Implementation Plan for the Research Activity of the Fondazione Bruno Kessler for the Year 2010

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Presentation

The purpose of this presentation is to outline the programme for 2010 of the Bruno Kessler Foundation, as part of the broader scientific programme defined by the Foundation for the 2009-2013 period. The Autonomous Province of Trento, in fact, is committed to financing the projects under the Framework Agreement, on a year by year basis, besides providing resources, on a more stable basis, for the future as well.

This partial Plan, therefore, has been drafted along the lines of the general plan presented to the Technical and Scientific Committee for Research and Innovation of the Autonomous Province of Trento, and previously approved by this board, and reflects the multiplicity of activities carried out at the FBK, by both its scientific and research support facilities, also including an *ad hoc* chapter on the planned strategic investments.

Compared to not very long ago, FBK's activities are now moving along three distinct – albeit closely related – lines of action. The first comprises the framework for the scientific and technological research, which is two-faceted.

On the one hand, in fact, is the development and strengthening of the scientific activities, *vis-à-vis* the typical competencies of the two MM and IT Centres, while on the other hand, and equally important, is the clearly highlighted forceful attempt to create a terrain where these two aspects can become embedded and, indeed, impregnate each other, in order to open up new perspectives and new opportunities, in respect of both research and the practical applications of the research. It is no accident that the scientific skills pursued and identified by the two Centres combine to describe an ambit of possible domains, which are already set to be transferred, as a result of the great successes reaped and offered by the researchers over the last year of repositioning of the FBK's strategic guidelines.

In particular, this plan is the outcome of an effort aimed at enhancing the structural and organic nature of the relationship between the two above mentioned system components, striving to accomplish the outline of this present framework, for the purpose of attempting to unify and valorise, as far as possible, the effort not just of the FBK, but of all the other system players as well.

With regard to the overall strategic guidelines that embody the future development of the FBK, we can single out and highlight a further two points identified as strategic, based on the letter of the establishing law, as well as on the opinions expressed by the competent organizations of the Autonomous Province of Trento, in connection with both their policy-setting and assessment activities. The reference here is to the issue of the relationship with the local communities and strengthening the internationalization approach. Significantly, both these aspects of a single proposition, from our point of view at least, permeate this entire document and become a cornerstone that can no longer be neglected.

On the contrary, as regards scientific programming, research in the humanities is still in a transitional phase, and has only recently started tackling change, having absorbed – as we shall more expediently see later on – the priorities set out in the agenda, such as the settlement of the “hilly” part of the FBK, which, it is a well known fact, employs about 80% of both the human and material resources made available.

According to us, this is a fundamentally significant transition process, because it is also related to the capacity to accomplish a synthesis, a viable convergence, between the very different fields of knowledge present in the FBK. It is our intention, in fact, to bridge this gap as soon as possible, by exploiting the projects and activities we have already launched, and the development of which is under way, as well as the interdisciplinary activities that the Centres have already started to plan, albeit in an experimental capacity.

The second part of this presentation addresses the new organizational and administrative structure introduced by the FBK. Clearly, the transformations under way can be measured here with respect to two differences, which are obvious even to a superficial observer, if compared with the proposed 2007-2008 Programme Agreement.

The first concerns the very concept on which the Foundation, as such, is grounded: a distinction can be made, in fact, between research support activities, the administration proper and the operation of the structures. Secondly, the systematic order is not an accidental one, but reflects the deep-rooted conviction that this sector of the FBK should be viewed as a support aimed at improving research and not as a counterparty intent on balancing the research work. Those of you who are acquainted with the dynamics at the origin of this Foundation will be able to grasp the effort underlying this transformation, and the potential thereof.

Observing the research support activities, we can see certain functions that had been strongly recommended by the oft cited assessment document.

First of all, on the issue of assessment, which has been implemented through the creation of an Office, which has set up the research database and is now engaged in developing a database of the publications. A first internal peer review has been scheduled for next autumn, with respect to the BIO sector, to start testing the efficiency of the system, with a view to implementing the proper self-assessment of the activities under way, which is a fundamental achievement for us.

Moreover, notice should also be taken of the creation of a Grant Office and Technology Transfer function, of the importance of which the Foundation had been aware for a long time now.

Lastly, an innovatory policy has been introduced aimed at both capitalizing on the human resources, and communicating to the outside world – and, therefore, to a much broader audience – a picture of the activities carried out by the Foundation.

But, beyond this specific reference or mention of this or that activity, we should also grasp the unitary effort of drawing a new horizon, within which to include the administrative frame work in a non-fragmented and more conscious fashion.

Furthermore, the fact cannot escape us that the extrapolation, from the overall framework of the 2009-2013 Programme Agreement, of a plan specifically dedicated to the investments, is an absolute first time. The Technical and Scientific Committee itself had already encouraged this, and we have attempted to implement it according to the framework outlined herein. It provides for investments in both machinery and instruments, as well as building construction and structural investments and, last but not least, those relating to new technological platforms.

The substantial fact that I would like to highlight here – with respect to the subject of investments – is the relationship between the FBK and the other players of the Trentino research and innovation system, which is the key focus of most of our considerations.

It should be clearly stated here that, with respect to this aspect as well, the work of concertation, especially with the University of Trento, has been particularly intense and convinced, on the structural level as well. The proposals tabled, in fact, are the result of mutual agreement, especially as regards the final organization of the scientific and technological research pole at Povo.

This is one of the crucial points on which I wish to close this brief presentation. Over the many years of the Foundation's history, there has never been a better moment (except, perhaps, at the beginning) for attempting to build a unique and unitary reality of the Trentino research system. The alignment under way with the University of Trento – of extreme importance, and symbolically forceful, by way of example only, is the conclusion of the single Agreement providing for the granting of 37 doctoral scholarships, assigned based on the real and mapped out needs of the research sector – is a key value that we are convincedly pursuing, also in partnership with the Fondazione Edmund Mach.

We are, in fact, convinced that this is the pathway that needs to be followed, to open a new phase in the world of Trentino research. It is no accident, in fact, that the President of the Autonomous Province of Trento has many times expressed the idea of developing a conceptually unique 2009-2013 Programme Agreement, based on the awareness of a specific derivation for each of the three players engaged in the system.

It is not up to us to judge whether this document properly and profoundly interprets this indication: one thing is certain, it is moving in accordance with this indication.

Its hope, and not just between the lines, is to be useful to the competent authorities who are responsible for setting the guidelines for the future, with the conviction of being able to interpret, in the near future, a unitary reference framework that can help qualify the Trentino system as an experimental spearhead, within the context of a national situation that is often lagging behind, with respect to the strong transformations under way in global research today.

The President of Fondazione Bruno Kessler

Prof. Andrea Zanotti

SCIENCE AND TECHNOLOGY

Introduction

In the changeover from ITC to FBK, the finalized steps have consisted in: the whole reorganization from research divisions to research units, the medium-long term strategic definition concerning the programs and the application domains, and in gaining on productivity following the strategic guidelines. The steps to be taken during the next years regard the consolidation aimed at pursuing the strategic objectives.

The 2010 scientific plan of the FBK-IRST Centers (the Information Technology Center, IT Center – and the Materials and Microsystems Center, MM Center) is devoted to this step and is in line with the 2009-2013 strategic plan, and keeps focusing on the three main research streams: “Future Internet (FI)”, “Embedded Intelligence & Systems (EI&S)”, and “Nano-Micro Technologies (NMT)”. Each research unit belonging to the FBK-IRST centers was meant to develop specific topics coherently to the strategies envisaged in the three main programs FI, EI&S, and NMT.

The 2010 plan aims at developing and consolidating the capabilities accomplished by the FBK-IRST centers in the past. This is pursued, on one side by creating new research units and, on the other side , by providing, , further opportunities for finding technological solutions useful in the everydays life.

Four new research units will start in 2010: “Biofunctional Surfaces and Interfaces” and “Silicon Radiation Sensors”, of the MM center, represent the natural evolution of the existing ones M2B2 and MEMS-RAD, while “Web of data” and “Security and trust”, of the IT Center, cover the competences of information retrieval and security, both pervasive in current challenges for information technology. The new units originate from the idea of focalizing the scientific and technological activities on the athwartship programs FI, EI&S, and NMT. The information security research, for instance, is transversal to both the FI and EI&S scientific research programs.

The aims of the new units are also coherent with the three domains of “Innovative Services”, “Energy & Environment” and “Life sciences”. The newly acquired EU projects and the agreements signed with private companies are consistent with this research view and with the objective of emphasizing the FBK-IRST incisiveness in the applicative fields. According to the 2009-2013 strategic plan, the 2010 scientific plan for the MM Center is, as in the past, strongly supported by the facilities of the micro- and nanofabrication (MTLab) and of the electron microscopy and electron and ion mass spectroscopy laboratories (MINALab). The Center IT programs pursue the idea of “living Labs” where innovative technologies are experimented in the territory, such as the experimentation of the “Personal Health Care Record” with a significant number of citizens, and the experimentation of mobile services for citizens and ambient assisted living technologies.

Many activities will be carried out in synergy with the local University: besides the well established PhD program, new initiatives are scheduled for the next year. It is

particularly worthy to mention the Interdisciplinary Laboratory of Computational Sciences (LISC), a joint project with the European Center of Theoretical Physics and the Physics Department of the University of Trento - aimed at creating a critical mass able to fulfill a center devoted to the computational aspects of materials sciences and engineering, molecular biology, quantum cromo dynamics, and nuclear physics. Also the neural-informatics activities (brain decoding and brain mapping) are conducted in collaboration with the local university, in particular with the Center for Mind/Brain Sciences (CiMeC), as well the activities in Bioinformatics are in collaboration with the University of Trento.

A fundamental step towards the internationalization is represented by the new director of Center MM, Dr Siddarth Saxena, who will take up his activity in Trento in January 2010. The wide number of relationships and the outstanding curriculum of Dr Saxena are important ingredients to provide a more and more extensive international visibility to Center MM and, as a consequence, to FBK.

The new Scientific Advisory Board of the IT center and the external strategic consultants of the MM center will provide advice and strategic suggestions to the FBK-IRST scientists in order to improve their academic excellence, to exploit their technical competences, and to bring out their organizational skills.

Details on the activities to be performed within each research unit are given in the sections that follow, where the description of the scientific objectives are detailed (financial data in the budget is under negotiation).

The Directors of CMM and CIT

ing. *Andrea Simoni* and ing. *Paolo Traverso*

CMM – Center for Materials and Microsystems

BIOMEMS – BIO MICROELECTRO-MECHANICAL SYSTEMS

Unit Name	BIOMEMS – Bio MicroElectro-Mechanical Systems	
Type	Research	
Head	Leandro Lorenzelli	
Staff	2009	2010
	9 Researchers	7 Researchers
	1 Technologist/Technician	1 Technologist
	0 Post Doc	0 Post Doc
	2 PhD	2 PhD

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1. Executive Summary

1.1. Objectives and main Activities

Starting from a background of expertises in microfabrication technology, Microsystems and biotechnology, the mission of the BioMEMS research unit is the development of Microsystems and microsensors in three main areas: i.) biomedical diagnostics, ii.) biotechnology and iii.) environmental safety and security.

In the biomedical area, the main task is the development of technologies for “Lab on a Chip” (LOC) for the large-scale analysis of genes and proteins functionality and for the in-vitro analysis of cells in medical diagnostics.

In the biotechnological area, the activity is mainly focused on the development of microsystems for the detection of specific indicators of the quality of agro-food products especially in the wine sector.

In the environmental safety and security area, the main task is the development of technologies for MEMS-based sensors for water and gas monitoring.

From the technological point of view, starting from a consolidated approach based on fabrication technologies for solid state-based devices, the vision is to extend the knowledge to the development and the realization of a technological platform for mass producible flexible and conformable smart systems. The sensors will be based on flexible polymeric materials fully compatible with both MEMS and IC processes. The issues related to the improvement of sensor interconnectivity and 3D surface conformability will be considered as a primary task in this activity. New methods will be explored for stretchable interconnections between devices and conditioning electronics circuitry between different modules.

The scientific program of the BioMEMS research unit is developed in the framework of the “Materials and Microsystems” area and it is included in two different

thematic areas of the PAT “Programma Pluriennale della Ricerca”: *i.) Nano-on-micro,* and *ii.) Bio-nano-technologies*.

The BioMEMS activities are aimed at basic and applied research activities, industrial research, technology transfer and training of young researcher.

1.2. Personnel

In a multidisciplinary approach, the competences required by the group span from physics to biology and biotechnology, from electronic to material engineering. In this aim, from January 2010, the BioMEMS research personnel will be composed by 6 researchers (2 Electronic Eng, 3 Material Science Eng., 1 Physician), 1 technician, 2 PhD Students (ICT – Biotechnology), and 1 junior researcher with short term contract for R&D activities in the framework of an already approved project. During the 2010, main attention points will mainly concern the assessment for a tenure track position and the involvement of post Doc researchers by means of specific EU research actions for researcher mobility (e.g. Marie Curie Actions). During the same period the BioMEMS research unit will host 1 foreign PhD student and graduate students for short term stages on nano-microtechnolgy.

1.3. Prominent collaborations

During 2010, the collaborations with the FBK Smart Optical Sensors and Interfaces (SOI) and New Materials and Analytical Methods for Biosensors and Bioelectronics (M2B2) Research Units will be maintained and improved in order to expand the synergic and strongly interdisciplinary research activities for the study and development of new microsystems and microsensors in the biomedical fields. Further collaborative actions will be activated with the Centre for Integrative Biology (CIBIO) of the University of Trento.

External collaborations with research centers and universities (e.g. Department of Electronics, University of Barcelona, Russian Research Center “Kurchatov Institute”, Scuola Superiore Sant’Anna – Pisa) will be focused to improve the technological issues inherent the main BIOMEMS scientific goals by introducing contributions in terms of complementary expertise and knowledge. Moreover, specific strategic networking actions will be undertaken with the University of Milano as a recognized reference point of research initiatives in the biomedical field

2. Vision and Scientific Program

2.1. Context and State of the Art

In this paragraph, some specific considerations concerning the technological aspects of the three considered application areas (biomedical, biotechnological, environmental) will be highlighted.

- *Microsystems for the biomedical area*

  a) Biomedical microsystems for *in vitro* analysis of cell cultures.

The development of new microsystems for *in vitro* cell culture analysis (Lab on a Cell, microelectrode arrays, micro-bioreactors) can provide real time information about the biochemical behaviour of a cell, when exposed to specific pharmacology treatments, and models to predict the toxicological effects at systemic level. New microsystems for cell analysis might be able to guarantee a real time control of the cell conditions not only in whole cell populations, but also for single cells. Moreover, in biomedical field there is a wide interest in the possibility to genetically handle single cells for gene therapy application. As a consequence, in the last years a strong interest has been focused on the fabrication of chips for electroporation and transfection, based on microelectrodes able to locally induce electric fields. Electroporation, compared to conventional transfection methods, has the advantage to be less invasive, since the induced cell membrane permeability is transitory and reversible. New microsystems have also been presented, using microfluidics to create trapping sites for cells and to guarantee a selective and local electroporation.

b) Biomedical microsystems for biomolecule detection through bioaffinity tests.

In the last years, many research activities have been dedicated to the study of chemical-biological sensors. Among different options, the most promising candidates for the future generation of sensors for bioaffinity tests are the systems based on microcantilevers (by means of surface stress or mass changes measurements) and using surface biofunctionalization technologies, able to perform high resolution and label-free measurements. Nowadays there is a big interest towards the fabrication of devices with thousands of integrated microcantilevers, as an alternative to the DNA microarrays and protein chip, since they can provide a high level of parallelism and real time, label-free detection of nucleotides hybridization, specific proteins and pathogenous elements. The strategy is to combine the high sensitivity of microcantilevers with respect to specific biomolecules with microfluidic structures to create sophisticated Lab on Chips (LOCs). Moreover, nanofabrication technologies can allow reaching sensitivity limit allowing the detection of single SNPs (Single nucleotide polymorphisms) in real time and the realisation of sophisticated and integrated systems for genomics and post genomics. The integration of the scientific areas cited above can be suitable for the design and fabrication of screening and diagnostic devices, which will have an impact on the health and welfare, and which are priority themes in the research guidelines of the European Community.

– *Microsystems for the biotechnological area*

In the last years, the biotechnological field has expressed an increasing interest for methods and instrumentations suitable for a widespread quality control of the products during the production and the distribution, from the raw material to the end users. Traditionally, the quality control is performed off-line by specialized analysis laboratories; consequently, the development of on-line systems and sensors is an important added value for the effective monitoring of the most significant chemical-physical parameters. The synergy between nano- and micro-technologies has demonstrated a great potential for the development of microsystems based on miniaturised chemical-physical sensors,

able to provide information useful for the quality control of the biotechnological processes. Advanced sensor techniques, as e-nose and e-tongue (electronic nose and tongue) using, for example, sensors coupled with biomolecular membranes, have strongly advanced in the last ten years. However, their success has been limited by issues such as a low lifetime and stability of biochemical components used as catalyst agents, the complexity of the chemical matrix in which the analytes must be detected and the presence of interfering substances. In order to reduce the interfering effects, MEMS technologies allow the miniaturisation and the integration of more sophisticated systems based on chemical separation (liquid-gas chromatography and electrophoretic methods) and on the sample pre-treatment. The combination of highly innovative technologies, devices and materials are fundamental for the development of multiparametric systems able to analyse liquid and gas mixtures and to discriminate the product quality. The dimension and cost reduction will allow a strong development of laboratory systems, in terms of performances and wide distribution. In perspective, these systems may substitute the expensive panel test and destructive laboratory analysis currently used.

– *Microsystems for the environmental security area*

  The main objective in the environmental security area is the development of knowledge and technologies needed to ensure the citizen security and to control and prevent risks coming from different society areas. Control of life quality in terms of environmental security requires the development of sophisticated, reproducible and reliable analysis systems. Advanced microsystems technologies have the capability to answer adequately to new requirements in the environmental security field. In this sector, the state of the art presents various technological approaches and methodologies able to measure the parameters of interest with high accuracy. Many sophisticated laboratory techniques (Thin Layer Chromatography, Ion Mobility Spectrometry, Gas Chromatography (GC), Electron Capture Detector (ECD), Thermal Energy Analyzer (TEA), Mass Spectrometer (MS), High Performance Liquid Chromatography (HPLC)) allow the measurement of target parameters; however, the complexity of the used systems, long measurement times and the sample pretreatment through expensive instrumentations often constitute a limit to the utilization of these techniques for the environmental control and security. The development of Microsystems in this field will allow a high integration level, fast response, low cost and widespread covering by means of both fixed stations wireless connected and portable systems with low power consumption. Microsystems based on miniaturised sensors can create new areas of application such as portable systems for on field measurement and for distributed monitoring architectures which have a high added value for environmental security with respect the already available technologies.

– *Emerging technologies for flexible sensors and systems*

  Electronic systems that can cover large areas on flexible substrates have received increasing attention in the last couple of decades. This type of electron-

ics sometimes referred to as macroelectronics, uses TFTs distributed over large areas. Thin devices possesses properties like compliance, flexibility, conformability, elasticity, lightweight, etc. for a wide range of applications such as tactile sensors, flexible displays, electronic paper, electronic skin etc. Here, the overall size of the systems rather than the minimum feature size of an individual circuit component represents the primary scaling metric. A variety of semiconductor materials ranging from amorphous silicon, to small molecule organics and polymers, to polycrystalline silicon, and other inorganics, to carbon nanotubes, have been explored for large area flexible electronics. Thin film transistors (TFTs) fabricated with a-Si:H represent, by far, the most successful systems for applications in large area electronics. Among organic semiconductor materials, two classes of materials, namely molecular compounds and polymers, have been used for flexible electronics. An emerging direction in research is to develop alternative materials and patterning techniques, with a goal of increasing performance, decreasing cost (per unit area), and enabling large area electronic systems to be formed on low cost, bendable substrates. Organic semiconductors are more studied for flexible electronic applications than some of the inorganic approaches (e.g. nanowires, nanocrystals). However, the modest performances demonstrated so far by organic semiconductors are limiting their range of applications. By contrast, many inorganic semiconductors exhibit high carrier mobilities and excellent stability. Concerning the BIOMEMS field, stretchable TFT circuits have also been reported for sensitive tactile sensors in smart skin applications. Recent advances in silicon based thin films makes it is possible to fabricate high performance, flexible and foldable integrated circuits. While some of the high-performance real-time robotic applications require to read signals from touch sensors at high speed, in other cases the speed may not be the key issue. Different technologies have their respective advantages and disadvantages. Thus merging different technologies can enable new possibilities for the skin system.

2.2. Vision and Goals

Innovative BioMEMS include the class of systems for diagnostics at cellular and molecular level, where the miniaturisation is generally considered the strategy to meet the requirements for efficient analysis and where further advances can be achieved by adopting a nano-microtechnological approach. In this aim, microsystems will provide essential interfaces between the macro world of human beings and the nano-world of molecules. The versatility offered by a multidisciplinary approach combining nano-microtechnology, nanomaterials and biology is the paradigm of a proposal for a BioMEMS research unit with high-tech content. The research on BioMEMS is aimed at the expansion of the synergic and strongly interdisciplinary research activities for the study and development of new microsystems and microsensors in the biomedical, biotechnological and environmental areas.

The fulfilment of this purpose is subordinated to the existence of collaborations with other Research Centers and University Departments with complementary expertises in fields such as materials science, nanotechnologies, biology and medical

diagnosis. With regard to knowledge transfer, we want to underline that the results of previous initiatives have already provided exploitation of results with SMEs and an increase of technological transfer activities is expected in the future.

In particular, the main research tasks are addressed to i.) biomedical, ii.) biotechnological, iii.) environmental safety and security, iv.) flexible sensors and systems areas. In details the main objectives will be:

- *Biomedical area main objectives*

  OB1: Development of innovative technologies for MEMS-based Lab-on-Chip (LOC) for gene and protein tests;

  OB2: Development of integrated systems for in-vitro cells assays.

  The BioMEMS research in the biomedical field is aimed at the study of microsystems devoted to four different classes of assays: MEMS-based microcantilever arrays for high throughput screens of gene (e.g. HLA - Human Leukocyte Antigens); protein assays using arrays of transparent microreactors coupled to an optical detection device; on-chip in-vitro tests of cells in medical diagnostics by means of electrically-actuated nanoporation approaches; on chip in-vitro drug screening tests for the treatment of osteoporosis using microfluidic mixers and gradient generators.

- *Biotechnological area main objectives*

  OB3: Development of integrated multiparametric probes for the monitoring of physical and chemical parameters in waters;

  OB4: Development of a Multisensor Portable Monitoring System (MPMS) for agrofood applications.

  The overall objective of the biotechnological tasks is the realization of different scenario-tailored multiparametric systems for quality monitoring and decision support in the food production chains (e.g. wine). The target of this research activity will be the fabrication and experimental validation of Multiparametric Portable Monitoring Systems (MPMS) conceived for water and fermentation monitoring (i.e. wine yeast analysis). Concerning the last issue, an integrated platform for high-throughput screening (HTS) of wine yeast strains will be realized in order to improve the overall quality and productivity of wine making process. Furthermore, a highly selective and miniaturized chemical separation module will be developed in order to provide a fingerprint of low volatile compounds inside wine-cellars for the quality assessment of oenological products during the fermentation process

- *Environmental safety and security area main objectives*

  OB5: Development of MEMS-based microsystems for environmental (indoor and outdoor) monitoring.

  In the safety and security area, the most appropriate technologies for the realisation low cost microsensors and microsystems will be investigated, aimed at gas monitoring (VOC-Volatile Organic Compounds, CH_4, CO, O_3, NO_x, H_2) in harsh environments (e.g. leakage monitoring of natural gas underwater pipeline) and for explosives (combined with pre-concentrators, solid state de-

tectors, nano-guide) and fire detection (e.g. for forest arson monitoring by means of wireless networks). In the considered period, technologies and approaches for the realisation of integrated energy harvesting modules based on thermoelectric materials and polymeric MEMS substrates will be investigated in order to guarantee the autonomous operation in distributed sensor networks.

– *Emerging technologies for flexible sensors and systems*

  OB6: Tactile sensing arrays on flexible silicon

  The goal is the development of tactile sensing modules and hence the skin for the humanoid robot, its integration with robot and subsequent use in the robot control loop for exploration and manipulation tasks. To this aim we will propose “smart” material films like piezoelectric polymers, as sensing element at the gate of a FET/TFT device for the implementation of touch sensors. A distribution of such devices over/into a flexible substrate will form the robot skin. Extensive experimental validation of the skin system and its suitability to various interaction, exploration and manipulation tasks will be performed on humanoid platforms.

2.3. Activities and Work Plan

In order to accomplish the scientific and technological main goals of the BioMEMS research unit, specific effort will be carried out through the considered activities. The first two activities are mainly focused on basic and applied research, while the third one, which is based on more consolidated technologies, is expected to provide also an effective technological transfer. These activities will run almost in-parallel, contributing to the overall goals of the scientific and technological research. Design, development, implementation and integration provide a logical sequence of keywords for the proposed research activities. At various phases of the tasks, validation procedures will be performed, ensuring that the implemented approach was successfully completed. As internal assessment approach, we will provide all the terms and methodologies to periodically validate and evaluate the individual steps, while experimental prototypes will be carried out at different stages of the objectives time-periods. The exploitation and dissemination of the results will constitute an additional activity for the whole duration of the research. All the activities concerning BIOMEMS research unit have been also included in the budget description and the percentage involvement of human resources has also been considered.

The description of the overall activity is analyzed according to the following work plan.

– *Innovative technologies for MEMS-based Lab-on-Chip (LOC) for gene and proteins tests.*

  Starting from the state-of-the-art in the literature, a suitable configuration for the LOC will be studied, in order to provide the handling of DNA samples, PCR amplification and HLA typing with a label-free approach based on a microcantilever array of appropriate size functionalised with oligonucleotide probes. The label-free detector will be realised with a microcantilever array

working in the bending mode (i.e. in the stress-detection mode), which is more suitable for operating in liquid phase. The technologies involved will deal with both ad hoc MEMS approaches for the realisation of thin suspended Silicon beams with tight thickness control, and the implementation of thin film cantilevers compatible with CMOS microelectronic processes. For what concerns protein tests, a fluorescent based detection approach will be followed. The aim is to realize an integrated MEMS-based microreactors array consisting of a matrix of transparent plugged wells realized on an opaque silicon substrate. The array will provide a number of reaction sites in the same chip that can be independently functionalized and monitored allowing for a fast and all-on chip analysis.

- *Integrated systems for in-vitro cells assays*

  The main goal of this task is the development of microsystems (Lab on Cell) for the study of the function of genes and proteins on in-vitro cell and more in general for monitoring the electrophysiological behaviour of a cell populations (e.g. neurons) after a bioelectronic or a biochemical stimulus. In the present approach, the microsystem will include MEMS-based cell-poration techniques, specific modules for cell handling and separation based on dielectrophoretic methods, high density microelectrode array for cell stimulation and electrophysiological signal recording, and microfluidics for cell transfection of specific biomarkers for the recognition of pathogen mutations. A very important aspect will concern the involvement of University of Milano. These collaborations will encompass a basic research for the study of nanostructured materials with specific morphological and reactivity surface properties aimed to improve the microsystems biocompatibility and to promote the cell growth and the synthesis of biomarkers. A second goal will be the realization of a microfluidic network for drug screening tests oriented to the treatment of osteoporosis. With this aim, in collaboration with the Politecnico di Milano, different solutions for MEMS-based drug gradient generation and mixing will be analysed and fabricated using polymeric material. Micro-bioreactors will be integrated in the chip in order to study the drug concentration effects on cell growth and differentiation.

- *Integrated multiparametric probes for the monitoring of physical and chemical parameters in waters*.

  This objective regards the study and realisation of multiparametric sensors for the monitoring of chemical-physical parameters (pH, ORP, conductivity, temperature, flow) for on-line monitoring of waters and biotechnological processes. Investigated detectors will include electrochemical sensors (Ion Sensitive Field Effect Transistors (ISFETs), integrated microelectrodes for amperometry and voltammetry) and physical sensors such as calorimetric flow sensors. Particular attention will be dedicated to the realisation of prototypes of integrated multiparametric probes for distributed system applications.

- *Multisensor Portable Monitoring System (MPMS) for agrofood applications*

  This activity will be devoted to the development of technologies for the realisation of integrated chemical separation modules and for the detection of indica-

tors of biotechnological parameters. Previous activities, regarding microfluidic modules for gas and liquid chromatographic separation, will be extended to the investigation of electrophoretic separation methods. The main application of this system will be the control of fermentation processes in the oenological field. In particular, components and portable systems with high integration level will be developed, in order to monitor on-line critical process parameters such as acetic acid and SO_2 in wine and organic acids (tartaric acid, malic acid and lactic acid) during the fermentation. Moreover, integrated multi-parametric microsensors (ISFETs, conductivity and temperature sensors) will be realized and experimental tested to monitor cell growth assays especially focused on yeast quality assessment for wine applications.

– *Microsystems for environmental gas detection*

  In the safety and security systems field, the main objective is to develop innovative systems for gas detection suitable for distributed sensor-based architectures.

  Starting from a consolidated technological platform for the realization of microheaters onto thin membranes (MEMS-based microhotplate), new technologies will be implemented to extend the potentialities of this class of sensors. In particular the improvement of these devices will be focused on the selectivity towards different gaseous species and on microsystems based on integrated pre-concentrators for the detection of volatile substances and high vapour pressure gases in the part per billion (ppb) range. The application of this research activity will concern both indoor and outdoor fields where the miniaturization is an essential advantage. In indoor applications, the attention is focused on the development of integrated sensors for the detection of dangerous emissions like NO_x, CO, SO_x, hydrocarbons. In outdoor applications the interest will be focused on the development of systems for the detection of different gases, such as H_2, in fire detection applications inside the forest and for the detection of nitro-derived compounds released by explosives. In addition, in order to enable the implementation of autonomous sensors nodes, activities related to the development of thermoelectric energy harvesting will deal with the study of polymers modified with opportune fillers for the realisation of thermally conductive substrates (hot junction), and of suspended structures for thermal insulation of cold junctions.

– *Tactile sensing arrays on flexible silicon*

  The activity will be focused on the study of a limited set of candidate transduction technologies for contact sensing; piezoelectric polymers, resistive, capacitive - being the most promising candidates for measuring geometric and mechanical quantities. The possibility of having transducers and conditioning electronics on same medium (or chip) will be explored as this will help to increase the signal to noise ratio and hence overall performance. Following this approach, each sensing device will have the transducer directly on a FET/TFT device, thereby reducing the length over which touch signal is transferred for further processing. Such a coupling of transducers (e.g. smart materials like piezoelectric polymers) with FET/TFT devices on rigid (e.g. silicon), or flexible

(e.g. elastomeric) substrates, would result in improved performance and would possibly reduce the number of connections, which is a major issue in robotics.

2.4. Collaborations

- Interdisciplinary Centre for Nanostructured Materials and Interfaces (CIMAINA), University of Milano, and Fondazione Filarete - Reference Person: Prof. Paolo Milani

  The collaboration with both the University of Milano and Fondazione Filarete will be strategic for 2010 BioMEMS activity for the high scientific contents in the nanobiotechnological fields for the possibility of networking actions. During the 2010, the collaboration will concern the implementation of nanostructured materials on polymers as substrate for biomedical devices.

- Laboratory of Biological Structure Mechanics – LaBS – Dept. of Structural Engineering Politecnico di Milano - Reference Person: Prof. Gabriele Dubini

  Development of microfluidic modules for drug gradient generation and mixing fabricated using polymeric material. Micro-bioreactors will be integrated in the chip in order to study the drug concentration effects on cell growth and differentiation.

- Scuola Superiore Sant'Anna – Pisa - Reference Person: Prof. A. Menciassi

  Modelling and development of microfluidic actuations modules (peristaltic micropumps and integrated valve for microfluidic handling) in lab on chip application.

- Italian Institute of Technology (IIT) and Dept. of Biophysical and Electronic Engineering – University of Genova.- Reference Person: Prof. G. Sandini, Prof. M. Valle.

  Development of innovative technologies for flexible tactile sensor array in robotic and haptic applications.

- CNR-IMM (sez. Lecce) and IMEM-CNR (Trento, Parma) - Reference Persons: Prof. Pietro Siciliano, Prof. S. Iannotta

  Development of integrated gas sensors and systems for quality monitoring in wine and characterization of SiC – based nanocomposite materials in biomedical field.

- Department of Electronics, University of Barcelona - Reference Person: Prof. A. R. Rodriguez.

  Innovative technologies for pressure-driven liquid chromatography fabricated directly from an unmodified cyclo olefin polymer.

- Russian Research Center "Kurchatov Institute", Institute of applied chemical physics, Moscow - Reference person: Prof. Alexey Vasiliv

  Deposition procedures of metal-oxides thik films on microhotplate-based gas microsensors for environmental applications and fire detection.

- Universidade Federal de Santa Catarina, Bairro Trindade – Florianópolis - SC – Brasil - Reference persons: Prof. Roberto Marchiori, prof. Andrè Pasa, Prof. A. Lago

  The collaboration with the University of Santa Caterina will mainly concern the following topics: a.) innovative technologies for carbon nanotubes deposition on microchip for both gas and biomedical applications; b.) Material study and development of technological approaches to magnetic-based microdevices; c.) Development of heath flow sensors based on miniaturized thermocouple integrated on silicon.

2.5. Specific Needs and Points of Attention

No specific needs in terms of acquisition of special equipment are required during the 2010. From the personnel point of view main attention points will concern the assessment for a tenure track position (within the December 2010) aimed to guarantee and to consolidate the internal group expertise on microfabrication technology.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
G1 Integrated systems for in-vitro cells assays	R	E	Dec.	Goal 100%: development and testing of the proposed devices	-
G2 Microreactors for gene and protein tests;	R	E	Dec.	Goal 50%: development and testing of the first prototypes in experimental conditions	-
G3 Multiparametric probes for the monitoring of physical and chemical parameters in waters	R	I	Sept.	Goal 100%: development and testing of the silicon chip	-
G4 Multisensor Portable Monitoring System (MPMS) for yeast analysis	R	I	Sept.	Goal 100%: development and testing of the proposed devices and results dissemination.	-
G5 Development of MEMS-based microsystems for gas monitoring	I	E	Dec.	Goal 100%: development of a technological platform for microhotplate for fire detectors.	-
G6 Tactile sensing arrays	R	E	Dec.	Goal 100%: development and characterization of a set of tactile sensors array for robotic applications	-

G7 Results dissemination	R	E	Sept.	Goal 100%: Organization of conference session for results dissemination of FBK research initiatives on nano-micro.	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	399.000
Travel	17.500
Equipment (HW/SW)	10.000
Other (e.g. subcontracting to external contractors)	193.700
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€620.200**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	124.748
Other external incomes (projects, grants, etc.)	201.562
Internal incomes (“subcontracted” by other units)	
Total Income	**€326.310**
Financial Need (Incomes – Expenditure)	**€293.890**
Required Structural funding from PAT (it should be equal to the previous item)	**€293.890**

5. Human Resources

From January 2010, the composition of the BioMEMS research personnel is: 6 researchers (2 Electronic Eng, 3 Material Science Eng., 1 Physician), 1 technician, 2 PhD Students (ICT – Biotechnology) and 1 junior researcher with short term contract for R&D activities in the framework of an already approved project. Thus, with respect the 2009, the overall BIOMEMS personnel situation will result almost unchanged. During the 2010, the following actions will be proposed:

Post Doc positions: In order to broaden the knowledge on specific sectors of interests (i.e. technologies for flexible sensors, innovative materials for sensors and microsystems), during the 2010 a policy aimed at the involvement in the BIOMEMS

research unit of post Doc researchers by means of specific EU research actions for researcher mobility (e.g. Marie Curie Actions) will be pursued.

Training and visiting researchers: During the same period the BioMEMS research unit will host 1 foreign PhD student and graduate students for short term stages on nano-microtechnolgy.

Tenure track position: Main attention points will concern the assessment for a tenure track position aimed to guarantee and to consolidate the internal group expertise on microfabrication technology.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Risk 1: Specifically for the biomedical device sector (DNA sensors), lack in the sensors reliability (e.g. low sensitivity and reproducibility).	M	S	Depending on the cause of the risk (technological or physical-chemical) contingency actions will be the improvement of the fabrication of technological steps and of the surfaces functionalisation procedures.
Risk 2: Lack at the system integration level of the proposed microsystems	L	L	Evaluation and investigation of all the aspects related to the system integration before the development of the optimized versions.
Risk 3: Lack of expertise in particular key sectors could emerge in case of changes in the BIOMEMS research staff.	M	S	Transfer of individual expertise and knowledge to other researchers. An accurate analysis of risks and deadlines for any project.

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

SOI – SMART OPTICAL SENSORS AND INTERFACES

Unit Name	SOI – Smart Optical Sensors and Interfaces	
Type	Applicative / Research	
Head	Lorenzo Gonzo	
Staff	2009	2010
	8 Researchers	8 Researchers
	5 Technologist	4 Technologist
	2 Post Doc	2 Post Doc
	3 PhD	2 PhD

Document Status submitted 2009-11-26

1. Executive Summary

The mission of the Smart Integrated Sensor and Interfaces - SOI Unit of FBK is devoted to the integration on silicon, by means of standard CMOS processes, of smart optical sensors and interfaces. Smartness in these microsystems is achieved by integrating on the same substrate, besides the detector elements, also electronic blocks which fully or partially processes locally the information provided by the detector itself. The main objectives of the Unit are those related to the design, fabrication test and system integration of complex sensors with particular focus on time resolved imagers, multispectral imagers, energy aware sensors and smart interfaces. A small activity on 3D modeling at different scale of resolution and details, which is somehow related to the optical sensing activity, is also part of the Units interests.

The work carried out during the life of the Unit (whose activity started in the 90ties), and especially that conducted in the last three to four years has been recognized by the international scientific community and has been the basis for a good number of funded projects both from the European FP6 and FP7 Programmes and from the local government (PAT). The main expertise build up by the Unit's researchers is in the of high sensitivity optical detector architectures which can be employed in different sensing device spanning from life science to ambient assisted living and from safety and security to cultural heritage preservation. Also the skills in designing smart interfaces, especially readout arrays for multispectral sensors, have an important role in the research activity of SOI, as well as the competences developed in the field of low power imaging sensors for wireless sensor networks. Most of these activities are driven both from scientific challenges as those set by the international funding agencies like the EU as well as from roadmaps set by the leading industries in the fields of Microsystems. Moreover the research activities of SOI

run along the lines dictated scientific strategic program of FBK for the period 2008-2013.

The Unit is composed by a staff of 18 highly motivated persons, 13 of them carrying out research in the fields mentioned above, while 5 are technologists supporting the research activity. Besides the professional skills in the design of integrated circuits, exhibited by SOI researchers, team working is one of the strengths of the group which allows it to perform well also under demanding conditions.

Due to the fact that most of sensors or interfaces, designed by SOI, connect the analog world to the digital domain of information processing, the Unit's activity lies within the overlap region between the two main research Centers of FBK: CMM and CIT. This allows the Unit to establish collaborations with Units of both Centers, as for example BIOMEMS, MEMS, ES, PMBE. Within the external collaborations it is worth to mention those with national universities and institutes working in the field of imaging and machine vision such as UNITN, UNIPV, POLIMI, CNR-IMM and CNR-INOA where projects and ideas are elaborated and put forward. At international level, strong collaborations have been started with CEA-LETI (F), BOSCH GmBH (D) and THALES (F) for the activity on multispectral imaging, and with CSEM (CH), EPFL (CH), STM (UK) University of Edinburgh for the activity on time resolved imaging

2. Vision and Scientific Program

Since ever the main activity of SOI has been focused on the integration of optical sensors on silicon, using standard micro-fabrication technologies such as CMOS. In 2007, when FBK took over ITC, the Unit's activity went straight into the new strategies of the Foundation contributing both to the *Nano and Micro Technologies – NMT* and to the *Embedded Intelligence and Systems - EIS* research programs, through the applicative domains on *Radiation Detector*, *Life science* and *Energy and Environment*. Within these contexts the focus of research has mainly been on advanced optical/vision sensors, energy aware sensors, smart integrated interfaces, and 3D modeling of the environment. All these activities have been carried out within funded projects and are the basis for the further and future development of the Unit's activities, which, as mentioned above fits with the FBK strategies but also with the directions of the Work Programmes set by the European Union in FP7 (2007-2013).

2.1. Context and State of the Art

The Strategic Research Agendas of the SOI international reference scientific communities, Photonics21 (www.photonics21.org) and EPOSS (www.smart-systems-integration.org), set the roadmaps for the development of integrated sensors for the next 5 years. SOI keeps pursuing its activity taking specifications for developed sensors from the above mentioned SRAs and at the same time keeps track of the requests coming from the local industrial community in order to develop knowledge

that might be useful or used for commercial exploitation, preferably by means of local SMEs.

In the domain of advanced optical/vision sensors, the activity is focused on *time resolved imaging sensors* and *multispectral imaging sensors*.

- **Time resolved imaging sensors**, when compared with traditional passive digital camera, offer great potential of improvement in many areas such as machine vision, where they are used to extract the distance information of the objects in the scene or in life sciences where investigation tools such as fluorescence-lifetime imaging microscopy (FLIM) allow the mapping of many cell parameters and the detection of pathologies or DNA sequencing.
- The SOI unit is involved within two European projects (under FP6 and FP7 respectively) where time-resolved imagers are developed. The MEGAFRAME project targets the design of a 128x128-pixel camera where each pixel contains a Single-Photon Avalanche Diode (SPAD) and a complex circuitry which can count the number of detected photons and measure their arrival time. This innovative sensor will be used coupled on a microscope for FLIM and FRET applications. The NETCARITY project which aims at the development of a low-cost 3D camera sensor for tracking elderly people within their home and detect situations of danger like falls or collapses. Within this project SOI conceived a new photo-detector, which allows the realization of time-resolved pixel having a pixel pitch of 10um only, representing the smallest pixel ever developed.
- **Multispectral imaging sensors**. Detection and generation of THz electromagnetic frequencies (300GHz-30THz) has become one of the challenges of these years: the peculiar properties of the electromagnetic radiation in the terahertz region makes it interesting in the field of security and surveillance, industrial production control, materials science, environment and biomedical sensing. Currently no practical THz imager exists. Some “millimeter waves” detectors have been developed in the region of 95GHz using heterodyne detection and antenna coupled bolometers. A sensor, although with a low sensitivity, has been demonstrated at 600GHz with only CMOS devices using oscillations of the electron plasma under the gate. Other devices suitable for imaging are built using quantum wells in expensive processes and materials and need cryogenic cooling. It is clear that there is a lack of a reliable and cost-effective THz detector suitable for imaging.
- The SOI Unit is involved in three projects where the detection of THz radiation is the main focus: IMATERA, an Euripides project aiming at the development of a 16x16 THz imager for security; MUTIVIS, a FP7 STREP project which will achieve a medium resolution multispectral detector with visible, infrared and terahertz detectors and spectroscopy capabilities; NAOMI, a large project of the Autonomous Province of Trento, which has an activity regarding the development of a single point THz detector for biological analysis. In these projects SOI is working together with big players like CEA-LETI (Grenoble, France), Thales (France), Bosch (Germany) who recognize the expertise and skills of SOI’s researchers in the integration on silicon of readout and processing electronics.

- **Energy aware sensors** are a big challenge in the implementation of the ICT program, above all for the topic regarding wireless sensor networks – WSN. The energy consumption of sensors nodes is a big constraint to the development and implementation of WSNs. Given that wireless data transmission between networks nodes is one of the biggest issues to be addressed in setting up a WSN, a possible approach to solve the problem is to process the signal at the sensing node and then transfer to the other nodes only high level coded information which requires lower bandwidth and thus lower electrical power.
- The activity of SOI in this field is quite new (started in 2008) and is mainly devoted on the development of very low power 2D vision systems which eventually could be used as a building block for WSNs in distributed security and safety monitoring systems. Although several implementations have been proposed for low-power CMOS vision sensors, currently the FBK sensor is the one exhibiting the best performance with 100µW max at 3.3V and 50fps. This is the first step toward the demonstration that vision technology is mature for energy-autonomous wireless sensor networks applications. In this sense, SOI started a new research project (BOViS), funded by a bilateral agreement between Israel and Italy for further investigating this topic. Furthermore, the activity on energy aware sensors is directly linked with FBK program on embedded intelligence and systems where WSN's are studied and implemented
- **Smart integrated interfaces**, are preferred over interfaces realized with standard off the shelf components whenever the integration and miniaturization of an electronic sensing systems has to be pushed to the limits of volume occupancy, reliability and customization. This is true in particular when the transducer, which is the front end of the sensor, is fabricated with a technology which does not allows the integration on the same substrate of both the sensing element and the reading and conditioning electronics, i.e. when CMOS compatibility is lacking. The smart integrated interfaces topic is particularly pushed in the SRA of the EPOSS technology platform where the paradigm *more-than-moore* pushes microsystem integration towards extreme miniaturization on one side and multifunctionality on the other.
- Although not being within the core activity of SOI, in the past three years works have been carried out with the support from funded projects such as MIDALCO, GOODFOOD and will be further supported in 2010 and 2011 from the project POCEMON. It is important to stress that the activity is conducted in strong contact with other Research Units of CMM, i.e. BIOMEMS and MEMSRAD, whose work on transducers is complemented and completed by the design of an integrated readout and conditioning electronics. And, as more and more transducers will be produced with non compatible CMOS processes, an increasing in the activity on this topic is expected. Even optical sensing could benefit from a smart interfaces when the radiation to be sensed is outside the sensitivity interval of silicon.
- **3D modeling of the environment.** Accurate and fotorealistic 3D models of either an object, a building or a landscape are requested in various applications such as virtual reality, cultural heritage, web 3D, land management and geomatics. The latter, which is the science of acquiring (*through sensors*),

processing, storing and delivering georeferenced geographical data has obtained a strong impulse from the advancement of new vision sensors and processing capabilities of desktop computers.

The SOI Unit has started working in this field back in 2002 in relation with the design of integrated sensors for high accuracy laser scanners to be employed in the preservation of cultural heritage. Since then the modeling activity has run in parallel with that on optical sensor design, giving important hints on for example requested sensor performances. Knowledge on the hardware development for 3D ranging systems as well as on 3D data processing has built up over the years and now the 3D modeling activity is on the verge of getting recognized as a standalone part of FBK lying in the middle of the Centers for Materials and Microsystems and Information Technologies. The intense dissemination and promotion activity conducted in the last two years, combined with the acquisition of a top researcher from abroad (ETH) and the participation to a funded project –APSAT- of the Autonomous Province of Trento has made the 3D modeling activity of FBK a reference point for the scientific community in the field.

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2.2. Vision and Goals

The roadmaps for contactless sensing set by scientific and industry panels and the increase of automation and remote monitoring applications let foresee an increase in the request of miniaturized, low power smart sensors, optical sensor are not an exception and will also follow the same trend.

The vision of SOI for the next three to five years is therefore that of consolidating its expertise and recognition level on integrated optical sensing, this approach is

also in agreement with what proposed by the scientific strategic planning of FBK (known as Accordo di Programma 2008-2013, *AdP2008-2013*) and supported by the Autonomous Province of Trento.

Concerning the *Time resolved imaging sensors*, the activity on the 3D imagers has produced excellent results and has contributed to advance the state of the art on these components. However, the NETCARITY project, which has partially funded the activity is planned to finish by the end of 2010 and, unless new projects are acquired, research on this topic will slow down. The technology developed so far could now enter a stage of market research for possible commercial exploitation; interests from companies like MESA Imaging, Siemens and OptoI have already been shown. IP protection/violation investigation should be carried out and, in parallel an activity of application driven system integration should be conducted.

The future challenges pursued by the scientific community in the field of time-resolved imagers are in the direction of increasing the number of pixels (megapixel sensor), solve the problem of background illumination and extend the dynamic range. The SOI Unit will explore new SPAD device structures and advanced pixel topology to realize a very compact pixel with in-pixel photon counting capability, which could potentially lead to the development of large SPAD array camera. In this context the on going project NETCARITY, NAOMI and LIVESENS will support the activity for the next one to two years. further two new proposals have been submitted to Call 5 of FP7 and are now under evaluation. The two proposals target applications in the biomedical imaging area.

On the front of *Multispectral imaging sensors*, the developments in the field of THz sensing will continue and follow different paths.

One will be to continue and strengthen the collaboration with our French partner CEA-LETI with the purpose of being recognized as reliable provider of readout circuits for their sensors with deep knowledge of the involved physical principles and technological constraints.

The other path will be to pursue an high-risk but high-pay off activity of investigation of alternative techniques which will enable FBK to take the lead in the development of THz sensors. This attempt will be made by exploiting solutions that will either foresee the use of the only CMOS technology for the sensing, and the exploitation of the FBK microfabrication capabilities.

At the same time, following also roadmaps given by the European technology platform Photonics21, developments will be aimed at achieving multispectral and multi-feature imaging sensors implementing on the same substrate different sensing technologies and different functionalities. Previous and current experience will allow to pursue the combination of X-ray, IR, visible, THz imaging, in passive or active, time-resolved and high-dynamic range sensors. Preferred fields of application for such sensors are the security, scientific, and biomedical environments.

*Energy aware sensors***.** Custom CMOS low power sensors need to be exploited through proper initiatives both, at research level and at application level. The main goal of BOViS project is exactly in this direction. Moreover, EnerViS, FP7 STREP project, which is now under evaluation, want to approach the same topic putting big emphasis on the power consumption of each component of the system.

Finally, a local initiative is going to be proposed aimed at integrating FBK low power technology with a interactive audio-guide for museum.

*Smart integrated interfaces. A*lthough it may be a promising field, the effort of SOI in this activity will maintain a low profile or eventually merge in the multispectral imaging sensors field. Nevertheless, the activity will still support requests coming from other Units within CMM. The project POCEMON, which should be re-started in January 2010, will be the main funding source of the activity for the next two years.

The *3D modeling of the environment* activity will start to move the focus on geomatics. At present, in fact, although at local level there are a few actors (both academics and industry) working on this field, there is a lack of competences and skills in pure geomatics capable of providing georeferenced 3D models at various working scale. This activity, if correctly implemented will be of support to offices of the local government responsible for managing and planning the development of the Trentino's territory. As mentioned in the previous section, the action of moving the scope towards geomatics would be explorative to the grounding of an standalone acitivity, with some bindings to the SOI Unit with respect to development of new optical sensing. In the next two years the 3D Modeling of the environment will be sustained by the APSAT and DITECH projects, while new project proposals are planned to be submitted in 2010.

2.3. Activities and Work Plan

In the year 2010 the activity of SOI will follow suit the planning set both from the ongoing projects and the AdP2008-2013. The internal activity will be focused more in the definition of a strategy which will allow to get the critical mass on topics in line with FBK strategic plan, while slowing down activities which might run out of scope.

Le research activity according to the ongoing projects will be the following:

- NETCARITY: two new devices will be designed fabricated and tested. The target is the fabrication of the 3D camera with the smallest pixel ever published. Issues as background subtraction and speed will be addressed in the architecture design.
- NAOMI: two devices will be designed, fabricated and tested for the time resolved imaging for proteomics applications. New architectures will be investigated in order to increase sensitivity and time resolution of the sensors. An architecture of an uncooled THz pixel detector will be designed and fabricated with the internal process; the readout electronics will be implemented and fabricated with a standard CMOS process.
- LIVESENS: characterization and system integration work for the linear array of SPADs fabricated in 2009. Although the project will finish by mid August 2009 the pertinent activity will continue within an internal project.
- MUTIVIS: the final ROIC for the multispectral VIS-IR-THz detector will be fabricated using a full wafer process. Successive testing of the devices will be carried out in collaboration with CEA-LETI.

- POCEMON: two devices will be designed aiming at the readout of the cantilever based detector array developed by the BIOMEMS Unit. The first device will contain different circuital topologies conceived to read very low signals on high backgrounds. Based on the best performing topology, the second device will implement an array of such readout channels and coupled to the cantilever based detector.
- ACUBE: a new version with increased sensitivity of an event driven digital camera will be designed fabricated and tested.
- BOViS: here a low power signal processing unit will be designed using standard components. The unit will be used to process data coming from low power event detection digital cameras which are developed in other projects.
- APSAT: full 3D modeling of an archaeological site located in Trentino at different levels of details will be realized. The location of the site will be decided with the Sopraintendenza ai Beni Monumentali of the Province of Trento.
- DITECH: the project will continue with the optimization of the 3D modeling approach of complex architecture using different sources of data (different sensors).
- ENERBUILD: here a method for aerial surveying of small municipalities aimed at defining the potential energy producing power through photovoltaic installations, will be investigated

2.4. Collaborations

Internal Collaborations

Institution	*Reference Person*	*Description*
BIOMEMS	Leandro Lorenzelli	Within the project POCEMON, the SOI Unit will be in charge of the design fabrication and test of an array of readout channels for the Design of a readout chip. Within the project NAOMI, the two Units will coordinate to develop an integrated fluorescence based proteomic device
MEMS	Benno Margesin	Within the project ESA MATRIX, SOI will contribute in integrating, at system level an electronic interface for readout and signal conditioning. Within the NAOMI project, the SOI unit will design the electronic interface for a the THz bolometer antenna
ES	Alessandro Cimatti	Within the ACUBE project, the SOI Unit will realize a wireless monitoring camera for behavioural pattern detection
PMBE	Cesare Furlanello	Within the project ENERBUILD, the SOI Unit will define a method for roof area and orientation estimation by means of aerial photogrammetry

External Collaborations

Institution	*Reference Person*	*Description*
TUM	Paolo Lugli	SOI will investigate new materials (organic) for multispectral imaging.
UNITN	Gianfranco Dalla Betta	SOI will investigate new architectures for hybrid CMOS and organic photodetectors.
UNITN	Lorenzo Pavesi	SOI will investigate the design of a detector for fluorescence detection in proteomcis. The reference project is NAOMI
UNIEDIN	Robert Henderson	Joint research activity on avalance photodiodes pixel in CMOS technologies
DELFT	Edoardo Charbon	Joint research activity on CMOS-SPAD detectors for fluorescence esperiments
MESA	Thierry Oddinger	Consulting activity on new deep submicron 3D camera
STM	Justin Richardson	Joint research activity on avalance photodiodes pixel in CMOS technologies with ST Microelectronics imaging process
CEA-LETI	Francois Simoens	Development of a multispectral sensor for security and safety. Reference project MUTIVIS and IMATERA
BOSCH GmBH	Michael Thiel	Development of a multispectral sensor for security and safety. Reference project MUTIVIS
THALES	Kim Pham	Development of a THz imager for security and safety. Reference project IMATERA
SIEMENS	Anton Schick	Investigation of applications for 3D imagers
Emza Visual Sense	Zeev Smilansky	With Emza Visual Sense, SOI is developing an ultra-low power wireless vision system for surveillance applications
Neuricam	Bruno Crespi	With Neuricam, SOI is developing an ultra-low power wireless vision system for surveillance applications
TUM	Larissa Vietzorreck	With TUM, SOI is developing an array of high voltage drivers for RF switch matrix
Alenia Spazio	Giovanni Mannocchi	With Alenia Spazio, SOI is developing an array of high voltage drivers for RF switch matrix
ETH & UNM	Armin Gruen and Jennifer von Schwerin	US NSF grant for the COPAN project (3D documentation of the Maya archaeological area in Honduras)
MTSN	Marco Avanzini	Continuation of dinosaur footprints surveying and 3D modeling
UNI-PV	Francesco Zucca	3 Cime di Lavaredo project
UNI-NCL & EH	John Mills	Heritage3D portal

2.5. Specific Needs and Points of Attention

Concerning the research activity, the Unit relies on state of the art software packages for the design and simulation and, on commercial foundries for the fabrication of the integrated devices, therefore no critical technical points exist. Furthermore, in 2009 the test labs, i.e. FUNLAB and LASERLAB have been renewed with larger

space allocation and new equipments; this allow for precise and accurate test procedures. However a specific need of the Unit is the buil-up of competences on *system integration*; these skills and knowledge is more and more required for the collaborative projects and is something that must be an in-house (in FBK) activity as is of paramount importance the tight work together between designers and system integrators.

Regarding the personnel, the Unit's strategy is that of having one or more key persons with permanent position for each step of the process of designing a sensor. This process will still take a couple of years and is hindered by the fact that training of a good analog designer takes at least one and half year depending from the starting expertise. The latter is worsened from the lack of electronics specifics degrees at the local University where most of FBK PhD students come from.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Fabrication and test of the final version of the 3D camera	R	E	Sept.	Working device	
Fabrication and test of the final ROIC for the multispectral sensor	R	E	June	Working device	
Fabrication and test of an low power event driven digital camera	R	E	Sept.	Working device	
Two publications of research results on journals	R	E	Dec.	Relevance of the Journal	
Acquisition of new projects	A	I	Dec.	Acquisition of grant	
Starting independent activity on 3D modeling	F	I	Sept.		

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	704.086,00
Travel	52.300,00
Equipment (HW/SW)	30.000.00
Other (e.g. subcontracting to external contractors)	442.600,00
Internal collaborations: "subcontracting" to other unit	

Total Expenditure	**€1.258.986.00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	340.000,00
Other external incomes (projects, grants, etc.)	416.220,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€756.220.00**
Financial Need (Incomes – Expenditure)	**€472.766,00**
Required Structural funding from PAT (it should be equal to the previous item)	472.766,00

5. Human Resources

As mentioned in section 2.5 the Unit’s strategy is to have key persons in the design process with permanent position and make use of some term positions and PhD students to contribute in carrying out the research activity. At present the Unit is composed by 8 researchers, 4 technicians, 2 Post Docs and 3 PhD students. Out of 8 researchers, 7 are from FBK and one from PAT; of them three are senior and 5 junior researchers, and 5 have a permanent position while 3 have a term position. Moreover there are two post docs (whose term contract expires on August 13, 2010), 4 technicians, of which 3 with contract position and one with permanent position (PAT), and 3 PhD students.

One more junior researcher of 5 mentioned above, will get a permanent position in 2010; this will fill the gap of the group in the activity related to testing and system integration. A two years tenure track, starting by September 2010, has been proposed for one of the Post Docs who will go to fill the gap for the step of transducers simulation.

6. Risks and Mitigation Plans

The activity of SOI is, per se, a risk free activity because it doesn’t relies on others contribution, except of course for the intrinsic risk of a research activity. However it has occurred in the past that, good trained researchers with term position having a key role in funded projects have left the Unit for a new job. This might have catastrophic consequences in the delivery of the project results especially for Units like SOI where the number of active projects is important.

Description	*Prob.*	*Impact*	*Contingency*
Researchers leave the Unit with warning time shorter than 6 months	M	H	Relying on good PhD students or post docs who can replace the researcher

Legend:

Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High

Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

MEMS – MicroElectroMechanicalSystems

Unit Name	MEMS – MicroElectroMechanicalSystems	
Type	Research	
Head	Benno Margesin	
Staff	2009	2010
	7 Researchers	9 Researchers
	0 Technologist	0 Technologist
	0 Post Doc	0 Post Doc
	2 PhD	3 PhD

Document Status submitted 2009-10-29

1. Executive Summary

The Research Unit MEMS has the mission to develop highly innovative sensors, actuators and electromechanic Microsystems (MEMS) for consumer and industrial applications and for basic research, using the in-house processing capabilities.

In the field of the MEMS devices the main objective is focused on the development of a technological platform for the fabrication of RF MEM switch based components as there are SPST and SPDT switches, phase shifter, bandpass filters, power divider and reflect array's.

In the next year a special attention will be paid to the reliability aspects of this technology and the 0-level packaging techniques for which the Unit will develop its own concept. In addition some effort will be made in exploring the possibility to employ this technology or a minor variant in the field of energy scavenging devices. The Unit will also augment its presence in the field of RF MEMS devices with the new activity on micromachined microwave filters. Other objectives in this sector are the study of bolometers for cryogenic temperatures and room temperature, mainly for the detection of THz radiation.

More in general the group has the objective to enforce his competences in designing and realizing microsensors and Microsystems. Therefore it intends to cooperate strongly with the SOI Unit in order to increase the system integration capability and to be able to build complete systems with a dedicated electronic interface that will augment the appeal of these products for the industrial market. To achieve this the Unit will also try to increase its capabilities in the field of 0-level packaging for RF switches and capacitive microphones.

Among the strategic objectives of the unit is to become a local, national end European reference point for the RF MEM switch technology. In case of the switch technology the Unit will continue to offer this technology platform as an external service in strong cooperation with OPTO-I (packaging) and the University of Perugia (electromagnetic design).

The so far developed experience by the Unit places its activity in the field of Materials and Microsystems, specifically in the field of Integrated Smart Systems and Sensors. Due to its expertise profile and scientific objectives the Research Unit has strong synergies with the research Units SOI.

Within CMM the MEMS Unit has the characteristic of a Research Unit whose activity is mainly devoted to applied research 65%) in the above mentioned fields, with some extensions in basic research (20%) and service for the industry (15%).

The actual staff of MEMS numbers to 7 researchers. In particular there are three permanent positions, one R1, one R1 and one PAT, three to term (RII, RIII, RIV) and one collaborator position (CoCoPro). For one position to term the extension of the contract is necessary as well as the consideration for a tenure track. For the next time an increase of two units is foreseen, one as a replacement for a lost position and one new acquisition on the MEMS2 project. The composition of the staff is already quite balanced and covers well the design, mechanical modelling, process development and control and the characterization. In With one of the new personnel acquisitions also the RF competences will be improved.

The major collaborations of the Unit are with the Universities of Perugia and Padova respectively for RF MEM design and reliability assessment, with IMEC for the development of the 0-level packaging technology, TAS-I for the development of space components, TAS-F and TUD for the development of reflect array antennas and University La Sapienza for the development of MKID bolometers.

2. Vision and Scientific Program

Since the establishment of the MEMSRaD Unit in 2007 the MEMS related activities have been focalized on the study and the development of a few selected device typologies that are at the same time of high interest to the industry or the basic research and challenging to make. The later aspect was and is considered important in order to exploit and extend the knowledge of the group. Last but not least the use of the in house fabrication technology is considered as another key strategic element that gives the activity an potential advantage with respect to competing institutions.

The activity of the last two years essentially confirm this approach even if in detail some changes and rebalancing of the activity of the group has been necessary.

2.1. Context and State of the Art

The MEMS Unit has mainly three distinct research lines: RF MEMS, capacitive microphones and bolometers, both cryogenic and room temperature.

The activity on RF MEMS originates from the development of low loss passive RF components on dielectric membranes within an INCO COPERNICUS Project MEMSWAVE. Starting from 2001 a much more complex development of a technology platform for RF MEM switches was started, first within an ESA contract on MEM Switches as a subcontractor of Alcatel Alenia Space, now Thales Alenia Space, and then within the NoE AMICOM project. From the beginning the primary objective was the development of an versatile technology platform for the fabrication of passive components, wide band micro switches and microwave and millimeter wave circuits for telecommunication, ground and satellite based and wireless applications. Within AMICOM the group developed successfully switches, tunable filters, phase shifters and reflect array antennas for 66 GHz and was able to provide the FBK technology plat for as a service for over 12 national and European research institutions. In addition in the last years the group has also worked on specific projects with distinguished institutions and industries mainly on the development of phase shifters.

In this field the group is currently involved in two ESA projects and two FP7 STREP projects. The first ESA project on 'Very Large Order Switch Matrices using MEMS Technology' aims at the realization of a 16x16 switching matrix for RF signals. In 2009 the group has realized the basic 2x2 switch matrixes that are now assembled by TAS-I in a final 16x16 matrix. For this activity the SOI group is providing the control circuits for the switch matrixes. The purpose of the second ESA project on 'High Reliability MEMS Redundancy Switch', with FBK in the role of prime contractor, is the development of an reliable redundancy switch for satellite applications with an expected life time of 10+ years. The project is in the first phase. For the reliability study 120+ device geometries have been designed. Two batches of 25 wafers each with 8 process variants has been recently completed and the devices undergo in this moment the selection process for the reliability study.

The first STREP project ARASCOM has the purpose to develop three demonstrators of reconfigurable reflect array antennas. This is one of the emerging fields for RF MEMS. These antennas are the low cost version of the much more complex phase array antennas, with potential applications in from ground and airborne telecommunication and obstacle detection. FBK is involved in the realization of an 77GHz reflect array and in the development of a hybride technology combining MEMS switches with Liquid Crystal based switches. At the moment the first passive prototypes are under fabrication.

The STREP project MEMSPACK is dedicated to the study of the packaging aspects of RF MEMS switches. This is one of the most critical issues for RF MEM switches. FBK is involved in providing the base technology on which different packaging concepts will be tested. In addition FBK will contribute in the mechanical study of the packaged devices and the development of microsensors suitable to measure the parameters relevant to the quality of the package. After an exhaustive design phase recently the first sensor chips have been completed and shipped to the partners.

All four projects will contribute in the next two years to enhance the FBK technology for RF MEM switches, one of very few available in Europe that allow the monolithic integration of different types of switches with passive elements as well.

Very recently a third ESA project on the development of Microwave Micromachined filters has been awarded. Also in this project FBK is the technology provider, but in this case a completely new technology has to be developed that include not only the bulk micromachining but also wafer to wafer bonding and conductive through wafer via's.

Together with the RF MEMS the silicon microphones are two of the three most fast growing markets of MEMS components. In the segment of the cellular phones they are quickly substituting the traditional microphones, due to their intrinsic robustness, degree of miniaturization and compatibility with automatic assembling techniques.

The activity at FBK on silicon microphones started within an commitment of STMicroelectronics. This allowed to develop a base process for microphones. With this process in the last two years a series of prototype microphones has been developed that have been included in different smart Microsystems. At the moment the activity in this field is marginal due to the lack of opportunities to participate in projects. Also for this type of devices the SOI group was involved in the development of specific interface electronic circuits.

The research and development on bolometers in FBK dates back in the early nineties The activity originates from the development of cryogenic type bolometers of the implanted silicon type. Within a few years it was possible to develop and optimize devices suitable for basic research, in particular for the measurement of the mass of the electron anti-neutrino. This, more than ten year effort is now dedicated to the realization of an large experiment (over 200 detectors). In recent years a new type of cryogenic bolometer has been also investigated. These kinetic inductance detectors, based on superconducting materials (niobium, aluminum) are potentially a good candidate for future large detector arrays, coupled to antennas for the detection of RF and THz radiation, that will be employed for the next generation satellites dedicated to CMB radiation polarization studies. At the moment two fabrication runs of these devices have been completed with success. It was possible to demonstrate the possibility to build these devices in aluminum on silicon and Safire substrates. In this context FBK has the opportunity to be among the few institution to be able to build these devices. In the next year this activity will grow due to the MEMS2 project with INFN.

In the last year also the development of uncooled bolometers started within the NA0MI project. After a first phase dedicated to modeling and design a layout has been prepared and a suitable process schedule has been devised.

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2.2. Vision and Goals

Within the next years the focus of the research activity will remain on the above mentioned research topics.

RF MEMS - The main goal for the next two years is still the stabilization of the technology. In addition two main aspects of the technology will be addressed: reliability and packaging. The first aspect regards the development of suitable process improvements but also design improvements that will allow to push the reliability of the devices at the level requested for space applications and other critical telecommunication applications. The development of reliable switching units within the ESA project REDUNDANCY will be a first goal for the next year. A second very important goal for this technology is the development of a suitable on wafer packaging technology, a prerequisite for the final industrialization of the technology and there introduction in demanding applications (space, airborne and ground telecommunication). One of the outcomes of the MEMSPACK project will be a better insight on the packaging approaches that will allow FBK to develop his one concept. For the next year first concept developments both for thin film capping and wafer capping with vertical feedthrough will be developed.

Other medium term objectives are the construction of a 16x16 switching matrix and the fabrication of subarrays for a reflectarray for 77GHz.

In addition in this field the unit will start a new activity on microwave filters, a key element for many RF systems. First goals in this area will be the demonstration of the wafer to wafer bonding and the fabrication of conductive wafer through via's, both synergic with one of the packaging concepts mentioned above.

Finally next year some effort will be devoted to the exploration of the possibility to employ this technology or a minor variant of it in the development of energy scavenging devices.

MICROPHONES – As stated above the development of the technology has been successful. Also this technology can benefit from the capping technology mentioned above. More in general in the next year the goal will be to see if the technology can be offered both to industry and for research purposes.

BOLOMETERS – In this area for the next years there are essentially two goals. One regards the complete development of the technology for MKID detectors. This will be performed within MEMS2 and in strong collaboration with basic research groups active in Cosmic Microvawe Background experiments and neutrino mass experiments. An intermediate goal will be the realization of MIKDs and there integration with suitable antennas for the microwave and millimetre radiation.

The second goal in this area is the development of sensible uncooled antenna coupled bolometers for THz detection. This goal is pursuit within the NAoMI project. A first result will be the realization and characterization of the prototype bolometers designed to test and develop the technology and in general the concept.

2.3. Activities and Work Plan

The activities and work planning of the group follows tightly the planning of the individual projects. In addition internal activities for further development of the technologies and test of new ideas/approaches are foreseen.

Within the ongoing contracts, we have fixed plans for 13 batches of wafers for the next year, all with custom design. In addition six extra batches are planned for internal developments.

In the the work flow is organized in three major areas: design and modelling, process development and control and characterization.

The specific activities planned for the different projects and internal developments for the next year are:

STREP ARASCOM: first prototype run for array elements and development of a cap for the MEM devices.

STREP MEMSPACK: second run of test structures for the characterization of the 0-level packages and a first run of teststructures with resonating structures for the measurement of the athmosphere in the package and the stress/strain exerted on the packaged devices by the cap.

ESA MATRIX: second run of basic matrix elements.

ESA REDUNDANCY: closure of phase one of the project, start of the long term tests on the most promising switching units, fabrication of the redundancy unit.

ESA MIGNON: development of the wafer bonding process, development of the conductive wafer through via, first prototypes of the filter elements.

CONAE09: delivery of a batch of MEM switches.

OPTEL: fabrication of the third batch of devices.

FMIS: realization of a batch of MEM switches developed for the switching of the antennas for the fire monitor sensor.

Thin film wafer capping: fabrication of the first technology test vehicles. Definition of the potentiality of this approach.

Wafer capping with vertical feed throughs: realization of the first wafer cap prototypes (in synergy with ESA MIGNON that needs the same technology capabilities)

NAoMI: realization of the first prototypes for the validation of the concept. In addition with a slightly different technology also Photo Conductive antennas will be realized.

MEMS2: development of the MKID technology. First prototypes with microwave antennas will be developed.

2.4. Collaborations

Internal collaborations

Research Unit	*Reference Person*	*Description*
MT-Lab	PL. Bellutti	All the research activity performed by the Unit is done using the Microtechnology Lab either by using existing technologies or by developing new ones. In the next year this collaboration will extend to the wafer bonding activity and the advanced packaging facility.
SOI	M. Gottardi	The SOI Unit develops the electronic interfaces for some of the devices. In particular within ESA MATRICI they are developing the driving unit and software for the matrix
PAM-SE	N. Bensaada	Compositional studies of the metal alloys employed in the switch process are studied with the help of the microanalysis facility of PAM

External collaborations

Research Unit	*Reference Person*	*Description*
Uni Perugia	Prof. R. Sorrentino	Uni PG is our partner in most of the projects on RF MEMS where they provide the electromagnetic design and the test capabilities.
SELEX SI	M. Dispenza	In ARASCOM we are developing the packaging of the reflect arrays
TAS-F	G. Caile	In ARASCOM we are developing together the reflect array
TUD	Prof. H. Jacobi	In ARASCOM we are developing the hybride technology for RF MEMS and LC MEMS
IMEC	H. Tilmans	In MEMSPACK we are cooperating on the 0-level packaging of RF MEMS
MEMSTC	S. Bouwstra	Within MEMSPACK we are cooperating on the mechanical modelling
IEMN	Prof. P. Roland	Within MEMSPACK we are working on the 0-level packaging
VTT	T. Heikilae	Within MEMSPACK we are developing the 1-level packaging with LTCC

ISIT	C. Hut	Within MEMSPACK we are working together on test structures for the characterization of packaged MEMS
TAS-I	G. Mannocchi	Within ESA MATRIX and ESA Redundancy we are developing the packaging with LTCC for space applications
CNR-IMM	R. Marcelli	Within ESA MATRIX and ESA Redundancy the CNR is characterizing our RF switches
TUM	Prof. L. Vietzorreck	Within ESA MATRIX and ESA Redundancy TUM is cooperating for the system design of the devices
TUM	Prof. G. Schrag	We are cooperating with TUM on the mechanical characterization of RF MEMS
Uni Padova	Prof. G. Meneghesso	Within ESA Redundancy a strong collaborstion with Padova exists on the reliability aspects of the RF MEM technology
CONAE	Prof. A. Lamagna	RF MEM phase shifter
Lehigh Univ.	Prof. J. Hwang	On RF MEMS Reliability within the broad stage of one of the PhD students (10 months)
OPTO-I	A. Maglione	Witin ESA Redundancy we are developing a low cost package for RF MEMS and for FMIS we are providing the technology for the RF detector for forest fires
OPTEL	G. Melone	Complex RF circuits and devices
SELEC Comms	I. Pomona	6 bit phase shifters for phase array antennas
Uni Tn	Prof. L. Pavesi	We are cooperating with UniTn on the development of uncooled Bolometers
Uni Bicocca	Prof. E. Fiorini	KID detectors and implanted silicon bolometers for the neutrino mass detection
CNRS-NEEL	A. Monfardini	KID detectors for use in astrophysics
La Sapienza	Prof. P. DeBernardis	KID detectors for CMB experiments
Uni Como	Prof. A. Giuliani	KID detectors and implanted silicon bolometers for the neutrino mass detection

2.5. Specific Needs and Points of Attention

For the activity of the next year the MEMS Unit has specific needs in two areas, personnel and technical support. For the activity of the Unit it is essential not only to maintain the actual level of employment simply in term of person-months but also to maintain the persons itself due to their specific knowledge not easily and quickly replaceable. In this regard attention has to be paid on two contracts that are expiring.

Regarding the technical aspects the Unit needs strong and constant support from the MT-Lab. Any temporary stop of the clean room or part of its machinery are deleterious for the timing of the projects of the Unit. In addition for the augmented volume of fabrication requested we strongly recommend the acquisition of a dedicated plating unit for the gold deposition (a crucial step for the RF MEM fabrication). Over more the new projects of the Unit require the possibility of the wafer bonding that will be operative in the new expansion area of the clean room. The availability

of this new area and the new equipment (wafer bonder and flipchip aligner) are therefor determinant for the start of the new activity.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Reliable Unit switch	R	E	April		
MW filter elemts	R	E	July		Wafer bonder
Wafer cap	R	E	Oct.		Wafer bonder
Thin film cap	R	E	June		
Uncooled bolometer	R	E	Sept.		
KID detector	R	E	Oct.		

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	543.860,00
Travel	37.850,00
Equipment (HW/SW)	24.000,00
Other (e.g. subcontracting to external contractors)	273.281,00
Internal collaborations: “subcontracting” to other unit	0,00
Total Expenditure	**€878.991,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	197.128,00
Other external incomes (projects, grants, etc.)	289.683,00
Internal incomes (“subcontracted” by other units)	€0,00
Total Income	**€486.811,00**
Financial Need (Incomes – Expenditure)	**€392.180,00**
Required Structural funding from PAT (it should be equal to the previous item)	392.181,00

5. Human Resources

The actual staff of the MEMS Unit numbers to 6 researchers. In particular there are three permanent positions: one R1, one R2 and one PAT, three to term (RII, RIII, RIV) and one collaborator position (CoCoPro). For the actual activities the Unit is therefore clearly under staffed.

The core team of the Unit consists in 3 expert researchers, two of which are senior. The team is complemented with researchers with a term contract on specific research projects. The composition is an interdisciplinary mix that covers essentially all needs of the Unit. The experience is generally high to very high. The team is particularly strong in all process and technology related aspects and the mechanical modelling. There exists a small gap regarding the RF competences, covered at the moment only by one person and an PhD student, but the next Year one of the persons joining the group will enforce this aspect.

At to the activity of the Unit contribute also three PhD students, which help in exploring new topics of high scientific relevance while working at their thesis.

For the next year two new positions are foreseen, one (RIV) substituting an position lost in 2008 and a new one on the MEMS2 project.

To keep the operating capability three positions to term will have to be extended. In one case the tenure track has to be considered due to the good performance of the person.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Contract extensions	L	M	Acquisition and training of new persons
Equipment down time	L	H	Out sourcing, delay
Delay in the availability of the CR extension area	M	S	Project delay

Legend:

Prob. VL = Very Low, L = Low, M = Medium, H = High, VH = Very High

Impact is one of: N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

MiNALab – Micro Nano Analytical Laboratory

Unit Name	MiNALab – Micro Nano Analytical Laboratory	
Type	Research	
Head	Massimo Bersani	
Staff	2009	2010
	11 Researchers (+7 Biosint)	11 Researchers
	1 Technologist	2 Technologists
	0 Post Doc	2 Post Doc (2 proposals submitted)
	0 PhD	1 PhD (proposal submitted)

Document Status submitted 2009-11-06

1. Executive Summary

Aim of the research unit is to develop and apply surface science analytical techniques and methodologies to fully characterize both inorganic and soft materials at micro and nano scale. A further core activity involves the set up of a common analytical platform at Trentino level.

The unit pursues three mains objectives:

- realize and manage an analytical infrastructure being able to group equipment and competences present in FBK. In this way it will be possible to start a facility able to attract and link other resources and competences present on the local territory. Hence in the medium term a technological platform for material analysis integrating inter-institute facilities will be constituted.
- Develop a research activity in some areas of surface science in order to improve the analytical methodologies and capabilities, set up networking and external collaboration; support the research activity of the other internal research units; push the analytical equipment improvement
- Support industries needing material characterization or involved in analytical equipment production through consulting service or innovation actions.

The main research topics are in the fields of: Micro-nanoelectronics; materials for energy; biomaterials;

The competences present in the unit are:

Analytical expertise. It comes from the historical mission and development of the group which has allowed to establish an important analytical infrastructure with a strong and diffuse expertise able to show the value and impact of research in surface science at a level of excellence

The experience acquired in the development of methodologies and all the experimental work carried out with the available techniques allowed to obtain a relevant competence on instrumentation development. A strong link with the world of analytical equipment producers, a constant update on analytical needs and solutions, specific expertise on ultra high vacuum project-design and software development complete the scenario in this field.

Data mining. This competence based on statistic multivariate methods was acquired and increased in the last five years. It allows to integrate the analytical result and to obtain a more complete interpretation in particular on complex system. The effects are highlighted by a specific increase of publication quality and an extension of our analytical application fields.

Accreditation and quality management. This competence closely connected to analytical activity and industrial relationships allows to obtain the accreditation following the norm UNI/ISO 17025.

The activity of the unit is strongly linked with the analytical equipment and therefore upgrades and new acquisitions are of crucial importance to maintain the state of art in the highly competitive and fast developing field of surface science characterization; however the real asset of the unit is the personnel, which is the unique and irreplaceable source of competence described above.

At this moment all the researchers involved in the unit have an experience of five years or longer. The number of researchers is dimensioned on the time needed to organize, manage and maintain the instrument infrastructure as well as to carry out research and technological activities.

Currently the Unit counts 11 researchers, 5 of them with a permanent position. One of them decided to move to PAT, his choice will become effective in 2010. Among the remaining 6 researchers, 2 have a tenure track position. Their tenure achievement is planned for 2010. For at least two other researchers a tenure track needs to be scheduled. Differently, the consequent lost of deep knowledge and specialized expertise will greatly penalize the Unit, nullifying de facto its long term investment.

The technical support to the Unit research activities is currently provided by a single technician, who takes charge of all the daily laboratory support activities and of the ordinary equipment maintenance.

The actions to be taken in the next year include:

- the two tenure achievements
- the implementation of a plan of career progression for researchers distinguishing themselves for their special commitment and working load.

It is necessary to acquire and form new instrument technicians. Those not yet present positions are necessary to ensure a suitable analytical service and to manage an analytical infrastructure in a configuration of open access to internal and external researchers.

Several collaborations characterize MiNALab research. Due to the nature itself devoted of analytical work the Unit activity relies very much on internal and external collaboration able to provide samples and complement MiNaLab expertise and capabilities. Collaborations are active in different fields: research, innovation and service activity. An extended list with a brief description is reported in paragraph 1.4.

2. Vision and Scientific Program

2.1 Context and State of the Art

The activity on surface characterization allowed to gather and maintain in FBK a set of state of art analytical instruments run by highly qualified personnel with technical and scientific expertise. This expertise at the moment is present in the M2B2 Research Unit. In following table the surface analytical instruments operating in the M2B2 Unit are reported.

Table 1: *Instrumentation present in M2B2 Unit*

Acronym	*Definition/description*	*Model*	*Provider*
SIMS	Dynamic Secondary Ion Mass Spectrometry	IMS WF/SC ULTRA	CAMECA
ToF-SIMS	Time of Flight Secondary Ion Mass Spectrometry	ToF-SIMS IV	Ion-Tof
XPS	X-Ray Photoelectron Spectroscopy	ESCA 200	SCIENTA
SEM	Scanning Electron Microscopy	JSM-7401F	Jeol
AFM	Atomic Force Microscopy	Solver Uni (P47)	Nt-mdt
AFM	Atomic Force Microscopy	Solver P47H	Nt-mdt
TXRF	Total Reflection X-Ray Fluorescence	TXRF 8010W	Atomika Instruments
Furnace	RTP Annealer	As-Micro	Annealsys
Profilmeter	Mechanical Profilmeter	P-6	KLA-Tencor

By means of these various techniques it is possible to investigate physic-chemical, topographical and morphological properties of surfaces and to correlate these with material properties.

The high level of analytical skills allowed to establish several international collaborations and receive funds for EU projects focused on characterization materials and analytical methodology development. In the table, the projects obtained in the last years are reported.

Table 2: *European project obtained in the last years*

Project	*Coordinator*	*Partners*	*Start/duration*	*FBK-Budget*
ILSIMS SEA; FP5	STM, Crolles	SIMENS, Lucent, Samsung, ITC-irst	1/9/2000; 18 months	36.440 €
IMPULSE IST; FP5	CNR-IMM	ESRF; ITC-irst; Univ. of Salford; AMD	1/12/2001; 36 months	132.887 €
ANNA I3; FP6	FBK-irst	12 partners	1/12/2006 48 months	1M €
ATHENIS; STREP; FP7	Austria Microsystems	Cavendish Kinetics; FBK; Univ. Wien; MASER; Valeo; Univ. Ferrara	1/1/2008; 36 months	100.000 €

From the analytical and methodological point of view, the previous described surface analytical instruments were used to study the following materials and related applicative/scientific issues:

- main activities topics are related to micro- and nanoelectronics; in particular, ultrashallow junctions, high-k and low-k films, nanocrystals, organic and inorganic contaminations, innovative substrates, and applications of new thermal processes have been the focus of different researches in this area
- at the same time, effort was devoted to explore new fields of material science, achieving evaluable results; organic materials for electronics and solar application, analyses related to environmental impact, food chemistry, thin film functional coating, nano-and biomaterials.

Currently, major publications and collaborations come from activities related to the microelectronics area. Nevertheless evaluable and very promising results were also obtained in the other previous listed fields.

In the last three years strategic actions were carried out to combine the consolidated research activities with new capabilities. The goal was to guarantee new impulse to the unit, also extending its field of competence. This expertise is focused on:

- development and application of machine learning techniques to exploit the multivariate nature of produced experimental data. Number and impact factor of related publications continuously increased in the considerate period.
- study, design and realization of new analytical instruments. The main result in this activity field has been obtained with a company start up devoted to X-ray diffraction instrument manufacturing.
- improvement of the laboratory management and the offer for the external service and support, introducing quality management. In 2009 the accreditation with the norm UNI-ISO 17025 hase been obtained.

2.2. Vision and Goals

The midterm strategy is structured in two main points:

Realization of a unique and common technological platform for the analytical facilities at Trentino level able to contribute effectively to the research in different fields of material science and to further develop the metrological and analytical skills. The expected impacts of this activity can be summarized as follows:

- Improvement of the local research on material science by a unique support on characterization
- Stronger interconnection and link between the different research groups
- Larger usability of the analytical instruments
- Improve quality of the service
- Define a common strategy on analytical infrastructure development to obtain a state of art facility
- Focus the investment in a more effective way
- Save management and maintenance costs
- Create a reference centre for metrological and analytical aspects

  To obtain an analytical platform with characteristics of real excellence a 3-5 years strategic development plan has to be discussed, finalised and financially supported. Other key points are an appropriate human resource strategy and a quality management system of the facility.

The second point is related to the activity of the Unit devoted to develop analytical methodology and to tackle unsolved characterization problems. In this case the overall objective is to obtain in new application fields the same results and visibility obtained during the past years in the microelectronics area. To obtain these results all the researchers of the Unit will be involved to collaborate in synergic and multidisciplinary way, with their specific expertises. The main promising topics are related to biomaterials, food chemistry and material for energy. The multidisciplinary characteristics of these research fields also strongly required to collaborate with other FBK research Units and with external research groups. The partner network will be therefore extended. To further pursue these research activities, the support of young scientists is strong recommended. Therefore, actions will be taken to offer PhD positions able to effective integrate the new scientific contributions into unit and its specific research activities, also to complete with different expertise the composite knowledge of the Unit.

2.3. Activities and Work Plan

The work will be organized following the hereinafter described activities:

1) Actions for analytical technology platforms realization;

This activity is focused to realize and manage an analytical infrastructure being able to group equipment and competences present in FBK. In this way it will be

possible to start a facility able to attract and link other resources and competences present on the local territory

This year is devoted to tackle and solve all problems and requirements emerging in:

- planning and implementing an effective management of the analytical infrastructure. This task involves the definition, testing and implementation of a set of procedures, supported by an ad hoc designed software, defined for the whole infrastructure management, the instrumentation monitoring and maintenance, the instrumentation access, the tutoring of new users;
- ensuring a rationale and effective organization of machine time distribution, in order to maximize the instrumental up-time and the number of users;
- inferring from the access statistics of the year useful information for future upgrade strategies, to be planned starting from this year.

2) Characterization of materials for nanoelectronic devices;

The downscaling of electronic devices has brought the transition from microelectronics to nano-electronics. To tackle the related technological challenges, the microelectronics industry faces the need for fast development of new processes and materials. Actual technological bottlenecks for next generation transistors.are the realisation of highly activated ultra shallow dopant distributions and new gate insulator materials (high-k materials). In the activities of the Unit, the ultra low energy SIMS (ULE-SIMS), other available surface analysis techniques and analytical instrumentation provided by established collaborations (such as synchrotron radiation laboratories) are combined to carry out accurate analysis and 'state-of-art' studies of the mechanisms lying behind the processes for solving such problems. Samples will be supplied by specific industrial demands or by important collaboration networks (e.g. ANNA). Other case samples will be internally provided by FBK Units.

This is the most developed and advanced activity of the Unit, giving the main contribution to the overall obtained results. Current collaborations and active projects will allow to maintain an international state of the art research program in one of the most competitive and advanced fields of technology. Specific objectives for the year 2010 are:

- To maintain the same excellence level of the research of previous years
- To improve the international network analytical activity
- To extend the analytical methodological approach to close scientific area (optoeletronic; inorganic material for solar cell)
- To extend the research activity on new material aiming at substituting silicon devices
- To submit new projects and promote collaboration at international level

3) Effort increase for the characterization and data analysis in food chemistry, archeometry, and biomaterials fields;

The activity in the food chemistry field will be characterized by a collaboration with the CEFSA-CNR of Trento, and will be focused on a complete methodological approach to find chemical fingerprints for sensory characteristics of different foods. The approach will exploit the realization of a new PTR mass spectrometer, (see next point) and the application of multivariate analysis techniques to maximize the information extraction from complex data obtained from this new instrument. On the same time, data mining on measurements coming from the currently in use PTRMS will continue. Further objectives will be the extension of the collaboration network and the submission of at least one dedicated project.

The archeometry activity will be conducted in collaboration with the faculty of Engineering of the University of Trento. It will be focused on metallurgic analyses on prehistoric samples coming from the Trentino Alps. One research proposal was submitted to PAT (Marie Curie Actions- COFUND-"Trentino" project - call for team research project proposal)

The biomaterial analysis and characterization are intended as part of multidisciplinary research investigations, requiring strong collaborations with biological and biomedical groups. Therefore they will benefit from interactions with the Biosint Unit of FBK, as concerns inner activities, and the University of Verona and its partners, as concerns external activities.

4) Focus on innovative analytical equipment design and implementation;

This point comprises three different activities:

- designing and implementing an upgraded PTR-mass spectrometer, with respect to that currently present in the CEFSA-CNR laboratory, to improve its resolution and sensibility. This new instrument will be used for food chemistry investigations.
- development of X-ray diffraction and fluorescence equipments in collaboration with TNX. In the 2008 a new company (TNX) have been started up by M2B2 initiative. FBK personnel is directly involved with the company activity to develop and design innovative equipment. In the next year the collaboration will be improved by the beginning of a financed project, the presentation of a new financed proposal on combined diffraction/fluorescence equipment, and a patent on a new goniometric system
- final evaluation of new ion source system partially developed in the 2007/2008
- formal collaboration with Ketek will involve the testing of a new drift solid state detector system for X-ray spectroscopy. The company will provide an innovative equipment that will be tested on a commercial equipment (TXRF) available at FBK and on the instrumentation developed in collaboration with TNX.

5) Support and involvement in industrial research initiatives, services;

In this framework, the acquired resources joined with the experience and knowledge gained from the project activities as above described are finalized in order to offer a high quality external analytical service. Particularly, the access to developed methodologies and micro-analytical experience as well as the use of the laborato-

ries and the know-how relative to biomaterial investigations are offered. The main reasons for the service offering can be summarized as follows: 1) To benefit funding; 2) To help on a scientific and technological level Trentino, and the national economy and society; 3) To enrich researcher's expertise, to increase researcher's visibility and satisfaction.

6) Definition of an educational plan, outlining of the typical research activities and expertise of the Unit

To strengthen the link to local territory, this Unit will organize, in collaboration with the Communication Area, some guided tours to the instrumental platform. These occasions are intended as educational events to be offered principally to the local scholastic community. Therefore part of the activity will be dedicated to elaborate presentations ad hoc developed and calibrated for different audiences.

2.4. Collaborations

For sake of simplicity the collaboration list can be divided in three typology:

Internal to FBK:

- Biosint, Cecilia Pederzolli, analytical characterization of functionalized surfaces in biomaterials investigations as support to activity research of Biosint Unit, in particular related to finalized project. The principal involved techniques are: XPS, SEM;, AFM. Concerning the analytical technological platform, Biosint people could in prospective have direct access to instrumentation.
- Advanced Photonics and Photovoltaic (APP), Georg Pucker, a collaboration is planned on photovoltaic material and optoelectronic material. Both Unit take part to European and to other financed projects.
- Computational Physics (CTP) Maurizio Dapor, a collaboration focused on the simulation of electronic properties for material investigations has been proposed.
- Analytical support and services will be also provided to any other internal Unit that will request analysis

Research Institutes

- University of verona, Francesca Monti, FT-IR analysis for food chemistry and biomedicine. The Unit contribute is focused on the application of advanced statistical techniques to maximize the information extraction from FT-IR dataset. This experimental equipment can also provide complementary information in physical-chemical characterization carried out in the Unit.
- CEFSA-CNR of Trento, Andrea Boschetti, development of new analytical instrumentation and application of multivariate data analysis techniques for mass spectrometry analysis in food chemistry.
- CNR of Parma, Salvatore Iannotta, physical and chemical surface characterization of new material for solar energy cell production (funded by DAFNE CARITRO project);

- Collaborations linked to microelectronic research: PTB, synchrotron beam line, Berlin, Buckhard Beckhoff; CNR-IMM, Bologna, Roberto Balboni; Atom Institut, ATI, Wien, Cristina Streli; IMEL Institute, Athens, Androula Nassiopulo; Fraunhofer Institut, IISB, Erlangen, Andreas Nutsch and Peter Pichler; MFA Institute, Peter Petrik; University of Salford, Jaap van den Berg; University of Surrey, Karen Kirby; University of Patras, Spiros Ladas; Seton Hall university, Mehmet Sahiner;Dublin City University DCU, Dublin, Patrick McNally; University of Newcastle, UK, Nick Cowen.

  Several European projects and other financed collaboration on microelectronic topics support these collaborations.
- University of Trento, Stefano Gialannella, common platform development for archeometric research.
- Fondazione Edmund Mach, Elena Gottardini, pollen characterization for environmental studies.
- Università di Roma “La Sapienza”, Antonio Polimeni, optoelectronics materials;
- Maryland University, Gary Rubloff, research activity focused on nanomaterial analysis by spatial resolved approach and combinatorial methodology
- Stanford Synchrotron Radiation Light Source, CA, Piero Pianetta, application and development of EXFS analysis on nanomaterials

Companies and Industrial partners:

- TNX, Povo Trento, Paolo Marconi, Start up in collaboration with FBK to manufacturing analytical equipment based on X-ray (diffraction and fluorescence)
- Numonyx, Agrate, Marialuisa Polignano, involved in ANNA EU Project
- MEMC Novara, Gabriella Borionetti, involved in ANNA EU Project
- INTEL Ireland, Alan Corcoran, involved in ANNA EU Project
- AustriaMicrosystem, Graz, Schrems Martin, involved in Athenis EU Project
- Plasticlogic, Cambridge, Patrick Too, service activity to production support on organic material
- MEMC Merano, Roberto Scala, service activity to production support on silicon wafers
- Applied Materials, AMAT, Santa Clara CA, Majeed Foad, research collaboration on innovative Annealing process for USJ formation
- Ketek, Munich, Sigfried Tehlke, company devoted to x-ray products, the collaboration is focused on test new detector system on our instrumentation

2.5. Specific Needs and Points of Attention

Infrastructure investment: some focused investments from a strategic fund (not included in the budget Unit) are necessary and have to be planned in the early part of the year. Any delay will have a relevant negative effect on the Unit activity.

Strategic plan: a three years detailed strategic plan to set up and organize the analytical technology plan has to be discussed and shared with other Units, approved by FBK management and agreed upon as priority.

Personnel: several appropriate figures for working in the MiNALab infrastructure are already present in FBK. It is however necessary to acquire and form new instrument technicians. These position are currently not present. Their are necessary to manage the instruments in the open access configuration, ensuring more in general an on-going support for any analytical services.

Budget: cost of maintenance, management, and running of infrastructure will be considered on a dedicated cost centre.

Support: Dedicated software for the infrastructure management is required as well as support of SIT. A software related to Quality Management will be provided within the framework of an external project.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Analytical technology platform development: starting year of a longer term realization plan	R,I	E,I	1 year	Determination of the instrument cost (10% of the goal) Structuring the organization management (30%) Management software realization (20%) Increase of the instrument use time (20%) Increase of the user number (20%)	To achieve this goal avoiding delays all the points of attention described in 1.5 need to be carried out.
Characterization of materials for nanoelectronic devices;	R	E	1 year	Presentation of new projects at European level. Dedicated publications	
Analytical methodologies consolidation on new application fields	R	E	Oct.	Results in following fields: Food chemistry Organic material for solar application nanoimaging	To consolidate and extend the collaborations
Start up of two industrial research projects (“legge 6”)	I, A	E	Jan.		Projects are to be approved (feedback in 2009)
Submission of new industrial research project	I, A	E	Sept.	At least one project at local or national level	
Publication and presentation @ congress	R	E	Dec.	Same rate of publications and communications obtained in the last	

				2 years	
First year accreditation confirmation	F	I	May		
Design and realization of new experimental analytical instrumentation	R,I	I,E	Sept.	Development of PTR mass spectrometer in collaboration with CNR (30% of the goal) Collaboration with TNX (40%) New source for ion production test and final assessment (10%) Test and application of Ketek detector (20%)	Infrastructure investments are necessary to obtain some of the listed goals, as described in 1.5,.
Patent in partnership with TNX on equipment development	I	I,E	Apr.		
Self financing; incoming	O	I	Dec.	At least 40 % of self financing is expected	It is essential not to consider the Infrastructure management cost in the Unit internal budget
Dissemination and education activities	I, O	E	1 year	Stage; on site presentation; focused lessons	

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	761.749,00
Travel	52.800,00
Equipment and maintenance (HW/SW)	14.000,00
Other (e.g. subcontracting to external contractors) 197.000	313.600,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€1.142.149,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	374.275,00
Other external incomes (projects, grants, etc.)	125.215,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€499.490,00**
Financial Need (Incomes – Expenditure)	**€642.659,00**
Required Structural funding from PAT (it should be equal to the previous item)	642.659,00

5. Human Resources

Currently the Unit counts 11 researchers, 5 of them with a permanent position. One of them decided to move to PAT, his choice will become effective in 2010. Among the remaining 6 researchers, 2 have a tenure track position. Their tenure achievement is planned for 2010. For at least two other researchers a tenure track needs to be scheduled. Differently, the consequent lost of deep knowledge and specialized expertise will greatly penalize the Unit, nullifying de facto its long term investment.

The technical support to the Unit research activities is currently provided by a single technician, who takes charge of all the daily laboratory support activities and of the ordinary equipment maintenance.

The actions to be taken in the next year include:

- the two tenure achievements
- he implementation of a plan of career progression for researchers distinguishing themselves for their special commitment and working load.

The current personnel's experience of the Unit is as follows:

Five senior researchers (Unit Responsible included) with more than 15 years of experience. Four of them have experience in the field of analytical technique applications and development, and in metrology area, one has the PhD degree and is expert of data mining and simulation. Their employment contracts are:: four permanent positions (1 FBK contract, 3 PAT contract) and one non-tenure track position.

Five researchers with more than 8 years of experience, two of them have the PhD degree and obtained in the past a Post PhD position financed by PAT. Two of them have a permanent position, two are in tenure track positions.

Two young researchers with less than 5 years of experience.

One technician with more than 15 years of experience in a permanent position. He is dedicated to infrastructure maintenance and support activities. Tenure track positions:

Giancarlo Pepponi: Degree in Physic University of Trento, June 1999, (110/110 with honor); PhD degree at the University of Technology, Vienna, January 2003. Post-Doc position:3 years contract financed by PAT. From 2006 he has a research position. Refereed publications: more than 40.

Current rule: Member of the management team, he closely workswith the coordinator of the EC project ANNA (FP6 - Integrated Infrastructure Initiative).ANNA, European Integrated Activity of Excellence and Networking for Nano and Micro- Electronics Analysis, aims at setting-up a distributed analytical laboratory with competences in microelectronics and nanotechnology. He is also the responsible for X-Ray fluorescence and X-Ray absorption applied to surface science, microelectronics and nanotechnology related topics. The tenure track conclusion is planned in 2010.

Erica Iacob: Degree in Physic University of Trento March 2000. CoCoCo position from 2000 to 2001. From 2002 she has a research position. Refereed publications: more than 25. Current position *Responsible* for AFM microscopy applied to surface science and for mechanical profiler, Operator for XPS instrumentation; Responsible of the quality system management on Standard UNI CEI EN ISO/IEC 17025. The tenure track conclusion is planned in 2010.

It is necessary to acquire and form new instrument technicians. These position are currently not present. Their are necessary to manage the instruments in the open access configuration, ensuring more in general an on-going support for any analytical services. PhD positions will be offered to increase the research productivity of the Unit.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Unavailability of a strategic medium term investment plan. Extra Unit budget is necessary to maintain and improve the analytical infrastructure. It is a fundamental step to set up a common technological platform for nano material characterization	Low	Severe	The main Unit goal will not be not reached. Delays in the implementation of the plan could have a strong impact on expected objectives. No effective alternative solutions have been identified..
The expected self financing contribution is not achieved. Main cause could be related to ANNA incoming (in particular the Transnational Access activity is not easily estimated)	Low	Medium	FBK reference persons to monitor the risk are Giancarlo Pepponi and Marco Filippozzi
Maintenance cost exceeding due to analytical equipment ageing	Medium	Low	A non relevant difference in terms of total amount is expected with respect to the planned budget. Solution: cut other costs.
Publication level decrement	Medium	Medium	

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

PAM-SE – PLASMA, ADVANCED MATERIALS AND SURFACE ENGINEERING

Unit Name	PAM-SE – Plasma, Advanced Materials and Surface Engineering	
Type	Research	
Head	Nadhira Bensaada Laidani	
Staff	2009	2010
	4 Researchers	3 Researchers
	2 Technologist	1 Technologist
	1 Research Technician	1 Research fellowship
	1 Technician	1 Research Technician
	2 PhD	1 Maintenance Technician
		4 PhD
		1 Research fellowship on project

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1. Executive Summary

Scientific research

The PAM-SE group competences, centered mainly on the synthesis and characterization of advanced materials (hard coatings, dielectrics, transparent materials, nano-composites and nano-laminates) have led in the past year to new prospects for a pluri-annual research activity based on the production of materials able to be used for alternative energy (photovoltaic) applications.

The research activity in this field tend towards the synthesis of innovative materials such as transparent conductive oxides (TCO) as well as towards the exploration of new strategies for photovoltaic cells efficiency improvement. On the latter subject, the group is engaged in widening the range of solar radiation frequencies which can be exploited by photovoltaic systems, carrying on a research work which will fully take advantage of the PAM-SE's former experience in the study of nano-composites and nano-laminate materials.

Another sector of the Unit research activity regards surface engineering, through functionalization and manipulation of nanostructures like nanolaminates, metal nano-clusters, carbon nano-structures such as carbon nanotubes and similar. These structures can be integrated with macroscopic materials to achieve higher performances applicable in innovative photovoltaic cells and innovative biosensors. The PAM-SE unit is engaged in the investigation of the photo-luminescence of CNT and CNT-hybrid materials.

Industrial research

Scientific and technological support will be given to private local and national companies for new materials development, in the frame of industrial contracts either already existing (Prysmian, Milan) or in course of negotiation (Zuani, Rovereto). Furthermore, facilities and expertises exist within the PAM-SE group in the field of material characterization and provide not only support to internal research projects, but also to local, national and international research institutions as well as private companies (like the Environment Park of Turin).

Education

PAM-SE Unit places a particular attention in education and formation of young researchers. 2 Ph.D candidates will continue their second year doctoral work, co-directed by PAM-SE Unit and Trento University (Physics Department), while 2 more candidates, from P. & M. Curie University (UPMC) of Paris, will join the Unit for Ph.D theses co-directed by PAM-SE Unit. The Unit will also entertain secondary school students (Centro Moda Canossa, Trento) for introduction to advanced textiles treatment processes.

Staff members

10 people : 4 researchers (1 FBK senior Res.II and head of the Unit, 1 PAT senior Res.II, 1 FBK Res. III, 1 junior researcher with “co.co.pro.” contract, 1 researcher fellowship owner (2 years), 1 Technologist, 1 research Technician (Db second level) and 1 maintenance Technician (Db), 2Ph.D students. Two more Ph.D students from UPMC will join PAM-SE for co-directed theses. A Tecnologist of the staff , with a contract valid till october 2010, is expected to be stabilized next year in his position. A tenure track has been asked for him. An annual fellowship on Nanosmart project will be available.

Most significant collaborations

(1) MT-Lab and APP unit, FBK: collaborations in the research filed of materials for photovoltaics, in the frame of common projects (PV and Oxi-Solar); (2) University of Trento, Physics and Engineering department for Nanosmart PAT project and (3) CNR- section of Trento; (4) University P.&M. Curie of Paris, France and (5) Institut des Nanosciences of Paris (INSP), France, for PV and Oxi-Solar projects; (6) Nice University and (7) Ecole des Mines of Nice, for collaboration in the field of transparent oxides for energy applications.

2. Vision and Scientific Program

2.1. Vision and Goals

The research program of PAM-SE globally responds to well defined objectives toward the innovation in the photovolatic industry and starts from the development of innovative materials. Subsequently the more important specific objectives of the research program for the photovoltaic sector:

- synthesis of new materials for the down-conversion of the UV-blue fraction of the solar spectrum.

- development of new conductive transparent oxides with processes at low temperature on flexible organic substrates and glasses.
- achievement of a meaningful increase of a c-Si solar efficiency by means of the use of photon converter materials.

The research on the materials will include:

(1) materials for the photon management with the purpose to exploit the more possible the available energy in the solar spectrum by widening the interval of the usable frequencies. We will use the principle of down-conversion of the radiation UV that is based on the use of materials with different structures and adequately doped to confer them a function of down-conversion (matrices of oxides doped with rare earths).

(2) materials used as transparent electrodes for the transport of the photo-produced electric charges. In existing photovoltaics, it is typically ITO that is used, the latter necessitates however deposition temperatures that are deleterious for the stability of the junctions or of the organic materials of the cell. The project foresees the synthesis of new oxides transparent conductors, more abundant and susceptible to be deposited at low temperature. New methods of material synthesis are needed, as the Atomic Layer Deposition (ALD), able to produce film at low temperature on organic (polymers) substrates.

Activity with longer term than next year regards:

- the integration of the down-converter in a cell of silicon and the further transfer of the process to an organic cell on flexible substrate.
- the synthesis of TCO with the technique of ALD to obtain films with high conductivity and coating conformality.
- optimization of the interface properties between silicon substrate and the TCOs and between organic substrate and TCOs produced with ALD and ALD assisted by plasma.
- Integration of the TCOs produced with the different methods on the solar cells in silicon implemented with photon down-converter material and on organic cells.

The originality of the objectives of this program will allow a scientific progress and an added value of high technological importance touching some important sectors in the photovoltaic research. Results of excellence can also be reached and exploit internal collaborations with the laboratory of micro-fabrication MtLab that has a long experience in the realization of devices in silicon and with the unity APP that develops its research on cells with organic materials.

Other important goals of our research are those related to surface engineering activities. The ability to synthesize and characterize materials of different natures is even more important for the development of appealing devices from the technological point of view. In this respect the PAM-SE unit has made a big investment in the development of instruments, plasma reactors to deposit specific thin films or for surface functionalization and for material characterization. This trend in the latest years was integrated with the acquisition to synthesize and manipulate nanostructured materials. This opens important perspectives since nowadays nanotechnolo-

gy is a common factor to all the research fields. Future trend will be the investigation of new nanostructures (graphene and other C nanostructures) and their integration with materials to obtain composite materials with advanced performances applicable for fabrication of sensors for environmental, health and biological purposes. Nanostructures are at the basis of the possibility to perform “nanoscopy” using non-invasive technologies that, if applied to bio-sector, preserve the physiological functions of living microorganisms.

2.2. Activities and Work Plan

The planned activity for 2010 will focus on the study of the growth process and mechanism in low pressure plasma for TCO thin films synthesis, for photon down-converter films based on rare-earth doped oxides and for surface treatment and engineering. An optimisation of the electrical and optical properties of the materials will be undertaken, as well as the development of reliable optical and electrical characterization procedures. In the case of TCO, the study will be applied to ZnO-based transparent conductive oxydes, along with an exploration of the conductive properties of TiO_2 and doped TiO_2 films. Interface properties will be examined, from both a chemical and electronic point of view, in systems composed by the oxyde-based film and crystalline silicon substrate, as well as interface between films of oxide and amorphous Si or a-Si(H).

The activity planned for year 2010 in the frame of projects is summarized as follows:

- Oxi-Solar project (Caritro Foundation funding): Development of oxide-based materials for photon conversion for photovoltaics

1- development of thin films of TiO2 and Y2O3 doped with a rare earth for processes of down-shifting assisted by luminescence.

2- exploration of the synthesis of thin films of TiO2 co-doped with couples of efficient rare earths for processes of down-conversion.

3- Optical and structural characterization of the films synthesized for the down-shifting and down conversion

- Nanosmart project (PAT funding)

1- gold nanoparticles (NP) synthesis,

2- functionalized NP coating

3- study by means of electron spectroscopy analysis of NP chemical stability and drug delivery, both aspects being related to tasks of other partners of the project and requiring deep characterizations.

- Prysmian contract

1- plasma treatment for a surface modification of Prysmian steel and characterization for the surface properties (wettability towards polar/non-polar compounds, roughness).

2- oxide and carbide films deposition on steel

3- structural characterization for abrasion resistance properties.

4- lab lests of adhesion and wear and friction properties of steel.

5- industrial tests.

2.3. Collaborations

The research collaborations which the Unit established so far and which it intends to care about in the future cover mainly:

(1) *internal collaborations***:** the skill to develop and characterize innovative materials may be the main road leading to synergistic crossovers with the research of other FBK units. The PAM-SE unit will collaborate with MTLab (Pierluiggi Belluti) and APP group (Georg Pucker).

(2) integrated characterizations

- for film defect structures with Trento University, Positron Lab (Prof. Roberto S. Brusa), related to PV and Oxi-Solar projects. Positron Anihilation Spectroscopy will be very useful to investigate film defects and defect structure and chemistry.
- for structural, optical and electronic properties with CNR section of Trento (Dr. Maurizio Ferrari) and with Nice University, France (Dr. Pierre Cheyssac) and Ecole des Mines de Paris (Prof. Evelyne Darque-Ceretti).

(3) joint studies of synthesis technology of selected material classes like transparent oxyde-based films with

- «Institut des Nanosciences de Paris » and CNRS, France (Dr. Jacques Perrière)
- Pierre & Marie Curie University, Plasma Process Engineering and Surface Treatments Lab, Paris, (Prof. Farzaneh Arefi)
- Blaise Pascal University, Inorganic Materials Lab, Clermont-Ferrand , France (Dr. Eric Tomasella)

2.4. Specific Needs and Points of Attention

- Need of one new research figure: With respect to 2009, the Unit lost one Senior Researcher and one Technologist, two figures with a highly specialised experience profile. In the meantime, new external projects have been acquired, which makes necessary hiring a new researcher with suited competences in nanoscience and thin film characterization.
- Need of a new film deposition technique: Thin nano-structured films synthesis at low temperatures, with suitable transparency and conductivity properties, can be achieved through the application of innovative technologies like Atomic Layer Deposition (ALD). Such a technology needs to be acquired and implemented with a remote plasma generation and with in-situ diagnostic techniques.
- Need of support for applications to European projects: The Unit competences in either thin films, surface engineering or characterization make it a suitable candidate to European projects. A suitable support from FBK in that sense is highly needed.

3. Goals

Assessments methods and evaluation criteria

The research which the Unit intends to conduct enters an area that requires materials development and is asked to address industrial and societal needs in energy and environment,. The design of new TCO materials (as an alternative to the conventional and costly indium-tin oxyde (ITO)) as well as the photon management based on nanostructured material science are relatively in their infancy, at a worldwide level, but they are characterised by a rapid growth and innovation.

The published literature affiliated to Italian research centres and dealing with materials for photovoltaics applications, one of the themes in which the Unit wishes to mature its experience, is poorly extended whatever be the research centre at local or national level. Italy comes behind Germany, France, Spain and Portugal for what concerns European countries. It is evident that there is an important discrepancy between the Italian research and that of the world in this domain, which regards all of the synthesis processes, the characterization and the applications. This doesn't mean that all is understood among all the published results throughout the world. Many gaps remain to be filled. So, the most important criterium the Unit will apply to its results evaluation will be the achievement of results able to cover one or more of the above aspects of the research in the field. That means the publications on international scientific journals and contributions to international conferences, with original and prime results in at least one of the following areas: the synthesis processes and plasma treatments of the materials of interest, the introduction of new non-conventional metodologies for the characterisation of materials and plasma and the associated phenomenological modeling.

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Mastering of plasma synthesis at low temperature of TCO on various substrates: polymers, glass, amorphous Si	R, A	I, E	Sept.	- consistent and valuable visibility through contributions and presentations at international conferences - accepted papers with prime novelty in International journals with impact factor or - patent	-
TCO conductivity control by means of Nanostructures with highly conformal deposition processes	R, A	I, E	Dec.	- consistent and valuable visibility through contributions and presentations at international conferences - accepted papers with prime novelty in International journals with impact factor or - patent	ALD instrument set-up

Post-deposition functionalization of TCO	R, A		Dec.	- consistent and valuable visibility through contributions and presentations at international conferences - accepted papers with prime novelty in International journals with impact factor or - patent	Up-grade of the existing electron spectroscopy instrument
Project NanoSmart: production of functionalized Au NPs;	I, R	E	During 2010	100% goal achieved if XPS characterization detects PAA and mimetic coating.	FBK facilities working properly
Project Nanosmart: detection of the Au NPs using Raman microscopy (SERS)	I, R	E	During 2010	100% goal achieved if using MicroRaman Au NPs will be visible in an infiltrated cell.	Raman instrument set up
Fabrication of an engineered surface for biosensing applications;	R, I, A	I	During 2010	100% goal achieved if the engineered surface will allow improvement of bioimage acquisition;	FBK facilities working properly
C-based nanostructure investigation and in particular attention will be focused on graphene and diamond nanopowder.	R, I, A	I	During 2010	100% goal achieved if we will able to set up collaborations with external Research institution to start this long term activity.	FBK facilities working properly

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	387.196,00
Travel	19.500,00
Equipment (HW/SW)	18.000,00
Other (e.g. subcontracting to external contractors)	119.340,00
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€544.040.00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	
Other external incomes (projects, grants, etc.)	230.664,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€230.664,00**
Financial Need (Incomes – Expenditure)	**€313.376,00**
Required Structural funding from PAT (it should be equal to the previous item)	313.376,00

5. Human Resources

The Unit employes expert senior researchers as well as well-skilled young researchers and technologist, all forming a well-suited personnel to cover the planned activities. The competences of the Unit allow to ensure an adequate participation to each activity group, thanks to the scientific profile of the members. The plasma, thin films and surface treatments activity is guaranteed by 4 researchers and PhD students, while the characterization task can be shared by 4 researchers, 1 technologist, 1 research technician and PhD student. The most of the staff is also available to industrial research support. A support to the internal group activity is given by a technician with skills in design and realisation of automatic systems for motion control, data acquisition and elaboration.

The composition of the PAM staff, which counts by the date 10 members, is as follows: 4 researchers (1 FBK senior Res.II and head of the Unit, 1 PAT senior Res.II, 1 FBK Res. III, 1 junior researcher with “co.co.pro.” contract, 1 researcher fellowship owner (2 years), 1 Technologist, 1 research technician (Db second level), 1 maintenance technician (Db) and 2Ph.D students. Two more Ph.D students from UPMC will join PAM-SE for co-directed theses. A Tecnologist of the staff, with a contract valid till October 2010, is expected to be stabilized in his position next year.

6. Risks and Mitigation Plans

The type of activity which the Unit intends to undertake, which falls into the basic research domain in material science field, although with application perspective, involves some not negligible risks. It is well known that the progress of a material, from the very beginning of its base concept to the final product form, costs between 10 to 20 years development. It is very often matter of medium/long term research. It is why the solar cell technology matures so slowly on one hand and in the other hand, it needs much more public funding than other technologies. The issue is particularly severe for a photovoltaic technology based on materials which do not have additional applications outside the photovoltaic industry. For example, development of the 1st generation solar cells, based on crystalline Si, took advantage of crystalline Si production for the microelectronics industry. For the 2nd generation solar cells, based on thin films, technology based on a-Si, a material used in the microelectronics industry, is more developed with respect to technology based on other materials (CdTe, CIGSS), not used elsewhere, in spite of the better optical properties of the latter. Technology based on a-Si benefits in fact from knowledge and established technical infrastructures which can be transferred from the microelectronics to the photovoltaic industry. In other words, when developing a new semiconductor-based material for the photovoltaic industry, risks could be decreased by considering existent, well-established technologies from other fields, such as the “electronic” or “photonic” industry.

Nevertheless, major risks connected with the research presented here reside in the medium/long term character of the research itself. The proposed activity does not intend and is not able to provide products or services of immediate use. Rather, it tries to meet environment and societal requirements which are recognized as more and more stringent as time goes by.

CTP – COMPUTATIONAL AND THEORETICAL PHYSICS

Unit Name	CTP – Computational and Theoretical Physics	
Type	Research	
Head	Maurizio Dapor	
Staff	2009	2010
	4 Researchers	6 Researchers
	0 Technologist	0 Technologist
	0 Post Doc	0 Post Doc
	1 PhD	1 PhD

Document Status submitted 2009-11-05

1. Executive Summary

1.1. Main Activities

Monte Carlo modeling of the secondary electron emission yield in dielectric materials for Critical Dimension Scanning Electron Microscopy

REELS: determination of SEP and DIIMFP

Many-body problems in scattering theory

Electronic properties of materials

Computer simulations of DNA interaction with functionalized surfaces

Dissipative phenomena in precision mechanical measurements

Modeling and simulations of high efficiency silicon solar cells for concentrators systems

Solar cells in solar concentration systems: search for high thermal – low electrical conductors

1.2. Personnel

6 Researchers (Maurizio Dapor, Lucia Calliari, Simone Taioli, Giovanni Garberoglio, Enrico Serra, TBH), 1 PhD student (Anna Battisti).

1.3. Prominent collaborations

Internal collaborations:

M2B2 Unit (RNA strategic project)

PAM Unit

MTLab

External collaborations:

Integrated Systems Laboratory, Swiss Federal Institute of Technology (ETH), Zurich

Department of Engineering Materials, The University of Sheffield

Department of Electronic and Electrical Engineering, The University of Sheffield

Department of Physics, University College London
Department of Physics, University of Vienna

Thermophysical Properties Division, National Institute of Standard and Technologies, Boulder (CO), USA

RRC Kurchatov Institute, Moscow, Russia

"MATI"-RGTU (Moscow Aviation Technology Institute-Russian Government Technology University), Moscow, Russia

Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Legnaro, Padova

International School for Advanced Studies (SISSA), Trieste

Department of Physics, University of Camerino

Scuola Normale Superiore, Pisa

Department of Physics, University of Trento

Department of Material Engineering, University of Trento

Unità di Padova-Trento della collaborazione Virgo, CNRS-INFN

Istituto di Fotonica e Nanotecnologie (CNR-FBK), Trento.

2. Vision and Scientific Program

2.1. Context and State of the Art

– Monte Carlo modeling of the secondary electron emission yield in dielectric materials for Critical Dimension Scanning Electron Microscopy

  Dielectric materials, notably biological assemblies, ceramics, glasses, microelectronic devices, are widely used in technological applications. Under electron irradiation, the insulator absorbs and traps a fraction of the primary electron beam, which undergoes several scattering processes depending on the kinetic energy. These injected electrons may recombine with positive charges created in proximity of the irradiated surface by secondary emission. If the primary electron beam is energetic enough, inelastic interactions with inner-shell electrons may occur. If the primary beam kinetic energy is such to promote electrons from valence to conduction band, electrons can interact inelastically with plasmons. For low incident electron kinetic energy, of the order of two or three times the energy gap, the electron energy loss is related to electron-phonon collisions. Furthermore, the modifications of the lattice strongly affect the mobility of the very low energy electrons, a phenomenon of relaxation known as "polaronic effect".

– REELS: determination of SEP and DIIMFP

  Quantitative understanding REELS in the plasmon region (so called “low energy” REELS) is nowadays the objective of a large amount of investigations. One of the most interesting topics deals with the separation of surface and bulk contributions to the spectra, i.e. with the determination of the Differential Surface Excitation Probability (DSEP) and the Differential Inverse Inelastic Mean Free Path (DIIMFP). Several approaches have appeared in the literature, with Monte Carlo simulations of spectra playing a key role in this regard. Crucial ingredients are experimental spectra with varying relative intensity of surface and bulk components, such as spectra acquired at different electron energies or for electrons crossing the surface at different angles.

– Many-body problems in scattering theory

  A mixed Quantum Mechanical/Monte Carlo method (QMMC) for calculating autoionization and Auger spectra from nanoclusters has been developed. The approach, based on a cluster method, consists of two steps. Ab-initio quantum mechanical calculations are first performed to obtain accurate energy and probability distributions of the generated Auger electrons. In a second step, using the calculated line-shape as electron source, the Monte Carlo method is used to simulate the effect of inelastic losses on the original Auger line-shape. The resulting spectrum can be directly compared to `as-acquired' experimental spectra, thus avoiding background subtraction or deconvolution procedures. As a case-study, the O K-LL and Si K-LL spectra from solid SiO_2, have been performed. Spectra computed before or after the electron has travelled through the solid, i.e. unaffected or affected by extrinsic energy losses, have been compared to the pertinent experimental spectra measured within our group, obtaining very good agreement.

– Electronic properties of materials

  Carbon nanotubes, are sheets of carbon atoms wrapped in cylindric topology. Soon after their discovery in 1991 by S. Iijima, they revealed a broad variety of remarkable electronic, optical, thermal, and structural properties depending on the diameter, length, and chirality, which define their size and shape. The theoretical study of the physical properties, notably the electronic band structure, of model zig-zag carbon nanotubes and chiral-edge graphene nanoribbon using a computational method for accelerating first-principles Green function calculations has been performed. This approach utilizes an optimal basis set for representing the polarization propagator lowering the computational cost without loss of accuracy. The electronic structures and the equilibrium geometries were obtained within the pseudopotential implementation of ab initio total energy Density Functional Theory (DFT). Accurate calculations to determine quasiparticle excitations in carbon nanostructures, notably electronic band gap, are performed in the framework of GW treatment of the self-energy. The obtained results on band gaps for (7,0), (8,0) CNTs at Gamma point and calculations on (4,2) nanoribbon with edge irregularities show the potential of this method to perform accurate calculations on large carbon-based systems of technological interest and structures with localized defects, otherwise difficult

to address with conventional approaches. This method, recently implemented by Umari and coworkers in SISSA (Trieste) may be used as a predictive tool of spectral properties, excited states and optical response in extended systems.

– Computer simulations of DNA interaction with functionalized surfaces

  The efficient extraction of DNA from a biological fluid sample is the first step towards the sequencing of the genome of living organisms. Among the various techniques that are being developed to perform this task, selective adsorption on functionalized surfaces is being actively investigated. This method is based on the fact that DNA molecules in solutions have a uniform distribution of negative charge and are therefore attracted by a distribution of positive charges. This latter distribution is made by attaching to silica surfaces organic molecule presenting amine groups (NH2), which become positively charged when in contact with water. It is experimentally verified that the magnitude of the DNA-surface interaction can be varied by changing the pH and the salt concentration of the solution, and this can be used to extract the DNA which has been previously adsorbed on the functionalized surface, although the optimal conditions under which this phenomenon occurs have not been investigated yet.

– Dissipative phenomena in precision mechanical measurements

  Development of low mechanical dissipation materials is a key issue in many technological fields and plays an important role in precision measurements for fundamental research. In our research we address specifically the field of gravitational wave detectors and of statistical mechanics. In fact the first generation of gravitational wave detectors has reached displacements sensitivity in the range 10^{-21} m/√Hz, and further increments could be obtained only by a substantial improvement of the existing detectors, among the others the use of cryogenic temperatures and of silicon-based optical systems. In this research we address the development of low dissipative silicon systems (optics and mechanical oscillators) and the study of their performances with Finite Element Modeling and experimental measurements.

– Modeling and simulations of high efficiency silicon solar cells for concentrator systems

  Crystalline silicon solar cells are presently the predominant method of photovoltaic power generation globally. Silicon technology is still currently the best proven and most widely available technology for developing solar cells working with intermediate concentration levels. In order to cut production costs by reducing the usage of silicon, significant effort has focused on thinning the wafers or by reducing the area of silicon.

  In our research we address specifically the field of small area single junction solar cells used in photovoltaic concentrator systems (CPV) with concentration levels in the range of 100X-130X. The availability of such cells, will be useful for the design of concentrator systems with a reasonable cost reduction with respect to conventional flat plate PV systems. Specifically, we focus our re-

search on the development of the cell design and the study of their performances with Finite Element Modeling and experimental measurements.

- Solar cells in solar concentration systems: search for high thermal – low electrical conductors

  The use of solar cells together with solar concentrators poses tremendous problems of heat dissipation at the cell site. This calls for novel materials exhibiting the combined properties of high thermal conductivity and low electrical conductivity. A promising candidate in this respect is amorphous Carbon (a-C). Rather than a single material, a-C represents a class of materials whose properties range from those of graphite (graphite-like a-C) to those of diamond (diamond-like a-C, or DLC), depending on the deposition conditions. Diamond-like Carbon, like diamond, would exhibit the required properties of electrical and thermal conductivity.

2.2. Vision and Goals

- Monte Carlo modeling of the secondary electron emission yield in dielectric materials for Critical Dimension Scanning Electron Microscopy

  We intend to establish the nature of charging phenomena in insulating materials under electron irradiation. The calculation of the secondary electron yield as a function of the primary electron beam energy is a fundamental step, since this quantity, together with depth distribution of secondary electrons and the implantation profile of the primary beam, can be directly related to the charge distortion due to positive charges, induced in the surface by secondary electron emission, and negative charges, induced in the bulk by the primary electron beam absorption.

- REELS: determination of SEP and DIIMFP

  Contribution of the CTP Unit to this very active research field will be focused on materials whose spectra exhibit well-defined surface and bulk plasmon losses (primarily Al and Si). Monte Carlo simulation of spectra acquired at different electron energies will be the main approach to understand the role of surface and bulk. It is expected that these spectra and their evolution with electron energy could be simulated within the next few years with good reproduction of all their features (overall intensity, relative intensity of surface and bulk features, single and multiple losses).

- Electronic properties of materials

  Applications of theoretical techniques to unravel exotic electronic and optical properties in a variety of systems such as carbon and boron nitride based nanostructures. Furthermore we will try to extend the available methodologies to include superconductivity phenomena.

- Many-body problems in scattering theory

  We will try to lower the computational load in the calculation of electronic spectra in condensed matter systems by implementing advanced many-body techniques on the top of the existent state of the art.

– Computer simulations of DNA interaction with functionalized surfaces

The description of the forces between the atoms is crucial to develop a realistic atomistic model for DNA-surface interaction. These forces do depend on the actual electronic structure of the interacting atoms, but a calculation of the electronic structure for each possible atomic configuration is very computationally demanding. Therefore one usually approximates the actual interactions with some suitable functional form (such as the Lennard-Jones potential), whose parameters have then to be fixed. This can be done either by fitting the interaction potential from *ab initio* electronic structure calculations or by comparing the simulation results with actual experimental data. Very good parametrizations are now available for biological simulations (such as the AMBER and SPC/E potentials for DNA and water, respectively), but almost nothing is known on how to parametrize the interaction of DNA and water with the functional groups on the surfaces of interest, as well as with the surfaces themselves. We will develop an accurate potential model and we will use it to set up and run calculations of DNA interacting with these surfaces.

– Dissipative phenomena in precision mechanical measurements

Silicon is widely used as material for precision instrumentation, but its mechanical performances at the sensitivity level of 10^{-21} m/√Hz are not well known. The occurrence of disturbances from non-equilibrium effects must be thoroughly investigated, as well as the temperature behavior of intrinsic and thermoelastic losses. In a few years the unit will produce a mechanical oscillator for measurements of dissipative phenomena and the modeling tools for understanding its physical behavior.

The know-how developed in this work will be used to develop low dissipation silicon-based optical components; a success in this task would represent a breakthrough in the field of precision measurements. Results from this research might be useful also for the development of micro and nano-mechanics membrane system in applications that include charge detectors, radio-frequency filters, magnetic resonance force microscopes, and torque magnetometers.

Modeling and simulations of high efficiency silicon solar cells for concentrator systems

Photovoltaic concentrator systems (CPV) have been available for almost 30 years in laboratories and research fields to provide ‘‘green’’ electricity to the market.

A number of interesting CPV systems with very different approaches and degrees of success have been tested, but none of them has achieved the mass production level of flat plates PV systems. The current, main research effort into concentrator solar cells focuses on multijunction III–V-based solar cells (MJ cells) which have now achieved much grater efficiencies and higher concentration levels with respect to the silicon solar cells.

However, high efficiency and high concentration concepts need very accurate systems, including their manufacture, installation and sun tracking which in-

crease the total cost of the module. On the other hand, the research in the use of silicon solar cells for intermediate concentration level has not been sufficiently explored. The main problem is that the large development of low and intermediate concentration PV will occur when companies and research labs will match a good trade-off between a low-cost industrial process for high volumes with the costs needed for increasing the efficiency of a module.

Once this problem is solved, the global trend of concentrator installations could easily climb to tens of megawatts per year. In the following years the Unit will assist with a specific simulation and design work and MTLab in its challenge to produce silicon solar cells with efficiency above 21 % at one sun and 23 % in medium concentration context (100-150 x sun).

- Solar cells in solar concentration systems: search for high thermal – low electrical conductors

  Research activity on this topic will be in connection with the Physics Department of the University of Trento (Prof. A. Miotello) and it will focus on the study of a-C materials in order to develop the technology for DLC deposition. The contribution of the CTP Unit will be in the characterization of a-C films by electron spectroscopy techniques and in modeling electron spectra at various levels of sophistication (phenomenological approaches, first principles calculations).

2.3. Activities and Work Plan

- Monte Carlo modeling of the secondary electron emission yield in dielectric materials for Critical Dimension Scanning Electron Microscopy

A realistic description of secondary electron emission from insulating materials needs, first, the knowledge of all likely scattering mechanisms in the entire spectrum of energies, ranging from the kinetic energy of the primary beam down to a few eV, after inelastic interactions occured; second, of the dynamics dependent from a number of parameters, such as the number of trapped electrons, the charge-space distribution, the mobility and the number of secondary electrons leaving the surface of the dielectric.

- REELS: determination of SEP and DIIMFP

For the next year, we will focus on REELS from Al and we will try to determine which is the best suited model (among those proposed in the literature) to account for surface and bulk spectral components.

- Electronic properties of materials

Since the discovery of two-dimensional (2D) and meta-stable materials by Geim and Novoselov in 2004, a dramatic increase in the research dedicated to explore their physical properties took place. This holds especially for graphene. Its electronic properties allow one to address basic questions of quantum electrodynamics such as relativistic Dirac fermions or the Klein paradox in a bench-top condensed-matter experiment. Furthermore, the nanometer size, the scalability and room-temperature ballistic transport properties make graphene a promising candidate for

future nanoelectronic devices with high charge carrier mobilities and an ideal material for spintronics. Much less is known about other 2D materials such as the hexagonal boron nitride (hBN) monolayer. BN is a wide gap semiconductor and is often under discussion as a material for blue and ultraviolet diode material. Its application is however severely hampered by the fact that: (1) its electronic properties are not fully understood (2) that it is difficult to grow large area hBN on arbitrary substrates. In this proposal a comparative theoretical and experimental spectroscopic study of in-situ grown and functionalized graphene and hBN is suggested. In collaboration with the University of Vienna and members of the synchrotron radiation source in Berlin, the electronic properties of these systems will be investigated by a combination of ultraviolet photoelectron spectroscopy (UPS), x-ray photoelectron spectroscopy (XPS) and absorption spectroscopies (XAS). Both, the graphene and the hBN layers will be grown in-situ by a chemical vapour deposition (CVD) approach. As a catalyst, transitition metal (111) surfaces are usually employed. This approach is particularly appealing if a thin Nickel layer is used as a catalytically active substrate because it allows for epitaxial growth of high-quality graphene and for transfer to arbitrary substrates of the graphene by etching away the Ni layer. In a second step following the growth, in-situ functionalization is carried out using metal intercalants and chemisorbed radicals such as atomic hydrogen. The resulting functionalized graphene and hBN layers will be of high structural and electronic quality as previously shown by angle resolved photemission and electron diffraction. The careful characterization of the core levels by XPS and the valence band by UPS will allow us to determine not only the substrate influence but also the effect of the chemisorbed species, such as hydrogen. Furthermore XAS will allow us to probe the unoccupied density of states of and their dependence on functionalization. Apart from the detail characterization of the bonding environment, the electronic structure by XPS,UPS and XAS, the transfer procedure developed by us, allows us to deposit the hBN and graphene monolayers on Si wafers for optical and transport characterization. Therefore, we have the full set of information to determine the effect of functionalization on the electronic properties of hBN and graphene.

– Many-body problems in scattering theory

The SURPRISES (Surface PhotoelectRon and Inner Shell Electron Spectroscopy) program suite performs ab-initio calculations of photoionization and non radiative decay spectra in nanoclusters and solid state systems by using a space-energy similarity procedure to reproduce the band-like part of the spectra. This approach provides an extension of Fano resonant multichannel scattering theory dealing with the complexity arising from condensed matter calculations at a computational cost comparable to that of molecules. The bottleneck of electron spectroscopy ab-initio calculations in condensed matter is the size of the Hilbert space where the wavefunctions are expanded and the increase in number of final decay states in comparison to that of atoms and molecules. In particular, the diagonalization of the interchannel interaction to take into account the correlation between the double ion and the escaping electron is impracticable when hole delocalization on valence bands and electronic excitations are included in the model. To overcome this problem SURPRISES uses a `space-energy similarity approach, which allows the

spreading of the Auger probability over the bands without tuning semi-empirical parameters. Furthermore, a completely new feature in the landscape of ab-initio resonant decay processes calculations is represented by including energy loss through a statistical approach. Using the calculated lineshape as electron source, a Monte Carlo routine simulates the effect of inelastic losses on the original lineshape. In this process, the computed spectrum can be directly compared to acquired experimental spectra, thus avoiding background subtraction, a procedure not free from uncertainty. The program can exploit the symmetry of the system under investigation to reduce the calculation scaling and may compute photoemission and Auger decay angular distribution patterns including energy loss for the electrons emitted in resonance-affected photo-ionization processes. We plan to apply this computational techniques to a number of numerical tests including Auger spectra in amorphous carbon, nanotubes and graphite. Furthermore photoemission spectra of silicon carbide (SiC) generated with supersonic flow of fullerene impinging a silicon surface will be studied in collaboration with a theoretical group at University College London and an experimental group in Trento.

- Computer simulations of DNA interaction with functionalized surfaces

In the first stages, the results from simulations using small DNA oligomers will be compared with actual experimental data, and a further refinement of the force field will be performed, if needed. Finally, the largest possible simulations will be performed on the systems of interest, and the results analyzed. The results of this analysis will be used to characterize the properties of the functional groups which are optimal for the various purposes.

- Dissipative phenomena in precision mechanical measurements

In collaboration with IFN-CNR Istituto di Fotonica e Nanotecnologie (Trento) we seek a new computational FEM-based tool for thermoelastic analysis of bonded structures and multilayer coating over a silicon substrate. This tool will be useful to design large masses of silicon and low-losses high reflectivity mirrors for the next generation gravitational wave detectors. In particular the development of an 8-node Reissner-Mindlin plate element for coupled thermoelasticity is the starting point for the evaluation of the dissipation losses in very thin structures like the bonding interface and the multilayer coating system.

The fabrication of a very low loss optical mirror on a silicon substrate will be developed in the MTLab-Fbk clean room facility by using a PECVD deposition process. The mirror design is based on the principle of distributed Bragg reflector and will be made of multiple periodic layers alternating materials with varying refractive index. MEMS micro-fabrication procedures will be used for making test structures for the material characterization.

The experimental cryogenic apparatus located at INFN Legnaro will be employed for characterization of the dissipative properties of those systems.

- Modeling and simulations of high efficiency silicon solar cells for concentrator systems

In collaboration with MTLab-Fbk we seek to optimize the design of the solar cell starting from the results of a previous research project HCSC (High Concentration

Solar Cells) where the major outcome was the development of a pre-industrialized process for silicon cells for intermediate sun concentration level.

The simulation and modeling activities will be mainly devoted towards:

- the improvements of the photogenerated current by enhancing the transmission coefficient of the anti-reflecting coating;
- the reduction of the rear surface recombination velocity via point contacts;
- the decreasing of the series resistance
- the optimization of the junction for 100 – 150 Sun concentration working conditions.

We will study the solar cell behaviors by using both a Finite Element based process and a device simulator. We will use the process simulator to identify a correct combination of ion implantation parameters, oxidation times and temperatures suited to the definition of a shallow junction. Based on the doping profiles produced with the process simulation, a device simulator will be used for the evaluation of the I-V curves, the Energy Efficiency and its External/Internal Quantum Efficiency. Investigations on the generation and recombination phenomena will be carried out with this analysis.

Analytical formulas based on the Transmission Transfer Matrix and numerical ray tracing techniques will be also used to minimize the reflectance of the anti-reflecting coating made up of a combination of a texturing and a double layer PECVD dielectric film.

Another issue that will be addressed in collaboration with MTLab-Fbk is the development of an original (hopefully innovative) junctions shape for a possible enhancement of the separation capabilities of the whole junction. We will investigate this idea by developing a specific mask layout according to the simulation results. Some critical parameters used in the simulations like the minority carrier lifetimes will be measured in the MTLab-Fbk facility in order to calibrate the simulation models.

- Solar cells in solar concentration systems: search for high thermal – low electrical conductors

a-C thin films will be deposited at the Physics Department of the University of Trento. Our activity, in strict contact with researchers at this Department, will consist in characterizing the deposited materials in order to provide hints for optimizing the deposition conditions and to obtain materials with the required properties. On the one hand, our previous knowledge on electron spectra from this class of materials will be used and, on the other hand, further knowledge will be gained by spectra simulations.

2.4. Collaborations

- Integrated Systems Laboratory, Swiss Federal Institute of Technology (ETH), Zurich - Prof. W. Fichtner

  In Critical Dimension Scanning Electron Microscopy (CDSEM), we are interested in modeling (Monte Carlo Model) the secondary electron yield as a function of the

primary electron beam energy in insulating materials, a fundamental step to establish the nature of charging phenomena under electron irradiation.

- Department of Engineering Materials, The University of Sheffield - Dr Cornelia Rodenburg

  The ever shrinking dimensions of semiconductor devices impose new challenges to the metrology of dopant distributions. Our main aim is to offer a solution to this challenge. In particular we aim to provide a theoretical model (Monte Carlo Model) that describes dopant contrast exact enough to form the basis for quantification of dopant contrast suitable for application in the semiconductor industry.

- Russian Research Center (RRC) Kurchatov Institute, Moscow, Russia - Dr Sergey Fanchenko, Dr Andrey Varfolomeev

  The simulation of Reflection Electron Energy Loss (REELS) measurements from a-C materials is crucial to derive quantitative information (such as material density and sp^2 fraction) from such spectra. Activity in this respect has started already and it will go on next year.

- Department of Physics, University of Camerino - Dr Stefano Simonucci

  We are extending theory and computational tools for calculating photoemission and Auger spectra in systems of increasing complexity, such as nanoclusters and solids.

- Department of Physics, University of Vienna - Dr Alex Gruneis

  The goal of this collaboration is to interpret electronic spectra (mainly time resolved X Ray Photolectron Spectroscopy and NEXAFS) from extended systems, such as graphene and boron nitride structures, adsorbed on metal surfaces.

- Department of Physics, University College London - Prof. Dario Alfé

  CNR-FBK Trento - Dr. Roberto Verrucchi.

  We use ab-initio molecular dynamics and many-body approaches in order to explain likely structures of materials, such as silicon carbide, produced by bombarding a silicon surface with supersonic flow of fullerene molecules.

- Department of Electronic and Electrical Engineering, The University of Sheffield - Prof. Maria Merlyne De Souza

  SISSA, Trieste - Dr Paolo Umari

  We apply a new theoretical approach to treat accurately correlations among electrons, extending the range of application of many-body perturbation theory.

- Thermophysical Properties Division, National Institute of Standard and Technologies - Dr Allan H. Harvey

  We will develop a computational model to calculate the temperature derivatives of the third virial coefficient, C(T), of quantum gases. Using two- and three-body interaction potentials obtained by ab-initio calculation we aim to calculate dC/dT with an uncertainty at least one order of magnitude smaller than the one obtained from the most accurate experiments, a procedure that

has already been demostrated to be effective in the case of the third virial coefficient.

- Department of Physics, University of Trento - Dr Pietro Faccioli, Dr Francesco Pederiva

  We will extend a recently developed computational method aimed to calculate the most probable molecular paths of chemical reactions under the effect of thermal fluctuations in order to calculate the rate of the reactions themselves. We will also strengthen our collaborations in the development of computational models for biomolecular simulations.

- Institute for Photonics and Nanotechnologies, CNR-FBK Trento - Dr M. Bonaldi

  Gravitational wave detectors, non-equilibrium properties of thermal noise, design and modeling of mechanical resonators

- National Institute of Nuclear Physics, National Laboratory of Legnaro - Dr J. P. Zendri

  Optical components and materials for gravitational wave detectors

- Unità di Padova-Trento della collaborazione Virgo, CNRS-INFN - Dr Giovanni Prodi

  Gravitational waves interferometer

- Department of Physics, University of Trento - Prof. Antonio Miotello

  We will perform a joint investigation on a-C thin films, aimed at obtaining films with diamond-like properties.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Publishing on international recognized scientific journals	R	E	Dec.	Relevance of the journal	
Fund raising	A	I/E	Dec.	Amount acquired	
Dissemination	R	I/E	Dec.		Availability of funds
Continuous learning	R	I	Dec.	Attendance to schools, seminars, PhD award	
LISC creation: merging of the unit CTP with the corresponding University group	I/R	I/E	June	Ability to find common objectives among the researchers	Availability of funds; Organization issues

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses *(EUROS)*	
Personnel	**€**327.415,00
Travel	21.000,00
Equipment (HW/SW)	20.000,00
Other (e.g. subcontracting to external contractors)	35.000,00
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€403.415,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	
Other external incomes (projects, grants, etc.)	77.443,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€77.443,00**
Financial Need (Incomes – Expenditure)	**€325.972,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€325.972,00**

5. Human Resources

6 Researchers (Maurizio Dapor, Lucia Calliari, Simone Taioli, Giovanni Garberoglio, Enrico Serra, TBH), 1 PhD student (Anna Battisti).

APP – ADVANCED PHOTONICS AND PHOTOVOLTAICS

Unit Name	APP – Advanced Photonics and Photovoltaics	
Type	Research	
Head	Georg Pucker	
Staff	2009	2010
	4 Researchers	4 Researchers
	0 Technologist	0 Technologist
	1 Post Doc	2 Post Doc
	2 students	0 PhD
Document Status	submitted 2009-10-17	

1. Executive Summary

The research unit APP performs research in the field of photonics and photovoltaics. An important part of our research is based on our experience in the growth of silicon nanocrystals in dielectric matrices. These materials are applied in both silicon base light emitting devices and solar-cells. In both cases the devices are not mature for applications, but highly interesting from a scientific and technological point of view. In addition we develop optical waveguides and different kind of optical filters and micro-resonators. Recently APP started to develop also organic solar cells. This research is performed within a project (Aurora II)founded by Radice Srl, from the Diatec group. Beside the project Aurora II the year 2010 will see the research unit occupied by the projects Naomi (Photonics) and the project LIMA (Photovoltaics) supported by the European Community. Within the project LIMA the research unit will participate in the improvement of the efficiency of back-contact silicon solar cells by the use of silicon-nanocrystals. In addition, we plan to enlarge our activities in non-linear optics in silicon for generation of NIR and THz radiation.

APP will stay constant in the overall number of persons, unless we do not manage to add personal by external funding.

2. Vision and Scientific Program

2.1. Context and State of the Art

APP unit performs research and develops technologies in the field of silicon PHOTONICS and PHOTOVOLTAICS. Photonics generally spoken, include all aspects of light formation (e.g. light sources for lightning, displays, lasers), light transport

and management (e.g. mirrors, optics and waveguides), and all aspects of light detection. The centre of Microsystems and Materials performs research in several fields of Photonics (e.g. the unit SOI develops intelligent sensors, RAD is specialized in the development of sensors for high energy particles and silicon photomultipliers, and MTLab among other devices produces both high energy particle sensors and photodiode based sensors). All these research in photonics is based on silicon, either using the in-house facility (MTLab) or by making use of an external foundry.

In silicon photonics research interest of APP is concentrated on (i) silicon-nanocrystals and their application in light emitting diodes and resonators, (ii) micro-resonators and coupled micro-resonators, (iii) optical waveguides and engineering of non-linear silicon waveguides.

(i) Within the last ten years MTLab in collaboration with the Department of Physics acquired considerable experience in the growth of silicon nano-crystals and their application. Silicon nano-crystals embedded in a dielectric matrix have physical properties, which differ significantly from bulk silicon (e.g. strong photo-luminescence due to carrier localization and quantum-confinement effects). Within a project funded by Intel, APP and UniTN used this knowledge to develop a light emitting diode, which switches on at a driving voltage of 1.7 V (APPLIED PHYSICS LETTERS 94, 221110 (2009)) and has a external power efficiency of 0.17%. The major achievement of this work is the excitation of the light emitting nano-crystals by both holes and electrons directly tunneling through the tiny oxide-layer separating the individual nano-crystals. This results in the low switch on voltage and increases significantly the lifetime of the device.

(ii) In addition APP recently started to investigate the properties of silicon nano-crystals in micro-resonators with quality factors larger than 5000. These research is motivated by the fact that in some cases silicon-nano-crystals can even show stimulated emission. By inclusion of the nano-crystals in a cavity (resonator) with extremely high quality factor, it might be possible to demonstrate on optical pumped laser. Silicon microfabrication technology driven by the miniaturization of the transistor allows nowadays to control the size or dimensions of devices and components with extremely high precisions down to some nanometers. Therefore it is often also the tool of choice for the realization of more complex optical structures such as coupled resonators. This devices can be used to study new and interesting optical phenomena such as optical Bloch oscillations, or forces between intense optical fields so called optical forces.

(iii) APP develops also optical waveguides for different spectral regions: Waveguides based on silicon nitride and oxynitrides for Lab on Chip applications, silicon and oxynitride waveguides for 1.5 micron and silicon based waveguides for the NIR and MIR region for the guiding and generation of NIR and THz radiation. Silicon based waveguides are also studied for the generation of super-continuum light. SC-generation means that a laser pulse of a defined frequency broadens during propagation forming a wide continuous spectrum of light maintaining the coherence of the starting pulse. SC generation is opti-

mized by appropriate design of the waveguides and of special interest in spectral regions where no tunable coherent light sources exist.

Silicon nano-crystals play also an important role in APP's second main research activity: PHOTOVOLTAICS. APP's research in photovoltaics is supported by the strategic project on photovoltaic's. In this field APP works on 2 projects: (i) nano-crystalline silicon based solar cells and (ii)organic solar cells.

(i) Research on solar cells based on silicon nano-crystals is part of a concept called 3rd generation photovoltaics developed and propagated by Prof. Martin Green of the University of New South Wales in Australia. 3rd generation solar cells should be significantly more efficient, cheaper and made from non toxic and abundant materials. Currently a variety of ideas and concepts are investigated to increase significantly the efficiency of solar cells. One of the approaches envisions the combination of solar cells in a tandem configuration using a series of solar cells in which the properties of the single cell are tailored to a certain spectral area of the solar spectrum by controlling the size of the silicon-nano-crystals. Many technological and physical problems to overcome in this kind of solar cell are similar to the ones in nano-crystal based LEDs and it represents therefore a rather natural continuation of our research in silicon photonics. Starting from January 2010 APP will address this topic in the European project LIMA-*Improve photovoltaic efficiency by applying new concepts on the limit of light matter interaction*, FP7-248909.

(ii) In addition APP started to perform research also on organic solar cells (AuroraI and AuroraII) within a project for Radice SRL, of the Diatec group. Aim of the project is the development of an organic flexible solar cell with improved performance in the near-infrared region of the solar spectrum. Thanks to this project members of APP have also the chance to acquire a lot of experience on conductive polymers. This experience might be the seed for a stronger involvement of CMM in organic electronics in general.

2.2. Vision and Goals

Referring to the famous phrase of Feynman, one could predict that there is plenty of room in silicon photonics and photovoltaic's. APP is achieving currently a level of control in the growth process of silicon nano-crystals by PECVD, which will give us the possibility to explore potential and limitations of the growth method within the next 2 to 3 years. Our nano-crystalline LED's have currently a power efficiency of ~0.2% at low driving voltages and within the next 3 years (if funding is available), we should be able to verify if the technology can achieve 1-5% of efficiency. A stable LED based on silicon technology with an efficiency in the 1-5% range would find considerable commercial interest. The Lima project will give us the possibility to evaluate the potential of the technology for photovoltaics. The goals of the project, improving by 10% the efficiency of a back contact silicon solar cell is very demanding and will request strong dedication of APP on the subject. However, the project gives FBK the possibility to collaborate with important players in the field of silicon photovoltaics - such as the University of New South Wales, Australia; Isofoton SA, (important producer of c-Si solar cells) ; the International Solar Energy Re-

search Center in Konstanz, Germany; and the Technical University of Valencia, Spain – and in case of success, it will allow not only APP but the whole CMM to reinforce the position as important player in research in photovoltaics.

APP performs also significant research in the fields of microcavities, microresonators and non-linear optical waveguides, which led to a series of important publications and conference contributions. In addition this experience is applied in the development of different sensing systems either for research or bio-medical applications(see the projects: Naomi PAT, Nemo FP7, in addition APP is currently exploring the possibility for a collaboration with Radisens Diagnostics on the development of optical filters for a portable blood analyzer system). The activity of APP in this field will strongly benefit from the new lithographic system with increased optical resolution currently installed in MTLab and will clearly grow in importance within the next years. To support this activity APP applied for a series of projects currently under evaluation: SMIR-*Electrically pumped mid infrared supercontinuum source*, call FP7-ICT_2009-5; PhoMBO-*innovative building blocks for silicon nano-photonics*-ERC-2010-StG_20091028, applicant PhD Mher Ghulinyan; and the project entitled *Studio della non linearita' di guide ottiche in silicio periodicamente stressato per nuove sorgenti laser nel medio infrarosso* submitted to Fondazione Cariplo.

2.3. Activities and Work Plan

The year 2010 will see the members of APP mainly engaged in 3 key projects: Lima, FP7-248909 ; Aurora II; and Naomi. APP is also involved to minor extend in the projects ANNA (CE) and OXISOLAR (Fondazione Caritro). In addition the beginning of next year will see the end of the European project Nemo in which APP developed narrowband filters for CMOS sensors, an activity which might be explored in the future through a collaboration with the company Radisens, which works on the development of a portable sensor for blood analysis.

Generally the work within APP is organized according the 2 main activities silicon photonics and photovoltaics and organic photovoltaics. 2 researchers work on the projects related to silicon photonics and photovoltaics and the other 2 on organic photovoltaics (1 person to be hired).

The work plan of the year 2010 is dictated mainly by the workplan of the most important projects:

The first months of 2010 will see intense activity on the development of nanocrystal based solar cells for the project Lima. This activity, will be coupled with the analytical study of silicon-nanocrystals in the project ANNA (CE).

2.4. Collaborations

The Nanosciencelab of the Department of Physics of the University of Trento, led by L. Pavesi is the most important partner in the field of silicon photonics, while APP has the expertise in device characterization, Nanosciencelab is well equipped and experienced in device fabrication. APP and Nanosciencelab collaborate also in the field of nano-Si solar cells.

Other important collaborations in the field of silicon photonics are (1) the silicon photonics group of the Advanced Technology Institute of the University of Surrey, UK, managed by G. Mashanovich. The group has enormous experience in the design and fabrication of waveguides, grating couplers, filters and modulators, and (2) with the Electromagnetic Fields and Photonics Group of DEA, at the University of Brescia, Italy, led by Prof. Stefan Wabnitz, specialized in theory and simulation of non-linear optics in nano-photonics and waveguides.

Radice SRL, of the Diatec group, is currently the main industrial partner for the development of organic solar cells and co-ordinator of the Aurora-project.

FBK signed a NDA with Radisens, Ireland, a company working in the field of instruments for medical sensing. APP is discussing with Radisens, possible interactions in the field of narrow band optical filters.

Prof. Michele Maggini, Department of Organic Chemistry of the University of Padova, is an outstanding expert for the synthesis and properties of fullerene derivates. He collaborates worldwide with groups working on organic solar cells and is adviser of APP and Radice in the Aurora-project.

MTLab is the most important internal collaboration of APP. The collaboration includes the development of processes for silicon-photonics and photovoltaics and support in the testing of solar cells. MTLab is strongly involved in the projects Aurora and Lima.

M2B2 is our most important partner for structural analysis in both photonics and photovoltaics due to the experience of M2B2 in important analytical methods such as scanning electron microscopy, atomic force microscopy, x-ray photo-electron-spectroscopy and secondary ion mass spectrometry. APP and M2B2 collaborate in the projects ANNA, Aurora and Lima.

APP contributes also to the project OXISOLAR (Fondazione Caritro) led by the research unit PAM. APP and PAM collaborate also regarding the development and application of TCO's for organic solar cells.

2.5. Specific Needs and Points of Attention

APP is primarily an experimental group working lab-less, or in other words using the laboratories facilities of others either within FBK (e.g. MTLab, M2B2) or outside (e.g. Nanosciencelab UniTN). This situation is on hand convenient because APP being a small unit does not need to take care of maintenance on the other hand, it is often very complicated to stay within the scheduling of projects. In terms of optical measurements for silicon photonics FBK is very poorly equipped for the needs of APP and the unit relies mainly on external collaborations. This is especially a problem for collaborations with companies were a minimum of device characterization should be possible at FBK. For this purpose APP would need to establish a small laboratory housing 2 or 3 small optical benches and equipment for thin-film thickness and refractive index measurement (the laboratory might be part of a larger one, but should allow members of APP free excess to their equipment and instrumentation). Currently we plan to resolve the problem within a internal collaboration with the unit SOI, which has its own laboratory for optical measurements.

The performance (efficiency and stability) of organic solar cells suffers extremely, if the fabrication is performed in air. Although APP achieved an external power efficiency close to 2% fabricating the cells in air, the activity will have the need of acquisition of a glove box to perform cell fabrication in the future under inert gas atmosphere. The costs of the necessary investment can be estimated to be around 40 to 50 kEuro and can only be partially covered by the budget of the project Aurora II. The glove box should be installed either in the new MEMS laboratory of MTLab or in the general chemistry laboratory of FBK.

3. Goals

The 4 main goals for the year 2010 are closely related to the key projects of APP:

1. LIMA: Proof that Si-quantum dots can result in an significant improvement in efficiency of back contact solar cells. Main risk for APP: APP might not succeed in controlling and improving the growth process.
2. Naomi: APP will intensively work on the optical and THz part of the sensor system. Realize an optical platform which is efficient enough to monitor very low concentrations of bio-molecules according to the requirements of the project.
3. Silicon Photonics: Generation of light in the NIR and THz by strain in silicon waveguides. This is the 1st step in the demonstration of the use of silicon waveguides for efficient light generation in the NIR and THz range. Main risk: in a first period the efficiencies might be low due to bad process control.
4. Aurora: Within the project Aurora, we plan to achieve an efficiency of 2-4 percent and to develop an process on flexible substrates. Main risk: devices might not be stable enough in time, since we have to process under air. Best solution would be the acquirement of a glove box to work under inert atmosphere. Second best solution: Try to do some of the processing outside FBK (complicated and difficult to organize).

Main risks of goals 1-3 are related to performance of instrumentation in MTLab (uptime of instrumentation and control). Problem will be kept under control by close collaboration with MTLab.

4. Budget

Expenses	
Personnel	194576.00
Travel	7500.00
Equipment (HW/SW)	5000.00
Other (e.g. subcontracting to external contractors)	75000.00
Internal collaborations: “subcontracting” to other unit	0.00

Total Expenditure (including overhead)	**€282.076.00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	71.261.00
Other external incomes (projects, grants, etc.)	111.275.00
Internal incomes (“subcontracted” by other units)	0.00
Total Income	**€182.536.00**
Financial Need (Incomes – Expenditure)	**€99.540,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€99.540,00**

5. Human Resources

During summer of 2010 the contracts of both Mher Ghulinyan and Yoann Jestin will end. Mher Ghulinyan has played a crucial role in the development of both competences and reputation of APP in photonics. Therefore, I would highly recommend to renew the contract of Ghulinyan and to insert him in the tenure track of FBK. In addition I would suggest to renew also the contract of Yoann Jestin to guarantee continuity in our research on organic photovoltaics.

In addition the research unit should grow in number by the arrival of PhD Valentina Troncale currently working on III-V quantum dots at EPFL in Lausanne, Swiss. PhD Valentina Troncale applied for 2 different post-doc scholarships to join APP one financed by PAT and the other from the Swiss National Science Foundation.

6. Risks and Mitigation Plans

Main risks of goals 1-3 are related to performance of instrumentation in MTLab (uptime of instrumentation and control) and process development. Problem will be kept under control by close collaboration with MTLab. Routinely meetings will be organized to inform MTLab in time about the requirements for our projects and to organize the efficient use of the equipment. For very critical steps in some cases we might look for a back-up solution outside FBK.

A minor problem is the lack of equipment for optical measurements inside FBK. Currently we plan to strengthen the collaboration with the unit SOI (e.g. join equipment, work in their lab …) to minimize the problem.

BIOSINT – BIOFUNCTIONAL SURFACES AND INTERFACES

Unit Name	BIOSINT – Biofunctional Surfaces and Interfaces	
Type	Research	
Head	Cecilia Perderzolli	
Staff	2009	2010
	3 Researchers	3 Researchers
	2 Research assistants	2 Research assistants
	1 Post doc	1 Post doc
		1 PhD student
		2 undergraduate students

Document Status submitted 2009-10-27

1. Executive Summary

1.1. Objectives

The research of the Biofunctional Surfaces and Interfaces (BIOSINT) group is devoted to the development of soft biocompatible and bio-functional interfaces on solid surfaces through a) the study of the interactions between surfaces and molecules/biomolecules in a biological perspective and b) the development of processes enabling controlled attachment of functional biomolecules. The research group is characterized for its multi-disciplinary competences with members having biological, physical and chemical background. The activity of the team covers three partially overlapping research fields: a) the study and development of surface functionalization processes aimed to the establishment of linkage strategies which allow the gentle immobilization of biomolecules to surfaces, preserving conformation and optimizing surface density and orientation; b) the investigation of biointerfaces for the development of micro-devices for nucleic acids and protein analysis in diagnosis; c) the design and study of interfaces in the context of carriers for drug delivery applications.

1.2. Main Activities

The BIOSINT unit activity will be focused on basic and applied research, also through joint activities and projects with start-up companies and industrial partners.

1.3. Personnel

The research personnel that belongs to the BIOSINT unit consists of three senior researchers - 2 graduated in Biology, 1 in Physics - with a background in biophysics, two senior research assistants having experience in nanotechnology field - 1

graduated in Engineering, 1 in Physics and 1 post-doc in Chemistry and 1 PhD student of the International PhD in Biomolecular Sciences of CIBIO Centre. Besides, the unit has the support of the surface science researchers (MiNALAB unit) particularly related to the electron spectroscopy and scanning electron microscopy analysis. During 2010 also two undergraduate students of the Department of Pharmaceutical Sciences, University of Padova will be taking part of the research activity. Moreover the group will host researchers from other Institutions, both in the arrangement of already established collaborations (Latemar consortium) and invited researchers within the collaborations with prof. F. Stellacci group at the Massachusetts Institute of Technology (MIT).

1.4. Prominent collaborations

Internal: Due to the closely related activities the established collaborations are with MiNALAB unit (material micro-analysis), Bio-MEMS unit (development of micro-devices for diagnostic applications), SOI unit (study of optical detection methods) and CTP unit (molecular simulation on surfaces).

External: CNR- Biophysics Institute - Division of Trento (drug delivery systems); Latemar Consortium (www.latemar.polito.it): Olivetti I-Jet, Polytechnic of Turin, University of Trieste, Biodiversity (development of advanced devices for diagnostics and therapeutics); Laboratory of Translational Genomics, Centre for Integrative Biology (CIBIO), University of Trento (RNA isolation from human tissues); Nanoscience Laboratory, Physics Department, University of Trento (biophotonic detection methods); Material Science and Engineering Department, Massachusetts Institute of Technology (drug delivery systems, material science); Molecular Stamping (surface functionalization for DNA microarray).

1.5. Ethical issues

The research activity involves the use of biological samples such as human or animal blood and human genetic materials.

2. Vision and Scientific Program

2.1. Context and State of the Art

The increasing demand of new technologies for the health and the personalized medicine requires the realization of low cost, flexible devices for diagnosis and therapy. A general requirement for the successful implementation of these tools is the development of suitable bio-functional materials and surfaces. The methods for the introduction of biological functionalities on inorganic/organic materials and tailoring their surface properties to improve their biocompatibility constitute indeed a core activity on which the successful development of these devices is based. In fact, extremely specific biorecognition elements have to be developed and linked on the device surface without compromising their bioactivity and addressing issues like the stability of the biocomponents. The utilization of these devices in contact with complex biological samples, comprising many kinds of biomolecules (proteins,

lipids and nucleic acids), poses indeed strict requirements on their interfacial properties, especially considering the large surface over volume (s/v) ratio characterizing the devices in which these materials are utilized. Thus biofouling, i.e. sticking of proteins to surfaces, becomes a bigger challenge. Non specific adsorption leads to an unpredictable concentration of assay components and influences the timing of delivery of analytes to the sensor area. On the other hand, some functions require the onset of strong non specific interaction between biomolecules and surfaces, a situation in which high s/v ratios permit the achievement of improved performances with respect to traditional devices. Therefore, both fundamental and applied research involving new materials and their biocompatibility have to be explored and represent a key step for the evolution of nanobiotechnology.

Since 2001, within the Physics and Chemistry of Surfaces and Interfaces Division of the ITC-irst (now FBK-CMM), our group started an activity in the field of nanoscience and nanotechnology related to organic and biological materials. In this frame an interdisciplinary group was gradually build based on the consolidated surface science background present in the Division and thus applying X-ray photoelectron spectroscopy (XPS), time-of-flight-secondary ion mass spectrometry (Tof-SIMS) and scanning electron microscopy (SEM) to characterize and study biomaterial surfaces, modified substrates and functional biofilms. Afterwards other techniques such as optical spectroscopies, fluorescence microscopy and atomic force microscopy (AFM) were added allowing biomaterials and coatings analysis at the nanometer to micron scale using a range of complementary approaches.

Presently the competences of the team are in the following fields: 1) Biological surface science: correlation of surface physico-chemical and morphological properties of materials with biological responses such as nucleic acids, proteins and cell adhesion; 2) Materials for biosensor and biochip development: a) carbon nanotubes functionalization with DNA for biosensor applications, b) surface functionalization for DNA microarray development; c) development of Lab-on-chip for diagnostics (in silicon and polymeric materials); 3) Drug delivery systems: liposomal drug coatings of polymeric materials; 4) Functionalisation processes: a) organic film deposition (i.e. PolyEhylenGlycols, chitosan, lipids, silanes) to create both non fouling surfaces and functional surfaces, b) peptides immobilization as a system stimulating cell adhesion and proliferation.

Since 2008, owing to the scientific reorganization of the MM Center, the research activity of the BIOSINT team is mainly focused on two aspects (as detailed later on): 1) the investigation and development of biofunctional interfaces suitable for the integration in micro-devices for diagnostic applications; 2) the investigation and development of surface coatings, based on lipid film deposition, for the transport and controlled release of active agents such as drugs.

2.2. Vision and Goals

Over the coming decades, the populations of many countries will age due to a decreasing birth rate and an increasing life expectancy. At the same time life-styles in developed countries have become increasingly sedentary. These developments will impact the healthcare system with certain disease appearing earlier in life while the older generation will require an higher quality of life. Nevertheless, the health-

care costs should be kept reasonable. Nanomedicine, the application of nanotechnology to healthcare, will be an essential tool to address many of these clinical needs in the future. It investigates the physical, chemical and biological properties of materials at the nanometers scale enabling the development of tools improving diagnosis, treatment and follow-up of diseases. Although the knowledge about the metabolism processes at cellular level continues to increase every year, they are still not fully understood to diagnose diseases at a very early stage, to treat and prevent them efficiently. Present medical practice is based on treatment of diseases once well defined and sure symptoms are occurring. Hence, in many cases curing cannot be achieved because the disease has spread all over the body, involving too many organs and compromising the body repair system. On this matter, the impact which nanotechnology will have on the medical sector has been regarded with huge expectation. New *"in vitro"* diagnostic tests will shift diagnosis to an earlier stage and allow preventive therapeutic measures. *"In vivo"* diagnosis will become more sensitive and precise due to new imaging techniques and nano-sized targeted agents. Therapy as well could be greatly improved in efficacy by new systems that allow targeted delivery of therapeutic agents directly to the diseased site.

In this very attractive and stimulating contest the research activity of the BIOSINT team will found its natural collocation for the next five years, being focused on medical diagnostics related in particular to the *"in vitro"* diagnostics. This activity will be carried out in close collaboration with technological partners (FBK-BioMEMS Unit, Olivetti I-Jet, Polytechnic of Turin, Molecular Stamping) and with biological groups, mainly the CIBIO Centre of Trento University and the Department of Development and Reproductive Sciences of the IRCCS Burlo Garofolo, University of Trieste. *In vitro* diagnosis has traditionally been a laborious task. Blood and other body fluids or tissue samples are sent to a laboratory for analysis, which could take hours or days, and could be highly labor intensive. Progressively, miniaturization, parallelization and integration of different functions on a single device, based on techniques derived from the electronics industry, have led to the development of a new generation of devices that are smaller, faster, cheaper and providing accurate readings. These analytical devices require much smaller samples and will deliver more complete and more accurate biological data from a single measurement. Within the Latemar consortium we have been working for three years on the development of a silicon-based lab-on-chip composed of three modules for genomic DNA purification starting from blood, PCR gene amplification and fluorescence detection of mutations related to the inherited illnesses (patent under application). In agreement with the aims of the MM Center (RNA project) and considering the financed projects (Naomi, Pocemon, Nanopur,) in the next five years we intend to carry on: 1) optimizing material surfaces for DNA purification in micro-conditions starting from untreated biological samples such as blood; 2) developing material surfaces for polysomal RNA isolation; 3) developing a solid-phase method for reverse transcriptase; 4) studying optical and label-free (i.e. cantilevers, microresonators) detection methods with the aim to obtain higher sensitivity and specificity of these diagnostic systems.

Furthermore, we intend to apply our competences to a different field of nanomedicine with the study and development of drug delivery systems, due to the interest

to: 1) increase and strengthen the collaboration with the CNR-IBF (M. Dalla Serra) based on the use of liposomes or lipid-coated nanoparticles; 2) continue the recently started collaboration with F. Stellacci related to the synthesis and analysis of nanoparticles. This year we have indeed started a fruitful collaboration with prof F. Stellacci, an expert of advanced surface materials science at the Massachusetts Institute of Technology (MIT), sharing the interest for the future not only in the field of the drug delivery systems but also for the development of biofunctional materials for diagnostic systems.

2.3. Activities and Work Plan

In order to accomplish the objectives of the BIOSINT unit the following research activities are planned for the next year:

a) Study of biomolecules-material interactions (Naomi, Latemar and Pocemon projects)

The investigation of the molecular interactions between biomolecules (DNA, RNA, proteins, lipids) and surfaces carrying different chemical, physical and morphological properties constitutes a fundamental topic for the development of opportunely designed materials. The material surface properties determine its behavior when it comes in contact with biological fluids and biomolecules. A layer (or a multilayer) of biomolecules quickly covers the material surface causing in turn subsequent reactions with the complex mixture of molecules that are present in the surrounding. That means that it is a thin layer of few nanometers which takes control of the material reactions. Within the Naomi, Latemar and Pocemon projects will be necessary to carry out this type of analysis to investigate on the biocompatibility extent of materials utilized for the chip microfluidics, for the lab-on-chip in polymeric materials and for the label-free detection chip module (cantilevers), respectively.

b) Development of biofunctional surfaces for lab-on-chips (Latemar, Pocemon and RNA projects)

This task includes several activities with important objectives for the next year regarding DNA lab-on-chips: 1) the fully integration of the silicon-based device produced in Latemar; 2) the realization of the prototype of a second Latemar lab-on-chip, made by using polymer based technologies; 3) the realization of a polymeric PCR chip module in PDMS, using engineered Taq DNA polymerases (by KAPA Biosystems or Finnzymes, for example) to amplify the desired gene sequence starting directly from blood samples.

Furthermore, the RNA project will continue during 2010 not only with the study of polysome structure using surface sensitive techniques such as AFM but also with: 1) the study of the interaction between polysomes and functional surfaces; 2) the development of functional surfaces for the solid-phase isolation of polysomal RNA in microdevices. During this year the research activity of this project involved mainly the CIBIO researchers for the experimentation on the polysome purification procedure and the BIOSINT researchers for the polysome analysis aimed the determination of their native structure. Now next step will be the study of the materials with the final goal to design and fabricate a working microstructure in collaboration with the Bio-MEMS unit.

c) Study of surface functionalization processes (Naomi, Pocemon, Nanopur, Imbio projects)

In order to achieve the scientific objectives of the ongoing projects a strong effort will be applied to the study of surface modification methods:

- to optimize already realized processes: 1) carbon nanotubes functionalization for the realisation of an electrochemiluminescence DNA sensor; 2) microresonators coating with a silane activating film and subsequently with DNA-aptamers molecules acting as highly specific receptor for thrombin (bioaffinity sensor); 3) lipid-based surface coating by nanoparticles (carbon-coated ferromagnetic, iron oxide) for genomic DNA isolation; 4) glass and silicon surface coating with organic molecules (silanes, polymers) allowing the controlled immobilization of DNA in microarrays applications; 5) the optimization of the surface positive charge density using wet and plasma methods (biosurfaces for DNA isolation).

- to study and develop new processes: 1) surface passivation procedures for microfluidics in polymeric materials; 2) functionalization of microcantilevers made of silicon and gold for DNA hybridization detection.

This last procedure involves critical aspects, requiring the ability to specifically functionalize the top area of the microcantilever and to passivate all the remaining surface area, allowing the utilization of not purified biological solutions.

2.4. Collaborations

- University of Trento: CIBIO Centre, prof. A. Quattrone – RNA isolation from human cells, study of polysome structure (RNA project); Physics Department, prof. P. Tosi, prof. G. Guella – development of functional polymeric surfaces by means of plasma treatments (Latemar and RNA projects); Physics Department, prof. L. Pavesi - biophotonic detection methods (Naomi project)
- Polytechnic of Turin: Materials and Processes for Micro & Nano Technologies Labs, prof. F. Pirri - development of polymeric Lab-on-chip for DNA isolation and amplification (Latemar project); Carbon Group, prof. A. Tagliaferro - Carbon nanotubes for DNA sensor development (Latemar project)
- University of Bologna: prof. L. Prodi - development and functionalization of an ECL DNA sensor (Latemar project)
- University of Trieste: IRRCS-Burlo-Garofalo, prof. P. Gasparini - development of a silicon-based lab-on-chip for DNA isolation, gene amplification and fluorescence detection of mutations (Latemar project)
- University of Padova: Department of Pharmaceutical Sciences, prof. B. Gatto - characterization and use of aptamers in bioaffinity sensors (Naomi project)
- National Autonomous University of Mexico: Instituto de Investigación en Materiales, prof. S Muhl - functional magnetic nanoparticles for DNA purification (Nanopur project)
- EPFL (Ecole Polytechnique Fédérale de Lausanne): Institute of Materials, prof. Klok - functional organic interfaces for controlled biomolecules immobilisation (Imbio project)

- MIT Material Science and Engineering Department, prof. F. Stellacci - synthesis and analysis of nanoparticles (Nanopur project)
- CNR-IBF Trento, M. Dalla Serra - lipid-based surface coatings (Nanopur project);
- CNR-IFN (Institute of Nanotechnology) Trento, S. Iannotta - functionalization and analysis of material activated by means of supersonic molecular beams (Naomi project)
- CNR-IFAC (Istituto di Fisica Applicata "Nello Carrara") Firenze, S. Soria - functionalization and biological testing of resonant μspheres for label-free protein detection (Naomi project)
- CIVEN (Coordinamento Interuniversitario Veneto per le Nanotecnologie), R. Bozio - functionalization processes and surface analysis, chip biological applications (Naomi project)
- Olivetti I-Jet, L. Cognolato - development of silicon and polymeric lab-on-chip for DNA analyses (Latemar project)
- Molecular Stamping Trento, A. Cuppoletti – development of functional surfaces for microarrays (Imbio project).

2.5. Specific Needs and Points of Attention

During 2009 the Biomolecular Sciences and Interfaces laboratory was moved to the Nord Building on a larger area newly equipped and all the works required for its completion are going to be finished by the end of the year. Also new equipments was bought: a state of the art atomic force microscope and a confocal microscope. For these reasons there are not special needs for the next year apart from the maintenance of the laboratory.

3. Goals

The foreseen activities for the next year and the following goals can be divided mainly in two types:

- the five years Latemar project is going to conclude (September 2010), then we are in the phase of the patent deposition, funding preparations supporting future initiatives, such as spin-off, but also other opportunities for the consortium activities. Here the goals are more easily attainable.
- The strategic RNA project of the MM Center is characterized by the requirement of performing several months of basic research activity before coming to the design of an application in medical diagnostics; this time will also depends on the number of the involved personnel. In agreement with the grant office we intend to apply for projects on this topic allowing the hiring of other collaborators.

Also the research activity within the Naomi and Pocemon projects require a definite numbers of dedicated man/months. Then the ability to reach the mentioned goals

will depend on both a strict organization of the planned activities and the ability to increase the incomes in the future.

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Silicon lab-on-chip integration	R, I	E	June	-	-
Carbon nanotubes for the realisation of an electrochemilu-mine scence DNA sensor	R, I	E	Sept.	-	-
Realization and characterization of a spotted biorecogni-tion layer	R	E	Dec.	-	-
Realization and characterization of a biorecognition layer on microresonators	R	E	Dec.	-	-
Determination of the interactions be-tween polysomes and functional sur-faces	R	E	Dec.	-	-
PCR chip module in PDMS using blood samples	R	E	June	-	-
Microcantilever functionalisation and DNA hybridiza-tion testing	R	E	Dec.	-	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	300.487,00
Travel	25.000,00
Equipment (HW/SW)	13.000,00
Consumables	47.000,00
Meeting preparation	2.000,00
Other (e.g. subcontracting to external contractors)	84.300,00
Internal collaborations: “subcontracting” to other unit	€0,00

Total Expenditure	**€ 471.787,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	86.535,00
Other external incomes (projects, grants, etc.)	154.223,00
Internal incomes ("subcontracted" by other units)	€ 0,00
Total Income	**€ 240.758,00**
Financial Need (Incomes – Expenditure)	**€ 231.029,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€ 231.029,00**

5. Human Resources

The research personnel that belongs to the BIOSINT unit consists of three senior researchers - 2 graduated in Biology, 1 in Physics - with a background in Biophysics, two senior research assistants having experience in nanotechnology field - 1 graduated in Engineering, 1 in Physics and 1 post doc in chemistry and 1 PhD student of the International PhD in Biomolecular Sciences of CIBIO Centre. Besides, the unit has the support of the surface science researchers (MiNALAB unit) particularly in relation to the electron spectroscopy and scanning electron microscopy analysis.

The unit needs to increase the personnel particularly with competences in biophysics and chemistry but this is an aspect connected to new incomes, hopefully during the next year. However in the budget for the 2010 there is a request for the renewal of a collaboration contract for a research assistant in the framework of the collaboration with prof. F. Stellacci and for a new PhD position within the Doctoral School in Physics.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
RNA project: the project goal is quite ambitious, and a very high level of complexity definitely characterizes this work.	M	L	Intermediate goals have been identified, whose achievement constitutes not only a progress toward the final goal, but also it can be considered of scientific relevance "per se".
Latemar project: functionalization of carbon nanotubes (CNTs) for DNA biosensor applications. Possible shortage of supported CNTs, whose production depends on a unique facility.	L	S	1) Distribute the CNTs production during the year, to maintain a reserve of samples. 2) A second furnace is going to be settled by the end of this year, mitigating the possible shortage problems.

Naomi project: developing a functional biorecognition layer for proteins of interest. - May be difficult to develop aptamers recognizing different sites of the same protein with the required specificity.	M	M	1) Use a simplified but working model, present in the literature (thrombin and related aptamers). 2) Move to the Naomi label-free approach (a single aptamer molecule per protein is required in this case).
Pocemon project: the development of a functional DNA lab-on-chip based on polymeric technology and a label-free detection may require an extended research activity to reach the scheduled goals.	M	S	Utilize the Latemar silicon-based lab-on-chip as a proof-of–principle of the genetic mutation detection of chronic autoimmune diseases (multiple sclerosis and rheumatoid arthritis).
Group strategy: the strength of the Unit is based on the cooperation of people having different background, rising possible issues if someone cannot continue to work for an extended period of time and/or is missing.	L	L	1) Maintain a high level of internal communication, by means of internal seminars. 2) Support the spreading of interdisciplinary skills, favoring the exchange of lab competences.

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

SRS – SILICON RADIATION SENSORS

Unit Name	Srs – Silicon Radiation Sensors	
Type	Research	
Head	Claudio Piemonte	
Staff	2009	2010
		7 Researchers
		1 PhD
		1 Consultant

Document Status submitted 2009-11-25

1. Executive Summary

1.1. Scientific context

Semiconductor detectors are used in a large variety of fields in science and technology, including nuclear physics, elementary particle physics, optical and x-ray astronomy, medicine, and materials testing – and the number of applications is growing continually. The success of semiconductor detectors is due to several unique properties that are not available with other types of detectors. FBK has been working in this field for more than ten years obtaining important results such as the mass production of silicon strip detectors for the AMS and ALICE experiments. In the last few years the activity has become even more important thanks to the development of new highly impacting technologies which led to the participation of the group to important EU projects.

1.2. Objectives and methods

The SrS research unit will collect the internal know-how in the field of Silicon Radiation Sensors to act in a more coordinate and effective way. The goals are the further improvement of the research quality developing sensors with high-tech content and the innovation transfer especially to the local territory.

The research content is focused in two areas:

- Low-Light sensors. The core activity is on Silicon Photomultipliers, which is one of the most interesting innovative technologies for low-light detection. FBK is developing its custom technology in the MTlab so the approah is complementary to the one followed by the SOI group in the same field. Still, the plan for the next years is to foster the collaboration between the two groups to develop more competitive systems.

- High-energy radiation sensors. This field includes a variety of detector technologies which are manufactured in fully depleted high resistivity silicon. The main interest is on pixel, micro-strip and drift detectors. On the first two types FBK has a strong competence and the goal is to provide new customized solutions for the different applications. The third type is a completely new technology which attracts a lot of interest in precision spectroscopic measurements.

The scientific program of the SRS research unit will be developed in the framework of the "*Materials and Microsystems Center*" and it is included in the "*Nano-micro tecnologie per rivelatori e sensori di radiazioni*" thematic area of the PAT "Programma Pluriennale della Ricerca".

Innovation of the local territory is a crucial point. The group intends to work on the generation of a spin-off based on the successful results on the SiPM research activity. An important objective will be to establish a productive relationship with this new entity with an efficient transfer of the research results.

1.3. Personell

By January 2010 the SrS research team will be composed of 7 researches employed by FBK, one PhD student and one consultant. Among the 7 researchers, two are senior scientists (1 physicist, 1 electronic engineer) with a permanent position (FBK contract).

1.4. Collaborations

The main *internal collaboration* is with the MTLab in which most of the devices are manufactured.

The main *external collaborations* are with:

- National Institute for Nuclear Research (INFN), in both fields of SrS activity. This is a strategic collaboration which is consolidated in time and even stronger thanks to the MEMS2 agreement.
- Philips, in the field of low-light sensors. FBK is participating in two large EU projects, one already funded whereas the second in negotiation phase, leaded by Philips.

2. Vision and Scientific Program

The SrS activity is focused on the development of radiation detectors using the silicon to convert the particle energy into an electrical signal. Silicon is probably the most interesting solid-state material in this field thanks both to the highly advanced process techniques available as well as the material availability compared to other semiconductors. These two advantages allow the production of high-quality, reliable sensors. Last but not least the cost is much lower compared to other semiconductors.

The SrS research interests cover two main topics**:** low-light sensors and high-energy radiation sensors.

2.1. Context and State of the Art

Low-light sensors

Within the scientific community developing machines based on the detection of very faint light (up to few thousands of photons per light pulse) there is a crescent need to work with a solid-state device able to replace the vacuum-based photomultiplier tube. The main advantages that can be achieved at the system level are: size reduction, ruggedness, cost.

A class of devices that have this potentiality are diodes working in a limited-Geiger regime. In this operation mode a diode can produce a very large (but finite) amount of charge per each photon converted, enabling, thus, the detection of single photons. Particularly appealing is a device, called silicon photomultiplier (SiPM), in which several of such micro-diodes are connected in parallel to allow photon counting even in a short burst of light. Another extremely important feature of devices operated in Geiger-more is the extremely fast response.

The applications of a device, which is both sensitive to extremely weak light and fast, are numerous:

- Nuclear medicine: time-of-flight positron emission tomography
- Physics experiments: calorimetry, fiber tracking
- Astrophysics
- Biology: fluorescence measurements, cytometry.

The SiPM development started at FBK in 2005 within the framework of the “PAT-INFN” agreement. Then, in 2008, FBK joined the EU project “HyperImage” coordinated by Philips for the development of SiPMs for a TOF-PET machine integrated with a magnetic resonance. Now FBK is one of the main actors in this field producing the largest devices in the world.

The technology developed by the goup is completely custom thanks to the presence of the MTlab clean room. This is a key advantage because the performance can be optimized acting on the fabrication process. It is worth noting that the SOI unit activity in this field is carried out with a different approach: exploit standard CMOS technology. This allows a more efficient integration at the system level but imposes many restrictions on the optimization of the device performance. For the coming years a more intensive collaboration between the two groups is foreseeable to obtain a more competitive hybrid system.

High-energy radiation sensors

High-energy radiation detection using silicon keeps continuing to be a very active field both in terms of R&D as well as market. The applications cover a wide range of fields:

- Physics experiments: trackers, ion detection
- Medical physics: X-ray detection, dosimetry

- Material characterization: spectroscopy;
- Homeland security
- Astrophysics

FBK has been working on high-energy silicon radiation detectors for more than 10 years obtaining important results such as the production of micro-strip sensors for the AMS and ALICE experiments in 2000-2004. This production activity is unique in Italy and one of the very few around the world. After those large productions, FBK had numerous requests (on average 6 per year) for small productions of customized micro-strip and pixel detectors for various experiments ranging from nuclear to medical physics. Flexibility in both the fabrication technology as well as the design has been FBK strong added value.

Besides pixel and micro-strip technologies, which are quite well established, FBK started completely new R&D activities on three-dimensional detectors (3D) and silicon drift detectors (SDD).

The development of 3D sensors, which represent the new frontier for large particle physics experiments, started in 2005 within the MEMS1 agreement between INFN and PAT. FBK has obtained extremely encouraging results being the second producer (after the inventor of the technology) whose devices have been characterized in a test beam. Still, a lot of work has still to be done to fulfil the requirements given by high-energy physics experiments.

The development of SDDs has started very recently: in 2009. The inputs that initiated such developments came both from industry as well as from INFN. This technology is extremely interesting both from the scientific as well as potential market point of view.

2.2. Vision and Goals

Low-light sensors

The SiPM is a rather a new sensor so significant improvements are expected in the coming years. There are common requirements coming from all applications such as the reduction of the dark noise and the improvement of the photo-detection efficiency. Then, each application has particular needs.

For a positron emission tomography system, which is so far the most interesting application, the photo-detection efficiency must be maximized in the blue region of the light spectrum. Then, special integrated packaging solutions have to be developed in order to allow the creation of large matrices with low dead area and without any obstacle on the sensitive side to allow the positioning of the scintillator crystal. Both aspects are quite delicate and require a consistent amount of work leading to a radical technological innovation (second generation SiPMs).

Thanks to the success of the SiPM activity, an important objective is the creation of a spin-off company. The key idea is to transfer continuously the R&D results to this company which in turn creates a link to the market.

High-energy radiation sensors

The SRS group intends to pursue three objectives in the coming years:

- provide, with even more efficiency than in the past, customized pixel and micro-strip detectors for the scientific community and industry. This task requires a lot of effort in terms of layout, processing and testing and relation with the partner because it is usually segmented in many different contracts.
- Finalize the development of 3D detectors in order to be ready for the upgrades of the large physics experiments at CERN. The primary goals are to develop a fully 3D sensor and an active edge detector.
- Develop competitive SDDs to satisfy the requirements both for spectroscopic and tracking systems. This means we need to develop a technology with extremely low leakage current and thin radiation entrance window.

2.3. Activities and Work Plan

To start accomplishing the long-term objectives mentioned above, significant activity has to be carried out in design, simulation, process technology and testing starting from the next year.

Low-light sensors

In order to enhance the photo-detection efficiency in the blue region we plan to modify the internal structure of the device. The first step, planned for the next year, is the development of a new p-on-n technology. The amount of activity is significant and an accurate parametric and functional testing is mandatory to have fast and reliable feed-back. For this reason the testing capability has to be reinforced with more sophisticated functional characterization.

In parallel the packaging issue will be tackled. The long-term plan is to develop a technology to bring the signals on the non-sensitive side of the device by means of conductive columns passing through the silicon bulk. The development requires a considerable effort on the technological side and this will be carried out in tight collaboration with the Micro Technology Laboratory. For the next year we plan to have some first test structure consisting in conductive columns.

High-energy sensors

Three activities will proceed in parallel to fulfil the goals mentioned in the previous section.

Objective 1: the activity consists mainly in a customization in terms of layout and process details of a consolidated technology platform. Each request will be treated according to the specific requirements.

Objective 2: the activity is mainly focused on the technological process. For the next year, the ambitious goal is to have a fully 3D sensor.

Objective 3: this task will require a lot of effort from all points of view since it is a completely new technology for FBK. First competitive Silicon Drift Detectors are expected by the end of the year.

The exploitation and dissemination of the results will constitute an additional activity for the whole year.

2.4. Collaborations

- INFN. The MEMS2 agreement is the framework for this collaboration. Within this project, both topics covered by the research unit are covered.
- PHILIPS. The EU project HyperImage is the framework for this collaboration. A large fraction of the low-level light topic is covered by this collaboration.
- Large Japanese company. The NexRay project is the framework for this collaboration. The activity in the High-energy radiation area.

2.5. Specific Needs and Points of Attention

The creation of the spin-off company is a point of attention for the next year. We have already done a considerable work on it but, in order to have a picture as clear as possible on the real feasibility, some pieces of information have still to be collected. In particular, the final result from the business plan analysis will give a definitive response.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
SiPM – blue enhanced device	R	E	Oct.		
Competitive Silicon Drift Detector technology	R	E	Dec.		
Full 3D silicon detector	R	E	Nov.		
New working model between MTlab and SrS units	F	I	June	Common research developments	
Enhanced collaboration with SOI	F	I	Dec.	Common scientific projects/results/publication	
Creation of a spin-off on SiPMs	I	E	March		See paragraph 2.5

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	401.676,00
Travel	23.500,00
Equipment (HW/SW)	10.000,00
Other (e.g. subcontracting to external contractors)	142.000,00
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€577.176,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	247.255,00
Other external incomes (projects, grants, etc.)	185.374,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€432.629,00**
Financial Need (Incomes – Expenditure)	**€144.547,00**
Required Structural funding from PAT (it should be equal to the previous item)	€144.547,00

5. Human Resources

By January 2010 the SrS research team will be composed of 7 researches employed by FBK, one PhD student and one consultant.

Among the 7 researchers, two are senior scientists (1 physicist, 1 electronic engineer) with a permanent position (FBK contract). They have core competencies in simulation/layout and testing. The 5 young researchers (2 physicists, 2 electronic engineers, 1 TBR) have competencies in simulation/layout, processing and testing respectively.

The consultant, being a well-known expert in the field, will provide assistance in both technical aspects as well as in the exploration of new topics and collaborations within the SrS field of activity.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Interruptions on the operability of the fabrication laboratory	L	S	
Delay in the development of fully 3D sensors	M	M	
Failure of the spin-off project	L	M	

Legend:

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

MTLAB – MICROTECHNOLOGIES LABORATORY

Unit Name	MTLab – Microtechnologies Laboratory	
Type	Laboratory	
Head	Pierluigi Bellutti	
Staff	2009	2010
	10 Researchers	10 Researchers
	3 Technologist	3 Technologist
	1 CoCoPro	1PhD
	1 Consultant	1 CoCoPro
	14 Technicians	1 Consultant
		14 Technicians

Document Status submitted 2009-11-18

1. Executive Summary

MTLab effort is concentrated on growing as a reliable and a technologically updated facility where R&D activities in Radiation Detectors and MEMS areas, can be successfully carried out and where SME's, interested in this knowHow and capability, can find the opportunity to introduce innovation in their products, working together with us in a high quality- R&D and manufacturing environment.

MTLab will also play a leading role in the technological progress of the Country through collaboration in higher-education initiatives with universities and other research Partners at national and European level.

To meet these purposes, MTLab is structured as a Facility fully equipped to cover a wide range of fully characterized processes on 100 mm wafers (Silicon, quartz, glass…) offering also extensive functional testing.

MTLab is organised:

- to develop and carry out technological processes on behalf of the FBK Research Units.
- to offer technological know how on the available processes (research activity) developed both internally or jointly with other Research Units of FBK .
- to carry out engineering work to transfer technological innovation into marketable products .
- to support industrial production for medium quantity standard products (services).

MTlab is very flexible in mixing these types of activities whose relative weight changes over time depending on internal and external conditions.

MTLab is structured in three labs:

- Microfabrication Lab carrying out silicon wafer processing and related technologies;
- Testing Lab with process parametric control and functional testing of devices
- Microsystems Integration Lab, developing solutions for advanced packaging. and System engineering.

Each lab has a qualified staff with researchers, developing new processes and controlling advanced technologies, and technicians, for equipment operation and maintenance and standard processing activities.

The most relevant longterm collaborations of MTLab are with: INFN, as a silicon processing facility; University of Trento (NanoScience Lab), for dedicated silicon photonics processes; Optoi Microlectronics, for development and production of devices for industrial application.

2. Vision and Scientific Program

2.1. Context and State of the Art

It is important to emphasize that know how and equipments of MTLab belong to the "MEMS world", quite different from Integrated Circuits (ICs) Silicon Technology. While ICs world is under pressure to follow the Moore's law (the continuous shrinking down of the minimum feature of the technology accounts for the rapid equipment obsolescence and the astonishing increase of plant costs), MEMS had opened new fields of technological development, where the effort is more focussed on smart exploitation of relatively stabilized technological capability, an approached named "more than Moore". In this way both equipments and basic processes blocks have much longer operating life with a beneficial impact on the related investments costs of (for instance, dismissed equipments from ICs are feeding a flourishing market of refurbished equipments for MEMS).

In comparing MEMS and ICs technologies one can recognise some common features, such as substrate material (i.e. silicon, although MEMS are also developed on quartz and glass) and the same suppliers of equipment, but also clear differences such as the use of gold which is widely used in MEMS and banned in ICs. A further feature of MEMS technology is the exploitation of the third dimension of silicon substrate, while ICs are a strictly planar technologies. It is important to notice that from a research point of view, ICs technology allows development of new devices in a fabless environment, because the customisation is at the design level and ICs silicon foundry offer standard technologies and packages. On the other hand, MEMS typically require customised technologies and this makes its access difficult for R&D institutions and SME. MTLab aims at making these resources more easily available to them. This is its core mission as well as its "raison d'etre".

Based on the growing application range of MEMS devices and the need to grow a multidisciplinary scientific and technological Know-How, a sparkling research activ-

ity is going on, driving innovation in key markets such as automotive, ambient assisted living and bio-applications.

MTLab wants to expand its role in this field of growing interest as an open facility for MEMS at international level, offering similar services as those of an ICs foundry to selected Partners and with a broad but limited spectrum of technologies. Besides it offers the right environment for some Partners to develop their own technologies and processes getting advantage of the full equipment line available. MTLab is indeed well equipped for customised MEMS development and, more generally speaking, is a flexible structure suitable to develop “customised technologies”. This is demonstrated by the undergoing activities with two major successes, both characterised by a high degree of a technological customisation: the production of large area detectors for space application and the growing production of customized optical devices for a local SME, with a worldwide market. During the last five years a remarkable financial effort was made to increase the capabilities of MTLab in terms of processing and testing equipment.

Microtechnologies activities at FBK are experiencing a period of indisputable visibility both a national and international level in well define application domains. MTLab is recognized as a unique Facility in Italy, and of comparable level to most of those present in Europe and elsewhere. To defend the actual position and to move to further developments itrequires a strategic plan to consolidate and expand the existing technological platforms. This plan may include the facility upgrading up to 6”, a substrate dimension that our competitors have already adopted or are moving to.

2.2. Vision and Goals

MTLab activities are strongly connected with the scientific work of FBK research units of the Material & Microsystems area. The major objective of MTLab is to be a reliable and a technological updated facility where R&D activities in the area of MEMS, micro and nano technologies can be carried out and where enterprise, interested in these know-how and capabilities, can find the right partner to address innovation of their products,.

To fulfil this objective, MTLab have to share a common strategy with the Units.

Furthermore, MTLab will work to extend its capabilities to national level through an action of strategic marketing where actors such as large research institution, University and Industry/Economical Development Ministry should be involved. This action is absolutely necessary, because a well performing MTLab has a processing capability much higher than required by the local scientific and industrial demand. Some results have definitely demonstrated that this way is the right one. The consolidated relationship with INFN (National Institute of Nuclear Physics) is an example of tight collaboration with a large research institution; while the successful development of a gas sensors for an international company together with a recently acquired R&D international industrial project testifies that MTLab can meet the needs even of big industrial partners. Last, but non least, the success story with a spin off (OptoI Microelectronics) is a proof of what technological transfer and innovation with local territory can produce.

What has just been said for the Country can be applied at European level, through strategic collaboration with outstanding partner such as CSEM, CEA-Leti and IMS-Fraunhofer. The seeds providing the starting point has already been thrown during 2009 and now MTLab is engaged in developing common projects, including those based on a "supply chain" model, to exploit the larger production capability available by these international partners. Within the international community, MTLab is qualified supplier for CERN experiment and is now involved setting up a "consortium" with some major detectors and integrated systems providers for the next generation experiments at LHC.

Beside this, MTLab has applied technological research activities focused on silicon based photovoltaic cells for solar concentrators. In this specific field MTLab would like to become a well recognised actor on the scene within the next 2-3 years, able to promote specific industrial exploitation of this promising technology.

2.3. Activities and Work Plan

MTLab is are structured on three labs closely cooperating to meet on schedule and with the allocated resources the expected results. For the 2010, MTLab plans to carry out the following activities:

- Processing as requested by the Research Units.
- Development of a demo system of PV panel on sun tracker (to be placed on the institute roof). This system is aimed at an "on field testing".
- Set up of a new interaction model with research units. Recent experiences have shown that the efficiency of the microsystems activity at FBK can be increased with some changes in the task management sharing between research Unit and MTLab.
- further improvement of the quality control procedures and the Cost accounting model to prepare MTLab for possible future ISO certification.

Specific activities for each labs are also planned including:

Microfabrication Lab:

- development of a silicon solar cell, for solar concentrators, having an efficiency of 21% @ 1sun. The ability to overtake the threshold of 20% of efficiency in a simple and economical way will open a way for large volume production.
- a Through Silicon Via contacts technological module. This will be a much needed technological module available to research units. It will include the development of a new galvanic processes for Silver.
- technology transfer of the SiPM. To meet the market needs, reduction of the production cost is mandatory. by providing the services of external silicon foundries.
- Starting up of the new stepper, development of the first set of recipes. Starting from February the new stepper should be available. It's a complex equipment and time will be required to fully exploit its capability.
- Tracking model for lots to reach a tight control of the "facility throughput"
- Evaluation of 6" upgrade of the microfabrication lab

Testing Lab:

- start up of a new prober and capability to test 8” wafers
- automation of the solar cell testing at wafer level.
- Development of a test set up for solar concentration measurements

Microsystems Integration Lab:

- Star up of wafer bonding and first process development activities
- Development of Hermetic packaging under vacuum for radiation sensors

2.4. Collaborations

Collaboration already settled:

- FBK Research Units. MTLab will further strength and expand its collaboration with all the research units active on Silicon Microtechnology: MEMS, SRS, Bio-MEMS and APP. Furthermore, joint activities with other units belonging to CMM are planned to have access to material and interfaces characterization (M2B2), for new materials suitable for PV application (PAM and APP), and support of electro-physical, thermo-electrical and mechanical simulation necessary for technologies developments (CTP).
- ENEA (Portici, Na), ARCES (Bologna): for Si photovoltaics technologies, the former for solar concentration systems, the latter for simulation.
- INFN: within the MEMS2 agreement, MTLab is playing the role of a “national facility” for INFN. for all INFN groups interested in silicon based microtechnologies.
- CERN: MTLab is within a consortium of European silicon detectors producers for future LHC upgrades
- OlivettiJet: the plant in Arnad (Ao) is the MTLab reference foundry in Italy for production
- OptoI Microelectronics: MTLab collaborate since long time with this spin off mainly in the fields of optical and MEMS devices. In the next year other development on sensors for building automation and PV systems are planned.

Collaboration are being set up also with:

- CSEM (Neuchatel, CH) and CEA-Leti (Grenoble, F) as partner on MEMS activity
- IMS Fraunhofer (Duisburg, D), for technology development, technology transfer and microsystems integration
- VTT (Helsinki, Fl), for detectors assembly

2.5. Specific Needs and Points of Attention

New equipment

Within MEMS2 project there are some specific investment already planned to support the microfabrication activity on MEMS. Among these are present: a galvanic wet bench for gold deposition, a dry etching systems and a new scrubbing system for exhaust abatement.

Training for working team

MTLab is experiencing the necessity of a support to improve both management attitude of coordinators and team spirit. For this reason specific action has been discussed with Human Resources Office to implement during 2010.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
demo system of PV panel on sun tracker	F	E	Sept.	-	-
silicon solar cell with 21% eff. @1sun	I	E	Nov.	-	-
new interaction model with research units & tracking model for lots	F	I	May	-	-
Test set up for solar concentration measurements	F	E	June	-	-
Through Silicon Via contacts with Ag filling	R	E	Sept.	-	-
Start up new stepper	F	I	July	-	-
New prober set up	F	I	May	-	-
Automation of solar cell testing	F	E	Oct.	-	-
Star up of the wafer bonder + process dev.	R	E	Nov.	-	-
Hermetic packaging development	R	E	Dec.	-	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	1.360.646 ,00
Travel	21.500,00
Equipment (HW/SW)	553.000,00
Other (e.g. subcontracting to external contractors)	1.073.500,00
Internal collaborations: “subcontracting” to other unit	0,0
Total Expenditure	**€3.008.646,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	229.041,00
Other external incomes (projects, grants, etc.)	1.309.966,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€1.539.007,00**
Financial Need (Incomes – Expenditure)	**€1.469.639,00**
Required Structural funding from PAT (it should be equal to the previous item)	**1.469.639,00**

5. Human Resources

The new CR area operativeness is ready to start. This will require to split part of the team, loosing in flexibility, because the two CRs will be separated. At present it is believed that no extra resources are required.

A new young researcher will join the group starting January to work on MEMS2 project, while Enrico Serra will move in the CTP Units. This last decision was taken based on the fact that Enrico Serra activity is focused on simulation, an activity that can fit the core one of CTP Units. The close relationship between Serra’s expertise an MTLab needs will guarantee a strategic link between MTLab and CTP units.

Stabilization. MTLab stabilization program is focused to ensure the covering of basic equipment know how from both technical and R&D viewpoints. This program foresees the stabilization of two technicians and one researcher in Microfabrication Lab as well as a researcher in Testing Lab. All these candidates have more than 4 years of specific experience matured in MTLab.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Equipment downtime	M	S	

Legend:

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

Equipment downtime can be faced with the well trained and skilled maintenance team present in MTLab. However, severe situation can occur keeping equipment down for several weeks. In this case the only viable solution we have is to exploit external processing services with a dedicated budget item. The most reliable way would be to turn to maintenance contracts, but this is still too expensive in absence of mass production. In any case, an adequate maintenance budget is mandatory to mitigate this risk.

7. Ethical Issues

Among the planned activities of MTLab none of the following listed issues, as related to ethical issues, are present.

REET – RENEWABLE ENERGIES AND ENVIRONMENTAL TECHNOLOGIES

Unit Name	REET – Renewable Energies and Environmental Technologies	
Type	Applicative	
Head	Alessandro Bozzoli	
Staff	2009	2010
	6 Researchers	7 Researchers
	3 Technologist	3 Technologist
	0 Post Doc	0 Post Doc
	0 PhD	2 PhD

Document Status submitted 2009-11-18

1. Executive Summary

REET unit is working on the sectors of *Renewable Energies*, *Environmental Technologies* and *Modelization processes*. Its activities in the specific fields go from *basic research* and *innovation* to *technology transfer* and *support to entrepreneurial sector* under the technological point of view.

The core attitude of REET unit is the support to local initiatives, networking the actions of the SME and the entrepreneurial sector, developing in parallel an international approach to its general vision, including cooperations, international projects, international partnerships and PhD students.

A brief description of the Main Activities include:

- *basic research*: starting activities on the sector of *Wireless energy and Rectennas technologies*, *Thermal Fluid research* applied to Solar and Geothermal technologies, *Energy Conversion processes* (biofuels, energy multigeneration) based on specific experience and skills of REET unit in the different sectors of Electromagnetic interactions, of Modeling, of Renewable energies.
- *innovation*: the innovation is the actual main application sector of REET unit. In the *Energy sector*, REET unit has launched a series of pilot projects in different areas including solar multi cogeneration technologies, energy conversion from waste biomasses, solar cooling and heating technologies; in the sector of *Environmental technologies* new technologies for the safety systems in industrial machineries and processes.
- *technology transfer and support to entrepreneurial sector*: REET unit is working on a series of projects, demonstrators and prototypes on the energy and environmental sectors. The specific projects have the intent to provide added

values to the partner companies, to which the results and technologies will be transferred. Some innovations of REET unit will be transferred directly to Start Up activities.

REET unit is composed by 6 researchers (3 seniors), 3 technicians. The specific skills well represent all the different Main Activities of the unit, from the theoretical point of view to the more applied physic and engineering field. The objective on the skills development is to grow up a shared expertise on the Modeling sector and to specialize the unit personnel on the three main sectors of Energy, Modelling and Environmental Technologies, by three workgroups working on parallel projects and initiatives.

The unit is cooperating internally and at local and international level with a series of Institutes and Companies:

- *internally* main cooperations are with the *Center for Information Technology* on the EIT KIC Energy initiative (*eCANDO*), and with some units from the *Center for Materials and Microsystems* on the energy technologies.
- *at local level*, REET unit is cooperating with all research and public institutions and the main companies at large and Small - Medium level (amongs them are UniTn, FEM, PAT, APE, Habitech, ITEA, Dolomiti Energia, Enervals, ELMA, Vescovi Stufe, Eurostandard, Steinex, CRF, Ceii, and others).
- *at national and international level*, REET unit has a wide cooperation from all over Europe and at International level (amongs them are Uppsala University, TU Graz, TU Hamburg, University of Twente, Politecnico di Milano, Massachusetts Institute of Technology, Narva Lichtquellen, Philippine GmbH, Aermec SpA, and others).

2. Vision and Scientific Program

2.1. Context and State of the Art

REET unit activities are build up on three main sectors, which include all projects and programs: *Renewable energies*, *Physical modeling* and *Bio-Electromagnetism*. Additional actions are guided within the ambit of *Dissemination and Exploitation*, including *Technology Transfer and support to Entrepreneurial world*. During the last year, REET unit has improved the following activities at local and international level:

- *Renewable energies sector*: REET unit has worked on a *full energy vision*, developing since two years a work plan divided into three phases. The plan is focused on innovations on the specific field of distributed cogeneration and retrofittable technologies applied to small-medium sized dimension.

  The below picture describes the general VISION of REET activities in the field of Renewable Energies:

At the present time the PHASE 1 is completely in progress for the pilot projects in different application fields, all coordinated by REET unit.

SOLAR THERMAL/THERMODYNAMIC: *DiGeSPo*, a FP7 funded European project (best project of the CALL Energy-2009-1) to obtain a micro cogenerating technology for domestic applications based on Concentrated Solar Power of small size and applied to a Heat Engine (Stirling).

BIOMASSES: *BioTec*, a local funded project by Fondazione CaRiTRo on Energy conversion processes by waste agricultural and forestry biomasses.

BioDomUs, a funded project by the Province Energy Agency on a cogeneration of energy from small sized Stirling engine applied to a domestic pellet boiler.

SOLAR APPLIED TECHNOLOGIES: *SolTerm*, a funded project by the Province Energy Agency on a solar heating and cooling technology based on adsorption processes.

GEOTHERMAL (low entalpy): a project is ready to run on both territorial planning and technology developments on ground probes and heat pumps.

- *Physical modeling*: the second sector of REET is active in mainly all the projects providing feedbacks and results for the optimal technology orientation and developments. Specific projects on Modelization has been run during this year (Iacobucci project to optimize heat exchangers for airplane coffee machines).
- *Technology transfer and support to local companies*: the third sector of REET, is composed of a series of projects and initiatives actually running or in phase of development.

  EUROSTANDARD project: about the development of a safety valve for natural gas infrastructures.

  STEINEX project: about a safe technology for operators working on cutting-stone machines.
- *Dissemination and Exploitation actions*: activities on scientific publishing for International Congresses and Journals, activities to build up start up activities. In specific participation to the networks of the ISES (world and European congresses), of WREN (world congresses) and the build up of HT Solar Start up in cooperation with AERMEC and PHILIPPINE companies.

2.2. Vision and Goals

The guiding Vision on Energy of REET unit starts from the consideration that no one technology or renewable energy system can support by itself the real and concrete realization of a energy-positive building. REET unit has worked on an ENERGY VISION for an integrated and hybrid system.

The realization of the plan should pass through a series of steps. The pilot projects on the specific themes and application areas, the technology transfer of consolidated technologies and the system integration and realization of hybrid technologies.

The whole plan is proceeding in the correct direction since two years and almost all the pilot projects has started or are starting at the present time. Some activities, as the solar cooling technology, are close to the second step, the technology transfer of results. Finally, all the pilot projects have been built looking forward to the third phase of hybrid technologies. In such way all the useful elements have been inserted within such projects. Some examples are the Technology Transfer Board for DiGeSPo project, where we have the intention to exploit, since now, the availability for a more complex hybrid system as an output of a pilot research oriented on the solar energy micro-cogeneration at distributed level.

The final objective is the realization of a FULL SYSTEM named the *+energy building*, able to produce in an integrated and feasible way thermal power for heating, cooling and hot sanitary water, electrical power and biofuels from domestic wastes and organic materials.

2.3. Activities and Work Plan

During 2010, REET unit will be running 6 funded project, from energy to environmental sectors, on the described topics. All the actual resources, plus an additional employee and two PhD, will cover almost completely the related projects (see more details and summary on paragraph 2.1). The below table summarize the division of resources between the different projects and activities.

REET - Resources workplan, %				*Start*				
	In progress	*In progress*	*In progress*	*01/01/2010*	*In progress*	*In progress*		
2010	***Eurostandard***	***Steinex***	***BIOTEC***	***DIGESPO***	***APE 1***	***APE2***	***New Projects***	TOTALI (%)
Alessandro Bozzoli	5	5	5	50	5	5	25	100
Luigi Crema			15	50	15	10	10	100
Marco Cozzini	40			60				100
Rolando Pontalti		70					30	100
Alessandro Vaccari		70					30	100
Guido Cicolini				20	50	30		100
Marco Frizzi		70		30				100
Alberto Zanetti					60	40		100
TBH 1 - Alberto Bertaso				100				100
TBH 2 - Ric. IV fascia				100				100
PhD Student, 1		100						100
PhD Student, 2			100					100
Total efforts (%)	45	315	120	410	130	85	95	1200

Additional projects have been submitted or will be during next year on different themes:

- *Biofuels from ALGAE*: participation as a partner on a proposed project lead by THETIS SpA that will be submitted on next March;
- *Next Generation Stoves/Boilers*: coordinator of a European project (FP7-ENERGY-2010-2) on the development of the next generation stoves and boilers;
- *ISySavE project*: coordinator of an European project (FP7-ENERGY-2011) on the theme of ICT for energy systems applied to the concept of Energy-positive building.

REET unit will participate to local projects on "Energy Sustainability of local Agro-Companies" and "Technological and sustainable alpine refuges".

REET will participate to mainly two international congresses, EUROSUN 2010 in Graz (Austria) and WREC XI in Abu Dhabi (United Arab Emirates).

2.4. Collaborations

The main REET foreseen cooperations will include:

- UPPSALA UNIVERSITY (Sweden), prof. Ewa Wackelgard: development of new Cer.Met. materials as adsorbing layers for solar thermal applications at medium temperatures. The development is an essential aspect within the DiGeSPo project;
- POLITECNICO di MILANO (Italy), prof. Giuseppe Silva and dr. Barbara Rivolta: development of new thermal fluids applied to solar thermal and thermodynamic technologies. The development is an essential aspect within the DiGeSPo project and for the application field of geothermal energy;
- SUSTAINABLE ENGINE SYSTEMS LTD. (UK), dr. Allan J. Organ and dr. Drummond Hislop: development of Stirling engine in both BioDomUs and DiGeSPo projects;
- MASSACHUSET INSTITUTE of TECHNOLOGY (USA), prof. Federico Casalegno and prof. Bill Mitchell: development of a sustainable building within the Manifattura Domani installation;
- NARVA LICHTQUELLEN (Germany), dr. Gerard Mientkewitz: development of new generation evacuated solar tubes. The development is an essential aspect within the DiGeSPo project;
- SUPSI - ISAAC – DACD - Centro Ticinese per la Geotermia - dr. Daniel PAHUD: research in geothermal domain to make better underground probes insulation; to improve thermal exchanges between working fluid and underground; to cooperate with solar thermal systems.
- UNIVERSITY of FERRARA, prof. Giuseppe Cruciani: investigations on a new porous material for adsorption cycles based on hydrophilic zeolite. The investigation is an essential aspect of SolTerm project on Solar Cooling Technology;
- ELECTRONIC MACHINING Srl, ing. Massimo Luminari: developments on reflection optics, on heat engines (Stirling), on solar tracking systems. The developments are essential aspects within the DiGeSPo and BioDomUs projects;

- FONDAZIONE EDMUND MACH, dr. Silvia Silvestri: development of a new combustion process to be applied to waste residues from agricultural and forestry sectors. The cooperation will be included in BioTec project.
- EURAC RESEARCH, dr. Wolfram Sparber, cooperation on international projects on +energy building.
- APE, ENERGY AGENCY OF THE PROVINCE OF TRENTO, dr. Roberto Bertoldi and arch. Giacomo Carlino: cooperation and support to the local energy plan of the Province of Trento; cooperation on local and international projects;
- ITEA, dr. Paolo Toniolli: cooperation on local and international projects related to +energy building and energy sustainability of domestic houses;
- DOLOMITI ENERGIA, dr. Stefano Quaglino: cooperation on local and international projects related to +energy building and energy sustainability of domestic houses;

Other foreseen cooperations on proposed projects include University "La Sapienza" (Rome), University of Trento, University of Padova, CRF (FIAT Research Centre), Vescovi Stufe, Technology University of Graz (Austria), University of Twente (Holland), E.ON research center from Aachen University (Germany), Technological University of Harburg Hamburg (Germany), University of Santiago (Chile), and all international cooperation within eCANDO KIC Energy initiative.

2.5. Specific Needs and Points of Attention

REET unit will need to develop some structures for the next year to possibly realize in a efficient and proper way the various developments, prototypes and demonstrators, object of the actual projects:

- specific logistic to realize prototypes on the combustion process from biomasses, possibly in a place assisted by a chemical;
- specific logistic to realize the prototype for a concentrated solar power system (15 - 20 m^2 of gross area on the roof of north FBK building);
- chemical hood for preparation of proper thermal fluids with nanostructured materials;
- monitoring and testing systems;
- suitable infrastructures on north FBK building assisting the prototypes energy provision.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Place REET as a reference unit in the Energy Sector for distributed energy multigeneration	I, O	E	Oct.	Participation to international congresses, to the local energy plan, to international boards on energy	Unit resources to be transferred to the dissemination of results.

				(e.g. Solar Heating and Cooling Program of IEA), scientific paper publication.	
Achieve the deliverables on DiGeSPo European project	R, O	E	March April	Project Committees properly outlined, Dissemination and Exploitation plan of the project, first targets and definitions on the innovation side.	Partners adhesion and participation, proper networking.
Increase the REET unit employees and expertise	F	I	March	Two people to be employed on the Energy sector mainly on DiGeSPo project.	-
Obtain good results on projects that will be closed or discussed during next year	R, I	E	June Dec.	Close Eurostandard project with good results, continue Steinex project in the proper way after the midterm meeting on June, close the Bio-DomUs project with good results by the end of the year.	Enough resources to be employed on the different initiatives.
Create a new START UP company on Solar technologies in Trento	O	E	March April	Goal 70% achieved as for actual agreement on the proposal .	AERMEC (I) and PHILIPPINE (D) adhesion to the initiative.
Write and submit at least two project proposals	A	I	March Oct.	Proposal submission either with a coordinating role or as a partner.	Definition of different project Consortia.

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	524.943,00
Travel	30.500,00
Equipment (HW/SW)	135.000,00
Other costs (consumables, general expenses)	96.000,00
Other (e.g. subcontracting to external contractors)	370.000,00
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€ 1.156.443,00**

Incomes (EUROS)	
EU Projects (total amount financed by EU)	336.445,00
Other external incomes (projects, grants, etc.)	683.212,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€ 1.019.657,00**
Financial Need (Incomes – Expenditure)	**€136.786,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€136.786,00**

5. Human Resources

REET team is actually composed by the following human resources:

N° 3 Senior Researchers

N° 3 Researchers

N° 3 Technicians

Tenure tracks prevision: the employment contract of the two researchers will be converted from the actually “forward contract” to “long term contract” within the next year.

The planned budget foresees an increasing in activities such as more companies cooperations and starting of new projects (both local and international) that requires the acquisition of new human resources.

The new projects acquired for the 2010 require the acquisition of two additional researchers for the next year.

The request of innovation and research has taken two PhD students from the University of Trento in developing their doctorate program within REET unit itself.

One senior researcher went away at the end of June to another employment in PAT – Research and University Service.

Totally, the resources foreseen for the next year will be twelve.

6. Risks and Mitigation Plans

From a general point of view, while exploring new and innovative technologies, the results and the success is not a goal without the presence of risks. The failure of a project and of a research is always takes into account since the beginning. Due to this fact, REET unit since the beginning of the actuation of its ENERGY VISION, which comprises several pilot projects, a lot of technology transfer actions to private entities and a certain number of innovations, covered by patents, but necessarily to be disseminated to all scientific community, has developed a series of mitigation plans running to prevent major failures. The below table summarize some of the main plans actuated.

Description	*Prob.*	*Impact*	*Contingency*
Failure on project results	M	S	Activate a network of international cooperation and select high level partners to work on specific themes. Train and prepare high skilled employees.
Project proposal failure	M	M	Develop project proposals on a networked program in which the single project is not left alone, but is integrated on a general vision, obtaining a higher overall impact.
Failure on technology transfer	H	S	The failure may have different origins, most of these come from the dialogue between research and entrepreneurial languages. To avoid discrepancy it is important to be related to companies in an emphatic attitude, fixing the proper monitoring points between parts.
Internal FBK Bureaucracy	M	M/S	Work in synergy with the different administration offices, trying to transfer the urgency of high impact actions to be run in cooperation with the research unit, try to develop a common language and a positive attitude.
Lack of resources, financial	L	M	The projects has a budget prevision. It should be planned with caution. In case of failure, it is important to monitor the problem and solve it with the required responsible level.
Lack of resources, human	L	M	In case of lack of planned resources on a project, direct possibly resources from other projects to cover the lack. In different case, plan the activities together with partners in a congruous time.

Legend:

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

CIT – Center for Information Technology

ES – EMBEDDED SYSTEMS

Unit Name	ES – Embedded Systems	
Type	Research	
Head	Alessandro Cimatti	
Staff	2009	2010
	6 Researchers	6 Researchers
	9 Technologist/Technician	7 Technologist
	4 Post Doc	5 Post Doc
	5 PhD	5 PhD

Document Status submitted 2009-11-25

1. Executive Summary

Embedded Systems are computer-based systems connected to some physical environment by means of sensors and actuators. They are pervasive in everyday life, in sectors including automotive, railways, space, industrial control, ambient assisted living, biomedical devices, and others. Embedded systems are often required to carry out complex and often critical tasks autonomously.

The Unit carries out activities in the field of Embedded Systems, along three main directions: advanced design methods, required to support the production of correct and reliable embedded systems; architectures for autonomous control, required to realize systems able to carry out complex tasks in destructured environments without direct human intervention; protocols for distributed embedded systems, with particular reference to wireless sensor networks, to ease the task of programming and to maximize the available resources.

These activities all span from research to technology transfer, and rely on the development of software tools providing strong experimental support and competitive advantage. The unit carries out research with a strong emphasis on practical applications, and is currently participating in various projects. It has a strong interest in training students.

In terms of human resources, the unit is composed by approximately twenty people (including six researchers, seven technologists, five post docs, and five doctoral students).

The unit has several important collaborations. Among these, we point out the collaboration with the University of Trento on the development of the MathSAT solver, a verification engine delivered to Intel to support various phases of the development flow (including microcode verification, equivalence checking of sequential circuits, and optimized physical layout). We also point out the ongoing set-up of a joint la-

boratory with ALES, a consultancy company specializing in model-based design, with the aim of further penetrating the market of design automation for critical systems.

2. Vision and Scientific Program

2.1. Context and State of the Art

Embedded systems (ES) are computation systems connected to some physical system by means of sensors and actuators. Embedded Systems are pervasively present in our society. Over 98% of all computing chips are are actually hidden or "embedded" in all sorts of things that do not even look like computers. Over 4 billion embedded processors were sold in 2006 and the global market is worth €60 billion with annual growth rates of 14%.

Application domains of ES are numerous. They include: the automotive domain (where ES are present in ABS, airbags, traction control, fuel injection), railways (where ES are used in control of the trackside devices such as switches and semaphores, onboard breaking control), avionics (where computers control most of the functions, ranging from power distribution, to diagnostic functions, to fly-by-wire procedures), space (where the use of software is continuously increasingly in satellite control and in autonomous rovers), energy (in industrial climatisation, building control and monitoring), bio-medical devices, and others.

A very important initiative denoting substantial interest in the field is the technological platform ARTEMIS (Advanced Research & Technology for Embedded Intelligence and Systems, http://www.artemis-ju.eu/) for the development of ES featuring some degree of intelligence and autonomy. The technology platform ARTEMIS has started in 2005 and has resulted in a Strategic Research Agenda in 2006. Based on this, the ARTEMIS members have created the european association ARTEMISIA, as a private component of the Joint Understaking (JU) ARTEMIS. The JU, created in February 2008, involves the European Commission and many member states, and more than 180 members ranging from large enterprises, SME's, and research institutions.

2.2. Vision and Goals

An Embedded System is typically composed by one or more sensors providing inputsto an electonic data elaboration system, often based on microprocessors, and communicating results of the elabotarion either to a final human user or to actuators that convert the results into actions in the environment, data-gathering portals, or to other embedded devices.

Fundamental features that must be guaranteed for the embedded systems – given their pervasiveness and their functionalities – are reliability, costs, security, and performance (including power consumption). In some safety-critical applications, (automotive, railways, avionics, biomedical devices), it is necessary not only high reliability, but also the ability to detect and adapt to faults, in order for the system to be able to provide continuous service (even if in degraded operational conditions).

The functions carried out by ES are of ever increasing complexity, and often critical. For this reason, there is a strong need for design techniques able to guarantee a high degree of assurance. Another challenge is the ability to program embedded systems so that complex functions can be obtained by combination of basic components within reliable composition schemas. It is also fundamentally important to be able to deal with aspects related to highly distributed ES, in particular the ones based on wireless communication.

The ES unit carries out activities in the setting of embedded systems, along the main directions outlined above. In particular, three main classes of challenges are considered: design methods, autonomous control, networked systems.

- *Design methods* are necessary because the functionalities are critical on one side, and very complex on the other. Traditional design methods may be unable to guarantee the required reliability measures within acceptable timing constraints. The approach investigated by the research line is based on expressive logical frameworks for the representation of different aspects of the design flow (such as requirmements, high level design, implementation, safety analysis) as well as application areas (including continuous dynamics in physical domains, complex data structures for software). Ensuring the properties of the artifacts under analysis is reduced to logical inference in expressive fragments of First Order Logic. Such techniques, that extend traditional propositional reasoning, are a backbone for the analysis of dynamic systems. The main challenge is to develop methods and tools able to deal with extremely large systems with an automated and efficient way, providing effective usage to designers, in order to discover and pinpoint flaws in the designs under analysis, or to certify their absence.
- *Autonomous control* aims at the development of schemas for the realization of complex functions at the run-time, dealing with unexpected and unpredictable events, faults, and discovery of complex phenomena in the environment the embedded system interacts with. A prominent approach, referred to as model-based approach, relies on the logical formalisms used for design, to represent the functions and the environment dynamics, and to carry out important functions such as planning, intelligent execution and monitoring, run-time diagnosis, fault detection, identification and recovery, and replanning. The main objective is the identification of a comprehensive architecture, combining logical frameworks and probabilistic representations, and the definition of advanced algorithms for the specified functionalities.
- *Networked systems***.** Recent trends in distributed computing break the traditional assumptions of network stability, forcing applications to consider the dynamics within the network itself. A key objective is the the development of new models and programming abstractions designed to ease application development for dynamic distributed scenarios, specifically wireless sensor networks (WSN). Although WSNs systems are composed of mostly immobile sensors, dynamicity arises from the insertion and removal of nodes, the use of mobile base stations, and inherent variabilities of wireless communication channels. The primary challenge is to develop models at the proper level of abstraction

that simplifies the programming effort, but still provides enough programmer control to enable efficient applications. The outcome of our activities are novel models implemented as middleware and distributed algorithms.

Recent studies have confirmed that programmability of WSN nodes is one of the major barriers in their widespread adoption. Indeed, a wealth of research exists on operating system abstractions and macro programming techniques to ease the programming effort. The operating system abstractions are, by nature, too general and low level to significantly ease the programming task. On the other side of the spectrum, macro programming significantly reduces programming effort, but often sacrifices too much in terms of solution efficiency. In the WSN environment, such limitations are manifest as reduced system lifetime. The key idea is to propose an abstraction running atop of an existing operating system, and offering system-wide coordination through a single node programming model. Adoption of our proposed model is eased due to our instantiation of a parallel set of core WSN components such as MAC, routing, time synchronization, etc. One major open challenge is supporting WSN applications in which quality of service of data delivery must be guaranteed. Most existing systems fall short either due to their inherent complexity or to their inability to work in a cross-layer fashion to support high level goals at all levels of the communication stack.

The above research directions are intended to be more tightly combined in the longer term. On the one side, the integration will help to develop systems with Embedded Intelligence, where distributed processing based on WSN and high level reasoning are blended in a coherent and unique architecture for the monitoring and control of complex, possibly social environments. Particularly interesting are application areas related to Energy, Ambient Assisted Living, and Environmental Monitoring. On the other side, dedicated design methods will be provided for the formal analysis and deployment of WSN's.

2.3. Activities and Work Plan

The activities of the Unit revolve around a number of software tools. Their function is twofold. On one side, they provide a solid basis for experimental validation of basic research; on the other side, they provide the technological infrastructure used in technology transfer project.

The unit maintains and develops several tools based on formal reasoning: the MathSAT SMT engine; the NuSMV model checker; the EuRailCheck tool for requirements analysis; the FSAP/COMPASS platform for diagnsability and performance evaluation.

Important activities include research in symbolic verification algorithms for the analysis of systems with continuous dynamics (referred to as hybrid systems), and of concurrent software. To this end, the NuSMV model checker will be extended with functionalities provided by MathSAT, such as interpolation and unsatisfiable core extraction.

In the field of intelligent control, the activity aims at tackling the problem of monitoring and diagnosability for hybrid systems. We will explore the use of expressive

logics to model and reason about resource consumption, and the automated synthesis of monitors from high level descriptions of monitoring functionalities.

In the line of WSN, there are several planned activitites. First, we will explore QoS in WSNs, and propose a new infrastructure called ReINS, a Resource-aware Infrastructure for Networks of Sensors. As an infrastructure, it will not be a single solution, but rather a suite of algorithms and protocols that can be combined to meet application demands. The ReINS-MAC protocol is grounded on the theoretical literature on pulse coupled oscillators, providing a solid framework enabling the straightforward description of our coordination mechanisms. Positioned low in the communication stack, ReINS-MAC provides the foundations for higher level abstractions to rein in the protocol anarchy, leading toward a comprehensive solution to communication resource control. Immediate plans include the implementation of the protocol and testing in a real environment. In parallel, we will explore the next layer up in the protocol stack, namely routing, to move closer to our vision of supporting. QoS in WSNs.

An important activity will be the realization of a testbed for WSN technology, having the goal to support testing and evaluation of new protocols, algorithms and applications. The testbed will be composed by over 50 WSN nodes deployed in the ceiling of the IRST building. The nodes will be wired, to allow remote reprogramming. The testbed will also be integrated within the ACUBE infrastructure, providing a full monitoring station, and integration with high level functionalities.

The activities outlined above are largely overlapping with and carried out within research projects involving the unit such as MISSA, COCONUT, TUNNEL, TRITON, ACUBE, and COMPASS.

2.4. Collaborations

Within FBK, the unit has several active collaborations: within ACUBE, an interdisciplinary project funded by the PAT, there are ongoing collaborations with the following research units: TEV (Lanz), Shine (Omologo), SOI (Gottardi), SE (Susi). There is a strong collaboration with the SE unit on the topic of requirements analysis. Interaction is planned with the DKM unit for the adoption of ontologies in various domains (e.g. energy efficiency, requirements analysis), with the SOI unit of CMM on the integration of custom sensors with wireless technologies, and with the REET unit on advanced control for energy-efficiency.

The unit has strong collaborations with the University of Trento. In particular, the NuSMV and MathSAT tools are developed as joing projects with the team of prof. Roberto Sebastiani; the unit participates as external contributor to WOLFLING, a project funded by the Semiconductor Resarch Corporation, where the MathSAT solver is being customized and deployed in various phases of Intel's design flow (including microcode verification, equivalence checking of sequential circuits, and optimized physical layout).

There are ongoing collaborations with the groups of prof. Passerone and Palopoli on the topics of paramenterized systems, and realizability, with an exchange of master and Ph.D. students hosted by the Unit.

Finally, there is a very strong collaboration with the group of prof. Gian Pietro Picco in the setting of wireless sensor networks, and in particular on the development of the TeenyLIME middleware, that is being applied in the TRITON and ACUBE projects.

International collaborations involve many partners, both academic and industrial. Research ollaborations are active with the University of Lugano (Anna Foerster) on non-uniform information dissemination with machine learning techniques, and CMU (prof. Clarke) in the development of the NuSMV model checker. The unit takes active part in the activities of the SMT community, involving Intel, Microsoft, Univeristy of Iowa, SRI International. Partnerships within projects involve Airbus UK, DE, FR, ThalesAlenia Space, Registro Italiano Navale (RINA), RWTH Aachen University, TU Graz.

Finally, we remark a strategic collaboration with ALES s.r.l., a consultancy company specialized in design of safety-critical complex embedded systems. The collaboration stems from ongoing technology transfer projects, and is aimed at the set up of a joint research laboratory, called DEVELAB. The laboratory has the mission of developing technologies for the design and verification of safety critical systems, addressing issues related to validation and certification.

2.5. Specific Needs and Points of Attention

The following needs and points of attention are identified.

It is fundamental to increase the number of Ph.D. students; a substantial activity in advertisement and recruiting is envisaged to this end.

Several projects will end in 2010. It is thus important to carry out an activity of project acquisition, in order to maintain the level of funding, and to increase it as far as the WSN activities are concerned. Associated actions are the set up of the DEVELAB, and the increased interest in the domain of energy.

The realization of the WSN testbed will require additional support from the technical staff of FBK. A detailed analysis of the requirements for the set up of the testbed is currently ongoing.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Compositional verification for Hybrid Systems	R	E	Dec.	Goal 100%: development and testing of the proposed devices	-
Software Model Checking for SystemC	R	E	June	Goal 60%: development and testing on selected set of benchmarks	-
Automated Verification Engine for Matlab	F	F	Dec.	Goal 100%: development and testing on large set of case	-

models				studies	
Development of advanced monitoring functionality and deployment in real-world daycare center	R	I	Sept.	Goal 100%: development and testing of the proposed system	-
WSN testbed	I	E	June	Goal 100% Demonstration and external availabilty	-
Monitoring and diagnosabilty algorithms	R	E	Dec.	Goal 100%: Submission of research papers on topic.	-
Design Space Exploration	R	E	Dec.	Goal 100%: testing and performance evaluation on selected case studies.	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	824.370,00
Travel	47.500,00
Equipment (HW/SW)	10.000,00
Other (e.g. subcontracting to external contractors)	83.700,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€965.570,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	310.489,00
Other external incomes (projects, grants, etc.)	361.481,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€671.969,88**
Financial Need (Incomes – Expenditure)	**€293.600,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€293.600,00**

5. Human Resources

The unit is composed of the following full time tenured researchers: Alessandro Cimatti, Marco Roveri, Marco Bozzano, Amy Murphy. It has a full time tenured senior technologist (Pietro Braghieri), and a technologist, Roberto Cavada, on tenure track to be evaluated within 2010.

The unit has several post-docs working on specific projects (Andrei Tchaltsev; Iman Narasamdya; Alessandro Ferrante), and two Post-docs supported by grants of the PAT (Viktor Schuppan, Stefano Tonetta). Tonetta is on an active tenure track for a researcher position. Two open positions for post-docs are budgeted for 2010.

Eliana Nardoni is an administrative person in staff to the Unit to provide administrative support on a large project.

The Unit has currently four Ph.D. Students (Sergio Mover; Matteo Ceriotti; Leonardo Fernandez, Anders Franzen), with an expected increase by two units in 2010. Additional Ph.D. studentrs (Jeremy Ridgeway, Yusi Ramadian) and pre-docs (Zhiyang Ong) are co-supervised by members of the Unit within collaborations with the University of Trento (prof. Sebastiani and prof. Palopoli).

The unit has several young programmers (Alessandro Mariotti, Marco Pensallorto, Andrea Micheli, Cristian Mattarei) working on various projects while studying at the University of Trento.

In 2009 there has been a substantial activity of training of young students from the University of Trento, with more than ten stages at the Unit. We intend to pursue this activity that has proved extremely satisfactory, and if possible increment the number of stages.

6. Risks and Mitigation Plans

The unit is involved in several research and technology transfer projects. Each of them has obvious risks associated with it, and standard risk mitigation majors are enforced.

There are no other specific risks that can be foreseen.

Description	*Prob.*	*Impact*	*Contingency*
Risk 1:	M	S	.
Risk 2:	L	L	.
Risk 3:	M	S	

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

SOFTWARE ENGINEERING

Unit Name	SE – Software Engineering	
Type	Research	
Head	Paolo Tonella	
Staff	2009	2010
	4 Researchers	5 Researchers
	2 Technologists	2 Technologists
	3 Post Doc	3 Post Doc
	5 PhD	5 PhD

Document Status submitted 2009-10-23

1. Executive Summary

Next generation software systems will be self-adaptive, dynamically changing and self-modifying, context aware and automatically configuring to the user's preferences and habits. Engineering such systems is challenging, since their quality becomes harder to control and verify. Our vision is that the two main tools to ensure high quality of next generation software are: (1) high quality requirements specification; and, (2) highly automated testing. The main activities planned for the upcoming years descend from this vision and include research on requirements modeling and empirical evaluation of requirements methods; search based testing and testing of future internet applications; software renovation. Such activities are expected to have a strong technological impact, thanks to the projects ongoing within the SE unit: A-cube (on ambient aware assistance); IoS (Internet of Services); IBT (migration of legacy banking code).

The personnel, composed of 5 structured researchers, 2 technologists, 3 postdocs and 5 PhD students, is adequate for the unit's goals and activities. Collaborations with world class universities, such as King's College London and Queen's University, Kingston, is expected to be a main driver for high quality and high impact research results. Points of attention include the integration of new team members and the improvement of the internal group cohesion.

2. Vision and Scientific Program

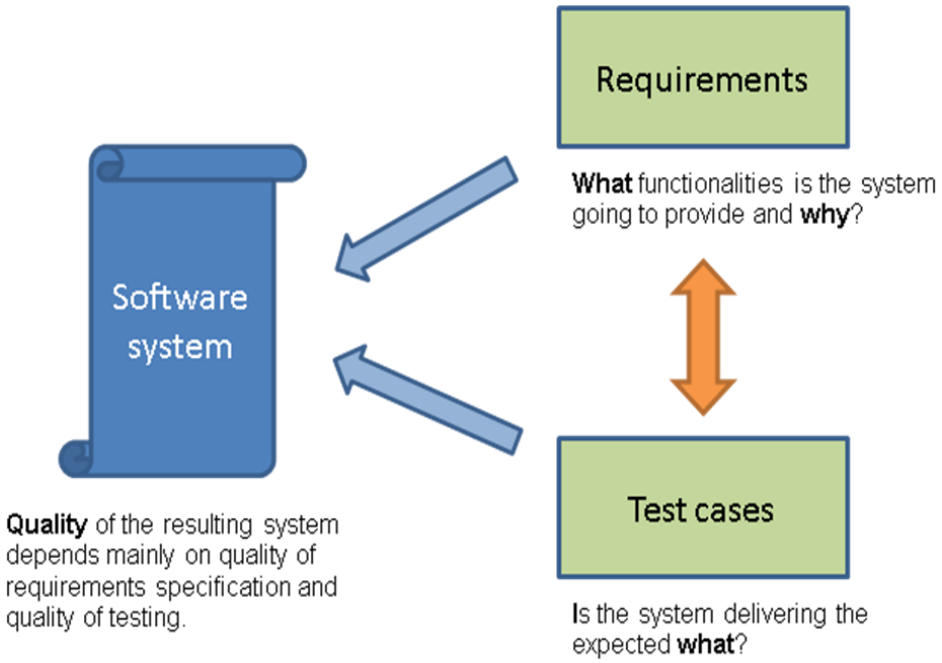

Figure 1. Vision on quality of software system

Next generation software systems, such as ambient assistance systems and Internet of services, will operate in an open and dynamically changing environment and will need to be able to cope with the heterogeneity of their users who can also dynamically change their preferences. Challenges for the engineering of such systems include:

- *Self-modification and autonomic behavior*: specification and validation of the expected behavior is hard to achieve, since all changes possibly occurring dynamically must be taken into account.
- *Low observability*: dynamic integration of 3rd party components makes it difficult to specify the composition's behavior upfront; testing becomes harder because of the limited access to dynamically discovered and integrated components.
- *Distribution and asynchronous interactions*: new software systems live and interact with each other through the Internet, giving rise to an exponentially high number of possible interleaving executions, whose specification and testing is problematic.
- *Ultra large scale*: next generation systems will be very large in scale, comprising systems of systems; requirements and test methods for them demand for novel approaches.

Our vision on the quality of such software systems, depicted in Figure 1, gives a central role to requirements specification and testing. Requirements specify *what* the system is supposed to do (functional requirements) and *how* it is supposed to

do it (non functional requirements, such as performance, resource consumption, etc.). Moreover, requirements descend from a domain analysis which includes the *why* dimension that represents stakeholders goals. The quality of specification of the *why*, *what* and *how* determine very profoundly the quality of the realized system. We cannot expect the system to deliver more or better functionalities than those specified in the requirements. We also cannot expect ambiguous or contradictory requirements to lead to a satisfactory system.

Once the system is realized, the main method to assure that requirements are actually and accurately realized in the system is testing. Having high quality requirements is not enough, since the implementation may deviate from them or may take shortcuts. It may just not meet them. Testing is a systematic way to exercise the realized system and check its behavior against the expected one, i.e., the one specified in the requirements. Hence high quality testing is always coupled with high quality requirements. Moreover, recent methodologies (e.g., agile methods) which stress the importance of *test driven development*, couple requirement gathering and test case definition from the very beginning of development. Requirements are immediately turned into executable test cases. Initially they can be executed only against a mock system, but once the system is implemented, they provide an immediate indication of the degree to which requirements are fulfilled.

The strategic vision of our group is based on the crucial importance that requirements and testing have for the quality of software systems. Hence, we intend to investigate these two techniques in isolation, as well as their integration.

2.1. Context and State of the Art

Requirements:

Our research develops in the context of the studies on software engineering methods and techniques for next generation software systems, such as ambient assistance systems and Internet of services. In order to understand the requirements for such systems two main aspects need to be to analyzed: first, the social (organizational) dimensions, that is the different stakeholders with their objectives and social dependencies; second, sources of uncertainty and variability in the operational environment, including users with their changing context and preferences.

To address the first issue, we plan to investigate the effectiveness of a multi-paradigm approach, which integrates user-centered and goal-oriented requirements elicitation methods.

Several approaches considered the use of User Centered Design (UCD) techniques, such as Personas and Scenarios, with semiformal or formal approaches such as Goal-Oriented techniques (GORE) [Penserini et al. 2007, Darimont et al. 1997], UML, first order/descriptive/temporal logics. In [Haumer et al. 1998] the authors present a scenario based approach to the specification of goal models. In [Sutcliffe et al. 1998] a language based on first order logic is used to represents scenarios and artifacts used in the user interaction phases of requirements elicitation and representation. Finally, in [Aoyama 2007] Personas and Scenarios are used together with goal oriented techniques to elicit requirements and represent them in a semi-formal framework. Our approach differs from them because we aim

at integrating UCD and GORE techniques both in the terms of the concepts and the requirements elicitation and analysis processes.

Addressing the second issue, we plan to investigate requirements engineering methods for adaptive systems, an under-explored area, according also to the Dagstuhl 08's research roadmap on Software Engineering for Self-Adaptive Systems [Cheng et al. 2008]. Our research aims at defining methods to support the system analyst when engineering requirements for adaptive systems, by analyzing variability in the operational context and in the user's goals; by identifying what needs to be monitored at run time and what are the candidate adaptation actions [Qureshi et al. 2009]. In our approach we build upon state of the art research on variability design [Liaskos et al. 2006, Salifu et al. 2007]. Moreover, we exploit a BDI software agent platform to get empirical evidence on the proposed requirements engineering methods [Morandini et al. 2008].

To validate the effectiveness of the proprosed requirements engineering method we intend to apply empirical study techniques [Wohlin 2000, Aranda et al. 2007].

Testing

The state of the art in search based test case generation [Harman 2007, Harman et al. 2001] is characterized by fitness functions that involve mainly coverage adequacy criteria. The distance from the coverage target is used as a fitness indicator. While these testing targets remain relevant for next generation complex software systems as well, their adaptivity, dynamism and self-modifiability demand for novel fitness function definitions and search algorithms.

The vast, existing literature [Ricca et al. 2001, Elbaum et al. 2005, Sampath et al. 2007] on Web testing is focused on client server applications which implement a strictly serialized model of interaction, based on <form submission, server response> sequences. Testing of next generation (Ajax/rich client) Web applications has been considered only more recently [Mesbah et al. 2009, Marchetto et al. 2008]. For them, testing focused on semantic interactions, previously exploited to drive the generation of test cases for the code which implements the application's GUIs [Yuan et al. 2007], seems particularly promising.

Existing techniques to infer models useful for testing purposes [Lorenzoli et al. 2008, Dallmeier et al. 2006] rely either on algorithms for regular language learning or on predefined, hardcoded abstraction function. The former produce a state model which is hardly interpretable by humans. In fact, while event sequences are meaningful, states do not necessarily correspond to an internal state of the application. The other option is hardly viable in the dynamic, adaptive context of next generation software systems. No abstraction defined once for all upfront is expected to be adequate for all dynamic execution scenarios in which the application will run. A promising direction is to co-evolve the abstraction together with the self-changing application by means of a search based algorithm.

Current research in the use of logs for testing focuses on observing errors from logs. We intend to extend this with the capability to infer oracles, likely oracles, and atypical executions from logs. State of the art tools for anomaly detection [Lorenzoli et al. 2008, Hangal et al. 2002] rely on invariant inference algorithms such as the one implemented in Daikon [Ernst et al. 2007]. However, richer temporal logics properties are not yet used to express the inferred invariants.

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2.2. Vision and Goals

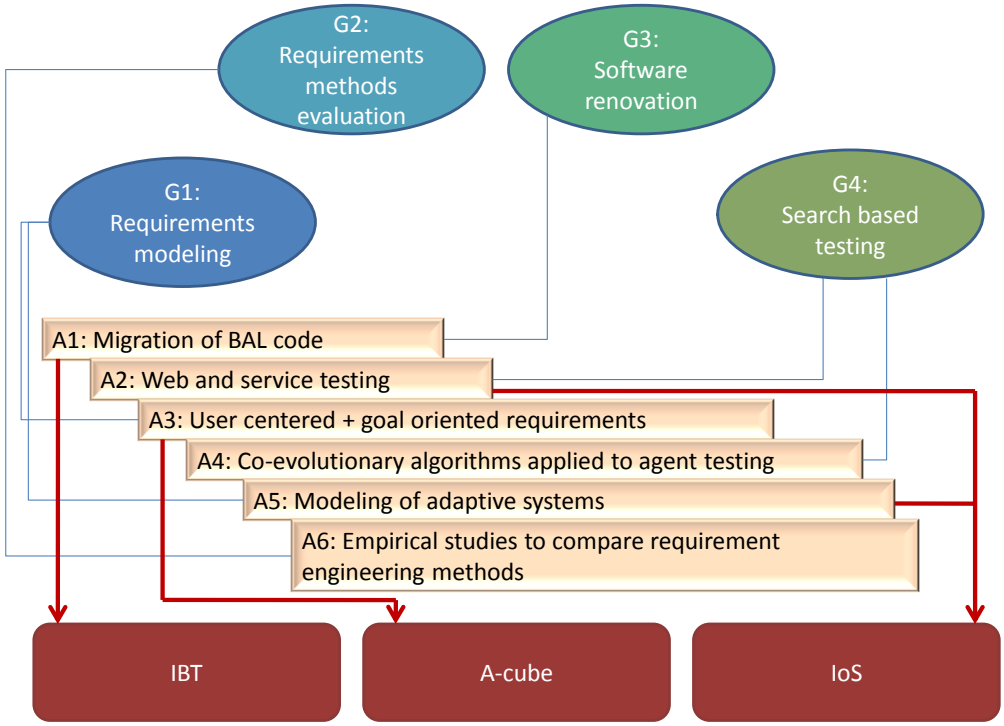

Figure 2. Links between (mid-term) goals, activities (planned for 2010) and ongoing projects

Our long term vision (5 years, see Figure 1) is that the quality of software systems descends mainly from the quality of requirements and testing. Hence, we intend to investigate advanced techniques for requirements gathering and test case creation, pushing the state of the art toward automated and methodology/tool supported approaches. In the medium term (3 years), we have identified four main goals, depicted at the top of Figure 2. Requirements modeling (G1) is essential to support requirements gathering and understanding. The expressiveness of current modeling languages need to be extended to allow expressing adaptivity and dynamicity properties of next generation software systems. Moreover, crucial aspects for socio-technical systems, such as the impact of law and regulations need to be explicitly represented and analyzed. However, requirements modeling methods should be compared and assessed empirically, in order to guide the research and to support decision making by software companies. Hence, another mid-term goal (G2) is about empirical assessment of the considered requirements methods, which will require to address open issues in evaluation of conceptual modeling frameworks.

With regards to testing, a very promising approach that we intend to investigate in the near future is *search based testing* (G4). The idea is to interpret the main test-

ing problems (test case definition, input data derivation, oracle specification, anomaly detection, etc.) as search problems, typically within a huge search space that cannot be explored exhaustively. We resort to search based methods (such as simulated annealing, genetic algorithms, etc.) to conduct such an exploration in a cost effective way. The resulting sub-optimal solution is often much better than one determined manually, especially for large and complex software systems, characterized by autonomic behavior, self-modifiability, dynamic integration with newly discovered components, large scale. With this category of systems (which include *legacy systems*), testing alone is usually not enough to ensure quality and evolvability. We will use source code analysis and automated program transformations (G3, software renovation) to support the improvement of the internal quality of the software (e.g., by re-engineering, refactoring or migrating the code).

2.3. Activities and Work Plan

The four top goals depicted in Figure 2 are associated with 6 main activities (middle of Figure 2) that will be carried out within the SE group in 2010. Other, minor, but still relevant, activities are not reported in this document for space reasons. They also fall within the four goals of our mid-term vision. The connection between activities and ongoing projects is depicted at the bottom of Figure 2.

- *A1: Migration of BAL code*

  Often software companies are keen to keep consolidated technology and avoid the risk of committing on the emerging ones. However, after some decades the ever-increasing distance between adopted and state-of-the-art technology becomes considerable and maintenance turns more and more difficult and expensive. In such cases, updating the programs often means rewriting them from scratch. When the program size is huge and rewriting cost can not be afforded, automatic code migration represents a valuable alternative.

  The Objective of the IBT project is to the migrate a large banking system to modern technology. Programs written in the proprietary legacy language BAL will be translated to JAVA, the de-facto industrial standard in software development. During 2010, the Software Engineering group will deliver a tool, able to translate the entire code-base. To achieve this goal an Object Oriented data model must be recovered from the legacy flat memory space. Unconditioned jumps (i.e., GOTO), not supported by modern programming languages have to be removed, or managed at the byte-code level, while preserving the original behavior. Inconsistent locks taken on persistent data must be detected and resolved.

- *A2: Web and service testing*

  Several problems in Web and service testing are intrinsically associated with a huge search space, which may be hard or impossible to explore manually. Hence, software defects may remain unrevealed due to the limitations of the capabilities of human testers. We intend to push test automation combined with search algorithms to improve the quality of testing and increase the chances of revealing faults. Specifically, in 2010 we intend to investigate

search based algorithms applied to the problem of input data generation for Ajax Web applications. In previous work, we used search algorithms to derive event sequences that exhibit a high fault revealing potential. However, we do not know whether such sequences are *feasible* or not (i.e., whether there exists any vector of input data that forces the program to go through a selected path). We will explore the huge space of possible input vectors using a search-based approach, interpreting failure of input data generation as an indicator of *likely* infeasibility. We also plan to evaluate the performance of such an approach empirically.

In the context of the IoS (Internet of Services) joint research project, we plan to define a testing methodology which takes advantage of simulation. Real Future Internet (FI) services, specified as semantically annotated business process, will be simulated for conformance with respect to the desired behavior, expressed through goal oriented models and requirements on the user assets. A search based approach is extremely promising when testing the huge number of configurations, environment events and (dynamic) compositions in which a real process may actually execute.

- *A3: User centered + goal oriented requirements*

  Integrating the User Centered Design (UCD) and Goal Oriented Requirements Engineering (GORE) approaches is a methodological challenge. While UCD pushes for understanding the intricate network of relationships among the users, their tasks and their actual environment, GORE offers formal representation techniques whose models can be automatically analyzed to detect conflicts and dependencies between requirements.

  The first objective of the activity is encoding the results of the contextual inquiry (obtained by collecting information about the work practice by observing the users while they actually work) and the interviews using the GORE's formal representation techniques in order to be able to provide a check for the consistency of the models. A second objective is to study the possibility of using the formal representation of the models together with the usual representation from UCD, such as Personas and Scenarios as a way of communicating between the users, the designers and the developers in order to avoid those misconceptions that so often arise in large software projects and often hinder the quality of the outcome. Operatively, in 2010, a first hypothesis of the coupling of the two methodologies will be provided; then, we will define guidelines and concepts for a unified methodology that will be described in a technical report and in papers. Moreover, we plan to apply the methodology in the A-cube project that aims to provide an infrastructure that enables advanced support to medical and assistance staff in healthcare organizations.

- *A4: Co-evolutionary algorithms applied to agent testing*

  Software agents behave autonomously and may include the capability to learn from experience. When agents have learning capabilities, their behavior becomes hard to predict, hence to test as well. We intend to take advantage of co-evolutionary algorithms to adapt the Tester Agent (TA, an autonomous test

case generator agent) to a changing Agent Under Test (AUT). When the AUT evolves, the TA has to generate more sophisticated testing scenarios and environments in order to make the AUT misbehave. When the AUT is learning also from the test scenarios produced by the TA, the role of the TA is not limited to testing (i.e., revealing faults). It is also improving the performance of (hence, training) the AUT. In such a context, the distinction between agent testing and agent training becomes not so sharp and the same algorithms (co-evolutionary, search based algorithms) can be used to test (i.e. reveal faults) or to train (i.e., improve performance) of the AUT. We intend to investigate the effectiveness of co-evolutionary algorithms both for agent testing and training. We plan to use as the reference scenario a multi-agent system consisting of autonomous unmanned vehicles moving in a dynamic environment.

- *A5: Modeling of adaptive systems*

  Adaptive software aims at dealing with changes that may occur in the operational environment at run time, including users preferences and needs. Research on methods and techniques for engineering adaptive software tend to address design-time solutions that enable run-time adaptation, while suitable approaches for eliciting and specifying requirements for such software are still missing.

  We intend to investigate requirements engineering issues along the following main lines. First we will define methods and techniques to support the elicitation and modeling of requirements for adaptive software. Those requirements should be flexible in nature and relate to (or include in case of self-adaptive software) specification of monitoring and adaptation functions of the system-to-be. Second, we will consider BDI agents as an experimental platform on which to perform empirical evaluations of the proposed methods and techniques. Self-adaptive properties will be specified at requirements and design-time and (semi-)automatically coded into BDI agents. The resulting agents will be executed in a simulated environment in which a Trainer Agent will generate dynamic changes while a Monitoring Agent will observe how the self-adaptive agents adapt to those changes. This framework will allow also investigating requirements self-reflection mechanisms, that is mechanisms that enable the system to exploit a requirements goal model to select an adaptation action at run-time.

- *A6: Empirical studies to compare requirements engineering methods*

  Goal-Oriented (GO) requirements engineering aims at providing effective modeling and analysis techniques for complex software systems by enabling the analysis of the system-to-be and of its operational environment; the analysis of alternatives in problem and solution spaces; the modeling of non-functional requirements and quality aspects; and more. The effectiveness of GO approaches is typically evaluated through case studies, but experimental comparisons of GO modeling methods with different paradigm methods, such as scenario-based, have been rarely conducted. This activity focuses on the evaluation of requirements modeling approaches resting on scenario analysis, i.e. UML-Use Case and GO paradigms, i.e. Tropos requirements models. We

intend to execute a controlled experiment with a group of students playing the role of analysts that perform comprehension and refinement tasks on requirements models.

2.4. Collaborations

- *King's College London, UK*, Mark Harman: joint research on search based software engineering (search based testing in particular); Michael Luck: joint research on agent testing and autonomously learning agents.
- *Wayne State University,USA,* Andrian Marcus: joint research on evaluating and improving the quality of the programmer's lexicon.
- *Queen's University, Kingston, CA,* Thomas Dean*:* joint research on legacy systems re-engineering.
- *University of Genova,* Filippo Ricca: joint research on empirical studies on requirements engineering methods and techniques.
- *MIS, University of Haifa, Israel*, Iris Reinhartz-Berger, Irit Hadar, Tsvika Kuflik: joint research on empirical studies on requirements engineering methods and techniques
- *University of Trento,* John Mylopoulos: joint research on norm compliant requirements and organization of the Int. IEEE Conference on Requirements Engineering RE'11 in Trento.

2.5. Specific Needs and Points of Attention

Activities and objectives might need replanning during the next year, especially those more research oriented, depending on newly identified promising directions, new opportunities or collaborations, new projects, and new ideas in general. Periodic revision of the activities and detailed goals (see next section) contained in this document are essential to capture the highly dynamic and reactive nature of the research work.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
A1.1: Translation of the whole IBT banking application	I	E	April	Bal2Java translator delivered to IBT	
A2.1: Real services simulation and testing tool	R	I	Sept.	Prototype tool available	
A2.2: Input data generation and feasibility check for Ajax testing	R	E	Dec.	Paper submitted	
A3.1: Draft integration of UCD and GORE methodologies	R	I	April	Technical report	

A3.2: Guidelines and concepts for a unified methodology	R	E	Nov.	Paper submitted	
A4.2: Co-evolutionary generation of execution scenarios	R	E	Oct.	Paper submitted	
A5.1: Engineering self-adaptive agents	R	E	Dec.	Paper submitted	
A5.2: Managing flexibile requirements for adaptive software	R	E	Dec.	Paper submitted	
A6.1: Empirical study to compare Tropos with UC requirements modeling methods	R	E	Oct.	Paper submitted	

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	566.003,00
Travel	15,000,00
Equipment (HW/SW)	500,00
Other (e.g. subcontracting to external contractors)	59.750,00
Internal collaborations: “subcontracting” to other unit	0.00
Total Expenditure	**€641.253,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	0.00
Other external incomes (projects, grants, etc.)	169.970.00
Internal incomes (“subcontracted” by other units)	0.00
Total Income	**€169.970.00**
Financial Need (Incomes – Expenditure)	**€471.283,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€471.283,00**

5. Human Resources

The SE unit has a core team which consists of five researchers, two of which are senior. The core team works with some post-doc researchers having a term contract on specific research projects (e.g., A-cube, IoS). The unit employs also qualified human resources involved in the technology transfer activities (e.g., project

IBT), with term contracts on project. Moreover, the exploration of topics having high scientific relevance for the group is carried out thanks to a substantial number of PhD students, who work toward their thesis within the SE group.

The professional growth of the researchers in the core team aims at an increased scientific visibility, the capability to attract funding and to have an impact in the local area. The development of the younger researchers toward seniority passes through scientific autonomy and recognisability. For them, a fundamental milestone will be coordinating and guiding PhD students and postdocs.

A new structured researcher, Roberto Tiella, will join the team in 2010. Smooth integration with the other team members and incremental involvement in the ongoing research and project activities will be a top priority.

The team composition and size is adequate for the activities and projects planned for the next year. Younger researchers should be stimulated to try target also top-ranked conferences and journals, planning ahead for such ambitious objectives. Since the group is dependent on the activity of the PhD students for most ongoing research, selection of outstanding PhD candidates is a priority for the group. The IBT project experienced difficulties in recent times due to the instability of the project team. The IBT project team should be consolidated, so as to remain stable for the remaining duration of the project.

Tenure track

Mariano Ceccato will conclude his tenure track on December 31st, 2010. His advisor is Paolo Tonella. He is regularly updating his tenure track book, so as to keep records of the activities performed during the tenure track period. Regular revisions of the tenure track state are made under the supervision of the tenure track advisor. Purpose of these revisions is also to update the high level and detailed goals, depending on the ongoing research and the achieved results. In 2010, two major tenure track review meetings with the advisor will take place (in June and December 2010), followed by the final assessment made by the FBK commission.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Insufficient self-funding	M	M	Apply for diversified types of grants.
Lack of group cohesion	L	M	Promote transversal activities across the areas of requirements modeling and testing.
Difficulty of integration of new team members	L	M	Promote joint research and activities within the group; promote internal discussion and presentation of ongoing work.
Critical mass necessary for top-ranked, high impact research not achieved	M	M	Promote focusing of research activities around a few selected, and promising topics.

Legend:

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

	YES
Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	X
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
Does the proposal involve tracking the location or observation of people?	X
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

SOA – SERVICE ORIENTED APPLICATIONS

Unit Name	SOA - Service Oriented Applications	
Type	Research	
Head	Marco Pistore	
Staff	2009	2010
	6 Researchers	6 Researchers
	7 Technologist	6 Technologist
	0 Post Doc	0 Post Doc
	5 PhD	7 PhD

Document Status submitted 2009-11-25

1. Executive Summary

The Service Oriented Application (SOA) Unit is concerned with the study and the development of advanced methodologies and techniques for the engineering of software applications based on the service-oriented paradigm. This paradigm defines a novel approach to software development that is gaining more and more impact in the ICT marketplace, namely the realization of new applications through the composition and customization of software "services". These services are self-contained, platform-agnostic computational elements that have been designed to be re-usable and to support rapid, low-cost and easy composition of loosely coupled distributed software applications. The service-oriented paradigm is recognized as one of the key enablers for companies to create new value from existing investments, reuse efforts across many projects and resources, and achieve new levels of agility through greater flexibility and lower cost structures. In the next years, the research unit will concentrate on key scientific challenges for service-oriented applications, including general and reliable mechanisms for composing applications out of existing services, novel approaches that allow end-users to be in charge of service composition, and novel approaches for to support "service level agreements" as the central concept for the realization of robust, adaptable service-oriented applications. The research is scenario-driven: we exploit scenarios in key application areas such as mobile value services and enterprise service integration, both for extracting requirements that drive the research activity, and for validating the research results.

To achieve its goals, the Unit has to perform activities that range from advanced research to technological scouting and, finally, to design, realization and exploitation of software tools and pilot studies. Research is carried out in a coordinated way by a core of 6 researchers (2 senior, 4 junior), which coordinate further research efforts by a growing set of PhD students (5 in 2009, 7 in 2010). A strong

emphasis is given to the realization of tools, prototypes and demonstrators and on the transfer of the results to industry; a strong team of technologists / project managers (7 in 2009, 6 in 2010) supports the Unit in these activities.

Internal collaborations are fostered by the Joint Research Project on “Internet of Services” and involve in particular the “Software Engineering”, “Data & Knowledge Management”, and “Intelligent Interfaces & Interaction” units. External collaborations involve large industrial partners at the European (in particular: SAP AG, DoCoMo Euro-Labs), national (in particular: Engineering SPA) as well as local companies in the ICT domain (in particular: GPI SPA). All these companies are partners of the Unit in research and/or industrial projects. External collaborations also involve, in addition to the University and to the research centers in Trentino, strong research groups at the leading edge of specific areas of Service Oriented Computing, such as the University of Stuttgart, or Politecnico di Milano, City University London. These collaborations aim at joint investigations based on a joint exploitation of the complementary competences and technologies of the partners.

In 2009, the SOA Unit has launched a spin-off, sayService (http://www.sayservice.com), with the goal of bringing to the market some of the solutions developed by the Unit in the last years. During the next 3 years, 6 staff members of the Unit will progressively move to sayService. During 2010, the activities of the Unit will also aim at streamlining the collaborations with sayService and at creating the preconditions for the passage of staff members to the spin-off.

2. Vision and Scientific Program

2.1. Context and State of the Art

The adoption of a service oriented business model is widely recognized as a necessary shift to change the European economy into a more dynamic and competitive knowledge-based society. This paradigm shift manifests itself by the evolution of business models from the sale of products to the provision of electronic services, where services are seen as utilities that can be used but that are not owned by users. In terms of IT technology, this shift translates into the evolution of implementations by software development into "solutions built by composition and configuration of software services".

Currently, in spite of established key principles for engineering service oriented applications (e.g. loose coupling, coarse grained service interfaces, dynamic service discovery and binding, self containment of services, service interoperability and protocol independence[1]) and of the existence of standards for service based applications (e.g. the ones from OASIS and W3C it is well recognized that "there is [still] a need for [novel] ways of producing applications by configuration and composition of loosely coupled services"[2].

[1] Erl, T.: Service-oriented Architecture. Prentice Hall, 2004.

[2] NESSI Strategic Research Agenda. Vol. 1. Framing the future of the Service Oriented Economy. 2006.

In this context, one of the key enabling techniques for service oriented engineering stands in the automated composition of distributed services into novel applications[3], an area where the group has built strong competences. The extension of these techniques to a comprehensive approach for the design of service oriented application is however still at a preliminary stage[4]. Adaptation techniques are also strongly needed, since adaptation is one of the key issues in service oriented engineering, both from the perspective of service providers and from the perspective of service consumers and composers. The results in the area of service adaptation and evolution are still very preliminary: they cover only limited aspects of the problem, such as monitoring the behavior of the service-oriented system to trigger adaptation when necessary[5]; or they focus on the infrastructural layer or on very specific aspects of the behavior of service compositions, such as addressing and binding.

Solving the two above problems is also crucial to enact mobile technology users to take full advantage of service provisioning. In particular, the very rapid evolution of mobile technologies has led to the mass-market adoption of mobile phones which increasingly integrate powerful connectivity capabilities, multimedia functionalities, as well as a variety of applications such as agendas, organizers, personal assistants, and address books. Such technology-rich mobile phones have the unique potential to act as portable gateways for their users, connecting them to a universe of "mobile services", ranging from personal management services, to internet services, and to services pervasively located in the environment. This paves the way to a huge marketplace of mobile services, whose enormous potential has been clearly recognized by the industry, as witnessed by the increasingly fast growth in the amount and diversity of services available to mobile phones. However, so far, the user is left alone with the task of combining available services in order to fully exploit their potential in an integrated way. This is an unbearable burden, to the point that paradoxically, the more services become available, the less they are likely to be effectively exploited by the user[6]. Specific techniques that support the user in composing services butting him/her at the center of the process need are severely lacking, and needed.

2.2. Vision and Goals

The goal of the Unit is the study and the development of advanced methodologies and techniques for the engineering of software applications based on a service-oriented paradigm. In particular, the unit will build on top of the state of the art just described and of the results achieved in the last years, targeting three specific research objectives.

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[3] Papazoglou, M.; Traverso, P.; Dustdar, S.; Leymann, F.: Service-Oriented Computing Research Roadmap. 2006.

[4] Bertoli P., Pistore M., Traverso P.: Automated Composition of Web Services via Planning in Asynchronous Domains. Journal of Artificial Intelligence, 2010. To appear.

[5] Marconi, A.; Pistore, M.; Traverso, P.: Automated Composition of Web Services: the ASTRO Approach. IEEE Data Eng. Bull. 31(3), 2008.

[6] Bouwman, H., Carlsson, C., Walden, P., and Molina-Castillo, F.J.: Trends in Mobile Services in Finland 2004-2006: From Ringtones to Mobile Internet. *INFO* 10(2), 2008.

- To consolidate and extend the methods and techniques for the composition of distributed business processed developed within the ASTRO research project.
- To develop novel approaches that allow end-users to be in charge of service composition, i.e., to provide usable, human-centric mechanisms for allowing the end-user to control the selection, configuration and composition of services according to their needs and requirements, without requiring them to understand the technical aspects of services and service composition.
- To support the adaptation and evolution of service oriented applications, in particular by promoting Service Level Agreements as the central concept for guiding their development.

These three objectives, which are complementary and strongly synergic, correspond, for year 2010, to the three activities detailed in the next subsections.

2.3. Activities and Work Plan

- *Distributed business processes*

  This activity addresses the automated composition of distributed business processes and builds on top of the results achieved within the ASTRO project (http://www.astroproject.org). Within this activity, the effort in the next year will be focused in finding effective ways to add “semantic” annotations to distributed business processes, i.e., annotations that are oriented to make as unambiguous and as rigorous as needed the meaning of the data and of the procedures exploited in the business processes. Differently from current approaches, such as those based on OWL-S and WSMO, that, in spite of their expressive power, are hard to use in practice since they require comprehensive and usually large semantic descriptions of the domain, the approach that we intend to follow is based on a “minimalistic” usage of semantic annotations. That is, we will pursue approaches that reduce to the minimum the usage of semantic annotations – stopping as soon as the semantic annotations are good enough for the configuration and composition task at hand.

- *User-centric services*

  The challenge addressed in this activity is to enable the mobile phone to take care of the burden of the combination of services, starting from simple user's constraints and requests. The goal is to make the mobile phone a simple yet extremely powerful tool that allows the user to keep control of the combination and exploitation of the services, while relieving her from the technical burden of composing them in a coherent picture. This will be achieved by further investigating the novel approach to service composition devised in SOA, centered on the user, her activities and her goals. In this "user centric" service composition approach to the combination and harmonization of the services available to the mobile user, the services become part of the user's activities, constraints, and goals. Within this activity, we intend to investigate a set of specific scenarios devised in the YourWay! project, refining and extending our theories and techniques to support the design and execution of user-centric service compositions. In particular, the short-term goal is to provide solutions for the specific selected classes of mobile services in the YourWay! scenarios,

providing the user with a unified interface to interact with them and to combine their functionalities.

- *Support of adaptation and evolution via Service Level Agreements*

  The objective of this activity is to investigate how adaptation and evolution can be supported for service-oriented applications, by making use of the key notion of Service Level Agreement. (SLA). SLAs define the exact conditions under which services are provided and consumed, and as such their run-time monitoring is the enabler that triggers an adaptation, since it signals the violation of a property on the quality of service required by the consumer: if there is no more agreement, then there is a need for change. This leads to two challenges: designing SLAs that allow the proper monitoring of properties related to adaptation, and designing SLAs that support as much as possible the autonomic adaptation and evolution of services.

  The objective of this activity is the realization of the "SLAs for monitoring" and of the "SLAs for adaptation" approaches just described. This includes the definition of an environment for the development and evolution of service oriented applications where the designer can defer to the run-time decisions on how to carry out a given process; conversely, the run-time environment can detect failures in performing the business process, for instance due to unforeseen changes in the business domain, and can trigger a redesign phase. During redesign, the overall model of the business application is updated, in order to reflect the changes in the domain (or in the strategic goals of a partner); decisions and procedures may now be fixed by the designer and, conversely, design decisions may be relaxed in order to give more flexibility to the run-time. In this framework, a redesign is not destructive with respect to the run-time: on the long term we envision a "continuous design" environment, where the human driven re-design and the supporting automated techniques concur to the achievement of the strategic goals in a service oriented world.

2.4. Collaborations

- DoCoMo Euro-Labs. Main reference person: Massimo Paolucci. Collaboration: bilateral YourWay! project between this Unit and DoCoMo Euro-Labs. The project focuses on the development of user-centric methodology and support tool for service adoption on mobile phones.
- SAP AG. Main reference person: Andreas Friesen. Collaboration in bilateral industrial project between this Unit and SAP AG. The project focuses on modeling and conformance analysis of service-oriented applications.
- Engineering SPA. Main reference persons: Piero Corte, Francesco Torelli. Collaboration: development of business process modeling methodology and support tool for service composition and adaptation (projects FRISBI and SLA@SOI). Exploitation of SLA-based techniques in the e-Government domain (SLA@SOI).
- University of Stuttgart. Main reference person: Frank Leymann. Collaboration: joint research on flow adaptation within the ALLOW project, and on techniques

for cross-layer adaptation of service-based applications and service compositions in the scope of S-Cube EU project.

- Politecnico di Milano. Main reference persons: Luciano Baresi, Elisabetta di Nitto. Collaboration: joint research in the scope of S-Cube EU project. The goals are: (1) to study and develop integrated monitoring solutions for complex service-based applications; (2) to study the design principles, methodologies, and patterns for adaptable service-based applications.
- Università di Ancona. Main reference person: Luca Spalazzi. Collaboration: joint research on process-level selection and composition of semantically annotated services.

2.5. Specific Needs and Points of Attention

Scientific program, objectives, projects and collaborations for year 2010 build on the work already undertaken by the Unit during the last years. For this reason, we do not foresee specific needs or points of attention pertaining the scientific work of the Unit.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Principles for design of adaptable service-oriented applications	R	E	July	Scientific publications, project deliverables (S-CUBE, SLA@SOI, FIRSBI), prototype tools	-
Formal framework for adaptable service-oriented applications	R	E	Sept.	Scientific publications, project deliverables (S-CUBE, SLA@SOI, ALLOW), prototype tools	-
Cross-layer service monitoring and adaptation framework	R	E	Dec.	Scientific publications, project deliverables (S-CUBE), prototype tools	-
Proactive service adaptation and evolution mechanisms	R	E	Dec.	Scientific publications, project deliverables m(S-CUBE, ALLOW), prototype tools	-
Conformance analysis of service compositions mechanisms	R	I	May	Project deliverables (SAP project), prototype tools	-
User-centric composition platform	R	I	Sept.	Prototype tools, acceptance event of the YourWay! project	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	€730.900,00
Travel	€85.250,00
Equipment (HW/SW)	€16.000,00
PhD Students (grants to the University)	€72.000,00
Other (e.g. subcontracting to external contractors)	€51.000,00
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€955.150,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	€459.300,00
Other external incomes (projects, grants, etc.)	€329.865,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€789.165,00**
Financial Need (Incomes – Expenditure)	**€165.985,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€165.985,00**

5. Human Resources

During 2009, the Unit has reached a stable dimension that is adequate to the objectives and undertaken activities. According to the current research plan, very few changes are expected in 2010, due to the arrival of two new PhD students, to personnel turnover, and to the beginning of the migration of personnel from the Unit to the sayService spin-off (see below).

The personnel of the Unit consists of 6 researchers (2 senior, 4 junior), which coordinate further research efforts by a growing set of PhD students (5 in 2009, 7 in 2010). A strong emphasis is given to the realization of tools, prototypes and demonstrators and on the transfer of the results to industry; a strong team of technologists / project managers (7 in 2009, 6 in 2010) supports the Unit in these activities.

No tenure tracks are currently active.

In 2009, the SOA Unit has launched the sayService spin-off. During the next 3 years, 6 staff members of the Unit will progressively move to sayService. Most of this personnel has now key roles in the governance and management of the SOA Unit. In parallel to the migration of personnel from SOA to sayService, new staff will be recruited in Unit, to in order to maintain the current critical mass. This process will start in 2010, even if most of the passages will happen in 2011-2012.

As reported also in the next section, one risk the Unit may face in year 2010 is a temporary need of more personnel due to the start of new EU research projects, foreseen for the second semester of 2010. For some months, these projects will

overlap with the currently ongoing projects, which will finish in the first semester of 2011. A plan for this contingency will be elaborated during the year, depending on the number and size of new projects. This plan will also be aligned with the passage of personnel to sayService.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Mid-term sustainability. At the moment, the Unit has a high self-funding rate, due to a large number of ongoing projects. Several ongoing projects will end in the first semester of 2011. The self-funding can hence decrease substantially starting from the second semester of 2011.	Low	Medium	Submission of project proposal is already ongoing and will continue during year 2010. The passage of personnel to sayService will also mitigate this risk.
Temporary need of additional personnel. This risk is related to the acceptance of new EU research projects, currently under evaluation. The projects are foreseen to start in the second semester of 2010, and will hence overlap with the final phases of currently ongoing projects, which will finish in the first semester of 2011.	Medium	Severe	Mitigation actions may include: (1) Recruitment of new personnel; on the short term, the new persons will compensate the needs due to the new projects; on the longer term, they will compensate the passage of personnel to sayService. (2) Outsourcing of some of the ongoing activities to other FBK unit or to 3rd parties.

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

Some of the evaluation activities undertaken by the SOA Unit may involve end users, whose location and activities are tracked in order to provide them contextual, personalized services. The Unit is aware of the ethical issues this involves. It will employ highest standard in dealing with these issues and have measures in place to ensure conformance with legislation, and to adhere to the fair information principles (collection limitation, data quality, purpose specification, use limitation, security safeguards, openness, individual participation and accountability).

	YES
Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	Possibly
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
Does the proposal involve tracking the location or observation of people?	Possibly
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

DKM – DATA AND KNOWLEDGE MANAGEMENT

Unit Name	DKM – Data and Knowledge Management	
Type	Applicative / Research	
Head	Luciano Serafini	
Staff	2009	2010
	3 Researchers	4 Researchers
	1 Technologist	2 Technologists
	3 Post Doc	2 Post Doc
	2 PhD	3 PhD
Document Status	submitted 2009-11-30	

1. Executive Summary

Main Activities

The Data & Knowledge Management research field comprises a range of practices used inside an organization (such as an enterprise, an interest group, or the entire web) to create, represent, share and make available knowledge and data, which are relevant for pursuing the organization's goals. It is an interdisciplinary research field on the border between computer science, sociology, economics, and mathematics. We contribute to the above research agenda by developing: methodologies and tools to support the elicitation of knowledge and its encoding in computer interpretable formats; logical formalisms for knowledge representation and reasoning; frameworks and tools for the integration of data and knowledge sources; and efficient and scalable services for the management of large, distributed, and modular knowledge bases.

Knowledge elicitation and modeling. This research area refers to the process of eliciting knowledge from data and people and its encoding in computer interpretable logical theories, called knowledge modules. Our current research is devoted to the development of web2.0 tools able to support an effective collaboration between knowledge experts and knowledge engineers in the construction of integrated domain and process models, and an efficient mix of elicitation from data and elicitation from experts.

Knowledge representation. The work of the DKM research unit in this area concentrates on the development of logical formalisms for the representation of different forms of knowledge. Our current focus is on the representation of contextualized ontologies, semantically annotated business processes, as well as on the development of formalisms able to combine of logical and statistical knowledge.

Knowledge integration. In this area we investigate and develop logical formalisms and tool tailored to support the process of integrating heterogeneous and autonomous knowledge modules in a coherent distributed and modular knowledge base. Heterogeneity means that modules can use different schemata to represent the same knowledge; autonomy means that the management of knowledge modules is not centralized.

Knowledge services. We work towards the implementation of efficient and scalable reasoning algorithms for distributed and modular knowledge bases. These services are applied to support automatic content extraction and integration, semantic web service composition, and analysis of medical procedures.

The unit is currently composed of 2 permanent positions (the coordinator and a senior researcher) 1 tenure, 3 post docs, a research assistant (to be stabilized by the end of 2010) 2. Phd. Students. For the next year(s) we plan to augment the number of Ph.D students

We can distinguish two groups of collaborations in which DKM is involved. The first group concerns the collaboration on genuine knowledge representation and reasoning (KR&R) theme, the second one concerns the combination of knowledge with other research areas. DKM unit collaborates on KR&R research themes with analogous research groups in University of Trento, Bolzano, and Mannheim. Furthermore there we establish a formal joint research activity with the Know-Center in Graz. As far as the research on the application/combination of KR&R method to/with other application areas, we collaborate internally and externally with many groups (see details in the appropriate section). Most of the activity concern the exploitation of knowledge for the management of large quantity of multimedia content.

2. Vision and Scientific Program

Knowledge is becoming an important asset in information technology for the following two main reasons: From the one hand the web, and the semantic web made available a *huge amount of content data*, under a multitude of forms spamming from completely unstructured (i.e., with no explicit semantics) information like natural language text, images, video, to well structured (i.e., with explicit semantic) information like linked data, RDF repositories and ontologies. On the other hand, the increased level of complexity, sophistication, and pervasiveness of the information technology in our everyday life, imposes that applications have to be general enough to smoothly adapt to the "real world". The consequences of this is that more and more applications require an *explicit, and as much complete as possible, representation of "the world"* in which they are suppose to operate. Such a representation should be machine understandable and will constitute the "store of meanings" to be attached to the object manipulated by the application.

The long term view of the research carried on in DKM is shown by the following schema:

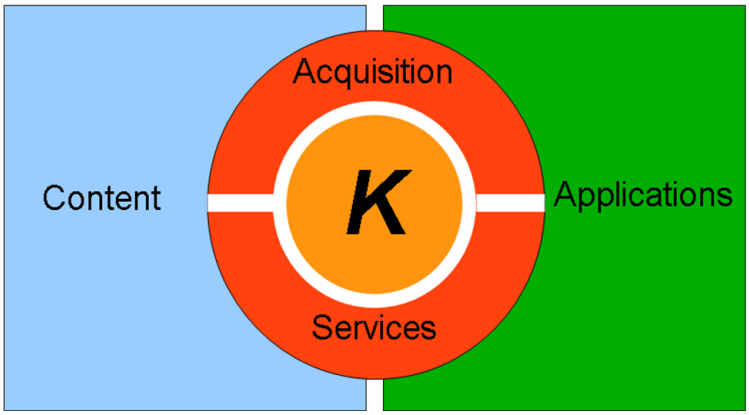

Figure 1. Knowledge acquisition, representation, integration and services.

From the one side we will concentrate on core research (K) on knowledge representation and knowledge integration. On the other side, in order to have impact and feedback from applications we do research in applying our results, as well as the relevant state of the art methodologies and tools for the acquisition of knowledge both from content and humans and knowledge services semantically rich applications.

2.1. Context and state of the art

In the last ten years, general approaches and tools for knowledge acquisition, representation, integration and services, have seen a tremendous improvement towards mature systems which can be applicable and integretable in real world complex applications. For knowledge acquisition, on the one side, we can find knowledge/ontology editors, like for instance Protégé, that support the manual editing of complex ontologies, on the other hand there is a number of tools for automatic content extraction, as for instance TextPro and Gate, that allow the automatic extraction of key concepts lists, basic facts, and other semi-structured material that represent an important pre-processed material for knowledge/ontology construction and population. However, using this tools and combining them for an effective knowledge acquisition process is far to be a pure standard application activity. The state of the art ontology editors are designed for knowledge engineers, which have a specific competence in logical modeling. Such tools do not provide sufficient support for assisting knowledge experts to input their knowledge about a certain domain in some informal (or semi formal) manner. On the other side, despite the state of the art tools for automatic knowledge mining from multimedia content are of great help in an early knowledge engineering phase, it's not easy to integrate them with other tools in order to create a full and integrated production chain for knowledge.

In the are of knowledge representation and reasoning, also the state of the art is quite advance, and provide off-the-shelf theories and tools for storing large knowledge base and doing complex reasoning. They spam from large RDF triple stores, like Sesame, Joseke, 3Store, etc. (see http://simile.mit.edu/reports/stores/ for a survey), to complex logical reasoners, such as Pellet, FACT++, OWLim, … (for

Description Logics) and, Prover9/Mace4, SPASS, Vampire … (for full first order logic). In the middle we can find system like CYC which is at the same time, a huge knowledge repository and a reasoner. Despite being great tools, the application of these tools has been limited to reason in well formalized environments (like program verification) but they are rarely applied to situation which are more open and not so well defined such as the processing of content of a multimedia document. Furthermore, all these approaches are well designed for crisp knowledge (mainly represented in some family of first order logic), while there is no much work done in integrating logical knowledge with statistical knowledge, which is now available by the huge quantity of data.

In the area of Knowledge integration, there are a number of theoretical and practical approaches, but the state of the art technology are far to be straightforward applicable to real situation in a plug and play manner. For instance semantic matching and ontology mapping are not ready to be deployable in real world applications.

Semantic services is indeed an important research area because it justify all the effort done in knowledge acquisition, representation and integration. The goal of knowledge services is the one to make available knowledge in all the other application in a proper format. This span in semantic look up, semantic enrichment of content, verification, etc. This is a very wide area and it is impossible to give a precise state of the art, but in general we can see that there are a plethora of services each of which is designed for some specific application. General knowledge services are limited to standard reasoning services like satisfiability and logical consequence. However, in order to effectively exploit knowledge in application of content extraction or in application of knowledge management we need more sophisticated general services, like for instance semantic enrichment, abductive reasoning, explanation, etc.

2.2. Vision and goals

The overall objective of the DKM research group is to apply and extend the stat-of-the-art methodologies and tools for knowledge acquisition, representation, integration, and services, in order to make them applicable into real case scenarios. This involves (i) the design of new theoretical frameworks and methodologies, (ii) the development/extension of tools, and (iii) the application of knowledge technologies to some specific domain.

The detailed plans in the four areas are described in the following subsections:

- *Knowledge Elicitation and Modeling (knowledge acquisition from human and content)*. The development of high quality declarative models such as ontologies (or knowledge bases) and business process diagrams is a strategic area for practical applications of Knowledge Management. Building from our experience in several European and National projects, such as the ONTOTEXT project, the EU PATEXPERT project and the EU APOSDLE project, we have started the development of methodologies and tools in order to support this modeling activity and to strengthen our position in technology transfer activities

of knowledge elicitation and modeling. This effort has originated three streams of research:

- The development of a tool, called Moki: the Modeling wiKi tailored to the collaborative development of integrated ontologies and process models.
- The development of tools that automatically elicit knowledge from structure/semi-structured data, like a file systems structure, a database schema, folksonomies, wikies.
- The development of large and complete ontology libraries describing typical domains, such as the work environment, governmental institutions, medical domains, which could be exploited in practical applications.

- *Knowledge Representation.* The DKM research unit has a solid background in the development of logical formalisms for the representation of different forms of knowledge. Our current focus is in the following directions:

  Formalisms for the representation of contextualized knowledge: In most of the cases, knowledge consists of a set of statements which are true only in a particular set of situations, often called context. In AI there has been a lot of work in defining general formalisms for the representation and reasoning about contextualized knowledge (e.g., logic of contexts, and Multi Context Systems). The objective of this research is to specialize these formalisms in order to represent contextualized knowledge in the semantic web. The peculiarity of this research stands in the fact that languages for Knowledge Representation of the semantic web are limited in the expressivity but they provide many advantages on the computational level. Within this activity we will define both a theoretical approach, called "contextualized knowledge repository" as well as an implementation on top of Sesame 2 RDF store.

  Formalisms for the representation of semantically annotated business processes: Enriching business process models with semantic annotations taken from an ontology has become a crucial necessity both in service provisioning, integration and composition, and in business processes management. In our work we represent semantically annotated business processes as part of an OWL knowledge base that formalises the business process structure, the b1usiness domain, and a set of criteria describing correct semantic annotations. We also investigate how Semantic Web representation and reasoning techniques can be effectively applied to formalise, and automatically verify, sets of constraints on Business Process Diagrams that involve both knowledge about the domain and the process structure.

  Formalisms for the combined representation of logical and statistical knowledge: Humans solve the problems of interpreting multimedia documentation by both exploiting structural regularities in the data, as well as making use of common sense and specialized knowledge that explicitly represents the meaning of data. In spite of this simple observation, current approaches to processing content over the Internet are based either on a statistical approach, which exploits the regularities of the content encoded in a statistical model, or, alternatively, by logical approaches, by exploiting logical knowledge encoded via logical theories (such as ontologies). In both cases this unilateral approach

leads to a limitation in the performance or in the quality of the results. We believe that combining statistical knowledge with logical knowledge in a unique system would improve the efficiency and the effectiveness of content management applications. This research line aims at investigating how statistical and logical knowledge can be combined and exploited in content and knowledge management, by proposing or extending a theoretical paradigm, test it in three use cases in the area of machine translation, content extraction from text, and image object recognition, and in case of positive results applying it to a real case scenario.

- *Knowledge Integration.* Our contribution to the area of knowledge integration is in the follwoing two main directions:

  Formal models for information integration: Strengthening the usage of Distributed First Order Logics (DFOL) as a general formalism for distributed knowledge representation. We formalize different aspects of knowledge integration in DFOL (as done in some previous work in database integration and to show formal properties of the proposed approach. We consider integration of ontologies with different granularity level, ontology import and modularity and integration of temporal and uncertain information. Similarly, we use DFOL as a metamodel for the comparison of different approaches to information integration and mappings. We also plan to improve ontology mapping languages. We propose to extend ontology mapping languages, by enriching DDL with mappings which represent typical, possibly complex, alternative conceptualizations of the same knowledge.

  Reasoning algorithms and decision procedure: Investigate and extend a family scalable distributed reasoning algorithms for DDL, implement and test them in a prototypical platform. In the recent years we have developed the DRAGO distributed reasoning platform. We plan to stabilize and extend the DRAGO prototype, in two main directions: (1) support of richer mapping constructs. The second extension targets the problem of finding logical errors in mappings generated by automated matching systems.

- *Knowledge Services*. The objective of this activity is twofold. On the one hand we apply existing approach/methodology/tool made available in the semantic web to the projects we are involved in. On the other hand we will develop innovative services if those are not available to the state of the art. A list of services to be investigated are *Semantic matching: Similarity service Normalization service, Semantic look up Instance migration, Mapping debugging/repairing:*

- *Knowledge management for …* Application of knowledge management techniques to different domains as Energy, Enviroment, Medicine, and Enterprise Modelling.

  Energy: The activity of the DKM unit is focused around two explorative the Definition of an information system for sharing and distributing knowledge about energy efficiency to support and expand the success of Energy Efficient technology. The outcome of this activity may consist of (i) the construction of information systems (IS) that enable data collection and mining on energy efficiency, and (ii) the construction of customized knowledge services on top of the IS

described above. These services should enable the customers to store and retrieve: lessons learned, best practices, practitioners guides, resource kits, project publications, courses and training which support knowledge uptake, ad so on..The system should support efficient Knowledge dissemination. Obviously it is not enough to collect and make data available but we need to be sure people can access it in an easy way, e.g., by using technical terminologies as well as lay terminology. The development of such information portal will be based on a semantic model of the domain of energy efficient buildings. The idea is to provide high-level (semantic) models of users, buildings, and policies describing preferences in energy use, which can be used in different phases of the life of the building: Simulation, design, education and involvement of the user.

Enterprise knowledge management system: The objective is to support the production of an enterprise model that can be used for the customization of a content management system for the enterprise. Pilot project with CEII (Laurea thesis). Other possibilities might become more concrete in the area of enterprise information integration to support the realization of social budged of large social companies. (Master thesis Maikol Miorandi).

Knowledge management for environmental information integration: here we concentrate on the development of collaborative semi automatic tools for the integration/extension of ontologies in the domain of environment, such as for instance http:// marinemetadata.org/references/sweetontologies, http://www.umweltbundesamt.at/CEDEX, http://marinemetadata.org/references/envontology, http://environmentontology.org, http://www.daml.org/ontologies/241.

Knowledge management for medicine: The aim of this activity is to develop a coherent medical resource (KNOWMED), which support the access to medical domain ontologies, to laypersons via medical layperson vocabulary, This kind of resource will be based on the development of lexical and ontological resources, and in particular it will includes: the creation of a Consumer Health Vocabulary for Italian language, able to reflect the different ways consumers and patients express and think about health topics, helping to bridge the vocabulary gap, and the creation of a Medical Ontology Repository with all medical ontologies and terminologies representing the general practice domain and the process of care. These resources can be integrated in a Personal Health Care (we will focus on a case study of the TreC Research Project) to help consumers and patients in the process of querying and searching healthcare information, translating and interpreting professional languages used in the clinical notes and other health documents present on the PHR, and finally to easily describe their problems, complaints and clinical history. (Ph.D. thesis Elena Cardillo).

2.3. Activity and work plan

See section on goals

2.4. Collaborations

Data and knowledge management is an activity that, in most of the cases, has sense only in combination with other specific applications. Vice-versa, there are more and more applications that require the capability of dealing with semantically enriched data (i.e., data that are enriched with some form of explicit representation of knowledge. The consequence of this being that DKM in order to carry on high level impact research need to have a tight collaboration with other groups dealing in the specific application field. More in detail we collaborate with the following research groups:

Internal collaborations

- HLT content extraction from textual data (Jrp. LiveMemories, Pescado, Jrp. Copilosk)
- TEV use of logical and statistical knowledge for object recognition in images (Jrp. Copilosk)
- SE semantic annotation of business processes (Jrp. IOS)
- SOA semantic internet of services (Jrp. IOS)
- e-Health collaborative specification of clinical guidelines (progetto e-onco) and construction of lay medical vocabulary (shared Ph.D. Elena Cardillo)

Local area collaborations

- DKM-UniTN Okkam entity repository
- Laboratory for Applied Ontology (ISTC-CNR) Collaborative enterprise modeling in MoKi

External collaborations

- Know Center Graz Collaborative Enterprise Modelling (MoKi)
- Technical University of Graz Knowledge management for Energy
- KRDB Research Centre for Knowledge and Data – University of Bolzano/Bozen Logic base ontology integration
- Knowledge Representation and Knowledge Management Research Group – University of Mannheim ontology integration and ontology mapping
- Laboratorio di Documentazione - Dipartimento di Linguistica, Università della Calabria Knowledge management for energy

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Collaborative construction of models	I/R/A	E	Jun. Dec.	MoKi deployments Paper publications Use cases Exploitation in the Pescado EU project	-
Contextualized knowledge repository + knowledge services for content extraction	I/R/A	E	Jun Sept.	CKR deployments Paper publications Exploitation in the LiveMemory project	-
Logical and statistical knowledge integration	R/A	I	June Dec.	Theoretical reference model for logic and statistical knowledge integration Use case on Natural language processing Use case on Image processing Paper publications Project Proposal submission	-
Integration of static and dynamic logics	R	I	Jun Dec.	Formal reference semantics for the integration of processes and ontologies Paper submission Implementation of related functionalities in MOKI Exploitation of these results in the Internet of Services JRP	-
Knowledge management for Energy	I/A	I/E	Jun Dec.	Define the role of knowledge management technologies in the are of energy Submission of a project proposal in the area.	-
Knowledge management for …	I/R	I/E		Successful application of the knowledge management tools we are developing to real case scenarios in the domains described above	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	424.560,00
Travel	24.500,00
Equipment (HW/SW)	6.000,00
Other (e.g. subcontracting to external contractors)	60.100,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€ 515.160,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	€141.719,00
Other external incomes (LiveMemories + small collaborations)	€109.431,00
Internal incomes	0
Total Income	**€251.150,00**
Financial Need (Incomes – Expenditure)	**€264.010,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€264.010,00**

5. Human Resources

The unit is currently composed of 2 permanent positions (the coordinator and a senior researcher) 1 junior researcher in tenure track, 3 post docs, a research assistant (to be stabilized by the end of 2010) 2. Phd. Students. For the next year(s) we plan to augment the number of Ph.D students and to acquire a new research assistant.

In the 2010 one tenure track should be concluded into, and we will ask for the activation of a second tenure track for a new young researcher who will finish his post doc in February 2010.

6. Risks and Mitigation Plans

The application of Knowledge Management technologies to different areas, such as the ones listed above, requires on the one hand the acquisition of minimal competences in these areas and, on the other hand, the necessity of the customization of the tools and the methodology, reducing the possibility of their reuse. The main risk we run concerns this aspect, i.e., we will concentrate our energies in domain specific applications without developing new innovative technologies and providing significant scientific results.

7. Ethical Issues

Some of the evaluation activities undertaken by the SOA Unit may involve end users, whose location and activities are tracked in order to provide them contextual, personalized services. The Unit is aware of the ethical issues this involves. It will employ highest standard in dealing with these issues and have measures in place to ensure conformance with legislation, and to adhere to the fair information principles (collection limitation, data quality, purpose specification, use limitation, security safeguards, openness, individual participation and accountability).

	YES
Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
Does the proposal involve tracking the location or observation of people?	
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	X
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

HLT – HUMAN LANGUAGE TECHNOLOGY

Unit Name	HLT – Human Language Technology	
Type	Research	
Head	Marcello Federico, Bernardo Magnini	
Staff	2009	2010
	14 Researchers	13 Researchers
	4 Technologists	4 Technologists
	4 Post Doc	3 Post Doc
	7 PhD	10 PhD
	1 Project assistant	
Document Status	submitted 2009-10-22	

1. Executive Summary

Human Language Technology is a multi-disciplinary research unit that addresses the automatic processing of human language for a range of tasks. In particular, our research unit will focus on:

- Automatic speech recognition, that is the conversion of a speech signal into a readable text
- Machine Translation, that is the translation of speech or text from one language into another
- Content Processing, that includes the extraction, integration and retrieval of information from texts

HLT draws on several disciplines, such as Computational Linguistics or Natural Language Processing, Speech Processing, Information Retrieval, Machine Learning, Pattern Recognition, etc.

The HLT unit has been developing state-of-the-art technology in all the main research areas it operates in. The group has performed consistently well in several international evaluations, and is currently engaged in international projects for open source software development (e.g. the Moses platform for statistical machine translation). Research on speech recognition also meets the highest standards, and has reached the application market in several occasions. Moreover, people of the unit are key-players of many international initiatives around evaluation and benchmarking. The unit also provides technological support and high-level services in order to optimize the internal research activities, namely a shared and efficient computing environment, software tools, up to the creation and management of large scale linguistic resources.

The staff is getting close to a stable configuration, with all tenure tracks activated during the first year being closed. According to our plans, future tenure-tracks will be mainly in the machine translation and speech recognition areas, however no requests for activation are foreseen in 2010. Moreover, in 2010 a staff researcher will be reintegrated in the unit after a 2 year period spent at the local company to support the commercial exploitation of our speech recognition technology. Hence, the foreseen personnel is moving toward a stable composition of 13 staff researchers, 4 technologists, 3 post-docs and 10 phd students.

The unit has a remarkable track of funded projects already running and to be started in 2010 thanks to strong and long lasting collaborations with key players in the field, such as U. Edinburgh UK, DFKI Germany, NiCT Japan, CMU USA, U. Karlsruhe Germany, U. Bar Ilan Israel, NIST USA, and U. Sheffield UK.

Finally, the unit is leading a network of strategic collaborations for high level education programs involving local universities and industries:

- International Master School in Human Language Technologies and Interface with University of Trento
- European Master in Language Technologies and Communication with the Free University of Bolzano
- International Doctorate School in Information and Communication Technologies with University of Trento

2. Vision and Scientific Program

2.1 Context and State of the Art

Currently, most research fields in the area of human language technologies [1], like speech recognition (ASR) [2], machine translation (MT) [3] and information extraction (IE) [4], are dominated by statistical approaches, also generally referred to as data-driven or machine learning methods. Statistical methods and large scale experimental evaluations are nowadays at the forefront of HLT for two main reasons: the large amount of language resources that the digital era is steadily producing, and the rapid increase of computing power and memory that technology is achieving year after year. Progress in automatic speech recognition has recently enabled industrial applications. Similar innovation processes are as well expected for other technologies in the next years, such as machine translation and information access technologies. Future challenges, also solicited by international research programmes, are the integration of statistical approaches with linguistic and logical knowledge, in order to reduce the performance gap with humans, and the development of cognitive models in natural language processing [6].

The HLT unit has developed state-of-the-art technology in all main research fields it contributes in. The group working on text and speech MT [7] has performed consistently well in several international evaluations, and contributes to the most relevant open source project in the field. Research on ASR [8] also meets the highest standards, and is currently supporting an important start-up initiative deploying FBK's speech transcription technology. Research on content extraction [9] has a

strong record of publications and evaluation results, namely on question answering and information extraction tasks. Finally, work on cognitive models will focus on so called affective computing, and the extraction of semantic information.

Moreover, people of the unit are key-players of many international initiatives around evaluation and benchmarking Finally, work on resulted in publications at top journals and conferences. Members of the HLT unit have a strong reputation in their scientific communities (Association for Computational Linguistics, Signal Processing Society, and Association for Computing Machinery).

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2.2 Vision and Goals

Our vision is to develop human language technologies that enable multilingual human-to-human communication and facilitate the access to large-scale spoken and written content, available through the Internet and other communication media.

Our short-medium term goals (3 to 5 years) are to become a world-class research group in the area of HLT, able to compete at the highest level in terms of scientific production, attraction of funding, recruitment of human resources, high-level education in collaboration with University of Trento, innovation and technological impact on the territory. Moreover, to reach maturity in the fields of information extraction and machine translation and to promote spin-offs, and to basically cover all

aspects needed to the deployment of HLT: basic education, advanced research, R&D projects, software development standards, language resources, computing resources, and technology transfer.

2.3 Activities and Work Plan

Key technologies that will be investigated are automatic speech recognition, machine translation, information extraction, and content processing. Privileged application scenarios include speech analytics, multimedia data mining, and multilingual communication.

- *A1: Speech Recognition*

  Description. This activity addresses relevant scientific and technological challenges in the field of ASR. Proposed topics will permit to keep the edge on technology, to fuel running industrial initiatives, and to open new scenarios for future applications.

  T1.1 Core technology. R&D will address improvements on all major components, namely the search architecture, the acoustic, the language, and the pronunciation models. Research topics include: (i) data selection methods for language modeling and acoustic modeling; (ii) podcast transcription; (iii) automatic estimation of speech transcription quality (iv) multi channel and multi speaker audio streams.

  T1.2 Speech Analytic. This task focuses on technological advances related to the deployment of FBK's transcription engine: (i) fast speech decoding for automatic subtitling, (ii) fast on line adaptation; (iii) tools and documentation for acoustic model training; (iv) low cost pronunciation modeling,

  T1.3 Multilingual Technology. This task focuses on: (i) advances in Arabic speech transcription; (ii) multilingual audio stream processing (German, French, Portuguese, Russian); (iii) cross-lingual language model adaptation; (iv) language detection, lightly supervised training from broadcast news streams.

- *A2: Machine Translation*

  Description. This activities cover research in the areas of text and speech translation. Considered languages will be Arabic, Chinese, Turkish, English, German, and Italian.

  T2.1 Linguistic knowledge. This research will explore: (i) the integration of linguistic knowledge at the syntactic and semantic level; (ii) the use of context in document translation to improve coherence of translation; (iii) methods to cope with under-resourced translation pairs to overcome the data bottleneck of statistical methods. Some of the results will be released as open-source (Moses, IrstLM).

  T2.2 Advanced modeling. Investigated issues will be: (i) adaptation of generic translation models to a specific domain, topic, or context; (ii) automatic acquisition of bilingual data from comparable; (iii) data-selection techniques from huge corpora to scale down complexity and fit specific application domains;

(iv) pivot-language based machine translation; (v) architectures and algorithms for stream-based machine translation.

T2.3 Sign language translation. This topic includes: (i) shrinking of a dictionary without loss of expressiveness; (ii) automatic choice/creation of paraphrases and synonims within the shrinked dictionary (iii) simplification of text.

- *A3. Content processing*

  This activity covers research in the areas of question answering, content acquisition and content integration from textual documents. The developed techniques will be applied in concrete use cases provided by the users involved in the various projects.

  T3.1 Question Answering (QA) research will focus on: (i) the consolidation of the QALL-ME platform for entailment-based QA over structured data, and (ii) the scalability of the QALL-ME approach, to be tested over the Wikipedia "info-boxes". Additional activity aims at the transfer of the technology through the launch of a start-up.

  T3.2 Textual Entailment (TE) will consolidate the EDITS open source platform. We will focus on the development of specialized entailment engines, particularly for managing contradictions, and on the automatic acquisition of textual entailment patterns for several applications, including the cross-language scenario of the Cosyne project.

  T3.3 Knowledge Acquisition (KA) is useful in various knowledge management scenarios and has direct application in concrete use cases. While the HLT group has been developing KA technologies since several years, investigated issues for the next year include: large scale disambiguation over Wikipedia pages (the "Wiki Machine" project); the automatic extraction of relations between entities, particularly temporal relations between events (to be exploited in the LiveMemories project); the extraction of relations based on Italian FrameNet, relevant for the Pescado project.

  T3.4 Content Integration deals with the integration of knowledge extracted from different sources, mainly textual sources and background ontologies, in order to improve the quality of the knowledge extraction process. The activity in 2010 will focus on: (i) integration of the BART system (developed at UniTN) for intra document coreference; developing of a cross document co-reference approach based on dynamic clustering. Both activities are relevant for the LiveMemories project (ii) the application of information extraction techniques to the medical domain (relevant for the E-Onco project); (iii) the integration of statistical and logical approaches, with specific focus on Markov Logics, in the context of the Copilosk project.

  T3.5 Sentiment analysis (SA) focuses on automatic detection of emotions in written and spoken language, a research area, which is becoming increasingly important in computational linguistics. Relevant applications include text categorization according to affective relevance, opinion exploration for market analysis, affective computing and natural language interfaces for e-learning environments or educational/edutainment games. Specific research will be

carried on fine-grained emotion annotation (for the Firb project) and opinion mining on large news archives (for the LiveMemories project).

- *A4. Infrastrucure*

  This activity provides technological support and high-level services in order to optimize the activities of the HLT Research Unit. Providing a shared and efficient environment, specific for the HLT issues, ranges from the management of special hardware equipments and software tools, up to the creation and management of linguistic resources.

  T4.1 Technological infrastructure. This item covers all activities related to hardware and software issues. It includes the management of the cluster of high performance machines, the installation and management of specific (e.g. linguistic) software tools and packages, the storage and retrieval of huge data (e.g. acoustic data) as well as the definition of their format and documentation, the support for inter-process communication of research prototypes, as well as the infrastructure to support Web-based or interactive demonstration systems.

  T4.2. Language Resources. Starting from the creation of a HLT repository of linguistic resources and a related website, the task addresses two main activities, namely (i) development and maintenance of written, spoken, and multilingual resources, and (ii) networking and dissemination. The first includes design and data collection, definition of annotation schemes, automatic annotation, creation of training data and gold standards, maintenance and management. The networking activity mainly focuses on maintaining relationships with other institutions, distributing resources, disseminating results, organising events and evaluation campaigns.

2.4 Collaborations

Major internal collaborations will be with the following FBK Units:

- DKM, for research on knowledge integration (LiveMemories project) and statistical logical models (Copilosk project).
- E-Health, for research on information extraction from text in the medical domain (E-Onco project).

Major collaborations within the territory will be with:

- U. of Trento (M. Poesio, G. Riccardi), Master school in HLTI and ICT doctorate school;
- U. of Bolzano (R. Bernardi), Master in LCT;
- CIMEC (M. Poesio), joint research on language and cognition, and CIMEC PhD;
- CELCT, for the organization of evaluation campaigns;
- PerVoice (A. Tescari), technological transfer of HLT's ASR technology;
- Eurac Bolzano, sign language translation

At the international level, the HLT foresees collaborations in 2010 with:

- NICT Japan and CMU USA for co-organizing the IWSLT workshop;
- U. Edinburgh, for the co-development of open source software;

- U. Bar Ilan, for joint research on textual entailment;
- NIST USA, for the organization of evaluations on text analysis.
- U. Sheffield, for information extraction.

A new collaboration with the Information Science Institute (ISI) at the University of Southern California will be established during the next year aiming at reinforcing the competences of the group in the area of knowledge acquisition and knowledge management using statistical approaches. An out-going post-doc project will be submitted to support this collaboration.

2.5 Specific Needs and Points of Attention (foreseen for the next year)

The HLT research unit will soon relocate to its new office spaces inside the same building. Some extra financial effort is expected in order to set up an appealing demonstration corner, made of two PCs equipped with large flat screens and two iPhones, and in general to refurbish offices and the common meeting room.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
ASR: Multilingual video podcast transcription	R	E	Sept.	Transcription of news and speeches in English/Italian.	Audio quality assessment methods.
ASR: stream-based model adaptation	I	E	Dec.	Hourly language model adaptation to news streams.	Incoming data streaming by FBK's computer cluster.
MT: Arabic-Italian	R	E	Sept.	Performance gain over a baseline just exploiting available parallel data.	Comparable corpora for Italian, English, Arabic.
MT: syntax model	R	E	Dec.	Performance competitive with phrase-based approach, with reasonable efficiency.	Identification of suitable and possible novel syntax model for statistical MT.
MT: portable system	I	I	June	Translation of traveling expressions.	Acquisition of programmer with Apple platform
CP: Wiki Machine	R	E	June	Precision and recall of Automatic mapping of texts to Wikipedia pages	Powerful infrastructure for real time applications
CP: cross-document coreference	R	E	Nov.	Large-scale efficient application of entity coreference	Availability of benchmarks

CP: Search-based Textual Entailment	R	E	Sept.	State-of-art performance on RTE datasets	Automatic acquisition of entailment rules
IS: HLT demon-stration platform	I	I	Sept.	Life news transcription translation	Acquisition of equipment

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	1.534.588,00
Travel	107.750,00
Equipment (HW/SW)	30.800,00
Other (e.g. subcontracting to external contractors)	330.350,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€2.003.488,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	494.225,00
Other external incomes (projects, grants, etc.)	760.389,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€1.254.614,00**
Financial Need (Incomes – Expenditure)	**€748.874,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€748.874,00**

5. Human Resources

The staff is getting close to a stable configuration, with all tenure tracks activated during the first year being closed. According to our plans, future tenure-tracks will be mainly in the machine translation and speech recognition areas, however no requests for activation are foreseen in 2010. During 2010, five positions will be released: one temporary researcher, three postdocs, and one project assistant. The plan for replacement is to open two post-doc temporary positions (three years) during 2010, which will be funded by new projects. A third post-doc position will be opened in 2011 according to the funding situation. Moreover, in 2010 Fabio Brugnara will be reintegrated in the HLT unit after a 2 year period spend at the local company Pervoice to support the commercial exploitation of our speech recognition technology.

The number of PhD students is also approaching the target number of 12, so for year 2010 we expect to open 4 new positions to compensate for 2 students closing in 2010. As usual we plan to open positions for Summer internships that will reimburse travel, living, and lodging expenses of foreign students, and some pre-phd internship that assign a fellowship equivalent to the phd fellowship. During 2010, we also plan to hire a software programmer (cocopro) to develop demonstration showcases for the LiveMemories project and one on the Apple iPhone platform, if this sort of skill is not available internally.

6. Risks and Mitigation Plans

During the lifetime of our research unit we have identified risks along the following dimensions:

- Research: i.e. the typical risks intrinsic of challenging activities, that may impact on foreseen research results, publications, and performance and utility of the developed technology.
- Resources: i.e. risks related to the availability and engagement of human resources, infrastructure resources, including computing and language resources.
- Funding: i.e. risks related to local and international competition for research funding

All the above risks may and should be mitigated through wise and well conducted management, by making senior members of the unit aware of such risks, by directing research towards worthy and exciting challenges, by favoring motivation through reward models of excellence and participation, by maintaining a pleasant working environment, by caring about established international relationships with top players in the research community also in terms of potential partnership in proposals.

MPBA – PREDICTIVE MODELS FOR BIOMEDICINE AND ENVIRONMENT

Unit Name	MPBA – Predictive Models for Biomedicine and Environment	
Type	Research	
Head	Cesare Furlanello	
Staff	2009	2010
	3 Researchers	3 Researchers
	12 Technologists*	16 Technologists**
	7 Post Doc	7 Post Doc
	4 PhD	4 PhD
Document Status	submitted 2009-11-15	

* 1 data specialist
** 4 data specialist

1. Executive Summary

An unprecedented volume of data is being generated in life science, and this is happening at all scales and interfaces. The scientific challenge of this research unit is to create models and computational tools that connect the newest high-throughput data in human and environmental health together. Based on a long-term experience in data analysis and statistical machine learning for Bioinformatics and Epidemiological Models, we will upscale systems in the high performance computing framework (HPC) to deal with complex patterns on millions of variables or of cases. The unit will also use know-how in Geoinformatics technologies to link environmental and socio-economic patterns to health data on the space-time scale.

In 2010, we aim at becoming one of the first laboratories internationally to develop predictive methods for functional genomics on Next-Generation Sequencing (NGS) data, in interdisciplinary collaboration with centers of excellence in biomedicine and plant genomics. The research work for computational pipelines on NGS platforms adds to the existing collaboration with the USA agency FDA for the MAQC initiative. We will further contribute to this investigation, studying sources of variability in identifying clinical biomarkers, with critical implications in pharmacogenomics. To measure replicability of predictive signatures from high-throughput gene expression and genotype arrays we will develop core research on bioinformatics and machine learning. Preprocessing methods for pattern identification, algebraic methods for biomarker ranking and network analysis will be devised and added to our MLPY library, one of the five most downloaded machine learning open source software systems in 2009. We plan to further make scientific computing a pillar activity for the Unit, investing on skills (junior specialists) and expanding the HPC cluster resources, also with first experiments with HPC on graphical processors (GPGPU) and in mobility. The bioinformatics platform will be used in several collaborative

projects in oncogenomics and neurogenomics: the Hiperdart FP7 project for colorectal biomarker identification with ICO Barcelona, a national project on the molecular basis of Major Depression led by Fatebenefratelli Brescia, Neural tumors (funded by Caritro, led by CiBio UniTN) and Neuroblastoma also with CiBIO and IST Genova. New projects will address fitting quantitative phenotype models from genotype in Autism with UniTN (Cognitive Science) and UniMiami, and applications in NGS for Plant Genomics and Metabolomics with the E. Mach Foundation. Collaboration with CiBIO and FEM will be consolidated by strategic agreements for joint lab initiatives.

The activity in Epidemic Models will be expanded, following the scientific and ethical impact obtained with the development of one of the first spatially-explicit individual based methods for describing the spatiotemporal spread of an influenza pandemic at continental scale (Europe). The collaboration with the national Health Institute (ISS), UniTN, UniPisa, Bocconi Univ, ISI Foundation, Indiana Univ. and other European centers will be funded by two FP7 and other national projects, with resources for postdoc researchers and data specialists. The projects will take account of the effects of spontaneous behavioral changes in response to a lethal epidemic and study of the effectiveness of mitigation measures in Europe for the ongoing A(H1N1) pandemic, also with an evaluation of its economic impact.

The connection between environment, genomic, epidemic mapping, and finally economy will be developed within the Major Project ENVIROCHANGE, led by FEM with ETHZ. We will set up the computational platform of the project, integrating biodata and models to study vulnerability to climate change of the agricultural environment in Trentino. Besides this initiative, we will use data integration by Geoinformatics in projects with strong ethical impact: for the surveillance of traffic accidents (MITRIS projects for Trentino and Friuli-Venezia Giulia); for the definition of socio-economic indicators on landscape planning (Economic Territorial Interface) and for an experimental Cancer Atlas for Trentino.

Finally, the Unit will confirm a strong commitment in scientific dissemination by promoting a scientific computing initiative and the WebValley FBK summer school, both for high school students

2. Vision and Scientific Program

2.1. Context and State of the Art

The true value of data is tied to their being both used and useful (Quackenbush, Genome Medicine 2009). The incorporation of Next Generation Sequencing (NGS) technologies into biomedical research and drug discovery programs is a key issue at many academic institutes and research facilities (e.g. Wold Lab at Caltech). When life scientists consider the latest whole-genome biotechnologies from NGS platforms (e.g Solid, Solexa Illumina, Roche 454, and others), the shared feeling is that a data tsunami is going to wash over all. This feeling is motivated by the huge relative increase in throughput and decrease in costs offered in the last 6 months for the new –omics data produced with such technologies. Moreover, only few cen-

ters are active with the parallel development of ad-hoc machine learning algorithm to extract patterns predictive of disease or any functional genomic target variable (Raetsch Lab at MPI Tuebingen). The larger picture is to make useable and useful for predictive models variables in integration with genomics data and health data, given that additional rich spatio-temporal information is made available from environmental and socio-economics 'sensors'. The boundary between epidemiology and high-throughput genomics has also been breached for evaluating vaccination programs using genetic sequence data (Halloran and Holmes Am. J. Epidemiol..2009). Mathematical models can be built for simulating plausible epidemic spread scenarios (e.g., for influenza pandemic) and for evaluating the impact of control policies. They represent the scientific basis on which public health policy makers take their decisions on the intervention strategies that should be performed at local (e.g. quarantine), national (e.g. isolation of cases, pharmacological interventions) and international scale (e.g., international travel restrictions). In this context, Individual-Based simulation Models (IBM) have become one of the most relevant approaches as they allow for a very detailed description of the population and they are particularly suitable to evaluate the effectiveness of (individually-targeted) public health control measures. We have developed the first IBM for describing the spatiotemporal spread of an influenza pandemic at continental scale (Europe). The strongest competitor laboratory in the Epidemiologic modeling area is Ferguson's MRC Centre for Outbreak Analysis and Modeling.

2.2. Vision and Goals

The long range path we intend to follow is directed towards an effective personalized medicine, that is aware of the environmental effects, and that in the case of infectious disease can progressively include the complexity of relationships between the disease mechanisms and the hosts. As a medium term milestone, a major goal will be the development of methods and computational solutions to integrate together molecular data, epidemiological models and environmental factors. To such aim, key steps will be (i) the integration of the information (both genomics and clinical) coming from different experiments and different scales and (ii) the development of new algorithms for classification, regression and feature ranking and selection that may extract 'integrative patterns'. We are trying to upscale methods by latest machine learning algorithms to deal with millions of static variables and millions of time series, using high performance computing to extract the most important features. A further challenge will be (iii) the development of new mathematical models to unveil the dynamic relations existing among the involved genomic entities, i.e. improving the existing knowledge on the underlying networks. For NGS data, the technology is so rapidly evolving that many changes are expected within one year (e.g. thousands of complete individual genomes available in 2010), with analysis and modeling issues mirroring the early development of microarray technology. In particular, data management and algorithmic issues will pose notable challenges. Considerable applications will include transcriptome analysis (e.g. non-coding RNA, miRNA and polymorphisms detection, down to digital gene expression profiling), novel gene discovery (both for human and plant genomics) and, eventually, the gradual replacement of all the previous -omics platforms with NGS approaches. How the sheer amount of NGS data will be managed is a huge technical challenge, but as not as serious as to guarantee utility of the data by capturing meta-data and ensur-

ing replicability of the modeling process. In terms of complexity, it is still poorly known to what extent the human behavior and its changes over time can affect the spread of an epidemic in a complex modern society as the one we live in today. We aim to give insight into this crucial question, by analyzing the effects of mobility patterns, population heterogeneity, individual behavior (e.g., spontaneous behavioral changes as a protective response to an epidemic, vaccination choices), demographic changes, immigration processes on the spread of an epidemic.

Most if not all of these data will be available also as high-throughput information on spatio-temporal coordinates. By working at the level of plant genomic and disease studies, we can offer some simplification in this highly ambitious research plan. For plant-pathogen systems we will build, in interdisciplinary collaboration, a complete infrastructure for data integration, and definition of models that may depend on stable and varying environmental driving forces as well as on genomic and disease specific knowledge. We aim at developing in the short term technologies and methods that will have an impact on how data from the different fields of climate change and genomics can be connected together and we will build such an infrastructure.

2.3. Activities and Work Plan

Activities for the 2010 will be structured in 4 main pillars (FGM, SciComp, EpiMod and Geo); the latter will also include connecting and dissemination actions.

1. *Bioinformatics for Functional Genomic Modeling (FGM)*
   - NGS-pipeline: development of a high performance computing (HPC) pipeline (RNA-seq and SNP identification) on and Next Generation Sequencing data, with studies on large scale test data by vendors and applications with centers of excellence in biomedicine and plant genomics. Installation of the pipeline in collaborating labs (e.g. Wistar Inst. Philadelphia).
   - FDA: advances in biomarker identification, analysis of sources of variability in identifying clinical biomarkers, reproducibility of studying sources of variability, pharmacogenomics aspects.
   - FP7 HIPERDART: colorectal (CRC) biomarker identification. Development of core research on bioinformatics and machine learning to evaluate replicability of predictive signatures
   - TRADENT and other neurogenomic studies: translational deregulation in neural tumors, with CiBio. Also: subclass identification of survival in neuroblastoma and Molecular Basis of Autism.
   - FBF: neurogenomics and pharmacogenomics strategies for individual treatment in major depression
2. *Scientific Computing (SciComp)*
   - Software: MLPY platform (machine learning and preprocessing solutions, graphical user interfaces);

     Hardware: consolidation of the Linux cluster facility and experiments with HPC on graphical processors (GPGPU) and in mobility (ContextAware).
3. *Epidemic Model (EpiMod): implemented within 4 funded projects and one exploratory action:*

- FP7 FLUMODCONT: evaluation of the effectiveness of mitigation measures in Europe for the ongoing A(H1N1) pandemic, study of the effects of spontaneous behavioral changes in response to a lethal epidemic, evaluation of the economic impact of the ongoing A(H1N1) pandemic in Europe.
- FP7 EPIWORK: study of the effects of mobility patterns on the spread of an epidemic, study of the effects of population heterogeneity on the spread of an epidemic;
- CCM RTMOD: real time models for the spread of influenza pandemic in Italy.
- CHICKISS: models of host-vector infectious diseases, with application to Chikungunya virus.
- HumanBehaviorMod: we plan to set the basis for study of the effects of demographic changes, immigration processes, vaccination choices on the long-term dynamics of endemic diseases.

4. *Geoinformatics (Geo):*
   - ENVIROCHANGE: Set up of the computational platform of the project, integrating biodata and models to study vulnerability to climate change of the agricultural environment in Trentino. Studies on high throughput time series clustering.
   - MITRIS: completing of regional projects (Trentino and Friuli Venezia Giulia) on WebGIS technology for surveillance and risk modeling of traffic accidents
   - IET: Definition of socio-economic indicators, implementation of interactive interfaces for on-line data analysis, interconnection of geographical and statistical data by web services; development of the ict4progress knowledge base for the OECD global project on measuring progress of society
   - CancerAtlas. Development of a Prototype platform for cancer epidemiology and spatial analysis
   - Dissemination: design of a scientific computing mentoring for high school students. Organization of the WebValley10 SummerCamp.

2.4. Collaborations

- University of Trento (CiBio), Alessandro Quattrone: (Caritro proj and Neuroblastoma) for NGS RNA-seq and integrative functional genomics for molecular oncology and neurogenomics
- Fondazione Mach, (Genomics and Crop Biology) Riccardo Velasco: development of a coordinated action for NGS (RNA-seq and SNP identification) on grape, apple (draft genome), and berry genomes. ENVIRO Major project (Ilaria Pertot)
- Fondazione Mach (Quality and Nutrition), Fulvio Mattivi: methods for mass-spectrometry in metabolomics, development of preprocessing interfaces and reproducible analysis plans
- Centro San Giovanni di Dio – Fatebenefratelli, Genetic Unit, Massimo Gennarelli: “Innovative strategies for depression treatment: novel pharmacological targets and preclinical studies for the personalization of therapy”, Brescia (Ricerca Finalizzata 2007 Min Sal. Conv. N° 42)

- U.S. Food and Drug Administration, Office of Translational Science, Federico Goodsaid: MAQC-II Genomewide Association Studies Working Group, for the identification of sources of variability – large scale experiments on WTCCC Major Disease and Ottawa CAD studies
- Catalan Institute of Oncology, ICO Barcelona, Victor Moreno: HIPERDART FP7 project, identifiction of novel biomarkers of
- Microsoft Research – CosBI, Attila Csikasz-Nagy: studies on networks: bioinformatics tools for network analysis
- The Wistar Institute, Philadelphia, Genomics Core, Louise Showe: development of bioinformatics pipelines for NGS in Functional Genomics
- Computational Biology and Informatics Laboratory, UPenn and MGED Society, Chris Stoeckert: development of international guidelines for data sharing in functional genomics and in NGS data in particular (special working group led by Marc Salit, NIST).
- University of Trento, Andrea Pugliese, FP7 FLUMODCONT: a) study of the effects of spontaneous behavioral changes in response to a lethal epidemic, b) evaluation of the effectiveness of mitigation measures in Europe for the ongoing A(H1N1) pandemic, c) evaluation of the economic impact of the ongoing A(H1N1) pandemic in Europe.
- ISI Foundation (Turin), Vittoria Colizza, FP7 EPIWORK: a) study of the effects of mobility patterns on the spread of an epidemic, b) study of the effects of population heterogeneity on the spread of an epidemic.
- Indiana University, Alessandro Vespignani, evaluation of different approaches for modeling the spatiotemporal spread of epidemics.
- University of Pisa, Piero Manfredi, study of the effects of demographic changes, immigration processes, vaccination choices on the long-term dynamics of endemic diseases.
- Bocconi University (Milan), Alessia Melegaro, FP7 FLUMODCONT: evaluation of the economic impact of the ongoing A(H1N1) pandemic in Europe.
- Istituto Superiore di Sanità (ISS), Caterina Rizzo, FP7 FLUMODCONT: a) evaluation of the economic impact of the ongoing A(H1N1) pandemic in Europe, b) evaluation of the effectiveness of mitigation measures in Europe for the ongoing A(H1N1) pandemic, CCM RTMOD: real time models for the spread of influenza pandemic in Italy; c) CHIKISS: Chikungunya virus models.

2.5. Specific Needs and Points of Attention

1. Development of strategic actions with UniTN and FEM for partnership in research, lab resource sharing, participation to projects as a unique Trento research node. In particular, we aim at defining
    - A joint lab with CiBio for Next Generation Sequencing studies and integrative bioinformatics, with a traslational focus on molecular oncology and neurogenomics, and applications in pharmacogenomics: currently: 1 PhD students, 1 post-doc fellow, 1 junior technical specialist, access to FBK-MPBA computing resources, two projects (one funded).

- A structured initiative with FEM on high-throughput and NGS data analysis for plant genomics (informally started October 2009).
- 'EpiCore' for a Joint Excellence Initiative of FBK (MPBA), UniTN (Research Group in Population Equations) and FEM (EFB/EFP) for research on the mathematical, computational and biological bases of infectious diseases.

2. Limited institutional resources available for proactive international actions in 2010 (FDA initiatives, training of students) with respect to self-funded but focused research. Need for explicit internal support actions.
3. Need for further investment program in HPC resources: computing nodes with high RAM availability are needed for the bioinformatics and epidemics models (128MB).

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
HiperDART: Set of probes (biomarkers defining a genetic signature for CRC) defined for molecular stamping/	R	E	Feb.	Report: internal validation by FDA MAQC-like exps + external validation on confirmatory db	Availability of adequate public datasets and possibly of original project data
NGS-Pipeline/FDA: HPC implementation of workflows for variant positions in the genome	R	E	April	Academic Paper describing a full system implementation	Adequate size of the additional confirmatory dataset.
EpiMod: Evaluation of the effectiveness of mitigation measures in Europe for the ongoing A(H1N1) pandemic	R	E	June	Academic paper	European datasets
EpiMod: Evaluation of the economic impact of the ongoing A(H1N1) pandemic in Europe	R	E	June	Academic paper	European datasets
SciComp: experiments with GPGPU on environmental health data	I	I/E	July	Demo system and report	Availability of environmental dataset

IET: platform for integrative analysis of socio-economic indicators on spatial scale	I/R	E	Oct.	Software beta version + Report on applications for pilot areas	Definition and delivery of indicators and pilot areas by project partners
ENVIRO-CHANGE: integration of weather driven patophysiology in ecological models (based on geographical information system and remote sensing)	I/R	E	Dec.	Software beta version + Report with list of existing available models	Delivery of models by project partners

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	925.414,00
Travel	53.000,00
Equipment (HW/SW)	47.700,00
Other (e.g. subcontracting to external contractors)	168.950,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€1.195.064,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	269.137,00
Other external incomes (projects, grants, etc.)	740.284,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€1.009.421,00**
Financial Need (Incomes – Expenditure)	**€185.643,00**
Required Structural funding from PAT (it should be equal to the previous item)	185.643,00

5. Human Resources

All current MPBA members are affiliated to FBK as employees. Only 3 senior Researchers (the coordinator R1 and two R2 researchers) have permanent positions.

The rest of the research personnel in the Unit is then composed by 7 postdoc fellows at R3 level (6 of them with up to 3 year positions, 1 collaborator): three of them, who joined from ETHZ and Dublin University College in 2009, were enlisted within the 'rientro dei cervelli' national initiative. Other two graduated in 2009 as FBK – UniTN ICT students, both in the Bioinformatics track. In 2009, the technical personnel currently includes one part-time senior data coordinator (formerly deputy of Statistical Services), one specialist operating in Trieste on data entry for the MITRISFVG3 project, and 10 scientific programmers of expertise ranging between 6 months and 3 years, all students at the IT or TLC degrees. Almost all of them were our most brilliant students at WebValley and they are now doing a first regular research experience – which in the first place is a positive outcome for our research: at the same time, they are positively enthusiasts, often giving remarkable technical contribution. In 2009, all the programmers had part-time contracts. The group also included 4 PhD fellows on average along 2009, with one fellowship funded by the Math department.

The increase in funded projects for 2010 will require a stronger contribute in data entry/processing and a consolidation of the scientific programming platforms. Moreover, considerable actions for interface and geo-bioinformatic integration will be needed. Fully funded by the projects, 3 additional data specialists will be selected to operate for epidemiological and entomological data collection (in Rome and in Cesena) and they will thus not provide organizational costs. The only collaborator within the postdoc fellows will also receive a R3-TD position, in case of positive collaboration in the first part of the year. We plan to move from part-time to full time position one third of the remaining technologists, those with higher computing skills and expected to graduate in early 2010. For all the junior programmers we have planned an external stage period, possibly abroad, following the strongly positive training experience at the Wistar Cancer Centre this year. The number of PhD students is also confirmed, with one fellowship awarded at the new CiBIO based PhD program. In case of favorable results, we will fund a second CiBIO PhD fellowship to one of the scientific programmers, who will receive a MsC degree in Biotechnology later this year. The opportunity of a PhD Fellowship on Epidemic Models, either at Mathematics or ICT, will also be considered.

From the collaboration with CiBio, we expect to share a PostDoc fellow in 2010 from funds of the Caritro Neural Tumour project, again with working space allocated externally. Further collaboration with FEM and CiBio could be possibly implemented by an additional postdoc fellowship, still under review.

Following a positive experience in 2009, a collaboration with the Department of Statistics of the University of Pisa will be activated to support the development of small-area spatio-temporal risk indicators for cancer for car accident risk estimates. Similarly, an expert free-lance programmer will be hired during the year for developing a database infrastructure from the RTMOD budget. While all the scientific programmers have been chosen, the health data specialists will be selected by the partner (ISS).

Given the impact of externally funded projects, a strong synchronization of activities will be required: most of the postdoc fellows will act as deputy coordinator of a research project, with one senior researcher tutoring on management of resources and scientific progress. Special coordination will also be assigned for data related tasks, for the main bioinformatics platform, and for the development of the Geoinformatics engine.

One postdoc position will be upgraded from consultant to employee within November 2010, and two tenure track slots will be possibly defined within 2010 at postdoc level. It should be advisable to add a third tenure-track or permanent position for a postdoc or a technologist (scientific programmer).

The ContextAware project (legge 6 PAT) will conclude its operation in September 2010: technical personnel from the project might be considered for a focused 'Innovation Team' or for a technological initiative such as a spin-off. We are prepared to host students and foreign researchers with own funds (4 and 5 respectively this year).

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
HiperDART: lack of discriminative probes on gene expression for disease (grade/stage) classes in colorectal cancer (CRC)	M/H	S	Consider fitting a quantitative phenotype (survival scores), genotype (SNPs/CNV), methylation (epigenetic).
NGS-Pipeline/FDA: HPC implementation of workflows (in particular single batch case-control) configuration) for variant positions in the genome due to inadequate computing resources	L	M	Obtain privileged access to memory/computing power within the FBKCLS cluster or on external computing facility – may be problematic due to huge dataset size
EpiMod: Too large confidence interval for model prediction of mitigation measures in Europe for the ongoing A(H1N1) pandemic or of economic impact	VL	M	Model will be reparameterized according to more reliable estimates of key parameters.
SciComp: inability of completing experiments with GPGPU (due to memory requests) or lack of upscale in performance	L-L	M-M	In the first case, alternative GPGPU or conventional cluster may be employed. Alternative time series distance (e.g. DTW variants) or clustering implementations should be explored in the second case (→ delay of results, but still within the year)
IET: too complex interaction is evaluated by user survey for the dynamic graphics or the overall interface	M	M	The user survey will be administered at least twice, anticipating a major prototype release at least 60 days before the end of the project
ENVIROCHANGE: lack of rich data available through webservices or too high complexity in web service integration	L	M	A replicate geo-database, including the most critical features/maps will be created and maintained along all the project.

Legend:

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

The application research of the MPBA Unit is strongly focused on the processing of genomic and epidemiological data and of its association with environmental and socio-economic variables. We acknowledge that genomic data and phenotypic data will be needed that may include a potential issue for personal identification. However:

- The Unit will not directly collect and be responsible for data acquisition, but definite agreements with data providers will be produced (e.g. investigator requests for access to data). In all cases, the personal ID will be removed and only anonymous coding systems employed.
- In all cases deemed relevant for potential of personal identification, an IRB or an IRB exemption will be requested to a certified Ethical Committee. The confidentiality of the personally identifiable information will be maintained throughout the research and thereafter. The Ethical Committee of Trento University will be most likely involved for all research projects including other teams from UniTN as collaborating units.

	YES
Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	X
Does the proposal involve tracking the location or observation of people?	X
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	

Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

TeV – Technologies of Vision

Unit Name	TeV – Technologies of Vision	
Type	Applicative / Research	
Head	Stefano Messelodi	
Staff	2009	2010
	11 Researchers	8 Researchers
	1 Technologist	3 Technologists
	0 Post Doc	0 Post Doc
	0 PhD	1 PhD

Document Status submitted 2009-11-03

1. Executive Summary

The TeV research unit is conducting leading research in the general field of computer vision and image analysis, with particular focus on the i) understanding of dynamic scenes populated by various kind of moving entities (people/vehicles) and ii) semantic annotation of images and videos aimed at the automated indexing of visual and multimedia material and subsequent integration of pieces of information coming from different sources.

Based on the results of the research activities, the TeV unit aims to develop new technologies and prototypes that promote innovation in society by stimulating technology-transfer to existing companies and/or the creation of new companies.

Specific goals for 2010 are focused in three directions: i) focus the research along the strategic lines devised by the Information Technologies Centre, i.e. the joint research projects in the areas of Future Internet (FI) and Embedded Intelligence and Systems (EMIS); ii) strengthen the self-funding capability of the unit by applying for new grants (both EU and industrial projects); iii) contribute to the impact on the local territory by supporting the creation of a new start-up company with the main role of exploiting a well consolidated result of our recent research.

Concerning TeV personnel in 2010, one PhD student will join the group and two researchers will be stabilized at the beginning of/or in the course of the year. In order to support the objectives of the unit for the next year a rebalancing of the allocation of human resources within TeV is appropriate. For this reason, a couple of researchers will be diverted from research oriented to more technical activities, mainly devoted to support research and developing software systems.

In the context of European projects, TeV is actively collaborating with ATOS Origin (Multi-national), the Institute of Computer and Communication Systems (Greece), the Instituto de Novas Tecnologias (Portugal), the Athens Information Technology

(Greece),the BBC (UK) and Queen Mary and Westfield College (UK); other external collaborations include the University of Modena and the University of Trento. Internal collaborations are active with other research units involved in the joint research projects, PuMALab and Copilosk, and the Acube project, in particular with the SHINE research unit. A goal for 2010 is the activation of a collaboration with research groups working on visual perception from a psychological and psychophysical point of view.

2. Vision and Scientific Program

2.1. Context and State of the Art

In recent years research activities have been focussed in two main areas:

- Dynamic scene understanding (DSU): understanding of dynamic scenes populated by people/vehicles as a basic tool for the implementation of surveillance systems and human/machine interaction systems
- Semantic image labelling (SIL): providing a semantic annotation of visual material focused on the development of systems for retrieval/browsing of large archives and for environmental monitoring.

Research in the former area has led to important scientific publications in which recent theoretical advancements in the area of people tracking have been presented ([1], [2], [3]). Moreover, the automatic people detection algorithm is the subject of a new international patent application [4].

A demonstration of the tracking technology system is constantly available and continuously updated through the integration of novel results produced by the research. Furthermore, the tracking technology has been tested in real environments, like in booths at exhibits, real apartments and in the FBK foyer, providing important cues about the critical issues that need to be addressed in the future.

Since 2008, we decided to investigate a novel approach to scene understanding, able to support perceptive adaptation to environmental conditions and to events taking place in the observed scene. This activity has brought about a new joint research project, named PuMALab, in the context of the strategic line EMIS of the Information Technologies Center, coordinated by a researcher from the TeV unit.

Currently the research in dynamic scene understanding is carried out within the PuMALab project and Acube, a project partially funded by PAT, where the people tracking technologies are applied in a care-home environment.

The research activities in the second area have been partially carried out within local and European projects and have produced various scientific publications ([5], [6], [7], [8], [9]), and the creation of a demonstrative system showing our object recognition technology, called MEMORI. Recently, we decided to focus our research on image annotation by exploiting contextual information coming from the image itself and/or from external sources like contextual and common-sense knowledge. This choice motivated our active involvement in the preparation and

launching of the Joint Research Project named Copilosk, within the FI strategic line of FBK.

In this research area we have recently launched an investigation in the context of automatic annotation of panoramic images. This activity, conducted within the internal Visual Environmental Monitoring project, is naturally embedded inside the FI strategic program and has led to the creation of the so-called Marmota technology ([10], [11], [12], [13]).

[1] O. Lanz, S. Messelodi, A sampling algorithm for occlusion robust multi target detection 6th IEEE International Conference on Advanced Video and Signal based Surveillance - AVSS 2009, Genova, Italy, September 2-4, 2009

[2] O. Lanz, A HJS Filter to Track Visually Interacting Targets IEEE International Conference on Acoustics, Speech, and Signal Processing - ICASSP 2009, Taipei, Taiwan, April 19-24, 2009

[3] O. Lanz, An Information Theoretic Rule for Sample Size Adaptation in Particle Filtering 14th International Conference on Image Analysis and Processing - ICIAP 2007, Modena, Italy, September 10-14, 2007

[4] O. Lanz, S. Messelodi (EU 09425338.2 - pending) - Method for Efficient Target Detection in Images robust to Occlusion [2009]

[5] M. Lecca, An Attention Module for Object Detection in Cluttered Images Electronic Letters on Computer Vision and Image Analysis - ECLVIA , Vol. 8, No. 2, pp. 68-83, July 2009

[6] M. Lecca, S. Messelodi, Computing von Kries Illuminant Changes by Piecewise Inversion of Cumulative Color Histograms Electronic Letters on Computer Vision and Image Analysis - ECLVIA , Vol. 8, No. 2, pp. 1-17, July 2009

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2.2. Vision and Goals

Building upon the competencies maturated in recent years and the results achieved in the research areas of understanding of complex/dynamic scenes and semantic image labelling, the future research in the TeV unit will move in two directions already mentioned in the previous section, that have been explored in the course of the past year.

Scientific activities in the Dynamic Scene Understanding (DSU) area will be organized mainly around two inter-connected objectives: (i) leveraging the potentials of SmarTrack to become a core technology in a wide range of real-world applications, and (ii) progressing on more fundamental aspects of machine perception from a rooted computational perspective.

Within the first objective, we intend to systematically address a number of issues which are faced in open and non-collaborative environments. With the FBK entrance hall as a live laboratory, we will study and test theoretically grounded solutions to tracking in unevenly illuminated scenes. This encompasses: (i) the on-line estimation of the spatial distribution of colour distortion induced by unknown directional light sources (e.g. daylight in windowed environments) and (ii) the adaptation to appearance changes in the target model by means of (iii) a fusion with illumination invariant features (e.g. normalized image contrast, or edges). On top of this, we will look at the problem of resource constrained tracking in large and structured environments, more consistently by investigating (iv) the adaptive spatio-temporal fusion of multiple video streams to provide logs for a more robust interpretation of peoples' behaviour and to support (v) non instantaneous target detection and model acquisition (required to operate reliably in complex scenes with frequent occlusions). While from an applicative point of view these activities are expected to have a direct and measurable impact on currently running projects (ACube,, MY-E-Director 2012) and will solidify the value proposition of the SmarTrack spin-off initiative and related theoretical results will match the scientific objectives of the PuMALab JRP. It is intended that the approaches will abstract from the sensing modality that they operate on and thus be generalized to various domains (video, audio, EM sensing), including multi-modality. In line with PuMALab, and as a long term activity, a state estimation framework supporting adaptation (e.g. to varying illumination conditions, but not only) will be developed which is tailored to the sequential nature of perceptual input and to the physical world it refers to.

In the Semantic Image Labelling (SIL) area, the scientific activities will address two partially overlapping objectives: (i) continuing Marmota technology research, by attempting to exploit its value in several directions, scientific progresses, access to grants, technology transfer, etc. and (ii) contributing to the fundamental research

foreseen in the Copilosk project, concerning the integration of statistical and logical knowledge, and its application in a computer vision oriented use-case.

The Marmota *concept* was born from a sense of curiosity about our surroundings. Over the past year the idea has grown from a tool to simply understanding the names of the mountain peaks around us, to what is now a fully fledged 'in-the-lab' prototype that can help us to visualize 2D photos in a 3D Augmented Reality (AR) way. Our expectations for Marmota over the next year will lead us in new exciting and stimulating directions: i) take our ideas outdoors through the development of an Android application; ii) diversify our research into geo-informatics and iii) begin to both explore and generate User Generated Content (UGC). These challenges will create many opportunities for TeV.

Concerning the research, we will focus on the geo-location estimation of photos based on content, e.g. foreground/background, text detection and reading, global classification of man-made/natural scenarios. A second interesting aspect is the exploration of population dynamics and population interest from UGC shared on sites like Flickr or Panoramio based of geo-reasoning and user rated aesthetic appeal.

We expect to be able to access new grants through the creation of and taking part in EU proposal generation (dependant on the recently submitted EU GATHERER proposal which TeV coordinated), and to produce relevant scientific publications both as journal papers and conference presentations.

Concerning the transfer of Marmota technology and its development, we foresee two directions which aim to exploiting an already existing collaboration and to set up a new service for the Android platform. Following on from our fruitful collaboration with the British Antarctic Survey (BAS), in which saw the creation of a Marmota powered image exploration website populated with Antarctica imagery, we will explore the possibility of further collaborations in the field of image annotation and augmented reality. Consumer AR is undoubtedly a hot topic since the birth of powerful and affordable smartphones, like the iPhone and Android phones. We will create a client-server architecture that will enable a user with such phones to visualize and explore his immediate surroundings through the exploitation of geo-referenced metadata. At the start of the year we aim to launch this application for the province of Trentino, and then in the summer we will deploy it on the World stage based on the local user studies.

We expect this research to open up a wide range of new applications, including support for tourism, exploiting augmented reality visualization and understanding of population dynamics, atmospheric and terrain environmental monitoring, etc. In fact, through our ever-expanding database of Alpine webcam imagery, we will explore the interesting topic of visual environmental monitoring, trying to classify what the current or 'typical' conditions for a particular region could be. This may be of particular interest to photographers, climatologists, environmentalists, etc

Finally, this research technology could enhance the capabilities of search engines by understanding more about the 3D and geo-referenced content of an image or video through the extraction of a wealth of new and rich meta-data.

Partially inter-connected with Marmota is the research activity carried out in the context of the Copilosk joint research project. The general goal of Copilosk is to investigate how statistical and logical knowledge can be combined and exploited in the management of multimedia content and knowledge, by designing a novel theoretical paradigm. Furthermore, the framework will be tested in a set of use cases including the task of semantic image annotation.

TeV's objectives are, on one side, to contribute in the design of the novel framework capable of accommodating, in a theoretically way, statistical and symbolic approaches for the tasks of knowledge representation, inference and learning. On the other side, TeV will play a central role in the implementation of the vision use case, whose main objective is the integration of contextual and common sense knowledge into the object recognition system and, in general, for the semantic annotation of images and videos.

2.3. Activities and Work Plan

TeV activities for 2010 are organized into two categories: research and technology transfer.

The first category includes the research activities carried out within several projects of two different types: internal strategic projects (PuMALab and Copilosk) and externally funded projects (My-E-director 2012 and Acube). Additionally, unforeseen research activities can arise which inevitably require additional effort, for example the preparation of proposals to apply for new grants, the revision of manuscripts in favour of journals editorial board or conference program committee, the tutoring of PhD or master thesis students, the presentation and demonstration of TeV's main results both at international and local level and the participation in FBK internal initiatives.

The foreseen activities for 2010 in the DSU area are the following:

- Formalization of a probabilistic framework to estimate a state space function using sparse (both in the state space and in time) observations, that arrive sequentially. Currently, we are investigating whether Belief Propagation, or the CCCP algorithm, can be used as a baseline framework for this purpose.
- Application of the framework to estimate the spatial distribution of colour distortion for improved tracking under uneven illumination. Ideally, this should be an online procedure that incrementally learns a non parametric representation of the distortion function from tracking observations, and adapts to its changes.
- Investigation of other applications of the framework, with particular attention to examples where the mapping to be estimated has a finite number of modes. The purpose of this is to show that the framework may be seen as an automatic tool for extracting symbolic representations from continuous data without prior knowledge, a key objective of the PuMALab JRP.
- Online fusion of multiple cues for tracking, which should adapt to the information content of each cue measurement, using an information theoretic approach.

- Use of adaptive fusion to understand when the target model has to be updated (e.g. when a tracked person takes off their jacket, the associated colour cue may become unreliable while shape features should remain stable).
- First attempt to camera auto-calibration by target detection (a moving person will here be used as a calibration pattern). To this purpose previous work on target detection will be revised to include camera parameters in the estimation process.

The foreseen activities for 2010 in the SIL area are the following:

- Estimation of the geo-location of photos based on the integration of available meta-data (although often partial) and content analysis (e.g. foreground/background segmentation, face and people detection, text detection and reading, global classification of man-made/natural scenes).
- Investigation and development of algorithms to correlate the content of a photo with a 360° model of the terrain. This task is not straightforward, as the features existing in the real and synthetic worlds are not always consistent due to DTM errors and/or visible occlusions in the image.
- Participation in Copilosk, aiming to select interesting statistical-logical models, with the goal of possibly extending, adapting and analysing them in terms of computational properties.
- Design and development of a novel object recognition algorithm which attempts to exploit the preliminary outcome of the Copilosk project, to improve the system capability to semantically annotate images and videos, by incorporating, within a unified framework, contextual and background knowledge.

The second category focused on the exploitation of the technologies realized by the unit, targets FBK's goal to push the innovation of the local industrial network.

- The most challenging goal is the creation of a company whose objective is the commercialization of new products based on the people tracking technology developed by TeV over the last five years (part of the FBK support to new industrial initiatives). Moreover, in the coming years, the company should work as an open channel for the timely transferral to the market of new tracking technology developments. TeV will provide support in terms of personnel, partially dedicated to the porting phase of the tracking technology from a laboratory demo to a commercial product.
- Creation of an Android application (App) based on a client-server architecture which will furnish the user with a powerful Augmented Reality (AR) experience in the countryside. This Marmota based App will provide users with a true feeling of AR in the palm of their hands, providing them with an intimate knowledge of their surroundings through the visualization of 3D geo-spatial information in real-time looking straight through the device's screen. The deployment of this technology with be carried out gradually over the year, beginning with an initial Alpha stage geo-spatial restricted to the province of Trentino. As problems and suggestions are resolved and integrated, the goal is to release the Marmota App on the World stage.
- We will continuously monitor the market to evaluate other possibilities for TeV technology transfer: for example the SCOCA traffic monitoring technology,

which has been developed and deployed locally and is still showing a great potential.

2.4. Collaborations

The most important external collaborations at present is within the EU-project *My-E-director 2012*. We have a very close working relationship with the perceptual component providers in the project, namely AIT and BBC, and will a directed effort in scene understanding and athlete detection in high dynamic sports events. Next year, our plans include the low level integration of AIT's face detector/recogniser with our text localization and reading module to improve the identification robustness of the system. Within *My-E-director* 2012, the BBC are primarily concern with the localization and tracking of football players using active tracking technologies, specifically RFid. In this scenario, we will attempt to compare the performance of hardware and software technologies focused on person tracking. It will be an interesting exercise in multi-modality to ascertain which mixture of results to use where and when.

We also have other active collaborations with Italian universities, such as Trento and Modena, in addition to local research centres like CreateNet.

Furthermore, we also have an excellent working relationship and historically successful collaborations with internal research units, which we intend to maintain and strengthen in the next year, in particular TeV is collaborating with SHINE, I3, DKM, ES and SOI.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Formalization of a probabilistic framework to estimate a state space function using sparse observations, and its application to estimate the spatial distribution of colour distortion for improved tracking under uneven illumination.	R	I/E	Sept.	The implemented framework can be tested in the live SmarTrack installation in the FBK foyer	-
Online adaptive fusion of multiple cues for tracking, and its use to understand when the target model has to be updated	R	I/E	Oct.	The module can be tested in the lab demo of SmarTrack	-
Camera autocalibration by target detection	R	I/E	June	The module can be tested in the lab demo of SmarTrack	-

Obtain a new grant in the SIL area	A	E	Dec.	-	-
Creation of an Android App based on Marmota technology	I	E	Sept.	-	-
Identification and analysis of a logical-probabilistic model for content processing and management	R	I	Dec.	-	-
Creation of a new start-up exploiting the SmarTrack technology	I	E	June	-	Approval by the FBK CdA

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	**549.289,00**
Travel	**16.000,00**
Equipment (HW/SW)	**9.000,00**
Other (e.g. subcontracting to external contractors)	**36.400,00**
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€ 610.689,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	84.491,00
Other external incomes (projects, grants, etc.)	69.740,00
Internal incomes (“subcontracted” by other units)	0
Other incomes	35.000,00
Total Income	**€ 189.231,00**
Financial Need (Incomes – Expenditure)	**€ 421.458,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€ 421.458,00**

5. Human Resources

At present, the TeV research unit is characterized by a well established team, that has matured and relevant expertise and competences in the field of computer vision and image analysis. Moreover the team has created, over time, a rich library

of software tools and technical competencies to support the research and to design and implement prototypes and demonstrative systems.

According to the mission of the unit, research activities have been conducted taking into account the general FBK aim to push innovation by creating collaborations with companies and institutions, especially those active in the Trentino territory.

In this respect, our recent collaborations with local companies and, mainly, the decision to undertake during the current year, a process aimed at the creation of a new company with the purpose of exploiting one of the most promising technologies realized in the TeV unit over the last years, i.e. SmarTrack.

In order to achieve our goals we believe it is appropriate to tune our activities in the group and to dedicate more effort towards technical support. In order to make this choice effective we are proposing to convert the research contracts of two researchers into technologist contracts. The impact of this decision is mitigated by the fact that recently two new researchers joined the group and a PhD student will join it in the next year.

6. Risks and Mitigation Plans

The main risk we envisage is the possibility of the unforeseen leaving of personnel with solid competences, especially in the development of prototypes and demonstrators, due to the new internal and national rules about the renewal of contracts.

Difficulties in finding sources of financial support could also lead to a diminished importance being paid to the scientific research activities, perhaps causing a temporary drop in the group's reputation and visibility.

The success of joint projects, which are crucial in the group's activities in 2010, depends not only on our disposition to collaborate and to create a good team, but also on factors which are external to the group control.

The potential impact of these risks can be reduced by continuously monitoring the activities and by detecting, as soon as possible, undesirable trends. Mitigation actions will include the reallocation of resources on the critical path and the focalisation of research and technological efforts on the core activities.

Description	*Prob.*	*Impact*	*Contingency*
Leaving of personnel	L	H	New personnel, refocusing
Problems in joint projects	M	M	Discover them as soon as possible
Difficulties in obtaining grants	L	M	More resources on that activity, joint work with the Grant Office

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

Some of the evaluation activities undertaken by the SOA Unit may involve end users, whose location and activities are tracked in order to provide them contextual, personalized services. The Unit is aware of the ethical issues this involves. It will employ highest standard in dealing with these issues and have measures in place to ensure conformance with legislation, and to adhere to the fair information principles (collection limitation, data quality, purpose specification, use limitation, security safeguards, openness, individual participation and accountability).

	YES
Informed Consent	
Does the proposal involve children?	X
Does the proposal involve patients or persons not able to give consent?	X
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	X
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
Does the proposal involve tracking the location or observation of people?	X
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

i3 – INTELLIGENT INTERFACES AND INTERACTION

Unit Name	i3 – Intelligent interfaces and interaction	
Type	Research	
Head	Massimo Zancanaro	
Staff	2009	2010
	11 Researchers	5 Researchers
	5 Technologist	4 Technologist
	0 Post Doc	3 Post Doc
	1 PhD	3 PhD

Document Status submitted 2009-10-26

1. Executive Summary

The i3 research unit focuses on designing interaction modalities for cutting-edge IT using a highly interdisciplinary approach borrowed from social sciences. The research objectives are at the same time technological – that is, developing innovative technologies – and social – that is, investigating how people use and benefit from these technologies.

The research activity is pursued along 4 challenges posed by new "intelligent" technologies to move beyond the "personal computer" paradigm: *implicit vs. explicit interaction*; *direct vs. indirect communication; shaping interaction for active learning by the system* and *interaction with stochastic systems.*

The workplan is divided in 3 areas targeted to research and innovation: *development of a framework for interaction design, design and development of active surfaces, automatic analysis of human behaviour*.

The group is experiencing a significant turn-over that will continue during 2010 because of the conclusion of an important project, the creation of a start-up and some contracts that cannot be renewed. The group begins 2010 with 12 people (including 1 senior researcher seconded to a local company and a student whose consultancy ends in February). At present, we have 3 technicians (of which 1 tenured), 3 senior researchers (of which 1 seconded), 5 junior researchers (of which 3 post-doc). Four new positions are envisaged, one for a technician to replace a person who left for a start up and three potential PhD students. One tenure track will start in Spring 2010 in the area of Interaction Design.

Prominent collaborations already started and likely to continue in 2010 include University of Haifa, University of Nottingham and IDIAP.

2. Vision and Scientific Program

2.1. Context and State of the Art

The field of Human-Computer Interaction is a branch of Computer Science that since the late '70 studies how people use computers and how computers can be better designed to fit people's needs. HCI was initially conceived as a branch of ergonomics but as computers became central to human life, it has become first a branch of design and latter a discipline in itself. A well established body of knowledge has been accumulating on the principles for designing usable graphical user interfaces for "traditional" computers as well as web sites. Traditionally, the whole debate has been focused around the notion of usability which denote the ease with which people can employ a particular tool or other human-made object in order to achieve a particular goal (ISO 9241): how to measure it and how to design for it.

The rapid progress of ICT in the last decade represents a challenge for Human-Computer Interaction because of the lack of well-established practices and guideline for the design. As computers are becoming available every time and embedded everywhere, usability in a strict sense is becoming a narrow concept. In fact, today research and open challenges on HCI consider a wider spectrum of aspects such as the possibility of interacting with a diversity of devices beyond traditional computers, the shift from single user-based interaction to collective interaction through users' communities and the need of defining new evaluation methodologies for such new interactive means.

Since its infancy, HCI recognized the importance of understanding the users in order to design better technologies and borrowed from the disciplines of Psychology and Sociology a large array of methodological frameworks and actual techniques. Today and tomorrow, it is of a paramount importance putting the human beings at the core of the design of technology: the pervasiveness of ICT in our world, its intrinsic role in shaping our society, makes the risk of digital divide a tragic possibility [Harper et al. 2008].

Shared co-located systems are an emerging class of devices and applications that allow a small group of users to share the same interface in the same place. They represent a radical shift from the paradigm of *one-user-one-computer*. As such, they are subject to different design constraints than standard Graphical User Interface (GUI) applications. Usually they are based on large interactive surfaces placed horizontally (in this configuration they are usually called tabletop devices) or vertically (often called wall displays) on which a specifically-designed interface is displayed or projected.

Automatic Behaviour Analysis represents the new frontier of research in multimodal systems. Multimodal analysis of behaviour is a relatively recent research area compared to the large body of studies focusing on multimodal input in human-computer interfaces, and aims at a deeper understanding of the context of interaction. Most of the present work on behaviour analysis (also known as activity recognition, but this term might be restrictive in some cases) is carried out by using devices such as sensors and motion detectors to collect data regarding the completion of activities in a properly equipped environment. A recent trend along this line

is the study of automatic analysis of social signals which can represent an interesting approach for future interaction with systems.

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2.2. Vision and Goals

The mission of the i^3 Research Unit is the study and the development of cutting-edge IT using a highly interdisciplinary approach borrowed from social sciences. The research objectives are at the same time technological (that is, developing innovative technologies) and social (that is, investigating how people use and benefit from these technologies). With the fast pace of technology advancement, the line between research and innovation is becoming blurred and instable. We aimed at advancing research by investigating basic issues of the relationships among IT and human beings while building a portfolio of skills that can be valued in the market. This portfolio will include a know-how on a set of techniques for design and rapid-prototyping of IT solutions as well as technical experience on a number of key IT domains to sustain the research and provide the basis for a regular spin-off of advanced technologies.

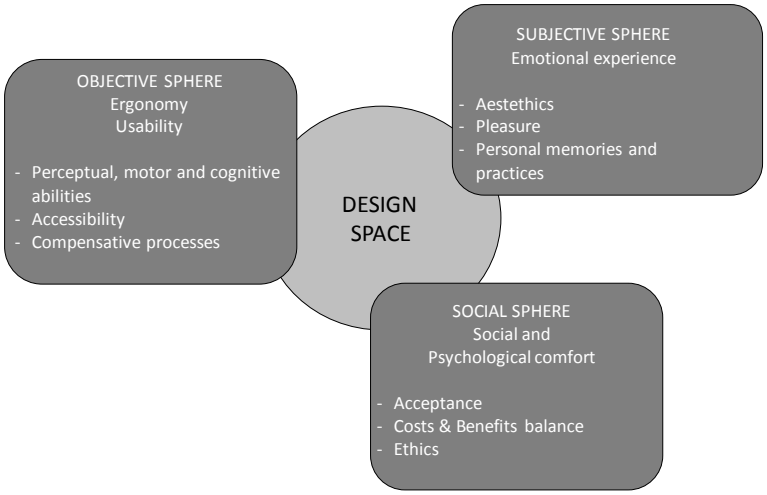

Figure 1. Beyond usability in the design of future IT

- *[what is design]* Design is the process that lays the basis for the making of an object or a system. Traditionally, there is a tension between the “engineering” perspective (getting the design right) and the “creative” perspective (getting the right design). The former requires accountable procedures and formal or semi-formal methods: from requirements analysis and ISO 830 documentation

to UML (or TROPOS) approaches to system description. The latter encourages less formal practices aimed at catching sparking ideas by inspirational techniques: from ethnographic fieldwork to get the gist of a domain to design storm to inspire “blue sky” concepts. Interaction design is a design discipline that focuses on making devices with which a user can interact, in particular computers.

- *[designing for the people by designing with the people]* Without informed design, any technology is more likely to be bad than good. Focusing with the people right from the beginning of the design (and development) process leads to more usable products. Adopting a user-centred approach implies: (i) early focus on users, tasks and environment; (ii) the active involvement of users; (iii) an appropriate allocation of function between user and system; (iv) the incorporation of user-derived feedback into system design; (v) iterative design whereby a prototype is designed, tested and modified. There is an international standard that is the basis for many UCD methodologies – ISO 13407: Human-centred design process (an improved version has been published as ISO TR 18529) – that defines a general process for including human-centred activities throughout a development life-cycle, though it does not specify exact methods.

  A step beyond user-centred design is focusing not only on functions and ergonomics by opening the design space subjective sphere of emotional experience and the social sphere of social and psychological comfort.

- *[i3 main objective: moving beyond the personal computer]* Although personal use of information technology has been the major trend in the last decades, new interesting trends are emerging for modalities of interaction that involve shared and ambient devices. These new technologies represents a challenge for Human-Computer Interaction because of the lack of well-established practices and guideline for the design. As computers is becoming embedded everywhere and available everytime, usability in a strict sense is becoming a narrow concept. When computers are no longer machine to work with sitting on the desk, new values emerge in the design process:
  - From single user to collaboration among a group
  - From the desktop to the environment
  - From products to services
  - From usability to user experience
  - From learnability to acceptability
  - From control to trust
  - From extrinsic to intrinsic motivation for interacting
  - Efficacy become more important than efficiency
  - “Intelligence” inside

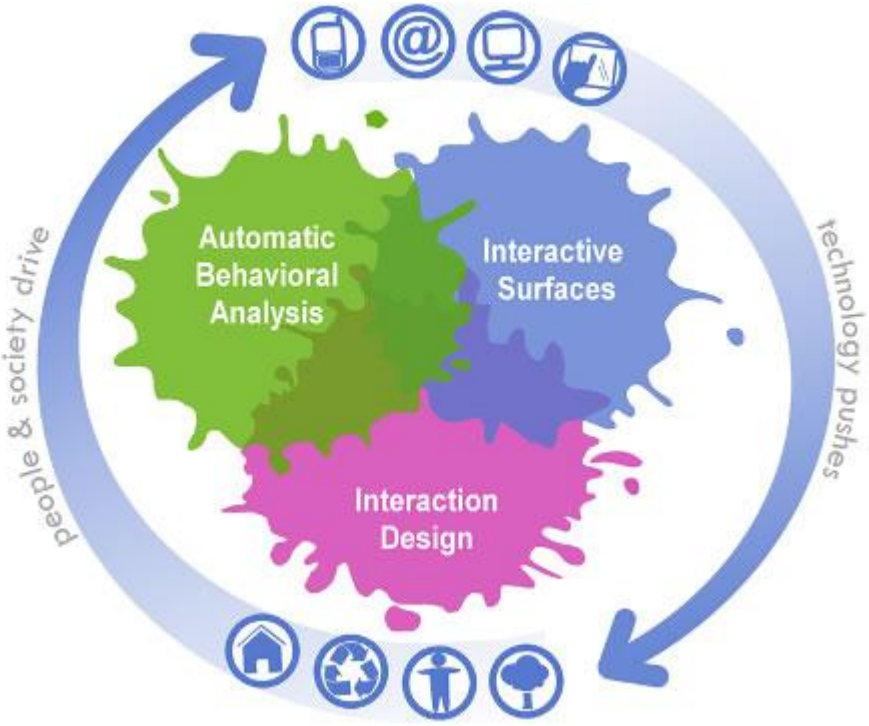

Figure 2. The 3 areas and the "cultural mediation"

- *[4 challenges to move beyond the personal computer]* In particular, four challenges may be recognized in designing interaction when the computer moves beyond the "personal" sphere:

  Challenge 1 - implicit vs. explicit interaction: multimodal components have the capability of enlarging the perceptual bandwidth of interactive systems and they provide the basis for extended input devices. For example, speech recognition may allow speech input, similarly automatic vision can be used to implement a gesture-based command interface. In these cases, the user directly and explicitly controls the system by using more natural or more effective way of communication. Furthermore, the same multimodal components may be used implicitly or indirectly by the system to understand the context of the interaction and respond autonomously to changes with little or no awareness by the users.

  Challenge 2 - direct vs. indirect communication: similarly, from the point of view of the output provided by the technology, computer systems have traditionally been thought as been on the focus of attention during the all the time required by the operator to perform a task. This is no longer the case with modern technologies, from mobile phones always on, emails for asynchronous communication or (inter)active digital signage, the way of communicating is often peripheral with respect to either the perceptual attention, the cognitive load or both. If the environment has to become (inter)active, it should stay in the peripheral most of time, to avoid flooding of information. How and when to move in the central focus of attention is something that has to be planned

considering the characteristics and limitations of the human cognitive system but also the social conventions of the society in which is deployed.

Of course, indirect interaction, both for input and for output, offers more potential benefits but also more risks. In particular, if the user is not aware of the interaction the notions of usability and acceptability has to be completely rethought while the notion of trust may assume more importance than the traditional notion of control.

Challenge 3 - shaping interaction for active learning by the system: differently from traditional human-computer interaction, multimodal systems cannot be deployed once for all. Being based on learned models of human behaviour (from phonetic to social models) they have to tackle with the large variability of human beings. These models can be based on common models learned from data or derived from cognitive traits (or both) but they also have to be refined for each user and to evolve during the lifetime of the system. Active learning, a new class of machine learning algorithms and techniques, may represent a new foundation for multimodal systems but it raises new issues on how to design a system that is changing during and because of its use. This aspect can requires a new foundation for usability which takes into account co-evolution among users and systems in time.

Challenge 4 - interaction with stochastic systems: most multimodal systems are stochastic in nature. That is, the models of which they are based to interpret human behaviour encode probabilities and reasoning under uncertainty. Yet, in traditional human-computer interaction users are not accustomed with stochastic behaviour, all traditional GUI (Graphical User Interfaces) are deterministic. Even when stochastic algorithm are used, the interaction is considered deterministic: the simplest example is a spam filter that computes the conditional probability for an email with a given content to be a spam; at the level of the GUI, an email is redirected in the spam filter should the probability exceeds a threshold. A new range of possibilities may be considered to represent the complexity and the richness of a probabilistic framework in designing GUIs for multimodal system provided that the cognitive limitation of the users is taken in consideration.

- *[3 areas for research and innovation*] A well established experience in interaction design practices is our core asset and our ultimate goal is merging the “engineering approach” with the “creative” approach by using qualitative approaches to gathering the user needs while pushing technology advancement. We aim at acting as “cultural mediators” between the users and the developers by offering a set of services from understanding the users to blueprinting an IT solution.

  Two technological strands will be pursued to instantiate the research, share co-located systems and automatic behavior analysis. The former is currently one of the IT hypes since when Microsoft Surface has been released, the latter might represent an interesting development for the future of the field of Human-Computer Interaction.

Shared co-located systems are an emerging class of devices and applications that allow a small group of users to share the same interface in the same place. They represent a radical shift from the paradigm of one-user-one-computer. As such, they are subject to different design constraints than standard Graphical User Interface (GUI) applications. Usually they are based on large interactive surfaces placed horizontally (in this configuration they are usually called tabletop devices) or vertically (often called wall displays) on which a specifically-designed interface is displayed or projected.

Automatic behaviour analysis represents a new frontier of research in IT. Multimodal analysis of behaviour is a relatively recent research area compared to the large body of studies focusing on multimodal input in human-computer interfaces, and aims at a deeper understanding of the context of interaction. The automatic analysis of activities of daily living (such as eating, cooking, cleaning up, watching TV, …) are of great theoretical importance and an essential component of many services especially in a domestic environment for ambient assisted living and for assisted cognition. Similarly, an important role could be played by automatic assessment of properties and states inferable from the observation of human behavior such as personality, emotions, intentions, mood and so on.

- *[Applicative scenarios]* Studying how people use technology invariably means to do research in applicative scenarios, though our research issues are more general in nature. The importance given on the approach of designing for the people by designing with the people and the exercise of design as mediation between technologist and people naturally brings us toward challenging domains where people are weaker, or the context is demanding or where the technology is a challenge. At present and in the next future, we are focusing in the following domains:
  - Ambient Assisted Living where technology is meant to assist elderly people to live longer in their homes.
  - E-Inclusion which encompasses the investigation and development of IT solution for improving the life or the therapy of disabled persons (in particular, autistic children, people with aphasia and mild cognitive disabilities and blind people).
  - Education. In particular for what concern children and teenagers both in formal and informal learning situations (such as museums).

2.3. Activities and Work Plan

The activities for 2010 are organized along the 3 areas discussed above.

- *[Interaction Design]* Consolidation of an advanced framework for Interaction Design strongly based on user involvement; in particular,
  - merging formal methods of software requirements with “soft” methods pursued in ACUBE (also in collaboration with SE)

  - targeting the specificity of service design rather than product design pursued in IOS (also in collaboration with SOA and SayService) and Netcarity (the home as a service metaphor)
  - refining the traceability and cost-effectiveness of “soft” methods for software engineering (through industrial project, like i-theatre, SenzaBarriere, and two new proposals of Legge 6)
- *[Interactive Surfaces]* Advancement of the state of the art on surface-based interaction in particular for what concerns multi-user interaction and as quasi-peripheral displays;
  - investigating multi-user interaction in the context of autism therapy and educational contexts pursued in COSPATIAL project
  - studying indirect communication system aimed at inducing attitude or behavioral changes in a group of people; pursued in the ITCH project (European proposal submitted)
  - experimenting with new techniques for surface interaction
  - planning a technology transfer to the MobiTable device build in the Netcarity project (a proposal in a short list for AAL, and a plan for a Legge 6 with a local company)
- *[Human Behavior Analysis]* Focus the activity on human behavior analysis toward design services for indirect (input) interaction with particular emphasis on home-based, non-functional services.
  - Investigating the dimensions of the new interaction paradigm through actual prototypes and user studies: Mirror prototype for well-being in Netcarity; Café Table for ITCH ; and so on.
  - Refining internal skills of human behavior analysis pursued in Pumalab, Netcarity.

We are also involved in the organization and conduction of a unique degree of study in Interfaces and Communication Technologies together with the Cognitive Science Department of the University of Trento in Rovereto. This degree is aimed at providing the students a truly interdisciplinary education including psychology, graphical design and computer science to train. Recently, the Department of Cognitive Science launched a new master degree with a track on the same topic.

2.4. Collaborations

- University of Haifa
  - Tamar Weiss (Department of Occupational Therapy) and Tsvi Kuflik (Department of Information Studies)
  - The collaboration with the department of OT is mainly related to the project COSPATIAL where we are exploring new interaction possibilities offered by tabletop devices in the therapy for children with autism. The work with the department of IS is mainly conducted in the context of the ITCH project for what concerns innovative interfaces in the museum.

- University of Bar-Ilan
  - Nirit Bauminger (School of Education, Faculty of Social Sciences)
  - The collaboration is mainly focused on the work on COSPATIAL. Dr. Bauminger is a reputed expert in Cognitive Behavioral Therapy which is used as the core of the new systems developed in the project.
- University of Nottingham
  - Sue Cobb (Mixed Reality Lab)
  - The collaboration is focused on the work on COSPATIAL in particular for what concern the relation between virtual reality and active surfaces as educational tools.
- Eberhard Karls Universitaet Tuebingen
  - Udo Weimer (Faculty of Chemistry)
  - The collaboration is related to the work on NETCARITY and is based mainly on the development of the concept of sustainable design for Ambient Assisted Living.
- IDIAP
  - Alessandro Vinciarelli and Daniel Gatica-Perez
  - The collaboration is based on common interests in the research fields of human-behavior analysis. Together with Dr. Vinciarelli, we are investigating the possibilities of automatic analysis of personality traits and with Dr. Perez we recently submitted an FP7 project proposal on indirect interfaces.
- University of Trento, CIMEC and Department of Cognitive Science and DISI
  - Gabriele Miceli (CIMEC/Cerin), Remo Job and Nicu Sebe (Department of Cognitive Science), Antonella De Angeli (DISI)
  - The collaboration with Unitn is based on a number of small activities related to human-behavior analysis for Assisted Cognition, tabletop devices for cognitive therapy (Prof. Miceli) and foundational research on human-behavior analysis (Prof. Sebe) and HCI (Prof. De Angeli). Researchers of the i3 unit are also involved in the new undergraduate course on interface design (Interfacce e Tecnologie della Comunicazione) and the communication track for the Cognitive Science Master (Prof. Job).

2.5. Specific Needs and Points of Attention

- The need of experimenting with non-traditional interfaces require the need of devoting a reasonable budget to hardware and consumables (such as projectors, sensors, special material). Because of the constraints on European funding, these costs should be covered with the AdP.
- The line of research on active surfaces and tabletop devices is at risk of being below critical mass after the successful start up of the company Teach & Touch. A recruiting campaign should start as soon as possible.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Behavior-based interfaces in the home	R	E	June	Installation in ITEA	-
Finalization of the multimedia center for the visually handicapped	I	E	Feb.	Finalization of the engineering of prototype	-
MobiTable exploitation	I	E	Nov.	An agreement with a local company for production and marketing of the Mobitable	An AAL project is in phase of negotiation. A "Legge 6 project" will also be considered
Indirect interfaces: the Augmented Coffee Table	R	E	Sept.	First working prototype to be evaluated with users	-
Multi-touch collaborative interfaces	R	E	Dec.	Working prototypes of multi-touch surfaces	Some of the work is related to the objectives and deadlines of COSPATIAL, other projects are under negotiation
Methodology for User Experience Design: from the User to the Developer	I	I	Dec.	Internal guidelines and protocols	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel:	583.188,00
Travel: €	47.000,00
Equipment (HW/SW):	20.000,00
Other (e.g. subcontracting to external contractors):	46.000,00
Internal collaborations: "subcontracting" to other unit	
Total Expenditure	**€ 696.188,00**

Incomes (EUROS)	
EU Projects (total amount financed by EU):	307.822,00
Other external incomes (projects, grants, etc.):	182.576,00
Internal incomes ("subcontracted" by other units):	0
Total Income	**€ 490.398,00**
Financial Need (Incomes – Expenditure)	**€ 205.790,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€ 205.790,00**

5. Human Resources

The group is experiencing a significant turn-over because of the conclusion of an important project, the creation of a start-up and the impossibility of renewal of contracts for some researchers. The group is now composed by 12 people (including 1 senior researcher seconded to a local company and a student whose consultancy ends in February). At present, we have 3 technicians (of which 1 tenured), 3 senior researchers (of which 1 seconded), 5 junior researchers (of which 3 post-doc). Four new positions are envisaged, one for a technician to replace a person who left for a start up and three potential PhD students.

The need to replace the know-how in the area of tabletop is crucial for the projects already opened and for the future of the unit.

Tenure Track

A tenure track for a position in the area of Interaction Design will be started in Spring 2010. This position is due to the necessity of strengthen the area which is key to any further development of the unit.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Loss of know-how on table-top devices	VH	S	Keeping a strong connection with the start-up and actively searching for new replacements
Reducing the amount of European funding due to the increase of competition at European level	M	S	Diversify the sources of funding by improving the skills on industrial projects
Excessive effort on industrial projects and reduction on impact on research	M	S	Focalize the industrial projects on either project for technology transfer or on very specific skills of the group (such as interaction design)

Legend:

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

Some of the evaluation activities undertaken by the SOA Unit may involve end users, whose location and activities are tracked in order to provide them contextual, personalized services. The Unit is aware of the ethical issues this involves. It will employ highest standard in dealing with these issues and have measures in place to ensure conformance with legislation, and to adhere to the fair information principles (collection limitation, data quality, purpose specification, use limitation, security safeguards, openness, individual participation and accountability).

	YES
Informed Consent	
Does the proposal involve children?	X
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	X
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	X
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
Does the proposal involve tracking the location or observation of people?	X
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

SHINE – SPEECH INTERACTION IN NOISY ENVIRONMENTS

Unit Name	Shine – SpeecH – Interaction in Noisy Environments	
Type	Research	
Head	Maurizio Omologo	
Staff	2009	2010
	5 Researchers	6 Researchers
	1 Technologist	1 Technologist
	1 Post Doc	1 Post Doc
	2.5 PhD	3.5 PhD

Document Status submitted 2009-11-25

1. Executive Summary

The SHINE research unit deals with the study and the development of novel advanced techniques of audio signal processing and interpretation, mainly concerning speech signals acquired by multi-microphone systems in real applications.

The research aims to tackle and solve real problems with regard to *Voice Interaction in noisy environments* and more generally to *Acoustic Scene Analysis,* in general in indoor contexts. Moreover, research is planned in other very challenging fields as *Acoustic scene processing in outdoor environments*, *Microphone array and loudspeaker array processing for Immersive Reality*, and *Musical Scene Analysis.* As for the strategic plan of the next five years, acoustic sensor networks for ambient intelligence and acoustic/speech interfaces for immersive digital environments (both indoor and outdoor) probably represent the two main directions on which the Unit will be active with long-term research actions. Moreover, the foreseen activities include the investigation on a possible technology transfer action for some of the related application areas.

At present, the Unit comprises: one senior researcher, two expert researchers, two young researchers, one technician, one post-doc, three PhD students. Moreover, the SHINE unit normally hosts master students and internships of students/researchers from abroad. Some of the members of the unit are active in education related activities, giving courses and supporting laboratories inside the Departments of Telecommunication, Information Engineering and Computer Science of University of Trento. It is planned that during the next three-five years two-three young researchers will be hired; moreover, new PhD positions will be opened, one per year as average. During the next three years, one or two present students will then be appointed to research positions, and a tenure-track will be established.

Important collaborations are maintained with research centers, universities, and in-

dustries in Italy and abroad, as the following ones: IBM Watson Center (USA), FAU – University of Erlangen (Germany), Politecnico di Milano e Como (I), Imperial College of London (UK), Elektrobit (D), Amuser (I), Fracarro Radioindustrie (I). Another activity of cooperation is foreseen in the short term with Konnekta (I) for technology transfer to domotic applications of command-and-control voice interaction technologies. Some of the given collaborations are maintained inside European Project consortia as for instance DICIT and SCENIC, which is under way. Inside FBK, an intense activity of collaboration is ongoing with the TeV unit, thanks to the important opportunities of integration in a multi-modal fashion provided by audio and video processing technologies available in the two units. Finally, some members of the SHINE unit are contributing to the ACube consortium activities by providing state-of-the-art acoustic sensing technologies to deploy in an ambient assisted living context.

2. Vision and Scientific Program

2.1. Context and State of the Art

The SHINE unit conducts research and development activities related to both acoustic and speech signal processing, with a major emphasis on multi-microphone based solutions for acoustic scene analysis and distant-talking speech recognition tasks.

During the last decade, there has been a significant growth of interest in these fields, primarily due to:

- the demand coming from developers of technologies for more advanced and flexible acoustic/speech enabled human-computer interfaces, and, at the same time,
- the serious limitation in flexibility and robustness that still characterizes close-talking speech recognition technology when used in uncontrolled situations, not observed in a training phase.

The corresponding acoustic and speech related international communities are growing considerably, and specific conferences and workshops are yearly organized to present and discuss on progresses in the field. The large participation to IEEE-Hands-free Speech Recognition and Microphone Arrays (HSCMA) workshop, recently organized by FBK, shows the important trend towards a confluence between traditionally independent research areas to a new inter-disciplinary context, which also characterizes the SHINE activity.

Numerous companies and research centers (e.g., IBM, Microsoft, etc.) are actively working on microphone arrays for selective acquisition of speech, localizing and tracking multiple acoustic sources in space, separating them from each other, cleaning them from reverberation and noise in order to enhance the resulting speech quality, etc. Industrial activities in the field witness a real need of progress with the aim of a more effective impact of these technologies in applications as command-and-control in domotics, automotive, video-conferencing, surveillance, etc.

However, there are many remaining challenges still very difficult to address, compared to voice interaction at less than one meter distance from microphones: some real environments exhibit a strongly reverberant and rather unpredictable behaviour, signals of interest are not narrowband, the allowed number of microphones and the spatial extension of their distribution are quite limited and, usually, heavily constrained. Consequently, a poor performance is still obtained in the presence of a reverberation time above half a second, or in the case of multiple simultaneously active speakers. The ability of microphone array processing to extract dry sources in the latter cases is usually extremely modest.

To tackle some of the above mentioned problems, distributing microphone arrays in space is another promising approach which was experimented under CHIL and DICIT (Distant-talking Interfaces for Control of Interactive TV) EC projects (http://chil.server.de, http://dicit.fbk.eu), as an example for the speaker localization and tracking task. In particular under DICIT, an EC project coordinated by FBK during the last three years, a multi-microphone front-end was realized that feeds a speech recognizer in a very effective way for voice control of TV and related devices; the resulting real-time prototype, recently presented by FBK at ICT 2008 and at IFA 2009 fairs, can support a natural human-machine dialogue interaction in a smart-home environment, even in a multi-speaker scenario. In the same project, an automatic detector of acoustic events was developed which can be deployed, in synergy with sensors of other nature, for anti-intrusion surveillance in a domestic environment. These achievements represent a state-of-the-art from which the SHINE unit intends to continue its research.

Again related to acoustic scene analysis, and in particular to the capability of separating and interpreting each contribution of a given set of sound sources diffused in an environment, another frontier is represented by blind source separation. During the last three years, the SHINE team has progressed significantly in this field, and a real-time prototype is now available for separation in a reverberant environment. A benchmarking that was conducted at international level showed the significant potential of the given solutions.

Finally, a field addressed more recently under SHINE regards musical signal processing. Several activities are being conducted worldwide by a growing research community that, in general, refers to MIREX, a framework under which algorithms proposed by different research teams are benchmarked in an objective and consistent way. As an example, MIREX includes tasks as audio melody extraction, audio beat tracking, and many problems related to the music information retrieval application field. In this context, during the last two years the SHINE team conducted research on the automatic chord recognition task, with very good performance achieved in the above-mentioned competition.

2.2. Vision and Goals

Most of the activities being conducted under SHINE reflects a long-term vision defined three years ago. In general, this research will continue in the short-medium term with the aim of further progressing in each field. Moreover, an extension in the scope of this research to other related areas of investigation is felt necessary, in particular for what concerns loudspeaker array based audio rendering, e.g. for im-

mersive audio application purposes. Acoustic scene reconstruction requires the adoption of accurate sound propagation systems and of proper techniques of multi-channel sound generation in space. From a strategic point of view, the combination of acoustic scene analysis and corresponding reconstruction makes, in principle, possible the realization of very promising novel applications in the areas of immersive virtual reality, for instance for entertainment (advanced immersive gaming, immersive content creation), immersive communications (telepresence), real-time architectural acoustics (designing environments with interactive walkthroughs), etc. The resulting more natural and personalized intelligent (3D) media for immersive experiences could connect people through remote presence, favour human-like socialization over the network, learning, training, rehabilitation, etc. Another application that would benefit from a number of loudspeaker arrays distributed in space is active acoustics: instead of using the array of speakers for shielding the rendering area from unwanted reflections and reverberations, new and desirable reverberations and reflections can be generated through active multi-channel rendering. The SHINE team has already started to experiment the use of small loudspeaker arrays under the EC project SCENIC, which represents a very good context where the problem will be investigated for indoor environment applications. Great interest also concerns similar investigation for outdoor environments, where quite different basic problems are addressed.

As far as acoustic scene analysis is concerned, another very challenging step regards loosely synchronized *microphone arrays*, which means that the microphones do not operate with same clocking and sampling frequency. With this regard, very preliminary activities were started recently, but other significant efforts are needed to obtain advances due to the very high complexity of the problem. It is worth noting that solving it would enable the development of real applications with no requirements of cabling and clocking the given devices (hence opened to wireless applications), which imply invasive approaches very often not accepted by end-users. This direction of research will also be pursued by adopting new multi-channel acquisition devices, as for instance arrays of digital MEMS microphones, which have been recently introduced in the market. Thanks to the low-cost, the robustness (also for outdoor) and the very small size, the foreseen ample diffusion of these devices in the consumer markets may enable a possible revolution in terms of novel acoustic sensing based applications for the forthcoming decade.

Beside the above-mentioned topics, microphone array processing and acoustic scene analysis need further study on issues as: self-calibration of devices and geometry; automatic understanding of the acoustics of the environment, both indoor and outdoor; automatic classification of the background noise characteristics typically associated to diffuse sound fields propagating in the environment; increased ability of detecting, localizing, and classifying any kind of acoustic event occurring in the given scene; improved performance in terms of blind source separation of the distinct contributions that compose the given acoustic scene. Finally, a very important field to further investigate is sensor fusion, where a (complex) scene interpretation is derived from both audio and video information, and eventually from other sensing technologies.

As for research on distant-talking speech recognition, the lack of performance remains the main issue to address during the next five years, trying to increase the recognition rate on tasks of progressively higher complexity. The DICIT scenario is a good and complex enough example on which this research can be conducted during the next years, focusing on microphone array and related adaptive beamforming techniques, multi-channel acoustic echo cancellation, speech activity detection and smart speech filtering, speaker identification, etc.. Moreover, research on acoustic modelling and novel acoustic features is necessary to improve the effectiveness of the distant-talking speech recognizer.

Further exploratory research on music signal processing is also envisaged, with the aim of devoting more efforts in the medium-long term if the achievements and the context (state-of-the-art at research and application levels) will suggest it.

Finally, technology transfer and exploitation of the most promising SHINE technologies represents an important next step. Some of the given techniques represent the starting-point for applications in domotics, video-conferencing, anti-intrusion, surveillance, automotive, robotics, and so on. In all these fields, the joint use of microphone array processing and distant-talking ASR for simple command-and-control tasks can also enable the development of smart advanced human-machine interfaces, as in the case of support to disabled individuals. A more challenging but effective approach for a wider perspective in terms of market opportunities could consist in implementing some of the given techniques on DSP processors, or on other dedicated platforms, and combine them with miniaturized devices as for instance MEMS digital microphone arrays which are today robust and cheap enough to predict their very large diffusion worldwide from 2010-2011.

2.3. Activities and Work Plan

The activities of SHINE during 2010 can be summarized in the following six main directions: 1) Acoustic Scene Analysis (ASA); 2) Distant-Talking ASR (DT-ASR); 3) Immersive audio; 4) Musical scene analysis 5) Integration with other sensing; 6) Technology transfer.

The first part of the year will also be devoted to some final management issues related to the DICIT project. It is also likely that some members of the unit will be active during 2010 and 2011 on the realization of a book focusing on acoustic scene analysis, which is commissioned by John Wiley & Sons.

- *Acoustic scene analysis*

  Methods to obtain information about the acoustic scene from Global Coherence Field (GCF)-based acoustic maps will be investigated, in particular under the EC SCENIC project. Temporal and spatial properties of the sound wavefield will be obtained with high-spatial-resolution microphone arrays and geometric room models. Study cases will be considered and compared with simple propagation models, in order to account for effects of reflections and obstacles; this experimentation requires a collection of a large amount of multichannel acoustic data in real environments. Moreover, activities on multi-speaker tracking (e.g. based on acoustic map models), blind source separation, speech/non speech classification under mismatch conditions, and model

adaptation for speaker identification in a distant-talking scenario will be continued. Some preliminary activities are also planned to investigate on the use of the given acoustic scene analysis techniques in outdoor contexts, on passive self-calibration of a microphone network and on loosely synchronized microphone array processing.

- *Distant-talking ASR*

  Based on the recent achievements of DICIT, acoustic feature extraction and acoustic modeling tasks will be addressed with activities on the following topics (reported in order of priority): development of noise robust features; methods of representing the signal that are less sensitive to the distortions caused by reverberation, such as the modulation spectrogram; adaptation techniques with less adaptation data and individual component (beamforming and acoustic echo cancellation) adaptation techniques; feature normalization techniques which normalize both clean and noisy features such that their differences is reduced in the normalized space; development and design of algorithms for improving speech intelligibility in noise, which subsequently improve ASR performance; de-reverberation algorithms; single microphone and multi-microphone signal processing to reduce the effects of noise, reverberation, and spectral distortion.

- *Immersive audio*

  Combined use of loudspeaker arrays and microphone arrays for active environment excitation will be explored. In conjunction with wavefield synthesis methods, loudspeaker arrays will be used with the purpose of producing structured emissions to probe an enclosure and observe the resulting response in terms of acoustic maps (GCF and Oriented-GCF). During 2010, these activities will be conducted for indoor environments. An extension to analysis and reconstruction of outdoor scenes may be tackled in the last part of the year, related to a possible EC project regarding the task of virtual visual and acoustic rendering of public spaces.

- *Musical scene analysis*

  New signal processing methods will be investigated for accurate and relevant feature extraction for the chord recognition problem. Participation to the MIREX competition is also planned during 2010.

- *Integration with other sensing*

  Activities are planned under ACube and PumaLab projects, in order to explore the possible use of the given acoustic sensing technologies in combination with sensors of different nature. In particular a tight cooperation on audio-visual scene analysis and interpretation is foreseen with the TeV research unit: in this context, activities on audio-video fusion for speaker's model adaptation and identification in a distant talking-scenario are also envisaged.

- *Technology transfer*

  The most advanced and mature technologies of SHINE will be object of an exploratory activity oriented to a transfer to the market. In most of the cases, this re-

quires to realize corresponding embedded solutions in general based on software implementations on DSP processors or on other dedicated platforms. This core could be initially tackled inside FBK and then moved to a spin-off/start-up whose core activity would consist in the exploitation of the SHINE technologies.

2.4. Collaborations

- Erlangen University(Prof. W. Kellermann): we will continue collaboration on acoustic scene analysis under SCENIC and on multi-microphone databases which started under DICIT.
- Konnekta(R.Giovannini): transfer technology to develop voice-enabled domotic services for disabled subjects
- Pol. Milano(Prof. Sarti): self-configuring environment-aware intelligent acoustic sensing under SCENIC.
- Imperial College of London(Prof. P. Naylor): under the SCENIC project we work on acoustic scene analysis.
- IBM Watson Research Center (USA)(Dr. R. Sicconi): some activities are foreseen on distant-talking ASR.
- Amuser (I)(Ing. R. Manione): in terms of DICIT exploitation, a cooperation may regard distant-talking ASR.

2.5. Specific Needs and Points of Attention

- If ARTAAS proposal is accepted by EC, under the corresponding project a set of very sophisticated spherical microphone arrays would be acquired with a foreseen expense equal to about 120.000 euro.
- If concrete actions will follow on the creation of a start-up/spin-off, some new activities, and costs not detailed here, are foreseen with regard to feasibility studies, intellectual property, etc.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Submission of a proposal for European project	A	E	July	-	-
Sound imaging tools, acoustic maps, and other achievements on acoustic scene analysis under SCENIC project	R	E	July	-	-
Journal paper submissions on distant-talking ASR and acoustic scene analysis	R	E	Dec.	-	-
Software components for acoustic sensing and au-	I	E	Dec.	-	-

dio-video fusion for ACube and PumaLab projects					
New distant-talking ASR prototype	I	I	Sept.	WER reduction wrt state-of-the-art system	-
Feasibility study for technology transfer	I	E	Sept.	-	It depends on possible next actions with this regard.
Signal processing methods for feature extraction in the chord recognition problem and for blind source separation.	R	I	Sept.	Possible participation to the MIREX and ICA competitions.	Activities on BSS depend on a possible contract for collaboration with Francesco Nesta after April 2010.

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel (only direct costs)	461.532,00
Travel	20.500,00
Equipment (HW/SW)	30.000,00
Other (e.g. subcontracting to external contractors)	91.500,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€ 603.532,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)*	105.272,00
Other external incomes (projects, grants, etc.) - ACUBE	57.208,00
Internal incomes (“subcontracted” by other units)	0
Total Incomes	**€ 162.480,00**
Financial Need (Incomes – Expenditure)	**€ 441.052,00**
Required Structural funding from PAT	**441.052,00**

5. Human Resources

STAFF	2009	2010
	5 Researchers: Maurizio Omologo, Alessio Brutti, Marco Matassoni, Piergiorgio Svaizer, Christian Zieger 1 Technologist: Luca Cristoforetti 1 Post Doc: Hari Krishna Maganti 2.5 PhD: Francesco Nesta, Maksim Khadkevich Waheed Abdul Mohammed (since November 2009) Alessandro Roat (with no grant)	In addition to the situation of 2009: 1 TBH (probably Francesco Nesta when he will complete his PhD); 2 new PhD students.

At present, the Unit comprises: one senior researcher, two expert researchers, two young researchers, one technician, one post-doc, three PhD students. It is planned that during the next three-five years two-three young researchers will be hired; moreover, new PhD positions will be opened, one per year as average. During the next three years, one or two present students will then be appointed to research positions, and a tenure-track will be established.

During 2010, we plan to have a new TBH, two PhD (starting from November 2009) and two PhD (starting from November 2010). In March 2009, Francesco Nesta will conclude his PhD. In October 2010 Alessandro Roat will conclude his PhD.

6. Risks and Mitigation Plans

Technology transfer, with a possible creation of a spin-off/start-up, is a critical issue of 2010. The related actions strongly depend on external conditions, as for instance the interest of investors, and the ongoing contacts with companies that may cooperate with us in this possible exploitation. The Unit will push towards this direction; however, at this moment the real impact of this action is unpredictable.

The activities on outdoor acoustics depend on the result of the review process regarding a proposal submitted in the end of 2009. It is worth noting that if this submission will succeed, it is likely we have to invest more than 120.000 euro in hardware acquisition during the second half of 2009. If it will not succeed, research activities on outdoor acoustics will be postponed to year 2011.

7. Ethical Issues

The Unit is sometimes involved in acoustic and speech data collection campaigns, during which the recruited subjects are asked to fill in related consent forms to allow the use of the resulting speech data for research purposes.

WeD – Web of Data

Unit Name	WeD – Web of Data	
Type	Research	
Head	Giovanni Tummarello	
Staff	2009	2010
		1 Researchers (p.t.)
		2 Technologist
		1 Post Doc
		0 PhD

Document Status submitted 2009-11-01

1. Executive Summary

A new unit, the Web of Data (WeD) unit will be established in 2010. The unit will perform research on mostly on scalable infrastructures which can add value and exploit data which is published online in interoperable formats such as RDF, RDFa and Microformats.

In 2010, it is expected that the unit will operate in constant joint operation with the Data Intensive Infrastructure unit (DI2), led by Dr. Tummarello at the DERI institute, Galway (Ireland). The two units will be able to leverage each other activities and skills and will contribute to the construction of a single infrastructure while however developing specific skills.

In particular, it is expected that in 2010 the WeD unit will concentrate on cluster computing based semi-structured data interlinking and how to apply this in the context of:

- The SINDICE semantic web search engine, started at DI2, to be extended together with WeD with the capability to offer scalable, on-line, world wide linkage service
- Okkam, a system for assigning identifiers stable identifiers to Entities and therefore interlinking records operating both on public datasets and within the enterprise databases.

On the other hand the DI2 unit will concentrate on:

- Extending Sindice operations with extended query capabilities in particular with the deployment of the SIREn system (by Renaud Delbru, ph.D candidate at DERI) and of the OpenLink Virtuoso cluster edition database, thanks to the DERI collaboration with OpenLink Software.

- Extending Sindice data acquisition capabilities with advanced crawling and other mechanisms
- Maintaining and operating the technical systems (system administration, hardware issues), including a large computational cluster (WebStar) which will be used on a daily basis also by WeD members.

The outcome of the collaboration is expected as follows:

- A new version of Sindice featuring the new indexing capabilities, improved data acquisition and "entity services", where strong links between entity representations in different datasets are provided by Sindice automatically
- Supporting tools, and in particular:

  a. A validator for online web data which aims at replacing any other validator currently in use. It will check *syntactic*, *semantic*, and *entity level aspects* and support data producers in creating datasets which automatically interoperate with others on the web

  b. Possibly, tools for demonstrating and interacting with the infrastructure such as version of http://sig.ma and or http://sparallax.deri.ie which make use of the new features.
- Improved understanding of the features en the industry as well as web market requirements thanks to early demonstrations of the above tools and other dissemination activities.

For 2010, Wed is expected to be composed by Dr. Giovanni Tummarello and will consist for the year 2009 of two senior developers to be hired to have heterogeneous backend development skills and one postdoc, to be hired for machine learning, data consolidation skills.

2. Vision and Scientific Program

2.1. Context and State of the Art

The need for linkage, the absence of links

The dream that inspired many Semantic Web researchers is that of a web where bits of information are discovered and connected automatically because they "matter" for the task at hand, possibly coming from any web location and ultimately reused well beyond the purpose for which they were originally created. Applied to commerce, for example, it would ideally eliminate the need for advertizing: sellers and suppliers would simply "be found" for the characteristics of the offer.

Given no expected imminent breakthrough in the ways machine can understand content meant for human consumption, the idea of the Semantic Web initiative has been that of proposing that Web Site "lend a hand" to machines by encoding semantics using RDF. For years, however, RDF descriptions on the Web have been made available almost exclusively by web data enthusiasts, i.e. by the Semantic Web community itself. Despite this, the community has been able to made available a remarkable amounts of information, known as the Linked Open Data cloud, to the point that many entities, e.g. encyclopedic entities but also the people partici-

pating in the community, are often “described” (have metadata about then in RDF) in several dozen different independent RDF sources on the web. The existence of descriptions alone, however, it is not sufficient condition for this data to be discovered automatically. For this reason the LOD community has been advocating the reuse of URIs of other sites as a way to create interlinks. In [-], it is explained that to allow crawlers and agents to understand that a description is about something described also elsewhere, URIs from other sites should be used. For these URIs to be found, one should first manually select datasets from a maintained list of known datasets, then explore these to find suitable URIs to link to, this for each entity to be linked.

This complexity, together with the – arguably temporary - lack of immediate incentives for doing this, makes it so that even among the LOD community formal data quality [-] and interlinks are scarce. A quick query on Sindice, currently indexing approximately 65 M semantic documents shows that less than 4 million RDF documents (usually entity descriptions from the LOD cloud) exhibit at least 1 sameAs link[1].

In the last year however LOD is becoming no more the only source of large amounts of RDF structured content. Thanks for the support of Google and Yahoo for RDFa encoded content for advanced snippets, it is safe to say that tens of millions of pages of database generated content have appeared, none of these, to the best of our knowledge, providing interlinks among descriptions on different websites.

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[1] http://sindice.com/search?q=*+%3Cowl%3AsameAs%3E+*&qt=advanced

2.2. Vision and Goals

The search for effective Semantic Web Interlinking, mixing rules and machine learning

Record Linkage at Web scale based on Semistructured data in RDF/RDFa and Microformats appears to be a problem that can be faced with:

- A coordinated array of technological solutions for state of the art and beyond data consolidation
  - Taking into account the shared reuse of ontologies and best practices on the web
  - Taking into account rules and reasoning, within due limits
  - Leveraging multiple machine learning methodologies to merge symbolic and subsymbolic inference.
- Technologies that can both scale and provide reliability e.g. Hadoop, HBase
- High quality companion tools in support for quality web data publishing

Among the tools that we envision is a validator which would aim to replace any other online data validator currently in use by providing features at *syntactic*, *semantic*, and *entity level aspects.* The tool will help data producers assess how well can Record Linkage be performed between their data and the rest of the Semantic Web Data – something we will here call *Web Linkage*. The workflow would be as follows:

- The dataset owner submits a link to the dataset. The dataset is fetched the following steps are performed:
  - Calculating how “close” dataset entities are to others previously known by the system to be on the Semantic Web. E.g. The system would warn when a person Giovann*e* Tummarello is inserted being this close both to Giovann*i* Tummarello and Giovann*a* Tummarello.
  - Evaluating how ambiguous are the properties and values that are being used. E.g. a perfect match with a record who’s name is “John Smith” would raise much more attention than a record match for the much rarer full name *Giovanni Tummarello*.
- A report is given to the dataset owner, possibly highlighting suggestions in case the Web Linkage of the data resulted poor. For example the owner could be suggested to:
  - add more attributes, or more specific attribute values
  - better specify classes and properties
  - in extreme cases, to manually put sameAs links where the records seem extraordinarily difficult to disambiguate.
- As unambiguous records can become ambiguous as more data joins the Semantic Web, the validator will likely offer services such as continuous dataset review, in this case the datasets would be periodically reviewed and warnings sent to the dataset owner as needed.

These tools will be used directly inside the Sindice semantic web search engine, and inside the OKKAM project.

2.3. Activities and Work Plan

Milestone 1 – M3

Hiring completed

State of the art in record linkage complete, a plan for scientific experimentation is also laid

Milestone 2 – M6

Developers are of the frameworks and hardware infrastructures

Very early prototype developed

Core algorithms developed

Milestone 3 - M9

First roll out prototype

Room for optimization and scalability tests

Algorithms are refined

Evaluations and defined

Milestone 4 – M12

Integration with the Sindice in production

Software packaged for other uses as well, e.g. Okkam.

2.4. Collaborations

WeD will coordinate with the Unit for Data Intesive Infrastructures in DERI with respect to the general activities and by sharing goals but also on a day to day basis when needed. In particular it is expected that Wed will leverage the large computational infrastructures at UDI2 (the WebStar cluster with more than 500 cores) and the related system administration skills. Dr. Tummarello will be sharing his time between DERI, FBK and other locations of common interest.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Impact of Research	R	E	9-12m	External roll out of web scale consolidation services in sindice	Satisfactory performance is obtained
	R	R	6-12m	Availability of a generic engine which can power the OKKAM application	-
Projects	A	E	6-12m	Invited as partners in national or eu level proposal	Enough dissemination for the new group is achieved
Team	F	I	3-6m	Small yet high quality team in close contact with the DI2 team	Effective hiring attracts skilled professionals and postdoctoral researcher

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel (2*35k developers + 1 postdoc 30k plus part time senior researcher 30k)	167.632,00
Travel	10.000,00
Equipment (HW/SW)	1.500,00
Other (e.g. subcontracting to external contractors)	18.000,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€197.132,00**

5. Human Resources

Currently just Giovanni Tummarello is in the team, Hiring will happen to acquire 2 senior developers and 1 Post Doc.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Effective consolidation techniques will require much more time than originally planned	M	M	Concentrate on asimpler techniques and try to close the loop early: go into a beta state production with simpler algorithms
Large scale data quality consolidation is very computational demanding	H	M	Make sure everything is designed on top of scalable cluster infrastructures, reducing boottlenecs to theminimum
It is not immediate how to “use” the created interlinks, so final impact is low	M	M	In cooperation with DERI Di2, te works on demonstrators such as Sig.ma will go on to make sure they full use the new infrastructures.

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

SECURITY AND TRUST

Unit Name	Security and Trust	
Type	Research	
Head	Alessandro Armando	
Staff	2009	2010
		2 Researchers
		0 Technologists
		1 Post Doc
		0 PhD

Document Status submitted 2009-11-24

1. Executive Summary

Identity and Access Management Systems (IAMS for short) ensure that the right people access the right services by centralizing identities and rights management, thereby greatly simplifying the design and implementation of complex distributed applications. So, IAMS implement the most security critical aspects of applications and any vulnerability in a IAMS may result in severe security breaches that make identity theft and other attacks possible to the whole system.

The goal of the project is to develop automated security analysis techniques and tools for IAMS to be used in several phases of their development cycle, ranging from design to deployment, thereby contributing to improve the security of such systems and the applications based on them. The project will focus on the development of automated analysis techniques for the security-critical aspects of the IAMS: browser-based protocols for the Single Sign-On (SSO) and access control policies.

The design and analysis of these components is usually so complex that severe vulnerabilities are often present even after intensive use of traditional verification techniques, such as manual inspection or testing. This is witnessed, for example, by vulnerabilities found in various SSO protocols, such as SAML SSO, MS Passport/CardSpace and the SAML-based SSO for Google Apps, even years after their publication, implementation, and usage.

Achieving the goals of the project will significantly advance the state-of-the-art in the security analysis of the IAMS. Today, there are no specific tools supporting the automatic analysis of security-sensitive browser-based protocols and access control policies of practical relevance.

2. Vision and Scientific Program

2.1. Context and State of the Art

Although many research lines have implications with the project, in this section we focus on the work that is most directly relevant to ours, namely the formal specification and automatic analysis of security protocols and access control policies.

Security protocols are usually modelled as state machines exchanging messages over one or more communication channels that are under the control of an attacker. The attacker is assumed to be able to observe, intercept, and insert messages over the channels and it is characterized by a set of deductive capabilities (e.g., the ability to compute the cleartext from the corresponding cyphertext once the encryption key is known). An attacker capable of all these activities is called a Dolev-Yao attacker. Most state-of-the-art protocol analysis techniques assume that communication channel are controlled by a Dolev-Yao attacker. However, there exist several situations of practical relevance (e.g., web-browser protocols assume that messages are exchanged over a SSL/TLS connection) where the Dolev-Yao model is unrealistic. This leads the available techniques to report spurious vulnerabilities (i.e. false positives) thereby making them almost unusable.

A lot of work has been devoted to the development of automated analysis techniques for security protocols . Many techniques have been put forward that are based on, e.g., Strand-Spaces, Constraint Solving, and Symbolic Model Checking. We have contributed to the field by developing a security analysis technique based on a combination of SAT developed in AI Planning with Bounded Model Checking for LTL. The technique has been implemented in a bounded model checker for security protocols, called SATMC. SATMC is one of the back-ends of the AVISPA Tool, one of the most successful tools systems for the automated analysis of security protocols (more than 500 registered users in the mailing lists and more than 1000 downloads) which has been used to tackle industrial size protocols. Furthermore, using SATMC, we have discovered two serious vulnerabilities in the SAML-based SSO protocol used by Google Apps. However SATMC does not directly support the modeling of browser-based protocols and the analyses mentioned above required some hardwiring of certain aspects of the model in the tool.

Declarative languages based on the Logic Programming paradigm are routinely used to model access control policies. They have two attractive features: expressiveness and unambiguous semantics. The former allows one to express a wide variety of key mechanisms for the decentralized management of access (such as delegation and trust) in a uniform framework. Delegation is a central concept of many languages such as SecPal and DKAL, which can be seen as extensions of Datalog. Furthermore, both SecPal and DKAL allow one to declaratively specify some additional features of policy management systems such as structured resources, role hierarchies, etc. Other declarative languages are tailored to specific aspects such as the handling of time constraints. Recent proposals extend these languages with a dynamic dimension so as to be able to express state updates as a result of the application of a policy rule. Mechanized analysis of logic-based languages is possible as they have unambiguous semantics. Several such techniques have been proposed in the literature. For example, certain analysis methods de-

veloped for ARBAC models permit to establish if a user can acquire a role that he is not supposed to get because of subtle interactions between the administration policy rules and the role hierarchy. More recently, analysis techniques for dynamic policies have been developed for (dynamic) extensions of Datalog. The main limitation of many of these techniques is that the number of users in the system should be known and fixed during the analysis phase.

2.2. Vision and Goals

The main goal of the project is to develop automated security analysis techniques and tools for Identity and Access Management Systems (IAMS). To this end the project will focus on the development of techniques for the automated analysis of security critical components of the IAMS, namely:

- browser-based Single Sign-On protocols and
- access control policies.

SSO protocols are a special type of security protocols and as such they aim at guaranteeing certain security properties (e.g., confidentiality or authentication) by using cryptographic primitives. The design of security protocols in general (and hence also of SSO protocols) is notoriously difficult. Severe vulnerabilities have been discovered in many protocols even after years from their publication and implementation or even their intensive use. Furthermore, some vulnerabilities allow one to perform attacks that do not exploit the weaknesses of the cryptographic primitives but are based on unforeseen interleaving of the actions of the participants and the attacker. This makes such attacks very easy to realize and thus they often may have dramatic impacts. Given the huge number of interleaving of the actions of the protocol participants, these vulnerabilities are very difficult to spot by manual inspection of the protocol or by traditional techniques (such as testing).

In the case of IAMS, the situation is further complicated by the fact that these protocols are executed by standard web-browsers: browsers are not uniquely devoted to execute the protocol but concurrently perform many other activities, they adopt a very primitive security policy (i.e. same origin policy) and their cryptographic capabilities are limited to the use of the SSL/TLS protocol. Browser-based SSO protocols are no exception: most of them (namely SAML SSO, MS Passport/CardSpace, and the SAML-based SSO for Google Apps) have been found to be vulnerable to serious flaws.

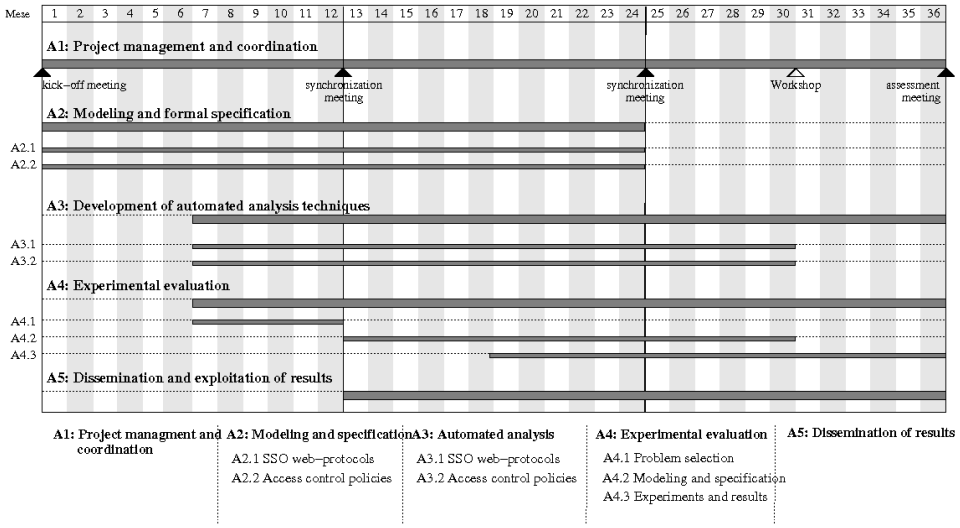
The definition of access control policies comes with many difficulties too. On the one hand, the policies should guarantee that a minimal set of users showing adequate permissions can access certain resources or functionalities (principle of least privilege). On the other hand, the policies should be flexible enough to allow the application to work in a wide range of situations. For this reason, the traditional models for access control (such as RBAC) have been extended in several ways; e.g., with delegation of roles or permissions and with rules for policy administration (ARBAC). Furthermore, access control policies can be dynamic, i.e. they may contribute to modify the state of the application in some way. All these aspects, which are ubiquitous in more advanced IAMS, make the analysis of access control policies so complex to make manual inspection of the rules impossible.

The project will focus on the following two scientific objectives:

- *Modeling and formal specification*: We will define formal languages for specifying security-critical components of IAMS and related security properties. The languages should be easily usable by both designers and security analysts and it should be easy to translate them to the input languages of automated analysis tools developed in the project. For SSO protocols, besides specifying the format of the exchanged messages, the language should allow one to describe the security of the communication channels (e.g., TLS/SSL), the inference capabilities of the attacker and a detailed model of the web-browser. For access control policies, the specification language should be able to express the attributes of user profiles and the mechanisms capable of identifying the attributes that are relevant for a certain application. The language should be able to express sophisticated features such as dynamic rules. Finally, the language must be able to express the key security properties of IAMS, such as safety, availability, and separation of duty.
- *Design of automated analysis techniques*. For SSO protocols, given a formal specification of an SSO browser-based protocol and the scenario where it is used (including the inference capabilities of the attacker) and a formula expressing the desired security properties, the analysis techniques should be able to establish whether the protocol satisfies the property in the given scenario. If it is not the case, the techniques should be able to produce a sequence of actions of the protocol leading to the violation of the property. Similarly, given a formal specification of an access control policy and the scenario where this is used and a formula expressing the desired security properties, the techniques should be able to establish whether the policy satisfies the property in the scenario. Furthermore, techniques capable of establishing some security properties for all possible scenarios will be developed. (These problems are un-decidable in the general case, but decidability results exist if additional hypotheses are assumed, e.g., only finitely many sessions are considered.)

2.3. Activities and Work Plan

The work plan of the research activity spans 3 years and it is organized in 5 activities (named A1, A2, A3, A4, and A5 below) as described in the following Gantt chart.



Activity A1 is devoted to project management and coordination. Activities A2 and A3 tackle the objectives O1 and O2 described in Section 2.2, respectively. Activity A4 starts at month 6 and it is devoted to assess the effectiveness of the techniques developed in A2 and A3. Activity A5 will be devoted to the dissemination and exploitation of the results. During the first year of the project (next year) we will focus on the following activities:

- ***Modeling and formal specification***: We will develop formal languages for specifying SSO protocols and access control policies. Syntactic analyzers and translators for such languages will be implemented in SATMC and their expressiveness will be experimentally evaluated against case studies selected in activity A4. For SSO protocols, the starting point will be the specification languages developed within the EU project AVANTSSAR. This language must be extended to support some mechanisms typical of web-browsers (e.g. the handling of cookies) and the specification of trust relationships. For access control policies, the starting point will be a declarative language such as SecPal or DKAL that allows one to express a vast variety of policy management mechanisms in a uniform way. The key extension will be to identify suitable constructs to express the dynamic effects of the application of policy rules.
- ***Development of automated analysis techniques***: We will develop techniques for the automated analysis of security protocols for identity management and access control policies. Such techniques will be implemented in SATMC and their effectiveness will be evaluated against case studies selected in activity A4. For SSO protocols, the model checking techniques available in SATMC will be extended to support the specification constructs identified in A2. We believe that these techniques will permit the verification of industrial size protocols using secure communication channels (such as SSL/TLS). For access control policies, we will extend the model checking techniques available in SATMC for the debugging of dynamic policies that are ubiquitous in IAMS. We will also develop parameterized techniques for the analysis of these policies regardless of the number of users in the system.

- ***Experimental evaluation***: We will define a library of problems of industrial relevance that will be used to assess the adequacy of the specification languages defined in A2 and the effectiveness of the analysis techniques developed in A3. In the first year, we will devote our efforts to identify a selection of representative problems. In general, IAMS are designed to meet a variety of security properties such as authentication, secrecy, anonymity, etc. By a careful scrutiny of the protocols and access control policies used in state-of-the-art IAMS (e.g., SAML, SSO, OpenId, OAuth), we will identify a set of practically relevant security problems. The selected problems will be formalized by using the languages identified in activity A2. This will give important hints about the adequacy of the languages and will provide the starting point for the experimental evaluation of the techniques developed in activity A3. The library of problems will be made available to the whole scientific community on the web site of the research unit.

2.4. Collaborations

- Univ. degli Studi di Verona (Prof. Luca Viganò): formal modeling of security policies.
- SAP AG (Dr. Volkmar Lotz, Dr. Luca Compagna): formal modeling of browser-based protocols and security-sensitive business processes.
- Siemens AG (Dr. Jorge Cuellar): formal modeling of browser-based protocols.
- Univ. degli Studi di Milano (Prof. Silvio Ghilardi): development of symbolic model checking techniques for infinite-state and parametric systems.

We also plan to host visits of Prof. David Basin (ETH, Zurich), Dr. Michael Rusinowitch (INRIA, Nancy, France) and Dr. Claude Kirchner (INRIA, Bordeaux, France).

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Design and development of a specification language for SSO protocols and access control policies	R	I	Dec.	Document describing syntax and semantics. Modeling of some case studies.	
Selection and formal analysis of selected case studies	R	I	Dec.	Document describing modeling of some case studies.	Specification language for SSO protocols and access control policies
Techniques for automated analysis of SSO protocols and access control policies	R	I	Dec.	Document describing techniques. First prototype and preliminary evaluation on selected case studies.	Specification language for SSO protocols and access control policies

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel:	155.300,00
Travel: €	5.000,00
Equipment (HW/SW)	7.000,00
Consumables	0
Visiting researcher	0
Other (e.g. subcontracting to external contractors):	28.900,00
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€ 196.200,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	0
Other external incomes (projects, grants, etc.):	124.964,00
Internal incomes (“subcontracted” by other units):	0
Total Income	**€ 124.964**
Financial Need (Incomes – Expenditure)	**€ 71.236,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€ 71.236,00**

5. Human Resources

Prof. Alessandro Armando will be the head of the research unit. Besides him, the research unit will be composed of two researchers and a post-doc with a PhD in a field directly related to the research area of the project, preferably with some experience in international research projects. It is also foreseen that two PhD students will join the project by the first year of activity. The resulting size of the research unit is adequate to support its innovative research project together with the efforts to set up fruitful collaborations with other research centers in Trento, in Italy, and abroad. In particular, it is foreseen a fruitful collaboration with the partners of the project AVANTSSAR (Automated VAlidatioN of Trust and Security of Service-oriented ARchitectures), funded by the EU in the context of the 7th framework to which Prof. Armando participates as the scientific head of the research unit at the University of Genova. In this context, in cooperation with SAP Research and Siemens AG, Prof. Armando contributed to identify the vulnerabilities to the SSO protocols used in the Google Apps mentioned above. Further collaborations on research topics that are relevant to the activities of the unit are also active with ETH in Zurich (Switzerland) and INRIA (France).

The recruitment of researchers and post-docs will be as open as possible and will be advertised in the international community by using mailing lists, leaflets at conferences, etc.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Failure to deliver design of the specification language for SSO protocols and access control policies	VL	C	The probability is very low as we have a solid starting point in the specification language developed in the AVANTSSAR project.
Failure to identify case studies	L	M	The assessment of the analysis techniques will be difficult but not impossible (e.g., by using artificially creafted examples). A preliminary analysis of further profiles of the SAML SSO and of the Oauth protocol has already been conducted.
Failure to perform automatic analysis of the selected case studies	L	M	The techniques developed in the AVANTSSAR project will provide the starting point. However, they can be used as they are to perform some analysis of IAMS with some hacking.
Recruitment	L	S	Scouting of potential researchers and post-docs has already started.

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

Some of the evaluation activities undertaken by the SOA Unit may involve end users, whose location and activities are tracked in order to provide them contextual, personalized services. The Unit is aware of the ethical issues this involves. It will employ highest standard in dealing with these issues and have measures in place to ensure conformance with legislation, and to adhere to the fair information principles (collection limitation, data quality, purpose specification, use limitation, security safeguards, openness, individual participation and accountability).

CCL – COMPUTATIONAL COGNITION LABORATORY

Unit Name	CCL – Computational Cognition Laboratory	
Type	Exploratory	
Head	Fabio Pianesi	
Staff	2009	2010
	1 Researchers	1 Researchers
	2 PhD students	1 Post Doc
		4 PhD students

Document Status submitted 2009-11-23

1. Executive Summary

The CCL exploratory project is a place where various competences and skills present in FBK and in UniTn-CIMEC interact to investigate new ideas and concepts in the field of Human Computing, feeding them into the Ambient Assisted Living (AAL) perspective on the design and development of advanced services for the elderly.

CCL structures its activities into three core areas: “Research Issues in Human Computing”, “Strategic Activities for AAL” and “Higher Education”.

Research Issues in Human Computing. A few selected research issues in Human Computing have been identified that can crucially improve the capabilities of computer system to deliver better services to older people: a) the extraction of static features (personality traits and dispositions, preferences, life styles) and the analysis of dynamic aspects of human life (activities executed be the user, mood and social dynamics); b) new interaction paradigms for older people..

Strategic Activities for AAL. The work done during the last few years has created a critical mass in Trentino in terms of research capability, interest of the relevant stakeholders, involvement of companies, and demonstrated capacity to use technology for answering societal needs. These important results will be put on firmer basis and consolidated by: a) the development of a long term strategic plan for AAL activities in Trentino; b) a stronger role of FBK in the promotion of national AAL activities, as members of the steering board of the Italian Association for Ambient Assisted Living (AItAAL) and organizers of its first national conference; c) a continued and increased participation in European initiatives and projects.

Higher Education. Human Computing and AAL require appropriate educational actions aimed to train the future levies of researchers and professionals. CCL will continue playing a major role in the new and quite successful ‘laurea’ curriculum on

Interfaces and Communication Technologies at the Faculty of Cognitive Science in Rovereto, and in the new track on multimodal communication at the master in Cognitive Science. An increasing involvement is expected in the COBRAS doctoral programme.

CCL is a joint FBK-CIMEC effort and exploits personnel from the partner research groups: I3 and HLT from FBK, CLIC and CeRiN from CIMEC. Its own endowment is currently limited to the coordinator and two doctoral students. In the course of the next year we expect to maintain a similar profile, with the addition of two more doctoral students and, possibly, one postdoc.

2. Vision and Scientific Program

2.1. Context and State of the Art

Variously called Human Computing, Human-Centric Computing, etc., a new body of knowledge and practices is growing that crosscuts advanced ICT sectors (Embedded Systems, Ambient Intelligence, Ubiquitous and Pervasive Computing, Internet of Things, Internet of People, etc.) joining them in marriage with frontier disciplines such as Human-Computer Interaction and Interaction Designs, having as best men Social Psychology and Cognitive Sciences, and with the non occasional assistance of Sociology. This broad and extremely interesting domain is finding its way into many research programmes, often disguised under various vests. For instance, in 2009-2010 FP7 Workprogramme there is virtually no challenge where the human-machine confrontation is not considered: objective ICT-2009-1.4 talks of human behaviour; challenge 2 is entirely dedicated to cognitive systems, ambient intelligence and interfaces, objective ICT-2008-4 addresses human perception and attention, human cooperation and decision, etc.

Human Computing finds a straightforward application to Ambient Assisted Living (AAL), a new perspective on the design and development of services aimed to improving the quality of life of different categories of users, and in particular the elderly. By 2020, 25% of the EU's population will be over 65. Spending on pensions, health and long-term care is expected to increase by 4-8% of GDP in coming decades, with total expenditures tripling by 2050. At the same time, older Europeans are important consumers with a combined wealth of over €3000 billion: a potential that is almost completely overlooked by ICT, given that the majority of older people do not enjoy the benefits of the digital age—e.g., only 10% use the internet. A major obstacle to a wider adoption of technology by the elders is the fact that current technologies and services have not been designed for older people, a highly diversified population, with specific needs and requirements that are continuously re-shaped by changing physical, cognitive and social conditions. Human Computing, by integrating all the necessary skills (ICT, social and cognitive psychology, HCI, sociology, etc) has therefore much to contribute to AAL.

Many national and trans-national bodies have taken important steps towards AAL: the EU has developed specific actions, both within FP6 and FP7 (€400m planned in FP7); the AAL Joint Programme (some €600m) has been launched and is now

up and running, featuring the participation of more than 23 member states (Switzerland will join soon); moreover, several European countries have adopted specific national actions. The result is that between 2008 and 2013, the EU, the Member States and the private sector are investing more than €1 billion in research and innovation for AAL.

In Trentino, PAT has been active in this area for years, framing its strategy within the e-Welfare political vision, adopted by the Provincial Council in 2007, and the more recent strategic initiative for family policies. PAT sensitivity to these issues is crucial: it is at the territorial level, in fact, that: a) societal requests and needs from older people become political issues; b) political issues are turned into actual services; c) services can be adapted to meet the demands and the requirements of the various stakeholders. Research institutions can and must accompany the process by devising and then deploying their own strategic visions where technologies are studied and developed to serve individual and societal needs and enforce individual and societal values.

Besides its scientific and technical articulations, Human Computing and AAL require appropriate educational actions aimed to train the future levies of researchers and professionals. A successful high education in this area does not only require a re-design of curricula and courses, but it takes advantage of a truly cross-disciplinary environment where students can contribute to shape the new Human-Computing perspective.

This EP provides a framework for various competences and skills present in FBK and in UniTn-CIMEC to interact and contribute to Human Computing and Ambient Assisted Living. After the start-up during 2008, the EP has formed a mixed FBK-UniTn working group, structuring its activities into three core areas: “Research Issues in Human Computing”, “Strategic Activities for AAL” and “Higher Education”. We briefly mention some of the results obtained so far.

Research Issues in Human Computing

CCL has been coordinating FBK activities in Netcarity (FP6), one of the biggest IP in the area of AAL.

We have addressed the execution of simple daily activities by people with mild cognitive disorders (dressing and undressing; buttoning/unbuttoning, for which a patent is pending) and investigated the import of the understanding of human traits and human activities for computer systems in AAL scenarios

Strategic Activities for AAL

Thanks to the Netcarity project, an ample network of relevant stakeholders (PAT, associations of older people, social services and their territorial articulations, companies, etc.) has been built and nurtured. Among the outcomes of this extended partnership we mention:

- the acquisition and successful completion of the ‘Contact Centre’ project, an *in vivo* experimentation of advanced service providing tele-care and the management of various types of alarms (water, smoke and fire, gas, fall-detection);

- the finalization of a FBK-ITEA-PAT-UniTn agreement for the setting up and management of a smart home to be used both as a showcasing and as an experimental facility;
- the constitution of AItAAL, the Italian Association for Ambient Assisted Living, together with other research institutions (CNR, Scuola Superiore Sant'Anna, IRCCS San Giovanni Rotondo), governmental institutions (PAT, Comune di Lecce, ARTEI-Regione Puglia), companies (GPI, MR&D Institute), and user organizations (AeA - Abitare e Anziani). FBK is a member of AItAAL steering board;
- the formation of a joint PAT-FBK working group entrusted with the definition of a 'Strategic Plan for AAL in Trentino' to be submitted to the Provincial Council.

Higher education

CCL has played a major role in the establishment and management of the new ITC (Interfaces and Communication Technologies) 'Laurea Triennale' curriculum in Rovereto. Freshmen registration has passed from 34 for the first academic year (2008-2009) to 54 in the second (and current) one. This highly innovative course is the first in Italy (and one of the few in Europe) to integrate psychology and cognitive science with computer science in a unique perspective Starting with this academic year, the educational offer has been enlarged by the constitution of a specific track on 'Language and Multimodal Interaction Technologies' within the international master in Cognitive Science.

2.2. Vision and Goals

In the next 3-5 years, we will continue articulating our activities along the three main directions discussed above.

2.2.1. Research in Human Computing

CCL has identified a few areas that are crucial for the development of Human Computing activities targeting the elders. They will be pursued through it internal partnership (I3, HLT, CeRiN and CLIC) and through the participation in national and European projects (e.g., Netcarity). The activities will take advantage of the facilities provided by the ITEA apartment and by the sensorised occupational therapy room at CeRiN.

The activities will focus on: a) the identification and analysis of aspects of human life that can improve the capability of computer system to deploy useful services in an appropriate manner to older people: static features (personality traits and dispositions, preferences, life styles) and dynamic aspects (activities executed be the person, mood, social dynamics); b) the identification of new interaction modalities for older people, with an emphasis on the indirect interaction pursued by I3; c) the development of advanced supports for people with mild cognitive disorders that incorporate results from points (a) and (b).

This EP will manage the activities of the Advisory Board of ACM/ICMI-MLMI (the ACM joint International Conference on Muiltimodal Interfaces and Machine Learning for Multimodal Interaction) for the next three years

2.2.2. Strategic Activities for AAL

Trentino has gained a leading position in AAL at the national and European level, also thanks to its stakeholders' demonstrated capability of using the territory as an extended laboratory where advanced solutions are tested and deployed. We strengthen and consolidate Trentino's critical mass reached (in terms of research capability, interest of the relevant stakeholders, involvement of companies, and demonstrated capacity to use technology for answering societal needs) by: a) promoting a long term strategic plan for AAL activities in Trentino; b) promoting Trentino's role in national AAL activities; c) participating in, and organizing, European initiatives and projects.

A strategic plan for AAL

A mixed PAT-FBK group has been entrusted with writing a proposal for the Provincial Council to discuss and possibly adopt. The plan will the identify societal needs and AAL research and innovation activities that can answer them in the considered time frame (4-5 years). Among the technical and scientific issues, the following topics are currently being discussed that are of interest to many groups of FBK.

- Development of advanced services for older people, including on-line shopping, teletransportation, access to useful information, etc.
- Social networking for older people. By this we mean both the extension of existing social networking platform or modalities (FaceBook, Twiter, etc.) to older people, and the much more interesting issue of extending the elder's physical network (her children and grandchildren, friends, communities) to a physical-virtual continuum for mutual assistance and support (e-altruism), leisure and entertainment..
- New interaction paradigms for older people, and in particular the indirect interaction paradigm being developed by I3.

National level activities

Being present in AItAAL's steering board, CCL will have the chance to play a major role in the definition and implementation of the association's strategies and in shaping the future of AAL in Italy. In particular:

- Taking advantage of the presence of many local governments (most notably, PAT), we will work towards a network of local governments that work together with the central one for the definition of relevant national policies for AAL and their articulation at the regional level.
- Specific attention will be devoted to the definition of university curricula that can satisfy the increasing demand of AAL professionals an researchers..

European level activities

This EP already participates in one of the biggest IP on AAL (Netcarity - FP6). We have participated in the activities of the Integrated Community Concept working group promoted by the AAL Association, and have been present in many fora for AAL. These activities will be continued and intensified during the next years, through the promotion of FBK participation in AAL-related projects and the estab-

lishments of long terms link between AItAAL and similar associations in other member states, as well as with the European AAL Association.

2.2.3. Higher Education

Our involvement will continue in the ICT 'corso di laurea' in Rovereto with the goal of making it into one of the most advanced places where higher education in Human Computing is pursued. To this end, we will contribute to strengthening areas such as the international programme (seminars and talks by relevant invited speakers; student exchanges; etc.) and the connection with companies, in particular local ones. An increasing involvement is expected in the new track of the master in Cognitive Science and in the COBRAS doctoral programme. In both cases we intend to strengthen the presence of topics relevant to Human Computing and Ambient Assisted Living.

2.3. Activities and Work Plan

Activity 1. Research in Human Computing.

- In the context of the Netcarity project, we will work at innovative services for mood control and improvement in older people. Experiments will be conducted in the ITEA apartment..
- Finalization of the current activities aiming at supporting people with mild cognitive disorders (dressing/undressing).
- Investigation of the role that context plays in the expression of personality.
- Preparation and submission of proposals to the next AAL-JP calls and to Call 6 of FP7.
- Exploitation of results from Netcarity and from the collaboration with CeRiN (distributed rehabilitation): we will submit AAL-JP and/or Legge 6 project proposals.
- Management of the activities of the Advisory Board of the ACM ICMI-MLMI Joint Conference.

Activity 2. Strategic Activities for AAL.

- Production of the strategic plan for AAL in Trentino.
- Participation in the steering board of AItAAL
- Organization of first national congress of AItAAL, to be held in Trento in 2010.

Activity 3. Higher education

- Establishment of links with companies (stages, student projects inspired to companies' needs).
- Tutoring of doctoral students (COBRAS)

2.4. Collaborations

- University of Haifa (Tamar Weiss and Tsvi Kuflik)
- Eberhard Karls Universitaet Tuebingen - dr. Udo Weimar
- CIMEC-CeRiN (Gabriele Miceli) and CIMEC-CLIC (Massimo Poesio)

- Facolta' di Scienze Cognitive (UniTn)
- IDIAP - Daniel Gatica-Perez, Alessandro Vinciarelli
- University of Trento, DISI - Nicu Sebe
- PAT - Luciano Malfer
- IMM-CNR - Pietro Siciliano
- DFKI - Hans Uszokoreit, Jan Alexandersson
- CreateNet - Oscar Mayora
- GPI - Paolo Girardi e Giampaolo Armellin

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
New strategic plan for AAL in Trentino	I/A	E	Feb.	Submission of the strategic plan for AAL in Trentino to the Provincial Council	-
Mood control and management	R	E	March Oct.	Installation and experiments at ITEA house	-
Assisted Cognition	R	E	June	Dressing-Undressing system tested and installed in CERIN	-
Exploitation of results from Netcarity and from the collaboration with CeRiN	I	E	June	Submission of Legge 6 and/or AAL-JP proposals	-
First Conference of AItAAL	I/R	E	Sept.	Organization of the First Conference of AItAAL	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	129.209,00
Travel	17.000,00
Equipment (HW/SW)	0
Doctoral students	21.000,00
Other (e.g. subcontracting to external contractors)	8.040,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€175.249,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	38.423,00
Other external incomes (projects, grants, etc.)	11.587,00
Internal incomes (“subcontracted” by other units)	0
Total Income	**€50.010,00**
Financial Need (Incomes – Expenditure)	**€125.239,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€125.239,00**

5. Human Resources

2009. The resources of this Exploratory Project consist of the coordinator and two PhD students of the COBRAS (Cognitive and Brain Sciences) doctoral school of the University of Trento.

Additional resources have been provided thanks to the cooperation with a number of RU of FBK: I3, TEV and HLT. Finally, being built on an agreement with UniTn-CIMEC, the EP exploits involves resources from CIMEC, and in particular its Centre for Neuro-Cognitive Rehabilitation (CERIN).

2010. Maintaining the typology of resources exploited so far, during 2010 this EP will make available two more scholarships for the COBRAS doctoral school, starting academic year 2010-2011. A pre-PhD application scholarship will be made available addressing candidates that might be interest to FBK.

The collaboration with I3 will be maintained invariant, while that with HLT will be slightly reduced and that with TEV will be suspended for year 2010.

6. Risks and Mitigation Plans

Some of our activities depend on ‘political’ factors, hence not ‘fully’ under our control. This is especially true of the strategic plan for AAL in Trentino. Once submitted, its approval and the subsequent implementation by means of specific actions

depend on the results of the discussion in the Provincial Council, on budget restrictions, etc. For these risks there are no real contingency plans; much more important seems the preliminary work towards mobilizing consensus from the relevant stakeholders.

The activities concerning the ICT course suffer of the same problem: a major risk is a dramatic drop in freshmen registration for the next academic year. Again, there aren't many contingencies to adopt in this case; rather, we must try hard to keep the course attractive and produce and to efficaciously advertise it among high school students.

Concerning the scientific/technical activities, below we report the only one for which reasonable risks can be foreseen.

Description	*Prob.*	*Impact*	*Contingency*
Failure in obtaining expected results for the mood control and management system by March	M	L	We have scheduled a second deployment of the system in October that will incorporate corrections suggested by the results of the first implementation

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

	YES
Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	X
Does the proposal involve adult healthy volunteers?	X
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	X
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	X
Does the proposal involve tracking the location or observation of people?	X

Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

ICT4G – INFORMATION AND COMMUNICATION TECHNOLOGIES

Unit Name	ICT4G – Information and Communication Tecnologies 4 Good	
Type	Applicative / Research	
Head	Adolfo Villafiorita	
Staff	2009	2010
	1 Researcher	1 Researcher
	5 Technologists	1 Post Doc
	0 Post Doc	3 Technologists
	1 PhD	0 PhD
		1 Pre-PhD
		4 Students

Document Status submitted 2009-10-26

* 2 f.t. and 1 p.t.

** 1-2 at the end of the year

1. Executive Summary

This is a proposal for a new unit, ICT4G.

The (longer term) goal of the unit is looking at novel ways of using technology to preserve and improve people's life. More specifically, the unit focuses on how to use ICT for addressing critical problems of societies with low ICT penetration in a way that life is impacted for the better. Notice that by low ICT penetration, we not only refer to developing countries (where the penetration is remarkably low) but also to societies with significant and tangible gaps that could be effectively addressed by the usage of new technologies.

An investment in a new thematic area is costly and presents risks, both for the people involved and for the organization supporting it; two main questions need to be answered: "why doing it?" and "why us?".

The answer to the first question is obvious. We could mention Kofi Annan[1] or simply restate the unit's mission. Concerning the second question we believe that there are very good motivations to take the lead on the initiative, specific competences that we can use, and opportunities for a structural and long term investment in the area.

Motivations are both local (where, by local, we mean Fondazione Bruno Kessler and Trentino) and global. Trentino has a long tradition in cooperation. We could mention, for instance, the recent agreement between the Government of Mozambique and PAT related to supporting ICT training and the Maputo living lab. The Uni-

[1] "While ICT cannot address all of [Africa's] problems, they can do much to place Africa on a firmer industrial footing... and strengthen the continent's human resources, with training that leads to sustainable livelihoods." - Kofi Annan, United Nations Secretary-General (20.11.2002)

versity of Trento has various programs to favor exchange of competences and resources with developing countries, in South America, Asia, and Africa. Finally, social impact is in the DNA of FBK (e.g. social balance).

FBK has the research and the inter-disciplinary competences required for starting the initiative up and making it grow significantly. The eD group has a recognized experience in some research areas of interest for the initiative (in order of relevance: mobile, web application, and security, system engineering, process modeling); it also has a proven experience in the management of complex and inter-disciplinary projects (we mention: the e-voting experimentations; the interoperability plan for the Government of Mozambique). More in general, various other competences of the IT center (e.g. e-Health, e-Gov, GIS) could have a tremendous impact and application for the implementation of ICT4G.

Opportunities relate to financing and longer-term sustainability of the initiative. Project opportunities are facilitated by existing contacts, either at the institutional level (interoperability contract with Mozambique) and at the personal contacts (Ethiopia, Paraguay, South Africa); partnership could involve GeorgiaTech and CUOA[2], but also local organizations (e.g. TUG). Concerning financing opportunities, we mention the EU VII framework (IST for Africa) and donors.

The group will take human resources from the eD group. Competence-wide, the composition will need to be re-balanced, strengthening research. (This is aligned with what happened in 2009 and that has seen two technologist moving to other initiatives.) We plan, in particular, to have a PostDoc and one Pre-PhD student working in 2010. We intend to open two PhD positions and prepare to open one or two R* positions in 2011. We have a relatively good base of MSc students and a good balance between italians and foreigners (of the eight resources “orbiting” in the group, four are foreigners).

The group has a good visibility in the scientific community, mainly for business process modeling and security analysis. We intend to keep pushing in these areas, as they are strategic for the initiative. The two main items we intend to push next year include:

- financing, through European projects and external collaborations (including Mozambique)
- networking, by moving from “personal” contacts to more institutionalized initiatives

2. Vision and Scientific Program

2.1 Context and State of the Art

To adequately describe the state of the art, we need to distinguish among the initiative, the approach, and the competences that we intend to foster in order to achieve the longer term goals.

[2] Centro universitario di organizzazione aziendale, master, consulenza e ricerca sui temi manageriali.

Comparing ICT4G with similar initiatives. Concerning the first point, there is growing research interest about the usage of ICT for development. We mention ICT4G at Georgia Tech, the D-Lab at MIT, FOKUS (Fraunhofer's Institute for Open Communication Institute for Open Communication Systems), and ICT for Development Centre, University of Cape Town, South Africa.

- *Georgia Tech's ICT4D.* Michael Best leads a group and teaches at Georgia Tech on topics related to the usage of ICT for developing countries. Initiatives seem to be focused on two main areas:
- analysis and policies, with topics such as. e.g. how ICT can be used to promote democracy and peace; the impact of Internet connectivity in developing countries; making ICT initiatives sustainable)
- human computer interaction, related to examining interaction design to address the needs, desires and aspirations of people in low-income areas. Quoting from the website: "Examining interaction design to address the needs, desires and aspirations of people in low-income areas. How do we design (or why) the personal out of personal computers, the desk out of the desktop and English from the QWERTY keyboard? Should we create a community computer based on agricultural or family metaphors, for instance? What is a user or community centered design for low-income countries?"
- *D-Lab, MIT.* Similar to ICT4D at Georgia Tech, D-Lab is a program at the Massachusetts Institute of Technology (MIT) that fosters the development of appropriate technologies and sustainable solutions within the framework of international development. D-Lab's mission is to improve the quality of life of low-income households through the creation and implementation of low cost technologies. D-Lab's portfolio of technologies also serves as an educational vehicle that allows students to gain an optimistic and practical understanding of their roles in alleviating poverty. (http://d-lab.mit.edu)

  There are currently nine different academic offerings that make up the suite of D-Lab classes, falling into the broad categories of Development, Design and Dissemination. All D-Lab courses are based on the same values and principles of providing experiential learning, using technology to address poverty, building the local creative capacity, promoting local innovation, valuing indigenous knowledge, fostering participatory development and co-creation, and building sustainable organizations and partnerships.
- *Fraunhofer FOKUS*. The institute, composed of seven different laboratories, research and develops communication and integration technologies in the fields of telecommunication, automotive, e-Government, and software development. Rather active in the developing countries, we mention the NET4DC project (really a program rather than a project), about providing universal access to global communication infrastructures. Among the initiatives we mention both programmatic actions (e.g. development of a –continuously updated– roadmap towards all-inclusion; R&D projects to install an initial wireless wide-area communication infrastructure for rural deployment) and concrete projects (e.g.technical solutions and use-cases for sustainable service

deployment in developing countries; a field-trial in rural Africa to evaluate real-world deployment). (http://www.fokus.fraunhofer.de/en/fokus/index.html)

- *ICT4D@UCT.* Created in 2008 the center is a multi-disciplinary group with a lot of emphasis in HCI and Ethnography. The group seems to bring together people with strong expertise in system development and deployment and focuses on the deployment of actual solutions. Application areas cover mobile, e-health. They also run a course with a mix of case studies and methods. (http://www.ict4d.cs.uct.ac.za/?p=142)

Concerning the technical competences that we intend to exploit and we need to develop, we mention:

- Business process modeling and procedural analysis
- Mobile and engineering of web applications
- Web application security

2.2 Vision and Goals

In shaping the long term vision of the group we focus on the following items:

- Mission and how we differentiate from similar initiatives
- Competences relevant for ICT4G that we have in house and competences that we need to acquire

Mission and how we differentiate from similar initiatives.

The (longer term) goal of the unit is looking at novel ways of using technology to preserve and improve people's life. More specifically, the unit focuses on how to use ICT for addressing critical problems of societies with low ICT penetration in a way that life is impacted for the better. Notice that by low ICT penetration, we not only refer to developing nations (where the penetration is remarkably low) but also to societies with significant and tangible gaps that could be effectively addressed by the usage of new technologies.

When compared with similar initiatives (see, e.g., related work) our initiatives has some weaknesses, some complementarities, and some strengths. Weaknesses are mainly related to training: we do not have courses at the University or exchange programs with other countries, such as Mozambique. The strategy here is joining forces and collaborate with the University of Trento. Complementarities refer to the technical know-how we have, which nicely complements that of other initiatives, such as ICT4D @ Georgia Tech. Also the strategy here is joining forces with existing initiatives. We mention (also in order of time and maturity) Georgia Tech, ICT4D@UCT, and FOKUS.

Competences

The group at the moment is competent and recognized in the scientific community for its contribution to process modeling and security analysis of processes. The competences of the group include web application development, and software processes.

On the other hand, the Economist recently published a special related to the Telcoms in emerging markets. Two striking figures of the report include:

- the growth of mobile phones in developing countries: “[...] in 2000 the developing countries accounted for around one quarter of the world’s 700m or so mobile phones. By the beginning of 2009 their share had grown to three-quarters of a total of which by then had risen to over 4 billion.”
- the impact of mobile phones in developing countries: “[...] a ten extra phones per 100 people in a typical developing country boosts growth in DFP per person by 0.8 percentage points. [...]”

If we stick to this vision, mobile technologies will soon become both the reference tool for the deployment of ICT solutions in developing countries and an important factor of growth.

We intend therefore to grow competences in two areas that are relevant for ICT4G. The first one is mobile and the second one is development of web application, with some emphasis on security of web applications.

Approach

We intend to focus on development and deployment of applications that could either be developed in response to a specific need of a stakeholder or as an internal initiative. In the second case, the solution needs to find some kind of eventual deployment on the field.

2.3 Activities and Work Plan

The goal for next year is getting solid ground for the initiative and get a good start. In particular the following areas will have to be developed:

- *Financing & projects*: we want to get funding for initiatives. There are three good starting points: European Projects (in particular the IST call planned for Winter and Spring 2010); joint fund raising with UTICT (Mozambique); joint fund raising with CUOA.
- *Networking*: we need to get into the research network. Good starting points here include GeorgiaTech, ICT4D South Africa, D-Lab.
- *Competences*: we want to strengthen our competences in the area of mobile and secure web applications, since these are two areas which, in our opinion will play a fundamental role in ICT4G.

Applications: we want to focus effort on the development of one/two key application that could be used to directly or indirectly contribute to a better development.

2.4 Collaborations

Already in place, continuing in 2010

- *UTICT, Mozambique*. Lourino Chemane (Head). Equivalent to the Italian CNIPA, UTICT is the unit responsible for the implementation of the eGovernment plan of Mozambique. We drafted the interoperability plan with them (together with UNITN and CREATE-NET) and we intend to collaborate on its implementation on 2010.

- *UCSB, Santa Barbara*. Richard Kemmerer (Head of the Security Group). One of the strongest group in web-security, we collaborated on analysis of e-voting systems and published together. We intend to continue the collaboration next year.

Planned (not in place, possible new collaborations)

Georgia Tech. GeorgiaTech has a group working on ICT for development. We intend to investigate the possibility of collaborations and work together towards the goals of ICT4G.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Collaboration with Mozambique	IA	E	2010	Some initiative between FBK and, e.g., UTICT. MSc students working on topics of shared interest.	-
Collaboration with Georgia Tech and UCSB	IF	E	2010	1 or 2 papers together	-
1-2 EU Project Proposal (submitted)	A	E	2010		-
Two Program Committees	R	E		Participation to one or two program Committee of Conferences.	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

The incomes include likely incomes (e.g. informal agreements). Notice that we do not take into account pending proposals: we recently submitted a proposal for a EU project, which could enter about 100K/year, if approved as budgeted.

With respect to 2009 there has been a sharp decline in expenditure (a saving of about 100K euros, mainly to a shift in human resources, however) and a sharp declined in consolidated incomes (from 130K in 2009 to 20K in 2010).

At the moment, self financing decreases from the 30% obtained in 2009 to 7%. Clearly an action will have to be taken to increase financing opportunities.

Expenses (EUROS)	
Personnel	243.269,00
Travel	10.000,00
Equipment (HW/SW)	4.000,00
Other (e.g. subcontracting to external contractors)	38.100,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€295.369,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	0
Other external incomes (projects, grants, etc.)	60.000,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€60.000,00**
Financial Need (Incomes – Expenditure)	**€235.369,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€235.369,00**

5. Human Resources

Composition in 2009

Resource	*Number*	*Name*
Researcher	1	Adolfo Villafiorita
Postdoc students	0	
PhD students	1	Komminist Sisai Weldemariam
Technologist	3 + 2	Andrea Mattioli Andrea Manica Giordano Adami Two technologists moved to other iniatives during the year: Maurizio Napolitano and Roberto Tiella
Short Term Collaborators (contract < 12 months)	3	Birhanu Mekuria Eshete Francesca Longo Aaron Ciaghi

Planned Composition in 2010

The group will take human resources from the eD group. Competence-wide, the composition will need to be re-balanced, strengthening research. (This is perfectly aligned with what happened in 2009 and that has seen two technologist moving to other initiatives.) We plan, in particular, to have a PostDoc and one Pre-PhD stu-

dent working in 2010, we intend to open two PhD positions and prepare the conditions to open one or two positions for R* in 2011. We have a relatively good base of MSc students and a good balance between italians and foreigners (of the eight resources “orbiting” in the group, four are foreigners).

Resource	*Number*	*Name*
Researcher	1	Adolfo Villafiorita
Postdoc students	1	Komminist Sisai Weldemariam
PhD	2	(To be opened in november 2010)
Pre-PhD Grant	1	Birhanu Mekuria Eshete
Technologist	2	Andrea Mattioli Andrea Manica
Short Term Collaborators	2	Francesca Longo Aaron Ciaghi

Main criticalities

All resources, except one, are on short-term contracts. This is unlikely to be sustainable in the longer term. Together with technical planning of activities it will be necessary to plan for human resources.

(The problem is organization wide, but, newer initiatives might be the most affected, given the existing distribution of contracts.)

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Staff turnover due to external constraints (e.g. short-term contracts)	VH	VH	Adequate HR planning.
Difficulties in consolidating partnership with new countries	M	M	Favor networking through students, personal connection, conferences.
Group size	VH	M	The group is quite compact. This will make rather difficult to exploit opportunities, if they arise.
Lack of focus on “hard” competences (risk of becoming solution providers with “nothing” to say)	H	VH	Define a few strong research lines; find collaborations; have student pursue the lines

Legend:
Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High
Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

Some of the evaluation activities undertaken by the SOA Unit may involve end users, whose location and activities are tracked in order to provide them contextual, personalized services. The Unit is aware of the ethical issues this involves. It will employ highest standard in dealing with these issues and have measures in place to ensure conformance with legislation, and to adhere to the fair information principles (collection limitation, data quality, purpose specification, use limitation, security safeguards, openness, individual participation and accountability).

NILAB – NEURO INFORMATICS LABORATORY

Unit Name	NILab – Neuro Informatics Laboratory	
Type	Research	
Head	Paolo Avesani	
Staff	2009	2010
	3 Researchers	3 Researchers
	0 Technologist	0 Technologist
	0 Post Doc	0 Post Doc
	2 PhD	3 PhD

Document Status submitted 2009-11-23

1. Executive Summary

NILab is a laboratory devoted to neuroinformatics raised as a joint initiative of Fondazione Bruno Kessler and University of Trento. The laboratory is located in Mattarello at the Center for Mind and Brain Sciences (CIMeC). Neuroinformatics is mainly concerned with the data interpretation and data management for neuroscience. Currently the activities of NILab are focussed on data interpretation.

The main effort of NILab is devoted to research. The goal is to advance the computational methods for brain data interpretation. More in detail the orientation is to investigate how machine learning approaches might provide competitive advantages in neuroscience investigations. The ambition is to cover the wide range of heterogeneous sources of brain data that are managed at CIMeC as fMRI, DW-MRI, MEG, EEG, TMS.

The research agenda includes three main challenges that are recognized as the most prominent by the scientific community: multivariate brain mapping, real-time brain decoding, functional and structural brain connectivity. The first challenge is concerned with the design of computational methods for whole brain multi-voxels pattern analysis; the second challenge aims to deliver a learning model to perform brain decoding in real-time, creating the premise for an adaptive protocol of stimuli; the third challenge is dealing with the issue of joint analysis of funtional and structural data that should become viable using a relational learning approach.

The open challenge is to devise an effective multidisciplinary collaboration with the researchers working at CIMeC on a broad scope of areas as cognitive neuroscience, social neuroscience, neuroeconomics. Special attention is devoted to the collaboration with CERIN, a research institute on health care devoted to cognitive rehabilitation. The ultimate goal is to deliver computational methods that might be beneficial for the diagnosis or the treatment of patients.

A second objective of NILab is related to technology. A support to brain data analysis and interpretation it is expected to take place by prototyping and engineering computational tools. The delivery of software component will represent the main strategy for sharing and spreading the results of research. The impact of our activity will be evaluated not only with respect to the original contribution but also the capability of promoting the best practice.

Part of the activities of NILab is devoted to support the education of COBRAS, the international PhD School on Mind and Brain Sciences of the University of Trento. More in general NILab is aiming to become a competence center for the best practice on multivariate pattern analysis at CIMeC.

The laboratory is conceived as a small research unit composed by six persons, half of them are researchers and the other half are PhD student at the international ICT PhD school of the University of Trento.

The research activities of the next year will involve collaborations with James Haxby, Darmouth, USA; Walter Shneider, LRDC, University of Pittsburgh, USA; Giorgio Coricelli, CNRS, Lyon, France; Gabriele Miceli, CERIN, Italy; Mark Girolami, Glasgow University, UK; Larry Manevitz, University of Haifa, Israel.

A critical point in the workplan for 2010 is concerned with an effective strategy for funding raising. Neuroinformatics is not properly covered by the 7 Framework Program of Europe. At the same time Italy, different from the other western countries doesn't support a national research program on neuroscience.

2. Vision and Scientific Program

Neuroinformatics is concerned with data interpretation and data management for neuroscientific investigations. In Trentino there are research institutions like Fondazione Bruno Kessler (FBK), the Department of Engineering and Information Science (DISI), the Center for Mind/Brain Sciences (CIMeC) that cover all these areas of competences. The Neuroinformatics Laboratory aims to become a reference point for the interdisciplinary research between computer science and neuroscience.

2.1. Context and State of the Art

The international community of neuroscience is experiencing a new emerging awarness of the role of computer science. The Organisation for Economic Cooperation and Development (OECD) Global Science Forum promoted few years ago the International Neuroinformatics Coordinating Facilities (INCF). INCF aims to acknowledge the scientific community working on neuroinformatics, a discipline that stands at the intersection of neuroscience and information science. This research field encompasses the data and knowledge management of neuroscientific data and the deveopment of computational models for improving the understanding of brain functions.

The research effort of NILab is focussed on the design of computational models and development of data analysis tools for neuroimaging interpretation. CIMeC represents a meaningful and demanding context for NILab: the laboratory on neuroimaging (LNIF) hosts many kinds of non-invasive instruments for brain activity recording and at the same time a large team of cognitive neuroscientists. The challenge is to address the wide range of heterogeneous data coming from different sources like fMRI, DW-MRI, MEG, EEG, TMS, all of them available at CIMeC. Additional complexity arises from the recent trend of multimodal imaging where different kinds of data are acquired simultaneously.

In fMRI data analysis the reference techniques are based on univariate model and haemodynamic filter. Only few years ago machine learning approaches have been introduced in the neuroscience community to enable multivariate pattern analysis of brain data. The main advantage is to address data analysis without the restrictive assumption of the knowledge on haemodynamic response. The usual processing of fMRI data to compute brain mapping has been extended to include also an additional task called brain decoding. Brain decoding allows to estimate the mental state of a subject looking at the recording of BOLD signal. There are still many open issues related to computational methods for brain decoding, we mention only few of them. To characterize from the statistical point of view the results of a classifier is an issue that usually is not considered in the community of machine learning but it is relevant for the testing of hypothesis in the neuroscience investigation. Shaping the computation of a brain map as a problem of classification has scalability issues that prevents the delivery of effective solutions. A further source of complexity rises from the meaningful variance that affects two subsequent brain recordings on the same subject or cross-subjects.

Further challenges for multivariate pattern analysis are related to the evolution of the neuroimaging techniques. The recent development of diffusion weighted imaging introduced the possibility to obtain the functional struture of the brain. While the reconstruction algorithms allow to rebuild the structure of fibers, the problem of segmenting the main anatomical tracts is still matter of research. The complexity of the problem rises from the difficulty of co-registering two brains since the meaningful cross-subject variance.

The new frontier of brain data analysis is the join interpretation of structural and functional data. Both functional and diffusion neuroimaging enables the synthesis of abstract representation of the brain in terms of graph, namely connectome. The acquisition of competences on managing both functional and structural data is a precondition to face with the most innovative challenge in brain data interpretation.

2.2. Vision and Goals

The evolution of the research in the field of neuroscience is requiring more advanced computational method to interpret brain data. The deep understanding of brain images has to be mediated by computer which is in charge to elaborate human readable results. The challenge of designing computational method for brain data interpretation is continuously evolving because new experimental protocols are proposed and because new imaging methods emerge.

The long term vision is to become a competence center for the elaboration of neuroscientific data as a natural complement of the neuroimaging laboratories at the Center for Brain and Mind Sciences. The ultimate goal of NILab is to advance the research on computational methods for brain data interpretation. The expectation is that more powerful methods for data analysis might provide competitive advantages to the cognitive neuroscience investigations taking place at CIMeC. Close relationships with neuroscientists should provide a better focus towards computational problems relevant for enhancing the understanding of brain functions.

Technology plays a key role in our vision. We argue that a meaningful impact on brain data interpretation requires not only the design of new computational methods but also the delivery of tools. Special attention will be devoted to design and to develop software solutions which should enforce the sharing of knowledge between computer scientists and neuroscientists. To ensure a sustainable strategy we devised to join an open source software project, namely pyMVPA, that already includes main reference actors of the international scientific community.

2.3. Activities and Work Plan

The next year the activities will be organized around five main lines.

- *Activity 1 - Brain Decoding*. Brain decoding is concerned with the prediction of mental state starting from the analysis of brain activity recording. The research aims to deal with the issues of deploying a classifier on data collected from a session different from the session whose data have been used for training. The ultimate goal is to design a computational method that enables the brain decoding in real time.
- *Activity 2 - Brain Mapping*. Brain mapping allows neuroscientists to recognize which brain areas are related to a specific activity. The goal of our research is to address a twofold challenge: to deploy a solution that at the same time will support multivariate analysis and will be computationally efficient. The expected benefit will be the opportunity to interpret brain data acquired using a wider range of design protocols.
- *Activity 3 - Brain Connectivity*. Brain connectivity aims to investigate brain function looking at the brain structure as a graph where voxels are nodes and tracts are arcs. The recent techniques of diffusion imaging allow to reconstruct the fiber tracts of the brain. The research goal is to recognize meaningful anatomical tracts using supervised machine learning approach. The challenge is to perform cross-subject tract segmentation without requiring brain coregistration.
- *Activity 4 - Software tool*. pyMVPA is an open source software tool based on python to support multivariate pattern analysis of brain data. The goal is twofold: on one hand it is to acquire the skills for an extensive use with data collected at CIMeC, on the other hand it is to contribute to the development of the tool implementing new computational methods.
- *Activity 5 - Education*. COBRAS is the international PhD school on mind and brain sciences of CIMeC. The objective is to partially support the education of

PhD students organizing seminars, tutorial and readings on multivariate pattern recognition of brain data.

2.4. Collaborations

- James Haxby, Darmouth, USA. Haxby is leading the group that is developing pyMVPA, an open source software tool based on python for supporting multivariate pattern analysis of brain imaging; NILab joined this initiative and is part of the team that is currently extending the software project.
- Walter Shneider, LRDC, University of Pittsburgh, USA. Schneider is the leader of the Pittsburgh Brain Competitions that since 2006 aim to propose to the scientific community a well defined challenges in brain imaging interpretation to enable computer scientists to join neuroscience research; NILab is contributing in organizing the scientific aspects of competitions.
- Giorgio Coricelli, CNRS, Lyon, France. Coricelli is working in the field of neuroeconomics and social neuroscience; NILab is working at a joint research project where to combine an investigation on neural mechanism of reputation building with a machine learning approach that enables a real-time fMRI brain imaging interpretation.
- Gabriele Miceli, CERIN, Italy. Miceli is the director of CERIN, a medical center devoted to cognitive rehabilitation. NILab is studying a computational learning method that allows physicians to interpret fMRI brain images when two subsequent acquisitions are interleaved by an innovative experimental therapy.
- Mark Girolami, Glasgow University, UK. Girolami is the head of the Inference Group, a laboratory devoted to machine learning and applied statistics; NILab es.collaborating to a project on new computational method based on bayesian approach for brain imaging interpretation.
- Larry Manevitz, University of Haifa, Israel. Manevitz is the head of Department of Computer Science; NILab is setting up a collaboration to investigate the use of liquid state machine as a computational method to interpret fMRI brain images.

2.5. Specific Needs and Points of Attention

Despite of the fact that neuroinformatics is in between neuroscience and computer science it is not true that the opportunity for funding is twice as a single discipline. Since neuroinformatics is mainly concerned with methodological aspects of brain interpretation, it is usually considered marginal in the neuroscience calls. At the same time the European Union doesn't include neuroscience among the main application domain for ICT. In Europe research on neuroscience is mainly funded by national agencies. Differently from other countries, like Germany or France, Italy doesn't provide a specific research funds program for neuroscience. To setup a funding strategy is not straightforward and additional effort is required to recognize alternative ways of proceeding.

Currently the research effort and the focus of activities is restricted to brain data interpretation. Nevertheless the challenge of brain data interpretation is strongly related to the challenge of brain data management. The scientific community of neuroinformatics covers both of them and also in Trento these competences are

available at the University of Trento and Fondazione Kessler. NILab is working to aggregate competences and interests around this research field. A major effort would be required to acknowledge this opportunity by the local government.

An additional issue is concerned with the policy to distribute brain data. Sharing data is becoming more and more a winning factor to promote own research and to increase the visibility of the institution. Nevertheless the distribution of data requires to adopt a licence that preserves the ownership without affecting the dissemination. This issue should be managed at the higher level than the single research unit.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Brain decoding	R	E	Dec.	Submission Publication	Dataset
Brain mapping	R	E	June	Submission Publication	Dataset
Brain connectivity	R	E	June	Submission Publication	Dataset
Software Tool	I	E	Dec.	Delivery software	
Education	O	E	Dec.	Lectures Seminars	

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	229.803,00
Travel	10.000,00
Equipment (HW/SW)	5.000,00
Other (e.g. subcontracting to external contractors)	63.400,00
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€308.203,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	
Other external incomes (projects, grants, etc.)	20.000,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€20.000,00**
Financial Need (Incomes – Expenditure)	**€288.202,00**
Required Structural funding from PAT (it should be equal to the previous item)	288.202,00

5. Human Resources

Currently the team of NILab includes 6 persons, half of them are researchers and the other half are PhD students. The researchers are qualified as follows: a senior research heading the laboratory, a junior research with a permanent position and a post-doc researcher with a tenure track. The three PhD students are distributed along different cycles of the international ICT PhD School of the University of Trento, the 23th, 24th and 25th respectively.

e-HEALTH

Unit Name	e-Health	
Type	Applicative	
Head	Stefano Forti	
Staff	2009	2010
	4 Researchers	4 Researchers
	5 Technologists	5 Technologists
	1 Research Technician	1 Research Technician
	1 PhD	2 PhD

Document Status submitted 2009-11-25

1. Executive Summary

1.1. Main Activities

The Pervasive e-Health Unit - PeH is a *multidisciplinary group* carrying out *innovation and applied research* in e-Health area within a conceptual framework that comprises four basic activities: formulation of models and concepts, developing innovative applications, validating these applications in laboratory (innovation laboratory) and on-the-field (territorial laboratory), studying the effects of these applications in several healthcare settings (clinical proof-of-concepts). This framework is implemented by methods and techniques from interaction design, a user-centered approach to design that emphasizes the importance of involving final users throughout the whole process of design of the product or system within an iterative design-evaluation process.

The activities of PeH unit will be carried out in strong collaboration at local, national and international levels and will focus on two main themes:

- Study of pervasive e-Health applications and services supporting new models of care in which citizens and patients are actively involved in the process of care (Patient-centered e-Health-PCeH).
- Study of pervasive e-Health applications and systems for healthcare operators (Clinical e-Health-CLeH) supporting the quality of the care process.

An innovation laboratory on Pervasive e-Health (SEPLab) has been established within the unit as a “inter-institutional and multidisciplinary common space” in which FBK researchers and technologist, policy makers (eg. from Healthcare department of Province of Trento and/of Ministry of Health), healthcare operators and managers (eg. from local and national healthcare institutions) and citizens share common strategies and carry out projects in the healthcare domain.

The ultimate goal of the PeH, in particular of SEPLab, is the promotion of innovation at local and national level in the domain of health and healthcare, through scientific projects aimed to introduce in the daily life of citizens and in the clinical practice of healthcare professionals innovative e-Health services, involving public and private stakeholders of healthcare domain. In this context, the PeH unit represents one of the means through which FBK may contribute to realize the challenges of its mission.

1.2 Personnel

4 Researchers, 5 Technologists, 1 Research Technician

2 PhD

2 tenure track positions for 2010

1.3. Prominent collaborations

- Dpt. of Health and Dpt of Innovation and Research, Autonomous Province of Trento
- Health Care Service Authority of Trento (Information systems, Medical Oncology Unit)
- Dpt of Sociology and Law, University of Trento
- Faculty of Art & Design, University of Venice
- Dpt.of Information and Knowledge Engennering, Danube University Krems-Austria
- Local IT companies (Argentea, AMS, MTT)

2. Vision and Scientific Program

2.1. Context and State of the Art

Industrialized countries are called to face new challenges in the health care sector due to many different changes such as:

- the percentage growth of the elderly population
- the increase in chronic pathologies
- the growing request for high quality health care services and their increased costs
- citizens' demand to be more involved and play an active role in the their own care

To face these problems health institutions of Western countries are starting to change their policies and their organizational structures implementing new forms of social and health services focusing more on primary and secondary prevention, experimenting new model of citizens-centered care that directly involve patients and their families, creating new forms of health care services for home-based management of chronic illness.

Information and communication technology (e-Health) can help in creating this "digital infrastructure" of innovative healthcare services (e-care), providing not only healthcare professionals but also citizens with technological tools to help and support them in managing health on a daily basis, easily, through different devices (computer, smartphone, TV and so on), everywhere they are (home, work, holidays) and whenever needed (pervasive e-care).

In the context of e-Health, pervasive e-Health is emerging as a new interdisciplinary research field that aims at using pervasive computing and ICT (internet, mobile and so on) and the biomedical engineering technologies (e.g. sensors) to study and design new solutions to support western health institutions in facing the challenges and changes described above. Even if pervasive e-health shares some research topics with other disciplines (e.g. biomedical engineering, medical informatics, pervasive and ubiquitous computing), it has its own objectives that pertain to medical domain (e.g. supporting new cure models) and approaches (clinical proof of concept) which give it a specific and distinct connotation. Some of the most relevant sub-fields of interest of pervasive healthcare are monitoring and body sensor network, pervasive assistive technologies, pervasive computing for hospitals, preventive and persuasive technologies, self-treatment e self-management, decision support systems.

A key to face the new challenges of the healthcare sector will be to implement a research and innovation paradigm with a strong multidisciplinary connotation, allowing people with different backgrounds (research, healthcare sector, public-private sector) to cooperate with a common aim sharing methods, technologies, platforms and infrastructures developed by different disciplines to create new solutions for the healthcare sector.

Previous work of PeH group has been focused on the study of e-Health applications in Heart Failure and Oncology disciplines. e-HeartFailure was a 44-month proof-of-concept study (started in May 2002, finished in December 2005) with the overall goal of assessing the feasibility of a computer-based co-operative work framework (e-HF system) for favouring a continuous and shared care delivery among the Health Care Professionals (HCPs) involved in the management of heart failure patients on the territory of the province of Trento (NE Italy). In June 1997 we started a 3-year project on Medical Informatics, founded by the Italian Ministry of Health. The objective of the project was a Teleconsultation system based on an web based Oncological Electronic Patient Record (OEPR) to share clinical data between the Oncological Unit of the S.Chiara hospital of Trento and the peripheral hospitals of our Province lacking an oncological service on site. Currently, all the patients accessing the Oncological Unit are managed through the OEPR. By the end of the year 2008, the OEPR contained data of more than 12,000 patients, and was accessed a total of about 70,000 times. The knowledge base services implemented in the Clinical e-Health activity (see below) will be integrated with the OEPR.

2.2. Vision and Goals

The general aim of the innovation applied research unit "Pervasive e-Health-PeH" is the study of methods and models for the design, implementation and evaluation

of prototypic applications and ICT-based innovative services supporting the management of data, information and knowledge in healthcare domain. The activities of PeH unit will be carried out in strong collaboration at local, national and international levels and will focus on two main themes:

- Study of pervasive e-Health applications and services supporting new models of care in which citizens and patients are actively involved in the process of care (Patient-centered e-Health-PCeH).
- Study of pervasive e-Health applications and systems for healthcare operators (Clinical e-Health-CLeH) supporting the quality of the care process.

From the *innovation perspective* (along the dimensions of services toward PA and of technology transfer for companies), the mission of PeH unit is to conduct research in collaboration with FBK research units (internal "interface") and promote innovation in the e-Health domain toward local and national PAs (Health Ministry, Health departments, hospitals, ecc) and companies active in the healthcare market.

In this context, an innovation laboratory on Pervasive e-Health (SEPLab) has been established as a "inter-institutional and multidisciplinary common space" in which FBK researchers and technologist, policy makers (eg. from Healthcare department of Province of Trento and/of Ministry of Health), healthcare operators and managers (eg. from local and national healthcare institutions) and citizens share common strategies and carry out projects in the healthcare domain. SEPLAb, composed by personnel, competencies, knowledge, methods and technologies, carries out innovation in e-Health area within a conceptual framework that comprises four basic activities: formulation of models and concepts, developing innovative applications, validating these applications in laboratory and on-the-field (territorial laboratory), studying the effects of these applications in several healthcare settings (clinical proof-of-concepts). This framework will be implemented by methods and techniques from interaction design, a user-centered approach to design that emphasizes the importance of involving final users throughout the whole process of design of the product or system within an iterative design-evaluation process.

The activities of PeH unit are dealing with the domain of innovative services of public utility (i-Services) and with the research program Future Internet (see Accordo di Programma of FBK 2009-2013)

2.3. Activities and Work Plan

The innovation and research activities at the PeH Unit will be organized within patient-centered and clinical e-Health areas, as follows:

Patient-Centered e-Health - PCeH

Patient-Centered e-Health (PCEH) and Consumer Health Informatics (CHI) have been rapidly emerging as important, distinct fields of scientific and practical endeavour. They can be considered as a form of e-health, focusing on applications in which the patient (or caregiver) is an active, involved participant in the management of his/her health and care. PCEH and CHI are branches of medical informatics that analyse consumers' needs for information, study and implement

methods for making information accessible to consumers, and model and integrate consumers' preferences into medical information systems. The social and policy context for this research area derives from the increasing attention devoted to personalized care and empowerment of citizens in the management of their care. Personal Health Record (PHR) is a specific application that falls within the domain of PCEH. There exist many PHR-related research themes including consumer research, health services research, and technical research.

In 2010, the activities dealing with this area will be carried out mainly under the project "TreC: la Cartella Clinica del Cittadino" funded by the Department of Health and the Department of Research and Innovation of Province Autonomous of Trento. Aim of the project is to design, develop, test the usability in laboratory and evaluate on-field the impact of a Personal Health Record in the Province of Trento. The PeH unit is in charge of the scientific and technical management of the project in strong collaboration with the local department of Health. The project is characterized by a highly interdisciplinary connotation and will involve public and private stakeholders, research, public administrations, and private companies.

The main activities for 2010 will be conducted in SEPLab and will regard: i) the on-the-field test of the base module of TreC for measuring the impact, the acceptance and usability of the system and for collecting a number of issues driving the tuning of the system and, ii) the design and prototype realization and laboratory test of specific modules of TreC system that use homecare and pervasive technologies and, iii) development of an ontology-based system for the creation of a consumer-oriented medical vocabulary for Italian (ICMV), reflecting the different ways consumers and patients express and think about health topics.

Clinical e-Health - CLeH

Despite the considerable progress in cancer prevention and treatments, studies in the U.S. and the Netherlands indicate that in the United States the quality of care provided is still sub-optimal. Pervasive knowledge-based computerized services supporting different moments of the everyday clinical activities (e.g., care-flow management tools, guideline-based Decision Support tools), available on a variety of devices and able to provide the right information and knowledge in the right place at the right time, can promote the practitioners' compliance with state-of-the-art evidence-based medicine and improve the care process outcomes. In light of this, the aim of this activity is to analyze and model the oncological care process and design, implement, and evaluate in a real clinical setting knowledge-based services to support oncologists in the task of delivering an evidence-based cost effective oncological care of high quality to cancer patients accessing the oncological unit of the S. Chiara hospital of Trento. This activity is collocated in the Knowledge Representation for Healthcare (KRH) research stream and spans several important research topics in Medical Informatics (MI): acquisition, modelling, integration and use of medical knowledge, design and evaluation of effective knowledge-based supporting tools, semantic interoperability between knowledge-based systems and data-based systems (HER), visualization of clinical information and knowledge.

In 2010, these activities will be mainly carried on under the internally funded project "eOnco JRP: Pervasive knowledge and data management in cancer care". The general aim of the project is to study and develop an ICT-based model for fully supporting the entire shared oncological care delivery process in an oncological department, trying to partly implement what can be called the "hospital of the future" paradigm. This model will support a multidisciplinary collaborative distributed process based on the best scientific evidence. Besides the collaboration with the Medical Oncology Unit, the project involves the research lines i3, HLT and DKM FBK.

In the eOnco project there are four specific activities: i) knowledge management for supporting the healthcare process (in collaboration with DKM), ii) design and implementation of tools for the provision of information and knowledge to the user, iii) design and development of a Natural Language Processing (NLP) based "vertical" application to extract structured information (medical terms and relations between terms) from surgical interventions and diagnostic reports, and iv) study, design, and integration into the platform of a specific tool for supporting the cooperative work of oncologists during the weekly multidisciplinary meeting in the ward (in collaboration with i3).

2.4. Collaborations

PA and Healthcare local Organizations

- Department of Health(Autonomous Province of Trento) (PCeH area, TreC project). The reference person is Diego Conforti. Department of Health has cofunded the project and coparticipate to the management of the project.
- Department of innovation and Research (Province Autonomous of Trento) (PCeH area, TreC project). Department of Innovation and Research Health has cofunded the project and coparticipate to the management of the project.
- Health Care Service Authority of Trento (TreC project, eOnco project)
  - Information systems. The reference person is Leonardo Sartori. Several technologists of the information system service participate to the design and development phases of TreC project, mainly on the aspect related to interoperability of TreC system with health information systems.
  - Oncology Department, S. Chiara Hospital, Trento (ClEH area, eOnco project) The reference person is Enzo Galligioni (Head of the Medical Oncology Unit.). The Medical Oncology Unit represents the "territorial laboratory" in which to test and evaluate the solutions developed by clinical e-Health area. Moreover, oncologists of the Unit are the domain experts for modelling the care process, define the user requirements and the functionalities of the systems.
  - Other Department of S. Chiara Hospital (PCeH area, treC project). Several health operators from departments of local Health Care Service Authority participate to the design, development and test phases of TreC project mainly on the realization of the specific modules of TreC systems.

Research Institutions

- University of Trento (TreC project)
  - Dpt of Sociology. The reference person is Alberto Zanutto. Researchers of sociology department participate to the needs assessment, requirements definition and on-the-field tests of the treC system
  - Dpt of Law. The reference person is Umberto Izzo. Researchers of law department participate to the study of the legal aspects related to the use of TreC system.
- University Iuav of Venice –Faculty of Art & Design (PCeH area, TreC project). The reference person is Mario Varesco. Researchers of IUAV participate to the realization of the user interface and graphical modules of TreC system
- Dpt. of Information and Knowledge Engineering - Danube University Krems-Austria (ClEH area, Caritro project) the reference person is dr. Silvia Miksch (Head of the Dpt. of Information and Knowledge Engineering) who is head of the group that maintains the formal guideline representation language Asbru and the Asbru interpreter. We use the Asbru language in the Oncocure project and we intend to continue the collaboration in 2010 for the evaluation and the extension of the DSS developed in the course of this project.
- Laboratory of Applied Ontology, Cognitive Science Institute, CNR, Roma (ClEH area, eOnco). The reference person is Domenico Pisanelli. who is an expert of ontologies in medicine. The collaboration regards the design and development of ontologies in the cancer domain (e.g, an ontology of therapies) for favouring both the unambiguous communication between doctors and computer scientist and the semantic interoperability between different software systems (e.g., an Electronic Healthcare Record and a guideline-based DSS).

Local Companies

- ClinicHall Consortium (SEPLab area. eOncoProjet) The reference person is Andrey Gromiko (from GPI). The collaboration is aimed at designing a model of the cancer screening process using a specific process language (BPEL) and building a prototype engine for executing the model, able to simulate the management of the screening process.
- MTT pro (SEPLab area , eOnco project). The reference person is Michele Galvagn. MTT pro is the company that owns and maintains the Electronic Healthcare Record used int ht eMedical Oncology Unit of the S.Chiara Hospital. Hence, the collaboration regards the integration, at data and user interface level, of the knowledge-based support tools designed by our line.
- Argentea (SEPLab area, Trec project). The reference person is Giampaolo Armellin. Argentea participate to the TreC project in the development and tuning phases of the TreC system.
- AMS Trento (SEPLab area, Trec project). The reference person is Andrea Gardumi. AMS participate to the TreC project in the study and integration of homecare solutions into the TreC system.

2.5. Specific needs and Points of Attention

The deployment of TreC requires a careful attention to some specific issues such as people's acceptance of the technology, privacy and accessibility problems, integration of the system in the existing healthcare infrastructures, organizational problems in managing patient-created information and their integration in the workflow. These dimensions will be explored through distinct research actions aimed at analyzing both the technical and socio-organizational effects of the deployment of the system.

3. Goals

Evaluation and possible extension of the guideline-based Decision Support System

Description:

Evaluation and extension of the Asbru-based decision support system (DSS) to an internet accessible system. The first objective is to perform a thorough evaluation of the system impact and effectiveness on the everyday clinical practice in the Medical Oncology Unit. The second objective is to design the system extension to a DSS tool published on the Internet and accessible to a wide community of Italian oncologists as a sort of easy-to-use active guideline reference manual.

Type:

Innovation (60%), Applied Research (40%)

Scope:

External

Time Frame:

June: results of the evaluation of the impact/effectiveness of the decision support system.

December: developing of the Internet-based DSS.

Measurement plan:

The results of the evaluation phase;

The Internet-based system.

Preconditions:

Evaluation of the DSS tool is subject to the active participation of the local Medical Oncology Unit.

4. Budget

Expenses (EUROS)	
Personnel	515.919,00
Travel	14.000,00
Equipment (HW/SW)	12.000,00
Other	123.400,00
Subcontracting to external contractors *	485.000,00
Internal collaborations: “subcontracting” to other unit	
Total Expenditure**	**1.150.319,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	
Other external incomes (projects, grants, etc.)***	483.970,00
Internal incomes (“subcontracted” by other units)	
Total Income	**€483.970,00**
Financial Need (Incomes – Expenditure)	**€666.349,00**
Required Structural funding from PAT (it should be equal to the previous item)	**666.349,00**

* progetto TreC: quota da girare a terze parti
** c.a. 849.000,00 Euro costo progetto TreC+350.000 c.a. per progetti eOnco e SEPLab
*** quota da Assessorato saluto = 60% dei costi. Da verificare se il rimanente 40% dell’Assesorato Ricerca e Innovazione possa essere caricato su fondi extra AdP

5. Human Resources

Pervasive e-Health unit can be ideally thought as constituted by two subgroups working in close collaboration and focused on applied research and innovation with different perspectives. A group composed by four researchers and two PhD students would be mainly focused on research topics and would aim to publish research papers and participate to conferences and workshops. This subgroup should represent the natural interface toward the FBK research units and the “external” interface of e-Health unit toward scientific communities focused on specific research fields and themes (e.g. knowledge management in healthcare). A second group composed by technologists and technician would be more focused on the design and development of e-Health systems and services in a perspective of innovation in e-Health arena. This subgroup should represent the “external” interface of e-Health unit toward the local and national community of stakeholders

involved in e-Health and should be mainly focused on the study of innovative services in healthcare (e.g. personal health record).

At present PeH unit has only three permanent positions (1 technologist, 1 researcher and 1 technician) and thus it is lacking of the critical mass that can guarantee the quality and continuity of the research and innovation activities. There is the strong need for the immediate stabilization of one researcher (E. Piras) and one technologist (B. Purin) within 2010. For that reason, Piras and Purin will be admitted to a tenure track position.

6. Risks and Mitigation Plans

Major risks are related to the deployment of TreC system on the field. In particular,

Description	*Prob.*	*Impact*	*Contingency*
Scarce use of TreC system by citizens (less than 100 using the service)	M	S	-
Scarce cooperation from health operator (eg. general practitioners) in the promotion of TreC use	M	S	-

Legend**:**

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

SoNet – Social Networking

Unit Name	Sonet – Social Networking	
Type	Exploratory	
Head	Paolo Massa	
Staff	2009	2010
	2 Researchers	1 Researchers
	1 Technologist	1 Technologist
	0 Post Doc	Z Post Doc
	0 PhD	0 PhD
	2 Developers	2 Developers

Document Status submitted 2009-11-03

1. Executive Summary

SoNet is currently an explorative project, started in 2008 and with a time span for exploration of 3 years. This section summarizes activities and goals for 2010.

About research, we should mention that Social Networking is a young and rapidly and tumultuously growing research field. For this reason, we tried to identify few niches in which we could reasonably achieve success (i.e. Publish papers). The niches are social networks among users in Wikipedia, Enterprise2.0 and social capital, communities sharing of memories.

About fund rising, we have tried creating alliances at the local and european level in order to apply for funding. We will apply for 2 European calls and one local scholarship.

About local impact/technology transfer, we have created and maintained a broad and fruitful set of relationships with local actors and in particular with the PAT, which acknowledge us as the main local experts on social networking. We will try to keep this relationship and put it at work in the real impact. We have created and maintained the social networking platform used in FBK in order to increase collaboration and mutual knowledge and released it as open source.

We have strong competencies in the technology sector, while we would benefit of one more team member who is devoted 100% to research.

Depending on what SoNet will become (a research unit or an innovation unit), this might or might not be a problem. Anyway, all the European calls we will participate in have the goal to acquire one post-doc devoted to research.

2. Vision and Scientific Program

2.1. Context and State of the Art

Social networking and Web2.0 are two of the most important trends in the current technology scenario, able to shake and completely redefine our societies and the daily activities of the world inhabitants. It is a change in how the Web is conceived as an enabler, a platform and its conceptualization of social interactions among humans.

Social networking sites (SNS), such as facebook.com, youtube.com, myspace.com, wikipedia.org, flickr.com, linkedin.com, twitter.com, etc, are currently referred as normal part of the daily activities by newspapers and general public discourse. The number of users of those SNSs counts in the hundreds of millions each and it is increasing daily, as new users start using them in order to share knowledge, collaborate and interact socially with already exiting friends and acquaintances and to meet new ones.

Research about these new forms of collaboration and interaction mediated by ICT tools have boomed recently since SNSs provide an incredible mean for studying social phenomena as they occur in the large. Research about SNSs involves fields as diverse as sociology, economics, anthropology, political science and, of course, computer science as a basic tool enabling them and providing ways to analyze them.

From a technological point of view, it is more and more crucial to be able to "deploy" SNSs systems in different contexts, for example, as platforms for improving collaboration inside intranets (Enterprise2.0 systems) or as systems enabling better communication and community sense-making for specific groups of people.

2.2. Vision and Goals

SoNet is currently an explorative project, started in 2008 and with a time span for exploration of 3 years. Depending on how our exploration will come out and its results, we envision SoNet to become a stable unit, probably with a strong focus on the applicative side. Our time horizon for this document is hence 1 year, up to the end of the 3 years period.

2.3. Activities and Work Plan

Activities are grouped into 3 main categories: research, fund rising, and local impact/technology transfer.

Research:

social networking is a recent but very large and undefined research topic. We focus our research effort in 4 main research niches.

- Research about social networks among users in Wikipedia (almost nobody is currently doing this)
- Research about Enterprise2.0 (social capital and statistics of use and change of Enterprise2.0 platform in FBK)

- Research about dynamic carpooling
- Research about how communities share memories in a Web2.0 era (livememories)

If the European proposals are accepted, we will focus also on networks among museums and cultural heritage institutions and networks among developers of software (both with a dedicated new person to be acquired).

The unifying point among these activities is the fact we look at these domains and problems from a social networking point of view, modelling them as social networks and using the typical tools used to analyze social networks.

Fundraising:

Apply to Social Sciences and Humanities part of the FP7 2010 call (section "The Citizen in the European Union") "Reinterpreting Europe's cultural heritage: towards the 21st century library and museum?" Our workpackage will deal with networks and cooperation among museums. It will analyse the existing patterns of cooperation and on this basis, develop proposals for enhanced cooperation, sharing of information and collaboration within such institutions and networks from a technological and sociological perspective. Asking for a Post-doc for 3 years and costs of personnel already in SoNet

Probability of submission: 100%

- Apply to FP7-ICT-2009-C FET Open scheme, with Vincenzo D'Andrea and Maurizio Teli (Sociology Unitn) and 6 other partners: "Considering Social and Network Aspects among developers and users, during design and development of Socio-technical systems". Probability of submission: 85%
- Formalize the agreement about one scholarship for the case study for Trentini nel Mondo.
- Find funding and start CarteBuonConsiglio project: impact of offline social network and random act of kindness on social capital of citizens

Local impact and technology transfer:

- Opening of desktop.fbk.eu to every FBK colleague, further development adding more social features, final report about if and how desktop.fbk.eu was proved to be a useful internal tool for FBK in order to increase collaboration and mutual knowledge. Desktop.fbk.eu software is released since the beginning as opensource at http://taolin.fbk.eu
- Research and technology leading for the creation of the social network platform that will become the first choice for PAT needs, in the context of the "Progetto Trentino As Lab - Rete sociale della comunita' Trentina"
- Becoming the main speaker of PAT for every issue about social networking, web2.0 and ICT mediated collaboration. Possibile introduction of Enterprise2.0 tools in PAT for its employees.
- Creation of an independent social network for the association "Trentini nel mondo" and research about it: as a LiveMemories case study, and as a case study for the previous project.

- Release as open source of a Dynamic Carpooling prototype and test with a sample of local population
- Extension of the "cartella clinica del cittadino" with social features, in collaboration with eHealth unit.
- Keep being good attractors for stagiers and thesists (in 2009, 9 thesists/stagiers, from unitn computer , unitn sociology, unibz computer science, redoddity bz, ITIS superiori di Rovereto)
- Collaboration with Michele Lanzingher, director of Museo Tridentino di Scienze Naturali and Muse, about Muse2012 and museums networks (See also European Call).

2.4. Collaborations

Unitn – sociology

- Vincenzo D'Andrea e Maurizio Teli - write proposal for fundraising and research
- Francesca Odella - activity of stages, thesis and research in the enterprise 2.0 area, publication of papers

Museo Tridentino di Scienze Naturali (director Michele Lanzingher)

Collaborate to drive the museum in the web2.0 world and also start to participate in some projects activity, possibly use the museum for case study for the proposal “Europe's cultural heritage: towards the 21st century library and museum?”

Prof. Sharon Macdonald (Social Anthropology/Museum Studies/Manchester University, UK), Prof. Wolfram Kaiser (European Studies/University in Portsmouth, UK), Associate Prof. Stefan Krankenhagen (Cultural Studies/Aestethics/NTNU Trondheim, Norway), Assistant Prof. Marta Kurkowska-Budzan (History/Jagiellonian University Krakow, Poland), Assistant Professor Maria Economou (Museum Studies/University of the Aegean, Greece), Dr. Alec Badenoch (Technology/History of Technology/Technical University Eindhoven, Netherlands)

research partners in the European FP7 proposal

Informatica Trentina – Trentino As Lab: Marco Corbetto / Isabella Bressan

The project “Progetto Trentino As Lab - Rete sociale della comunitá Trentina" ends in May 2010. We will collaborate with them also in future.

Provincia Autonoma di Trento – Servizio Semplificazione e Sistemi Informativi e Ufficio Stampa

Several contacts with the PAT (Servizio Semplificazione e Sistemi Informativi – Sergio Bettotti/Italo Della Noce and Ufficio Stampa – Nicola Prantil/Pier Fedrizzi) to coordinate advice on choices of social networking platforms open source together with local businesses and Informatica Trentina and initiation of possible projects on these issues.

Michele Lanzingher, director of Museo Tridentino di Scienze Naturali and Muse.

We have ongoing collaborations with companies for projects with local and european vision (Tassullo SPA Trento, YMIR Trento, Futur3 Trento, Intesys Verona).

We have internal collaboration with many FBK units, mainly HTL, e-health, i3.

2.5. Specific Needs and Points of Attention

Need to hire one post-doc entirely devoted to research if significant research output have to be produced (we try to get the post-doc with the participation to the European project but we are not sure we get the funding of course).

Need to define as soon as possible the future of SoNet: if it will become an innovation unit, we will concentrate more on innovation and technology, if it will become a research unit, we will concentrate more on research.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
2 papers about Wikipedia social networks	R	E	Dec.	-	-
2 papers about Social capital and Enterprise2.0	R	E	Oct.	-	-
1 paper about Dynamic Carpooling	R	E	Nov.	-	-
A paper about how communities build and maintain their memories in the Web2.0 era (LiveMemories project)	R	E	Sept.	-	-
Apply to FP7 Bid for a small-medium sized project under SSH.2010.5.2-2	A	E	Febr.	-	-
Apply to FP7-ICT-2009-C FET	A	E	March	-	-
Find funding and start CarteBuonConsiglio project	A	E	Aug.	-	-
Formalize the agreement about one scholarship for the case study for Trentini nel Mondo.	A	E	Jan.	-	-
Opening of desktop.fbk.eu to every FBK colleague and further development	F	I	Jan.	-	-
Continuous Release of taolin (powering desktop.fbk.eu) as open source	I	E	continual	-	-

Research and technology leading for the creation of the social network platform that will become the first choice for PAT needs, in the context of the "Progetto Trentino As Lab - Rete sociale della comunita' Trentina"	I	I (maybe E)	May	-	-
Becoming the main speaker of PAT for every issue about social networking, web2.0 and ICT mediated collaboration (focused on open source software).	O	E	July	-	-
Possibile introduction of Enterprise2.0 tools in PAT for its employees.	O	E	Nov.	-	There is an initial agreement and an ongoing discussion with PAT and Informatica Trentina
Creation of an independent social network for the association "Trentini nel mondo" and research about it: as a LiveMemories case study, and as a case study for the previous project.	I	E	Nov.	-	High risk: because a lot of conditions have to be meet (burocratic, involvement of partners, ...)
Release as open source of a Dynamic Carpooling prototype and test with a sample of local population	I	E	May	--	-
Extension of the "cartella clinica del cittadino" with social features, in collaboration with eHealth unit.	I	E	Dec.	-	-
Collaboration with Michele Lanzingher about Muse2012 and museums networks (see also European Call).	I	E	Nov.	-	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	143.018,00
Travel	4.000,00
Equipment (HW/SW)	3.000,00
Other (e.g. subcontracting to external contractors)	33.250,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€183.268,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	0
Other external incomes (projects, grants, etc.)	31.600,00
Internal incomes (□gsubcontracted□h by other units)	0
Total Income	**€31.600,00**
Financial Need (Incomes – Expenditure)	**€151.668,00**
Required Structural funding from PAT (it should be equal to the previous item)	151.668,00

5. Human Resources

For 2010, we would like to consolidate the group by confirming the members of the last year, with similar position. The only difference will be Michela Ferron which will become PhD student but will keep working on the same topic in the LiveMemories project.

Davide Setti, developer

Marco Frassoni, developer

Maurizio Napolitano, technologist

Michela Ferron, PhD student at CIMEC unitn

Paolo Massa, researcher

edoc dna gnipytotorp tsaf htiw slliks taerg ,sdnuorgkcab ni ytisrevid doog :htgnertS dna tnempoleved with Web services apis (very required for the empirical research we want to do in social networking)

Gaps: profiles are not very well equipped from the research point of view.

For next year we need :

- a postdoc and possibly a phd to improve the research area (all the European proposals go in this direction)
- have team members attend conferences in order to improve their research attitude.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Papers not written because the focus is too much on innovation and development	30%	high	Need to hire a post-doc entirely devoted to research. A good post-doc. The European submissions go in this direction but it is possible they are not successful.
The topic (social networking) is too vast and we are not able to find a small niche for us	5%	medium	-
The topic is very crossdisciplinary (economics, sociology, ...) and we fail to address the right communities (i.e. Less visibility, research papers rejected)	15%	medium	-
Project CarteDelBuonConsiglio (and the opening new line about social capital in the real world) was not submitted because the priority for the FondCaritro call was given to another internal project. The research effort can be capitalized only if we find another way to fund the project and research line.	50%	Low	We will simply not address this research line
Important to decide and agree soon on the future of SoNet of that we can concentrate our efforts, for example, mainly research, or mainly local impact and applications or mainly fund raising, ...	30%	high	-

Legend:

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

7. Ethical Issues

	YES
Informed Consent	
Does the proposal involve children?	X
Does the proposal involve patients or persons not able to give consent?	X
Does the proposal involve adult healthy volunteers?	X
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	X

Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	X
Does the proposal involve tracking the location or observation of people? Does the proposal involve tracking of the users activities on web sites?	X[1]
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

[1] We have developed our own privacy policies users are required to accept before using the service.

FREEIT – FREE INFORMATION TECHNOLOGY

Unit Name	FreeIT – Free Information Technology	
Type	Exploratory	
Head	Bruno Caprile	
Staff	2009	2010
		2 Researchers

Document Status submitted 2009-11-26

1. Executive Summary

The FreeIT exploratory project aims at fostering Free Culture in the Information Technology domain, with special attention to the world of education and the public administrations. While broad in interests and intellectual scope, the project targets the local (Trentino) society with joint initiatives addressing the application of Free Culture's principles and devices as a key innovation factor of society. The project builds on the expertise and a number of encouraging response obtained in the recent past, focusing its activities on two main dimensions – education and the public administrations – that have emerged as particularly interesting and in "need of intervention". In this second year of life, the project shall also take a more technically minded approach, laying out possible directions for contribution not only in the promotion of Free Culture ideas, but also in tackling specific, challenging problems arising in the free, participatory construction of data.

In this perspective, OpenStreetMap, the open initiative aimed at building a free world map, can thus be seen as a sort of connective tissue or – better – a special reference for the FreeIT project. Issues and opportunities offered by various aspects of OpenStreetMap are therefore going to be dealt with, as a way to provide a concrete example in the dissemination of free culture in the public of young students, as a very interesting vehicle to inject innovation in the public administrations and, finally, as a source of technical problems in the construction and maintenance of geographic data.

In 2010, we plan to lead a joint project for the definition of a protocol (an "how to" guide, if you wish), enabling public (commune) administrations in Trentino to release under an open license a selection of the geographic data in their possession. The project will bring technical and legal competences coming from the research world to work together with the administrations and the owner of data and the domain knowledge. We expect the Consorzio Trentino dei Comuni to play, in this initiative, an especially important role as a coordinator and facilitator. On the educational side, we will continue and made stronger the connection already established

with the high schools in our province, providing relatively short, introductory courses on how to participate to the construction of free culture, mastering the basic technicalities and best practices of OpenStreetMap. As a side effect of this activity we expect to expand and consolidate the series of educational packages we have started developing in the last year, making them freely accessible through our portal to the public of students, teachers and (self)learners. The last, perhaps most ambitious goal for this year will be that of starting to have some technical impact on the development and evolution of OpenStreetMap. In 2009, our group organized and hosted the first Italian Conference on the State of the Map (OSMIT 2009). A clear indication has come out from the conference that the OpenStreetMap project would greatly benefit from the insight and technologies coming from the (insofar) more technically skilled community of open Geographic Information Systems (GIS), especially for what concerns the assessment and control of data quality. FBK has for many years hosted the distribution of GRASS, perhaps the most powerful and successful free-software GIS, and one of the leading figures in the open GIS technologies is now at Fondazione Edmund Mach. The trentino territory appears therefore especially well positioned to be one of places where convergence of traditional GIS technologies with new models for production of geographic data may be tried and experimented on a suitably large scale.

As all exploratory enterprises, and science in general for that matters, the project brings with it also a fair amount of risk. However, if the experience of the last few years is any indication for the future, the bigger challenge to the success of the project may not lie in its technical or intellectual difficulties, as much as in its capability of communicating the importance of the problems it tries to tackle, and the symmetric capability by public institutions to receive, with awareness and determination, what the project has to offer on the innovation game.

2. Vision and Scientific Program

As it is by now well established, the onset and development of the Information Society is characterized by the emergence of new models for the production, distribution, sharing and reuse of digital contents. Especially interesting among such models are those that in the recent literature go under the name of “Commons-based peer production”, aimed as they are to promote participation in the construction of knowledge and free, unimpeded access to it. While, for example, mathematical knowledge has for centuries enjoyed an (almost) undisputed status of “common”, very different has been the situation in other realms of science, in the humanities, and in the arts in general. Dating back to the seventies, the free software movement has represented the first, and perhaps most lucid attempt to create a common of knowledge in technology, based on the elegant, ingenious licensing device (the General Public License, GPL) that has made the operating system GNU-Linux possible, beside serving as a standard reference for the generations of free licenses to come.

In this perspective, Creative Commons (CC) is today the most systematic and possibly promising initiative aimed at extending the spirit and approach of Free Software to a wide variety of domains, ranging from digital images and videos, to texts, music, educational material, and virtually any kind of digital contents. Founded in 2001 by Lawrence Lessig as a nonprofit organization, Creative Commons is devoted to building and evolving a system of copyright licenses allowing authors to effectively communicate which rights they elect to reserve, and which rights they waive for the benefit of recipients or other creators.

Simple as it may appear, the Creative Commons mechanism has been extremely successful and pervasive worldwide: most of wikipedia's contents, counting millions of articles, are released under CC licenses, as in fact is OpenStreetMap (the free, editable map of the whole world), or tens of millions of digital images at Flickr.com. Based on free licensing of educational material are also the Open Learning programs at several universities, and the Open Access paradigm of scholarly publishing.

The (free) license is therefore at the heart of free culture, in fact representing the true mechanism allowing for the widest circulation and reuse of contents and the knowledge they bring with them. The relationship between free licenses, the contents they made available, the usage that users may make of such contents – either commercial or not – and many other aspect of this culture may not be immediately perceived by the public (and the policy makers) generally accustomed with more traditional, proprietary frameworks.

Quite a few people and research groups at our Foundation have been active on issues related to the dissemination of Free Culture in the last ten years. Let us recall here the early experiments we have made of all-free software labs at WebValley, since the first edition of the summer camp (2001), and the contributions given to the development of the GRASS Geographic Information System.

Starting in 2004, we have contributed to the E-Society Project promoted by the Provincia Autonoma di Trento, serving in two of the task-forces of the project. The first task-force focused on Interoperability and Open Source Software, and the second on Education and Digital Literacy. On the basis of the recommendations issued by the first task-force, the constitution of a local center of competence for Free and Open Source Software was funded by the Province government. The center, whose primary aim is dissemination, has since been hosted by our group. As a second result, a survey was carried out (in 2007) to assess the degree of awareness of the public administrations in Trentino towards free software and interoperability. The survey set the baseline from which to move on, and it's going to be replicated in 2010. As for education and digital literacy, the task force recommended a series of actions aimed at improving the technological infrastructure and an evoluted, more competent use of technology in the classroom. The task force also recommended that the student's skills in managing digital information contents be closely monitored, especially for what concerns (self)awareness in the use of technology and digital literacy in the social dimension. A project (SYLLABUS) was therefore carried out for the study and implementation of a methodology for the assessment of the digital competence of teen-age students. A wide range survey was therefore carried out targeting sixteen-year old students across Trentino, covering 25% of the whole population (56 classes, 1035 samples).

If the research world has been reasonably ready to exploit the opportunities offered by the adoption of free software, somewhat slower and more problematic has been the injection of free culture models and paradigms in the local society.

In the last two years we have carried out a wide variety of promotion and dissemination activities, organizing discussion events (e.g., “Si può fare”, in 2008) bringing together the research and the public administrations, organizing (e.g., OSMIT 2009) and participating to national and international conferences (UMAP 2009). We have also been consistently committed to education, developing and offering introductory tracks for students (starting from the 2nd grade!) and teachers, in which the emphasis is set on the nature and management of information as opposed to the mere “apelike” usage of the PC. Finally, we have also served as a connection between the international dimension of research and the local system of public administrations and small enterprises.

2.1. Vision and Goals

The project is exploratory. As such, underlying vision has been outlined in the previous section. The foreseeable outcomes and goals are short term (2010), and are described in the coming section.

2.2. Activities and Work Plan

In 2010 the project shall focus on one technical activity, and two complementary initiatives devoted to innovation and dissemination. In particular:

- development of models and technologies for data quality assessment in the OpenStreetMap project. Over the last year, the construction of the free map of the world has gained impressive momentum. If participation and overall coverage have grown exponentially, quality of data, and their representations, definitely deserve more attention, as they become critical factor for the success of the whole project. This is all the more so, at a time when OpenStreetMap is becoming a credible alternative to proprietary data for car navigation systems, or online traffic monitoring.
- Quality of (road) maps is a highly dimensional feature, requiring convergence of a variety of skills in the management of data, modelling and algorithmics, domain knowledge. The (open) Geographical Information System community already holds a strong competence on these topics, and is traditionally committed to demanding quality standards. Collaboration between OpenStreetMap and the GIS community aimed at improving data quality appears therefore a very appealing and timely path to follow.
- study and development of a protocol for the free licensing of public geographic data owned by public (city) administrations in Trentino. Public administrations, and especially communes, own produce and use huge amounts of geographical data. It would be extremely interesting if at least some of these data could be released for reuse under a free (e.g., Creative Commons) license. Straightforward and appealing as it may appear, the project is not immediate to realize. Not always the public administration are the owner of the data they use; mostly for cultural reasons, they are also generally unwilling to release

data if a commercial exploitation can be foreseen; data often contain private information, unsuited for public use, etc. A way to overcome these difficulties is that of making a joint effort to develop an “how-to” guide (a protocol) able to support the public administrations in the release of data, providing a set of best practices, technical and legal guidance.

At the time of writing, a draft of the project (which also sees the collaboration of the Law Department, University of Trento) is being considered by the Consorzio dei Comuni Trentini.

Dissemination of free culture in the local educational system. A series of short courses has been planned aimed at exposing high-school students (and teachers) to the principles and technicalities of building and publishing geographical data. Once again, the OpenStreetMap project is taken as a reference. As a side effect, project will also result in the construction of simple educational packages (digital), to be published and distributed through the portal of the FreeIT project.

2.3. Collaborations

- Fondazione Edmund Mach, Trento. We are planning to study and develop a joint project on the assessment and improvement of OpenStreetMap data quality, taking advantage of GIS tools. The GIS unit at Fondazione Mach is coordinated by Markus Neteler (former FBK researcher), a leading figure in the GRASS project and current member of the board of directors of the OS-Geo Foundation.
- Consorzio dei Comuni Trentini. Partner in the definition of a protocol for the release of geographic data.
- Facoltà di Scienze Giuridiche, Università di Trento. Partner in the definition of a protocol for the release of geographic data. Andrea Rossato, an expert in digital rights, is the key person for the legal aspects of the project.
- Liceo Rosmini, Rovereto; Elementary school, Levico Terme.

3. Goals

Submission to the international conference OSM 2010, of a technical paper on the quality of geographic data;

- drafting and experimentation of a protocol for the free-licensing of geographic data owned by the public administrations.
- Precondition for this goal is the definition of a project in coordination with the Consorzio Trentino dei Comuni.

4. Budget

Expenses (EUROS)	
Personnel	71.119,00
Travel	5.000,00
Equipment (HW/SW)	3.000,00
Other (e.g. subcontracting to external contractors)	2.500,00
Internal collaborations: “subcontracting” to other unit	0
Total Expenditure	**€81.619,00**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	0
Other external incomes (projects, grants, etc.)	0
Internal incomes (“subcontracted” by other units)	0
Total Income	**€0.00**
Financial Need (Incomes – Expenditure)	**€81.619,00**
Required Structural funding from PAT (it should be equal to the previous item)	**€81.619,00**

5. Human Resources

- junior researcher
- contract researcher

6. Ethical Issues

Some of the evaluation activities undertaken by the SOA Unit may involve end users, whose location and activities are tracked in order to provide them contextual, personalized services. The Unit is aware of the ethical issues this involves. It will employ highest standard in dealing with these issues and have measures in place to ensure conformance with legislation, and to adhere to the fair information principles (collection limitation, data quality, purpose specification, use limitation, security safeguards, openness, individual participation and accountability).

Other Research Areas

ECT* – EUROPEAN CENTRE FOR THEORETICAL STUDIES IN NUCLEAR PHYSICS AND RELATED AREAS

Name	ECT* - European Centre for Theoretical Studies in Nuclear Physics and Related Areas	
Type	Research	
Head	Achim Richter	
Staff	2009	2010
	9 Researchers	9 Researchers
	1 Technologist	1 Technologist
	8 Administrative Staff	7 Administrative Staff

Document Status submitted 2009-10-06

1. Executive Summary

The objectives of the European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) concern fundamental research. With nearly 700 visitors from all over the world, spending from a week to several months at the Centre, ECT* has achieved high visibility and a coordinating function in the European and international scientific community by holding

- Workshops and Collaboration Meetings on topical problems at the forefront of contemporary developments in nuclear physics and related areas like astrophysics. condensed matter physics and quantal physics of small systems,
- Doctoral Training Programs for talented young physicists,

and by fostering

- Research done by an in-house group of Postdoctoral Fellows and Senior Research Associates together with visitors and physicists elsewhere.

Furthermore, since 2009 ECT* administers scientifically a new research project named

- AURORA, which consists of interdisciplinary proposals that explore the architectural opportunities for high performance computing (HPC) systems optimized for a limited number of highly relevant scientific computing applications in physics, biology, genomics and radiation therapy. It is a joint PAT/INFN project involving several local and national institutions and is furthermore embedded into the European scene of HPC.

The prerequisite for reaching the ambitious goals of the research program and for guaranteeing and still improving the present high performance of ECT* requires.

- Fixed term competitive positions at the Research Associate and Postdoctoral level
- An administrative framework and a fully developed infrastructure for an optimal operation of the Centre, and
- A continuing financial support from the FBK, European research councils and EU programs.

All these points are treated in some detail in this document.

2. Vision and Scientific Program

2.1 Context and State of the Art

The European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) grew from a concerted action of the European Nuclear Physics community. It started operating in 1993 and has since developed into a very successful research center for nuclear physics in a broad sense, promoting contact between theorists and experimentalists, providing support for ongoing or planned experimental programs, and playing an increasingly important role in the training of young researchers. With an average of nearly 700 visitors per year, spending from a week to several months at the centre, ECT* has achieved high visibility and a coordinating function in the European and international scientific community.

ECT* is unique and the only center of its kind in Europe. It is similar in scope and mission to the Institute for Nuclear Theory in Seattle, USA. It is an institutional member of NuPECC, the Associated Nuclear Physics Expert Committee of the European Science Foundation. It was recognized within the fifth and sixth EU programs as a « Major Research Infrastructure », and has just been accepted within the transnational access activity of the FP7 program. It has also been operating as a "Marie Curie Training Site" for several years. It has its own Statutes, which have been endorsed by the European Science Foundation and by the FBK. The Scientific Policy of ECT* is decided by an internationally assembled Scientific Board.

2.2 Vision and Goals

As stipulated in the Statutes the scientific goals of the ECT* are:

- to arrange in-depth research on topical problems at the forefront of contemporary developments in theoretical nuclear physics
- to foster interdisciplinary contacts between nuclear physics and neighbouring fields such as particle physics, astrophysics, condensed matter physics and the quantal physics of small systems
- to encourage talented young physicists by arranging for them to participate in the activities of the ECT*, by organizing training projects and establishing networks of active young researchers
- to strengthen the interaction between theoretical and experimental physicists .

These benchmarks will be reached through the following scientific activities: international workshops and collaboration meetings, advanced doctoral training pro-

grams, and research carried out by postdoctoral fellows and research associates as well as long term visitors, interacting closely with the director of the centre. Research collaborations exist also with the Physics Department and the Center for Bose-Einstein Condensation (BEC) at the University of Trento. There are further agreements with other scientific institutions worldwide, in particular with the ICTP in Trieste which allows its visitors to spend time at ECT*.

The first phase of a new research project, named AURORA, has just been approved. It consists of interdisciplinary proposals that explore the architectural opportunities for high performance computing systems optimized for a limited number of highly relevant scientific computing applications, including: theoretical physics, biology, genomics, and radiation therapy. It involves several local and national institutions like: ECT*, Fondazione Edmondo Mach, IASMA, ATreP, Dipartimento di Fisica Università di Trento, Dipartimento di Fisica Università di Ferrara, Dipartimento di Fisica Università di Parma, INFN and its local sections (Trento, Ferrara, Parma, Milano), Dipartimento di Ingegneria dell'Informazione Università di Padova, Dipartimento di Fisica Universita` di Milano-Bicocca. A tremendous effort has now to be put into having a 20 Teraflops prototype high performance computer operating in 2010 in order to obtain support for a second phase in which the machine will be brought up into the Petaflops scale.

On top of its technical and scientific results, the project is expected to have a significant impact on the local scientific community by training also junior researchers at the forefront of scientific and technological problems and to provide the basis to create and exploit a leading High Performance Computer (HPC) infrastructure. This will eventually put the Trento Province on the map of high performance computer centers in Europe. The project is scientifically administered by ECT*.

The ECT* is highly appreciated by the large community of its users and its Scientific Board has recently conducted a reflection on the future of the Centre. This is summarized in a short document ("ECT* in 2020 – A Vision") that was circulated among the ECT* associates for comments and input and is now available on the ECT* web site. This document will serve as a guideline for strategic planning over and above the present period of 2009 – 2013.

In fact the gradual emergence of a European Research Area (ERA) and growing international coordination ECT* faces new opportunities and challenges. Significant European and global investments are made presently in accelerator and other experimental facilities. Their efficient utilization requires good coordination and exchanges of ideas – experiments stimulating theory and *vice versa*. Interdisciplinary contacts between the various subfields covered by ECT* and with related areas of physics and science is beneficial to all parties.

The ECT* workshop program has developed very successfully and already serves many of these needs. The unifying Europe and global research scene motivate further strengthening and innovation:

- More proactive measures, whereby ECT* as an ideal meeting ground identifies the need for workshops on specific topics, and makes them happen.
- ECT* as a place of choice for collaboration meetings of experimental and theoretical research groups of various sizes.

- An active visitor program, including physicists who work in areas related to ongoing training activities at ECT*.
- Cross-disciplinary activities, such as the physics of cold atoms and of mesoscopic physics.
- Activities that bring science closer to the citizens.

The benefits for the ERA are therefore:

- ECT* furthers the mobility of frontline researchers within and to Europe.
- ECT* generates future leaders of research. Its fixed-term faculty forms a talent pool for universities and laboratories.

They require for the ECT* a continuity for the:

- Fixed term competitive positions at research associate and postdoctoral level
- An administrative framework for an optimal operation of the Centre
- A fully developed infrastructure
- A continuing financial support from the FBK, European research councils and EU programs.

Finally it should be stressed that Europe faces a shortage of skilled scientists. To improve the situation in the years to come ECT* will thus increasingly support the training of PhD students and postdocs through lecture courses and visits.

- Extended training periods in topical areas. Students attend lectures, are guided by ECT* scientists and participate in workshops during their stay. They are provided with office space and encouraged to pursue also their own research work.
- Collaboration with Graduate Schools operating at a European level. ECT* hosts lecture weeks and supports other training events.
- Promotion of joint research projects between its researchers and physicists elsewhere. In the context of such projects ECT* senior researchers may serve as co-supervisors of PhD students at European universities.

2.3. Activities and Work Plan

Objectives

The scientific activities of ECT* concern fundamental research. As recalled above, these accompany the developments of nuclear physics in a broad sense, and occasionally concern cross-disciplinary topics. The choices of the various workshops and training programs are made by the Scientific Board in accord with the scientific director of the Centre. Both also decide about the main orientations of the research done at ECT* by selecting the research personnel and taking initiative in opening positions in specific areas. In what follows the projects of 2010 are summarized.

Projects

1. International workshops and collaboration meetings

   In 2010 the following eight projects are already approved:

   Diffractive and Electromagnetic Processes at the LHC, (4–8 January, Organizers: R. Schicker, R. Orava, A. Szczurek, J. Nystrand, K. Piotrzkowski, L. Jenkovszky); *Many-Body Open Quantum Systems: From Atomic Nuclei to*

Quantum Dots, (22-26 February, Organizers: J. Vaagen, W. Schleich); *Reactions and Nucleon Properties in Rare Isotopes,* (6-10 April, Organizers: W. Dickhoff, T. Aumann, C. Barbieri, F. Nunes, J. Piekarewicz); *Decoherence in Quantum Dynamical Systems*, (26-30 April, Organizers: A. Diaz-Torres, I. Burghardt, C. Martens, J. Tostevin); *Electromagnetic Probes of Strongly Interacting Matter: Status and Future of Low-Mass Lepton-Pair Spectroscopy*, (17-21 May, Organizers: J. Stroth, J. Kapusta, R. Rapp); *Confining Flux Tubes and Strings*, (5-10 July, Organizers: M. Teper, O. Aharony, B. Bringoltz); *QCD at the LHC*, (J. Bluemlein, H. Fritzsch, M. Mangano); *Hard Photon and Meson Production*, (10-15 October, Organizers: N. D'Hose, R. Kaiser, P. Kroll); *Monte Carlo Models for High-Energy Hadron and Cosmic-Ray Physics versus First LHC Data* (dates still to be fixed, Organizers: D. Enterria, R. Engel, T. Sjostrand).

The approval of the following nine projects in 2010 is still pending:

The Limits of Existence of Light Nuclei, (Organizers: C. Bertulani, T. Aumann, A. Bonaccorso, U. Van Kolck); *Recent Theoretical Advances in Weak Interaction Rates for Nuclear Astrophysics*, (Organizers: C. Johnson, J. Nabi); *Strangeness in Nuclei* (Organizers: C. Curceanu, P. Kienle, T. Yamazaki, T. Bressani, J. Zmeskal); *Workshop on Transverse Momentum Distributions* (Organizers: A. Bacchetta, F. Yuan, C. Aidala, M. Contalbrigo); *Low Energy Precision Tests of the Standard Model in the LHC Era* (Organizers: W. Van Oers, R. Carlini, K. Kumar, F. Maas); *Searches for CP-and T-Violation in Atoms and Nuclei* (Organizers: L. Willmann, P. Butler, J. Martin); *New Frontiers in Graphene Physics* (Organizers: I. Carusotto, S. Hands, A. Richter, S. Stringari, B. Trauzettel); *QCD from the Bound States' Perspective* (Organizers: C. Roberts, B.-El Bennich, Ph. Hägler, M. R. Pennington); *Chiral Symmetry and Confinement in Cold, Dense Quark Matter* (Organizers: L. Glozman, K. Fukushima, L. McLerran, R. Pisarski).

Since the deadline of applications is December 15, 2009 the total number of projects that will be run in 2010 is thus expected to be about 20. This number is to be compared to the total number in 2009 which was 17, corresponding to 604 visitors of the ECT*, each one spending about 6 days at Trento. The national distribution of participants to these activities is stable over the years: about 40% come from France, Germany and Italy, 40% from the other European countries, 15% from the USA, and 5% from the rest of the world.

2. Advanced doctoral training program

The advanced training of young researchers represents an important part of ECT*'s activities. The by now traditional spring doctoral training program (DTP) has developed into a very successful format, with each year a group of about 15 students spending three months at ECT*. In 2009 (March 29 - June 19), the doctoral training program was focused on «Strongly correlated quantum systems». It has been a multidisciplinary program with a strong overlap with the physics of cold atoms and it involved the BEC center at University of Trento in its organization. In 2010 the program will be centered about «Nuclear structure and nuclear astrophysics with radioactive ion beams». It is co-organized by Hans Feldmeier (GSI Darmstadt), Jeff Tostevin (University of

Surrey) and Hendrik Schatz (NSCL/MSU East Lansing). The program is designed to train the young generation of theoretical and experimental physicists about the physics investigated at the present and later on at the upcoming new radioactive beam facilities in Europe, Japan and the United States of America. The lecturers of the DTP are: M. Alliota (University of Edinburgh), T. Aumann (GSI Darmstadt), P. F. Bortignon (University of Milan), D. Baye (ULB Brussels), R. Diehl (MPE Garching), H. Feldmeier (GSI Darmstadt), P. van Isacker (GANIL Caen), R. Johnson (University of Surrey), G. Martinez Pinedo (GSI Darmstadt), B. Meyer (Clemson University), T. Neff (GSI Darmstadt), F. Nunes (NSCL/MSU East Lansing), T. Otsuka (University of Tokyo), E. Rehm (ANL, Argonne), Hendrik Schatz (NSCL/MSU East Lansing), Jeff Tostevin (University of Surrey), S. Typel (TU Munich), A. Vitturi (INFN Padua), R. Zegers (NSCL/MSU East Lansing).

The main topics are covering modern developments in the fields of nuclear structure, nuclear reactions and nuclear astrophysics. As in previous years George Ripka (Saclay) will act in an important function as student coordinator and advisor within the 2010 DTP from April 12 to June 13.

2.4. Visiting Scientists, Research Personnel and Collaborations

The presence of visiting scientists is extremely important for the research carried out at the Centre. Usually typical times visitors spend ant interact with the research personnel range from a week to a few months. In 2009 46 scientists visited the ECT*: Austria (1), Australia (1), Croatia (1) Denmark (2), Finland (4), France (3), Germany (6), India (1), Italy (8), Japan (3), Lithuania (1), Netherlands (2), Poland (3), Scotland (1), Switzerland (3), USA (6).

For the year 2010 (and each year to come afterwards) the number of visiting scientists is expected to be about the same as in 2009 and the years before.

The research personnel at ECT* in 2010 consist of the following members:

- Daniele Binosi (Senior Postdoc)
- Cesar Fernandez Ramirez (Junior Postdoc)
- Lorenzo Fortunato (Junior Postdoc)
- Bingwei Long (Junior Postdoc)
- Luigi Scorzato (Senior Postdoc)
- Dionysis Triantafyllopoulos (Senior Research Associate)
- NN (Junior Postdoc, to be hired for Hadron Physics 2)
- NN(Junior Postdoc, to be hired for AURORA)
- NN (Junior Postdoc, to be hired as successor of Bingwei Long)
- NN (Junior Postdoc, to be hired)

This research personnel will allow the scientific director of ECT* to continue and develop further a core of research at ECT* covering a wide spectrum of activities in nuclear physics, and also facilitate cross fertilization between its various subfield.

Scientific collaborations between the in-house researchers will continue and start new, respectively, with each new researcher joining ECT*. Furthermore, strong collaborations with physicists outside the Centre are particularly important for its

scientific standing, and these the last ECT* Annual Report from 2008 (www.ect.it), Chapter 4, p. 64-96, may serve as an example.

Strong scientific relations exist not only with Bose-Einstein-Condensation center but also with the internationally well known theoretical group in nuclear and atomic many-body physics at the University department of Trento. Furthermore a PhD student is supported by ECT*; a joint colloquium between ECT*, BEC and the physics department is organized regularly and - as noted above – a joint workshop will be organized in 2010. Also the presence at ECT* of researchers belonging to the "Quantum Information Processing Group" should be recorded. Particularly noteworthy is the important responsibility taken by Daniele Binosi (in close cooperation with Tommaso Calarco, now professor at University of Ulm, Germany) in the coordination of a large European consortium on quantum computing (QUITE).

Finally, a prerequisite for the success in 2010 of the high performance computing project AURORA described in Sect. 2.2 above is a strong and efficient collaboration of all partners involved.

2.5. Specific Needs and Points of Attention

The number of researchers at the ECT* has decreased continuously from 14 in 2006 to 6 in the first part of 2009. In the same time, however, the number of projects and the size of the scientific activities of the Centre have become larger. In order to execute the ambitious program in 2010 and the years thereafter the four positions labeled NN in Sect. 2.4 above must be filled with Junior Postdocs. The first position is partially paid for within the EU FP7 program Hadron Physics 2, the second one is financed through funds of the AURORA project and the third one will be used to replace Bingwei Long when he will leave the ECT* in the fall of 2010. The fourth position is absolutely essential for hiring a researcher in nuclear many-body physics. This position was originally thought to be for a second Senior Research Associate but the cut in the funding forced us to ask for a Junior Postdoc instead.

3. Goals

Here the various goals of ECT* for 2010 described in some detail in Sect. 2 are again summarized as follows:

- Research at the forefront of theoretical nuclear physics
- Foster interdisciplinary contacts between nuclear physics and neighboring research fields
- Strengthen the interaction between theoretical and experimental physicists
- Doctoral training programs for talented young researchers
- Workshops and collaboration meetings on topics at the forefront of physics;

Create a high performance computer infrastructure and operate the first 20 Teraflops module successfully. Precondition: more effective collaboration between FBK/ECT*, UNITN, INFN and other institutions.

4. Budget

The ambitious scientific program of the ECT* outlined in Sect. 2 above requires proper funding. The typical budget of ECT* (in terms of direct costs) has been in the last two years between 1.2 and 1.3 million Euro per year. Unfortunately, the budget foreseen (1.1 million Euro) by the FBK management for 2010 is somewhat lower. This is truly regrettable given the impeccable record and recognition ECT* has internationally. Since it has been founded 16 years ago the first truly international institute in Trentino has grown scientifically to a very high level, and with its international network of institutions and researchers and its co-funding system with substantial outside funds it is still a model for other institutions within the FBK. It is thus hoped that those facts will be taken into account for the final budget of 2010. New (and clearly separate from the standard ECT* budget) is the budget for the first phase of the AURORA project in 2010 (1.0 million Euro) which ECT* in the frame of having to overlook the funds allocated by the PAT for the FBK has to handle.

Expenses (EUROS)	
Personnel	€ 936.766
PhD at the University of Trento	€ 20.000
Travel	€ 55.000
Equipment (HW/SW)	€ 452.500
Other (e.g. subcontracting to external contractors)	€.356.226
Organization workshops, seminars, DTP, etc.	€ 341.000
Library	€ 25.000
Total Expenditure	**€ 2.186.492**
Incomes (EUROS)	
EU Projects (total amount financed by EU and European Funding Agencies)	€ 598.407
Other external incomes (projects, grants, etc.)	€ 40.000
Incomes from Local Public funding	€ 1.049.804
Total Income	**€ 1.688.242**
Financial Need (Incomes – Expenditure)	**€ 498.249**
Required Structural funding from PAT (it should be equal to the previous item)	**€ 498. 249**

* It contains the administrative staff contracts, the researchers' contracts, the cost of the canteen, the occasional collaborations.

5. Human Resources

The present status of administrative personnel has to be maintained in 2010 and the years afterwards. The contract of the two administrative assistants Serena degli Avancini and Susan Driessen should, however, definitely be changed into one of a tenure track. Serena is taking care of the whole ECT* budget, of the budget for the EU FP7 program Hadron Physics 2, of the upcoming EU project ENSAR in which

ECT* is included, and of the very involved organization of the yearly international doctoral training program. Susan is the assistant to the director of ECT* and has a tremendous workload to handle within her part-time position. In addition to the responsibilities she was carrying when her former colleague was still at the ECT*, she had to take over everything from Luana when she left. She is absolutely indispensable for the director. Furthermore, when the former vice-director Professor Traini resigned from his position at the end of October 2009 both Serena and Susan have had to take over totally the administrative responsibilities he had within the Centre. Finally, it is also necessary to prolong the Co.co.pro contract of Gian Maria Ziglio who manages the ECT* database and website and who is responsible for the ECT*'s Annual Report. These three main actions are absolutely necessary for a most effective operation of the Centre and should receive highest priority.

CREATE-NET – CENTER FOR RESEARCH AND TELECOMMUNICATION EXPERIMENTATION FOR NETWORKED COMMUNITIES

Name	CREATE-NET – Center for REsearch And Telecommunication Experimentation for NETworked communities	
Type	Research	
Head	Imrich Chlamtac	
Staff	2009	2010
	57 Researchers	61 Researchers
	20 Support Personnel	21 Support Personnel
		12 Marketing Personnel

Document Status submitted 2009-11-25

1. Executive Summary

CREATE-NET was founded by some of the most prestigious universities and research centers in Europe in April 2003. We have now established a network of over 300 research partners throughout Europe, including top research institutions and companies. We also have funded collaborations with leading institutions in the US (MIT and Georgia Tech), China (Tsinghua and BUPT), South Africa (SAP) and Israel (Technion).

CREATE-NET has been very successful in attracting European and local funding. In the last three calls of Europe's FP6 program and first three calls of FP7, we were awarded 19 projects, including the coordination of an Integrated Project called BIONETS, applying biologically-inspired approaches to networks and services, especially in the emerging pervasive world where billions or trillions of devices will need to be connected.

CREATE-NET established a state-of-the art test-bed for the testing and experimentation of new technologies. The test-bed includes an optical and wireless network, plus the Living Space home-of-the future, ambient intelligence lab.

By creating synergies between leading academic institutions, companies and research centers in Europe and around the world, CREATE-NET's objective is to sponsor the highest quality research and innovation, and help convert talent and human capital into patents and start-ups for promoting European high-tech competitiveness, with the aim of building a global platform of scientific collaboration and experimentation in communications-driven technologies and applications.

Through research and development of these technologies CREATE-NET seeks to impact communications-enabled services which improve the quality of life of the

global society. Moreover, being an international association, CREATE-NET acts as a promoter of “globalization of knowledge and research” facilitating the cooperation and interaction of research competences around the world to became the focal point in Europe for “engineering of research/innovation”.

At the same time, our objective is to provide significant benefit to the Autonomous Province of Trento by bringing technology and business talent here, enhancing the prestige of the province internationally and making an important contribution to the local economy.

Over the coming years, research in CREATE-NET will focus on topics related to the networks and next-generation services for the "Internet of the Future" and to pervasive networks in the field of "Embedded Intelligence & Systems".

2. Vision and Scientific Program

During the course of 2009 CREATE-NET has perfomed a review process of its research activities with the objective of analysing the current strenghts and weaknesses and identify a strategy also in view of the current market trends and opportunities.

The result has been a refocussing of the research activities and the identification of market sectors, seen as application ares, to which address results of our core research, which remains focussed in the ICT and specifically the telecom sector. Addressing specific application areas will also help focussing CREATE-NET innovation drive with specific targets, and will also guide the definition of an extended exploitation plan towards the industry, which will include, in addition to the ICT sector, also the most prominent sectors to which ICT technologies will be applied.

2.1. Context and Positioning

A highly complex and decentralized communication system, a system for processing and delivering user-centered information, where users and technology evolve together, is the shared vision of the future in CREATE-NET.

Drawing on a multidisciplinary approach, CREATE-NET builds a bridge between researchers, users’ communities and industry with the aim of identifying and proposing solutions to the new challenges in the technology area of digital communication networks and in society.

It is for this reason that, in CREATE-NET’s approach to research, it is crucial to take into account the impact of innovations on society from a technological perspective, but above all in terms of services and applications based on the next communication networks.

In this scenario, CREATE-NET will focus on a set of network technologies which are expected to deliver major contributions to evolution and change. We will also consider some application fields that have and will have a critical impact on the development of society and which are seen as strategic also in the EU research

programs, being an integral part of the Lisbon objectives. These include: sustainable development, energy and environment, health and welfare and services to citizens.

As for the areas of technology research, the figure below shows the positioning of CREATE-NET in the ICT research arena.

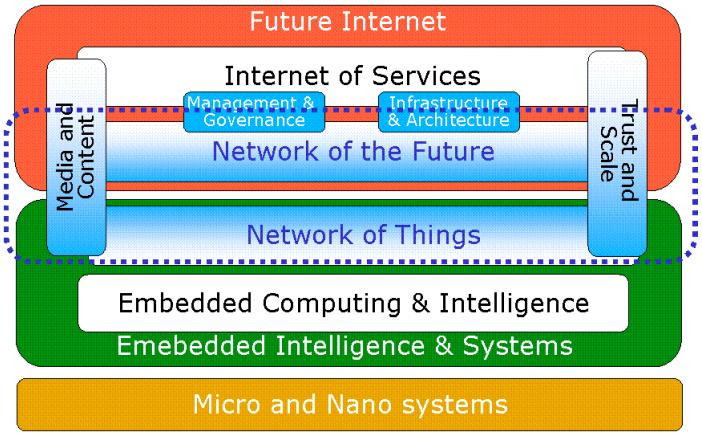


Figure 1. Positioning of CREATE-NET in terms of research topics

2.2. Vision and Goals

CREATE-NET mission statement consists of four key points:

- *Achieve Research excellence in ICT;*
- *Promote technology transfer through Engineering of technologies & solutions;*
- *Promote Innovation to improve European high-tech competitiveness;*
- *Focus on key application areas and services with Impact on quality of life for the global Society.*

The development of CREATE-NET mission statement provides a clear path of the lifecycle the centre develops for its projects, that starting from research follow a path through engineering of technologies and solutions to innovation with the objective of achieving market impact.

The organisational structure of CREATE-NET has been designed to implement the mission, with a *Research and Engineering Unit* and an *Innovation Unit*.

The Research and Engineering Unit is structured along three Research areas that with a synergic approach cover different scientific and technological fields in the ICT world, plus an Engineering area responsible for technology transfer and innovation projects.

The Research and Engineering Unit is coordinated by the Principal Technologist responsible among others of monitoring research developments at EU and international level and ICT service markets, in order to define in a dynamic way the strategic reserch plan of the Centre. The strauctures is therefore dynamic and ready to respond, with appropriate changes, to stimuli from the external environment. The

current structure is therefore aligned to research themes that are considered relevant in terms of innovation opportunities and capabilities.

To complement the overall vision three application areas, covering green tech (namely energy and transport), wellbeing and social mobile media, cut across the research areas giving an overall matrix structure as illustrated in the following picture.

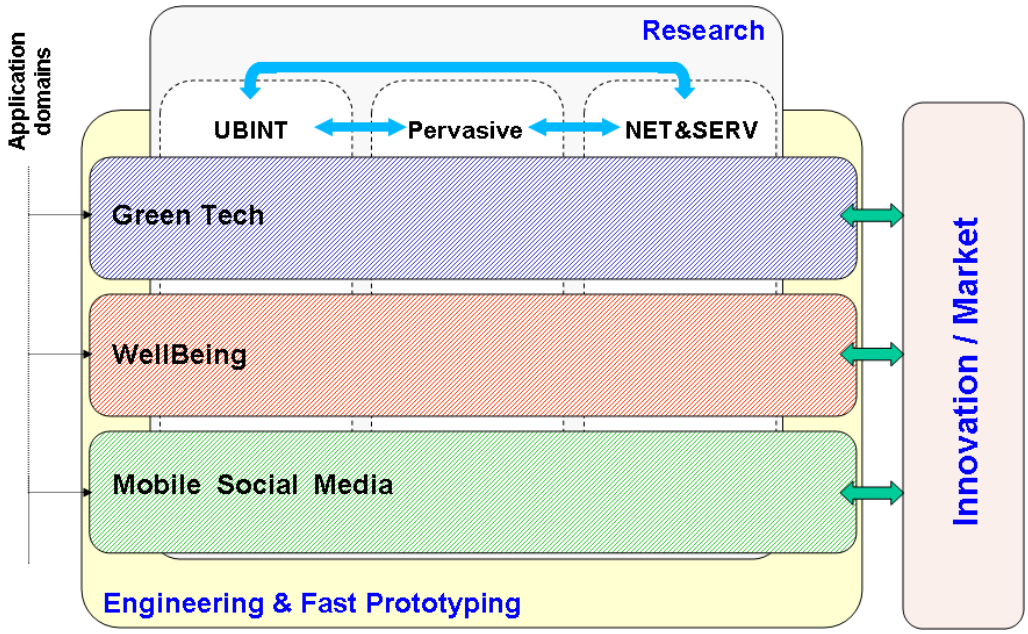


Figure 2. CREATE-NET operation structure

The picture shows how CREATE-NET approach to the market is focussed on three application areas, which also represent key market sectors for ICT.

Such focussing is the result of a decision process based on an analysis of the telecom market, in Italy in particular, where we see a general negative trend in investing in telecommunication research, while we see, at the same time, significant innovation in application sectors with strong request of applied technology. As an example, the energy sector (green tech) is a sector where there are strong actors at national level, with a strong push towards innovation both in the native technologies of the sector (renewable/alternative sources) and in the supportive technologies, among which is ICT.

2.2.1. Research and Application Areas: overview

This clause gives a general overview of the research and application areas within the scope of CREATE-NET activities. It has to be noted that currently only research areas are staffed. With regard to the application areas the model adopted by CREATE-NET foresees at this stage a role in terms of unifying element for the research efforts, with the objectives of developing integrated innovative solutions for the relevant sector. At the same time the application areas provide requirements

and as such constitute an important input for the research activities. Therefore, for each application area, it is foreseen to have a reference person with the responsibility of developing a market vision, identify relevant actors and industrial partners with the objective of developing joint projects in which the vision can be implemented and realised.

- *NET&SERV - Future Network Infrastructures & Service Platforms* **–** Main focus of this Research Area is on dynamic control and management of infrastructure resources at different levels. The first level is the Physical, where control and management algorithms and techniques for the core optical transport network are studied together with cognitive management of resources in the wireless/cellular access network. At higher layers focus is on service platforms and in particular on novel data management, monitoring and self-learning techniques for the management of appropriate and adequate quality levels in service provisioning. From a market viewpoint NET&SERV targets technologies related to the evolution of the business model of traditional operators and service providers and their role in the Internet of the Future.
- *PERVASIVE – Pervasive and Secure Computing Environment* **–** Main focus of this Research Area is on technologies algorithms and methodologies for designing and managing non-conventional wireless networks, emerging at the fringes of the core Internet (Wireless mesh networks, Wireless sensor networks, Delay-tolerant mobile networks and, in more general terms, Pervasive computing environments). In addition the area addresses also the applications supported by such light infrastructures, keeping into account also aspects such as user profiling, context of use and security. From a market viewpoint, PERVASIVE addresses emerging business models that foresee the development of new roles and actors, including users, as central elements in the value networks.
- *UBINT - Ubiquitous Interactions* **–** Objective of this Research Area is close the loop between the User and the distributed mobile and fixed infrastructure focusing their studies on methodologies and technologies for the user interaction. The activities include also aspects related to understanding user context (location, activities, etc.) in order to adapt in an effective application to the way of interacting. A key competence is related to the design and evaluation of interative applications using user-centred methodologies. Users are understood as single users, but also as communities where social dynamics need to be taken into consideration.
- *ENGINEERING - Engineering & Fast Prototyping* **–** The role of ENGINEERING in CREATE-NET is indeed that of engineering innovative technologies with the objective of prototyping innovative solutions for users, both as individuals and institutions, and for communities. According to this role, the mission of ENGINEERING articulates along three main lines: (i) development of experimental facilities for studies of the Future Internet - experimental foundation for the Future Internet; (ii) provision of consulting services on innovation technologies at local level - Trusted Advisory; (iii) creation of instruments for the

commercial exploitation of research results by means the development of prototypes and demonstrators.

- *Green Tech* **–** This application area comes from the confirmed international trend to link climate change to green-house gas emissions and a more efficient energy usage. Within this context CREATE-NET wants to exploit the points of strength of the research groups to promote the use of ICT technologies for reducing the environmental impact coming from our behaviour in daily activities including the impact strictly related to the usage of ICT technologies. The relevance if this application area within CREATE-NET strategy is supported by our involvement in projects focussed on delivery of concrete results in the area of Green Technologies. The leading projects in this area are MOTUS (a cooperative project led by Telecom Italia under the Industria 2015 Programme) on sustainable environmental-friendly mobility and TRITON on energy savings in road tunnels. Other projects are in the EU arena: Complex-Energy (a coordinated action to bridge the ICT, Energy and Complex Systems research communities for a multidisciplinary approach to efficient energy management), C2POWER (access technologies to minimise energy consumption in portable devices) and FIT4GREEN (reduction of energy consumption in data centres and federated data centres through an "energy-aware" process allocation and management). HP and ENI are part of the FIT4GREEN consortium.

- *WellBeing* **–** The rapid evolution of ICT technologies of the recent year brings a huge opportunity to apply such technologies to achieve a positive impact on people's wellbeing in the different dimensions of their everyday life. In CREATE-NET such opportunity has been exploited to apply the different competences of our research areas to the development of services and solutions able to improve quality of life and people's wellbeing through ICT. Put focus in this application area is on the development and application of ubiquitous computing technologies for managing and monitoring personal health, providing assistance in daily activities and, more in general, supporting through continuous monitoring and care the personal wellness of people. Projects in this area are: ACUBE, MONARCA and Interstress. All three projects focus on non-invasive monitoring of patients affected by different pathologies and in different contexts: ACUBE deals with Alzheimer patients in day-care centres; MONARCA is about a multi-parametric monitoring of patients affected by bipolar disorders; Interstress studies the use of virtual reality techniques for developing appropriate therapies for people affected by stress disorders.

- *Mobile Social Media* **–** Social Media emerges as the new way for mass media communication. Leveraging people's needs for social interaction, the culture of participation is developed by means of modern Web 2.0 technologies, making de-facto Web 2.0 a synonym for participation. Mobile Social Media moves an additional step forward, combining the powerful concept of Social Media with the immediacy enabled by mobile technologies. Mobile Social Media allows the development of novel application scenarios where individuals have

the possibility of capturing moments of their lives, instantly share them with other and making available information and contents to other member of the group. In this application area CREATE-NET has developed and is developing competences of excellence. Among the current projects, uHOPPER, currently under experimentation jointly with a telecom operator and on the basis of which develop a spin-off activity. Of partial relevance also SAMBA, an EU project recently closed coordinated by CREATE-NET, where media technologies are used to provide services to communities.

2.2.2. European Alliance for Innovation: overview

The EAI initiative is a pan-European movement which will work as a unique Innovation Society composed of professionals at all levels of the Innovation Cycle, involving major European players including ETSI, ICST, EIT, COST, CEPIS, Informatics Europe, EUREKA, EATCS, EICTA, Engineering, NESSI, Living Labs, Fraunhofer Fokus, EVCA, EIFN, PBN, CREATECH, CSEM, Gesellschaft für Informatik, ITIF, Joint Institute for Innovation Policy, PSCE and REEEP.

The unique approach of EAI consists of involving active participation of member organisations and empowering their communities through a grassroots paradigm, thus promoting effective technology transfer, entrepreneurial mindset in education, and increased competitiveness of European companies.

The EAI started as a follow-up of a European Commission sponsored meeting which took place in Lyon (ICT2008), in which the idea of forming a European Alliance for Innovation was put forward, consisting of a partnership of ICT key actors. The principal objective is to address the issue of the fragmentation of R&D efforts, and to represent the European ICT sector as one.

CREATE-NET has been instrumental in creating the European Alliance for Innovation. The main steps that have already taken place in creating this society have been:

- March 2008. During a meeting with Fabio Colasanti, Director-General, Information Society and Media (INFSO) Directorate of the European Commission, in Trento, CREATE-NET presented the idea of creating a grassroots research society to improve innovation in Europe. It was proposed that this would be based on The Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering (ICST), a non-profit research society that CREATE-NET has been instrumental in founding and supporting.
- November 2008. As a follow up, a European Commission sponsored consultation workshop was held in Lyon to discuss the formation of a European research society. A key result of this meeting was the creation of the European Alliance for Innovation consisting of key European players.
- February 2009. The first meeting of the European Alliance for Innovation was held resulting in the interest of the above 23 key European players with a concrete set of action items and initiatives based on an agreed framework document.
- November 2009. The 4th European Alliance for innovation Preparatory Meeting took place in Budapest to to present the EAI initiative to key players and

experts of the ICT sector, involved in all aspects of the Innovation Cycle. It was agreed to share recommendations with key players in Europe including the European Commission, Organizations and Institutions expressing interest and other key actors in Europe.

A renewed strategic framework is being established for the EAI by CREATE-NET and ICST which targets a concrete and effective operational approach towards consolidation in Innovation in Europe by establishing the EAI.

The establishment of the Alliance will be the tool to enable European Innovation to move forward in excellence in enterprise, education and scientific community building by building the cooperation from a bottom-up approach where Innovation is seen in the Seed-phase.

2.3. Activities and Work Plan

An overview of 2010 Work Plan is provided for each of the areas within Research and Engineering.

- *Future Network Infrastructures & Service Platforms (NER&SERV)* - The workplan for 2010 will see the NET&SERV area involved in a number of different collaborative projects listed hereafter in summary and presented then with a little bit more detail. NET&SERV researchers will contribute to 5 EU collaborative projects (FP6 OPAALS (NoE ending in May), FP7 DICONET (ending June 2010), UWB, C2POWER and FIT4GREEN), one national project (MOTUS) and one local project (TasLab). The following section can be consulted to find more details about what role NET&SERV will play in these projects in 2010.

  Apart from project related tasks, given the recent formation of the merged group, some of the 2010 activities will seek further funding opportunities to strengthen focus and achieve further momentum necessary to sustain a common future vision for the above mentioned project activities.

  In this respect NET&SERV area will explore the issues preventing dynamic control, management and integration of communication resources at various levels (DYMARCOM and PSATS Conferences), capitalise on extended knowledge in data management, monitoring and live data-stream processing techniques in support of solving the above-mentioned issues (SANGREAL Call 5 proposal submission), sow the seeds for optical-wireless access technologies integration (as part of the evolution of research in the Optical Advanced Systems group). Taking a more industry oriented look at the planned NET&SERV non-project activities reveals the intention of finding applications in both the IT industry (data center management, Enterprise 2.0 – see REFINE Call 5 submission) and the telecommunication industry where they contribute to the evolution of traditional operator business models.
- *Pervasive and Secure Computing Environment (PERVASIVE)* - The workplan for 2010 will see the Pervasive area involved in a number of different collaborative projects. The Pervasive team will contribute to 5 EU collaborative projects (FP6 BIONETS (IP, coordinated by CREATE-NET ending in February), FP7 CONSEQUENCE (STREP, ending December 2010), FP7 SMART-

Net (STREP), FP7 EPIWORK (IP) and FP7 ComplexEnergy (SSA)), one industrial project (Obelix) and two local projects (TRITON and ACube). The following section can be consulted to find more details about what role Pervasive will play in these projects in 2010.

Apart from project related tasks, given the recent merging with the former Security Area, some of the 2010 activities will seek further funding opportunities to strengthen focus and achieve further momentum necessary to sustain a common future vision for the above mentioned project activities.

In this respect Pervasive area will explore (i) opportunities arising from the widespread diffusion of smart-phone devices embedding short-range communication capabilities and a number of sensors (audio, video, GPS, accelerometers) (ii) issues related to the development and deployment of self-management strategies in light infrastructure networks (WMNs, LTE) (iii) research avenues related to the design and development of novel security solutions for pervasive computing environments. In this respect, one important objective is the strengthening of existing links with major players in the ICT arena, as well as the establishment of new strategic partnerships with key stakeholders in the field.

- *Ubiquitous Interactions (UBINT)* - Ubiquitous Interaction Group (UBiNT) will be active overall in nine projects during 2010. Three of them are new EU projects (MONARCA, INTERSTRESS and NEXT MEDIA) from which one is coordinated by CREATE-NET (MONARCA); one new PAT-Legge 6 project (iTheater), two ongoing local projects (ACube and Triton) and one collaboration supported by MAE for mobility of researchers with Georgia Tech (Perceptive Ambient).

  In addition to project related activities, UBiNT will pursue new opportunities of conducting research activities through funding mechanisms such as FP7 Call 6 (e.g. on International Collaboration topics) and other National and Local instruments. The research activity overall will focus on three main aspects:

  - Development of innovative interactive means (e.g. based on tangible interfaces, persuasive interfaces, physical computing, beyond audio/visual interaction);
  - Analysis and understanding of users contextual situation for providing timely and relevant information (e.g. through human activity recognition, context sensitive systems);
  - Investigation on innovative methodologies for design and evaluation of interactive ubiquitous environments. As part of this focus of activities, UBiNT will collaborate with other areas of CREATE-NET for improving their prototypes design through user-centered methodologies rendering them more engaging.

- *Engineering and Fast Prototyping (ENGINEERING)*- During 2010 Engineering will be involved in several projects, 6 in total, some of which are under Engineering direct coordination, while others are under the overall coordination of other research areas. Indeed, being strongly focused on experimental research activity, Engineering is strongly tied with research performed by all Research

Areas in CREATE-NET, and contributes to many of the projects they are involved with. It is expected that such strong cooperation with other research areas will increase in time.

The Engineering group is also involved in cooperation activities with several industry partners such as one of the leading networking equipment manufacturer (DAIGO project) and Siemens ITS (TRITON project). During 2010 and beyond, more efforts will be devoted to consolidating relationships with industry and building new collaborations, including local SMEs in the Trento province. A few examples of industry targets nationally/internationally: Alcatel Lucent Italia, Huawei; and locally: Algorab, Win-Net.

The specific projects in which Engineering will work in 2010 are listed under.

2.4. *Expected collaboratiaons*

In addition to cooperative and industry projects, Engineering is working at the set up of a test-bed infrastructure (so called Testbed 2.0), leveraging on the investments already made and currently under-utilized, and on the opportunity of setting up a Joint-Lab with Cisco. Such a test-bed will support the Engineering experimental activities and will represent an asset also for the participation in future calls, in particular under FIRE initiative.

Engineering is strongly focusing on investigating network virtualization techniques on such an infrastructure to both invest on a key research field for Future Internet but also to give controlled access to the network infrastructure not only to all Research Areas in CN (i.e. by assigning a slice of the network infrastructure to each research project where experimenting new ideas through a geographically distributed testbed), but potentially to external Research Groups as well.

The usage of Testbed 2.0 will be pushed as potential international and national experimental facility through its inclusions within initiatives such as KIC and Piano Nazionale della Ricerca.

- European Alliance for Innovation (EAI) - The objective of the Alliance is to promote and foster innovation at all steps of the innovation cycle within all technology domains impacted by Information and Communication Technologies (ICT). This should be achieved by combining a Grassroots research approach with effective technology transfer, promoting entrepreneurial mindset in education, and increased competitiveness of the European industry.

The Grassroots paradigm contributes to the European Alliance for Innovation (EAI) Initiative by strengthening civil society by proposing new strategies, ideas and innovative concepts. Through a structured platform the EAI will facilitate the convergence of social innovation outside European national boundaries, mobilising and freeing new innovative creativity and sharing best practices.

The EAI Initiative plans to contribute to the Social Innovation Report of the European Commission in early 2010, aiming to consolidate its role as contributor to the overall strategy of the European Commission’s Innovation agenda for Europe.

CREATE-NET objective in the EAI is put Trentino in the center of this European innovation network and provide the following benefits locally:

- establish the province's reputation as a catalyst for innovation in Europe;
- bring companies to Trentino (e.g. for testing);
- promote Trentino research and education;
- create new interactions with the European Commission and key EU players;
- bring top people to the province for events with global exposure;
- give global visibility to the research, projects and achievements from the province;
- act as a clearing house and due-diligence coming from the network;
- create other new businesses in Trentino.

In order to achieve these objectives in 2010 CREATE-NET will establish a coordinating and operational entity that will serve as a coordination point for the European Innovation Alliance. In particular, it will develop and manage a series of portals which will serve as the online meeting place of what is today a collection of uncoordinated, fragmented organizations in the scientific community in Europe.

Most of the collaborations foreseen for 2010 will take place within the scope of EU-funded projects. In addition co-operations are taking place within locally and nationally funded projects and industry funded projects. Where not otherwise indicated the project is assumed under EU scope.

The following table provides an overview of the projects that will see CREATE-NET involvement in 2010. The table includes approved projects only. In addition to the listed projects, a number of additional projects or cooperation proposals have been submitted that will be confirmed during the course of 2010.

Project	*Description*	*Reference person/Areas involved*	*Key Partners*
FIT4GREEN	FIT4Green aims at contributing to ICT energy reducing efforts by creating an energy-aware layer of plug-ins for data centre automation frameworks.	Regis Saint Paul, NET&SERV	HP, ENI
C2POWER	Cognitive and cooperative strategies to decrease the overall energy consumption and radiated power of mobile devices while still enabling the required performance in terms of QoS.	Kandee Sinthaparanatan, NET&SERV	EADS, Infineon Tech
OPAALS	Development of a sustainable interdisciplinary research community in the emerging area of Digital Ecosystems and integrated theoretical foundation for Digital Ecosystems research.	Francesco Botto, UBINT	WIT
TasLAB	Consultancy for TasLab to support local communities, users and enterprises facing world wide chal-	Raffaele Giaffreda, NET&SERV	Informatica Trentina

	lenges with an eco-systemic framework enhancing local specificities and vocations, increasing the collaboration and sharing of knowledge among the stakeholders of local innovation.		
MOTUS	Industry (Funding Source MAP) research project lead by Telecom Italia to develop a complete solution for sustainable mobility including tracing and monitoring vehicles and giving suggestions for mobility solutions to reduce air pollution and to encourage citizens consciousness.	Raffaele Giaffreda, NET&SERV	Telecom Italia, CFR
EUWB	Advanced methods of wireless technology such as cognitive signalling, intelligent multiple antenna and multiband/multimode UWB system concepts to enable the introduction of advanced services and competitive applications using flexible spectrum allocation.	Abdur Rahim, NET&SERV	EADS Airbus, Philips, Telefonica, Bosch, Thales
DICONET	Dynamic Impairment Constraint Optical Networking. Novel approach to optical networking, providing a disruptive solution for the development of the core network of the future.	Chava Saradhi (NET&SERV) in collab. with ENGINEERING	UPC, AIT
BIONETS	Bio-inspired solutions in pervasive computing/communication environments.	Daniele Miorandi, PERVASIVE	INRIA, Telecom Italia, LSE
CONSEQUENCE	Data-centric information protection framework based on data-sharing agreements.	Giovanni Russello, PERVASIVE	CNR Pisa, ICL
SMART-Net	Scalability, resilience, security, system capacities, coverage, connectivity and cost reduction of the telecommunication infrastructure in broadband wireless access (BWA) scenarios	Tinku Rasheed, PERVASIVE	France Telecom, Thales
EPIWORK	Multidisciplinary research and development for the design of epidemic forecast infrastructures to be used in by epidemiologists and public health scientists.	Iacopo Carreras, PERVASIVE	ISI Torino
ComplexEnergy	Support action to bridge the ICT, Energy and Complex Systems research communities in order to formulate innovative approaches to energy system modeling, design and governance.	Daniele Miorandi, PERVASIVE	INNAXIS
TERANETS	TERANETS is funded by the Ital-	Daniele Miorandi,	University of

	ian Ministry of Foreign Affairs (MAE). The funding covers mobility costs related to short-term scientific missions to University of Notre Dame (Indiana).	PERVASIVE	Notre Dame (Indiana)
OBELIX	Industry cooperation on distributed monitoring platform for wireless mesh networks. The platform will include a SNMP interface and a visualization tool, for facilitating network management operations.	Roberto Riggio (PERVASIVE) in collab. with ENGINEERING	France Telecom
MONARCA	Develop and validate solutions for multi-parametric, long term monitoring of behavioural and physiological information relevant to bipolar disorder.	Oscar Mayora, UBINT	Univ. Passau, ETHZ, IT Univ. of Copenhagen, TILAK
INTER-STRESS	Design, develop and test an advanced ICT based solution for the objective and quantitative assessment of symptoms using biosensors and behavioural analysis for the treatment of psychological stress.	Oscar Mayora, UBINT	Istituto Auxologico, FIMI Philips
ACUBE	Advanced integrated infrastructure for intelligent monitoring in nursing homes.	Oscar Mayora, UBINT in collab. with PERVASIVE, ENGINEERING	FBK, UNITN, Don Gnocchi
Perceptive Ambients	Perceptive Ambient is funded by the Italian Ministry of Foreign Affairs (MAE). The funding covers mobility costs related to short-term scientific missions to the Georgia Tech University (Georgia).	Oscar Mayora, UBINT	GeorgiaTech
NextMedia	Coordination of the efforts in Europe towards producing a clear situation of the Future Media Internet, create common pillars (e.g. the Future Media Internet reference architecture for Europe) and support the results of the developments of the European projects by means of the following actions.	Oscar Mayora, UBINT	UPM, CERTH, ATOS
iTheater	Funding PAT/Legge 6. Development of an interactive integrated system for story-creation and storytelling based on tangible interfaces and animation editing dedicated to children in pre-scholar age.	Cristina Costa, UBINT	Computer Learning, FBK
TRITON	The objective of this project in collaboration with Siemens, Heidi, UNITN DISI, and FBK is to perform experimentation on novel technologies (mainly based on	Elio Salvadori, ENGINEERING in collab. with UBINT, PERVASIVE	Siemens ITS, Far Systems

	Wireless Sensor Networks) for energy savings and monitoring of road tunnels.		
DAIGO	Industry cooperation on impact of impairments on the dynamic establishment of light-paths in translucent optical networks.	Elio Salvadori, ENGINEERING	CISCO

3. Goals

Goals in CREATE-NET identified for the different areas according to the following four categories:

- Funding,
- Research Excellence,
- Business Development, Industry and IPR,
- People Development.

These general goal categories are mapped and scoped to the different areas, according to their role and activity plan. This process is currently ongoing.

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*
Funding	A	E	Dec.	Number of successful projects and funding level
Research Excellence	R	E	Dec.	Number and type of publications
Business Development, Industry and IPR	I	E	Dec.	Number of processed industry contacts, industry funding, number of invention reports
People Development	CN	I	Dec.	Performance Evaluation

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Here follows the Budget figures for the CREATE-NET Research and Engineering activities.

Expenses (EUROS)	
Personnel	
Travel	
Equipment (HW/SW)	
Other (e.g. subcontracting to external contractors)	
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€ 5.000.290**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	1.266.318
Other external incomes (projects, grants, etc.)	1.181.899
Internal incomes (“subcontracted” by other units)	
Total Income	**€ 2.448.280**
Financial Need (Incomes – Expenditure)	**€ 2.550.000**
Required Structural funding from PAT (it should be equal to the previous item)	**€ 2.550.000**

The Budget figures for the CREATE-NET Alliance for Innovation activities are summarized below.

Expenses (EUROS)	
Personnel	
Travel	
Equipment (HW/SW)	
Other (e.g. subcontracting to external contractors)	
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€ 605.000**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	
Other external incomes (projects, grants, etc.)	205.000
Internal incomes (“subcontracted” by other units)	
Total Income	**€ 205.000**
Financial Need (Incomes – Expenditure)	**€ 400.000**
Required Structural funding from PAT (it should be equal to the previous item)	**€ 400.000**

5. Human Resources

To manage the increased number of activities in the research projects CREATE-NET is involved (e.g. the 6 new EU projects approved on the IV Call), we need to hire selected resources in certain areas. The overall hiring plan is as follows:

Research and Engineering HR plan	2009	2010
Research and Engineering	57	61
Support personnel	20	21
Total	77	82

For the Alliance for Innovation activities we plan the following Human Resources:

Alliance for Innovation HR Plan	2010
EAI Coordination	1
Meetings & Summits Officer	2
EAI IT Services	3
SIB coordination	3
Marketing & Membership Officer	3
Total	12

CIRM – CENTRO INTERNAZIONALE PER LA RICERCA MATEMATICA

Name	CIRM – Centro Internazionale per la Ricerca Matematica	
Type	Applicative / Research	
Head	Fabrizio Catanese	
Staff	2009	2010
	0 Researchers	0 Researchers
	0 Technologist	0 Technologist
	2 Post Doc	2 Post Doc
	0 PhD	0 PhD
	1 Administrative Assistant	1 Administrative Assistant

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1. Executive Summary

In 1978 CIRM was founded by ITC in collaboration with the Italian National Research Council (C.N.R.) with targeted main activity the organization of week long workshops and Conferences on mathematical research. The Centre began working on a provisional basis in Spring 1979; in 1982 it was formally established with the ITC.

Next to the traditional activity, which has seen the CIRM organize 225 mathematical Meetings and Conferences, and next to the related editorial activity, which has seen the publication of 57 research books and journal volumes, in 2008 the Comitato Direttivo set up a new range of activities, focused on the aim to have research done at the CIRM, along with scientific training. Especially a new program was set up, encompassing four types of visiting positions, with the intention of stimulating the interaction between the mathematical research community of the Trento area and the European and international mathematical community.

The new range of activities includes:

- 2 Post Doc positions per year;
- Visiting Professor and Visiting Scholars positions;
- Research in Pairs.

In 2010 CIRM will organize nine scientific events in the fields of Algebraic Geometry, Calculus of Variations, Stochastic Analysis, Theoretical Mechanics, Cauchy-Riemann Geometry, Real and Complex Geometry. For the specific program please see points 2 and 2.3. We would like to highlight that eight events were organized in 2009: the activity is increasing in view of growing external support.

Outstanding scientists such as Jaroslaw Wisniewski (Warsaw) and top level post-doctoral fellows such as Claudio Dappiaggi (Erwin Schroedinger Institute, Wien) and Michela Eleuteri (Trento) will visit CIRM to do joint research with scientists active in the Trento area.

The Research in Pairs project about “Free boundary problem for compressible Euler equations with self-gravitation in physical vacuum” by Jean-Francois Coulombel, Alessandro Morando and Paolo Secchi has been already approved by the Comitato Direttivo and it will be carried out next April. The Comitato Direttivo is discussing other submitted research projects for next year and other proposals are in progress.

The personnel of the CIRM consists of the Director, the Administrative Assistant and two Post-Docs. The current Director is Fabrizio Catanese, professor at Bayreuth University, who was re-appointed for the period 2008-2011. The Administrative Assistant is Augusto Micheletti, who is in charge of organizing the logistic aspects of the several scientific activities and to create and maintain an excellent environment allowing the researchers to have a fruitful scientific activity during a problem and trouble-free visit. Starting from the year 2008 CIRM offers two annual Postdoc Fellowships for researches in the field of Mathematics. After a very close examination of the scientific merits of the candidates, the CIRM’s Consulting Committee agreed that the best candidate is Hiep Hoang Pham, who not only published 23 papers at the age of 27 years, but recently solved very important conjectures. On December 14, 2009 he will start his research at CIRM about “Complex Monge-Ampère equation and its connection to algebraic geometry and complex geometry”.

The second of the applicants in the ranking, Alessandra Bernardi, began her research at CIRM on November 2, 2009. She is working under the scientific direction of Edoardo Ballico (University of Trento).

Special mention is made of the collaborations signed by the Director of CIRM, which will bring external incomes by the Mathematics Department of the University of Trento for the next three years of Euro 15000 per year and by the INdAM (Istituto Nazionale di Alta Matematica), which will financially support the scheduled common activities.

Other incomes to the budget of CIRM will come from the Municipality of Levico and APT and the Departments of Mathematics of the University of Padova.

2. Vision and Scientific Program

The Scientific Program of CIRM for the year 2010 includes the following Conferences and Schools:

- *First CIRM-HCM Joint Meeting Stochastic Analysis, Particle Systems, Optimal Transport*

Scientific Organizers: Sergio Albeverio (Bonn), A. Bovier (Bonn), F. Flandoli (Pisa), Giuseppe Da Prato (SNS Pisa), Th. Sturm (Bonn), Luciano Tubaro (Trento).
Period: January 25-31, 2010.

- *XX Convegno Nazionale di Calcolo delle Variazioni*
  Scientific Organizers: Luigi Ambrosio (SNS Pisa), Gianni Dal Maso (SISSA Trieste), Paolo Marcellini (Firenze), Raul Serapioni (Trento), Francesco Serra Cassano (Trento).
  Period: February 21-26, 2010.
- *Symmetric Spaces and their Generalisations*
  Scientific Organizers: Willem de Graaf (Trento), Peter Littelmann (Koeln), Dmitri Panyushev (Moscow), Oksana Yakimova (Erlangen).
  Period: June 14-18, 2010.
- *CR Geometry and PDE's – IV*
  Scientific Organizers: Antonio Bove (Bologna), Dmitri Zaitsev (Dublin), Giuseppe Zampieri (Padova).
  Period: June 6-11, 2010.
- *International Summer School on Mathematical Fluid Dynamics*
  Scientific Organizers: Hugo Beirao da Veiga (Pisa), Paolo Secchi (Brescia).
  Period: June 27-July 2, 2010.
- *School (and Workshop) on Minimal Model Program and Shokurov's ACC Conjecture*
  Scientific Organizers: Gianfranco Casnati (Pol. Torino), Claudio Fontanari (Trento), Roberto Notari (Pol. Milano), Gianluca Pacienza (Strasbourg), Massimiliano Mella (Ferrara).
  Period: July 4-10, 2010.
- *XXV International Workshop on Differential Geometric Methods in Theoretical Mechanics*
  Scientific Organizers: Frans Cantrijn (Gent), Jesus Clemente Gallardo (Zaragoza), Janusz Grabowski (Polish Academy of Sciences), Alberto Ibort (Madrid), Giuseppe Marmo (Napoli), Witold Respondek (Rouen), Enrico Pagani (Trento).
  Period: August 22-28, 2010.
- *International Conference on Perspectives on Algebraic Varieties*
  Scientific Organizers: Marco Andreatta (Trento), Arnaud Beauville (Nice), Fedor Bogomolov (Courant Institute, New York University), Alessio Corti (Imperial College, London), Igor Dolgachev (Ann Arbor, Michigan), Gerard Van der Geer (Amsterdam University), Fritz Grunewald (Universitaet Duesseldorf), Klaus Hulek (Hannover), Yujiro Kawamata (Tokyo University), János Kollár (Princeton University), Rick Miranda (University of Colorado, Fort Collins), Miles Reid (Warwick University and Sogang University, Seoul), Edoardo Sernesi (Università di Roma III).
  Period: September 5-11, 2010.
- *Progressi Recenti in Geometria Reale e Complessa*

Scientific Organizers: Vincenzo Ancona (Firenze), Paolo de Bartolomeis (Firenze), Alessandro Silva (Roma I).
Period: October 17-22, 2010.

Concerning the Visiting Professors, Visiting Scholars and the RIP's programs the projects will continue in 2010. Visiting Scholars will perform mathematical research in cooperation with scientists and researchers of Trento University or, more generally, of the Trento area, holding some research seminars. A list of accepted CIRM's Visitors for 2010 includes: Jaroslaw Wisniewski (Warsaw), Claudio Dappiaggi (ESI Wien), Michela Eleuteri (Trento) and the RIP's Jean Francois Coulombel (Lille 1), Alessandro Morando (Brescia) and Paolo Secchi (Brescia). Other research proposals are in progress.

- The two Postdocs, Hiep Hoang Pham (nationality Vietnamese) and Alessandra Bernardi, will work the first in the areas of specializations of Complex Geometry and Several Complex Variables while the second in the field of Algebraic Geometry.
- The research's title by Pham is "Complex Monge-Ampère equation and its connection to algebraic geometry and complex geometry" while the main subject of Alessandra Bernardi's researches (namely tackling the problem of decomposition of tensors via the study of secant varieties) is one that is quite at the crossroad of many interest in applied and pure Mathematics, and one on which the energies of many mathematicians are at work.

2.1. Context and State of the Art

Mathematical research nowadays is no longer the fruit of powerful minds working in isolation and quiet.

On the one hand all the unprecedented scientific and technological development of society cries our for large investments, and for an increased mathematization of all the applied sciences.

Nowadays mathematics plays a double challenge.

The future of mankind, especially in view of the future shortage of resources, and the need to find new sources and a less wasteful use of the existing ones are relying on a vast scale growth of rationality and programming (this includes of course giving up to war as a way of solving problems and disputes), and a spreading of scientific knowledge. Mathematics is then the primary discipline, since centuries source of rational thinking , the primary science which deals with solving new problems by logic deduction and not by random trial and error experiments.

On the other hand even the progress of theoretical (pure) mathematics has become more of a social enterprise than an accomplishment of isolated individuals. A typical example was the solution of the Fermat problem in 1994, where more than a hundred researchers from different nationalities were involved on a long term research project, encompassing more than 80 years, each giving essential inputs in the directions which were envisaged in several scientific Conferences, especially those which took place in the 50's and 60's in USA and Japan.

Mathematics is now officially recognized as being an international enterprise, and each environment must be immediately open to the new directions and innovations which make their way through.

For this reason it is recognized to be of primary importance the existence of research structures, many of which (like in Luminy, France, or in Barcelona, Spain, Trento, Italia) are called CIRM = International Centre for Mathematics Research.

There are many of these research Institutions, usually one or two in many nations, like the Mathematisches Forschungsinstitut in Oberwolfach (Germany), the Max Planck Institut fuer Mathematik (Bonn, Germany), the Centre Emil Borel de l' Institute Henri Poincare' , Paris, the IHES= Institut des Hautes Etudes Scientifiques (Bur sur Yvette, France), the Banach Centre in Warsaw and in Bedlewo,the Isaac Newton Centre for Mathematical Sciences in Cambridge (GB), the IAS= Institute for Advanced Study, Princeton (USA), the Clay Mathematics Institute (Cambridge USA),the KIAS= Korean Institute for Advanced Study (Seoul), the Research Institute for Mathematical Sciences (Kyoto, Japan), and many others.

There is also the deeply felt need that these research Institutions, especially the European ones, should keep in close contact and collaboration which each other. For this reason was also founded the ERCOM , with the intention of coordinating the activities , and fostering exchanges.

The CIRM has set up its role recently in this context as an Institution which is not only active in the organization of scientific exchanges through international workshops, schools and Conferences, but also is a permanent institution which hosts mathematical research, stimulating the scientific growth of the mathematical community in the Trento area.

This is witnessed by the extremely high scientific stature of the Members of the Comitato Direttivo:

Fabrizio Catanese, Universität Bayreuth,
Luigi Ambrosio, Scuola Normale Superiore Pisa,
Marco Andreatta, Università degli Studi di Trento,
Fritz Grunewald, Universität Düsseldorf,
Alberto Valli, Università degli Studi di Trento,
Don Zagier, Max Planck Institut für Mathematik Bonn e College de France Paris.

2.2. Vision and Goals

The CIRM has a long term established reputation for the invaluable service to the mathematical community rendered through the organization of Conferences, schools and workshops.

Our long term goal is to establish also a reputation as a place where high quality mathematical research is produced, through the new research activities which have been set up in the last 2 years.

These are the new programs:

- Visiting professors and visiting scholars: this activity is focused around the target to stimulate cooperation with scientists who are active in the Trento

area, be it for joint research projects, or for delivering series of lectures, or Ph.D. courses, to disseminate new knowledge, methodologies and techniques

- Research in Pairs. It is the most original and innovative activity: it brings together foreign scientists who work together, in a fully free environment, on a well defined research project, with the intention of bringing it to end through the intense and direct cooperation. This project is very interesting , and also not very expensive, since the visiting scientists receive essentially from the CIRM only an expense reimbursement.
- Post doc Fellowships .It is instead crucial for the future: the training of future researchers, especially in this critical situation, plays a primary role concerning the general aims sketched in section 2.1.

In all of these activities it is planned to intensify the existing cooperations with other research Institutions, both the formalized ones, with the Istituto Nazionale di Matematica "Francesco Severi", and with the Dipartimento di Matematica della Universita' di Trento. But also, and more important, the non formalized or occasional ones, as with the Max Planck Institute in Bonn, the Hausdorff Zentrum in Bonn, the Forschergruppe 790 of the Deutsche Forschungsgemeinschaft, the Scuola Normale Superiore di Pisa and many others.

For this reason the new programs of the CIRM have been advertized on the Notices of the major Mathematical Societies (Italian, American, …).

2.3. Activities and Work Plan

- *First CIRM-HCM Joint Meeting Stochastic Analysis, Particle Systems, Optimal Transport*

In recent years there have been exciting developments in stochastic analysis in relation to stochastic partial differential equations, on one hand, and to the statistical mechanics particle systems on the other hand. In the study of optimal transport, methods of stochastic analysis and calculus of variations combined with geometric analytic methods have found striking applications. Each of these areas has had an intensive, often very technical development, attracting an increasing number of young mathematicians and scientists, in addition to specialists. Time has come to make an effort to bring together the different communities, to better stress the connections between the approaches and stimulate further developments, enhancing the new opportunities offered by active collaborations across boundaries of specialized research areas. Several mathematicians working in the areas of the planned meeting have already strong connections with CIRM and/or HCM. The meeting could also constitute a catalyst for further collaborations between these Centers and, at the same time, attract to the Centers active mathematicians and scientists working all over the world in areas which are at the forefront of research in mathematics and its applications.

The meeting will consists of ca 30 invited lecturers, giving ample space for discussions and free room for additional shorter presentations.

A balance in number between senior and young participants and lecturers is aimed to.

The following list contains the prospective main invited speakers.

- *XX Convegno Nazionale di Calcolo delle Variazioni*

This is the twentieth edition of a series of meetings started in 1990 focused on the scientific personality of Ennio De Giorgi, one of the most famous Italian mathematicians, dead on October 25, 1996. The purpose of this conference is to give an overview of the current researches and to define a few open problems in the field. The Organizing Committee has been componed by the national responsibles of three National Projects of research. More than 100 participants attended the last editions of this conference and the exchanges of ideas and the fruitful interactions have produced a lot of scientific collaborations and papers.

- *Symmetric Spaces and their Generalisations*

Symmetric spaces were introduced by Elie Cartan in the 1920-s as a special class of homogeneous Riemannian manifolds. Since then theory of symmetric spaces has been vastly developed and took its place as a central topic in many fields of research such as Lie Theory, Differential Geometry, and Harmonic Analysis. They also appear in Number Theory, Algebraic Geometry, and Representation Theory. Symmetric spaces alongside their numerous generalisations, e.g., Vinberg's theta-groups, spherical varieties, or Gelfand pairs, provide an inexhaustible source of most interesting open problems.

As was shown by Kostant and Rallis, the isotropy representation of a symmetric space enjoys several nice properties, similar to the adjoint representation of a reductive Lie algebra. In particular, there is only a finite number of nilpotent orbits. Vinberg generalised results of Kostant-Rallis to the semisimple automorphisms of any finite order, leading to the so called theta-representations. The classification of the arising nilpotent orbits can be vastly used in invariant theory and differential geometry. We may say that in the complex case this problem is almost solved. In the real case, which has more applications in geometry, the work has just begun. Another challenge is to extend classification methods to finite characteristic.

The isotropy representation and an algebraic point of view seem to be only the first approximation to the geometric and analytic properties of symmetric spaces and their generalisations such as Gelfand pairs. On the other hand, harmonic analysis on symmetric spaces would be hardly possible without the purely algebraic fact that the ring of invariant differential operators is polynomial, and generators can be described explicitly. Surprisingly, the fact remains true for a wide class of Gelfand pairs associated with nilpotent groups. Developing harmonic analysis in this context is an ongoing project.

The De Concini-Procesi compactification of symmetric spaces is an example of the reverse process. Taking its structural properties as a definition in the algebraic setting we arrive at a concept of a wonderful variety, one of the most amazing specimen among spherical varieties. In this area a great breakthrough was made recently. By constructing a geometrical realisation S. Cupit-Foutou proved Luna's long standing conjecture asserting that wonderful varieties can be classified by combinatorial invariants, the so called spherical systems.

A very fruitful and promising idea is to replace one involution (which defines a symmetric space) by a pair of commuting ones. Here again arise certain representations with only finitely many nilpotent orbits. Their classification should be possible, but methods do not exist yet. Such pairs of involutions are also extremely important for the propagation of the "multiplicity free" property, one of the main characterisations of symmetric spaces.

The purpose of this conference is to bring together experts from different fields having to do with various generalisations of symmetric spaces. This will lead to fruitful interactions, and exchanges of ideas.

The Organizing Committee feels that possibilities to apply algebraic and representation theory methods in analysis and differential geometry are far from being exhausted and also that some algebraic questions may gain new dimensions as a result of this cooperation.

The tentative list of speakers includes: Michel Brion (Grenoble), Stéphanie Cupit-Foutou (Koeln) , Corrado De Concini (Roma), Hong Van Le (Prague), Paul Levy (Lancaster), Alexander Premet (Manchester), Claudio Procesi (Roma), Fulvio Ricci (Pisa), Simon Salamon (Torino), Ernest Vinberg (Moscow).

Ample space will be left in the scientific programme for contributed talks.

- *CR Geometry and PDE's – IV*

This conference is intended to be the continuation of those with the same title held in 2004, 2006, 2008 under CIRM sponsorship. The main topics are Complex analysis in several complex variables, Systems of vector fields, CR Geometry.

CR Geometry is a relatively young and nowadays intensively studied research area having interconnections with many other areas of mathematics and its applications.

It deals with restrictions and boundary values of holomorphic functions (CR functions) and of holomorphic mappings (CR mappings) to real submanifolds. A phenomenon arising in dimension higher than one is the rich intrinsic structure that leads to the existence of real submanifolds of different non-equivalent types.

Systems of vector fields, sums of squares, subelliptic estimates are a field in the between of complex analysis related to the ∂-Neumann problem and microlocal analysis (hypoellipticity in the interior and at the boundary of PDE's).

The systems of tangential Cauchy-Riemann equations for functions and mappings present important examples of systems of partial differential equations. A celebrated example of a system of this kind due to Hans Lewy played a crucial role in the development of the solvability theory for more general classes of PDEs.

CR Geometry and Partial Differential Equations present a field of interaction with a wide range of mathematical areas such as Real and Complex Symplectic Geometry, Differential Geometry, Complex Dynamics, Jet Theory, Microlocal Analysis. This makes them to be one of the most advanced and actual streams in the mathematical research.

The aim of this sequence of conferences is to bring together both active senior researchers and young mathematicians with interest in CR Geometry and Partial Differential Equations and to foster exchange of ideas and interaction between these fields.

- *International Summer School on Mathematical Fluid Dynamic*

The school is directed to post-doc students and researchers who wish to become aquainted with recent developments and promising methods in the mathematical theory of fluid dynamics. Four courses will be delivered by leading experts in the field. The courses will be organized in such a way that not experts in the field will be able to understand the directions of the actual research. The tentative list of speakers includes Claude Bardos (Paris VII) with the title of the course "Classical, recent, and challenging open problems on the Euler equations of incompressible perfect fluids", Sylvie Benzoni-Gavage (Lyon 1) with the title "Propagating phase boundaries and capillary fluids", Zhouping Xin (Hong Kong) with the title "Mathematical theory of boundary layers and inviscid limit problems", Alexis F. Vasseur (Texas at Austin) with the course "The De Giorgi method for regularity of solutions of elliptic equations and its applications to fluid dynamics".

The school will be also supported by PRIN 2007 with the sum of Euro 6000. Other financial applications will be addressed to INdAM and other institutions.

- *School (and Workshop) on Minimal Model Program and Shokurov's ACC Conjecture*

Main speakers for the school will be prof. C. Birkar (DPMMS, Center for Mathematical Sciences, Cambridge, UK), and prof. T. de Fernex (University of Utah, USA).

Birational geometry, that is, the classification of algebraic varieties up to birational equivalence occupies a central position in algebraic geometry. Designed over the model of classification of surfaces (one of the main achievements of the Italian school at the beginning of the 20th century), the Log Minimal Model Program has become in the last decades one of the major trends in algebraic geometry. Several leading mathematicians, like J. Kawamata, J. Kollàr, S. Mori, M. Reid, and V. Shokurov, have deeply contributed to the program throughout the years, and very recently there has been some spectacular progress which is bringing us very close to a complete program in all dimensions

Birational geometry is primarily concerned with smooth projective varieties. However, to run the LMMP, first we have to deal with singularities as they appear in the study of extremal rays and contractions. Landmarks in the classification of higher dimensional algebraic varieties have motivated a deeper understanding of various notions of singularities and related invariants arising within the context of birational geometry.

Singularities have now become an indispensable part of the study of algebraic varieties. Moreover, a conjecture due to Shokurov, called the ACC conjecture, concerning invariants of singularities is deeply related to the major missing piece in the Minimal Model Program: the Termination of flips.

As for the previous schools held at FBK-CIRM in Povo (Trento) in September 2006, 2007, 2008, 2009, the 2010 meeting is primarily aimed at both graduate and Ph.D.

students, and to both young and senior researchers.

The meeting is articulated in a School and in a Workshop. The School will give the students and young researchers the opportunity of learning the subject from leading experts in the area. Birkar is one of the author, together with Cascini, Hacon and McKernan, of the spectacular proof of the finite generation of the canonical ring.

De Fernex, in collaboration with Ein and Mustata, obtained recently the major confirmations of the ACC conjecture. They will deliver 5 or 6 lectures each and participate in individual consultations with the participants.

The Workshop on the state of the art will give the opportunity to senior researchers to address common problems. Most of the conferences will be delivered by invited speakers, some others by participants to the school. The invited speakers will be selected from a list of experts in the subject, such as Campana, Casagrande, Cheltsov, Debarre, Lazic, Occhetta, Paun, accordingly to the budget at disposal.

- *XXV International Workshop on Differential Geometric Methods in Theoretical Mechanics*

The Workshop has been held every year in the last week of August (recently it has been held in Levico Terme (Trento), Balatonfoldvar (Hungary), Bedlewo (Poland), Madrid (Spain), Gent (Belgium) etc.) and is an important opportunity of scientific exchange of ideas between people who are active in research in differential geometric methods related to theoretical mechanics and more generally to physics. Participants, in the approximate number of 45, belong to European Countries and form a stable group; most of them are scientific authorities in their own fields (F. Cantrijn (Belgium), J. F. Carinena (Spain), Clemente-Gallardo (Spain), M. Crampin (UK), M. De Leon (Spain), J. Grabowski (Poland), E. Massa (Italy), F. Magri (Italy), G. Marmo (Italy), W. Respondek (France), W. Sarlet (Belgium), D. Saunders (UK), and so on).

The 25th Workshop will be organized in 12 plenary talks of one hour, held by some participants selected by the Scientific Committee, on the following topics: Poisson, Symplectic and Contact Geometry; Classical and Quantum Constraints; Classical and Quantum Control; Hamilton-Jacobi theories, Integrable and Superintegrable Systems; and in short communications (half hour talks) of the participants. Accordingly with the tradition of the Workshop, the Scientific Committee will not plan to invite and to pay people external to the group to give talks.

The 17th and the 24th editions of the Workshop have been organized in Trento in the years 2002 and 2009 by C.I.R.M. at Grand Hotel Bellavista of Levico Terme.

- *International Conference on Perspective on Algebraic Varieties*

The study of varieties from a ‘classical’ perspective is central to modern algebraic geometry, and it remains the foundation for contemporary developments such as the theory of moduli and quantum cohomology. The Organizing Committee proposes to organise a high-level scientific event with the title “Perspectives on Algebraic Varieties”, centred on new developments in the theory of algebraic varieties with an emphasis on low-dimensional varieties (curves, surfaces, 3-folds) and on moduli spaces. The Organizing Committee has in mind for instance the following topics:

- The construction of new algebraic surfaces of general type and their moduli
- The study of the geometry of moduli spaces related to Abelian varieties, algebraic curves, and other algebra-geometric objects, including special cases with small invariants.
- Recent development in classification of higher dimensional varieties.

The year 2010 will simultaneously see the 60th birthdays of Fabrizio Catanese, Ciro Ciliberto and Alessandro Verra. The conference is not intended to be a celebration, but the fact may serve as a way to focus the subject and frame the perspective of the event.

The following targeted speakers have already agreed informally that they are willing to take part in the conference: Enrico Bombieri, Chen Meng, Olivier Debarre, Gavril Farkas, Christopher Hacon, Daniel Huybrechts, JongHae Keum, Shigeyuki Kondo, Alexander Kuznetsov, Robert Lazarsfeld, Eduard Looijenga, Massimiliano Mella, Shigeru Mukai, Keiji Oguiso, Rita Pardini, Giampietro Pirola, Mihnea Popa, Nick Shepherd-Barron, Burt Totaro, Ravi Vakil, Bert van Geemen, Claire Voisin.

Financial support has been asked to GNSAGA-INdAM, Foundation Compositio Mathematica, the European Research group GDRE GRIFGA, and the "German-Italian University".

- *Progressi Recenti in Geometria Reale e Complessa*

This conference is the seventh of a series, which started in Bari 1997 and followed then in Palermo 1999 and 2002, Levico Terme 2004, 2006, 2008). This conference is directed to young mathematicians (post-doc students, researchers) actively involved in researches of Complex and Real Geometry.

The advances of the current Geometry propose a costant and deep interaction between methods and techniques of different kinds (algebraic, differential-geometric, homological, etc.): the exploitation of this mixture is one of the most qualifying aspects of this event, in the perspective to build a solid community of young mathematicians becoming acquainted with researchers working in different fields and places (in Italy and abroad).

We foresee the participation of 40-50 young researchers plus 20-25 senior researchers.

2.4. Collaborations

An agreement between the Department of Mathematics of the University of Trento and the CIRM was signed, by Fabrizio Catanese, Director of CIRM, and Raul Serapioni, Director of the Department. The Department will contribute each year, for the three following years, Euro 15000 directly to the CIRM. A joint Committee, formed by Andreatta, Catanese and Valli is nominated, which will decide the ways in which the cooperation will take place.

On May 8, 2008 another agreement between the INdAM (Istituto Nazionale di Alta Matematica) and the CIRM was signed by Fabrizio Catanese and Vincenzo Ancona, Director of the INdAM. CIRM and INdAM will collaborate in the organization of

scientific activities and will support them financially. A joint Committee formed by Andreatta, Catanese, Ancona and Capuzzo Dolcetta is nominated.

3. Budget

Expenses (EUROS)	
Personnel	115.306
Travel	7.000
Equipment (HW/SW)	1.044
Organization of Conferences	76.000
Visiting Positions (No Map)	36.000
Other Expenses	1.650
Total Expenditure	237.000
Incomes (EUROS)	
EU Projects (total amount financed by EU)	
Other external incomes (projects, grants, etc.)	40.000
Total Income	**€40.000**
Financial Need (Incomes – Expenditure)	**€197.000**
Required Structural funding from PAT (it should be equal to the previous item)	**€197.000**

GRAPHITECH – CENTRE FOR ADVANCED COMPUTER GRAPHICS TECHNOLOGIES

Director: Raffaele de Amicis

Background

GraphiTech, Centre for Advanced Computer Graphics Technologies, was envisioned as a joint venture between the INI-GraphicsNet Stiftung, the Cultural Institute of Trento (Istituto Trentino di Cultura, now Fondazione Bruno Kessler) and the University of Trento (Università degli Studi di Trento).

The Foundation was founded in Trento on July 2nd 2002, at the office of public notary Paolo Piccoli, located in via Grazioli n. 79, registered at the Board of Public Notaries of the United Districts of Trento and Rovereto. On January 23rd 2003 GraphiTech acquired its legal status following the registration at the "Registro delle Persone Giuridiche" held by the "Commissariato del Governo" of the city of Trento, according to the Decree of the President of the Italian Republic n. 361 of 10-02-2000.

Mission

GraphiTech has been established in order to conduct research and development activities in the broad technology area of advanced computer graphics, mixed reality, information and communication systems. The aim of the joint venture is to enhance the competitiveness of Trentino's industries through the development and application of advanced computer graphics.

The mission of the Foundation is to contribute towards the transfer of knowledge between the research sector and the industry through the promotion of research on advanced graphics, information processing and visual communication, including Mixed Reality and virtual engineering. GraphiTech, through its activities, stimulates collaboration and friendship in the field of information technology, between the Trentino province, Italy and Germany and it performs world-class research and development in advanced computer graphics technologies and services.

In seven years of Research and Development activities at Local, National, EU and International level, GraphiTech has participated and contributed to the scientific community in the following understanding of Computer Graphics as: "the technology with which pictures, in the broadest sense of the word (synthetic graphics as well as grayscale and color images), are captured or generated, presented, manipulated, digitally processed in the appropriate form for the respective application and merged with other, non graphical application data. This also includes the computer-supported integration and manipulation of these pictures and 3D models with other kinds of data, such as audio, speech and video (to create multimedia sys-

tems) as well as corresponding advanced dialog and interactive technologies. Concepts which characterize the important topics of computer graphics are, to name a few, Visualizing Information, Visual Data Mining, Visual Computing, Virtual Reality (VR), Augmented Reality (AR), Interactive Internet Services and Secure Image Transmission and Communication."

Research Topics

The frequently cited, and sometimes even strained, adage "standstill is regression", is the driving force for the staff at GraphiTech. After a time of a kaleidoscopic vision, in the last years GraphiTech has achieved a more stable phase, where scientific vision and conceptual re-orientation have been promoted and pursued in parallel to the global and local changes.

Thanks to an outstanding research group, GraphiTech has carried out research in different, but very much related, areas. Some keywords which could be used to describe our research works are: Design Theory, Computer Aided Design, Visualisation Technologies, Intelligent and Multimodal Interfaces and Interactions, Visual Analytics, Technology Transfer, Science and Technology Policy to name but a few.

The successful establishment and positioning of its competences and expertises within seminal key research areas is grounded upon its endeavour within three different application domains:

- Virtual Engineering
- Virtual content creation and interactive applications for Cultural Heritage.
- GeoVisual Analytics.

In 2009 GraphiTech has been involved in a numbers of projects both at the EU and at the national level and international level. Projects have been carried out as R&D activities, both through financing by the EU or by local framework programmes, as well as through applied research projects, commissioned by industries or local authorities. Among these, for their relevance, it is worth mentioning the following R&D projects:

- BRISEIDE – BRIdging SErvices, Information and Data for Europe (under negotiation), within the Competitiveness and Innovation Framework Programme - ICT Policy Support Programme (ICT PSP), on the development of spatio-temporal web processes for geospatial applications, of which the Foundation is the coordinating partner.
- i-Tour - Intelligent Transport system for Optimized URban trips, (Grant agreement no.: 234239), – on Intelligent mobility systems and multi-modal interfaces for transport of passengers, financed by the 7th Framework Programme and of which the Foundation is technical manager.
- A feasibility study for a system to detect environmental pollution at urban scale funded by NATO-OTAN (North Atlantic Treaty Organization) within the Science for Peace and Security Programme.
- The project for an Advanced Research Workshop on Geographical Information Processing and Visual Analytics for Environmental Security (NATO-ARW)

funded by NATO – OTAN (North Atlantic Treaty Organization) within the Science for Peace and Security Programme.

- The NATURE-SDIPlus "Best Practice Network for SDI in Nature Conservation" financed within the 2007 call of the e-eContentPlus Programme.
- ShApes, Geometry and Algebra “SAGA”, a Marie Curie Initial Training Network (ITN) (Call: FP7-PEOPLE-2007-1-1-ITN).

Scientific and Industrial Research Projects – Grant Holder

2009-2012 Funding Agency/Call: EU ICP-PSP.

Project name: **BRISEIDE: BRIdging SErvices, Information and Data for Europe**

Project type: Research Project

Project Budget: 484.342 €

Participant organisation name:

- Sapienza University of Rome – Department CAVEA – LABSITA, Italy
- University of West Bohemia, Czech Republic
- European Umbrella Organisation for Geographic Information, The Netherlands
- Epsilon International, Greece
- Geofoto d.o.o.Croatia
- Technology Development Forum, Latvia
- Sinergis, Italy
- Czech Center of Science and Society, Czech Republic
- Geographical Information Systems International Group, Italy
- Government of Navarra, Spain
- Trabajos Catastrales S.A., Spain
- Istituto per la Protezione e la Ricerca Ambientale, Italy
- Reggiani S.p.A., Italy

*Project goals***:**

BRISEIDE (BRIdging SErvices, Information and Data for Europe)” aims at delivering (1) time-aware extension of data models developed in the context of previous/ongoing EU INSPIRE related projects (e.g. in the context of GMES, eContentPlus), (2) application (e.g. Civil Protection) based on the integration of existing, user operational information and (3) value added services for spatio-temporal data management, authoring, processing, analysis and interactive visualisation.

BRISEIDE will be applied, tested and validated within a Civil Protection application context, using the INSPIRE relevant themes, via a chain of stakeholders, data providers, technology partners, and downstream users. The Pilot operational phase will last 12 months and will consider real life events, with extensions in additional domains, being considered and assessed.

Project services converge with Free & Open Source Software (FOSS) initiatives from the Open Source Geospatial Foundation (www.osgeo.org). This ensures further development and processing functionalities built on top of the BRISEIDE framework, to be extended by public administrations or private industries according to their specific needs. The BRISEIDE platform will be available on lease, thus ensuring economic sustainability and partners' investment recovery.

Role of GraphiTech:

GraphiTech is the coordinator of the proposal ensuring that all activities are running according to the work plan and with the required quality level. Furthermore it will play a key role during the definition of requirements and definition of the architecture of BRISEIDE. GraphiTech will also provide essential contribution to the deployment of the pilot through development of spatio-temporal processing services. The final BRISEIDE client will be also based on existing prototype developed by GraphiTech which will be extended to support spatio-temporal services. GT will be also involved in the testing and validation of the pilot. Finally GraphiTech will be involved in dissemination, exploitation, IPR management.

2009-2012:	Funding Agency/Call: EU FP7-STREP.
Project name:	**I-Tour: Intelligent Transport system for Optimized URban trips**
Project webpage:	http://www.itourproject.com/
Project type:	Research Project
Funding:	501.000 €

Participant organisation name:

- FORMIT Servizi S.p.a., IT
- University College of London, UK
- Eindhoven University of Technology, NL
- Magma Srl, IT
- ELASIS S.C.p.A., IT
- PTV AG – Traffic Mobility Logistics, DE
- Cadzow Communications Consulting Ltd.,UK
- Transport for London, UK
- Provincia di Bologna, IT
- Autostrade Meridionali, IT
- Provincia Autonoma di Trento, IT
- Circumvesuviana, IT

Project goals:

i-Tour client will support and suggest, in a user-friendly way, the use of different forms of transport (bus, car, railroad, tram, etc.) taking into account user preferences as well as real-time information on road conditions, weather, and public transport network condition. To do so i-Tour promotes a new approach to data col-

lection based on recommender system based on the information provided by the whole user community.

i-Tour mobility client applications will feature a very user-friendly interface accessible from PCs, PDAs and Smartphones. i-Tour clients are designed to promote use of public transport by encouraging sustainable travel choices and by providing rewarding mechanisms for users choosing public travel options. Sustainable travel preferences, e.g. measured in terms of CO2 emission saved by using public transport, are rewarded, e.g. through free public transport tickets, thus promoting and encouraging environmental friendly travel behaviours.

Role of GraphiTech:

GraphiTech is technical coordinator of the entire project. GraphiTech will monitor technical quality of i-Tour activities and it will provide RTD development in the field of human-computer interaction, coordinating the development of a work package on “User-Friendly Travel Information Portal” and its client applications. GraphiTech will also contribute in the context of geographical data, through the development of the i-Tour middleware in the work package on “Infrastructure Deployment and Platform Integration”.

Last but not least GraphiTech will play a key role in horizontal activities such as dissemination, awareness and exploitation of i-Tour’s results.

2008-2012: Funding Agency: EU Marie Curie, FP7-PEOPLE-2007-1-1-ITN

Project name: **ShApes Geometry Algebra**

Project webpage: http://www.saga-network.eu

Project type: Research Project

Funding: 328.051 €

Participant organisation name:

- Research Institute SINTEF, NORWAY
- University of Oslo, NORWAY
- Johannes Kepler University, AUSTRIA
- Research Institute INRIA,FRANCE
- University of Cantabria, SPAIN
- Vilnius University, LITHUANIA
- University Athens, NKUA GREECE
- Missler Software, Missler, FRANCE
- Kongsberg SIM GmbH SIM-Austria, AUSTRIA

Project goals:

The project will enhance mathematical results and techniques, covering the full spectrum from Algebraic Geometry and Computer Algebra to Computer Aided Geometric Design (CAGD), Numerical Analysis and Approximation Theory.

Specifically SAGA aims at promoting this new field that opens new horizons and applications, and in general at strengthening interdisciplinary and inter-sectorial research and development concerning CAD/CAM, by training a new generation of

researchers familiar with both academic and industry viewpoints, while supporting the cooperation among the partners and with other interested collaborators in Europe. As one of the reviewers said in the final review of the GAIA II project, he was “very impressed by the results” of that project, but still felt that the project “had just scratched the surface”.

There are plenty of questions for research and opportunities for exploitation of this technology, which are to be explored within this initial training network. A representative set of issues is described in some detail in the rest of this section, providing a more elaborate view on the training-through-research envisaged by the consortium and the individual projects for fellows than it was possible to give in the outline of stage 1, thus addressing the evaluation comments from that phase commenting on a “rather sketchy and vague” training design and soliciting “more concrete research output”.

Role of GraphiTech:

GraphiTech will investigate the possibility of defining different forms of constraint-based design. Within this context the project refers to designed features as “constraints”, preliminary defined by an operator, which should be properly integrated with the final CAD product. The integration involves studying the type of representation of constraints and CAD models, analysis of their geometry and topology, identifying the points at which a constraint can fit the designed object as well as how the object should be evolved to satisfy the constraints, areas of possible interpolation of the constraints and the model.

2008-2011:	Funding Agency: EU eContentPlus.
Project name:	**NatureSDI+: Best Practice Network for SDI in Nature Conservation**
Project webpage:	www.nature-sdi.eu/
Project type:	Research Project
Funding:	140.400 €

Participant organisation name:

- Geographical Information Systems International Group, IT
- Austrian Academy of Sciences, Research Unit for Geographic Information Science, AT
- Trabajos Catastrales, ES
- Intergraph Italia, IT
- Epsilon International, GR
- Katholieke Universiteit Leuven, BE
- Disy Informationssysteme, DE
- Consiglio Nazionale delle Ricerche, IMATI, IT
- Institute of Aerial Geodesy, LT
- University of Aberdeen, UK
- Portuguese Geographical Institute, PT

- Government of Navarra, ES
- Regione Piemonte, IT
- Research Institute of Geodesy, Topography and Cartography, CZ
- University of West Hungary - Faculty of Geoinformatics, HU
- Institute of Ecology and Botany of the Hungarian Academy of Sciences, HU
- Head Office of Geodesy and Cartography, PL
- The State Forestry Agency, BG
- University of Cyprus, CY
- University of Gävle, SE
- Centre National du Machinisme Agricole, du Génie Rural, des Eaux et des Forets, FR
- French Research Institute for Development, FR
- Danube Delta National Institute for Research and Development,RO
- Regione Liguria, IT
- Fraunhofer Institute, DE
- Atelier Technique des Espaces Naturels, FR
- University of Zilina, SK
- Stichting Nederlands Normalisatie-Instituut, INT

Project goals:

The establishment at EU level of the Natura 2000 Network ("Habitats Directive" 43/92/EEC) and the new approach in the protected areas management, which often implies the overcoming of regional or national boundaries, enforced the link between nature conservation and geo-information and generated the need to have harmonised datasets at EU level which are easily accessible by stakeholders and comparable each other, i.e. for decision making activities, for management planning and for the implementation of biodiversity conservation measures. This is also supported by the recent INSPIRE Directive (2007/2/EC) which addresses a European Spatial Data Infrastructure to support environmental policies and which includes in its Annexes a cluster of data themes strictly connected to the nature conservation.

In such a context, Nature-SDIplus Network aims, through the use of appropriate communication and operational tools and best practice examples, at improving the harmonization process of the national datasets into a seamless European coverage to make digital information more accessible and exploitable contributing also to the INSPIRE Directive implementation, with specific reference to this cluster of data themes:

- Protected sites (Annex I)
- Biogeographical regions (Annex III)
- Habitats and biotopes (Annex III)
- Species distribution (Annex III)

Nature-SDIplus, along 30 months, is then aimed at defining and testing a metadata profile and a common data model for the four considered INSPIRE data themes in

order to make related data sets interoperable and sharable at EU level. The project aims also to give a contribution to the definition of the INSPIRE Implementing Rules on Data Specifications.

Exemplar data on nature conservation are provided by the project partners and cover a meaningful part of Europe thanks to the partnership of about 20 countries. Target user needs on data specification are investigated in a wide geographical and operational range of different situations in view of designing a common data model and defining a comprehensive metadata profile for the addressed set of INSPIRE items, which are validated throughout a process of consensus building shared by main EU stakeholders in the field.

Web services and a metadata catalogue will be implemented within a geoportal as powerful tools to actively involve the different kinds of addressed stakeholders.

The project deals also with multilingual issues and multicultural and interdisciplinary ontology to lead users to a standard and easier access to spatial data.

Finally, Nature-SDIplus networking activities are addressed, on the one hand, to collect best practice experiences by stakeholder organisations and, on the other ones, to involve a valuable number of stakeholders in the data specification process with the objective to establish a Community also as a real demonstration of the liveliness of the Nature-GIS thematic Spatial Data Interest Community (SDIC) already registered within INSPIRE.

Dissemination and awareness activities accompany the project development to support a wide impact at EU level.

Role of GraphiTech:

GraphiTech is responsible for definition of the system architecture of the final geoportal and for the technical development, and implementation with the other GIS services, of a 3D geobrowser providing access to a pan European database of multilingual geographical data. Furthermore GraphiTech is task leader of the definition of the system architecture of the final NatureSDIPlus geoportal.

Human Resources

The positive acquisition activity which has characterised the years 2009 requires starting new R&D activities both to reach the goal set by each and every ongoing project and to comply with the statutory principles of the Foundation. For this reason in the near future we have foreseen a appropriate enlargement of the Foundation’s staff.

The following list highlights the different roles of the Graphitech staff members and its students:

1. De Amicis Raffaele Director	1. Marco Calderan, Diploma student
2. Santato Letizia Administration	2. Daniele Magliochetti, Diploma student
3. Conti Giuseppe Senior Researcher	3. Erika Kausi, Diploma student
4. Girardi Gabrio Analyst Developer	4. Silvia Bordin, Diploma student
5. Piffer Stefano Analyst Developer	5. Michele De Biasi Diploma student
6. Bruno Simoes PhD Student	6. Federico Devigili Diploma student
7. Savadkoohi Bita PhD Student	7. Massimo Santini Diploma student
8. Andreolli Michele Developer	

Currently only one research is not employed as structured member of staff, and it currently benefits from a fixed-term employment contract “a progetto” in the context a Marie Curie ITN project in conformity with the provisions set forth in the grant agreement signed with the European Commission.

The first three Early Stage Researcher (ESR) who will join the Foundation in the end of 2009 will be most probably recruited among trainees and students working at GraphiTech for their master thesis. These will join the Foundation through a fixed-term employment contract leading to a tenure track. At least two of them will work in the application domain of GeoVisual Analytics. Nevertheless to maintain and enhance the competitively of the Foundation it is indispensable to strengthen GraphiTech’s internal competences both through recruiting senior researcher, through an international call, or through direct call of internationally acknowledged scientist from abroad, in the following area:

- Virtual Engineering
- Technoculture, Art and Games
- GeoVisual Analytics

Senior researcher will cooperate with Graphitech researchers thus contributing to the strengthening of the Foundation’s competences.

With regard to this, Graphitech expectations can be summarized as follow:

- To develop and carry out a research project under the control of Graphitech’s management.
- To present the proposed research to at least three top peer-reviewed conferences and/or journals in the domain of reference per year, with the exception of the first year for which only one top peer-reviewed publication is expected.
- To prepare a research grant applications to national and international funding programs or equivalent organization.
- To design and teach one undergraduate course during the three-year fellowship on a topic proposed and developed in collaboration with Graphitech’s management.

- To participate actively in the bi-monthly Graphitech Seminar.
- To conform to worldwide standards of responsible conduct in research and comply with all applicable policies and procedures.
- To participate in open and timely discussion with staff at Graphitech regarding all facets of the fellow's research and educational activities.

To meet this goal it is necessary to have access to a further economical and financial support within the Framework Programme with the Province, through instruments and opportunities similar to those that may be offered to the other players within the Trentino research ecosystem.

The three research lines, expressed according to the principles at the basis of the aforementioned definition of computer graphics, all reflect a common underlying vision of an networked digital environment, extending across the so-called "information continuum", spanning from Virtual Reality to, whenever digital content is blended with the real world, Mixed and Augmented Reality.

GraphiTech Publications

2009

Edited books

- De Amicis R., Stojanovic R., Conti G. (2009). Geographical Information Processing and Visual Analytics for Environmental Security, proceedings of NATO ARW. NATO Science for Peace and Security Series - C: Environmental Security. Springer Science and Business Media.

Book Chapters & Articles in Monographs

- Giuseppe Conti, Raffaele De Amicis, Gabrio Girardi, Michele Andreolli, Stefano Piffer (2009). The role of interactive computer graphics to augment the learning experience of cultural heritage within museums and expositions. In Handbook of Research on Learning Culture and Language via ICTs: Methods for Enhanced Instruction, Maiga Chang and Chen-Wo Kuo (Editors), Information Science Reference, Hershey, USA, pp. 153-169. ISBN 978-160566166-7.

International Journals

- De Amicis R., Conti G., Simões B., Lattuca R., Tosi N., Piffer S., Pellitteri G. (2009). Geo-Visual Analytics in the Future Internet. In the International Journal on Interactive Design and Manufacturing (IJIDeM), March 2009, Springer.
- Giuseppe Conti, Raffaele De Amicis, Gabrio Girardi, Michele Andreolli, Stefano Piffer (2009). The role of interactive computer graphics to augment the learning experience of cultural heritage within museums and expositions. In Handbook of Research on Learning Culture and Language via ICTs: Methods for Enhanced Instruction, Maiga Chang and Chen-Wo Kuo (Editors), Information Science Reference, Hershey, USA, pp. 153-169. ISBN 978-160566166-7.

International Conferences

- Bita Ture savadkkohi and Raffaele de Amicis, " A CAD system for evaluating footwear fit". In first International Conference on Multimedia, Computer Graphic and Broadcasting, Jeju Island, Korea, December 10-12, 2009.

- Bita Ture savadkoohi and Raffaele de Amicis, "Similarity Estimation for computerize footwear fit". In 19th International Conference on Computer Graphic and Vision, Moscow, Russia, October 5-9, 2009.
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- De Amicis R., Conti G., Simões B., Piffer S. (2009). User-friendly interactive WPS programming. In proceedings of FOSS4G 2008 Open Source GIS: an option for Developing Nations. Sydney, Australia, 20th -23rd Oct. 2009.
- De Amicis R., Conti G., Simões B., Piffer S. (2009). An innovative platform for territorial control and monitoring - The experience of a project at the local administration level In Proceedings of eChallenges e-2009, 21 - 23 October 2009, Istanbul, Turkey.
- Conti G., De Amicis R. (2009). i-Tour - "intelligent Transport system for Optimized URban trips. In Proceedings of eChallenges e-2009, 21 - 23 October 2009, Istanbul, Turkey.
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- Bita Ture savadkkohi and Raffaele de Amicis, "Foot wear from three- dimensional scans: An accurate reverse engineering system and comparison". In Conference on Geometry Theory and application, Plizen, Czench Republic, Jun 29-July 2,2009
- Conti G. Disperati S., De Amicis R., Thornton P. (2009). The use of Geobrowser, Virtual Worlds and Visual Analytics in the context of developing countries' Environmental Security. In Proceedings of 6th Digital Earth Conference, Beijing, 2009.
- Giuseppe Pellitteri, Raimondo Lattuca, Salvatore Concialdi, Giuseppe Conti and Raffaele De Amicis (2009). Architectural Shape Generating, Through Environmental Forces. In T. Tidafi and T. Dorta (eds) Joining Languages, Cultures and Visions: CAAD Futures 2009 - proceedings of CAAD Futures 2009, Montreal. Pp 875-886, PUM, Montreal.
- Simoes B., Conti G., De Amicis R., Piffer S., (2009). Enterprise-level architecture for interactive web-based 3D visualization of geo-referenced repositories. In proceedings of Web3D, Darmstadt 2009.
- Conti G., Simões B., Piffer S., De Amicis R. (2009). Interactive Processing Service Orchestration of Environmental Information within a 3D web client. In proceedings of GSDI 11, Spatial Data Infrastructure Convergence: Building SDI Bridges to Address Global Challenge, Rotterdam, The Netherlands 15-19 June 2009
- Pellitteri G., Lattuca R., Concialdi S., Conti G., De Amicis R. (2009). Architectural Shapes Generated In 3d Geobrowser Through Environmental Constraints. In proceedings of 4th ASCAAD Conference, May 11-12 2009, Manama, Bahrain.

CELCT – CENTER FOR THE EVALUATION OF LANGUAGE AND COMMUNICATION TECHNOLOGIES

Name	CELCT – Center for the Evaluation of Language and Communication Technologies	
Type	Applicative	
Head	Emanuele Pianta	
Staff	2009	2010
	7 Researchers	6 Researchers
	3 Technologists	3 Technologists
	0 Post Doc	0 Post Doc
	0 PhD	0 PhD

Document Status submitted 2009-11-18

1. Executive Summary

CELCT is an independent center founded in 2003 under the initiative of ITC-irst (now FBK) and DFKI (Deutches Forschungszentrum für Künstliche Intelligenz), with the mission of becoming a competence unit for the evaluation of multimodal language and communication technologies. Evaluation activities in this area were already performed within the two institutions that are the charter members of the center. However FBK and DFKI thought that it was convenient for them to move those activities to an independent specialized organization, which could offer its services to a larger research and industry community, and could also guarantee the high level of competence and independence which is expected from an international evaluation center. In the last four years the center has interpreted its mission by promoting and participating in a number of evaluation-related activities. The activity of CELCT should be put in a international context where evaluation activities for language and communication technologies are becoming more and more widespread especially in the research community. Evaluation activities imply at least four aspects: definition of a task to evaluate, production of reference datasets (benchmarks); development of evaluation paradigms and methodologies; organization of evaluation campaigns. CELCT can play an important role in this international context. The main rationale for CELCT activity is the need to concentrate and factorize competences which are now scattered in different organizations and that suffer a lack of coordination and long term view, as well as shortage of funding. The role of as small center as CELCT cannot be that of substituting those activities, but should be facilitating and promoting them, acting as reference point and multiplier. In the first phase of its activities CELCT has mainly struggled to gather competences an to gain visibility and credibility in the evaluation community. It is now

time to increase the level of linking and interaction with all the important players in the arena. For this reason, in accordance to the indications coming from the Autonomous Province of Trento as well as from FBK and DFKI, we are planning to transform CELCT in a non-profit association between European research institutions that recognize the need for establishing a center specialized in evaluation activities in the Human-Language Multi-Modal Communication Technology field (HL-MCT). In the near future we plan to contact a number of international institutions sharing common strategic views about the relevance of evaluation activities for research and industry, about the role of CELCT to foster such activities, and about the best ways of promoting and sustaining them in a European context. Research institution will be invited to share the CELCT project by becoming associates of the center. The members of the association sponsoring CELCT activities will be asked: (1) to pay a relatively small association fee; (2) to involve CELCT in project proposals, when this is appropriate given the aims of the projects and the competences of CELCT; (3) to contribute human and/or infrastructural resources to the activities of the center on the basis of project plans to be agreed upon between CELCT and each of the members (something that in this moment FBK is already doing); (4) to promote the exchange of scientific expertise between the associated members and the evaluation center.

At the beginning of 2009, the Province of Trento, has extended the financial support to CELCT for one year, asking us to improve the level of inter-connection of the center both in Italy (with special emphasis on the relations with CNR) and with other European Institutions. A number of important steps have been done in the requested direction. Prof. Francesco Beltrame, director of the CNR Department for Information and Communication Technology has been contacted, and talks are undergoing about the preparation of a national level program in collaboration with Istituto Enciclopedia Trecanni. Local contacts have also been taken with CNR Laboratory for Applied Ontologies (LOA). Given the publication by the PAT of a number of post-doc grants for researcher willing to move from outside to research institutions based in Trentino, a number of Italian and European Research Centers were contacted to ask for candidates which would be willing to apply: University of Lisbon, University Pompeu Fabre in Barcelona, University of Sheffield, University of Prague, Bar Ilan University in Tel Aviv, Institute for Language and Speech Processing in Athens. This activity has allowed CELCT to start new promising relationships which can produce interesting results in the future. We are also in the processing of organizing an Advisory Board for the center, which will gather representatives from both the research and industry communities. Six candidates of local, national, and international level have been contacted and are ready to join the Board. Other will be involved in the near future. A networking activity has also been the level of the European Commission (dott. Roberto Cencioni). As a result of this meeting it has been agreed that the EU is willing to host in Luxembourg an event organized by CELCT with the aim of raising the level of awareness about the importance of evaluation activities in Europe.

2. Vision and Scientific Program

2.1. Context and State of the Art

CELCT is an independent center founded in 2003 under the initiative of ITC-irst (now FBK) and DFKI (Deutches Forschungszentrum für Künstliche Intelligenz). The activities of the center actually began at the end of 2004 and have been funded up to 2008 by a grant of the Province of Trento (PAT). The grant has been extended for one year in 2009. Negotiations are undergoing for a new three-years grant for the period 2010-2012.

The center was founded with the mission of becoming a competence unit for the evaluation of multimodal language and communication technologies. Evaluation activities in this area were already performed within the two institutions that are the charter members of the center. However FBK and DFKI thought that it was convenient for them to move those activities to an independent specialized organization, which could offer its services to a larger research and industry community, and could also guarantee the high level of competence and independence which is expected from an international evaluation center.

In the last four years the center has interpreted its mission by promoting and participating in a number of evaluation-related activities. More specifically CELCT has contributed to the organization of national and international evaluation campaigns, such as CLEF (Cross Language Information Access - with specific focus on Cross Language Question Answering), DUC (Document Understanding Conference, automatic summarization), IWSLT (International Workshop on Spoken Language Translation, speech-to-speech automatic translation), Evalita (Evaluation of tools for Italian language processing), RTE-PASCAL (Recognizing Textual Entailment). The center contributed also to the evaluation activities of two European Projects (EuroMatrix, PatExpert) and to a number of national research projects such as ontoPrivacy (creation of domain ontology from the Italian Data Protection Code) and LiveMemories (annotation of a corpus of Italian news according to the TimeMl standard). CELCT has also been involved the SmsCollector industry project (collection and annotation of a corpus of 2 million words of Sms messages).

The activity of CELCT should be put in a international context where evaluation activities for language and communication technologies are becoming more and more widespread especially in the research community. Evaluation activities imply at least four aspects: definition of a task to evaluate, production of reference datasets (benchmarks); development of evaluation paradigms and methodologies; organization of evaluation campaigns.

The *selection of a target task* to evaluate is a crucial aspect of any evaluation activity. The choice can be done on the basis of theoretical motivations or as an answer to the (real or supposed) needs of technology users; it can follow research community interests and practices, or can be urged by funding agencies (possibly inspired to political motivations). For instance, evaluation activities on information extraction and machine translation have been promoted in the United States by public government agencies, in specific domains such as terrorist attacks, and for specific languages such as Arabic or Farsi, which show a clear connection with the priorities of the foreign policy of the United States government. On the other side,

evaluation activities on the task of word sense disambiguation have been promoted by researchers groups in Europe mostly in accordance with the theoretical interests of the research community. Finally, evaluation in the area of information retrieval may constitute an example of technology-driven evaluation activities, given the high impact of search engine development for the Internet industry. It should be noted that whereas in the United States the institutions responsible for research funding have since long time understood that evaluation can be used as a means to orient and foster research according to specific strategic directions, in Europe evaluation activities have been basically left to the research community, with little or no public support. This has both advantages and disadvantages, as we will see below.

Once a task has been chosen, it is very important that it is clearly defined in a way that allows for actually measuring and comparing the performance of concrete systems. For instance, whereas the natural language processing research community has since longtime recognized the importance of inference for text understanding, only recently with the definition of the task of textual entailment it has become possible to evaluate the ability of systems to deal with inference on a shared and measurable ground.

The second activity crucial to evaluation is producing *reference benchmarks*. This requires first of all a *selection* of relevant data (e.g. text documents, user clicks, video-recordings, etc), so that they constitute a significant sampling of the data on which systems are expected to operate in a real life situation; for instance, if the task consists in extracting relevant texts from HTML pages (by skipping menus, advertisement, copyright warnings, etc.), then we need to collect a set of HTML pages which reflects the variability of structures and layouts that can be found in current websites. Reference datasets are usually split in two parts, the *development* and the *test dataset*. The development dataset can be inspected by system developers and used to train or tune their systems, whereas the test dataset should be used blindly to evaluate the final performance of a system. The splitting between development and test dataset should be performed so that they are reasonably homogeneous in terms of sampling of significant phenomena. In most, but not all, cases a manual annotation of the selected dataset is performed, which is then used as gold standard (or ground truth) for measuring the performance of automatic systems, that is as the optimal output that systems should try to obtain. Note that if the manual effort to annotate data is too intensive, the benchmark may be produced only for test purposes (no development set is made available). *Manual annotation* of data requires very specialized skills: design of the annotation scheme; production of clear annotation guidelines; development or adaptation of specific graphical user interfaces for annotation; selection, instruction, training and coordination of annotators; assessment of the agreement between them; release of the annotations in standard-compliant exchange formats.

In the area of manual annotation, two innovative approaches have been recently introduced with the aim of getting more annotated data at lower costs. They are both based on Internet and on-line communities. The first approach exploits on-line games. The idea here is set up on-line games that are entertaining for internet users, and allow, as a side effect, for the collection of data which can be used in the

same way as manual annotations (see the ESP game, which allows for collecting word-annotated images). Another innovation in this area comes from the recent introduction of the so called Mechanical Turk, which is a web-based service made available by Amazon America. The service can be seen as a sort of on-line work market, where people can propose simple tasks to be executed through an on-line interface, and other people from all over the world accept to execute the task. The proposed tasks must be very simple and their cost are usually relatively low. A number of people have proposed the following strategy to exploit the Mechanical Turk for data annotation: take a possibly complex annotation task and try to decompose it in a number of elementary steps; propose each of them as an elementary task through the Mechanical Turk; propose each elementary task to at least 5 or more annotators, and keep only those annotations which show a good level of agreement between annotators. The total number of annotators required by this strategy is much higher than in the traditional approach, but, given their lower cost, the total cost of the annotation may be consistently lower as well.

It should also be noted that not all tasks allow for adopting the gold standard approach to evaluation, that is deciding in advance what is the optimal output of a system. In some cases, as for instance in information retrieval, where systems are expected to select a ranked list of documents relevant for a topic, the nature of the task makes the gold standard approach unfeasible. For this tasks it is necessary to use post-hoc evaluation, that is we first take the output of the system and then assess its goodness.

Whether the evaluation is based on a priori gold standard, or post-doc evaluation, a crucial issue is what *metrics* can be used to measure the performance of a system in comparison with other systems. A good metrics should be clearly defined; it should be meaningful, that is it should be easy for humans to understand what aspect of the task it measures; ideally it should also be possible to calculate the metrics in a automatic way, without the need of human judgment/intervention, but maintaining a good correlation with human judgments. The field of information retrieval has produced some of the most widely used metrics that are *precision*, *recall*, and a combination of them called *F-measure*. The rationale behind these metrics is measuring on one side how accurate the output of the system is (precision) and on the other side how much of the expected output is actually produced (recall). Other metrics have been proposed for different tasks. For instance the so called Blue Score proposed for the evaluation of machine translation, turned out to be crucial for a substantial advancement of the field. Note that the machine translation task can exploit the gold standard approach, as human-made translations can be used to this purpose. However the research in this field did not develop all its potentialities until a metrics was developed which could be calculated automatically by comparing the output of the machine translation systems with a pool of reference human translations, and which proved to correlate in a significant way with human judgment about the quality of a translation. Generally speaking the availability of a gold standard combined with a metrics which can be calculated independently of human intervention is crucial for the development of any task, as it allows system developers to tune and measure in any moment the performance of their systems.

The so called *evaluation campaigns* are the most successful modality for promoting the assessment of the state of the art of a field on a specific task, although they are and should not be considered as the only option (see below). A typical evaluation campaign is based on the following steps: definition of the task which is object of the campaign; publication of a call for participation; preparation of a possibly annotated dataset to be distributed to participants; distribution of the training data to be used by participants to train or tune their systems; distribution of the test set to the participants, who in a limited time slot (e.g. one or two weeks) are expected to run their systems on the test data and to send the results to the organizers; evaluation of the results of the systems on the basis of well established and shared evaluation metrics; analysis of the results of the campaign; organization of a workshop or conference, where the results of the campaign are made public and are analyzed by all participants in order to assess the degree of advancement of the field on the specific task and the perspectives for further developments; publication of the papers presented at the workshop/conference. The datasets used for the campaign use usually made available through a portal and can be used by other system developers to compare the performance of their systems against the results of state of the art systems.

This approach to evaluation can be labeled as *in-vitro*. As all in-vitro research, it has a huge number of advantages, but also some shortcomings. The main problem with the in-vitro evaluation of technology is that it does not take into account the role of the user of the technology. This may explain perhaps why the research on language and communication technologies has had so far relatively little impact on the industry. To obviate to this lack of impact, evaluation of language and communication technologies should be more and more concerned with the role, the needs, and the reaction of users of such technologies. This is not an easy task, however. Involving the user can be highly challenging from an organization and methodology point of view, and will require much higher investments than in-vitro evaluation.

2.2. Vision and Goals

CELCT can play an important role in the international context sketched in the previous section. The main rationale for CELCT activity is the need to concentrate and factorize competences which are now scattered in different organizations and that suffer a lack of coordination and long term view, as well as shortage of funding. The role of as small center as CELCT cannot be that of substituting those activities, but should consist in facilitating and promoting them, acting as reference point and multiplier. In the first phase of its activities CELCT has mainly struggled to gather competences and to gain visibility and credibility in the evaluation community. It is now time to increase the level of linking and interaction with all the important players in the arena. For this reason, in accordance to the indications coming from the Autonomous Province of Trento as well as from FBK and DFKI, we are planning to transform CELCT in a non-profit association between European research institutions that recognize the need for establishing a center specialized in evaluation activities in the Human-Language Multi-Modal Communication Technology field (HL-MCT). In the near future we plan to contact a number of international institutions sharing the following strategic views:

- *Evaluation* is crucial to the development of HL-MCT research; this is clearly shown by the growing number and relevance of evaluation campaigns in the research practice of the field; evaluation campaigns provide the ground for a fair and methodologically sound comparison of results obtained by competing scientific approaches; they also provide benchmarks and annotated data that foster research beyond the campaign itself.
- Organizing an *evaluation campaign* is a complex, specialized and costly task, which requires scientific strategic vision, managing skills, specialized methodological competence, computational infrastructures, trained human resources to annotate data and/or evaluate them.
- Although the HL-MCT community already deems evaluation-related issues as fundamental, there is much space for improvement. For instance, it still happens too often that the results described in a published paper can hardly be reproduced by other researchers. What we would like to see is something like the following: if a researcher runs an experiment and publishes its results, then the set up, the data sets, even the software used for the run, are made available from a stable and public repository so that other researchers can reproduce the same results, understand how they where obtained, test the same software on a different dataset. At least, it should be possible to make a difference between researcher that follow this practice and those who do not.
- Whereas in the United States, there exist an *official institution* (National Institute of Standards and Technology - NIST), funded by the central government, which promotes and co-ordinates evaluation activities, in Europe evaluation activities are self-organized and promoted by individual researchers on a voluntary basis; one of the few evaluation initiatives receiving partial funds from the EU (Treble-CLEF) has been recently discontinued. This bottom-up approach to evaluation has in immense value and should not be neglected. However it also has its weaknesses, such as the lack of coordination and long-term view, the potential lack of continuity due to its volunteering basis, the difficulty in finding synergies and exploit scale factors; the inability to trigger fund raising.
- Another crucial aspect sets Europe apart from the Unites States, as far as the evaluation of language related research is concerned. Europe is strongly *multilingual*. The evaluation effort must be multiplied by the number of languages that are spoken in the European Union. The lack of evaluation benchmarks and organized evaluation activities can seriously hinder the development of HLT research on minority languages. A super-national institution could take the role of facilitating the development of language-specific evaluation activities by factorizing effort and porting methodological and managing expertise from resource-rich to resource-poor languages.
- It is time for the European research community to support an institution that takes over the task of promoting and coordinating evaluation activities in a *stable* and *organized* way, complementing and integrating the bottom-up, volunteering approach.
- Although the European Commission seems not to be ready at the moment to directly create/fund an evaluation center, *European research institutions* can

promote and support the development of such a center, with the final aim of getting recognized (and partly funded) by the EU. The supporting research institutions share the view that the evaluation center should be distinct from each of the supporting institutions, but also recognize their interest in influencing and promoting its evaluation policy.

This plan can look like too ambitious, but this is not true if we start from what CELCT already is, and can do. We are not saying that CELCT is already the center that has been tentatively described above. We are saying that it has the concrete potentiality of becoming what we are looking for.

A number of accompanying conditions make CELCT a good candidate to become a European reference point for the evaluation of HL-MCT research and development. Based in Trento, near the cross-point of the boarder between South and Nord Europe, and the border between West and East Europe, CELCT takes advantage of the financial and strategic support of a local government that strongly believes on the necessity to foster research and innovation, as a means to win the challenges of economical and social development. Also, CELCT is based in a geographical area hosting a pool of research institutions and companies which form a sort of education, research, and development district focused on HL-MCT topics: FBK, University of Trento (DISI, CIMEC, HLTI Master), University of Bolzano (European Master in Language and Communication Technologies), Expert System spa, PerVoice spa. Some of the research institutions in this group are participating, along with CELCT and with a big number of other research institutions in Europe, to the proposal for the creation of a Knowledge and Innovation Community (KIC) funded by the European Institute of Innovation and Technology (EIT).

Although the research community is the first addressee of the CELCT activity, we think that the interaction with the industry world is also an essential part of our mission. To improve on this aspect, we are in the process of creating an Advisory Board which will include a number of local, national and international industry players in the HL-MCT field. This organism is expected to give CELCT advice about the needs and the perspectives of the HL-MCT industry with a focus on evaluation-related activities.

Given the requirements for a European evaluation center in the HL-MCT field that has been sketched above, the first issue to be settled is how would such an ideal center sustain itself, assuming that CELCT is the starting point for that. Here follows what we think is a reasonable hypothesis. In the first phase, around half of the funding will come from the Autonomous Province of Trento, which has funded CELCT so far and is willing to do that for at least the next coming years. The other half of the funding should come from European and industrial projects.

The members of the association sponsoring CELCT activities will be asked:

- to pay a relatively small association fee (around 10.000 Euros);
- to involve CELCT in project proposals, when this is appropriate given the aims of the projects and the competences of CELCT;
- to contribute human and/or infrastructural resources to the activities of the center on the basis of project plans to be agreed upon between CELCT and each of the members (something that in this moment FBK is already doing) - this contribution can vary from one member to the other and from time to time;

- to promote the exchange of scientific expertise between the associated members and the evaluation center.

Each member will have a representative in the Associates Board, and will vote for the election of the representatives in the Board of Directors.

The detachment of human resources is probably the most demanding requirement for the associate members. To make an example, what we mean is the temporary detachment of a researcher (e.g. 6 person months) to act as the scientific responsible of an evaluation campaign. CELCT should be very flexible on this point, and expect that this actually happens only when the participation of an associate member in the center is well consolidated and the reciprocal advantages are well defined. At a very short term, in order to start the process of enlarging the associates base and make the project behind it plausible, CELCT needs from new associated member at least items (1) and (2) of the above list.

2.3. Activities and Work Plan

Here follows a list of activities that we think CELCT could carry out to realize its mission (a portion of them are already part of what CELCT is currently doing).

- Define, organize and run *evaluation campaigns*.
- Provide *managing support* to research individual/groups willing to organize an evaluation campaign.
- Develop evaluation-oriented *benchmarks*.
- Promote the evaluation/comparison of specific *HL-MCT engines* distributed for research purposes and or under open/free software license.
- Promote the development of a *Web Service infrastructure* facilitating the comparison of HL-MCT software installed in different places but accessible trough the Internet.
- Support *companies* developing HL-MCT applications in the (public or private) assessment of the software they produce.
- Design and support a rich and *interactive portal*, collecting all information about evaluation related issues.
- Certify that a commercial HL-MCT application is compliant with a recognized *standard* (should such a standard be defined).
- Certify that a publicly funded research project has followed *safe evaluation methodologies*.

The evaluation related activities of CELCT can span on a broad range of HL-MCT tasks. For some of them CELCT has already internal scientific competences: morphological analysis, PoS tagging, chunking, sentence splitting, word and sentence alignment, multi-word extraction, key-phrase extraction, entity recognition, relation extraction, event recognition, local and cross-document co-reference, shallow and deep parsing, question answering, lexical acquisition, wordnet and framenet development, cross-language semantic projection, ontology learning, corpora annotation, textual entailment.

For other tasks the center can rely on the scientific co-operation with its two supporters, FBK and DFKI, and the increasing integration between FBK, CELCT and University of Trento, in the HL-MCT area: anaphora resolution, semantic role labelling, opinion mining, dialogue processing, word sense disambiguation, text classification, information extraction, machine translation, speech recognition, human computer interaction, computational humour, assisted cognition.

We expect that the broadening of the pool of research institution that support CELCT can widen also the range of scientific topics for which CELCT has the expertise or scientific consultancy to carry out evaluation activities: see for instance automatic generation, summarization, ontology development.

As for the coming year (2010) CELCT has already planned a number of specific activities which are described in the following list:

- *CLEF2010*: CELCT will be the organizer of CLEF2010 (Conference on Multilingual and Multimodal Information Access Evaluation). More specifically it will be responsible for maintaining the site of the conference and the related evaluation campaign, and will also be responsible for the publications.
- *RTE-6*: CELCT will participate in the organization of the sixth edition of the Pascal Challenge called Recognizing Textual Entailment.
- *LiveMemories*: CELCT will continue an activity started in 2009 aiming at the annotation of a corpus of local newspaper documents according to the TimeML standard. TimeML allows for annotating information about temporal expressions, events, and temporal relations between events. Temporal processing is becoming a very important task for language processing, and CELCT aims at becoming a reference point at international level for the evaluation of this task.
- *Cosyne*: CELCT will participate in the annotation activities of a European project led by FBK, whose aim is applying concepts and techniques coming from the Textual Entailment task to machine translation.
- *Evaluation Portal*: CELCT will start an activity aiming at building a portal where evaluation related information and resources will be collected and made available to the public. In building this infrastructure we will experiment with innovative ways of offering evaluation services through the Web.
- *Publications*: acquiring credibility in the scientific community is crucial for a center which aims at being considered a reference point for evaluation activities. For this reason it is important that CELCT gets published the results of its work in relevant scientific conferences and journals.

2.4. Collaborations

At the beginning of 2009, the Province of Trento, has extended the financial support to CELCT for one year, asking us to improve the level of inter-connection of the center both in Italy (with special emphasis on the relations with CNR) and with other European Institutions. The realizations of such ambitious objectives has been at the top of the priority list of the managing activities of the center although a few factors did not help in realizing them. On one hand the uncertainty about the amount of the PAT funding for the 2009 was not an optimal condition for looking

outside and forward. On the other hand, the change of the director of the Center (a process which was started in May 2009, and, because of administrative reasons, was formalized only at the end of October), has caused, at least for a short period, a discontinuity and a new start of the managing activities.

Nevertheless a number of important steps have been done in the direction requested by the PAT. Prof. Amedeo Cappelli, former director of CELCT, has been requested by the Board of Directors to explore the possibilities of a stricter cooperation with CNR. This has led to a meeting with prof. Francesco Beltrame, director of the CNR Department for Information and Communication Technology. In this meeting CELCT has been introduced and the chances of cooperation with CNR have been explored. Thanks to the support of prof. Beltrame, a further meeting has followed including also representatives (Tullio Gregory, Francesco Tatò) of the Istituto dell'Enciclopedia Italiana Treccani, the most important Italian encyclopedia editor, which is undergoing a big effort to renew and widen its cultural and editorial offering. The aim of the meeting was to investigate the perspectives of a cooperation between Istituto Treccani, CNR, and CELCT, in which CELCT would be responsible for the evaluation of the language technologies used in the project. Further meetings are planned for the near future. We are confident that the reciprocal knowledge and trust which can develop in the framework of this project will make possible a more structural involvement of CNR in the CELCT activities and governance.

Besides the contacts at national level, given the presence of a CNR institute also in Trento, contacts have been established with the Laboratory of Applied Ontologies (LOA), led by Dr. Nicola Guarino. This has led to organizing a half day retreat for the beginning of December, where CELCT and LOA will present their activities, and look for contact points and cooperation chances.

A networking activity has also been carried out at European level. Given the publication by the PAT of a number of post-doc grants for researcher willing to move from outside to research institutions based in Trentino, a number of Italian and European Research Centers were contacted to ask for candidates which would be willing to apply: University of Lisbon, University Pompeu Fabre in Barcelona, University of Sheffield, University of Prague, Bar Ilan University in Tel Aviv, Institute for Language and Speech Processing in Athens, are among the institutions from which candidates have been solicited. Although in practice none of the contacted international institutions contributed with any grant candidate, also because of the summer period when the call for application was published, we think that this activity has allowed CELCT to start new promising relationships which can produce interesting results in the future. Also, the search for grant candidates has produced a result within Italy, from Pisa University, with an excellent Italian candidate who has good international connections, and with a project which could be of great interest for CELCT and for evaluation activities in Italy.

Although the final aim of the CELCT networking activity is bringing new institutions to actively support the center (according to the plan sketched in section 2.2 above), we should also underline the fact that this cannot be achieved in a too short period of time. The first condition for achieving this result is that institutions which we would like to involve become to know the center, its activities, its long-term objec-

tives. We want them to appreciate our competence and to become aware of the potentialities of the center and the vision which supports our work. We want them to appreciate the plus which is guaranteed to the center from getting financial support from the local government and from being based in geographical area hosting one the most important research districts for language and communication technologies. This takes time, and we think it could be facilitated by inviting relevant research institutions to participate in the Advisory Board of the center, which has also the aim of getting feedback and advise from industry language technology players. To this extent a number of contacts have already been established with positive results:

- Frederique Segonde, Principal Scientist & Area Manager at the XEROX research center in Grenoble, France;
- Ido Dagan, president of the Association for Computational Linguistics, from Bar Hilan Unversity in Tel Aviv, Israel;
- Khalid Choukri, director the ELDA company in Paris, France;
- Luca Dini, head of the CELI company in Torino;
- Alessandro Tescari, responsible of the PerVoice company in Trento;
- Marco Varone, president of COGITO company in Trento, and founder of Expert Systems the most important language technology company in Italy;

We are planning to activate further contacts with both companies and research institutions. Prof. Hans Uszkoreit, from DFKI, has agreed to cooperate in the search for contacts in the German language technology industry. Among the already active links, we would like to emphasize the relevance of the contact with the ELDA company. This is a well known company which is responsible for the distribution of Language Resources at European level, with interests also in the evaluation area. The availability of this company to co-operate with CELCT should be taken as an important result of the work done so far by the center. As a first result of this link we would like to mention the cooperation of ELDA and CELCT in the organization of the MLIA-day (Multi Language Information Access) in December in Berlin.

Getting support from the European Union is one of the long term goals of the CELCT internationalization activity. For this reason a meeting has been organized in September 2009 with dr. Roberto Cencioni head of unit at the EU in Luxembourg, responsible for the EU projects in the language area. The meeting allowed us to present CELCT's mission and to discuss its positioning at European level. As a result of this meeting it has been agreed that the EU is willing to host in Luxembourg an event organized by CELCT with the aim of raising the level of awareness about the importance of evaluation activities in Europe.

Finally we would like to mention the longstanding cooperation of CELCT with Donna Harman and her colleagues from the National Institute for Standards and Technology (NIST) in the United States. This cooperation will continue in the framework of the 6th RTE campaign (Recognizing Textual Entailment). Donna Harman is also a good candidate to become part of the CELCT Advisory Board.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Improve scientific visibility	R	E	Dec.	Number of publications, Involvement in scientific committees	
Acquire at least one new European Project	A	E	Dec.	Approval of the project by the EU	
Start the Advisory board of the Center	O	E	March	First meeting of the Board	
Involve 1 o 2 new research institutions as active supporters of the center	O	E	Dec.		
Improve project management	F	I	Dec.		

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Although in previous years CELCT has been able to reach a level of self-financing near to 50%, this is clearly not the case for the coming year 2010. The reason for this should be looked for in the uncertainty about the prosecution and the amount of PAT financial support which has been experienced at the end of the first three years grant in 2008. Of course it is very difficult to engage in the search for industry projects, or for European projects which asks for long term engagements, without a reasonable certainty about the availability and the amount of the complementary financial resources which are needed to run an institution such as CELCT. This explains in large part the low level of self-financing which is foreseen for the next year, but also suggests that it is very important that the situation changes. Guaranteeing a well defined and constant financial support (as has happened in the first years of the PAT grant to CELCT) is the best way to foster the ability of CELCT to improve its level of self-financing. Thus it is very important that CELCT gets a steady financing in a perspective of at least three years. The minimal level of public funded needed by CELCT is around 300.000 Euros per year. We prepared a budget which tries to keep both PAT funding and expenses at the minimal level which is still compatible with the achievement of the ambitious objectives of the Center (becoming a reference point in Europe for evaluation activities). Any reduction of these amounts will hinder the ability of the center to pursue its mission. We

are confident that during 2010 CELCT will be able to acquire new external projects which will enable the center to improve the level of self-financing and will widen the range of activities which the center can carry out. Whereas the provisional budget, based on certain incomes, assumes a self-financing of about 13%, we hope that thanks to the acquisition of projects and sub-contracting we can reach a level of self-financing equal or greater than 30%.

A correct illustration of the CELCT budget should take into consideration also the contribution of FBK and other associate members to the activities of the center. FBK is currently giving full logistic support to CELCT, and is paying two part-time people who play the role of director and vice-director of the center. This gives strong evidence of the active support of FBK and of its confidence into the strategic relevance and the perspectives of CELCT. The same confidence has been recently formally stated by DFKI. For the future we expect that further active support comes both from DFKI and from the new research institutes which will be involved as CELCT associates. As mentioned in Section 2.2 above, by active support from an associate member we mean the involvement of CELCT as partner or sub-contractor of funded projects run by the associate, and/or the temporary detachment of specialized personnel to CELCT.

The following tables illustrates the provisional budgets for 2009 and 2010. As for 2010 we provide a provisional budget based on certain incomes and another provisional budget which expresses the final objectives of the center.

Expenses (EUROS)	**2009 final**
Personnel	235,846
Travel	45,000
Equipment (HW/SW)	0
Other (e.g. subcontracting to external contractors)	153,775
Internal collaborations: “subcontracting”	0
Total Expenditure	**€434.621**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	159,197
Other external incomes (projects, grants, etc.)	20,000
Internal incomes (“subcontracted” by other units)	0
Total Income	**€179,197**
Financial Need (Incomes – Expenditure)	**€253,424**
Required Structural funding from PAT (it should be equal to the previous item)	***€253,424***
People paid by CELCT	**10**
People paid by FBK	**2**
Person months (CELCT)	**94**
Person months (FBK)	**12**

Expenses (EUROS)	**2010 prev**	**2010 final**
Personnel	220,000	270,000
Travel	25,000	30,000
Equipment (HW/SW)	5,000	5,000
Other (e.g. subcontracting to external contractors)	95,000	125,000
Internal collaborations: “subcontracting” to other unit	0	0
Total Expenditure	**€345.000**	**€430.000**
Incomes (EUROS)		
EU Projects (total amount financed by EU)	20,000	80,000
Other external incomes (projects, grants, etc.)	25,000	50,000
Internal incomes (“subcontracted” by other units)	0	0
Total Income	**€45,000 (13%)**	**€130,000 (30%)**
Financial Need (Incomes – Expenditure)	**€300,000**	**€300,000**
Required Structural funding from PAT (it should be equal to the previous item – TO BE DEFINED WITH PAT)	***€0***	***€0***
People paid by CELCT	**9**	**10**
People paid by FBK	**2**	**2**
Person months (CELCT)	**81**	**97**
Person months (FBK)	**12**	**12**

5. Human Resources

The CELCT staff is currently composed of 11 people; 2 of them are FBK employees. Distribution of works is as follow:

- 1 director (part-time)
- 1 secretary (full-time)
- 2 senior researchers (one part-time and one full-time)
- 3 researchers (full time)
- 2 junior researcher (full and part-time)
- 2 computer technicians (part-time)

Computer technicians are currently based in Pisa. One of the most important actions to improve the personnel situation will consists in hiring a full-time computer technician based in Trento (in substitution of the two part-time ones). We also need to improve project management. Given the high complexity of the skills required by the work, permanent education should be pursued mainly thanks to the cooperation with FBK, DFKI and the University of Trento. Salary levels are quite low. Although the financial situation for 2010 does not allow for much improvement on this area, it should be kept as important action for the following years.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
No new research center accepts to become CELCT's associate	M	M	If this happens, we would need to understand why other institutions are not convinced by CELCT proposal. Maybe this was not presented in the right way? Maybe the income-outcome of the proposal is not clear enough or not convenient enough? Depending on the answer we give to this question, we may need to adjust the presentation of the proposal and try again in the following year, or re-think the all internationalization strategy.
No new project is acquired	M	M/H	If the PAT financial contribution is kept steady in the next three years, this will cause a lack of additional financial resources. The balance can be kept by not extending or slightly reducing the center activities. If the Pat financial contribution is decreasing, this could cause e serious problem (the center may not be in a position to pursue its mission).

Legend*:*

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

CNR-FBK. BIOMOLECULES AND BIOLOGICAL MEMBRANES (IBF-CMM)

Name	Biomolecules and Biological Membranes (IBF-CMM)	
Type	Research	
Head	Mauro Dalla Serra	
Staff	2009	2010
	FBK	*FBK*
		1 researcher (permanent position)
		1 researcher as tenure track
	1 post doc	1 post doc
	0.3 secretary	0.3 secretary
	IBF	*IBF*
	1 senior researcher	1 senior researcher
	1 researcher npp[1]	1 researcher npp[1]
	1 post doc	1 post doc
	1 PhD student[3]	1 PhD student
	2 undergraduate students	1 undergraduate student
	0.3 secretary	0.3 secretary
		1 secretary[3]
		1 researcher[3]
		1 technician[3]
	1 associate professor	1 associate professor
	1 associate post-doc	1 associate post-doc

[1] npp = non permanent position;
[2] Starting by 2009/11/01 on a CNR grant);
[3] to be hired in process

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1. Executive Summary

Biomolecules and Biological Membranes (BioMBio) Unit has developed an original, inter- and multidisciplinary biophysical and biochemical approach to investigate structural and functional aspects of the interaction between proteins and biological membrane. Particular efforts have been devoted to study the mechanism of action of membrane-damaging toxins using model and biological membranes. These tox-

ins, known as Pore-Forming Toxins (PFTs) and AntiMicrobial Peptides (AMPs), are mainly bacterial toxins relevant for human health, but they are also produced by plants and animals and constitute their arsenal weapons for attack or defence. They reach the target cell causing destabilization of the plasma membrane and final cell death. A biophysical characterization of PFTs is important since they are excellent archetypal model systems for understanding key aspects of protein-protein and protein lipid interactions and protein conformational transitions. Recently, new evidences show a concentration dependence of PFTs action. Therefore particular attention will be focused towards the understanding of the secondary cellular effects induced by sublitic amounts of PFTs. In addition these toxins may have also many interesting biotechnological applications. For example as (i) component of antitumoral and antifungal drugs, (ii) biosensors in aqueous phase and (iii) component in drug delivery systems; some of which have been investigated from BioMBio Unit.

Collectively, the BioMBio Unit main activities will be focused on basic research on the understanding the mechanism of action of macro biomolecules with high relevance for human health and environmental impact.

The research personnel that belong to the BioMBio is mainly composed by highly motivated post-docs and PhD students. The only person with a permanent position is Mauro Dalla Serra, recently employee of CNR-IBF. An increase in the number of staff members is urgently needed.

Prominent collaborations:

Internal: C. Pederzolli on anticancer drug design and construction, drug delivery, design and construction lipid coated biomimetic nanosystems

Local: G. Guella (Dept. Physics, Uni. Trento): analysis of lipid composition of natural cell membranes (MS and NMR study), NMR study on bicelles of protein-lipid interaction, evaluation of some steps in anticancer drug design and tests (MS); C. Moser (FEM): characterization of AMPs involved in plant protection.

National: L. Bubacco (Dept. Biology, Uni. Padova): molecular mechanisms of neurodegeneration (Parkinson's disease); A. Carpaneto (CNR-IBF): electropysiological characterization of biomolecules able to modulate cell membrane permeability M. Colombatti (Dept.Pathology, Uni. Verona): anticancer drug design and tests.

International: G. Anderluh (Dept.Biology, Uni. Ljubljana, Slovenia): pore-forming toxins as useful tools in biotechnology, molecular mechanisms of action; M. Tejuca (Dept. Biochemistry, Uni. La Havana, Cuba): design and construction of new anticancer drugs; G. Prévost (Lab.Toxinologie Bacterienne, University L. Pasteur, Strasbourg, France): expression, characterization of the mode of action of beta PFTs from *Staphylococcus aureus*, design and test of new toxin inhibitors.

The research activity involves the use of biological samples such as human or animal blood.

2. Vision and Scientific Program

2.1. Context and State of the Art

Pore forming protein toxins (PFTs) and antimicrobial peptides (AMPs) are one of Nature's most potent biological factors of attack and/or defence. They are widespread throughout all the biological kingdoms. They constitute the arsenal of sophisticated and efficient weapons produced during the ancient evolutionary race between host and pathogens. PFTs produced by bacteria represent roughly 30% of all known bacterial toxins and constitute well known virulence factors of the pathogenic organisms which use them to wage war against rival bacteria and to attack human cells. PFTs are widespread in the venoms, fluids or secretions of many organisms and the number described is constantly increasing (Alouf, 2006). Similarly, AMPs represent a universal feature of the host defense system of virtually all forms of life (bacteria, plants, vertebrate, invertebrate, mammals): their primary role is to kill invading pathogenic organisms.

Not surprisingly, both classes of weapons interact and impair the integrity of the plasma membrane, which represents the first line of cell defence and is crucial for cell identity, function and vitality. PFTs and AMPs often kill cells simply by punching an aqueous pore through their membranes (Iacovache et al., 2008). Despite different in amino acid sequence and structure, the major steps leading to pore formation are similar (Anderluh and Lakey, 2008).

An essential feature of their toxicity is the remarkable property that PFTs can exist either in a stable water-soluble state or as an integral membrane pore. Pore-forming toxins are produced as soluble proteins but undergo a transition from hydrophilic to amphipathic nature in contact with membranes; this involves oligomerization of the surface-bound toxin. In fact, while the conformational change occurring within one monomer is generally small, the cooperative transition of a number of monomers and the favorable noncovalent interactions occurring in the oligomer together generate a stable membrane-inserted protein complex. The resulting poorly selective transmembrane pore is crossed by water and small molecules, but excludes proteins, nucleic acids and organelles. This can lead to osmotic unbalancement and subsequent cell lysis. In this way the pathogen can decrease the host defences and gain access to nutrients.

Interestingly, it has been recently demonstrated that some proteins playing key roles in the vertebrate innate immunity, like perforin and complement, share structural homologies with cholesterol-dependent cytolysins (Hadders et al., 2007;Rosado et al., 2007), a special class of Gram positive produced PFTs, which need cholesterol for exerting their toxicity. Furthermore, ubiquitary and endogenous proteins like amyloid peptides involved in neurodegenerative diseases could produce aberrant aggregates which mimic PFT (the so called amyloid pore hypotesis) (Lashuel and Lansbury, Jr., 2006). Similarly apoptotic proteins that are implicated in the programmed cell death share similar mode of action with PFTs (García-Sáez et al., 2006;Basanez and Hardwick, 2008).

It was originally proposed that the permeabilization of the cell membranes was the sole mode of action of these cytolytic macromolecules, there is an increasing body of evidences indicating that some PFTs as well as some AMPs exert their effects

through alternative mode of actions. At sublytic doses they could induce many cellular responses (Gonzalez et al., 2007), like pathway activation and modulation of endogenous channels activity (Kloft et al., 2009;Baba-Moussa et al., 1999); AMPs can act as metabolic inhibitors (Brogden, 2005) and modulators of immune response (Kruse and Kristensen, 2008;Bowdish et al., 2005).

Collectively, these molecules can be considered excellent candidates for studying and understanding key aspects of protein-protein and protein-membrane interactions, and for shining light on the structure-function relationships. In addition, they offer a number of biotechnological applications as component of antitumoral and antifungal drugs (for improving the biocontrol of pests and diseases), as biosensors in aqueous phase (for DNA sequencing and dangerous analytes detection), and as component in drug delivery systems. They can be also good targets for the development of new inhibiting strategies against bacterial and fungal infections, especially against resistant strains. Some of the above applications have been already investigated by this Unit. For example we have extensively studied staphylococcal leukotoxins, an important bacterial virulence factor. Moreover, they can be target for new antimicrobials, which may act by blocking these toxins, which are among the most potent bacterial weapons.

In the last five years BioMBio Unit has published more than 30 papers in peer reviewed journals on the effects of PFTs and AMPs, significantly contributing to the advancement of knowledge with international visibility.

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2.2. Vision and Goals

The main interest of BioMBio RU resides in the understanding of the structural and functional aspects of protein-biological membrane interaction, and in particular of the membrane-damaging protein toxins mechanism of action. This will be achieved using model and biological membranes through the application of typical methodologies and techniques of the physical sciences (e.g. biophysics, electrophysiology, molecular biology, biochemistry, spectroscopy and lipidomics). Knowledgeable use of these approaches and techniques makes it possible to go beyond the qualitative description of the macro and micro structures of living matter, and to move on to the identification of the molecular mechanisms underlying their function. As for the last few years the topic of our investigation will be the study of peptides and proteins (and their supermolecular structures) on the basis of their importance for human health and environmental impact. The aim is always to gain an integrated and multidisciplinary viewpoint that may allow us to advance and deepen our understanding of biological processes beyond a mere qualitative description.

In particular, depending upon the success of the submitted proposals, we will focus our attention and reinforce our collaborations with groups working on the scientific topics briefly described below.

(i) New evidences show a concentration dependence of PFTs action. Besides pore formation it was shown that at sublytic concentration they may cause a response in the host cell. They can (i) induce cell death through a necrotic pathway or apoptotic one, (ii) modulate the immune system, (iii) regulate the cell survival or proliferation, (iv) modulate ion channels activity. Our scientific interest will be focused on the understanding of the cellular effects induced by sublytic PFT concentrations. These state-of-the-art investigations will open new deep understanding of the biological role of these and other virulence fac-

tors. *In collaboration with CiBio (Viero), FEM (Moser) and Uni.Strasbourg (Prévost).*

(ii) Identification and characterization of PFTs that permits the design and development of anticancer devices. These proteins can be the toxic component present in immunotoxin or that can be loaded on magnetic nanoparticles. Furthermore the capability of PFTs to open pores of definite dimension (in the range of 1-100 nm) guarantees their use in drug delivery systems. *In collaboration with FBK (Pederzolli, Speranza), UniHabana (Tejuca) and UniTN (Migliaresi).*

(iii) The recently proposed "amyloid pore hypothesis" suggests the involvement of pore formation in the etiopathogenesis of some neurodegenerative diseases, like Parkinson's. Interesting results are recently obtained by BioMBio RU on α-synuclein effect, which need to be further investigated. In particular, the research focus aims to identify the part of the molecule responsible of such activity with some hypothesis on the mechanism of pore formation. Moreover, the unit aims to study in details the lipid composition of synaptic vesicle membranes, to better understand α-synuclein interaction with membrane in a more physiological environment. *In collaboration with UniPD (Bubacco), UniTN (Ricci) and CiBio (Macchi, Guella).*

(iv) The ability of PFTs and AMPs to interfere with cell viability is mediated by their interaction with the cell membrane, which is a complex and organized system. Some of these can recognize specific receptors on the membrane. This is why some PFTs and AMPs could be good sensor for investigating lipid composition and organization of cell membranes. *In collaboration with Uni.Ljubljana (Anderluh, Sepcic), FEM (Moser) and Uni.Lublin (Gagos).*

(v) Since PFTs can exist in two stable forms and need to oligomerize and to undergo a conformational transition to insert into target membranes becoming active they are excellent archetypes for the investigation of (i) protein-protein interaction, (ii) protein-lipid interaction, and (iii) protein conformational changes. This can be pursued by using our home-techniques and mass spectrometry and magnetic resonances facilities. *In collaboration* with UniTN (Guella).

(vi) Mitochondria generate most of the cell's supply of adenosine triphosphate (ATP), used as a source of the chemical energy. In addition, they are involved in a range of other processes, such as signaling, cellular differentiation, cell death, as well as the control of the cell cycle and cell growth. Mitochondria have been implicated in several human diseases, including mitochondrial disorders and cardiac dysfunction, and may play a role in the aging process. It was already proved that in some mitochondrial disfunctions proteins interacting with their membranes are involved (for example, pro and antiapoptotic proteins). Methods for preparing and testing mitochondrial viability will be developed.

(vii) The ability to express protein in heterologous systems will improve the study of all the above topics. It can give us the possibility to have a protein pool with all the kind of mutation in order to study in a refined way the structure, the function, and even to identify the parts of the protein responsible of a particular function or activity and to better characterize them. This fact enhances the potentiality of the investigation, also because mutations can be designed to

functionalize proteins with fluorescent molecules or spin probes, enlarging the number of possible experiments and results.

The results achieved will be evaluated in terms of publications in peer reviewed journals, invited oral presentations at international congresses, establishment of new prototypes and protocols, patents.

2.3. Activities and Work Plan

Activities and work plan for the next year will be mainly focused on the already funded research projects which are in the drugs delivery, neuroscience and agricultural fields.

The unit will be partially involved into basic research activities for improving our knowledge on protein-protein and protein-lipid interactions.

Since our approach is multi- and inter-disciplinary we will contribute to the establishment and reinforcement of local common technological platforms, e.g. mass spectrometry and magnetic resonances facilities at UniTN (G. Guella, K. Mueller) and FEM (F. Mattivi).

In more details the research activities of the next year will be focused on:

- Studies on the mechanism of action of some cholesterol dependent cytolysins and perforin. Both protein families are able to form huge yet uncharacterized pores that may be used also for facilitating nanoparticles and/or drug delivery into the cell. Electrophysiological data so far collected will be finalized to be published in two separate papers and will be described into two PhD theses in collaboration with the Slovenian group.
- In collaboration with the Cuban group of Mayra Tejuca we will continue our investigations toward building an anticancer chimera immunotoxin.
- Further investigations on the permeabilizing ability of α-synuclein (wt, mutants, dimers and truncated forms) are necessary for supporting our preliminary data and model. Electrophysiology, fluorescence and infra-red spectroscopy techniques will be involved. Lipid requirement and specificity for α-synuclein activity will be investigated by SPR (in Ljubliana), MS and NMR spectrometry (in Guella's lab).
- Studies on the lipid specificities of defensins, interesting AMPs involved in the plant innate immunity will be performed with classical biophysical techniques. We will also check the defensin ability to interfere with fungal endogenous channels (with Port-A-Patch system).
- We will start a new activity devoted to protein expression in heterologous systems. BioMBio RU will gain a lot from this new activity in terms of expertise and research autonomy and potentiality, as described above.

Roughly 20% of our activities are dedicated to: curiosity driven research, referee activity for reviewing international papers and project, high scientific formation and training of both internal and external personnel (by participating to international congresses and by teaching and tutoring activities at the school of doctorate), improve international collaborations also with exchanges of researchers, hosting stu-

dents for short term stages and opening the labs to schools, scientific knowledge dissemination through general seminars.

2.4. Collaborations

- FBK, Cecilia Pederzolli; anticancer drug design and construction, drug delivery, design and construction lipid coated biomimetic nanosystems
- FBK, Giorgio Speranza; stability and cell localization of functionalized nanoparticles possibly involved in cancer diagnosis and therapy
- CNR-IBF Genoa, Armando Carpaneto; electropysiological characterization of biomolecules able to modulate cell membrane permeability
- Dept. Physics, Uni. Trento; Graziano Guella; analysis of lipid composition of natural cell membranes (MS and NMR study), NMR study on bicelles of protein-lipid interaction, evaluation of some steps in anticancer drug design and tests (MS)
- Dept. Physics, Uni. Trento; Leonardo Ricci; noise interpretation and analysis of electrophysiological signals obtained from planar lipid membranes and/or patch clamp experiments
- CiBio, Uni. Trento; Gabriella Viero; regulatory effects of sublytic α-hemolysin doses
- CiBio, Uni. Trento; Paolo Macchi; *in vitro* studies of the cellular effects of proteins involved in neurodegenerative diseases
- FEM, Claudio Moser; expression and characterization of AMPs (defensins) involved in plant biotic stress
- CNR-IFN; Salvatore Iannotta; design and construction of new biosensors based on organic transistors
- BIOtech Research Center; Claudio Migliaresi; characterization, *in vitro* cell interaction and localization of functionalized magnetic nanoparticles possibly involved in cancer diagnosis and therapy
- Dept.Pathology, Uni. Verona; Marco Colombatti; anticancer drug design and tests, antibody production
- Dept. Biology, Uni. Padova; Luigi Bubacco; expression, biochemical and biophysical characterization of α-synuclein involved in Parkinson's disease
- Dept. Biology, Uni. Bologna; Elena Baraldi; expression and characterization of AMPs (defensins) involved in plant biotic stress
- Dept.Biology, Uni. Ljubljana, Slovenia; Gregor Anderluh; pore-forming toxins as useful tools in biotechnology, molecular mechanisms of action, Surface Plasmon Resonance studies
- Dept. Biochemistry, Uni. La Havana, Cuba; Mayra Tejuca; design and construction of new anticancer drugs
- Lab.Toxinologie Bacterienne, University L. Pasteur, Strasbourg, France; Gilles Prévost; expression, characterization of the mode of action of β-PFTs from *Staphylococcus aureus*, design and test of new toxin inhibitors

- Dept. Physics, Uni. of Lublin, Poland; Mariusz Gagos; biophysical and spectroscopic analysis of protein lipid interaction (FTIR on supported lipid mono- and bi-layers)

2.5. *Specific Needs and Points of Attention*

As stated by CNR-IBF scientific council that recognize the UdR as "… a small unit with high productivity on up-to-date biophysical topics with potential technological applications. The evaluation of the activity is optimal. It will be desiderable an expansion of the people at staff".

Besides the recent efforts of CNR to reach a unit critical mass by directly hiring new people and by testing the feasibility of moving here research activities and people which could become well integrated into the local research strategies, a concrete care from FBK is more than welcome.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Smart nanoparticles for imaging, detection and therapy of cancers (NanoSmart)	R	E	Dec.	publication	-
Electrophysiological characterization of alpha-synuclein, a protein involved into the neurodegeneration of Parkinson's Disease (SynPark)	R	E	June Dec.	publication publication	-
Novel ElectroChemical Organic Transistors For Biosensing (BIONECT)	R	E	Nov.	biosensor prototype	-
Translational tuning in neuroblastoma by bacterial toxins	R	E	Dec.	publication	-
Defensins as mediators of the innate immunity: mechanism of action and biotechnological applications in human health and biocontrol	R	E	June Dec.	protein expression publication	-
Development of a carbon matrix for the in micro-chip extraction and purification of genomic DNA (NanoPur)	R	E	Dec.	-	-
Grapevine defensins as mediators of the innate immunity response: characterization and exploitation	A	E	-	-	If approved (ager 2009)
Structural and dynamical aspects of the pheromone-receptor interaction in the	A	E	-	-	If approved (prin 2008)

"model" ciliate Euplotes					
Characterization and possible biotechnological applications of plant defensins (BioDif)	A	E	-	-	If approved (PAT post doc 2009)
Molecular mechanism of action of cholesterol dependent cytolysins and possible biotechnological applications (CDC_action)	A	E	-	-	If approved (PAT post doc 2009)
Pore-forming toxins as useful tools in biotechnology: molecular mechanisms of action	A	E	-	-	If approved (MAE Italian-Slovenian bilateral project renewal 2010)
The molecular basis of Parkinson's disease: from single molecule to *in vivo* aggregates	A	E	-	-	If approved (Compagnia di San Paolo, bando programma neuroscienze 2008)

4. Budget

Expenses (EUROS)	**CNR-IBF**	**FBK**
Personnel	183.692,13	36.608,80
Travel	3.000,00	3.000,00
Equipment (HW/SW)	0	0
Other (e.g. subcontracting to external contractors)	13.620,37	14.800,00
Internal collaborations: "subcontracting" to other unit	0	0
Total Expenditure	**€200.312,50**	**€54.408,80**
Incomes (EUROS)		
EU Projects (total amount financed by EU)	0	0
Other external incomes (projects, grants, etc.)	114.890,00	11.979,60
Internal incomes ("subcontracted" by other units)	0	0
Total Income	**€114.890,00**	**€11.979,60**
Financial Need (Incomes – Expenditure)	**€85.422,50**	**€42.429,20**
Required Structural funding from PAT (it should be equal to the previous item)	**€0**	**€42.429,20**

5. Human Resources

The research team of BioMBio RU consists of only one senior researcher at staff, plus many post-docs (none of them with a permanent position) and students with expertises and competences in biophysics, biochemistry, cell biology, cell biophysics, molecular biology, and physics.

In the very recent past CNR is putting big efforts to stabilize the most critical situation of the RU which is its low staff mass. In fact CNR-IBF opened a 3 years PhD student position (starting 1st Nov 2009), and it is going to hire a unit of administrative person and to open a competition for 2 positions, one as a researcher and one as a technician. Herewith a permanent position as FBK researcher has been proposed. Actually this is not to be interpreted as a new position, rather than a necessary replacement of the FBK permanent position of Mauro Dalla Serra, that has recently been hired by CNR-IBF.

A tenure track position to a post-doc with at least two postdoctoral years documented experience in biophysical/biochemical scientific research is here proposed. This carrier progression will positively stimulate the interest of other motivated collaborators that will see the opportunity to be hired by a local institute.

6. Risks and Mitigation Plans

This session highlights the main criticalities of our project and provides the alternatives to manage, mitigate, and control risks in order to successfully achieve goals under the restraint of a fixed budget and schedule. In any case, it is clear that it's difficult to identify all the risks in advance. It is the intent of the RU coordinator to provide the means to handle identified hypothetical risks, as they appear.

Acquisition Alternatives

The key subjects of our investigations are PFTs and AMPs. We obtain these macromolecules at high purified degree through an already well established collaborative network, having both support and leadership roles. Protein and mutant production require deep expertise in molecular biology and in protein purification, and it is expensive and time consuming. Therefore its delocalization may represent an advantage, but it could become a critical point when the local needs do not fit a general network interest. Experts in protein expression and purification methods have been acquired by the BioMBio RU to circumvent this eventuality. Alternatively, some of the molecules of our interest can be available off-the-shelf or under custom design, but at variable prices.

Fund rising

The planned and future activities are strongly based on the acquired expertise and international visibility of the Unit members. None of them hold a permanent position yet. Salaries are charged directly on the projects. A very critical point is to guarantee a vital financial support for the staff members involved. This is mainly based on the success of the applications that in last analysis reside on the excellence of the

personnel involved. People have to be highly motivated, well determined in reaching the planned tasks, with a strong scientific competence and high sense of responsibility, and prone to publish all the results. A crucial point is therefore a very accurate selection of the people to be hired.

Risk monitor and communication

A continuous monitoring of the risk as they arise will be crucial. For this it could be helpful a proactive and open discussion with lab members at weekly lab meetings on the identification and analysis of the risks and on the mitigation actions to be needed to address the identified risks.

Administration and management

All the administrative workload is carried on only by one secretary. This can be good since a single person has the entire view of all the aspects of our unit. But at the same time this role could become too heavy. In a short-time CNR is hiring a new position in support of and to be coordinated by the actual unit secretary. CNR will also warrant a decentralized administrative support.

One of the project goals is not achieved

If one of the projects isn't actuated on time it will not stop our activity since, even if we are not a big group, our *modus operandi* is trying to work at the same time on more than one project instead of working only on a big one.

If a person is leaving

There is also the possibility that one member of the group leaves. We will overcome its absence thanks to the support of our external strong collaborations. In fact most of the projects are accomplished with well-establish open and trusted collaborators.

7. Ethical Issues

	YES
Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	X
Does the proposal involve Human biological samples?	X
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	

Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	
Does the proposal involve tracking the location or observation of people?	
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	X
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

CNR-FBK. PHOTONICS: MATERIALS, STRUCTURES AND DIAGNOSTIC (IFN-CMM)

Name	Photonics: Materials, Structures and Diagnostic (IFN-CMM)	
Type	Research	
Head	Maurizio Ferrari	
Staff	2009	2010
	FBK	*FBK*
	3 Researchers	4 Researchers
	1 Technician	1 Technician
	0 Post Doc	0 Post Doc
	0 PhD	0 PhD
	0.3 Administration	0.3 Administration
	IFN	*IFN*
	2 Researchers	3 Researchers
	1 Technician	1 Technician
	2 Post Doc	2 Post Doc
	1 PhD	2 PhD
	0.3 Administration	0.3 Administration
Document Status	submitted 2009-11-06	

1. Executive Summary

The document presents three significant activities characterized by a common scientific background that, thanks synergistic exploitation of the different competences and transversal technological and scientific interests, contribute to the strategic motivations of the unit “Photonics: Materials, Structures and Diagnostic”. The research unit is constituted by researchers which belong to FBK and CNR-IFN, and FBK people are associated to IFN-CNR at full time. The research cover several topics well identified in the CNR-FBK general agreement signed on 8th June 2009 and fully fit with the themes of the Materials and Devices CNR Department where the Photonics unit and the CNR-IFN institute are active.

The main activities concern research, innovation, as well as education through the study of advanced devices, systems and structures for photonics and nanotechnology. The research unit promotes the development and the application, both from the scientific and technological point of view, in several fields such as Photonics, Nanotechnologies and Microfabrication, Microelectronic, Lasers and Incoherent Sources, Synchrotron light and X rays. The scientific and technological skills, as

well as the diagnostic techniques, which constitute an important patrimony of the photonics unit cover the full range from the study of physical mechanisms crucial for synthesis, development and characterization of innovative photonic materials to architecture and fabrication of devices suitable for application in strategic interest areas such as sensing, information technology, and light sources. The research activities managed by the unit have an important innovative lift because the proposed subjects favor cross-disciplinarily among physics, material science, and technologies crucial for fabrication of materials, structures, and photonic devices as well as for the assessment of their physical and chemical properties. The tackled subjects enhance the growing of technological and scientific competences in area of photonics potentially transferable to innovative commercial deliverables. The social impact of the activity concerns professional training of high-qualified researchers in the area of photonics and in the technological-scientific innovation of synthesis of materials, fabrication and characterization techniques, devices architecture, and understanding of physical mechanisms. The synergy with local research centers and university are optimal. The collaborations activated at national and international level reflect the ability of the research unit in promoting projects of local, national, and international strategic interest including European projects.

The unit has a staff consisting seven permanent positions, five researchers (2 CNR/ 3 FBK) and two technicians (1 CNR/1 FBK) distributed on the three main research topics above presented. The researchers have excellent skill and competences in the specific topics and the human resources are based on motivated PhD students and very competent time contract researchers funded by projects.

The prominent collaborations are:

at internal level with

- FBK - Materials and Microsystems
- CNR – IFN Milano and Roma units

at local level with

- Department of Physics
- Department of Materials Engineering and Industrial Technologies
- Department of Mechanical and Structural Engineering

at national level with

- Dept. of Physics, Univ. Roma 3
- Dept. of Physics, Univ. Messina
- University of Padova
- INFN Section of Padua and Laboratori Nazionali di Legnaro
- IFAC-CNR

at international level with

- INFN-CNR OGG and GILDA-CRG at ESRF
- ISSP – Riga Latvia
- Coe College – Cedar Rapids, USA
- CNRS and Université Marseille

- Département Chimie, IUT and Lab. des Fluorures CNRS Le Mans,
- Ecole Nationale Supérieure des Sciences Appliquées et de Technologies, Lannion
- Hyderabad University
- University of Nottingham
- University of Leiden

2. Vision and Scientific Program

New materials, nanomaterials, metamaterials, optical fibers, microsystems, micro/nanotechnologies and complex systems are the scientific and technological fields covered by photonics. In general photonics materials and innovative structures based on photonics should assist in enhancing performance and applications envelope of photonics. This is generally concerned with enhancing *functionality* and *reducing cost*. In many applications one also has to address *footprint* and, of increasing importance, *power dissipation* so that the so called green photonics has to be considered. The photonics research units focus its activity to develop significant contribution in this area characterized by a high degree of cross-linked topics and interdisciplinary activities which involve *glass photonics*, *X-ray photonics* and *quantum mechatronics*. Long-term research in photonics of strategic importance concerns study, design, fabrication, assessment, development of components, systems, materials and structures where transversal technologies and synergistic use of different competences present in the research unit are the substantial add value and the main requests/goals are high functionality, innovation, viability, low power consumption, efficiency, and knowledge development.

2.1. Context and State of the Art

– *Glass photonics* activity, responsible M. Ferrari, refers to the strategic areas identified by European Union in the Photonics21 technological platform and the corresponding Italian platform PhoRIt (Photonics Research in Italy). Motivation of glass photonics research is related to the historical fact that breakthroughs in technology – and hence new applications that create wealth and improve the quality of life and of the environment – come from blue sky frontier research, and in photonics several examples demonstrate that the time lag from research to the market is relatively small. Research addressing this challenge will develop emerging materials such as metamaterials, nanostructured and nanocomposites systems, plasmonic based structures, as well as confined geometries. The issues are connected to optics and physics of the materials joint to the accompanying technological development. Examples are photonic crystals, quantum dots of different complexities, such as composite colloidal quantum dots, and different kind of waveguides, microresonators and micro-nano cavities. Materials for UV, mid-IR devices, THz diagnostics are also considered crucial. Materials, new structures, innovative systems, and new phenomena offer endless possibilities for the creation of novel devices with application in *green photonics* covering the field of ICT, sensing including biological systems and structural engineering, environment monitoring,

photovoltaic. The main objective of the unit is then to provide a high-level scientific and technological research on these fields playing a significant role on the long term photonic strategies but also to be a reliable scientific resource for specific solution to the local industrial requirement.

– *X-ray photonics* activity, responsible F. Rocca, mainly refers to the development and application of instrumentation and methodologies for X-Ray use Material Physics investigation. The current development of nanotechnologies is the direct consequence of the large knowledge in Physics and Chemistry obtained in previous years through a myriad of spectroscopic and structural studies. They produced the necessary background and knowledge for the development of methods of production and techniques of investigation focused on the manipulation and interaction with objects of sub-micrometer dimensions, typical of the Nanosciences. The use of Synchrotron Light and Neutron Sources at the Large Scale International and National Facilities is fundamental in this field, with the value added to be intrinsically an internationally open and networked scientific environment. The current state and the new perspectives of the Upgrade process at ESRF (European Synchrotron Radiation Facility) promise for the next years the possibility of new structural investigations and spectroscopies with coherent beams having nano dimensions and peculiar temporal structure. These aspects, together with the possibility to have different complementary information on different scales (from interatomic distances, to short and medium range ordering, to large scale aggregations of matter) justify the choice to be present in the field with sufficient critical mass in frontier experiments. The project “STRUMEX” is active since many years within these perspectives and is originally deep-rooted on the Research Activities on Solid State Physics developed in collaboration with the Dept. of Physics, University of Trento. On the other side, the participation to RD activities at Synchrotron Radiation Facilities is one of the peculiar characteristics of the Group, that since 1980 is directly cooperating to the development of Beamlines and related Instrumentations in national and European Synchrotron Radiation Facilities.The Activities of the Group are centered on the study of structural and dynamical properties from a local point of view on systems having different degree of disorder (glasses, amorphous systems, gels, crystals, dopants, films,…). We develop techniques and methodologies to investigate, at the local level, the origin of applicative properties. The main aim is to gain an ab initio interpretation of physical and physico-chemical phenomena that determine the useful properties, through an integration of experimental techniques.

– *Quantum mechatronics* activity, responsible P. Falferi, is mostly dedicated to the development of ultra-low noise sensors applied to detectors of gravitational waves. The direct detection of gravitational waves (GW) is one of the great challenges of contemporary experimental physics. Its aim is to open up a new window on the Universe, in astrophysics as well as in cosmology and in fundamental physics. Gravitational waves are a potentially unique probe, which can carry fundamental information, inaccessible by electromagnetic or other means. Their first detection is pursued by means of planned space-borne detectors (low frequency band, 0.1-100 mHz) and routinely operating and improving Earth-based detectors (high frequency band, 10-10000 Hz). As unexpected by-product, the ultrasensitive displacement measurement techniques developed for the latter may offer a way to experimentally test quantum effects in macro-

scopic objects (analogous to the superposition of states in Schrodinger's cat), a goal that has stimulated worldwide intense experimental efforts in the last years. Currently three resonant bar GW detectors are routinely operating: AURIGA, the most sensitive, EXPLORER and NAUTILUS, all with a good duty cycle and a bandwidth of several tens of Hz in the 1 kHz range. Recently, three large GW interferometers (the two LIGO in the US and VIRGO in Italy) have been completed and are now in operation with a sensitivity exceeding that of resonant bars and having a larger bandwidth. The preparation of a space-based interferometric detector (LISA) is underway, with an earliest launch date scheduled for 2018.

2.2. Vision and Goals

– *Glass photonics* activity will exploit its competences to succeed in the achievement of the scheduled deliverables related to several specific projects already funded or still in evaluation. In the following we briefly report on general topics where the goals allow to understand the different specific objectives. Fabrication of photonic crystals based structures for the development of photonic devices is a project allowing to exploit the competence of the unit in sol-gel photonics, plasmonic structures, and sensing. The main goal of this project is the realization and the characterization of new class of nanostructured systems, for the development of three different functionalities. The following systems will be fabricated and experimentally explored for their possible applications: a) Photonic crystal structures in inverse opal configuration made of a dielectric network codoped with Er^{3+} and Yb^{3+} ions, in order to obtain laser action exploiting the random laser effect in the integrated circuits. b) Nanostructures in direct opal configuration infiltrated with elastic polymeric materials to be used as a strain sensor c) Semispherical metallic voids to obtain an enhancement in the Raman signal of organic molecules. Fabrication of oxide-based structures for downconverter application is a project where the competences of the unit in the fabrication of active waveguides, also by rf sputtering technique, will be exploited with the aim to increase the efficiency of the silicon-based solar cells. Advanced materials for coherent emission at new wavelengths activity aims at establishing a forefront of research in the field of novel optical coherent sources working at new wavelengths, i.e. in the visible and in the mid infrared wavelength region. The novelty is on the investigation of new materials, up to now only envisaged, which could act efficiently as coherent sources for emitting photons at wavelengths by direct emission in the visible and in the mid-IR, at wavelengths higher than 2 micron and up to 10 micron. The advanced materials investigated within this project will then be processed into different configurations including optical fibres and planar waveguides. Micro-nano structures exploit the competences in 1D microcavities, spherical microresonators to develop a new generation of micro-laser and optical sensors

– *X-ray photonics* activity is based on 4 Lines, parallel and complementary: (i)Basic Studies of Physics of Condensed Matter, with particular focus on Local Structure and Dynamics in amorphous and crystalline solids investigated by X-ray Absorption and Diffraction; (ii) Development of new Equipment and Methodologies for Synchrotron Radiation experiments; (iii) Application of expertise to specific problems of interest; (iv) Production and first characterization of glassy systems (via melt

quenching or sol-gel), crystals, nanoclusters, and films. The main research topics that will be developed in the next years can be summarized as follows: a) Study of the static and dynamic properties of matter in crystalline and amorphous state: in particular EXAFS will be used in comparison with diffraction measurements, in order to describe the local dynamics around some selected atoms of the materials under investigation. An example of application of these studies is the description of the local mechanism of negative thermal expansion. b) Study of local structure and dynamics in confined systems and nanostructures. This is the natural extension of previous works on bulk crystalline materials, Si nanoclusters, glass ceramics and, from a more technical point of view, of our cooperation in developing tools for near field microscopy using X-ray at Synchrotron Radiation Facilities. c) Study of the correlation between local structure and conduction properties in amorphous systems. We have a long history in studying fast ion conducing glasses and the effects of dopants in amorphous semiconductors. We plan to study new glassy systems and the effect of dopant on crystallization of amorphous semiconductors. d) Study of the local environment of rare-earths ions and basic components in relation with the optical properties in glasses and crystals for photonics applications. This is one of the main topics of common interest of IFN-CNR: new possibilities are now open by the micro focused beamlines and tools for investigations at the nanoscale. As usual, we are working also on the development of dedicated instrumentation necessary for the study of new materials. e) Modelization and experimental characterization of disorder in solid state materials by X-ray Spectroscopies: the knowledge and description of short and medium-range structures is the general goal of a long term programme that span from careful experimental studies to development of appropriate methodologies and theoretical approaches dedicated to the study of “disorder” of the matter. Concerning specific experimental resources: a) recently, we have upgraded the gas-sensors of our big Glove-Box for sample preparation in controlled atmosphere: this apparatus may be still improved with special equipment inside. b) A cryostat-oven (77-750 K) of IFN-CNR is availble for XRD in situ measurements. The XRD activity is open to requests coming from local groups and cooperators of University, IFN-CNR and FBK. Informal cooperations are active in the fields of Energetics, Environment, Cultural Heritage, Sensors, NanoSciences, c) The complex instrumentation for detection of X-ray excited Optical luminescence (XEOL) is currently working, and can be upgraded in the future for time-resolved measurements; d) for the use of the XEOL apparatus using SNOM probes, we should continue the International Cooperation with partners of X-TIP, or invest money to build an independent apparatus. For future applications at Synchrotron Radiation, a dedicated effort and manpower resources should be programmed. Possibilities for new activity in X-ray Microscopy should be evaluated in the future.; e) our cooperation with ther GILDA Beamline at ESRF (F) should be renewed, in correspondence with the future Upgrade Programme of the Beamline, at present under discussion with CNR and MIUR.

– The group working in *quantum mechatronics* is involved in a good fraction of the worldwide activities in the field of gravitational waves, being an active partner in AURIGA (INFN resonant detector), LISA (ESA/NASA space interferometer) VIRGO (ground based interferometer) and ET (Einstein Telescope, a third generation cryogenic interferometer) projects. The group has developed a variety of original

experimental techniques. These include for instance high sensitivity, almost quantum limited, SQUID amplifiers, to be used as the final stage of ultra sensitive motion detectors in gravitational wave antennas and similar systems. They also include femto-Newton sensitivity torsion-pendulums to test parasitic forces on test-masses to be used as geodetic tracers in space-borne gravitational experiment. These technologies are and will be employed for the development of the mirror control system of ET, the feedback cooling of ultracryogenic mechanical resonators and for testing on ground of LISA sensor performances. The main goals for the next 5 years are the following.

– The launch of the ESA LISA Pathfinder mission is foreseen for the second half of 2011. This mission aims to demonstrate the near-perfect free-fall of geodesic reference test masses inside a satellite, to within 3 fm/s2/Hz1/2. In addition to demonstrating the key technology for the LISA gravitational wave observatory – which aims at a launch in roughly 10 years – LISA Pathfinder represents the test-bench for all future missions requiring high precision free-fall.
– Third generation cryogenic GW detectors, like the proposed underground ET, aim at a sensitivity curve 100 times better than that of current LIGO and Virgo detectors; to this end the development of new techniques for the control system used to keep the interferometer on resonance is required and the noise introduced by the actuators on the mirrors must be kept below their mechanical thermal noise at 4.2K
– In the field of the experimental tests on quantum effects in macroscopic objects the remarkable result obtained last year (Phys. Rev. Lett. 101, 033601 (2008); article included by the American Institute of Physics in the top ten results of the year 2008 in Physics (Physics News Update, AIP Bulletin 879, 2008)) can be improved with a dedicated experiment in which an ultracryogenic macroscopic mechanical resonator is feedback cooled towards its quantum ground state.

2.3. Activities and Work Plan

– *Glass photonics* activity is scheduled as follows: (A1) Fabrication and characterization of sol-gel derived photonics crystals and rf-sputtering prepared microcavities; (A2) fabrication and assessment of nanostructured glass-ceramic waveguides and spherical microresonators; (A3) design of appropriate structures for THz transmission; (A4) fabrication and assessment of downconverters systems based on combined action of nanocrystals (nanoparticles) and luminescent ions. WP A1 will consider: - opal fabrication with direct and inverse structure, infiltration with elastomers and active materials, – colloidal structures fabrication, – plasmonic system fabrication, – 1 D microcavities fabrication, morphologic, structural and spectroscopic assessment of the fabricated systems. WP A2 will consider: - definition of the fabrication protocol of SiO_2-SnO_2 glass ceramic waveguides, - spherical microresonators fabrication and development of the experimental setup for optical assessment. WP A3 will consider: - Design of polymer based structures for THz transmission, - evaluation of suitable configurations. WP4 will consider: - fabrication of TiO_2 and HfO_2 based film activated by rare earth ions, - evaluation of the

energy transfer mechanism – developing of specific diagnostic techniques for efficiency estimation.

– *X-ray photonics* will perform the following axis of activity. Ordinary Research Activity: Previous Research Programs on negative thermal expansion, fast ion conducting glasses, semiconductors, glass ceramics, optical waveguides, X-ray Instrumentation will be continued, within our network of relationships. Results wil be presented at some very important Conferences (Int. Glass Confeerence (Brazil), Int. Conf. on Non-Crystalline Solids (Paris)). *EXAFS new proposals*: We plan to measure at ESRF (AgI vs T; Cr and Ni in a-Si for metal-induced crystallization, Er in waveguides, Cu-doped ZnO film), at SOLEIL (Cd in CdTe vs.T; V in Lead-Vanadate Glasses using microfocused beam). *Samples and new materials*: depending on grants and manpower, we will prepare new Cu-based borate glasses, ZnO films, a-Si doped with metals (Cr, Ni,), optical waveguides doped with Er. Some of the new samples will be, of course, done in cooperation with other local and International participants (from USA, from India through ITPAR) to our Projects. *Exploiting new perspectives*: an effort will be done to reinforce our network of cooperation, in order to have access to EU or International Grants. Possible fields will be: glasses for photonics, Nano-scale chemical mapping, X-ray Spectroscopies and Applications.

– The group working in *quantum mechatronics* schedules his activity for the next year on the following tasks: (i) The role of the control system of an interferometric gravitational wave detector is to maintain the correct resonant condition of fields (lengths and alignments) inside the interferometer within a series of maximum residual RMS fluctuations of all the degrees of freedom around the operating point. The use of the actuation system currently employed in the room temperature interferometers (coil-magnet) in the cryogenic interferometers (ET) could not only compromise the control at very low frequencies but also represent an extra noise source in the detection bandwidth. To check this hypothesis we will start SQUID measurements of the magnetic noise produced by permanent magnets at 4.2K. (ii) As regards the activity on quantum effects in macroscopic objects we will start measurements of quality factor of mechanical resonators and tests of the noise performance of a two-stage SQUID amplifier and the working principle of the feedback cooling technique on a macroscopic electrical resonator with the goal to obtain an average occupation number of 30. (iii) For the LISA Pathfinder mission, the immediate objectives are the in-laboratory testing of the hardware relevant to the purity of free-fall. Specifically, the group will perform, using a torsion pendulum with sub-fN sensitivity, the final tests of the force noise that arises in the interaction between the test mass and the surrounding capacitive sensor that is used to control the flight of the satellite around the free-falling test mass.

2.4. Collaborations

FBK Materials and Microsystems (N. Laidhani, G. Speranza, G. Pucker) Photovoltaic, Emerging materials, Integrated optics, sensing

Trento University

- Department of Physics: (Giovanni Andrea Prodi and Stefano Vitale) - Ultra-cryogenic tests of mechanical resonators and torsion pendulum tests for LISA Pathfinder; *X-ray Group* (Giuseppe Dalba): Local Stucture and Dynamics in Solids studied by X-ray Absorption and Diffraction; *Optical Spectroscopy Group* (M. Montagna) Materials for Photonics and Basic Science; *Lab. IDEA* (A. Miotello): X-ray Diffraction Studies of materials of interest, rf-sputtering fabricated structures; *Lab. Nanoscienze* (L. Pavesi) Photonics structures, nano-photonics.
- Department of Materials Engineering and Industrial Technologies: Material Science, Nanoscience, XRD
- Department of Mechanical and Structural Engineering (D. Zonta, R. Zandonini) Sensing

CNR-IFN

- Trento - Commessa Nanoscienze (Michele Bonaldi) – Design, production and testing of mechanical resonators for feedback cooling experiments
- IFN Milano (R. Ramponi) Laser writing and micromachining
- IFN Roma (V. Foglietti) Waveguide patterning
- INFN-CNR OGG and GILDA-CRG at ESRF (Grenoble – F) (F. D'Acapito,. C. Maurizio) Synchrotron Radiation.
- Dept. of Physics, Univ. Roma 3 (S. Mobilio, C. Meneghini) Local Stucture and Dynamics in Solids.
- Dept. of Physics, Univ. Messina (M. Cutroni, A. Mandanici) and Dept. of Chemical-Physics, Univ. Pavia (P. Mustarelli). Fast Ion conducting Glasses:
- University of Padova: (M. Cerdonio) – AURIGA data taking; (A. Martucci) sol-gel photonics, (M. Paolo) - Nanophase materials.
- INFN Section of Padua and Laboratori Nazionali di Legnaro (J.P Zendri and L. Taffarello) – Low temperature measurements of quality factor of mechanical resonators
- IFAC-CNR Firenze MDF Lab (G.C. Righini) Glass Photonics – Materials and devices fabrication
- University of Leiden – (G. Frossati) SQUID amplifiers
- ISSP – Riga Latvia (J.Purans, A. Kuzmins) XANES and EXAFS Studies on glasses and crystals
- IBM-Zurich (N. Afify) Rare-earth doped systems for photonics
- Coe College – Cedar Rapids, USA (M. Affatigato) Structural and spectroscopical studied on Glasses
- CNRS and Université Marseille (D. Pailarey and D. Tonneau) X-ray Microscopies
- Departamento de Engenharia de Materiais, Instituto Superior Técnico, Lisboa, Portugal, Almeida Rui (Sol-gel waveguides, rare earth and metallic nanoparticles codoped systems, non-conventional glasses).

- Département Chimie, IUT and Lab. des Fluorures CNRS Le Mans, (C Duverger, B. Boulard) Education, Training and Qualifying technologies, Non-conventional glasses and glass ceramics)
- Ecole Nationale Supérieure des Sciences Appliquées et de Technologies, Lannion France, (Feron Patrice) Integrated optics microlasers.
- Hyderabad University, School of Physics, (D. Narayana Rao) Nonlinear optics, Ultrafast phenomena and Spectroscopy, material science, nanocomposite materials
- Institut für Physik, Universität Greifswald, Germany, (A. Quandt) Theory of Low Dimensional Composite Nanomaterials, Metamaterials, Plasmonics.
- ITIMS International Training Institute for Material Science, Hanoi University of Technology, Vietnam, (Pham Than Huy) Synthesis and Processing of nanomaterials for sensing, optoelectronics and photonic applications.
- University of Nottingham Novel Photonic Glasses School of Mechanical Materials, Manufacturing Engineering and Management, (A.B. Seddon) Glass Ceramics in non oxide glasses.
- Rudjer Boskovic Institute, Zagreb, Croatia, (Mile Ivanda) Nanocomposite-based complex structures fabrication by LPCVD, Stimulated Raman,Scattering.

Experiments

- AURIGA: the INFN Sections of Padua, LNL, Trento and Ferrara and the Universities of Padua, Trento and Ferrara involved
- VIRGO: more than 20 institutions in Europe are involved in Virgo
- LISA and LISA Pathfinder: more than 100 institutions involved worldwide
- Experimental Activity at Synchrotron Radiation: development and utilization (Europe- Japan)

European Projects

- ET (Einstein Telescope) is a Design Study project concerning the conceptual design of a cryogenic GW interferometer of third generation. Eight research institutions involved.
- ILIAS-next (proposed, developing from its successful FP6 parent) is an Integrating Activity that aims to coordinate Europe's Deep Underground Laboratories for the advance of astroparticle physics. ILIAS-next unites expertise from the 4 European Deep Underground Laboratories, the most important EU science agencies and more than 100 institutions, Universities and companies.
- COST Action MP0702 2008-2011: Towards Functional Sub-Wavelength Photonic Structures (26 counties involved)

2.5. Specific Needs and Points of Attention

The specific needs for the research unit concern the increase of the human resources. During 2009 one CNR researcher was acquired and another one is ex-

pected in 2010. It is important the interest of FBK on this aspect so that one researcher will be a great help for the increase of the competitively of the unit.

Point of attentions are:

- contrary to the other (present and past) activities, the project on the quantum effects in macroscopic objects currently is not financially supported by other institutes. Given the significance of the subject and the important results recently obtained by the unit, we think that this activity deserves special attention and support from FBK.
- X-ray photonics group employs the total of the funds for experiments at Synchrotron Radiation, Conferences and support to International visiting scientists. Financial support from FBK should be considered.
- Glass photonics unit has acquired a CO_2 laser for laser material processing. A full cooperation with FBK for the development of this activity deserves a certain attention.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Evaluation of the noise from magnet-coil actuator for ET	R	E	-	-	-
Feedback cooling applied to a macroscopic electrical resonator to obtain an average occupation number of 30	R	E	-	-	See specific needs and points of attention
Torsion pendulum testing of the force noise with flight model capacitive position sensor (LISA Pathfinder)	R	E	-	-	-
Meccatronica al limite Quantico (PAT team 2009 – Incoming	A	E	-	-	Approval
Novel silicon based materials for optoelectronics (PAT post-doc 2009 – Incoming)	A	E	-	-	Approval
Fabbricazione di nanostrutture metalliche a cristallo fotonico per biosensori SERS (PAT post-doc 2009 – Incoming)	A	E	-	-	Approval
Spherical whispering gallery mode micro laser temperature stabilized. (PAT post-doc 2009 – Incoming)	A	E	-	-	Approval

Computational research for composite nanomaterials and nanodevices (PAT team 2009 – Incoming)	A	E	-	-	Approval
Fabrication of nanostructured systems in opal configuration for the development of photonic devices (FIRB - programma "futuro in ricerca")	A	E	-	-	Approval
Novel active materials for coherent light sources in the visible and in the mid infrared wavelength region (FIRB - programma "futuro in ricerca")	A	E	-	-	Approval
Novel high power Microstructured Fiber Lasers: Mid-IR emission for ICT applications (STREP proposal, ICT Call 5, FP7-ICT-2009-5)	A	E	-	-	Approval
NIR emission: new materials and laser prototypes for remote sensing and biomedicine applications (PRIN 2008)	A	E	-	-	Approval
Inverse Photonic Crystals Fabrication by sol gel route	R	E	Apr.	Quality factor	-
1D microcavities for luminescence enhancement	R	E	July	Efficiency	-
Glass ceramic spherical microresonators	R	E	Oct.	Quality factor	-
Experiments at SR	R	I/E	2010	Numbers of Accepted and realized experiments	Acceptance from International Committees
Papers	R	E	2010	Numbers/quality	-
Conferences	R	E	2010	Numbers of Accepted Contributions/ Invitations	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	**CNR**	**FBK**
Personnel	256.137,09	272.885,64
Travel	10.000	10.000
Equipment (HW/SW)		0
Other (e.g. subcontracting to external contractors)	14.902,44	18.700
Internal collaborations: “subcontracting” to other unit		0
Total Expenditure	**281.039,53**	**€301.585,64**
Incomes (EUROS)		
EU Projects (total amount financed by EU)		0
Other external incomes (projects, grants, etc.)	47590	0
Internal incomes (“subcontracted” by other units)		0
Total Income	**47590**	**0**
Financial Need (Incomes – Expenditure)	**233.449,53**	**€301.585,64**
Required Structural funding from PAT (it should be equal to the previous item)		**€301.585,64**

5. Human Resources

The unit has a staff consisting seven permanent positions, five researchers (2 CNR/ 3 FBK) and two technicians (1 CNR/1 FBK) distributed on the three main research topics above presented. The researchers have excellent skill and competences in the specific topics and the human resources are based on motivated PhD students and very competent time contract researchers funded by projects. However the research unit is clearly understaffed in respect to the scheduled activities. Moreover there are some young and active researchers, which have the competences and the scientific skill to be the perfect candidates for a permanent position as researcher in the unit Photonics: Materials, Structures and Diagnostic. For these reasons the unit asks for a FBK research position.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Loss of coherence among the main activities	M	S	Periodical meetings among the persons in charge in order to strength the common point of the different research and collaborate to the solution of specific problems.
Understaffed units	H	C	Continuous synergistic use of the important collaboration network in order to provide human resources

			devoted to the understaffed research tasks.
Spread out of competences due to the large amount of different tasks inside each main activity	M	S	Assure the full contact among the researcher, technicians and students involved in the research in order to share competences and reduce time consuming.

Legend*:*

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophi

CNR-FBK. NANOSCIENCE: MATERIALS, FUNCTIONALIZATION AND PROTOTYPE DEVICES (IFN-IMEM-CMM)

Name	Nanoscience: Materials, Functionalization and Prototype Devices (IFN-IMEM-CMM)	
Type	Research	
Head	Salvatore Iannotta	
	FBK	*FBK*
	2 Researchers	2 Researchers
	1 Technician	1 Technician
	0 Post Doc	0 Post Doc
	0 PhD	0 PhD
	0.3 Administration	0.3 Administration
	IFN	*IFN*
	7 Researchers	7 Researchers
	3 Technician	3 Technician
	6 Post Doc	7 Post Doc
	2 PhD	2 PhD
	0.3 Administration	0.3 Administration
Document Status	submitted 2009-11-16	

1. Executive Summary

The approach and horizon of the activities developed by the research group "Nanoscience: materials, functionalization and prototype devices" span from basic studies and methods up to prototype development to validate and enable potential applications and technology developments. Our interdisciplinary vision and research practice complements refined growth synthesis and characterization methods with device prototyping aiming at exploring and demonstrating functional properties, applications and technological perspectives. This is carried out via the fruitful interchange among the very active principal investigators of the team and the strong interactions at the international and national levels as well as within the provincial research network, FBK to start with.

The team includes researchers of FBK, CNR-IFN, and CNR-IMEM and work on projects focused on state of the art themes that well fit the CNR-FBK general agreement signed on 8th June 2009 and at the core of the major trends defined by the strategic plans of the Materials and Devices CNR Department. The group is al-

so involved in major research projects involving the Department System of Production dealing with industrial research.

From the point of view of the basic studies and method developments our original efforts are aimed at the synthesis/growth of (multi-) functional materials based on inorganic (metal-oxides and wide band-gap semi-conductors in particular), organic (pi-conjugated and bio-molecules) and hybrids, aiming at controlling chemical-physical, structural and morphological properties at the different length-scales, while we are engaged in fundamental studies concerning the understanding of noise fluctuations. Development of Instrumentation is a key strength of the group that is approached with the aim both of extending the ability to explore the materials preparation and properties as well as of paving the way to application and technology potential developments. We finalize our studies to two major areas of application, innovation and technological interests: sensing (passive and active devices mainly for VOC and bio) and energy (in particular dye sensitized and bulk hetero-junction photovoltaic). Along these tacks we develop materials, processes, structures, systems and prototype devices.

The expertise developed by the team has strong elements of originality since the team has devoted during the years strong efforts in developing methods and instrumentation as well as original processes cross-linking the original expertise in physics, chemistry and material sciences that form the background of the researchers involved. Such an hard core experimental approach makes even more direct and natural the applicative and technological projection. From this point of view the team is very complementary to the research activities carried out in CMM – FBK and the University departments of Physics and Engineering with which an increasingly effective collaboration is being developed on several subjects as the numerous co-participated projects demonstrate. The final destination of our research work is on subjects of strong social impact such as materials, processes and devices for renewable energy, for sensing and instrumentation applied to agro-food, environment and bio-medical applications. On these topics we also develop a strong effective work in preparing young scientists that come from different university and very often are being formed in virtuous exchanges with foreign leading labs. In fact the very tight collaboration with national and international leading labs is the outcome of the propensity and ability of this research team to promote projects of local, national, and international strategic interest including European projects.

The unit has a staff consisting 9 permanent positions, six researchers (4 CNR/ 2 FBK) and three technicians (2 CNR/1 FBK) distributed. At present the staff includes also 3 CNR researchers with yearly renewable contracts. The activities, lead by full time staff the researchers can count on strongly motivated PhD students.

Pominent collaborations:

at internal level with: FBK - Materials and Microsystems - CNR – IFN – Photonics Trento; IMEM – Institute of Materials for Electronics and Magnetism -CNR – IBF – Institute of Biophysics

at local level with: IVALSA-*CNR; -Fondazione E. Mach* - Department of Physics - Department of Materials engineering and Industrial Technologies - Department of Environmental Engineering - -CIBIO – Università di Trento

at national level with CNR Institutes: IMM-Catania; INOA-Firenze, ISOF- Bologna; ISMN-Bologna, ISM -Roma. INFN –Padova laboratori di Legnaro. -Dipartments of Physics, Chemikstry and Environmental Agronomy and Crop Science University of Padova; IIT- Genova and NNL- CNR – Lecce; - Politecnico di Torino; -University of Cagliari; Dipartiments of Physics and Chemistry -University of Parma - ELETTRA synchrotron radiation faility, S. Nannarone (BEAR beamline).

at international level with: University of Groningen (NL); University of Innsbruck (A); University of Leiden (Olanda)- University of Berlin; Imperial College – London; University of Cornell Ithaca NY- USA —University of Montreal (CAN)- Institute of ThermoPhysics – Russsian Academy of Sciences, IMM - University of Nijmegen, Max Planck and University of Stuttgart (D).

2. Vision and Scientific Program

Within the exploding field of nanoscience and nanotechnology the development of materials at the different length-scales, their hierarchical organization and their ability to give multi-parameter, multifunctional responses when assembled, organized or used in systems and devices are some of the major issues that make the world “nano” so interesting scientifically and so appealing and promising for the technological perspectives.

The ability to synthesize/tailor, functionalize/sensitize and assemble the material to make systems and devices requires an intrinsic multidisciplinary approach with complementary expertise. The major promise of nanoscience is the ability to produce materials, systems and devices with tailorable innovative properties that could transversally produce strong impact on many, if not all, technologically relevant fields ranging from (nano) electronics, mechanics, bio-medicine. It’s a field where the distance between long-term research and application is supposed to be strongly reduced so that the impact could be very strong and effective. We approach this challenging field by developing novel strategies to the growth/synthesis of inorganic, molecular-organic and of hybrid nanostructures, by studying fundamental properties at the different length-scales and by developing instrumentation specific and complementary instrumentation. On this basis we are able to cover the whole chain going from the material, the study an understanding of its properties up to the preparation of prototype devices where the (multi-) functional properties are demonstrated and validated.

2.1. Context and State of the Art

– Functional/multifunctional inorganic, organic and hybrid materials (Activity coordinated by S. Iannotta, responsible R. Verucchi).

It’s an activity that addresses the key issue of tailoring materials and properties at the different length-scales. The approach and ideas developed are based on the

basic idea of overcoming the limits of (wet) chemistry using kinetically activated processes by controlling the precursors in gas phase. Such an approach could potentially combine very different advantages: extending the number and quality of viable processes to prepare the nanostructures, controlling the assembling and positioning of the nanoaggregates, forming and controlling properties at the interfaces, defining novel structures and systems; combining materials that could be hardly be combined by standard chemical processes where the number of viable "linkers" are often very limited. Particularly very interesting is the case of nano-organic-inorganic hybrids where the way the organic molecule is being reacted with the inorganic counterpart can be usually carried out by a few functional groups such as carboxylic, amino etc. The final properties of the nano-hybrid will of course depend on such groups with limitation that could not easily be overcome by standard chemical routes. The extension to novel nanostructures that can be prepared/synthesized by such non-equilibrium processes are of great interest because they can be tailored producing novel and extended properties and/or increasing control on the way they interact. These are issues of interest by themselves from the point of view of basic understanding and studies but they are also very promising in applications such as (bio)sensing, sensitized photovoltaic conversion as we have already demonstrated in the last few years. Sensitization, organic/inorganic nano-interface control and growth of the organic layers by the kinetic approach, developed by the proposers, based on supersonic seeded beams, is uniquely suitable to promote controlled reactivity and has been successfully applied to hybrids synthesis and surface functionalization paving the way to new classes of devices.

– *Spontaneous fluctuations and dissipation (responsible M. Bonaldi)*.

The study of the spontaneous fluctuations (thermal noise) and dissipation in mechanical systems probes fundamental aspects of statistical mechanics. In fact fluctuations and dissipation originate by the same physical phenomenon, namely the interaction with the thermal bath, which is also responsible for the irreversible entropy production. For this reason fluctuations give an insight into the behavior of systems kept out of equilibrium, where the standard thermodynamic rules are no more applicable. This is the case of small systems like drifting Brownian particles, where short-time violations of the II law of thermodynamic were recently observed [Wang, PRL 89, 050601 (2002)], or molecular machines, which are thought to harness thermal fluctuations and rectify them using energy from chemical sources [Bustamante, Physics Today, July 2005, p 43-46]. On the other hand nonequilibrium effects are ubiquitous, and can be observed, at the energy scales typical of thermal fluctuations, both in nanosystems or in ton-sized resonators [Bonaldi, PRL 103, 010601 (2009)], Therefore experiments on thermal noise connects usually separated fields of research: nonequilibrium statistical mechanics and precision position measurement.

– Laser Spectroscopy and Mass Spectrometry Methods for Sensing and Monitoring (responsible A. Boschetti)

At present many chemical-physics processes, due to human activities, are subject to more and more accurate and sensitive controls for environmental quality, process quality or safety reason. Many of these processes can be monitored by non invasive detection of gaseous systems produced (atmospheric pollution, combustion, food preservation, agro-biological processes, breath analysis etc.). Detailed understanding of such processes is more and more demanding in real time and high sensitivity detection of many molecular systems at the same time. Real time multicomponent trace gas detection is quickly growing in interest: monitoring and diagnosis of complex processes need the knowledge ,possibly in non destructive way, of the most possible molecular species emitted. Important application fields are quality air control, combustion processes, modified atmospheres in food preservation, ripening and senescence processes in agronomic products, plant physiology studies and medical diagnosis by breath analysis. Our team combines the development of solid state devices with instrumentation development and applications so that complementary approaches can be used to cross-calibrate the methods and, most important of all to address applications and technology developments. High sensitivity trace gas detection of interest for biological, agro-industrial processes, energetics and environmental quality control by means of CO2 and/or diode lasers based resonant photoacoustic spectroscopy and proton transfer reaction mass spectrometry techniques *will further developed to extend selectivity and sensitivity.*

2.2. Vision and Goals

– Functional/multifunctional inorganic, organic and hybrid materials

The nanoscience road seems to be the best way to achieve materials desired final properties, with a control of physical/chemical processes at several length scales enabling an unprecedented success in realizing specifically designed multifunctionalities. In this framework, our group has developed an original approach to synthesis of organic, inorganic and hybrid materials based on growth of thin films in vacuum by means of supersonic seeded beams (SuMBD). Based on the achieved results the capability of SuMBD to control and tailor the chemical, physical and structural properties of films by tuning the kinetics of the particles in the beam, namely their kinetic energy, will be further studied and extended to different classes of molecules and cluster of atoms aiming at tailoring electron, optical and functional properties. Potential hierarchical organization of the structures by the deposition itself will be explored. The results achieved on pentacene, where the control of the growth process has achieved unprecedented results on SiO2, as well as TiO phthalocyanine on quartz and mica have demonstrated that SuMBD is a well-suited method for controlling deposition over a wide range of length-scales. The ability to control the assembling of molecules will be combine with the unique possibility to synthesize refractory nano-micro-crystalline materials. We have already shown that polycrystalline SiC can be synthesized by using C60 supersonic beams on a Si(111) substrate at low temperature (down to room), suggesting the possibility to induce formation of bonds at the surface by kinetic activation of chemical reactions.

The unprecedented perspective that we are pursuing is functionalization by direct co-deposition of inorganic materials, (e.g. metal oxides, SiC, etc.) by organic molecules like phthalocyanines, porphyrins and bio-relevant molecules. This opens a fully new perspective where the realization of devices engineered at the nanoscale and based on the use of new organic, inorganic and hybrid materials becomes feasible and applicable to the fields of health care, energetic, electronics. The group will further develop the ability to produce prototype devices having as active element materials synthesized by means of the SuMBD approach. The aforementioned codeposition system will be further developed and equipped in order to realize devices like sensors, organic FET, photovoltaic cells. The major developments will be in active sensing devices based on OFET's Electrochemical sensors, new generation of Photovoltaic cells. Organic FET based on highly ordered pentacene thin film have been produced, as well as photovoltaic cells based on organic and hybrid materials. Together with the ability to realize devices, specific instrumentation for sensors, FET and PV cells characterization have been developed. The sensing devices will be specifically tailored to work in gas-phase for VOC and trace gases sensing as well as in liquid and micro-fluidic environment. We envisage the development of systems combining the different devices developed in microfluidic integrated systems where simultaneously will be monitored head space and liquid parameter.

We envisage novel architectures for all-solid-state solar cells that promise: vast, tailorable contact area between hybrid materials which is beneficial to separate electric charges, best contact between the nanohybrids and the TCO (transparent conductive oxides), a viable innovative approach for matching solar spectrum using "simple" molecules via kinetically activated reactivity, forming the equivalent of a multiple molecular junction with potentially higher PV conversion efficiency, favorable conduction properties and high charge mobility synthesizing ordered materials and structures. A main advantage of our approach is the ability to study and optimize, quasi-independently, several of the different processes contributing to PV.

Characterization by means of in-situ surface electron spectroscopies and ellipsometry will made possible the interpretation and correct analysis of the chemical, physical and structural properties of the synthesized materials. A UHV system, fully devoted to growth of thin films in a codeposition approach and their analysis in-situ has been developed in our lab. Nevertheless, ex-situ SEM analysis and the several collaborations of this group has made achievable a complete characterization of morphological and structural properties of thin films, also exploiting the potentialities of synchrotron radiation light experiments.

The group is involved in several medium term projects (2-3 years), having main goals the synthesis of thin film organic/inorganic hybrid materials, to be used as active elements in sensing and PV cells solid state devices, and the growth of organic based electronics and optoelectronics. From the point of view of future development (up to 5 years), also exploiting the several collaborations with national and international leading groups, we will explore the use of multifunctional materials as SiC and graphene, their functionalization by means of organic molecules in order to exploit the intrinsic biocompatibility and good transport properties, respectively. The approach will be always based on the use of supersonic seeded beams from the

point of view of the synthesis. The creation of new PV cells based on the use of functionalized nanoaggregates, also exploiting quantum effects will be addressed. An important issue will be to study the functionalization of organic/inorganic surfaces to make them compatible for interaction with other specific organic molecules, also achieving a significant biocompatibility.

In the next future (2-3 years), and according to the currently active projects, main goals are related to the realization of PV solid state solar cells, based on organic thin films synthesized by SuMBD approach and functionalizing metal oxides structures. The need to manage all step involved in the realization of a PV device, in particular control of the interfaces, material purity, thin film chemical and physical structure requires a tough work, mainly realized exploiting the skills of our group but also thanks to the several collaborations in the field. The long term evolution of this work will be the production of devices showing high efficiency in specific light absorption ranges, fully controlling the energy production processes in all aspects.

The development of gas sensors has long been one of the main task of our activity. The idea is to increase gas selectivity of inorganic based sensors due to specific surface functionalization. The activity will be addressed to sensing of VOC or gas strongly related to health care. Moreover, the achievement of a high biocompatibility will make possible the realization of devices suitable also for in vivo applications. From a technical point of view, the possibility to create sensors based also on active responses will be explored, being them transistors or optical emitting materials. Finally, electrochemical sensors for bio-fields will be explored

– *Spontaneous fluctuations and dissipation*

The current theoretical approaches to nonequilibrium fluctuations (“Fluctuation Theorems”) address time reversal properties of the fluctuations, but do not describe the amplitude of the thermal noise produced in practical experimental devices. As we have developed a state of the art technology for precision measurements in resonating mechanical systems (displacement sensitivity of some 10^{-19} m/√Hz and intrinsic loss as low as 10^{-8}), we can investigate in full detail the Probability Density Function (PDF) of fluctuations in mechanical systems maintained in nonequilibrium steady state. As a first step we shall address steady states obtained by a thermal gradient, and we expect that new theoretical results will be reachable from the outcome of these experiments. We also note that, as this experimental configuration is common in precision measurements, our results will be useful in the design of the next generation of interferometric gravitational wave detector. As a second step we plan to use the the devices developed during step one for studying feedback cooled systems, where the thermal noise is reduced due to a properly chosen feedback. These are nonequilibrium systems where the detection of quantum effects could be at reach.

– *Laser Spectroscopy and Mass Spectrometry Methods for Sensing and Moniotring*

Major developments will concern further development of the instrumentation with the goal of extending the monitoring capabilities of multi-gas and VOC (Volatile Organic Compounds) detection both on the side of Laser Spectroscopy and Mass-

spectrometric methods. Both of them, in parallel to the developments of the devices based on nanostructures will be used as referring standards for the calibration of the sensitivity, selectivity and reliability under different environment. From this point of view of interest will be the development of interfaces for microfluidic environment where to measure head-space developments in conjunction with bio-relevant processes and eventually bio-medical. For the laser based systems the instrumentation developments will deal with the extension of the methods to solid state lasers while for the mass spectrometric methods the PTR-MS will be implemented with a TOF mass spectrometer that will enhance the ability to attribute to specific chemicals and processes the monitoring of the masses that will be detected. Strategies based on modern statistical methods will be also developed to this end in collaboration with CMM-FBK. From the application point of view, besides, processes relevant for bio-medical applications we will further focus on agro-industrial, agro-food, energy production and environmental studies.

2.3. Activities and Work Plan

– Functional/multifunctional inorganic, organic and hybrid materials

The research activity will be developed according to the several projects the group is involved. Attention will be mainly focused on the functionalization of Si3N4 and SiO2 substrates, for application in a optical sensing device for proteomic and in nanocantilever mass sensors, and of TiO2 and ZnO surfaces, for application in energetics. An extensive characterization activity will be devoted to the study and comprehension of the chemical/physical processes occurring at the film interface: in situ surface electron spectroscopies and ellipsometry, as well as ex situ microscopies and use of synchrotron radiation light will be also exploited.

A relevant part of the work will deal with the development of active sensing devices both OFET and EC-FET specifically designed to detect the evolution of biosystems and their interaction with nanoparticles. The devices will be based on pi-conjugated molecules, on hybrid materials, functionalized oxides and polymers, engineered in the preparation itself of the active materials.

New generation of sensitized solar cells will be developed based on ZnO and TiO2 nanostructures sensitized with phthalocyanines, porphyrines and other organic molecules. Particularly challenging is the development of PV cells base on ZnO tetrapods and ordered nanorods the functionalization of which will follow innovative schemes where simultaneous sensitization of each nanostructure will be carried out with up to three molecules with complementary properties so to much at the best the sola spectrum.

– Spontaneous fluctuations and dissipation.

We will produce a silicon oscillators properly designed to allow the application of a thermal gradient and the detection of the thermal noise with a sensitivity better than 10^{-13} m/√Hz. The choice of silicon make our results readily applicable to other fields of research, as it is the elective material for the next generation of gravitational wave detectors, while already being the choice for most MEMS and high-precision devices. The oscillator will be designed with the aid of Finite Element Modeling, in

order to set up a nodal support minimizing energy dissipation toward the holder. Other fundamental dissipative processes, like thermoelastic effect and structural damping will be also considered. The prototype will be then characterized in terms of dissipation and modal spectrum. In the second part of the year we shall design of the vibration readout used to measure the thermal noise. We point out that this device, which could be also used for generic dissipation measurements, will allow to extend our collaboration network and will improve our fund-raising capabilities.

– Laser Spectroscopy and Mass Spectrometry Methods for Sensing and Monitoring

The ongoing studies on the relationship between VOC emissions and physiological aspects in plants and products of interest for the local territory will be further developed aiming at understanding and applying preservation and agronomical procedures that best optimize quality and time-duration. Products such as apple, berry-fruits, olives and olive oil etc.ill be subject of our studies. Cross-correlated studies using the sensing devices developed using the materials and methods developed in the other activities of the group will be also developed aiming at qualifying the properties and performance of devices and processes. A focus of interest will be the study and monitoring of environmental processes also correlated to energy production. integration of the different instrumentation and devices will also be investigated and developed.

2.4. Collaborations

- FBK Materials and Microsystems. FBK, C. Pederzolli (M2B2): functionalization and characterization of SiO2 surface, L. Lorenzelli (BioMEMS): realization of biosensore based on TiO" deposited by SuMBD, M. Dapor (CTP): theoretical simulations of photoemission and functionalization processes, – study of dissipative phenomena in mechanical oscillators and thin films. Development of models to evaluate thermoelastic noise of silicon devices. M. Bersani (M2B2) development and characterization of hybrid materials for PV and devlopmkent of instrumentation base on mass spectrometry and innovative ionization methods. Benno Margesin – MemSRAad -Development of silicon mechanical resonators, with low losses properly designed to measure non-equilibrium effects in spontaneous oscillation (thermal noise). RET – A. Bozzoli – On line monitoring of the environmental impact of Energy production prototype plants by detection of VOC and Gas emissions
- Trento University. - Department of Physics: *Low Temperature Laboratory* (Giovanni Andrea Prodi) measurements of quality factor of mechanical resonators - *Lab. Nanoscienze* (L. Pavesi) Molecular materials for Photonics and Sensing; M. Scotoni – Molecular Aligned supersonic beams and developments of laser base for VOC and trace gas detection. - Department of Materials Engineering and Industrial Technologies: Material Science, Bio-Nanoscience, Bio-medical applications (C.Migliaresi and A.Motta) - Department of Civil and Environmental Engineering *Prof. Paolo Baggio*-monitoring fumes in processes of thermo-chemical conversion of bio-masses.

- CNR-IMEM, G. Salviati: AFM, CL, TEM characterization of inorganic and functionalized surfaces; -A. Zappettini nanostructure of Oxides for PV and Sensing; F. Albertini – magnetic nanoparticles for bio-medical applications; R. Mosca – Development of EC-FET for application in microfluidic environments
- CNR-IFN.Trento - Commessa Photonics (Falferi) – Design, production and testing of mechanical resonators for feedback cooling experiments
- CNR-IVALSA – (M. Negri) VOCs monitoring to assess bio-mass evolution and woods provenance quality, including health impact in confined environments
- University of Padova: Departments of Physic (M. Cerdonio) – AURIGA data taking, Chemistry (M. Casarin) theoretical simulations of photoemission and XAS experiments from organic molecules; Department of Environmental Agronomy and Crop Science University (A. Ramina) plant Physiology and Genetics -- Nanophase materials.
- Politecnico di Torino – Lamberto Rondoni – Development of theoretical models for system kept out of equilibrium, molecular dynamics simulation of the system; F. Pirri, SiC based devices and electronics.
- INFN Section of Padovaa and Laboratori Nazionali di Legnaro (J.P Zendri and L. Taffarello) – Low temperature measurements of quality factor of mechanical resonators; (L.Conti) measurements on nonequilibrium systems
- CNR-ISM (A. Amore Buonapasta) theoretical simulations of organic-inorganic interactions
- University of Groningen (NL)– (F. Hernike materials research center) (P. Rudolf) studies of elementary processe in the growth of molecular materials on solid surfaces
- University of Leiden (NL)– (A. Vinante) Feedback cooling on resonant Microsystems.
- University of Berlin (D)(department of Physics) (Prof N. Koch) molecular transistors)
- University of Cornell (USA) (Nanoscience Facility) (Prof. G. Malliaras) new generation, polymer based EC-FET)
- University of Nijmegen – Life Science Trace gas Facility – F. Harren
- University of Montreal (CAN)- (F. Rosei) sensitized nanotube based devices
- Institute of ThermoPhysics – Russian Academy of Sciences (Prof. A. Rebrov) Novel Supersonic Beam Sources ,
- Max Planck and University of Stuttgart (D) (F. Schrieber) molecular systems, growth and self-assembling on solid surfaces

Experiments

- AURIGA: the INFN Sections of Padua, LNL, Trento and Ferrara and the Universities of Padua, Trento and Ferrara involved
- ELETTRA synchrotron, S. Nannarone (BEAR beamline): PES, XAS analysis of organic/inorganic materials

Ongoing European Projects

TOPOS - Tailoring Growth and Opto-Electronic Properties for Organic Nanoscale Semiconductor Devices (MOIF –CT 2006 – 040864

RARENOISE Low-probability, large fluctuations of the noise in detectors of gravitational waves ERC –(202280)

2.5. Specific Needs and Points of Attention

The research team needs further expansion in personnel and projects to support the wide spectrum of expertise and know how that is being developed. On the CNR side in 2009 we increased of one researcher the staff and one further possible researcher could be hired in 2010. All the personnel has jointly unanimously applied that the research unit being transferred to the IMEM Institute where the perspectives of the activities are supposed to be best fitted and synergic. FBK is expected to favour this process and possible subscribe an agreement for joint research efforts to be developed with this Institute

Point of attentions are:

a) the increasing synergy with research activities in CMM could be further developed by the financial support of young scientist both for a PhD program and coming from abroad. Such a program should be developed by joint applications.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Development of O-FET based on modified Oligohiophenes Nnosmart Project	R	E	Oct.	Electrical characteristics	-
Control of the growth of organic structures on surfaces in the submonolayer regime	R	E	-	Chemical-Physical, structural an mophological characterization	-
Preparation and characterization of EC-OFET – TOPOS EU project	A	E	Oct.	In water measuraments	-
SIC synthesis and characterization at low temperatures FISICA project (PAT post-doc 2009 – Incoming)	A	E	-	Paper on low temperature growth and phnomena	Approval
Graphene for Sensing (PAT post-doc 2009 – Incoming)	A	E	July	First attempt of synthesis	Approval
Preparation of PV cells based on Nanohybrids (project DAFNE)	R	E	Nov.	Paper on nanohybrids synthesis and Prototype devices	-

Production of a low loss ($Q>10^7$) silicon resonator	R-A	E	Oct.	80 % achieved if low temperature quality factor is below 10^7	-
Monitoring and control of wood biomasses and their combustion	I-A	E	Nov.	VOC spectra and report	-
Virgin Olive oil traced by harvest time of the olives	R	E	Oct.	VOC spectra and reports	-
Papers	R	E	2010	6 Paper on leading international journals	-
Conferences	R	E	2010	Numbers of Accepted Contributions/ Invitations	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	**CNR**	**FBK**
Personnel	427.438,20	252.721,32
Travel	12.585,00	4.000
Equipment (HW/SW)		2.000
Other (e.g. subcontracting to external contractors)	15.000,00	16.500
Internal collaborations: “subcontracting” to other unit		0
Total Expenditure	**€455.023,20**	**€275.221,32**
Incomes (EUROS)		
EU Projects (total amount financed by EU)	26.397,90	0
Other external incomes (projects, grants, etc.)	161.800,00	34.688,88
Internal incomes (“subcontracted” by other units)	0	0
Total Income	**188.197,90**	**34.688,88**
Financial Need (Incomes – Expenditure)	**€266.825,30**	**€240.532,44**
Required Structural funding from PAT (it should be equal to the previous item)		**€240.532,44**

5. Human Resources

The unit has a staff consisting 9 permanent positions, six researchers (4 CNR/ 2 FBK) and three technicians (2 CNR/1 FBK) distributed. At present the staff includes also 3 CNR researchers with yearly renewable contracts. The activities, lead by the full time researchers can count on strongly motivated PhD students. However the research would requires a significant recruiting to best cope with the scheduled activities. Moreover there are some young and active researchers, which have the competences and the scientific skill to be the perfect candidates for a permanent position as researcher in the unit Nanoscience: materials, functionalization and prototype devices (CNR-IFN-IMEM). For these reasons the unit proposes to hire a FBK research position.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Loss of overall coherence in the specific planning of the main activities	L	M	Organization through module of activities with periodical meetings. Planning as a project with specific Gannt
Under-critical Size of the groups involved in the different tasks and financed projects	H	S	Strong coordination with all the partners involved in the different projects. Coordination beyond the single financed projects.

Legend*:*

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

HAIFA

Name	HAIFA	
Type	Research	
Head	Oliviero Stock	
Staff	2009	2010
	1 Researcher	1 Researcher

Document Status submitted 2009-10-22

1. Executive Summary

The present project, called Intelligent Technologies for Cultural Visits and Mobile Education – a.k.a. ITCH (Intelligent Technologies for Cultural Heritage) – is funded by the Italian Ministry for Universities and Research under a “FIRB” framework of Israeli-Italian projects and by a special initiative of the Provincia Autonoma di Trento. It is devoted to the development of intelligent technology for cultural heritage and mobile learning.

Cultural heritage is an important applied area, and an extremely rich setting for studying novel user interfaces and language processing systems. The area is particularly relevant also for the prospects of new investments in musea in Trentino. (including in particular the new MUSE) .

The relevant units at FBK-irst are essential components of this project.

Partners in this distributed activity are: University of Haifa, Bar Ilan University and University of Trento.

The theme of this project focuses on an area for which there was substantial work done at IRST through the years (see in particular the PEACH project) and then was also part of previous collaboration with University of Haifa

The collaboration with University of Haifa, and with Bar Ilan University has already benefitted activity within FBK-irst, at these levels: a) technical quality of collaboration (e.g. the direct impact of scientific developments in the language processing area); b) possibility of exploiting multidisciplinary aspects not present at FBK (e.g. involvement of conflict resolution experts, or drama experts in relation to novel interfaces for the museum); c) instrumenting a museum within the university permits to carry on experimentations difficult to realize in a different situation; d) as a side

effect, being a catalyzing element for industrial relations (e.g. the agreement between Trento Innovation Center and Israeli partners) and for the promotion of the Trentino system (e.g. see the emphasis put on the project by by the Italian Ambassador in Israel on many occasions).

2. Vision and Scientific Program

The present project, called Intelligent Technologies for Cultural Visits and Mobile Education - a.k.a. ITCH (Intelligent Technologies for Cultural Heritage) - is funded by the Italian Ministry for Universities and Research under a “FIRB” framework of Israeli-Italian projects. It is devoted to the development of intelligent technology for cultural heritage and mobile learning. Thirty-one projects were retained for funding out of over 160 applicants, and ITCH received the largest funding.

Partners are FBK-IRST and University of Trento in Italy, and University of Haifa and Bar Ilan University in Israel.

- Formally, ITCH began in October 2006. However, the official start was earlier than expected and on most fronts we were operational by spring 2007. In some cases we were obliged to start open operations later, due to the difficulty of finding suitable postdocs or PhD students in Israel while the economy was flourishing.
- As far as the financial structure of the project is concerned, the main problem was that Italian funding is only for the Italian side and the Israeli Minister was not in a position to fund the Israeli side. Since then, the President of the Trento province has agreed to provide funding for activities in Israel which, together with funding from the University of Haifa has enabled us to keep the project rolling.

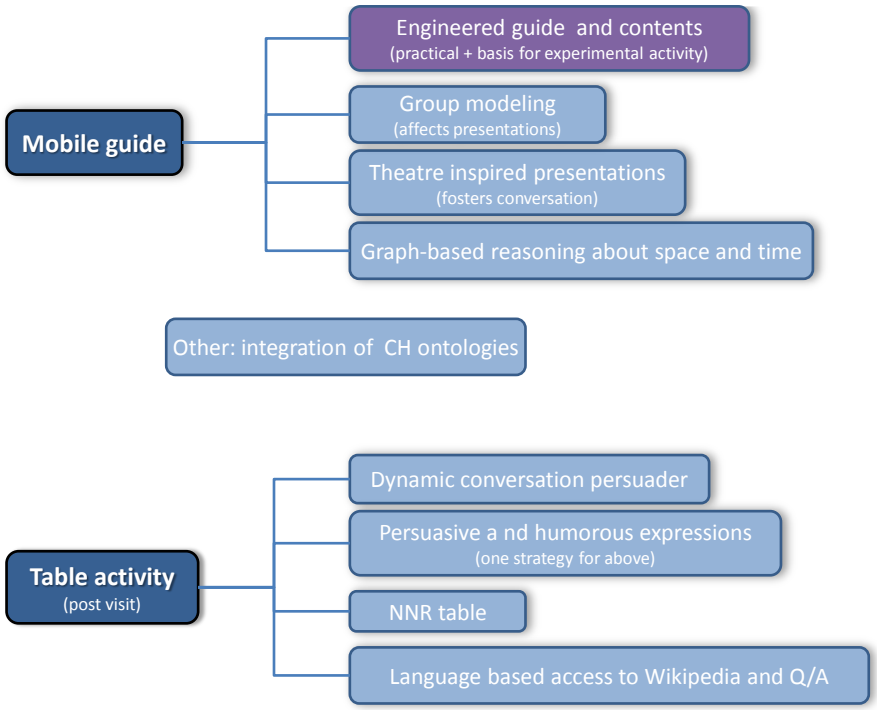
2.1. Context and State of the Art

This project takes place in the context of the ongoing collaboration with Israel and focuses on technology for roviding better guides and interfaces for museum visits. State of the art is provided in several papers of ours.

For example the PEACH book (O. Stock, M. Zancanaro (eds.) PEACH: Intelligent Interfaces for Museum Visits Cognitive Technologies Series, Springer, Berlin-Heidelberg, ISBN: 978-3-540-68754-2, 2007.

2.2. Vision and Goals

The overall structure of the project’s components is represented in the following figure:



The project includes a practical side: one goal is to engineer the guide produced as a prototype in the previous project and make it a real tool to be used by the public. This means rewriting the code, acquiring a better positioning system and substantially expanding the contents, to cover most of the Hecht Museum and to include presentations in English, Hebrew and Arabic. In order to cope with expenses such as equipment, maintenance etc., additional funds were successfully secured and we obtained a good portion of the requested funds from the Hecht Foundation. The installation at the Hecht Museum will be open to the public and will also integrate new prototypical components and perform extended testing with real users.

As for the research themes in the project, they are centered around the concept of small group of visitors. The adoption of intelligent technologies has mainly been focused on the idea of yielding personalized material to the individual visitor. But mostly, visitors come to museums in small groups-- a family or friends, and the idea is to see how intelligent technologies can be designed to exploit this particular social dimension to provide a better museum experience. Therefore, in this project we have included themes such as group modeling, as an aspect complementary to single user modeling, and referring to detection of behaviors from which to infer cohesion, dominance and so on; mobile presentations for individuals in a group, inspired by the wealth of experience in theatre and drama; technology for the museum café (a social setting *par excellence*), where activity is based on a sensor-equipped table that aims at orienting the conversation to the recent museum experience. Other themes in the project are more obvious in the project context: language processing for information extraction and access, integration of ontologies and techniques for semantic matching, and, with a more theory-oriented approach,

temporal and spatial reasoning based on graphs. We found appropriate space in the project also for inserting refinement and experiments with the Narrative Negotiation and Reconciliation Table, as it can constitute a tool that can be eventually positioned in a museum for fostering coexistence.

2.3. Activities and Work Plan

To use the terminology present in the description of themes in the FIRB document (in Italian) the points of development are listed here below with the main partners working on the subject.

- 1.1. Museum Visitors Guide for the whole Hecht museum - historic/archeological part (University of Haifa)
- 1.2. User modeling techniques for small groups (University of Haifa)
- 2.1. Methodology for dealing with presentations on personal spaces and on large displays (University of Haifa and FBK-IRST, Trento)
- 2.2. Techniques for advertisement of exhibits and persuasion (FBK-IRST, Trento)
- 3.1. Reasoning about graphs with application to temporal and spatial reasoning (University of Haifa)
- 3.2. Semantic matching and ontological graphs (Università di Trento)
- 4. Planner for dynamic presentations for members of a small group (University of Haifa)
- 5. Table for joint narration (University of Haifa, FBK-IRST, Trento)
- 6. Natural language processing and information extraction (Bar Ilan University, IRST Trento)
- 7. Tabletop interface for a group at Museum Café (FBK-IRST Trento)
- 8. Evaluation of interfaces

2.4. Collaborations

- On this project FBK-irst has as partners Università di Trento, University of Haifa and Bar Ilan University.
- Co-coordinator of the project is Professor Martin Golumbic from University of Haifa.

2.5. Specific Needs and Points of Attention

Due to slow start in resource acquisition, at least the part concerned with activities in Haifa will need to be extended (with no need for additional money, just the money already allocated for the project).

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Hecht Museum guide in place and operational	I and R	E	June	Evaluation with humans	All components functioning, positioning system satisfactory, integration tested, equipment acquired.
Drama inspired group presentations	R	E	Sept.	Evaluation with humans. Publications	-
Cafè table	R	E	Sept.	Evaluation with humans. Publications	-
Access to linguistic info about archeology	R	E	Sept.	Simulations . Publications	-
NNR tbale	R	E	Sept.	Long Experiments with humans. Publications	-

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	128.640
Travel	13.000
Equipment (HW/SW)	0
Other (e.g. subcontracting to external contractors)	132.800
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€274.440**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	5.767
Other external incomes (projects, grants, etc.) FIRB, Fondo provincial	79.432
Internal incomes (“subcontracted” by other units)	
Total Income	**€85.199**
Financial Need (Incomes – Expenditure)	**€189.241**
Required Structural funding from PAT (it should be equal to the previous item)	

5. Human Resources

Coordinator
Two units involved: I3P and HLT
Human resources at Univ. of Haifa

6. Ethical Issues

	YES
Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	
Does the proposal involve tracking the location or observation of people?	X
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

MIT-FBK ALLIANCE – MOBILE EXPERIENCE LAB ALLIANCE

Name	MIT-FBK Alliance – Mobile Experience Lab Alliance	
Type	Applicative	
Head	Federico Casalegno	
Staff	2009	2010
	2 Researchers	4 Researchers
	0 Technologist	0 Technologist
	2 Post Doc	2 Post Doc
	3 PhD	3 PhD-

Document Status submitted 2009-11-18

1. Executive Summary

Our research focus on “Connected Sustainable Home”:

Our vision aims to design a home where architecture and urbanism are truly sustainable, not only by virtue of the materials they use but also by what buildings can do and the better lives they enable their inhabitants to live.

The Connected Sustainable Home is built on four main design principles that pose four fundamental questions:

- Sustainable Architecture
- Green Energy
- Information and Communication Technologies
- Social Sustainability

In order to answer these design principles and to realize our vision, we started the first phase of the MEL-FBK Alliance activities with initial studies on:

- Background Research on Green Building
- Advances on Solar Energy and Climate
- Digital Fabrication and Dynamic Window
- Impact of ICT on Sustainable Behavior

We aim to achieve our vision with the construction of a full scale prototype. We are collaborating internally with REET. External collaboration are established with Distretto Tecnologico Trentino, and with Manifattura Domani.

2. Vision and Scientific Program

2.1 Vision and Goals

Our vision includes the construction of a full scale prototype of connected sustainable home.

Within this prototype we would like to pursue different research areas:

- SUSTAINABLE ARCHITECTURE: implementation of a vivid and specialized architecture that embodies particular sustainable principles, integrated into the landscape in an efficient and elegant way.
- SMART ENERGY SYSTEM: use of natural sources of energy for the energy supply of the home such as solar panels, rainwater retention, biomass and windmills.
- INFORMATION AND COMMUNICATION TECHNOLOGIES: integration of information and communication technologies to create a responsive system between users, architecture and energy systems.
- SOCIAL SUSTAINABILITY: integration of the individual home with the community with a focus on the social aspects of sustainable living and the local economy.

2.2 Context and State of the Art

What are the current systems implemented around the world that rate green buildings?

There are many labs and researchers actively involved in constructing green buildings. Successful green architecture uses resources like energy and water efficiently, while reducing waste generated during the construction process. Yet, there is currently no standardized set of indicators for

measuring and monitoring sustainable development worldwide.

We looked at a selection of case studies and built designs of both architectural and energy systems that illustrate the emergent notion of critical radical sustainability.

The alliance then investigated and developed innovative procedures to design and manufacture composite materials with variable properties. Taking into account local conditions, the alliance applied these procedures to design home configurations that take advantage of both local environmental conditions and new materials.

Finally, by linking previous explorations on material distribution and form factors the alliance created a landscape design strategy to optimize location, form factor, orientation, materials, and fabrication processes. The following projects tallies features commonly found in the some of the most innovative green buildings.

2.3 Activities and Work Plan

We aim to build the prototype in Rovereto, Italy, within Manifattura Domani.

Our prototype is a modular research platform to experiment pioneering architectural and electronics solutions in order to design spaces to promote sustainable living.

Designed as living environment, it will evolve according to emerging research areas.

Initially, we envision four areas:

- Home office environment;
- Children's room;
- Sustainable kitchen;
- Connected living room;

2.4 Collaborations

We have an FBK researcher in residence researching home technologies.

We work with the CSAIL Artificial Intelligence Lab at MIT in order to design the optimization system for the dynamic window for energy management.

After the Board meeting in October 2009, we are actively exploring how to strengthen our collaboration with other research groups.

Finally, we also aim to enlarge our collaboration with the territory, and to strength our work with local companies which can help and benefit with the prototype, and we work with Manifattura Domani, Habitech, Trentino Sviluppo and the Provincia of Trento.

2.5 Specific Needs and Points of Attention

Building a full scale prototype is extremely complex for several reasons. We are dealing with internal and external legal issues, working to have the appropriate construction permits and authorization, hiring and interviewing the right personnel, ensuring we are following the protocols, and abiding by the MOU agreement signed between MIT and FBK, and finalizing the contract agreement between MIT and FBK in order to proceed with the building of the prototype.

3. Goals

The goal is really to experiment our research through the construction of our prototype and keep experimenting new research areas and subjects while focusing on the topic of sustainability.

4. Budget

We are working on the budget as we don't have a complete visibility of costs, as we are engaged in a very advanced research project and need customized hardware, software and elements for the prototype. As our Alliance has a specific agreement, with specific budget, we are trying to stay within this budget.

In 2010 we intent to spend the total allocated budget of 693.454 Euro.

However, as we have a specific project, and most of the coast will happened during the prototype construction, we would like to have flexibility and eventually use some budget for 2011 on 2010, if the prototype will be built in 2010.

Expenses (EUROS)	
Personnel	
Travel	
Equipment (HW/SW) prototype	
Other (e.g. subcontracting to external contractors)	
Internal collaborations: “subcontracting” to other unit	
Total Expenditure	**€ 693.454**
Incomes	
EU Projects (total amount financed by EU)	
Other external incomes (projects, grants, etc.)	
Internal incomes (“subcontracted” by other units)	
Total Income	**€ 0.00**
Financial Need (Incomes – Expenditure)	**€ 693.454**
Required Structural funding from PAT (it should be equal to the previous item)	

MEMS-2

The MEMS-2 project has to be considered as a continuation of the one developed within the frame of the first PAT-INFN agreement. MEMS-2 is a direct agreement between INFN and FBK, supported and co-funded by PAT.

There are three strategic lines in the project. The first one is the continuation of the R&D activities on two projects inherited from MEMS-1, that are Silicon Photomultiplier (SiPM) and the Kinetic Inductance Detectors (KID). The second line concern the engineering work of the first SiPM technology version in order to address its industrial exploitation. The engineering work will also include the second technology generation, in case of success of the dedicated R&D activity. The latter line is focused to assure an access to all INFN Groups to FBK-MTLab capabilities, including the expertise of the MEMS and SRS Research Units, to support their research activities in new detectors. This last strategic line, named “Facility”, allows also the prosecution of the project activities that were present in the previous MEMS-1 and not officially included in MEMS-2. In this way, the FBK capabilities will be available for all the INFN Groups, independently on the specific project.

The foreseen programmed activities and related results for 2010 are the following:

- Recruitment of dedicated resources. There are four position available, one is already assigned, while for the remaining a specific call has been activated. It is planned to hire the researchers before the end of February.
- Silicon Photomultiplier. The main results expected for the 2010 is the realization of device having a “through silicon vias” solution for the device/package electrical connection.
- Kinetic Inductance Detectors. This work is strongly linked to the activity of prof. de Bernardis research team in Rome, “La Sapienza” University. During 2010 a cryostat, able to work at 300 mK, specifically designed and realized for this project task, will be installed within the Physics Department of UniTN. This equipment will require a lot of work assure by one of the hired researchers. It is foreseen the realization of a first set of device on sapphire and their testing by using the new cryostat.
- Facility. The activities to be ascribed to the Facility actions depend on the interest of INFN Groups. FBK-MTlab, in this case, will assure the best effort to respond in a professional way to the several requests.

In the MEMS-2 project there are not real critical issues, with the exception of the equipment up time, typical for the Facility action and already commented in MTLab budget.

AURORA

AURORA-Science is a research project at the crossroad of Computational Sciences and Computer Architecture. It builds on the combined know-how collectively available to the members of the collaboration on:

design, development and operation of application-driven high-performance computer system (e.g., the series of APE machines, developed by INFN).

algorithm development and physics analysis in compute-based areas of physics (Lattice Gauge Theory, Computational Fluid-Dynamics, Molecular Dynamics), quantitative-biology (Protein Folding), Bio-Informatics (Gene-Sequencing) and medical physics.

Aurora-Science can be seen as a scientific project enabled by leading-edge computational systems and by specific competences in the useful operation of these systems. The milestones of the project for 2010 are the following:

1. Development of the Aurora computing system. Availability of a small system with at least 2 chassis completely equipped. The system should have a working operating system and support communications between the processors. The system should be able to execute demonstrative parallel applications as described in the next items. This milestone should be reached by summer 2010, in order to allow the evaluation of the first phase of the project and the approval of the second phase. This ambitious goal is realistic thanks to an intensive preparatory work started before the formal approval of the project.
2. Optimization Methodologies. Definition of a general computing model for multicore systems and networks based on nearest neighbours communications. Such model should provide a solid framework for the optimization of algorithms and programs. Specification of the model for the Aurora system. Preliminary evaluation of the impact of the network routing on the performances of the applications relevant for Aurora-Science.
3. Lattice QCD. Demonstration of functionality on the Aurora prototype of a full Lattice QCD code, able to produce significant results on the final module planned for the second phase of the project.
4. Nuclear Physics. Adaptation to the Aurora system of existing algorithms and codes both for Auxiliary Field Diffusion Monte Carlo and for few bodies computations. This activity includes the analysis of the optimal parallelization strategy of the algorithms in order to exploit the special features of the Aurora network.
5. Protein Folding. Demonstration of functionality on the Aurora system of the critical computing routines relevant for the Dominant Folding Pathaway (DFP) method, employing simple parallel techniques.

6. Bioinformatics. Development of an interface between the data produced in laboratory and the Aurora system. Parallelization of the main computing routines.
7. Radiotherapy. Numerical simulation of radiation with a complexity analogous to the one necessary in a typical radiotherapy treatment plan, employing and adapting existing programs and test geometries.
8. High Level Training. Organization in fall 2010 of a school for PhD students on Scientific Computing for Nuclear Physics and Lattice QCD.

These milestones justify the financial requests for the Aurora-Science project in 2010. In fact, the first module in item [1] will cost 740kE. The first 100kE are being used now, 240kE constitute the part of INFN competence and 400kE will be spent in 2010. The items [2-7] involve different scientific competences which are met in the different institutions that contribute to the project, but require the work of full time research positions completely dedicated to those tasks. This justifies the request in 2010 of 270kE for FBK research positions (some of them working under the supervision of INFN staff) and 250kE for collaborations with the other partner institutions. In particular the Fondazione E.Mach will coordinate the developments in item [6], ATreP the activities in [7], the University of Trento those in items [4,5], FBK-ECT* those in item [3] and the University of Padova those in item [2]. The organization of the school in item [8] will cost about 35kE. The remaining 20kE of the budget for High Level Training will be used either to invite a senior visiting professor or to co-fund a PhD position, according to what will appear more strategic next year. The remaining items in the budget refer to smaller expenses (for equipments, software, computers, hard-disks...), that are motivated in the full proposal of Aurora-Science.

SPIN-OFFS AND HOLDINGS

Among Fondazione Bruno Kessler's main objectives, already specifically acknowledged in its Bylaws, is the transfer of research results and the support of new entrepreneurships.

This objective can be achieved in various ways, including that of creating and/or participating in consortia, companies and other public or private juridical subjects, in compliance with the foundation's purposes.

This plan is also precisely envisaged in article 7 of the previous Framework Agreement stipulated with the Autonomous Province of Trento that states, among the indicators of the state of implementation of said Agreement, the scientific production index, elsewhere defined also as "the creation of spin-offs or of new initiatives".

Assuming that this scenario also represents the context of Fondazione Bruno Kessler's strategic objectives, as from 2009 work has been done to precisely actuate the support for the launching of several initiatives, by defining not only the rules and procedures for governing the spin-off phenomenon but also by defining a dedicated cost centre placed under the supervision of the General Secretary, so as to provide an immediate accounting feedback of the activity under negotiation.

As regards the 2010 budget, this item includes costs referred to entrepreneurial activities that are about to start or have started in 2009 plus those that are most likely to start in 2010.

Solely for information purposes, here under are the activities carried out by the first category of enterprises:

- Z2M s.r.l. (in which FBK holds a 10% stake): this newco works in the field of anti-forgery and product traceability, via the creation of a uniqueness and originality certificate located in a patented high tech microchip. The main market sector is the "Made in Italy" one.
- TnX s.r.l. (in which FBK holds a 20% stake): a newco born of the cooperation between 2Effe Engineering (BS) and FBK. It consists of a team of professionals working to create innovative material analysis tools and methods using diffraction and X-ray fluorescence techniques. The market demand comes from the field of quality control of materials that is becoming constantly more demanding.
- SayService s.r.l. (in which FBK holds a 20% stake): the newco's technological core is an innovative technological platform (first devised in FBK) that supports the use, development, installation and updating of software applications for the business and government services areas and Internet Services.

- Teach&Touch (in which FBK holds a 20% stake): the future newco shall supply hardware and software solutions in support of collaborative learning sessions for small groups, especially in the field of medical training (continuous learning), via the use of multi-touch screens. The newco stems from the cooperation with the LINK Group (MO), already active in this specific market.

HUMANITIES

Introduction

Foreword

The necessity to rethink the humanistic sector stems from a series of factors that cannot be disregarded and which are grounded on the following reasons:

- the stakeholder's hope to assess whether the progress made by research in this field is capable of interpreting in the best possible way the need to build a reference framework – within the civilization context that also touches Trentino – that can be used to outline the future development of this community. To achieve this purpose, the observations contained in the document prepared at the end of the previous term by external referees, and adopted by the Provincial Evaluation Board, should be taken into due account;
- the intention expressed by the Board of Directors, which has adopted the Scientific Committee's opinion, to enhance the strategic nature of this sector of FBK, in consideration of the fact that the Foundation is unique in Italy, as it comprises both a humanistic and a scientific-technological division. This being the situation, the resolve and preparedness, which has been well discussed and put down in writing, by the Board of Directors to invest even greater resources on this front should be highlighted;
- the recent overhauling of the FBK-IRST division as regards both the research strategies and organizational profile, thus introducing a new approach, in which humanistic research has a role to play;
- and, last but not least, our awareness that an important cycle of humanistic studies, gathered in our Santa Croce facility, is drawing to a close and is making way for a new horizon which we need to provide for.

Based on the above considerations, therefore, the process launched by the Building Team cannot be nipped in the bud, or, worse, deprived of possible developments, precisely because of the simultaneous transformation under way, which sets at the same time both on the ethical sphere and the internal and external expectations, on the one hand, and on the task assigned to the Board of Directors of FBK and the provincial stakeholder, on the other.

The original model and its successor

The rationale serving as the basis for the creation of Isig and Isr is the revealing of two typical vocations of Trentino: its historical character as a sort of postal station on the North-South road (i.e. between Italy and Germany) and its inclination to become a venue for discussions on issues such as sacred issues and theological knowledge, the roots of which go back to that period of European history that concentrated its contradictions in the Council of Trent and opened up the continent to modernity. At a time in which it was essential to bring Trentino to the fore within the

international scientific community, the decision was taken to focus around two Directors endowed with a strong personality the primacy and paternity of a debate which was becoming increasingly identified precisely with these two important figures, supported by an efficient logistical structure and a number of researchers engaged in developing their research work with a vertical reference to the directorates. The strongpoint of this approach was to associate the Isr and Isig brands with those prestigious directorates and to enhance their value both nationally and internationally; the down side of the project was the failed formation and growth of a community of scholars capable of interpreting and organically developing the selected research lines, so as to firmly place Trento on the map as the most advanced venue for discussions on a core of well-defined issues. The passing of time has further dilated this "drift" – even though, generally speaking, the scientific quality of the research work produced is certainly not under discussion – thus creating a degree of uncertainty, also of an organizational nature, which tends to short-circuit the personal destinies of the researchers themselves.

This fact, which is significantly affecting the present transitional phase, should be duly taken into account, although it cannot become the focal point around which the reorganization of the humanistic division is made to revolve. On the contrary, it should be viewed independently, compared to the contingencies which should then be tackled and settled once the future pathway has been determined.

In order to overcome the original model, it might be indicatively useful – albeit taking into due consideration the fact that a certain model may not be automatically applicable in a significantly different context – to examine the results of the overhauling process concerning the scientific-technological research profile. Given the concentration of competencies in two Centres featuring a suitable critical mass, the strategic development, subsequently channelled into the Programme Agreements, has outlined horizontal scientific development strategies aimed at consolidating and, indeed, expanding the core of activities with respect to which the two Centres had already gained a certain international renown. At the same time, however, two vertical sequences were defined – called *domains* – along which the contamination of different competencies can produce integrated and more incisive projects showing a greater capacity to conquer evolutionary capability niches which are also susceptible of usefully transferring know how to the community and businesses. In brief, the two scientific-technological Centres have definitely not given up further investigating and developing their scientific vocation, they have merely engaged in pooling some of their skills in order to convincedly and assertively give rise to an opening-up process that can be perceived from the outside.

Albeit with the distinctions and reservations mentioned above, we think that this model can be duly kept in mind when overhauling the humanistic division.

Research development lines and "application domains"

Unquestionably, both Isr and Isig have tried and tested over time well-defined skills and vocations within the context of humanistic research; such skills must now be made to emerge with greater clarity, focused and supported in their capacity to ex-

pand and be further valorized, as this would represent the capitalization of the investments already made, which it would be pointless to scrap.

In particular, the European approach developed by Isig, which is now focusing on the dynamics of the contemporary world, as well as the sensitivity towards the role of theologies in their rooting in the public sphere, and not just with respect to religious belonging, represent important channels that cannot be neglected. But, alongside these horizontal lines of development, which should be declared and highlighted over a short period of time, we believe that the time may have come in which to pool the skills and knowledge acquired to date within those vertical segments we have christened *domains.*

Following are proposed, and not just as an exercise of style, three spheres of integrated collaboration the aim of which would be openly, and right from the start, to provide elements of discussion and of "building on" in a community, such as the community of Trentino, which is looking for its own pathway towards the future:

- the issue of *secularization*, with respect to which any outside observer can easily see the large amount of material produced, in a separate capacity, by the two Centres. Today, the issues related to post-secularization within the progress of the technical era require a certain amount of authoritative reflection to guide the compass – now quite out of control – indicating both the twilight of all things sacred, and the loss of the "sense of politics";
- the issue of *territoriality*, whereby it is now obvious how the political-institutional form of the states in Europe is declining towards forms of disaggregation, with respect to which the question is increasingly being asked as to the meaning of those historically autonomous "middle lands" in the construction of the new European scenario. And this is precisely the most hotly debated issue in the arena of local politics today, caught as it is between a centralized national Government and the possibility, which has yet to be built, of an Alpine region, or macro-region, representing the spearhead for building something different to be developed on the common European horizon.
- But those who speak about the interpretation of territoriality also speak of its social organization, of its multiple cohabiting identities coming daily to terms with an intercultural and inter-religious dialogue which has now become harder and harsher, but which, at the same time, cannot be postponed. Nothing more need to be added for us to understand how the interactions of Isr and Isig, with respect to this context, can be powerful and, indeed, decisive: likewise the contribution by Irvapp in measuring the effectiveness of the Public Administration's interventions on public policies, to the point of virtually imagining their effects over a time frame longer than one term of the provincial council.
- The *convergence of different disciplines* and the issue of discomfort often resulting from an acceleration in technological progress, when it is not reflected in and mediated by other forms of knowledge and scholarship. The question here is the relationship between technical evolution and mankind's capacity to metabolize it: an open issue that affects and conditions the individual life of

people, as well as the life of the community as a whole. In this case, the Isig and Isr *domain* can and, indeed, must be contaminated by the hill land component, launching scientific project-making capacities that can help outline and define this issue in a more innovative manner.

Organization procedures

If the issues and matters detailed herein above are to be implemented, we must move along two lines of action.

- The first concerns the necessity to make choices, in order to distinguish between that which, based on the reflection carried out and its developments, can become the "*core*" (or not) in the scientific strategies of the two Centres, with regard to both the horizontal and the vertical lines. It is precisely in this context, and not in any other, that we must build our decision-making capacities, if and where this is deemed to be necessary, with a view to taking decisions, including important decisions, with respect to researchers and their role.
- The second line of action concerns and relates, among others, to the imagination and the new outlook with which to determine the reality – which has become too static – that characterizes the current organization of the Santa Croce division, especially as regards the clear cut separation between the upper and the lower storeys, with the structural difficulties the researchers have in communicating among themselves and in building a community of scholars, and with that organizational and secretarial isolation that has often characterized the two Centres in the past as non-communicating units within first the body of ITC and then of FBK.

Road map and transitional procedures

If this project is pooled, then, in my capacity as President and with the support of Prof. Maurizio Sobrero, we could communicate a great decision-making stance on the model that should be pursued, already at the joint session of the Board of Directors and the Scientific Committee which is scheduled to be held on 9th November next.

At the same time, an *ad interim* information link should be created about the initiatives in progress, to the benefit of both the stakeholder and FBK Members. It is of the essence, in fact, that a vaster sensitivity be expressed at this stage; a sensitivity that is not confined only within the scientific community, but affects with its spin-offs the civil community of reference as well.

In the meantime, and generally speaking by the end of the year, we should clarify and, indeed, corroborate the scientific strategies along the horizontal and the vertical axes, in order that they may be expediently proposed in the Programme Agreement, by making the work of the *Building Team* out-dated for this purpose, and relying, instead, on a coordination among the Directors, the President's Office

and the Scientific Committee, aimed at a speedy and more effective alignment with the new outlook.

Hence also the need of modulating the commitment of assets and the budget for 2010, which should already be usefully aimed and directed at the implementation of the above mentioned new outlook. In this context, the Directors shall act in close partnership with the President, because, at this point in the transition process, FBK as a whole shall undertake the overall responsibility with respect to the process, relieving the Directorates from a situation whereby their operations must not be perceived as the result of isolation or of personal guidelines.

In this sense it might even prove useful – and we can assure all our availability in this connection as from now – to organize a joint meeting with the research sector, precisely to highlight and stress that the dynamics that are set to be inaugurated are the outcome of an overall rethinking and will to change, which issues from and, at the same time, can be traced back to the Board of Directors and the *governance* of the organization and which, therefore, does not answer separately, and for itself alone, to the scientific condition of any individual Centre.

If it should be deemed expedient, we can also put into place an agenda of the more urgent matters that need to be tackled, studying ad hoc concerted procedures and timeframes, such as to enable the step by step supervision of both the evolution as a whole and the subjective episodes of the pathway in progress.

The President of Fondazione Bruno Kessler

Prof. Andrea Zanotti

Isig – Centro per gli studi storici italo-germanici

In view of the discussions held at various levels within the Foundation in these past months, I would like to reiterate the Centre's general operational strategy for the year 2010.

The Centre confirms its role as the seat of advanced research in several specific sectors of general scientific importance, that have already gained standing abroad, especially in Germany with the two institutes that conduct similar studies (Institut für Zeitgeschichte in Munich and the Zentrum für zeithistorische Forschung in Berlin/Potsdam). To this we may add the German Historical Institute (DHI) in Rome.

We are now concentrating our energies on three large common projects that will involve all of the researchers already at work in the Institute, in order to create a veritable "research community" capable of attracting resources and other external researchers. The strategy is based on a gradual transformation aimed at enhancing the work of the researchers already active in the Institute's traditional sectors of study (birth of the Modern era, history of Germany and of Austria and their many links with Italy, history of Trentino).

Now is the time to strengthen and intensify the theory quality of all of the research work under way by working on several paradigms or key concepts (*Grundbegriffe*) that in the long run will qualify the research work in Isig in Trento. We have identified three guiding concepts: *the public sphere* (that includes political and historiographic communication as a public topic), *secularization* (not to be understood only in the restrictive terms of relations between society and religion, between Church and State and the relating theme of secularism and laicality, but also as a long-term historical process, as a set of rationalization phenomena typical of the modern and contemporary world); *territory-nation* (considered in its historical metamorphoses, especially from the 19th century concept to the contemporary post-national forms; without forgetting regionalization, the European region and other phenomena).

These key concepts or paradigms will act as core to the specific study themes on which individual researchers are already working, or to new ones. This compelling work has two final objectives. The first is to establish a space for open and free discussion regarding the more general theoretic and epistemological assumptions of historical research and of the historian's work, capable of engaging all of the researchers working in the Centre. The second is to contribute to the improvement and consolidation of the quality of each single study and research project under way, triggering high level thought that goes beyond guiding concepts.

Management is convinced that the work regarding the *Grundbegriffe* – to be achieved via internal monthly seminars to be attended by all of the Centre's researchers – will contribute to producing and firmly establishing a veritable «re-

search community» while strengthening the concrete and specific study activities of the Centre.

This common effort, together with the actual returns on research projects already under way or in the making, shall be supervised and monitored not only by the Centre's Director but also with a high-level ad hoc «tutor», and obviously will be able to count on all of the external experts and scholars necessary.

Other qualifying aspects

In order to further reinforce the Centre's position, also at an institutional level, Management believes it is indispensable not only to continue seeking special and selective relations with the Universities, starting with the University of Trento, but also and especially to activate relations and conventions with other similar institutes in Italy and abroad. All of this driven by a spirit of internationalization that not only includes Germany, an obvious partnership, but also more in general the whole of Europe.

The conferencing and publishing activities of the Centre are a strategic factor in its repositioning and for its public image, especially at a local level. Management is convinced that the conferencing activity should be somewhat streamlined and more specifically aimed at the discussion of the themes subject of research projects, envisaging the active participation of the researchers actually involved in such projects, and that the publishing activity must be enhanced in order to become the natural outcome, as well as the «prize» and concrete result, of said projects.

First positive results

After launching, quite some time ago, the internal discussion about the Centre's repositioning and reorganization, the Director has taken note of the fact that all of the researchers have favourably greeted the hypothesis of launching a common work effort on the *Grundbegriffe* that would achieve the value of training and of debate as well as have tangible effects on their research. Several researchers have accepted the invitation to reroute and, in some cases, change their individual work in order to group it into more ample and complex collective research projects.

Without going into the details of a process that has just started, a "research unit" is now forming, consisting of various researchers from the Modern area, that will work on a common project regarding the "forms of political communication" starting from the first modern era. In the same way, a second "research unit" is forming which, because its core interest verges on Germany and Austria, will turn them into a "case study" for the history of the modern nation in all of its developments. Within this major project is the study focused on the relations between the German world and Italy in the years when the two nations, the German and the Italian, were forming (also in view of the 150th anniversary of the Italian Unification). Finally, a third "research unit" will dedicate its work to the complex and transversal theme of secularization and will liaison with several researchers of the Centre for Religious Studies.

Public initiatives are planned for the end of the year (in the form of Conferences) regarding the three conceptual axes of research, with the researchers involved playing leading roles together with Italian and foreign scholars invited ad hoc.

One of the critical points of this operation consists in the connection between the transition phase of the incoming year, 2010, and the planning of future years. Obviously, we will work hard at solving this problem too.

The Director of Isig

Prof. Gian Enrico Rusconi

Isr – Centro per le scienze religiose

Foreword

a) a process under way in recent years, essentially consisting in placing the focus on research issues regarded as characterizing and strategic.

The transition from a broad range of occasional issues to a horizon featuring the current three subject matters (nature, theological aesthetics, gender studies and theological disciplines).

b) The assessment of the possibilities and opportunities for identifying the original and typical nature of the Isr Institution is being developed within the framework of a dialogical process, the impulse for which comes from the Governance of the FBK, but which is built within the internal and external interchange with the Isr Centre. With regard to external consulting, we must consider the exchanges with both individuals (K. Merks/NL – E. Zenger/D – J.Keenan/USA – F. van Fleeteren/USA. Here we also capitalize the resource of Ex-Visiting fellows and members of the former Executive Committee) and institutions (IWV/A – Stiftung Weltethos/D – Divinity School-University of Glasgow (UK - Boston College/USA – Centre of Theological Inquiry – Princeton/USA - Centre Sèvres/F).

Internally, exchanges take place with the persons in charge of the three projects currently under way at the Isr. These exchanges have occurred at different times, from last May.

Identification of the characteristics

a) the theological subject matter and the venues where the theological discourse takes place: *the public arena*.

b) the "*emancipatory*" relevance and overcoming of the theology's claim to "neutrality" and innocuousness. An example of the declination of this characteristic is the reflection on the "gender-based" approach and, in particular, on all that is associated with and related to the discussion on the emergence of *corporality* and its meanings.

c) the necessity to explore the conditions of possibility of the secular character and of the emancipatory relevance of theology: this point focuses on the exploration in the thematic area of anthropology of the subjectivity and the *public/private tension* that tends to pervade political philosophy, within the horizon of a "mature" modernity.

"IN BRIEF": the reorganization procedure should be viewed as a repositioning of the Isr Centre, based on the intensification of the theological subject matter, with the necessary recalibration between the general interests, referred to

theology, and the corresponding special interests. We can rightly speak of a "theological u-turn" of the Centre.

Motives relating to legitimation

a) *filling in* a void in the Italian scenario. This void can be represented by the absence of theology as a university subject, but which is expressed in a climate and a language where the theological discourse is excluded, in its specificity as a cultural and, therefore, "secular" discourse, from public perception both in the analysis of the theoretical problems and their practical consequences (see the discourse on ethics).

b) Trento *historically highlights* (see the Council, Reformation-Counter-reformation) the emergence of this void and the confining of theology within the fence of the ecclesiastical institutions, at the dawn of the modern era.

c) and it is precisely in Trento and from Trento that we can *once again start the process* aimed at overcoming this situation of confinement ("clearance" of theology). To *characterize* Trento and the Isr as a venue for further investigating and carrying out research in respect of "Public Theology". Promoting links and exchanges with study centres (especially in the USA), which have started and share this approach, of both an epistemological and strategic nature, of theology and its position within the public arena.

d) to enhance the importance, as far as possible, of the existing infrastructures (libraries, publishing, etc.), in the FBK, but, above all, to find more opportunities of convergence with the internal FBK institutions (and especially the Isig, with regard to the necessary historical reference, in particular with respect to the issues of a mature modernity, a secular society, secularization, the post-secular, but also to investigate into important religious personalities in Italy who, ante litteram, have tried to follow paths of this nature (e.g. Dossetti – Milani, etc.).

e) the existence of an academic pathway of the theological disciplines (CSSR) in the FBK, hitherto viewed as a secondary area or – as in the last few years – even as a "critical area" (see the conflict/relations with the STAT), should be reconsidered as a resource, and because Trento is the only place with a similar structure in a civil institution (first the ITC, followed by the FBK), which is in agreement with the ecclesiastical institution, this structure of ours is a further reason for the legitimation of the theological u-turn in the research activities of FBK-Sr.

Orientation decisions

a) to take on the subject matter of *Public Theology* as a core idea and a horizon for research activities within the Isr Centre.

b) to break down this subject matter into complementary thematic units (so, therefore, a project – PT – featuring different references) responding to priority

options which, even acknowledging the rest, focus each time (e.g. long-term planning) on priority articulations.

c) to define the priorities in respect of the first section (e.g. over the next 4/5 years). The priorities today are the issues related to fundamental theology, with the implications relating to anthropological and ethical issues (corporeality) and philosophical and political issues (public/private in a context of secularization).

d) to further requalify the CSSR, albeit assigning priority status, and its own characterization, to research work.

Breakdown of the research issues

a) *Fundamental theology as a public theology*

– The starting point, in this respect, is to recognize the implicitly fundamental theological profile of a survey on the different *ways of believing* (on a diachronic, but especially a synchronic scale) and to theologically valorise the category of doubt. This points to a "stylistic" rather than a "dogmatic" approach to religious and believing identity as a lifestyle within a plurality of different ways of living in this world. Against this backdrop we can also theoretically and pragmatically consider the issue of inter-religious dialogue.

– The issue of the *faith of the theologian*. If only he who believes can be a theologian, then this subject matter can hardly spread much among the publicly organized forms of knowledge; but if faith is irrelevant for the purpose of embarking on a research pathway, then theology has nothing to add to what can already be found in a philosophy of religion. The issue cannot be solved on the basis of a binary faith/disbelief dialectic, and this undecidability is a fact that tells us something about theology itself.

– Fundamental theology and *textual hermeneutics*: the "vulnerability of the account" as opportunities for theological reason and as guarantees of a space of freedom. The biblical text plays a twofold role: it is the cornerstone for theological reflection and the product of a culture that has profoundly affected the genesis of modern thought. To the extent that the exegetical study identifies, in the biblical text, the origin of the categories and ways of thinking that have contributed to the formation of modernity, it can initiate a dialogue with the forms of knowledge that have accepted or have formed themselves through its concepts and its language. The narrative nature of the text has strong repercussions on the exercise of theology (in which way can the text be viewed as "foundational"?), besides all the possible specific fields of exegetical investigation, which highlight the public role of religion.

b) *The body as a public space*

– Belonging to the public space is basically determined and marked by our condition as men and women, as beings who exist in their body and who manifest themselves through it. The body is the place where both the individual and so-

cial dimensions of the human being and the discourses of various disciplines (biology, sociology, religion, medicine, etc.) meet. Through our body, as a "genderised" body (not just because of its biological basis, but also as it is interpreted and viewed as a cultural and social entity), we establish our identity, we interact with society and thus realize our humanity. The realization of our existence in our body never takes place in a vacuum and in full autonomy, but always under concrete (historical, social, cultural, biological) conditions, which mutually condition themselves.

- One of these conditions – perhaps the most decisive – has always been and still is religion, which has had a strong influence on the image of the human body and, therefore, on the human being as male/female. Another condition – which cannot be disregarded today – is that of the media, which broadcast and build normative images of the body. The intertwining of these two coordinates can fruitfully contribute to the research on the issue of corporeality, from the point of view of gender studies, and certainly entails an in-depth investigation into anthropology (including theological anthropology), leading to the highlighting of several aspects that contribute to the reflection on the role of theology and its contribution to the public arena.
- The task of a theology in the public arena will be that of analysing the modes whereby theology too has contributed to form and force bodies (and how, through the images of the body, it has created images of men and women, of the genderised human being). Step two, however, will be to discover how theology also offers the instruments for overcoming the conditioning, contrasting the dominant normative ideologies based on the "perfect body".

c) *Public and private in modern theory and practice*

- The general purpose of this segment of research is, on the one hand, the systematic analysis of a central dichotomy in the modern cultures and anthropologies of subjectivity, and, on the other hand, the investigation into the historical evolution of the "public/private" dichotomy in the modern era, with special reference to the concepts of self and of personal interiority (definition of the limits of the "self", with respect to the outside or the stranger; changes in the normative models of balance between the public and private dimensions of existence).
- The centrality of the concept of public reason from Kant to Rawls, and its metamorphosis from the paradigm of "rationality" to that of "reasonableness".
- The "return" of religions into the public sphere as a crucial problem of the theories of secularization (the public and/or private dimension of religious belief). Consequently, the political implications of the tightening or the breaking up of the borders between the public and the private spheres, in the contemporary democracies, should be further investigated.

Final remarks

- The possible areas of convergence and synergy with the Isig Centre should be identified each time, with respect to the selected search pathways. Of a preferential nature are the common investigations on the issues of secularization, the secular society, democracy, but also investigations into the figures and profiles of the precursors in the religious history of Italy.
- After the internal consultation phase, in view of the development of the draft presented here, and in consequence of the assessment of it by the BT, an external consultation phase should be launched, with the contribution of scholars that can offer some interesting perspectives, in view of the definition of a research programme based on the option described here. This phase could be launched in the near future.

3. This draft does not mention the necessary reorganization of the human resources, in support of the research work (the secretariat, for example), nor the investment forecasts for implementing the programmes. With respect to these matters, an operating consultation should be launched with the FBK governance bodies.

The Director of Isr

Prof. Antonio Autiero

Other Research Areas

IRVAPP – ISTITUTO PER LA RICERCA VALUTATIVA SULLE POLITICHE PUBBLICHE

Name	Irvapp – Istituto per la ricerca valutativa sulle politiche pubbliche	
Type	Research	
Head	Antonio Schizzerotto	
Staff	2009	2010
	14 Researchers	16 Researchers

Document Status submitted 2009-09-28

1. Executive Summary

For the year 2010 IRVAPP will undertake ten research projects. Three of them are impact evaluations of policies, commissioned by the Autonomous Province of Trento. One of them is the impact evaluation of an important Development Project in Nigeria - for which IRVAPP has recently signed a research contract with the World Bank group. The remaining six projects are impact evaluations of national policies/programmes whose effects shape people's life conditions both at the national and local level. They are evaluations of the effects of education policies, labour market programmes, industrial policies and financial literacy programmes (for more detailed information, see this document: point 1.3).

With respect to external training activities, in March 2010 Irvapp will organize an advanced course for PhD students on "Fundamentals and methods of policy impact evaluation" to be held in Trento. The course will present the fundamental principles of impact evaluation analysis with a specific focus on the counterfactual theory of causal inference as well as on the statistical methods and techniques for counterfactual analysis. In addition, a 4-day training course for public servants from the Province of Trento on "Fundamentals of policy impact evaluation and their possible uses in policy-making" (joint with Progetto Valutazione, a research institution based in Turin) will be held in Trento in May 2010.

In 2010 the most prominent collaboration for IRVAPP will be with the Development IMpact Evaluation (DIME) Initiative group of the WORLD BANK. In October 2009 IRVAPP signed a research contract with the World Bank group to collaborate on the impact evaluation of an important Development Project in Nigeria: the Commercial Agriculture Development Project (CADP). The impact evaluation, IRVAPP will contribute to, will inform project design and test the efficacy of various project components in achieving project objectives. This very fist collaboration between IRVAPP and the WORLD BANK is likely to open up in 2010 opportunities

for setting up impact evaluations of development policies in Latin America as well. Another prominent collaboration in 2010 will be with the Italian Ministry of Education and Fondazione Giovanni Agnelli to evaluate the impact of the introduction of new learning technologies (Interactive Whiteboards) in the lower secondary school.

In 2010 the IRVAPP research staff will be composed of an interdisciplinary team of at least 16 researchers in Sociology, Economics, and Statistics, 1 Research Secretary and 1 Research Finance Assistant (see points 1.5 and 4). For those junior researchers in need of strengthening their research skills, specific training will be arranged.

In 2010 IRVAPP is going to strengthen its research and institutional networks by formally admitting new members (associates). In 2009 the Consiglio per le Scienze Sociali (CSS, Rome) and Fondazione Istituto Carlo Cattaneo (Bologna) were admitted as new associate members. In 2010 the Department of Economics of Turin University will be formally accepted as a new associate.

The most salient ethical issue concerning IRVAPP research activities is related to privacy and data protection. As a research institution, IRVAPP is subject to the "Code of conduct and professional practice applying to processing of personal data for statistical and scientific purposes" - *Codice di deontologia e di buona condotta per i trattamenti di dati personali per scopi statistici e scientifici* (Provvedimento del Garante n. 2 del 16 giugno 2004, Gazzetta Ufficiale 14 agosto 2004, n. 190). Therefore, IRVAPP is allowed to disseminate statistical results, also by publishing them, only in aggregated format, or else in a manner preventing data subjects from being identified.

2. Vision and Scientific Program

2.1. Context and State of the Art

IRVAPP was established in March 2008 by the Fondazione Bruno Kessler (Trento) and started its activity on April 1st, 2008. IRVAPP aims at providing evaluations of *policy impact* to international, national and local agencies engaged in public policy in order to contribute to the establishing of an informed and *evidence-based* policy making. The methodological paradigm underlying IRVAPP's empirical work is the counterfactual model of causality. That is, the effects of public policies are measured as a difference between the expected policy outcomes and what would have occurred in the absence of the intervention.

In 2009 IRVAPP has completed the following research projects:

- The Treu Reform and contract mobility. A comparison between cohorts of first entrance into the labour market.
- The Effects of Temporary Job Experiences On Short-term Labour Market Outcomes in Italy.
- The effects of remedial exams on student achievement in the higher secondary school system in Italy.

The relative working papers are available on IRVAPP website at the address below: http://irvapp.fbk.eu/pubblications/progress%20reports

2.2. Vision and Goals

The Institute for the evaluation of public policies is a policy-relevant research organization. IRVAPP aims at carrying out policy evaluation research to disentangle and measure the effects of policy interventions. The scientific mission for the next five years includes the evaluation of social policies, the dissemination of findings from this research, the promotion of a culture of impact evaluation, the training of policy evaluators, and the setting-up of a policy-relevant data archive.

Although some progress has been made in recent years, in Italy the lack of a culture of impact evaluation and the difficulty in accessing both administrative and survey data remain major problems in policy evaluation. Therefore, promoting a culture of impact evaluation through training activities, research dissemination, and the establishment of a policy-relevant data archive will be key activities for the Institute.

IRVAPP intends to fulfill its mission also through the promotion and implementation of policy pilots. The use of pilots has been widespread in the USA and Canada, as well as in the UK. IRVAPP wants to open up new opportunities, at both national and international level, for the utilization of policy pilots. The aim is to provide policy makers with an *ex-ante* test of the policy on a small-scale population that will help shaping and - if necessary - redesigning the final policy, before being rolled out on a large-scale.

2.3. Activities and Work Plan

Research projects for the year 2010

- *Evaluating the impact of a Minimum Income Guarantee programme in the Province of Trento*

  The project evaluates the impact of a Minimum Income Guarantee programme, being introduced in the Province of Trento, on several outcomes: poverty, labour market participation and consumption behaviour. The Minimum Income Guarantee program is means-tested and aims at lifting out of poverty families living below the national poverty line by topping their income up to a 'guaranteed' level, defined according to household composition and circumstances.

- *Merit-based Financial aid to Students from low-income Families and its Effects on University Enrollment*

  The project is aimed at measuring the effectiveness of a means-tested policy intervention of the Province of Trento designed to reduce education inequality by increasing participation in higher education through financial aid.

- *Reconciling paid work and family responsibilities: the role of 'service vouchers' in the Province of Trento*

The project aims at evaluating the impact of a child care voucher scheme recently introduced by the Province of Trento and designed to reduce gender inequality by increasing female labour market participation.

- *Impact evaluation of the Nigeria Commercial Agriculture Development Project*

  The Commercial Agriculture Development Project (CADP) aims at strengthening agricultural production systems and supporting the dissemination and adoption of new technologies, for targeted value chains among small and medium scale commercial farmers in five participating states in the country. The impact evaluation evaluate the impact of various project components in achieving project objectives.

- *Evaluation of the 2001 reform of Higher Education in Italy*

  This project will assess the effects of the reform of Higher Education approved in Italy in 1999 and implemented in 2001.

- *The Italian programme 'Liste di Mobilità': An analysis of the impact of its 'passive' component*

  The project aims at evaluating the impact of the Liste di mobilità, an Italian labour market programme introduced in the early '90s to handle redundancies in the labour market.

- *Changes in the Italian unemployment insurance scheme and estimation of their effects on unemployment duration and transition to a new job*

  This project exploits discontinuities over time in order to estimate the impact of the recently increased replacement rate of the Italian unemployment insurance scheme on the length of unemployment spells and probabilities of re-employment.

- *Evaluating the introduction of new learning technologies in the lower secondary school in Italy*

  The aim of the project is to assess the impact of the introduction of new learning technologies in the Italian lower secondary schools.

- *Incentives to Firms: Do They Affect the Output of the Innovation Process?*

  In this project we evaluate the impact of state aid programs on investment in R&D and investment spending of small and medium Italian manufacturing firms. Estimating a production function that links the inputs (fixed and R&D investments) to the number and types of innovations introduced by firms allows us to provide evidence about the importance of state aids in helping firms to generate technological progress.

- *Power Calculations for the Minimum Detectable Effect*

  The aim of the project is to review the existing literature on the optimal design of social experiments considering statistical problems of longstanding concern in agricultural, biological, educational and social policy research, and to look into the possibility of addressing the same problem for non-experimental designs.

Training activities for the year 2010

- A 4-day training course for public servants from the Province of Trento on "Fundamentals of policy impact evaluation and their possible uses in policy-making" (joint with Progetto Valutazione, a research organization based in Turin) will be held in Trento in May 2010.
- In March 2009 IRVAPP organizes an advanced training course on "Fundamentals and Methods for the Evaluation of Public Policies" for Ph.D students and academic researchers.

Seminars for the year 2010

In 2010 IRVAPP - in collaboration with Fondazione Istituto Carlo Cattaneo, Bologna -will organise a series of six seminars for young researchers in social and political sciences (Seminari "Fare Ricerca").

The seminars will be held alternatively in Trento and Bologna. IRVAPP will be presenting its first three empirical studies: 1) *The Treu Reform and contract mobility. A comparison between cohorts of first entrance into the labour market,* 2) *The Effects of Temporary Job Experiences On Short-term Labour Market Outcomes in Italy,* 3) *The effects of remedial exams on student achievement in the higher secondary school system in Italy*

2.4. Collaborations

- Institution: THE WORLD BANK

  IRVAPP reference person: Antonio Schizzerotto

  Reference person: Arianna Legovini, Head, Development Impact Evaluation Initiative, World Bank

  The aim of this partnership is to collaborate on the impact evaluation of an important Development Project in Nigeria. The Commercial Agriculture Development Project (CADP) aims at strengthening agricultural production systems and supporting the dissemination and adoption of new technologies, for targeted value chains among small and medium scale commercial farmers in five participating states in the country.
- Institution: FONDAZIONE ISTITUTO CARLO CATTANEO

  IRVAPP reference person: Antonio Schizzerotto

  Reference person: Raimondo Catanzaro, President of Fondazione Istituto Carlo Cattaneo

  IRVAPP, jointly with Istituto Carlo Cattaneo, will organise a series of six seminars for young researchers in social and political sciences. IRVAPP will be presenting its first three empirical studies.
- Institution: MIUR/FONDAZIONE GIOVANNI AGNELLI

  IRVAPP reference person: Antonio Schizzerotto

  Reference person: Andrea Gavosto, President of Fondazione Giovanni Agnelli

  The aim of such collaboration is to assess the impact of the introduction of new learning technologies in the Italian lower secondary school system.

2.5. Specific Needs and Points of Attention (foreseen for 2010)

Due to the increasing number of projects and researchers involved in them, for the next year IRVAPP is in need of office space. At the moment, we have reached full capacity.

IRVAPP is also in need of administrative staff. We need a Research Finance Assistant responsible for the development (drafting, negotiating, reviewing) of applications and relative costing in order to establish international contracts for research, research grants, EU projects, World Bank projects as well as Italian contracts.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Research activity	R	E	Dec.	9 research projects	
Research dissemination	R	E	Dec.	2 conferences, 6 seminars, 5 publications	
Promoting culture of impact evaluation	O	E	April	2 training courses	

Legend:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Budget

Expenses (EUROS)	
Personnel	470.000
Travel	20.000
Equipment (HW/SW)	10.000
Other (e.g. subcontracting to external contractors)	315.000
Internal collaborations: “subcontracting” to other unit	35.000
Total Expenditure	**850.000**
Incomes (EUROS)	
EU Projects (total amount financed by EU)	0
Other external incomes (projects, grants, etc.)	90.000
Internal incomes (“subcontracted” by other units)	0
Total Income	**€90.000**
Financial Need (Incomes – Expenditure)	**€760.000**
Required Structural funding from PAT (it should be equal to the previous item)	

5. Human Resources

In 2009 the IRVAPP research staff is composed of an interdisciplinary team of 14 researchers in Sociology, Economics, and Statistics, and 1 administrative secretary.

Antonio Schizzerotto, professor in Sociology at the University of Trento, is Director of IRVAPP. Senior researchers are Erich Battistin (associate professor of Economic Statistics, University of Padova), Ilaria Covizzi (researcher in Sociology and Deputy Director), Enrico Rettore (professor of Economic Statistics, University of Padova) and Ugo Trivellato (Director of Research and professor of Economic Statistics, University of Padova). Junior Researchers of IRVAPP are: Rossella Bozzon, Marco Cosconati, Alvaro Martinez Perez, Loris Vergolini, Nadir Zanini, and Francesca Zantomio. Anna Stenghel is IRVAPP's administrative secreatry.

There are also external researchers whose contribution to the Institute is strictly related to specific research projects. They are Ivano Bison (researcher in Sociology, University of Trento), Adriano Paggiaro (researcher in Economic Statistics, University of Padova) and Roberto Leombruni (researcher in Economics, University of Turin).

Considering the increasing amount of research projects the Institute has been carrying out, for the year 2010 IRVAPP intends to hire new permanent researchers. That means IRVAPP is going to make less and less use of external collaborations.

6. Ethical Issues

	YES
Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	X
Does the proposal involve tracking the location or observation of people?	
Research on Animals	

Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

RESEARCH SUPPORT, ADMINISTRATION, AND FUNCTIONING

In support of research, administration, and functioning

The strategic horizon defined in the plan of research activities for the Programme Agreement of Fondazione Bruno Kessler for the five-year period 2009-2013, as regards the management support activities ensured by the service system designed by the organizational logics launched in July 2009, is confirmed for the year 2010 too. Reference is made therefore to that “plan” for a more organized representation of the context of reference, of the long-term objectives and of the structural actions linked to the latter.

Also referable to the 2009-2013 plan are the projects and activities described in the “Partial Plan 2009” - projects and activities which, with a view to ensuring continuity, are almost all confirmed for the year 2010. In order to promote a more precise analytical assessment of costs and overhead, the division of management activities into “support”, “administration” and “functioning” activities has been confirmed. This reinforces the process, and not only at accounting level, that allows to increasingly highlight the specific nature of the costs generated by the Foundation’s activities as a whole.

More in detail, the year 2010 looms as an important transitional phase that leads beyond the critical dimension of the process of institutional and organizational transformation put in place by the reform of the research and innovation system. Within this context, all ordinary activities incur the coming into full force of the new regular setup and of the operational proxies, which in 2010 will result in the implementation of the corresponding system of procedures and service charters. This phase is ensuring, with the same amount of resources used, a significant increase in production and in the services offered both inwards and towards all of the subjects related to the Foundation through the Programme Agreement.

Further support to the increase in efficiency undertaken via the Foundation’s transition shall be contributed by the operational launching of the actions required to progressively introduce the information system prevailingly adopted by the provincial authority agencies. The year 2010, by way of conclusion of the process of verification of suitability of the information system model in use and of the relating performances, shall be dedicated to configuring and testing the first “package” of IT solutions regarding HCM. It should be noted that the turnover of personnel used in all management, support and operation services, already being programmed, has been intentionally subordinated to the rate of implementation of the new information system.

Also with reference to the structural actions dedicated to breaking with the management models adopted in the previous publications regime, application has been made for an effective system for the assessment of top and middle management figures that will be implemented in 2010. At the same time, the year 2010 will fa-

vour the reward-based systems linked to management procedures based on the principles of merit, transparency and traceability.

As regards staff policies, in parallel with the consolidation of the management system for the various and differentiated contract platforms existing within the Foundation and with the conclusion of a large set of pilot projects conducted to activate the potentials nested in the combination of the new organization of the Foundation, on the one side, with the new contract for research, on the other, the year 2010 will see the implementation of an organic set of policies and actions specifically tailored to the professional life cycle and to the individual trajectories of the research personnel. For greater insight into this matter, reference is made to the “plan”, currently under construction, to be passed in the first quarter of 2010.

The reorganization of the entire administration area has been routed by the new accounting drivers put in place by the move to a private accounting system and by the contextual parallel management of the financial practices still in use as regards the shareholder of reference. Said reorganization, implemented also by the organizational choices tending towards the affirmation of a new corporate culture, approached 2010 with the macro objective of European certification. This objective is the target of all of the actions required in order to direct the business model towards the most important forms of funding not according to Programme Agreement, in terms of magnitude. With reference to the Programme Agreement, 2010 should be the year of final configuration of the most effective regulatory and operational management model for financial relations with the shareholder of reference.

As regards the service in support of the Humanities hub, 2010 shall be the decisive year as regards the implementation of the open access policies, which in perspective shall also be implemented in terms of results of scientific research; policies which – transversally – will regard all of the areas involved in the organization and filing of significant data in terms of the intellectual and social capital of the Foundation. Also as regards the progressive actions with respect to the ordinary management, in 2010 access will be gained to a provincial electronic library system with the unprecedented expansion of the current offer of e-books and e-journals. In addition to the revision of the organizational model historically settled within the two Humanities centres, a radical and coherent reconfiguration of the services and of the internal organization shall be carried out.

In 2010, when the jump in quality achieved in the last two years will have consolidated, the units dedicated to internal and external communication and marketing shall concentrate their efforts mainly on two fronts: 1) the visibility of the Foundation’s distinctive features at international level and, 2) the social network. In view of the success of the 2009 edition, “Researchers’ Night” is reconfirmed. Once the research reorganization process is stabilized, the first issue of the series of Annual Reports of the Foundation’s activities shall be released.

As regards the infostructures and IT services, the year 2010 shall witness the strong innovation of the entire system under Technology Innovation by means of the preparation of the architectures necessary for supporting the rapid changes in electronics offered by the subjects of the research and upper education system,

and the creation of veritable common platforms. An additional and special effort shall be dedicated to the introduction of the new information system.

The actions dedicated to operations, considering the extraordinary nature of the interventions necessary after years of general negligence, have been opportunely, and necessarily, recovered through investments; to this regard, reference is made to the specific chapter that explains in greater detail the interventions foreseen for the year 2010. Worthy of mention here, however, are the efforts that are envisaged in 2010 for the reorganization and requalification of the indoor spaces, the implementation of the plan for high energy efficiency actions and the sustainability project, as well as the awarding of contracts for the primary services currently managed via outsourcing.

STRATEGIC INVESTMENTS

Labs and instrumentation

During 2010 some specific action will be launched to support the technological capabilities of CMM Laboratories. This mainly means specific investment in MTLab and MiNALab to upgrade the existing equipment as well as the covering of technical vacancies.

Referring to MTLab, investments will be finalized to move the first steps towards the 6” wafers upgrade of the Microfabrication line. With this respect, MTLab is planning to work on the upgrade of the wet benches including both the the 6” wafers process capability and the improvement of the energy saving, this last being pursued by an optimization of the air flows. Another task is focused on the upgrade of the scrubber systems of the lab for exhaust abatement to comply environmental needs.

Also MiNALab, which recently received the accreditation following the norm UNI/ISO 17025, needs some focused upgrades. These are mandatory to maintain the state of art in the highly competitive developing field of surface science characterization.

To this purpose the following specific upgrading are strongly recommended for:

the final set up of an innovative PTR-MS system (Proton Transfer Reaction Mass Spectrometry) to realize an analytical platform able to detect ions produced by different sources;

the ToF-SIMS IV ions, to be equipped with a sputtering beam by C60 cluster gun, thus allowing a complete and useful characterization for organic and bio material;

the improving of the sample preparation methodology for microscopy and spectroscopy techniques with a plasma cleaner and critical point dryer.

Building Plan

FBK has submitted to the Autonomous Province of Trento, within the framework of the Programme Agreement, a building plan that includes the works envisaged in the 2009-2013 period plan. It includes works intended to improve institutional activities (laboratories, offices, communal spaces) and for services aimed at improving the quality of life on site and encompassing also subjects external to the Foundation, such as the scientific hub of the University and its resident population. Such works would include, among others: a new service centre with cafeteria and snack bar, a reading room, a fitness room, a kindergarten and a welcoming structure for other age groups (space 0_100), as well as the expansion of the space available for the University library and a conference centre. The LEED NC (new construction) rating system will be applied to the new buildings, in compliance with the choices made by the Province for its work projects.

Among the restructuring works on the existing structures, of particular significance is the energy efficiency enhancement project designed for both the technological systems and the outer walls of the buildings, for which forms of Provincial and State aids are being sought.

SAP – Information Systems

In view of the redefinition of its organizational and operational model, Fondazione Bruno Kessler has launched a plan for the replacement of the current information system in order to obtain greater efficiency, efficacy and timeliness in the execution of the various processes, in tune with its strategic objectives, organizational structure, information flows and corporate processes. FBK currently uses various information systems. This fact generates the dispersion of data and a significant consumption of time in terms of handling and effectiveness.

In order to make possible the evaluation and introduction of a new system, it was necessary to review and redefine the main corporate processes with a view to improving them through the implementation of short-term, quick win and medium/long-term solutions.

To this end, it was decided to replace the information system and consider it a structural investment.

The plan, that should last at least three years, initially shall focus on Human Resources, subsequently extending to the administration and accounting activities and to project management.

Various activities are envisaged for the year 2010:

– selection of ERP software, of suppliers and of project partners;
– detailed project definition and appointment of the project manager;
– search for internal resources within Human Resources and Administration (key users) who are to interface with the analysts;
– search for new resources dedicated to the project (functional analysts, programmers, trainers);
– implementation of the ERP for Human Resources;
– training of users.

Ahref

The Fondazione Ahref was instituted April 19, 2010, upon the initiative of the Provincia Autonoma di Trento with the support of its Founding Member the Foundazione Bruno Kessler and of Informatica Trentina S.p.A., its first Participating Member.

The Ahref Foundation is engaged in interdisciplinary research, in development and training in the areas of social networks and Internet especially focuses on the relations that establish themselves in the economy of knowledge between the development of Internet and the socio-economic implications that are a feature of a territory and its evolution.

In particular, the aims and goals pursued by the Ahref Foundation are:

1. to study, research, and analyze Internet and the media, especially their economic, political, social, and cultural effects on society; to study the social media, the role of the citizens, the institutions, and the businesses in generating information;
2. to share information and knowledge services and instruments for the citizens in their dealings with institutions, businesses, the public administration, and all social actors; to evaluate and boost the quality of information; to study and boost innovative ways of financing information and the subjects generating information;
3. to study innovative future scenarios regarding the interaction between Internet, the media system, the social realm, the economy and technology, the innovation in languages, in the design and the technologies of the information containers;
4. to educate the citizens towards the production of information, the decodification of media messages; to study and build on the social dynamics connected with the media, oriented towards the development of civil living-together and the cultural quality of information;
5. to contribute to the development of the relational good, of human capital—which then becomes social capital—of contents in the horizontal exchange between the people, the public administration, and the businesses;
6. to heighten the awareness of society and above all schools of the these topics;
7. to transfer knew knowledge and research results to the citizens, the institutions, the businesses, and to the workforce;
8. to promote and develop projects—including pilot projects—finalized towards experimenting, verifying, and circulating the ideas coming from research,

coherent with its own aims and goals at the local, national, and international level with special regard also for the developing countries;

9. to plan events, exhibits, meetings, conferences; to stage and produce multimedia events, with the aim of achieving its goals.

The Ahref Foundation's research model is based on a dual paradigm: one regarding the humanities and the other regarding the technological domain.

In its first months of activity, the Ahref Foundation's management model has taken shape following a principle of strong integration with the scientific and corporate realities already operating in the Province's system of research and innovation, and it is being enforced in the perspective of implementing the action plan currently undergoing assessment by the competent authorities.

Trento, october 2010

FINANCIAL PLANNING 2010	COSTI	Ricavi	ADP Richiesto
Polo scientifico e tecnologico			
CMM	10.564	4.786	5.779
CIT	11.900	6.129	5.771
Pool di Segreteria	238	0	238
ECT	1.137	638	498
Cefsa	631	47	584
Create-Net	2.950	0	2.950
Cirm	237	40	197
Graphitech	400	0	400
CELCT	300	0	300
AHREF	1.000	0	1.000
Progetto HAIFA	274	85	189
Progetto MITLAB	693	0	693
Progetto MEMS2	1.045	1.006	39
Progetto AURORA	1.050	1.050	0
Spin-off	500	0	500
Polo umanistico			
ISIG	833	54	779
ISR	663	28	635
IRVAPP	760	0	760
Valutazione	172	0	172
Grant Office e Trasferimento Tecnologico	709	0	709
Supporto al polo umanistico	879	88	791
People Innovation	691	0	691
Technology Innovation	571	0	571
Legale	132	0	132
Sicurezza	277	0	277
PS FBK	708	45	663
Organi Istituzionali	940	0	940
Amministrazione contabile	2.216	0	2.216
Amministrazione del personale	558	0	558
Acquisti e Appalti	618	0	618
Patrimonio	111	0	111
Servizio Tecnico	417	0	417
Plessi	2.458	0	2.458
Costi comuni	2.972	562	2.410
Investimenti strategici	1.200	0	1.200
Piano edilizio	1.100	0	1.100
Nuovo Sistema Informativo	560	0	560
RICERCA	**35.175**	**13.862**	**21.312**
SUPPORTO ALLA RICERCA	**4.140**	**133**	**4.006**
AMMINISTRAZIONE	**4.332**	**0**	**4.332**
FUNZIONAMENTO	**5.957**	**562**	**5.395**
PIANO DEGLI INVESTIMENTI	**2.860**	**0**	**2.860**
TOTALI	**52.464**	**14.558**	**37.906**