Laboratoire d'Informatique de Grenoble

Grenoble Informatics Laboratory (LIG UMR 5217)

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The First Four Years (2007-2010) and Beyond
Volume 1: The Research Program and Activity Report

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The First Four Years (2007–2010) and Beyond
Volume 1: Research Program and Activity Report

LIG

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Overview

Chapter 1

LIG in a few words

1.1 Introduction

The Grenoble Informatics Laboratory (LIG) has been created in 2007 to address the scientific challenges raised by the emergence of Ambient Computing. LIG is governed by three principles:

Scientific excellence: Promotion of scientific excellence through provision of an attractive and visible research centre that supports academic staff members to ensure both individual and collective success.

Transparency: Decision-making processes driven by the team leaders as well as by the laboratory council.

Subsidiarity: Support for the dynamic scientific evolution of the research teams while respecting the autonomy of teams in their projects proposals, management of research contract and publishing policy.

The LIG laboratory is part of the ICT (Information and Communication Technologies) academic pole of Grenoble. This pole, which brings together close to 1500 academic staff members, comprises seven University research laboratories. Four of these laboratories concentrate on the fundamental disciplines of ICT: Informatics (LIG), Computing and embedded systems (VERIMAG), Applied Mathematics and Image Processing (LJK), and Automation and Signal Processing (GIPSA). The remaining three laboratories are multi-disciplinary, responding to societal needs in Computing for Health Care systems (TIMC-IMAG), Production Systems (G-SCOP), and Micro-electronics (TIMA).

The Grenoble Informatics Laboratory (LIG) unites a majority of the academic strengths in informatics **to establish Grenoble as a leading academic reference for informatics in Europe**.

The academic institutional actors of the Grenoble ICT pole are the following: the universities (grouped within the "University of Grenoble", an EPCS - Établissement Public de Coopération Scientifique - with a leading role of UJF and Grenoble INP, and an increasing role of UPMF), two EPSTs - Établissement Public à Caractère Scientifique et Technologique (i.e. CNRS and INRIA), and one EPIC - Établissement Public à Caractère Industriel et Commercial (i.e. CEA).

The informatics community in Grenoble is a highly dynamic ecosystem. The institutional and economic landscape in informatics within the Grenoble area is characterised by the presence of major industrial groups: STMicroelectronics, HP, and BULL. The existence of strong industrial research and development centres including Xerox Research (XRCE), and Orange Labs, as well as the state-owned research centres of INRIA Grenoble Rhône-Alpes and CEA. Among the 24 research teams of LIG, 10 are joint project teams with INRIA.

Within this world class scientific and technological environment, synergy between the industrial and academic actors is catalysed by the existence of the Minatec and Minalogic research and innovation poles as well as by the LSI CARNOT Institute, the ISLE Regional Research Cluster and by the RTRA Nanoscience.

Minatec: The Minatec innovation campus is an international centre for micro and nanotechnologies. It has been created in 2002 at the initiative of CEA and of Grenoble INP in partnership with the local authorities.

Minalogic: The global competitive cluster Minalogic fosters research-led innovation in intelligent micro-electronics products and solutions for industry. It relies on Minatec for nano and micro technologies and on the academic community (such as LIG) for software research. One third of the teams of LIG are involved in

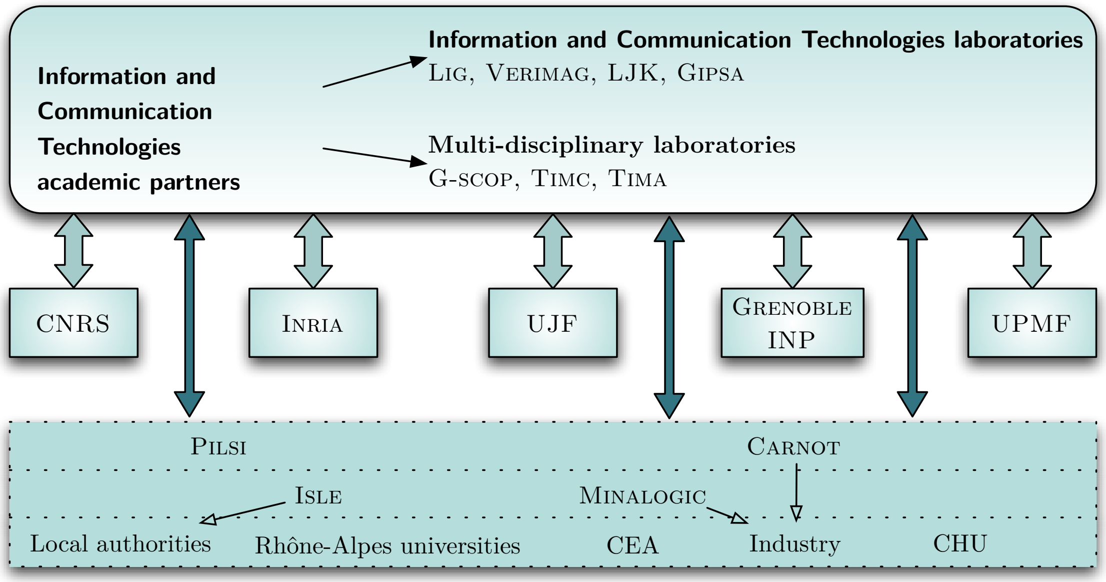

Figure 1.1: The Grenoble ecosystem

projects certified by Minalogic (i.e. 8 teams of LIG for a total of 10 projects financed by the FUI - Fonds Unique Interministériel).

Carnot LSI – Logiciel et Systèmes Intelligents: Several teams of LIG are involved in the LSI Carnot Institute (Software and Intelligent Systems) to carry research projects with industrial partners in domains such as embedded systems, transportation, safety, home automation (or domotics) and medical applications.

Cluster ISLE – Informatique, Signal, Logiciel Embarqué: The ISLE regional research cluster brings together some forty research laboratories of the Rhône-Alpes region as well as industrial partners in the area of computer science, signal processing and embedded systems.

RTRA Nanoscience: LIG is also active in the RTRA Nanoscience — Réseau Thématique de Recherche Avancée — on computing environments for nano sciences and quantum computing.

This landscape is completed with a world class University system delivering an extensive range of diplomas and specialties in computer science for a population of some 3 000 students: Engineering degree, Bachelors and Masters degrees, and Technological University Diplomas (DUT) offered by Grenoble INP, UJF, and UPMF.

1.2 Profile and Scientific Project: Ambient and Sustainable Computing

Over the next four years, LIG will continue to develop the scientific and technological foundations of Ambient Computing. In addition, progress from the previous four years places LIG in a position to address emerging societal problems of sustainability. Our goal is to elaborate the concepts, theorems, methods, software, and tools required for ubiquitous and pervasive computing and services in a manner that accommodates the environmental constraints and limited resources of the planet. This new area allows LIG to actively participate in the emergence of an economic and societal model that respects the population and their ethical values. From embedded nano-devices to the planetary Web, the challenge is to build multi-scale, adaptive software capable of supporting multiple modes of interaction while guaranteeing a large variety of quality objectives including new requirements for supporting sustainability. These aspects will be further developed in the “project” section of this document.

The activities of LIG range from the creation of novel emerging scientific problems to collaborative research, and to technology transfer.

The expertise of LIG can be broken down into 4 major themes with relatively comparable numbers of researchers and staff: Infrastructure, Software, Interaction and Knowledge. LIG promotes the results of these

4 themes and exploits their synergy for the development of fundamental subjects of the discipline as well as for the project of the laboratory **Ambient and Sustainable Computing**.

Theme 1 — Software infrastructures: from network to data

The theme "infrastructure" covers a research area whose ambition is to study the software infrastructures that are fundamental to the emergence of an informatics whose resources (data and computing) may be widely distributed, at very different scales, from embedded equipment (e.g., sensors, micro- and nano-controllers) and heterogeneous and massively parallel (multi-core) architectures, to machine grids at the Internet scale.

Software infrastructure supports the exploitation and the administration of networked computing. This includes functions related to operating systems, to middleware, to data administration and to basic software such as communication protocols. Two closely related, requirements are raised by the development of reliable and efficient ambient systems: adaptability and self-organisation. Both of these are necessary for the management of highly dynamic and heterogenous environments. Key scientific and technical challenges include:

- Support for generalised physical mobility at the Internet level (structure and protocols).
- Development of programming models and environments for the construction of dynamically and automatically configurable software infrastructures and systems (*cloud computing*).
- Development of self-stabilising algorithms for managing computation, data, memory and energy at a large scale.
- Development of software architectures, analysis models, programming techniques and command synthesis techniques for the construction of self-optimising distributed systems.
- Support for new multi-core and hybrid architectures.

Theme 2 — Software: foundations, models, and engineering

Software, as an object of study, is central to the research activities of LIG. The expertise of LIG teams complement each other to cover a wide spectrum of research in software, from computational models and programming languages to engineering tools for the management of very large software, to methods and tools for modelling, implementation, verification, and validation of high quality and trustworthy software.

Models have become an important paradigm in software engineering and bring significant advances for abstraction, durability, generality, upgradability, etc. New areas of research have emerged to take models into account in all software engineering activities (i.e. model-driven engineering, requirements engineering). These areas are associated with more conventional problems such as the foundations of the notions of model and meta-model along with their development and validation (model driven engineering).

A variety of research problems are central to this area, including computational models, languages, ontologies, formal methods, integrated development environments and information systems engineering. The LIG laboratory contributes to these in the following ways:

- Formalisation and modelling: fundamental concepts for models, meta-models and their semantics; generic approaches and technologies such as transformation, validation, model composition, and interoperability across multiple technological spaces.
- Construction and composition: construction of software applications by composition, models and meta-models refinement and transformation, software reuse (design patterns, legacy and off-the-shelf components, ...).
- Evaluation, validation and quality: a priori verification of a software by analysing the behaviour of its models; a posteriori validation using tests and proof techniques to compare an implementation with its models; correctness by construction through stepwise refinements from model to implementation; measure and control of software testability to ensure quality; design choices traceability.
- Adaptation and evolution: context-aware, self-adaptable, and autonomic software; support of software evolution through abstraction layers; generic models with support for composition and refinement.

This is indisputably research which contribute to the foundations of Information and Communication Sciences and Technologies, the very objectives LIG has set to itself.

Theme 3 — Interaction: perception and action

Interaction, perception and action unify a panorama of different scientific areas: human-computer interaction, human factors and ergonomics, virtual and augmented reality, information accessibility, dialogue, speech and natural language interaction, computer vision and robotics. The term "interaction" takes on different connotations whether the aim is to bring together people and/or environments with machines (HCI and robotics for instance), or people interacting with their environment enhanced with machines (e.g., augmented reality, surveillance) or people interacting between themselves through natural language and assisted by Information and communication technologies. This research theme is structured around three common elements: human(s)-artefact(s)-environments(s):

- Interaction between humans and services through systems: software engineering for HCI, 2D and 3D interaction, virtual, augmented or mixed-reality interaction, user interface design, man-machine dialogue, information retrieval, human factors and usages study.
- Interaction between autonomous artefacts including robotics, artificial systems exhibiting capacities for perception, decision making and action evolving in open environments and leading to various forms of interaction with humans.
- Interaction between humans mediated by systems including collaborative work, speech-based communication, vocal services and any language-based service such as assisted writing and translation.

"Interaction" requires the study of the "objects" on which it relies, namely: movement (gesture, haptics, proprioception), image (computer vision, visualisation), sound, language, information, as well as the physical world. These "objects" are studied both from the human and the system perspectives, and apprehended both in synthesis and analysis. In addition, it is necessary to consider the multimodal combination of these "objects" at different levels of abstraction (from signal processing to information) under various conditions of use characterised by inconsistency, uncertainty, and incompleteness. The teams involved in this theme develop human-centred research to improve the computational models and to integrate the user into the development process. These teams draw from the cognitive and social sciences, as well as from signal processing and mathematical and physical models.

The research in this theme concerns new theoretical frameworks for supporting and creating novel forms of robust and flexible interaction (including multi-modality, immersion, ubiquity, robustness, multilingualism and adaptability) raise by the challenges of Ambient Computing. These challenges are at the very core of LIG scientific project.

Theme 4 — Knowledge: extraction, transformation, usage

Information technologies have enabled the production of a very large quantity of resources, forming a complex, heterogenous and open-ended informational universe. Access to such resources creates a growing need for information extraction and interpretation methods, for knowledge processing, and for the design of cooperative systems. This knowledge may be the source of mathematical models or be used for studying usage patterns; it may be embedded or represented, or expressed in a language adapted to the user; it may be the driving force of complex, centralised or distributed systems; it may finally be the result of learning processes. Learning, perception, representation, reasoning, interaction, decision, and evaluation constitute the major challenges associated with knowledge. These different processes may be combined. Knowledge representation per se is the subject of studies where the balance between the power of representation (among which modalities and non-monotony) and processing efficiency is a fundamental, recurring problem.

Research conducted at LIG covers some aspects of this theme, primarily:

- Knowledge extraction with representation techniques and reasoning mechanisms: the goal is to construct the models that are appropriate for the objectives. This is the case for geographical information systems and for EIAHs (Computer Environments for Human Learning), as well as for knowledge-based systems used in the health domain. The fundamental problems relate to (a) the structuring of knowledge into models that make a distinction between declarative, procedural, strategic, and gestural knowledge; (b) the introduction of an "evolution" dimension in knowledge; (c) the representation of inaccurate, incomplete or erroneous knowledge; (d) the distinction between internal representations and representations at the interface; and (e) the study for concrete representations at the interface between abstract knowledge and mechanisms that enable users to manipulate this knowledge.

- Knowledge unification and transformation to improve the communication between human and software agents. In particular, this consists of aligning different knowledge models and of exploiting these alignments for communication: communication between heterogeneous software agents, adaptation of a multimedia document to its user and to the context, or the construction of mediators in peer-to-peer systems. Work on multi-agent systems consists in elaborating general models for knowledge-based distributed applications and in providing an efficient paradigm for applications development.

These two problematics — knowledge extraction and unification — include a significant interaction dimension: the developed systems are used by humans in the context of their work or for training. As a result, high quality interaction with users is central. Interaction with humans can serve as an object of study for testing the models in realistic conditions. Finally, the research is pursued simultaneously on the theoretical, software and applicative aspects of knowledge.

Thematic view of the research teams

The scientific activity of the 24 LIG teams span these 4 areas in an overlapping manner, with individual teams often concerned with more than one area, as shown by the following table. Within Table 1.1, 1 indicates the primary theme for a team while 2 indicates possible secondary themes. **The themes do not partition the LIG laboratory into scientific departments and do not set boundaries between the teams. On the contrary, the strength of the laboratory consists of its capacity to evolve and to establish numerous bridges between these different themes.**

For the period 2007-2010, LIG had concentrated its research efforts to implement a unifying scientific project around Ambient Computing, with 3 major challenges: multi-scalability, autonomy and the multifaceted quality criterion. Chapter 3 of this document will describe how LIG has addressed this project.

1.3 Salient facts and figures

This section summarizes the scientific impact of LIG at the national and international levels, providing a partial image of the major impact of the LIG laboratory.

Scientific impact

Following the adoption of Ambient Computing as its unifying theme for the creation of LIG in 2007, CNRS and MENRT invited the laboratory to coordinate a national reflection in this area. This work was carried out by Joëlle Coutaz and James Crowley. Similarly, Yves Ledru has created a GDR in the area of "Programming and Software Engineering" to promote a scientific vision for software. In addition, LIG has been very active in the national and international animation and assessment of scientific research: Marie-Christine Rousset has co-supervised a reflection group of the SNRI, Brigitte Plateau has chaired the evaluation committee of ANR for "Embedded Systems and Large Infrastructures", Catherine Garbay has chaired the evaluation committee of ANR for the DEFI programme "Emerging Domains", Hervé Martin is Chairman of SPECIF, Eric Gaussier and Marie-Christine Rousset have been members of the experts panel of the ERC programme, James Crowley chaired the panel that prepared the FET proactive research program in Human Computer Confluence (PCRD VII Call 5).

Pioneering domains and local scientific dynamics of PILSI

During this four-year contract, LIG has developed expertise in 6 socially important domains: Smart Building, Open Enterprise, Embedded Systems, Safety, Computation for Sciences, and Education, Leisure and Culture. Five out of these 6 domains have been taken up in PILSI (PILSI, as part of the "Plan Campus", is the scientific project of the Grenoble community around Software and Intelligent Systems). This dynamics has served as a driving force where LIG is a major actor of the scientific initiatives undertaken for PILSI.

Awards and salient facts

The scientific life of LIG is punctuated with numerous scientific awards among which a selection can be found on `www.liglab.fr` and a more exhaustive description in the teams records.

Teams	Infrastructure	Software	Interaction	Knowledge
ADELE	2	1		
CAPP		1		
DIAM			1	2
DRAKKAR	1	2		
E-MOTION			1	2
EXMO		2	2	1
GETALP			1	2
HADAS	1	2		2
I3D			1	
IIHM	2	2	1	
MAGMA			2	1
MESCAL	1	2		
METAH		2	2	1
MOAIS	1	2		
MRIM			1	2
MULTICOM			1	
POP ART	2	1		
PRIMA	2		1	2
SARDES	1	2		
SIGMA		1		2
STEAMER	2			1
VASCO		1		
VASY	2	1		
WAM	1		2	

Table 1.1: Thematic view of the research teams. 1 and 2 denote the primary and the secondary themes, respectively

Remarkable awards to LIG members include *fellowship* and *awards* for Joëlle Coutaz, Yves Ledru, Pierre Geneves, Franck Rousseau, Marie-Christine Rousset... the position of Laurence Nigay in the IUF, books written by Christian Laugier, Pierre Bessière, Eric Rutten, Claudia Roncancio, Jérôme Euzenat... organisations of major conferences (in an environment where financial but especially human support is severely missing in this regard), industrial collaborations with tangible impact (PSA, ST Micro Electronics, Schneider...) and creations of start-up companies, competitions wherein the teams of LIG ranked first among teams from all around the world.

Attractiveness

Since its creation, LIG has accommodated (recruitment or mobility from another laboratory) some sixty people for approximately the same number of departures. LIG has hence renewed approx. 20% of its staff during the four-year contract with 50% external recruitment.

Contractual activity

The teams of LIG have a long tradition with industrial collaboration. The latter is further stimulated by the European and national actions in the domain. The contractual activity of the 24 research teams of LIG consists of approximately **51 contracts funded per year** generating a **financial volume of approximately 6.2 M€**.

The average grant per contract is approximately **120 K€**. Contractual activity amounts to 59 contracts in 2005, 49 in 2006, 44 in 2007, 73 in 2008 for 45% funding from the French State, 10% from Europe, 25% from industrials directly, and 20% from the local authorities and universities.

Among the major projects funded by these organisms, the **NOMAD** project on next generation of user interfaces for mobile devices, or the **SMART ELECTRICITY** project on the convergence of the domains of electricity, automation and communication. Both these projects have also received the Minalogic label from the competitiveness pole of the same name. As of end of 2009, the laboratory received Minalogic certification for 13 collaborative research projects.

European contracts, although less numerous, provide for 1/4 of the financing received on contracts. LIG is present in major European projects. Among them, the **QUAERO** programme supported by the industrial innovation agency up to 1,5 M€ as well as the **OPEN INTERFACE** project, coordinated by LIG, benefiting from a 2,4 M€ financing.

LIG works in close collaboration with the industrial world as well as with major companies such as France Telecom, PSA, Schneider, STMicroelectronics, Thalès, Thomson, through research contracts and doctoral students' theses. As such, LIG is a partner of the LSI Carnot Institute (Software and Intelligent Systems) whose aim is to mobilise the world of research with socio-economic actors and major private groups to promote technology transfers.

Chapter 2

Operation rules and organisation

Due to the size of the laboratory and recent reorganisations, we have decided to follow the following rules:

1. provide a scientific leadership to our community and promote scientific collaboration between LIG teams as well as between the laboratory and external partners;
2. develop and enhance scientific visibility while respecting the scientific lifestyles of LIG teams;
3. take into account the size of LIG and adopt suitable structures and processes;
4. set up decision-making venues and moments to create group dynamics;
5. operate according to the principle of subsidiarity that grants teams great autonomy of scientific and financial supervision;
6. manage human resources at the laboratory level.

The description of the first two items belongs to the overview in Chapter 3 while the last four are presented below.

This chapter presents the result of the refinement process concerning the organisation of LIG since its creation: its decision-making structures, the operation, and the achievements of the research support teams.

2.1 Debate and decision-making structures

During 2006 and 2007, we had to invent LIG from the organisational and operational viewpoints bearing in mind that we started from five laboratories that knew each other fairly well, but had different customs and habits. The organisation task consisted in:

- setting up debate and decision-making structures;
- defining operational functions (lab members in charge of given tasks) and finding volunteers to perform them;
- reorganising the research support teams (based on the staff from the former five laboratories).

The founder principle of LIG is *rake organisation*: teams benefit from proximity support and are in direct relationship with the direction. The staff in charge of different tasks and research support departments help the direction. Figure 2.1 presents the organisation chart of LIG. In this section and the following ones, we provide more details on the laboratory structures and organisation.

The operation of LIG depends on the following decision-making and operational authorities:

The management team: composed of five members (C. Garbay, DR. CNRS, Ch. Laugier DR. INRIA, H. Martin PR. UJF, B. Plateau PR. Grenoble INP, D. Rieu PR. UPMF). Its composition shows a strong link between LIG, the three Grenoble universities, CNRS and INRIA research institutions, as well as the diversity of its scientific expertise. The team meets once a week and addresses all the issues relative to the operation of the laboratory. Without any specialisation, each member of the team is able to represent the laboratory with respect to LIG's partners and to discus all subjects.

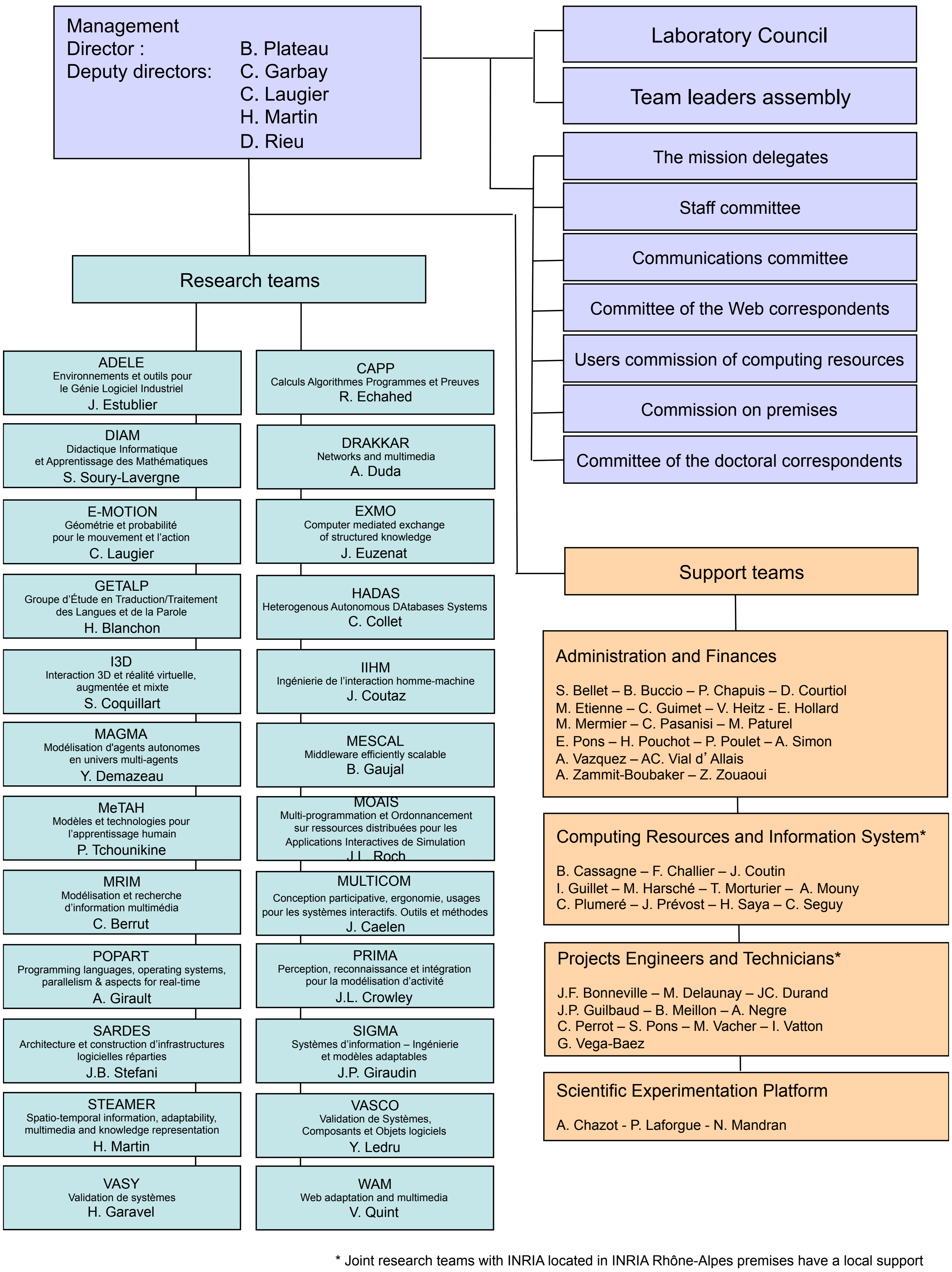

Figure 2.1: Organisation chart of LIG

The assembly of the team leaders: composed of all the leaders of the scientific or research support teams, it is the decision-making and controlling authority of LIG. It meets every other week and discusses propositions of profiles for recruitments, debates on the scientific orientations of the laboratory, gives an advice on newcomers or the use of the budget. It is also a place of debate on local and national organisation issues of research, on the evaluation, the organisation of certain events, etc. Any member of the LIG may ask an issue to be put on the agenda. The agendas and minutes are available on the laboratory Intranet.

The laboratory council: it meets three times a year. The task of this assembly is to supervise and control the policy aspects of the laboratory: budget, open position profiles, scientific orientations, evolution in terms of premises and staff members. This assembly also suggests orientations and public positions of the laboratory. Its operation adheres to the general rules of laboratory councils.

The staff committee: it receives a delegation of the laboratory council to *study* the issues related to the staff. The staff committee is, just like the laboratory council, an elected and consultative body. The mission of the committee is to study the records of the ITA staff members, to draw up the list of the producing/non-producing members of the laboratory and discuss their findings with our parent organisations and to discuss with the concerned members, as well as listen to personal problems.

The mission delegates: LIG relies on thirteen mission delegates. Certain mission units are concerned with external issues: Communication, Industrial Relations and Valorisation, European relations, International Relations, Scientific and Technical Information, or internal issues: Scientific Prospective, Supervision of doctoral students, Human Resources, Patrimony, Budget, Ethical Reflection, Computing Resources, Information System.

The role of the mission delegates is to prepare the records, the events, and optionally to supervise units (the communication unit, which includes some ten members, is very active) related to the missions pertaining to them. The purpose is not to be a decision-making authority like the assembly of the team leaders, but rather to act as an operational entity. Due to the size of the laboratory, the implication of the mission delegates in problems transversal to all the teams results in a very fruitful dynamics and enables LIG to participate in numerous actions. This assembly meets every other week.

The other committees: LIG also includes a *Users commission of computing resources* (CUMI), a *Commission on premises*, a *Committee of the Web correspondents*, a *Committee of the doctoral correspondents* who work on issues pertaining to the specified domains. These commissions have one representative per team.

2.2 Administration and Finances team

The administrative team of LIG —**Adminfi**— is made up of 14 members: 11 FTE full-time equivalent together with 5 colleagues of INRIA. The team is characterised by its youth (4 maternities since 2007), its dynamism (3 success in competitive examination for a permanent post, 2 category A, 1 category B), and its mobility (2 departures by reason of re-appointments and a single internal transfer). *This team has not known any increase in staff members since the creation of LIG.* It has kept the same composition thanks to repositioning of people, departures and substitutions.

Movements have taken place regularly with time, all establishments put together (13 newcomers for 13 leavers).

Our "rake" organisation will have provided the sought-after service quality which we always need to improve. Each **team assistant**, in the corresponding teams, must be polyvalent on all the establishments and fully responsible for its management proceedings. Each team assistant is in charge of two teams, that is to say 50 to 80 people. These assistants are 10 in number, corresponding to 7 ETPs, for 14 teams. The 10 joint teams with INRIA have a team assistant employed by INRIA. These INRIA assistants, although non-members of LIG, work closely with the **Adminfi** team and attend the monthly meetings of this team.

The transversal missions of the laboratory have been formed around four category-A and one category-C staff members. One of them (assistant engineer), in September 2007, accepted the charge, within the **budget unit**, of financial affairs, in particular for the current expenses of the laboratory. The **budget unit** includes 1.5 people. In the Summer 2008 the **contracts unit** (2 ETPs) could be strengthened by the appointment of a second category-A colleague, a study engineer, provided from CNRS by France Telecom (a colleague currently on secondment). The **human resources** are managed by an assistant engineer of CNRS. The person in charge of the **Adminfi** team, who also occupies the office of **Secretary-General of LIG**, is also an interested party to the contract unit. This accumulation of responsibilities denotes the blatant lack of high level administrative staff within LIG. The executive assistant is a category-C staff member and takes care of the production of all working documents, summary notes and communication documents with our parent organisations. The secretary-general and executive assistant assist the management in every aspect of administrative relations with the parent organisations.

2.2.1 Software tools

The activity of the whole administrative team is organised around this rake structure and the geographical dissemination of the laboratory requires information to be shared thanks to distributively accessible software packages.

- software packages which are imposed by the parent establishments and organisations of the laboratory: XLAB for the budget, SIFAC and NABUCO for the management of universities, LABINTEL for the information system of CNRS, GRAAL for that of the universities, ASSET for the Defense Security Official.
- software packages that we have developed, to meet our own needs and which enable joint interfaces with INRIA Grenoble Rhône-Alpes. This work results from a joint effort of 3 units (LIG, LJK, INRIA RA). Among these, OSE – for Staff member monitoring tool, OSC – for Contracts monitoring tool. These software packages enable distributed access, sharing and securisation of information on all the sites and the implementation of common referentials.

2.2.2 Team assistants

Their actions are structured around four areas:

Missions monitoring: reservation and ordering transport tickets, entering invoices and liquidation, entering missions and expenses, liquidation and payment by money order, double entry of UJF and Grenoble INP invoices into XLAB.

Monitoring the orders and invoices: entering the operation and equipment orders, entering and liquidating the corresponding invoices, double entry of UJF and Grenoble INP invoices into XLAB.

Monitoring the contracts: with the issuance of receipts.

Monitoring the staff: welcoming the doctoral students, monitoring the circuit of thesis charters, preparation of grant application or prolongation thereof. welcoming the trainees, monitoring of signature circuit of training agreements, preparation of the records for payment of gratifications. Statements to the Defence Security Official. Updating the OSE software, Staff member monitoring tool, indispensable and powerful for administrative enquiries, directories, face directories and investigations.

2.2.3 Contracts unit

The role of the contracts unit of LIG is to help the teams of the laboratory throughout all the realisation phases of the research contracts: it provides the interface between researchers, parent organisations and their branches, and with the financing organisations, among which the French National Research Agency (ANR), Ministries, the European Commission (EC).

It may be called upon:

For putting projects together

- assistance in putting the budget together;
- preparation of the administrative record;
- signature circuit and shipment of documents.

When executing the contract

- the contracts unit makes sure that the major deadlines are met during the execution period of said contracts; it monitors the establishment of the credits;
- it assists the team administrators in issuing the receipts.

For the administration of contracts

- preparation of the budget (initial budget and modifying decisions) in collaboration with the budget unit of LIG and the financial departments of the parent organisations.

The contracts unit works with the Contracts Monitoring Tool, OSC. All the elements pertaining to the contracts (contract type, dates, partners, budget, payment schedule, allocated staff members, scanned contract) are posted to this tool. OSC enables publishing performance charts and provides the necessary statistics to meet the demands of the management.

2.2.4 Budget unit

For an UMR of the importance of LIG, it is crucial that competences and knowledge complete each other. The budget unit is in charge of monitoring the budget of the laboratory and of the teams in conjunction with the team assistants, the relation with the accounts agencies of the establishments and the implementation of the laboratory expenses (so-called current expenses). The contract unit is the driving force of the budget unit for the major part of annual budgetary preparations. The activity with the installation of SIFAC in January 2009 in UJF will have been somehow rocked by learning this new software, but the year 2010 will be more propitious to the installation of SIFAC in Grenoble INP, further to our first experience.

The objective set to the budget unit, is to evolve towards the implementation of an anticipation performance chart.

2.2.5 Human resources

The task consists on the one hand in establishing a connection between the staff departments of the employing establishments and the agents for monitoring the careers, the attribution of bonuses, the management of paid holidays and recruitments, and on the other hand the recruitment of the fixed-term jobs. The application of the recruitment procedures for scientific collaborators, doctoral students, post-doctoral researchers, engineers on research contracts lies with the person on charge of human resources, in connection with the affected establishments. This activity, expressed in months, has been constantly on the increase since 2007 as mentioned in Table 2.1.

	2007	**2008**	**May 2009**
CNRS	73	79	48
Grenoble INP	83	117	91
UJF	266	287	352
Total	**422**	**483**	**491**

Table 2.1: Volume HR management (in months)

2.2.6 Executive assistant

The **executive assistant** may occasionally collaborate at different levels. She does not only support the Management and the Vice-Management directly, she also collaborates with all the actors of the laboratory: secretary-general, the budget unit, the team of the mission delegates, the team leaders, the team assistants, the Computing Resources and Information System team (MISI), ... The executive assistant is situated upstream of the decision-making process which she aims to facilitate, and downstream to enable its implementation. She is involved in the investigation of complex cases, in the design and the updating of performance charts, in the monitoring of different indicators defined by the management and/or by the partners for driving the unit from the information systems. She is in charge of the technical supervision and the training of the staff members and provides them with resources and expertise in the use and the exploitation of the staff database (OSE). Due to the dissemination of the activity over several sites and in several buildings, an **internal control** of all the OSE entries is performed by the **executive assistant** who watches the last data entered into the tool on a daily basis. She also guarantees the coherence between the different databases (LABINTEL, OSE and GRAAL). She performed the testing task for the Joseph Fourier University for GRAAL, a software which enables management of the state of the activity and of the means of the laboratories — a project supported by Savoie, Clermont 1, Strasbourg, UJF and Grenoble INP. Finally, she is the relay person for the affairs ascribed to the Defence Security Official.

2.3 Computing Resources and Information System team

2.3.1 Missions of the team

The missions of the **MISI** (Computing Resources and Information System) department are the establishment, the administration, the securisation and the exploitation of the computer infrastructure and of the information system of the laboratory as well as assistance to users. Its corollary missions are the study of new departments meeting non-satisfied needs and the evolution of the departments and of the infrastructures (networks, servers, workstations). The team manages in total 20 local networks, 44 servers, one thousand workstations. Direct support to research (defining and setting up platforms, developing software packages...) does not come under those missions. The services offered are as follows: authentication, control and validation of electronic applications for CNRS certificates, messaging, implementation of file servers, back-ups, public and internal web servers, remote secured access, connection to wireless network, printing server, secured media for collaborative work accessible to external collaborators, databases, interfaces and applicative services for administration and for research.

2.3.2 Personnel

The team is composed of:

- 1 head of Project, team leader;
- 2 system and network experts;
- 1 system and network expert (up to 31/12/08);
- 1 system and network administrator;
- 2 computer park administrators;
- 1 information system administrator (since 1/12/08);
- 1 application developer;
- 2 exploitation and maintenance technicians;
- 1 graphic designer.

2.3.3 Operation

The team is also organised as a "rake" with a necessary presence with the teams. The remainder of the work includes a significant mutualisation of efforts for developing and implementing transversal services. The MISI team has produced a considerable organisation work of its departments. It maintains relations with the CUMI (for Users Commissions of Computing Resources) for a global expression of the users needs.

The team meets every third week to evaluate the progress of the projects, to define the priorities, joint methods and choose configurations, prepare the budget, present achievements. An agenda and minutes and are communicated, then available over the Intranet. An engineer, member of the experimental "Marvelig" platform is invited to all the meetings so as to promote collaboration. The team has appointed a technical correspondent for security. All the engineers in charge of the maintenance of the systems receive the alerts and security instructions transmitted by the CERTA. With all the necessary caution for this subject, we could observe a small number of incident due to weaknesses in the systems or the applications.

2.3.4 Training and seminars

When the laboratory was created, a 3-day seminar, common to the MISI and AdminFi teams, with an external speaker, initiated the cohesion of the teams and enabled to set up several operating procedures in the laboratory. In March 2009, a seminar proper to the MISI team was organised internally with the participation of a quality engineer, to establish an overview after 2 years and to draw up the perspectives. The team has obtained the CATI homologation (Automated Centre of Information Processing) of CNRS and all its members have obtained the PFI award (Award for Computer Functions). Its members have attended numerous training qualifications:

Windows, Linux, PVR, JRES, LDAP, Law. One of the technicians has benefited from an internal tutorship which enabled him to progress in his functions. Several members of the team have acquired the mastery of the virtual operating systems.

2.3.5 Achievements

The major achievements of the MISI team since the creation of LIG have been:

- As regards infrastructure, several investments have enabled to render the machine rooms reliable, to rejuvenate the server park and to set up new mutualised services: messenging server, logs archival, workstations back-up.
- An important reorganisation work of the local networks of the buildings is in progress, in conjunction with the Grenoble MI2S service unit, the networks administrator.
- The team has also accepted the responsibility for hosting all the web servers of the laboratory and of the research teams. All these servers are configured in virtual mode, which enables to maintain back-up servers and to deploy new servers very rapidly. As departments moved physically from one geographical site to another, these methods have enabled swifter virtual removal than the actual transfer.
- Set-up of applications for collaborative work: calendar, reservations of rooms, versions administrator and forge, XLAB base, wiki.
- As regards the information system, it has implemented a dynamic public web site and an Intranet site, a staff monitoring tool (OSE database) and a research contracts monitoring tool of the teams (OSC tool). A publications monitoring tool is being finalised and will be used for the publications of this four-year contract. A gateway is under study towards GRAAL and HAL.

2.3.6 Positioning in the environment and impact

The team leader is invited to the fortnightly meetings of the team leaders and takes part in the meetings of the Users commission of computing resources, to take their demands into account and inform them about the achievements. The system and network administrators are frequently in relation with the MI2S unit, which manages the network infrastructures, the messaging service of the domain, the servers back-up, the LDAP authentication database. They are also occasionally in relation with the CRIs and DSIs of the parent universities of the laboratory and of Grenoble University, as well as with the DSI of the CNRS Alpes delegation. The team has given training sessions to the users of the applications which it has deployed: site web, Tools for monitoring Staff numbers, Contracts, Publications. It has filed 2 software packages with the APP (OSE and OSC). One of them has been adopted by a UP CNRS. Two members are strongly involved in the co-ordination of the professional network of the “SARI” computer specialists.

2.4 Project Engineers and Technicians team

The Project Engineers and Technicians (ITPs) are members of the research teams of LIG (11 people) or of the team of the Marvelig platform (3 people). It is essential that the engineers performing the technical work in support to research are immersed in the research teams and go along with their scientific and human dynamics.

They exert various trades, represented by the “typical jobs”:

- “development of applications”, “systems and networks”, and “scientific calculation” of the predominantly computer-oriented BAP;
- linguist of the communication sciences BAP;
- sociologist of the human sciences BAP.

During the past four-year contract, there have been 3 departures and 3 arrivals. The policy of LIG is to assign the newcomers to 2 research teams using neighbouring technological skills. Indeed, the demand is extremely high on the one hand, and on the other hand we deem important to be able to provide a significant spectrum of potentialities to the staff joining us. The domains covered by their current competences are as follows:

- Intelligent building and transport;
- Man-machine interface, ergonomics and usages;
- software engineering;
- Automatic language processing;
- Automatic speech and sound processing.

The current distribution within the teams, which can be accounted for by a recent history and policy, is as follows:

- 1 person shared over ADELE and VASCO, 1 person on E-MOTION and PRIMA, 1 person on IIHM and METAH (in December 2009),
- 3 people in each GETALP team, MULTICOM
- 1 person with DIAM (retiring at the end of 2009) and one person with VASCO and with WAM who are entitled to retirement during the next four-year contract.

Due to the reality of their function inside a research team the ITP staff members have numerous and specific activities: publications, management of projects, development of prototype software packages, valorisation activity, implementing and going through experiments, assistance to users, supervision of students and equipment management. During this four-year contract the ITPs have taken part in the writing of 40 scientific articles published in conferences or journals and have been involved in some fifteen various projects (Europe, ANR, industrial...). Their competences are hence an important asset for research and training programmes.

The role of the engineers assigned to the Marvelig platform, for their own part, is to promote experiments within the laboratory and to valorise the prototypes realised by the different research teams in view of mutualising the methods, tools and infrastructures.

This immersion of the IPTs in the teams is accompanied by a supervision at the level of LIG: by regular encounters and the installation of tools, the IPTs will share and valorise their knowledge and their know-how. This community includes a supervisor who should set up these dynamics which we wish to strengthen during the next period.

2.5 Scientific Experimentation Platform: Marvelig

Marvelig is the platform for scientific experimentation of LIG. It has been created for valorising the strong activity in prototype design within the laboratory and for mutualising a number of means associated with this activity. Its activity is structured in three areas:

Capitalisation: the prototypes of LIG are maintained on a dedicated architecture, by defining experimental tests to validate their usage and guarantee their robustness, by providing advices to test them and an appropriate assistance for their implementation;

Mutualisation: support and partnership is proposed for experimentation, by granting access to a large software collection and high-end technical environment (processing, storage, etc.), designing and implementing experimental protocols, experiment plans, techniques and tools, as well as the adequate statistical methods for analysing the generated data;

Communication: prototypes are made accessible to the industry, our parent organisations and the general public, accompanied by demonstrations.

The support given by Marvelig to the research teams to conduct experimentations is hence simultaneously technical — making material resources tools available and mutualisation of experiments — and methodological — with advices on the methodology to set up, on experiments instrumentation and on statistical analyses.

Marvelig has conducted a reflection on the life cycle of a prototype as well as on the quality approach for monitoring a prototype from the moment when it is managed by Marvelig and until its exploitation has been launched within the laboratory.

For supporting experiments and deploying the prototypes, Marvelig offers mutualised hardware and software means to the research teams:

- a float of virtual servers with a capacity to suit the needs,
- 32 TB of storage,
- different interaction facilities,
- specific software packages for experiments or their valorisation.

The Marvelig team consists of a head of project, a lecturer-researcher in charge of the scientific aspects and three engineers, also members of the Project Engineers and Technicians team: a research engineer for operational aspects, and two study engineers, one for methodological aspects and another for technical aspects.

2.6 Health and Safety

The Health and Safety commission is composed of four members distributed over the sites occupied by LIG. For this four-year contract, this commission has accepted the following responsibilities in particular:

- The organisation of works for the creation of an archival room. This archival room, situated on the ground floor of building B, has been upgraded to the fire standards by the Technical Department of UJF. This room is henceforth regulatory for hosting the archives of LIG and of the laboratories existing before the creation of LIG.
- Upgrade to electrical safety regulations of building D of the Ensimag hosting four teams of LIG was conducted up to the distribution cabinets.
- Taking a census of the people interested in attending a first aid course so as to provide a first aid carer in every building of LIG. Contact with CNRS has been made to organise this training.

Chapter 3

Scientific life

This section presents a scientific report of the activity of the laboratory. It must be clear that the research environment consists first of all of the teams and that the results and breakthroughs of this four-year period are described in detail in the team reports. This section presents the activity conducted at the level of the laboratory in order to implement the "Ambient computing" scientific project which had been announced. This chapter also presents a global overview of the scientific production of the teams of LIG (publications, contracts, international relations) and visibility elements.

3.1 Scientific animation

The aim of the scientific animation of the laboratory was to coin the scientific identity of LIG, to stimulate exchanges between teams, to promote the scientific integration of the doctoral students, but also to make this new laboratory known to the outside world.

Different types of action have been undertaken in this context:

Two brainstorming days (29-30 March 2007) supervised according to the metaplan technique by an external practitioner: the objective was to reveal a form of "vision statement", a scientific perspective encompassing the whole laboratory and highlighting the complementarity of the teams. The result has been better mutual knowledge among teams and people as well as the emergence of applicative domains capable of gather the teams.

The thematic mornings with a rather internal vocation, this action aims at a cross-fertilisation of the scientific visions and approaches within LIG on themes such as autonomy, adaptability, interoperability, learning, multimodal interaction or evaluation. They have been organised at the rate of one every three months.

The experimental mornings organised by the supervisors of Marvelig, the vocation of these mornings is to make the prototypes realised by the teams known and to initiate collaborations between teams around experimental processes. They take place twice a year.

The seminars of LIG with an external vocation, seminars supported financially by the laboratory take place and enable numerous outside contributors to visit us.

Team visit the objective is to better understand the components of LIG, their scientific approach, their perspectives, their demands, and to take time for exchanging views. The people who take part in these visits are the members of the management, the mission delegates for "scientific prospective" and "communication". The visit is scheduled for half a day, comprising a general policy overview, salient facts, perspectives, demonstrations and free exchanges enabling mutual expectations of the team and of the management to be voiced. These visits started in September 2007, they had affected 11 out of the 24 teams of LIG by the month of June 2009.

The doctoral workshops in association with the MSTII Doctoral College, the doctoral students of LIG have organised ALaNOTr a series of "Workshops on Languages, Notations, Ontologies, Transformations". This has enabled doctoral students to present their works transversally, from the angle of languages and transformations; the days are valorised by ECTS credits. Other events have taken place, on an annual basis, for easier integration of the doctoral students": "short theses" which are defence rehearsals and a doctoral students' welcome day. For this welcome day, the last thesis year doctoral students prepare a poster and present it during a session entitled *One minute Madness*. Three graduates are awarded a prize.

3.2 Emergence of challenging domains

Orthogonally to the 4 major themes of LIG (Infrastructure, Software, Interaction and Knowledge), 6 challenging transversal domains have emerged: Embedded Systems, Security and Safety, Smart Building, Open Enterprise, Education, Leisure and Culture, Computation for sciences. Table 3.1 shows which teams contribute to these challenging domains.

They are a way to decline the vision given by LIG to its "Ambient computing" project during that four-year period. They are meeting points for collaboration with other laboratories and inductrial actors of the Grenoble scientific pole. In particular, they have fed the work of the PILSI pole (International Innovation Pole for Software and Intelligent Systems) of the "Grenoble — University of Innovation" project.

Workgroups have been formed around these six transversal domains, whose role has been

- to identify the main challenges of the domain and structure it according to them;
- to position the skills of the laboratory in view of these challenges;
- to identify academic and industrial partners (on a local basis in a first step) with which collaborations have been or should be engaged;
- to write a presentation document intended for various publics (parent organisations, internal, external diffusion. . .).

Syntheses of these workgroups are presented below. The complete documents derived from these groups have been used for positioning LIG in partnership actions at Grenoble and Regional level, and also for bringing a contribution in national debates. These transversal domains have evolved and have been complemented by new "challenges" in the project which we present for the next four-year contract 2011-2014.

3.2.1 Embedded Systems

Embedded system cover a very wide spectrum of applications, regarding industrial control-command systems, transports (avionics, space, railway, automotive), energy production and distribution, up to general public electronic equipment (digital, electric household appliances, chip cards, etc.). The economic and societal prominence of these applications is colossal and growing rapidly. Informatics plays a major role therein. LIG, like other laboratories of he Grenoble area, plays an internationally acknowledged role by bringing contributions to numerous problems raised when designing embedded systems such as: embedded software, design techniques using formal methods, optimisation techniques, user interactions, data processing, etc. in quite diverse domains, from automotive to telephony. The teams contributing to this transversal domain are: ADELE, CAPP, DRAKKAR, GETALP, IIHM, MOAIS, MRIM, MULTICOM, POP ART, PRIMA, SARDES, SIGMA, VASCO, VASY.

3.2.2 Security and Safety

With the development of Internet, companies and organisations open their information system to their partners. It becomes vital for them to to protect access to sensitive information and to guarantee privacy of their users. In addition, with nomadism, the communications involved are potentially security holes. Within LIG, research is conducted at the level of the secured software architectures, of the execution certification on distributed platform, of the construction of models for the expression and the verification of the safety of software. Three categories of challenges have been identified: challenges associated with hardware and its interactions with software; challenges associated with the size and the complexity of real systems, challenges associated with ambient computing, with the interconnection of the information systems and the user's implication. The teams contributing to this transversal domain are: CAPP, EXMO, MAGMA, MOAIS, POP ART, SARDES, STEAMER, VASCO, VASY, WAM.

	Embedded Systems	Security and Safety	Smart Building	Open Enterprise	Education, Leisure and Culture	Computation for Sciences
WAM		X	X	X	X	
VASY	X	X				X
VASCO	X	X	X			
STEAMER		X	X	X	X	
SIGMA	X		X	X		
SARDES	X	X				X
PRIMA	X		X			
POP ART	X	X				
MULTICOM	X		X		X	
MRIM	X				X	X
MOAIS	X	X				X
METAH			X		X	
MESCAL						X
MAGMA		X	X	X	X	
IIHM	X		X	X	X	
I3D			X		X	
HADAS			X	X		X
GETALP	X		X	X	X	
EXMO		X	X	X		
E-MOTION			X			
DRAKKAR	X		X			X
DIAM						
CAPP	X	X				
ADELE	X		X			

Table 3.1: Teams working in challenging domains

3.2.3 Smart Building

One can read in the specialised press: "By 2030, the concept of smart building will be long gone (inevitably) and smart buildings will have adapted to their users automatically. Intelligent sensors will analyse the behaviours, the users' habits" and will adapt the environment (air treatment, heating, security, luminosity. . .)". In this context, LIG engages research actions in the domains of human interaction (sound, haptics, visual), efficient sensor networks, interoperability and cooperation of facilities, usages studied, for personal assistance at home, for tertiary and industry offices and buildings. The teams contributing to this transversal domain are: ADELE, DRAKKAR, E-MOTION, EXMO, GETALP, HADAS, I3D, IIHM, MAGMA, METAH, MULTICOM, PRIMA, SIGMA, STEAMER, VASCO, WAM.

3.2.4 Open Enterprise

To meet the increasingly volatile and demanding expectations (costs and quality) of the clients, companies extend and/or network themselves. Organisations join forces to offer products or services which they could not offer individually. We refer to extended enterprise, virtual enterprise, etc. These organisational forms are diverse: joint or individual administrative structure, common or complementary trades, frozen or open-ended consortium, limited or unlimited duration of the consortium, mode of collaboration (customer/supplier relation, partners. . .), etc. In this context, LIG undertakes research actions on data capture and integration, data sharing, related services (SOA), communications tools (textual, vocal), contents management tools, for situations of uses such as intelligent offices, tertiary work organisation tools (*workflow*), digital factory, collaborative engineering, etc. The teams contributing to this transversal domain are: EXMO, GETALP, HADAS, IIHM, MAGMA, SIGMA, STEAMER, WAM.

3.2.5 Education, Leisure and Culture

Education and training technologies, *serious games*, massively multiplayer video games (MMO), interactive museology, digital preservation and multilingual access to cultural heritage, etc. are as many computer application sectors wherein expectations are growing (education and training) and the increasingly competitive markets (culture and leisure). The rapprochement between learning and games in professional sectors using simulations (air plane piloting, surgery, etc), as well as the rapprochement between the cultural and playful aspects in the mediation schemes of museums, constitute a strategic stake on the scientific and economic planes. The teams of LIG engage themselves on these themes by addressing problems from a technological angle, at the crossroad of knowledge computer science, of ambient computing and networks (Internet, personal assistants, telephony, RFID), in a methodological perspective for evaluation and experimentation (protocols, data acquisition, analyses) and a theoretical perspective (formalisation of the emerging forms of knowledge, emotions, modelling of activities and usages). The teams contributing to this transversal domain are: GETALP, I3D, IIHM, MAGMA, METAH, MRIM, MULTICOM, STEAMER, WAM.

3.2.6 Computation for Sciences

In a near future, certain systems should be composed of several million computation and storage units, interconnected by high-speed networks enabling to reach computation and storage powers for ambitious applications but also for everybody's access to computational power. As of now, the use of high-speed networks in the Internet has enabled to build distributed computer infrastructures, called "grids", within which computing power is used as electrical power. We have highlighted three scientific priorities which ought to be handled in the next few years: scaling, mastering and optimising energy consumption and finally access to and efficient management of data. The teams contributing to this transversal domain are: DRAKKAR, HADAS, MESCAL, MOAIS, MRIM, SARDES, VASY.

3.3 Research teams

The teams of LIG are the place for scientific activity, the place where science blossoms. The task of the laboratory is to promote synergy, to open up new avenues, to display collective strengths. The teams entertain relations to one another at diverse levels and the following table gives a picture thereof. Table 3.2 also reflects the variable positioning of the teams within LIG, according to their thematic (central or rather on the fringe) and to their size. Certain have numerous internal collaborations, other work in a more restricted circle and the policy of LIG is to let the teams develop their own personality.

3.4 Ethical discussion

LIG has appointed a mission delegate on Ethics, mission which seemed important in view of the scientific project on Ambient Computing. Ethical discussion within a computer science laboratory is neither common nor natural. Indeed, the ethical committees such as the People's Protection Committees within the University Hospital centres, the ethical committee of CNRS or still the National ethical consultative committee for living and health sciences are institutions whereof the advices and recommendations have a legal bearing. However, the influence of information technologies on society, in the broadest sense, over these last ten years is no longer to demonstrate. "Ambient computing", "ubiquity", "safety", "confidence", "pervasive", etc. which are vocables used for describing the activity of LIG are sufficiently explicit in this regard. Our research has concrete incidences on everybody's daily life. From then on, taking some distance to ponder over it, review the evolutions in progress is a necessary process. The objective of this ethical action within LIG is not at all to judge or to propose standards governing research. Its aim is twofold: on the one hand, the idea is to make the researchers aware of the implications of their findings on society (how are the latter perceived, used, apprehended by civil

	ADELE	AMA	CAPP	DIAM	DRAKKAR	E-MOTION	EXMO	GETALP	HADAS	I3D	IIHM	MAGMA	MESCAL	METAH	MOAIS	MRIM	MULTICOM	POP ART	PRIMA	SARDES	SIGMA	STEAMER	VASCO	VASY	WAM
ADELE																									
AMA																									
CAPP																									
DIAM																									
DRAKKAR																									
E-MOTION		3			3																				
EXMO	3		3																						
GETALP		2																							
HADAS	3	2			3		1																		
I3D																									
IIHM	1								2	3															
MAGMA	3	2					3		3		1														
MESCAL					3				1			1													
METAH		3		1		3	3	3		3	2	3													
MOAIS			2						1	3			1												
MRIM	3	1	3					2	3		2	3	3												
MULTICOM								1			1	3		1		2									
POP ART			3						3						1										
PRIMA	3	3				1	3				1	3		3		3	2								
SARDES									3		3		2		2										
SIGMA	2						3				1	3		3		3	2								
STEAMER							3		3		3	3	3				2				3				
VASCO	1				3						2										3				
VASY			2															1	3	2					
WAM							1	3	3		3									1					

1 strong and regular collaboration
2 contacts
3 common interests

Table 3.2: Cooperations between the teams of LIG (October 2009)

society?); on the other hand, the idea is to communicate with society to explain and discuss the impacts of our research. The aim is hence to establish a dialogue between civil society and LIG. Concretely, this intent has been materialised through several actions:

- Organisation of conferences/"aperethical" debates to which institutional (representative of the CNIL) or civil (science fiction author about problems raised by the notion of identity between reality and fiction) participants have been invited..
- Participation in numerous colloquia/debates on ethical issues in research (a seminar on the Socially Responsible Research of CNRS, a seminar on ethical research and deontology organised by the study group on Law and Science).
- Participation in the activities of the Grenoble group GIERE (interventions in the ethical module of research, supervision of doctoral students).

3.5 International relations

In terms of international relations, LIG did not need to intervene in a very dense network of collaborations already maintained by the teams. It has been the natural relay of the numerous calls for international collaboration and its objective is to be a place for information exchange in this regard by building a web site grouping the existing data available. To analyse the prominence of the international relations of LIG according to the regions of the world, we have adopted the number of teams collaborating with at least one institution of each country. The collaborations taken into account are those supported by a contract or a specific financing as well as those which have given rise to joint publications.

- A country-based analysis reveals a group of 5 countries with each of which at least 10 teams of LIG collaborate, the United-States (12 teams) and four major European countries: Italy (13 teams), Germany (12), Spain (12) and the United-Kingdom (10).

- The second group is formed of extra-European countries: Japan (9 teams), Brazil (8), Canada (7), Vietnam (7) and Mexico (6). They include major scientific countries (Japan, Canada) and countries with which LIG has privileged relations, notably through international joint units (Vietnam, Mexico).
- The third group includes the countries with which 3 to 5 teams have relations. It concerns mostly smaller European countries than those in the first group: Belgium (5), Ireland (5), Netherlands (5), Czech Republic (4), Switzerland (4), Finland (3), Greece (3), Portugal (3), Romania (3), Turkey (3). This group also includes China (5), Columbia (5), Tunisia (4) and Singapore (3), which entails a joint unit.
- To finish with, a list of countries with which only one or two teams are working. In Europe: Austria, Denmark, Estonia, Hungary, Luxemburg, Norway, Poland, Sweden. In the rest of the world: Algeria, Australia, Argentina, Cambodia, Cameroon, Korea, Egypt, India, Israel, Laos, Malaysia, Morocco, New-Zealand, Russia, Syria, Taiwan, Thailand, Uruguay.

We may also consider the international relations of LIG per continent, by cumulating the number of teams having collaborations with each country of the continent. Europe leads miles ahead, then Americas and Asia are almost on a par. Africa and Oceania lag largely behind:

- Europe: 98 (22 countries)
- Americas: 40 (7 countries)
- Asia: 38 (15 countries)
- Africa: 9 (5 countries)
- Oceania: 4 (2 countries)

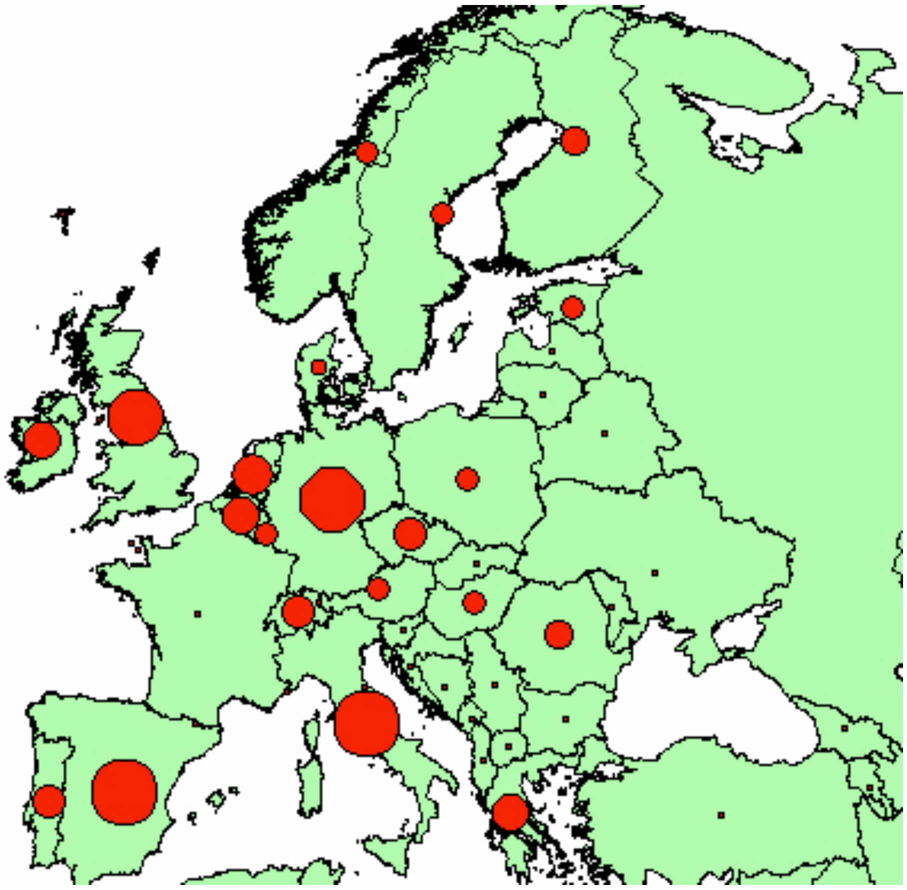

Figure 3.1: European cooperations

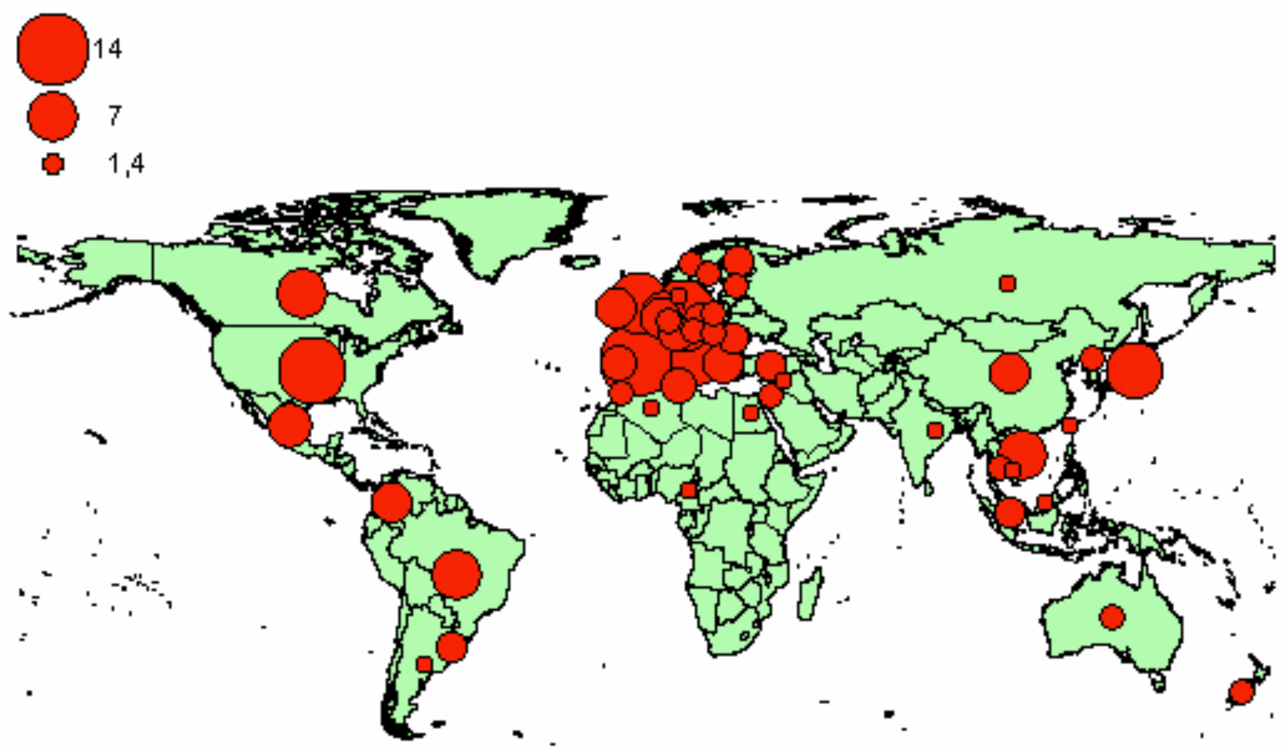

Figure 3.2: International cooperations

In addition to the considerable relations network maintained by the teams, LIG has initiated a few voluntarist actions, by getting involved in three international joint research units:

IPAL (Image, Perception, Access and Language, CNRS UMI 2955) is a Franco-Singaporean joint laboratory. Jean-Pierre Chevallet, a member of LIG, was its Deputy director from 2003 to 2008.

LAFMIA (Franco-Mexican Laboratory on Information Technologies, CNRS UMI 3175) is a Franco-Mexican laboratory based in Puebla, Mexico, focused on ambient systems, heterogeneous networks and mobile robotics. Genoveva Vargas-Solar, a member of LIG, is Deputy director of the LAFMIA.

MICA (Multimedia, Information, Communication and Applications, CNRS UMI 2954) is a Franco-Vietnamese laboratory based in Hanoi. Eric Castelli, a former member of LIG, is Deputy director of MICA.

An action has also been undertaken to join the Franco-Japanese laboratory, JFLI, on the thematics of this laboratory: *Next Generation Networks*, *Grid and High-Performance Computing*, *Computer Security*, *Images and Multimedia*, *Quantum Computing*.

3.6 LIG in national animation actions

The laboratory takes part actively in national animation actions by contributing to all the GRDs (research groups) and scholar societies falling into its sphere of activity. Several members of LIG have accepted important responsibilities (chairing GDRs and several scholar societies), and are also involved in discussion groups on prospective initiated by CNRS and the Ministry.

GDR

- GDRI3 (Information, Interaction, Intelligence): Gaëlle Calvary (IIHM) Member of the Scientific Steering Committee and Co-official of the CESAME GT (Workgroup); Laurence Nigay (IIHM) Co-official of the UBIMOB GT; Agnès Front (SIGMA) in charge of the MADSI GT; Dominique Rieu (SIGMA) coordinator of the "model-driven and oriented information systems engineering" theme; Sylvie Pesty (MAGMA): Co-official of the workgroup on "Animated Conversational Agents" GDRI3;
- GDR on Robotics: Christian Laugier (E-MOTION) Members of the scientific steering committee;
- GDR on LGP: Yves Ledru (VASCO) Director.

Scholar societies
- AFIHM (French-speaking conference on man-computer interaction): Gaëlle Calvary (IIHM) Vice-president; Renaud Blanch (IIHM) Member of the board of administration (secretary); Laurence Nigay (IIHM) President of the Steering Commission of Scientific Events and Publications (CPPMS);
- ARIA (Association on Information Search and Applications): Catherine Berrut (MRIM) President; Philippe Mulhem (MRIM) Member of the office, in charge of communications;
- INFORSID: Dominique Rieu (SIGMA) President;
- SPECIF: Hervé Martin (STEAMER) President.

GIS and GIP
- Observatory of Sciences and Techniques (OST): Joëlle Coutaz (IIHM) expert member for the definition of scientific production indicators in STIC;
- GIS Surveillance, safety and security of large systems: Hubert Garavel (VASY) member of the scientific council.

Thesis prize
- ASTI: Catherine Garbay (MAGMA) President of the thesis prize jury;
- Research: Laurence Nigay (IIHM) Member of the "Prize for Research" jury (14 members);
- SPECIF: Marie-Christine Rousset (HADAS) Member of the jury - Gilles Kahn Thesis prize (a prize awarded by SPECIF and under the patronage of the Academy of Sciences).

CNRS
- Nicolas Balacheff (METAH) and Catherine Garbay (MAGMA) are experts before the ST2I department of CNRS in charge of the ST2I/SHS interface — Nicolas Balacheff is responsible for putting together an interdisciplinary programme of CNRS at this interface;
- Joëlle Coutaz (IIHM) and James Crowley (PRIMA) have been mandated by the ST2I department of CNRS to supervise two workgroups on Ambient Intelligence set up parallel by the ST2I CNRS (in the context of its strategic prospective) and by the DGRI A3 of the Ministry of Superior Education and Research (within the framework of the sectorial concertation group on "mathematics, physics, nanotechnologies, usage, security and STIC").

INRIA
- Olivier Richard takes part in the steering committee of the Aladdin development action (sequel to GRID'5000).

3.7 LIG in the teaching context

Composed predominantly of professors and associate professors, the teams of LIG are also strongly engaged in teaching. These professors are, moreover, often in charge of educational teams. The courses provided cover the whole spectrum of levels (from first to fifth year university), in all the educational institutions of the Grenoble site[1], also with a significant portion of interventions in external educational institutions and in continuing education. As regards doctoral training, the members of LIG provide the greater portion of the "research" specialty courses of the second year of the "Mathematics, Computer Science" Master's degree of the Grenoble doctoral college on MSTII (Mathematics, Information Sciences and Technologies, Computer Science). Moreover, LIG has been a major actor in the creation of the International Master's degree, MOSIG[2]. Several members of LIG also intervene in the EDISCE school (Engineering for Health, Cognition and Environment) and EEATS (Electronics, Electrotechnics, Automatics and Signal Processing). In a very succinct and quantified manner, the members of LIG provide:

- 30% of the 12 courses of the specialty on Cryptology, security and encoding of information;
- 85% of the 42 courses of the specialties on Systems and software engineering, Interaction and Information, Artificial Intelligence;
- 80% of the 6 courses of the specialty on Human and didactic learning computer environments;
- 45% of the 9 courses of the Information Systems specialty;
- 30% of the 18 courses of the specialty on Image, vision, robotics.

The members of LIG are in charge of 4 out of the 6 specialties and co-responsible for a fifth. The members of LIG are also involved in the organisation of numerous thematic schools covering the whole spectrum of the domains of LIG (see the team reports).

[1] `http://www.liglab.fr`, item *Resources/Links*
[2] `http://mosig.imag.fr/`

3.8 Synthesis of the scientific production

3.8.1 Publications

Table 3.3 below summarizes the number and the categories of LIG publications. This table should be considered in the light of its 180 academic staff members.[3]

	2005	2006	2007	2008	2009*	Total
International peer reviewed journal [ACL]	39	50	68	61	61	279
International peer reviewed conference proceedings [ACT]	218	294	307	296	229	1344
Short communications [COM] and posters [AFF] in conferences and workshops	8	9	10	6	9	42
Scientific books and chapter [OS]	18	26	19	46	32	141
National peer reviewed journal [ACLN]	28	14	18	19	15	94
National peer reviewed conference proceedings [ACTN]	49	72	72	47	47	287
Book or Proceedings editing [DO]	5	8	13	14	9	49
Invited conferences [INV]	1	7	16	21	17	62
Doctoral Dissertations and Habilitations Thesis [TH]	38	33	46	39	23	179
Scientific popularisation [OV]	1	11	3	7	3	25
Other Publications [AP]	78	70	69	64	29	310
Total	483	594	641	620	474	2812

* publications are counted only from January to September

Table 3.3: Synthetic table of publications

It clearly seems to us that a research laboratory such as LIG must pursue goals in terms of scientific excellence and maximum visibility, via recruitments, scientific dynamics, valorisation and communication actions.

3.8.2 Contracts

The contractual activity of LIG supervised by its 24 research teams consists in average of 51 contracts accepted per annum generating an annual average financial volume of 6.2 M€. An analysis of this resource of the laboratory is given in section 4.6.

3.8.3 Start-up companies

Over the period 2005-2008 the teams of LIG created 5 start-up companies, in addition to the companies already existing[4].

- DRAKKAR: MOTWIN, created in 2008 by Dr Stephane Perret, a former member of DRAKKAR. The object of the company is to develop software for mobile phone. The collaboration is still going on during the incubation period. The laboratory supports this start-up company.
- IIHM and PRIMA: HiLabs[5] was created by Julien Letessier after his doctorate in 2008. HiLabs designs, develops, markets and sells interactive products and systems whose objective is to improve access to digitised services.

[3] Bear in mind that the bibliographic database of LIG is rather recent and not fully up-to-date.
[4] `www.liglab.fr`
[5] `www.hilabs.net`

- MESCAL: RealTimeAtWork.com is a start-up company of INRIA created in 2007. Under the responsibility of a researcher in Lorraine, MESCAL members are associated therewith. The objective of RealTimeAtWork.com is to design and develop software tools for solving the real-time constraints of embedded systems.
- METAH: ARISTOD, created in 2008. The objective of the company is to transform the Aplusix prototype developed in LIG into a web application and to develop new functionalities for algebra teaching.
- MOAIS: 4D Views Solution was created by Clément Ménier, after his doctorate, in 2007. The aim of 4D Views is to design and sell products based upon real-time 3D rendering. 4D Views Solution stems from the works of MOAIS and of PERCEPTION (a team of the LJK).

3.8.4 Patents

Over the period 2005-2008, the teams of LIG filed 3 patents:

- E-MOTION: APP filing (Programme Protection Agency).
  Patent number: IDDN.FR.001.280011.000.S.P.2004.000.10000.
  Patent title: Filter BOF toolbox (a library which implants a Bayesian occupancy filter in a space)
  Year of publication: 2005
  Applicants: ProBayes
- PRIMA Patent number: A3550-US-NP
  Title: Identifying objects tracked in images using active device
  Year of publication: 2005
  Inventors: Jean-Luc Meunier (XRCE), Frédéric Roulland (XRCE), Alba Ferrer-Biosca (XRCE), James L. Crowley (Grenoble INP)
  Applicant: Xerox Corporation.
- SIGMA APP filing (Programme Protection Agency).
  Patent number: IDDN.FR.001.240031.000.R.P.2007.000.31230
  Patent title: Pluggable alert system
  Year of publication: 2007
  Applicants: société Calystène Santé
  Inventors: C. Verdier (80%) and Calystène Santé (20%)

3.8.5 Open source software

The laboratory is strongly involved in the implementation of software prototypes so as to test, study in depth, validate the concepts derived from our research activity. A list is given on the site of LIG[6]. At 01/01/09 some fifty software prototypes were available on the forges of LIG or INRIA, Apache, ObjectWeb, W3C, etc. These productions concern all of the 4 scientific themes of LIG and the MISI team (Computing Resources and Information Systems). One of the roles of the Marvelig platform[7] is to make these prototypes known within LIG and to our partners and sponsors, enable their re-use, their enrichment by the implementation of demonstrations combining several prototypes.

3.8.6 Training through research

A few figures illustrative of the intensity and the quality of the training of doctors[8]:

- In July 2009 (knowing that this population is subjected to important variations according to the time of the year), LIG had 193 doctoral students, that is to say 1.07 doctoral students per academic member.
- The number of doctorates defended during this past four-years period is 194 (this figure should be compared with 180 academic permanent members).

[6] `http://www.liglab.fr`, item *Production/Open Source Software*
[7] `http://www.liglab.fr`, item *Production/Marvelig*
[8] An overview of the doctoral population can be found in section 4.1, in particular their current professional position.

- The average number of publications per doctoral student having defended a thesis during this past four-years is 4.3 per Doctor.
- We have information on their current professional position for 97% of them: They have a job (fixed-term job or permanent job). The main opening of a thesis in LIG is the academic sector for 47% whereas 29% have a stable job in the industry.

The following doctoral students trained in LIG have been distinguished:

- Renaud Lachaize (SARDES): one of the graduates of the Grenoble INP 2005 Thesis prize for his work dedicated to the construction of storage systems distributed over machine clusters.
- Simon Perdrix (CAPP): one of the graduates of the Grenoble INP 2005 Thesis prize for his work entitled "Formal models of quantum computing: resources, abstract machines and measurement-based computing".
- Jean-Sébastien Sottet (IIHM): best paper award for the article "Towards Model-Driven Engineering of Plastic User Interfaces". Workshop on model driven development of advanced user interfaces (MDDAUI'05), October 2005.
- Samir Jafar (MOAIS): best paper award for the article "Theft-induced checkpointing for reconfigurable dataflow applications". In IEEE, editor, IEEE Electro/Information Technology Conference, (EIT 2005), Lincoln, Nebraska, May 2005.
- Philippe Bidinger (SARDES): best paper award for the article "An abstract machine for the Kell calculus". In 7th IFIP International Conference on Formal Methods for Object-Based Distributed Systems (FMOODS), Athens, Greece, June 2005.
- Echenim Bertrand Mnacho (CAPP): one of the graduates of the Grenoble INP 2005 Thesis prize on the deduction in permutative equational theories.
- Oliver Brdiczka (PRIMA): best paper award for the article "Unsupervised segmentation of meeting configurations and activities using speech activity detection". In 3rd IFIP Conference on Artificial Intelligence Applications and Innovations (AIAI) 2006.
- Pierre Genevès (WAM): distinction for "Logics for XML". The prize for the best thesis in Information and Communication Sciences and Technologies 2007 by the EADS enterprise foundation.
- Laurent D'Orazio (HADAS): best paper award for the article "Query and data caching in grid middleware". In Latin American Conference of High Performance Computing (CLCAR'07), August 2007.
- Anne Bouillard (MESCAL): best paper award for the article "Optimal routing for end-to-end guarantees: the price of multiplexing" at the Valuetools conference in 2007.
- Jean-Denis Lesage (MOAIS): excellent student paper award for the article "A Hierarchical Programming Model for Large Parallel Interactive Applications". IFIP International Conference on Network and Parallel Computing, 2007.
- Pierre Genevès (WAM): finalist in the Cor Baayen Award 2008, Pierre Genevès of the WAM team was among the 16 European finalists (among whom 2 French finalists) of the Cor Baayen Award 2008.
- Xavier Besseron (MOAIS): PlugTest contest, 1st prize: The Kaapi/Taktuk team (n-queens challenge), 2008.
- Blaise Omer Yenke (MESCAL): best paper award in the IEEE APSCC-08 "Scheduling deadline-constrained checkpointing on virtual clusters".
- Benoît Scherrer (MAGMA): best paper award for the article "Fully Bayesian joint model for MR brain scan tissue and structure segmentation" in the proceedings of the 11th International conference on medical image computing and computer assisted intervention (MICCAI), 2008.
- Victor Cuevas-Vicenttin (HADAS): best paper award in the ENC 2008.
- Xavier Besseron (MOAIS): PlugTest contest, 1st prize, The Kaapi/Taktuk team (Grids for Finance and Telecommunication), 2009.
- Dizan Vasquez (E-MOTION): currently in post-doctorate at the ETH of Zurich, was awarded on 7 April 2009 the Georges Giralt/EURON Thesis Prize for the best European thesis in the domain of robotics for his work entitled: "Incremental Learning for Motion Prediction of Pedestrians and Vehicles".

- Oliver Brdiczka (PRIMA): one of the graduates of the Grenoble INP 2009 Thesis prize entitled: "Learning situation models for providing context-aware services".
- Abdelmalik Bachir (DRAKKAR): one of the graduates of the Grenoble INP 2009 Thesis prize for his work entitled "Optimizing routing and channel access protocols to extend the lifetime of wireless sensor networks".

Chapter 4

Resources

This chapter details two pillars of LIG. For the most important one, which are human resources, we shall outline a profile of who we are, define our recruitment policy, who our doctoral students are and what they become. We shall also tackle the further tuition issue and the schemes set up for monitoring the staff members within LIG. Another section will detail our financial, in particular contractual, resources.

4.1 Staff members

A few tables of the population of LIG

On 30 June 2009, the LIG laboratory numbered 500 people, apart from trainees and guests, and 633 when including these staff members. A few characteristics of the laboratory:

- Out of the 500 people mentioned previously, there are more temporary staff members (55.5%), doctoral students, post-doctoral researchers or fixed-term job employees, than permanent staff members. This is a token of vitality of the laboratory, of its capacity to swarm and to diffuse its knowledge via the people who have stayed there. It is also a sign that the capitalisation of know-how, which is indispensable for valorisation actions, requires means all the more important since the proportion of temporary staff members is significant.

- The executive level ratio by ITA staff members is 8.6% for these 500 people, and 7% for the 633 (including trainees and guests). When considering the permanent population, there is 1 ITA member for 4 scholars. This ratio is hence particularly low since the accommodation of trainees and guests understandably requires a lot of work on a repeated basis. We suffer from a chronic lack of staff in support to research. The most blatant point is that of research support engineers. The results of the investigation given in chapter 5 highlight this detrimental deficit. The MISI and Adminfi teams always work on a just-in-time basis and certain tasks are not fulfilled, such as support to the organisation of conference, through lack of means.

The 4.1 diagram specifies the distribution of the staff members per employer. UJF has 74 lecturers/researchers pursuing their research in LIG, thus providing the greatest portion of assets. However, the ITA support of UJF remains quite limited in spite of the efforts made during the past four-year period. The second actor is CNRS with 50 staff members among whom 27 ITA members. It is important to mention that without this logistic support (who had been maintained throughout the past four-year) LIG could not exist. Then come Grenoble INP with 38 staff members, UPMF with 26 staff members (and no ITA), INRIA with 25 staff members (the ITA members helping LIG/INRIA teams are not formally part of LIG), and Stendhal with 3 staff members and INRP of Lyon with 2.

The global feminisation ratio in LIG is 25%, and is detailed as follows: 25% for lecturers-researchers, 50% for ITA, 19% for doctoral students and 14% for researchers. These figures for the female doctoral students are not really sound indices but reflect a national tendency. When considering the graphs of Figures 4.2 and 4.3 showing the feminisation ratio per age bracket, it can be observed that the ITA population feminises itself in younger people whereas the population of scholars has a reverse tendency: for the 40-59 age bracket, ladies account for one third of scholars and for the 20-39 bracket 19.6%. It can be noted that the prolongation of activity after 60 is more significant in men.

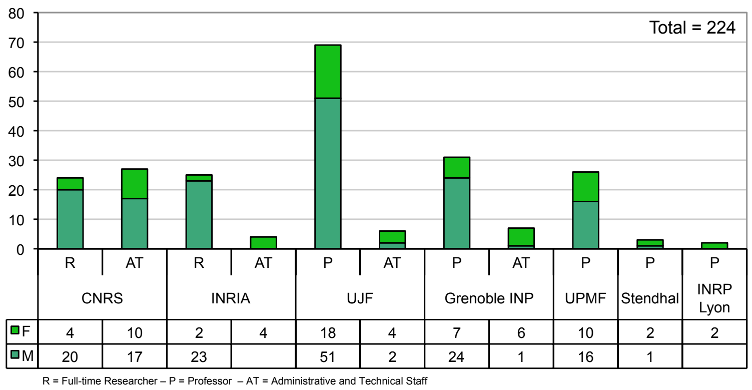

Figure 4.1: Distribution of the staff members

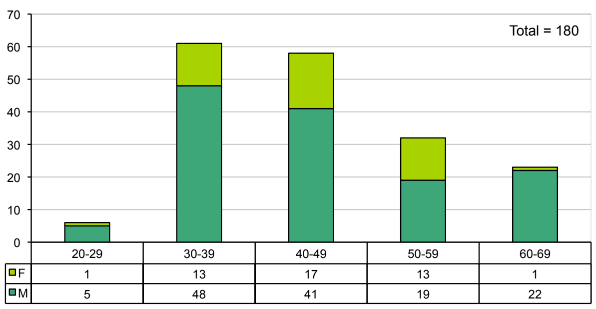

Figure 4.2: Age pyramid for academic staff

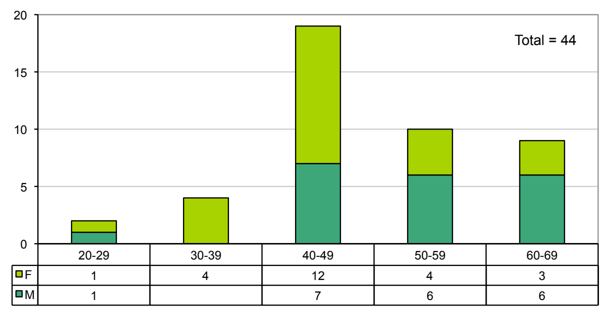

Figure 4.3: Age pyramid for administrative and technical staff

The age pyramid shows a number of retirements of the order of 30 for the next four-year period (2011-2014) which must go along with the renewal of the executives of LIG and the recruitment of young staff.

Analysis of evolutions over the 4 previous years, 2006-2009

The number of the permanent LIG staff has increased by 11 people since 2005, with 28 retirements. The number of ITA staff has increased by 2 people (1 UJF and 1 CNRS), the number of lecturers-researchers by 2 (+1 Grenoble INP, +3 UPMF and -2 UJF) and the number of researchers by 7 (4 CNRS and 3 INRIA).

In our last four-year document, we had requested 30 lecturer-researcher's posts, 12 researchers and 15 additional ITA members. The stagnation of the number of students has not enabled to meet our forecasts in terms of lecturers-researchers and the difficulty for obtaining ITA posts in a laboratory such as LIG, outlined below, could not be overcome.

These global figures mask far greater mobility: 24 recruitments of Senior lecturers, 18 for professors, 13 for junior scientists, 4 for senior scientists, 18 for ITA members.

Recruitment policy, 2006-2009

Over the four-year period 2006-2009, LIG has recruited 54 people, 13 professors, 24 senior lecturers, 4 senior scientists (CNRS, INRIA), 13 junior scientists (CNRS, INRIA).

Among these recruitments, 57% are external recruitments (and per category: 50% for professors, 62% for senior lecturers, 25% for senior scientist and 69% for junior scientists). Recruitment is considered external when the previous job — academic (senior lecturer, junior scientist, professor, senior scientist) or in industry — or PhD thesis (for senior lecturer and junior scientist), was held outside the laboratory.

These figures demonstrate a balanced and non-dogmatic recruitment policy:

- On the one hand a majority of external recruitments (especially for young people) so as to enrich our competences and to cross-reference our points of view with first-rank scientific personalities who we try to attract to us.

- Nevertheless, LIG endeavours to take into account the careers of its members for a more than deserved promotion and never gives up on the return of young brilliant students after a post-doctorate.

We wish to keep this course of 50% "truly" external recruitments.

Recruitment of the teams, 2006-2009

The EPSTs (CNRS, INRIA) rarely advertise for vacancies and have recruitment juries working at national level while LIG plays a minimal part in the process. As regards posts in universities, a yearly work within the laboratory enables to collect the demands of the teams and to extract from these demands research profiles matching the scientific dynamics of the laboratory and in line with the needs of the teaching components. Typically, a senior lecturer's post is targeted on 2 or 3 teams who are then responsible for attracting candidates, interviewing them and organise seminars for them. Professors' candidacies have much wider profiles (6 to 10 teams), so as to open up to the best in a quite competitive market.

The overview, in terms of recruitment and promotion (senior lecturer/professor or junior/senior scientist of the different teams is as follows: ADELE (1), CAPP (3), DIAM (0), DRAKKAR (2), E-MOTION (2), EXMO (1), GETALP (4), HADAS(1), IIHM (4), I3D (0), MAGMA (4), MESCAL (4), METAH (1), MOAIS (3), MRIM(1), MULTICOM (1), POP ART (4), PRIMA (2), SARDES (5), SIGMA (2), STEAMER (3), VASCO (1), VASY (2), WAM (1). These figures do not take into account departures nor inter-team mobilities. The deviations between the teams are due to two factors, essentially: the departures from the teams and the demands of teaching components.

In 2007 4 teams who previously had been purely INRIA joined LIG, i.e. EXMO, POP ART, VASY and WAM. Among these, 3 have recruited a CNRS or academic staff member over that period. INRIA recruitments are for their own part restricted to the EPIs.

Dynamics of the teams

In a major laboratory such as LIG, **we strongly wish that certain fluidity of people and teams may be established**. It ought to be noticed that, during the period 2006-2009, this fluidity has been relatively reduced which shows good stability of the teams as well as a difficulty in shifting people around painlessly. This type of difficulty could be noticed by the staff members themselves in the investigation whose results are presented below. The team losing a staff member has a tendency to view this departure as disapproval, whereas swarming is source of potential wealth and thematic mobility is source of creativity. Between 2007 and June 2009, 4 people changed teams (HADAS-SIGMA, IIHM-SIGMA, POP ART-SARDES). As regards the teams properly speaking, LIG had two very small teams at the beginning of this four-year contract (EXMO and I3D). EXMO started to grow and I3D has lost staff. As regards I3D, during the next four-year contract, the future of the virtual reality activity in Grenoble should give rise to in-depth reflection with INRIA Grenoble Rhône-Alpes. LIG thinks that the prominence of such activity is justified. The I3D team will however cease as such and a rapprochement of the current activities of I3D and PRIMA is under study. Besides, the DIAM team specialised in mathematics didactics has seen its staff dwindle since the recruitment in this domain has been concentrated in the Pure Mathematics laboratory. The remaining members of the DIAM team will join the METAH team whose scientific problematic is quite close. Finally, the thematic of automatic learning, dispersed in several teams of LIG and also in several laboratories gives birth to the proposition of a new team within LIG. The thematic of learning is of growing significance with objectives such as autonomy and adaptation of the intelligent ambient systems. If several teams of LIG address this theme for their needs, we deem it quite relevant "also" and coherent to focus a team on this important subject, the more so since it meets a demand from researchers. We propose hence, at the end of the four-year period, to select two teams and to suggest the creation of a team, AMA.

4.2 Population of the doctoral students

The doctoral students play a significant role in LIG. In July 2009 (knowing that this population is subjected to important variations according to the time of the year), LIG includes 193 doctoral students, that is to say 1.07 doctoral students per academic member. In this population, 19% only are ladies (there are globally 24% ladies in LIG). Over the four-year period, 60% of these students originate from Grenoble Masters and 22% are foreigners (see Figure 4.4). Certain foreigners attend Masters courses in Grenoble. This significant foreign recruitment is an indicator of the attractiveness policy conducted by Grenoble establishments and of the prominence of the international scientific relations of the teams. All the doctoral students of LIG are financed and the Figure 4.5 gives the distribution of these financings. 37% originate from contractual and industrial resources (contracts and CIFRE), 33% from State allocations (MENSER, CORDI, BDI, DGA), 18% from foreign financing. The portion of the territorial collectivities (mainly the region) is 9%. It should be noted that a vast majority of the grants (contracts, CIFREs, BDIs, CORDI, Region, and a portion of the MENSERs) could be obtained after calls for tender and the subjects must follow the scientific orientations of the financer partners.

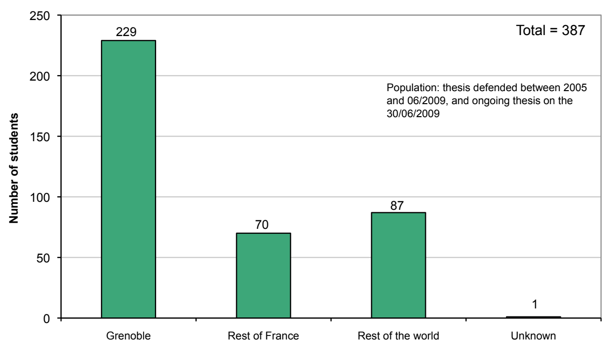

Figure 4.4: Origin of PhD students

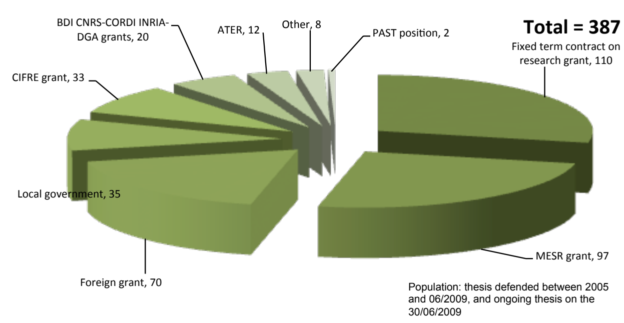

Figure 4.5: Financing of PhD students

Regarding their life in LIG, the average duration of a thesis is 3.9 years and a doctoral student obtains his/her thesis at the age of 30 in average. The histograms are given in Figures 4.6 and 4.7. It seems hence that the durations of the theses are a little long (we do not have national statistics as we are writing this report) within LIG and this ought to be corrected. This figure should however be studied with respect to the proportion of foreign students, with language difficulties and sometimes 4-year grants. This figure should also be reconciled with the 4.3 publications in average per doctor trained in LIG.

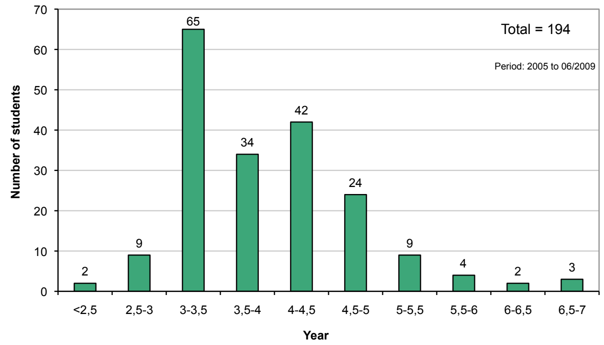

Figure 4.6: Duration of PhDs

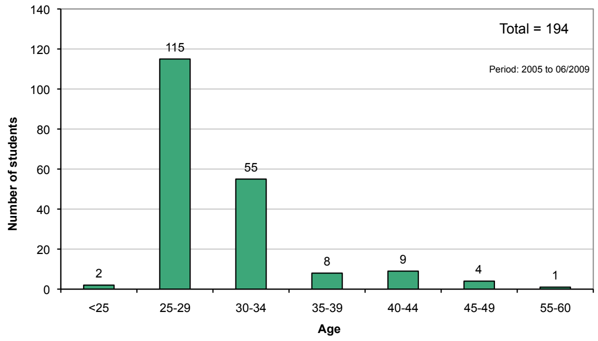

Figure 4.7: Age of PhD students

Regarding their professional situation after the thesis, the number of students having defended a doctorate in LIG over the period 01/05-06/09 is 194. The Figure 4.8 shows that the main opening of a thesis is the academic sector for 47% whereas 29% have a stable job in the industry. It may be assumed that the transient population of the post-docs will, eventually, obtain an academic job.

4.3 Organisation and management of human resources

Principles

The task relative to the management of human resources is distributed among the management team, a mission delegate in charge of human resources who, for this four-year period, was the director of LIG and the team leaders. They are assisted in this task by a person of the administrative and financial team in charge of this aspect for the laboratory and proximity team assistants. A staff committee has been elected, is accountable to the laboratory council and to the management and handles ITA CNRS classifications for examinations, the establishment of documents in response to the demands for "producing/non-producing staff" from the parent organisations, and may be a resort for any person with relational and/or staff difficulties.

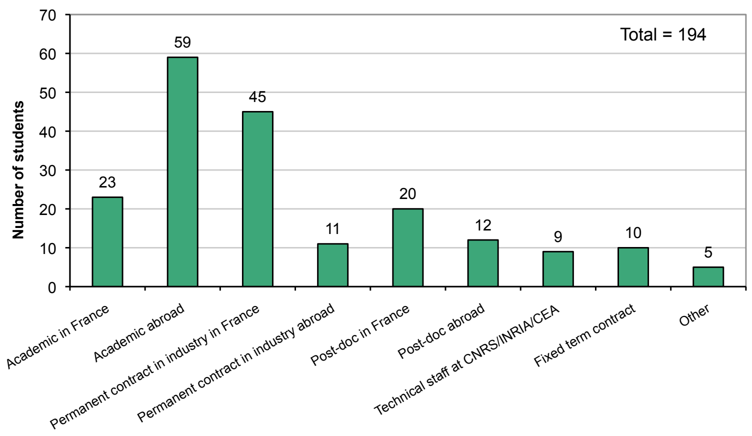

Figure 4.8: Positions of former PhD students

Recruitment policy

The recruitment policy is established as follows: the management collects the demands of the scientific and research support teams. It prepares a classification and optionally a spread of these demands. This proposition is discussed and amended in the assembly of team leaders. In fine, the management arbitrates, classifies and transmits the classifications to the employer bodies for discussion with the management, apply their policy and render their own arbitrations. This process is presented to the laboratory council as it progresses for advice and control. Pluriannual overviews are published and distributed for each decision made.

4.4 Continuing education

4.4.1 Training of researchers and lecturers/researchers

The training of the researchers and of the lecturers/researchers is structured in three areas.

Languages spoken English, written English, scientific communication in English, Spanish, German, Chinese, Japanese.

Administrative legislation and training contractual procedures and rules imposed by the European Commission, management of European contracts, management of national contracts, hiring staff for fixed-term jobs, contractual procedures and rules imposed by ANR, LOLF and its tools, public accounting and management rules.

Health, safety and first aid the "health and safety" courses, FACW (first aid carer at work) recycling.

Overview of the actions followed (2007-2009)

- 14 training actions have been conducted by scholars (3 CNRS, 1 INRIA, 7 UJF, 1 UPMF) for a total of 37.1 days.
- 2 people have attended more than one course.
- 7 teams are affected by these courses.

4.4.2 Training of the ITA staff

The management of the laboratory has always authorised (and financed if necessary) the demands for training. Career progression is an important factor of well-being for ITA staff within the laboratory. The continuing education departments of CNRS are particularly open and efficient and we work a lot with them. INRIA is also very active and opens up towards certain non-INRIA staff members of the unit for technical courses.

Overview of the actions followed (2007-2009)

Three teams are affected:

Projects Engineers and Technicians team (ITP). The members of this team are part of the research teams or of the experimentation platform (Marvelig). 22 training courses have been attended by the members of this team. This affected CNRS staff members (8) and UJF staff (1) for a total of 87 days. 5 teams are affected by these courses.

Computing Resources and Information System team (MISI). 36 training courses have been attended by the members of this team. This affected CNRS staff members (9) and Grenoble INP staff (1) for a total of 143 days.

Administration and Finances team (Adminfi). 98 training courses have been attended by the members of this team. This affected CNRS staff members (7), UJF staff members (6), Grenoble INP staff members (6), INRIA staff members (3) for a total of 227 days. A member of staff (CNRS) started this year a Professional Degree on "Management of human resources and pay roll" within the framework of the Individual Training Leave (CIF).

Training needs for 2011-2014

Courses on partners management computer tools (Xlab, Nabuco / Sifac) should be organised for the newly appointed members in the Adminfi team. Certain courses should be arranged as of the start of university year (installation date of university staff). Technical courses in computer science (languages, development environments, etc.) are always necessary for close monitoring of the most powerful tools.

4.4.3 Know-how transfer

The transfer of know-how to the laboratory takes place at several levels:

- through the organisation of thematic schools, colloquia and conferences in various domains;
- through the regular organisation of Thematic mornings, Experimental mornings, encounters and seminars of LIG, doctoral workshops. This point is detailed in paragraph 3.1. of this document.)
- participation in groups. Thus the MISI team takes an active part in the SARI business network (Grenoble network of System and Network Administrator Computer Specialists).

4.4.4 Post-doctoral researchers, doctoral students, trainees

LIG ambitions to provide a multilingual work environment. We support the idea that Master's memoirs and theses may be written in English (with an abstract in French whereof the characteristics remain to be defined). This possibility enables more easily to welcome doctoral students on co-supervision programmes since they are regrettably too few in France and to accommodate foreign, non-French speaking, post-doctoral researchers. Of course, all these people must be offered French classes. LIG intends to pursue this quite voluntarist training policy through research and the supervision of foreign doctoral students (half the doctoral students of LIG). LIG may rely on the MOSIG International Master — *Master of Science in Informatics at Grenoble.*

Internal training of doctoral students

Thematic mornings, Experimental mornings, the encounters and seminars of LIG create an environment for exchanges and transfer of know-how. These exchange days are added doctoral workshops such as ALaNOTrn coordinated by the MSTII Doctoral College. The activities offered to doctoral students are described in section 3.1 of this document.

Training of doctoral students by the establishments

The doctoral students engage themselves, by signing the doctoral charter, attend scientific or non-scientific complementary courses. They are determined by the doctoral student in agreement with his/her thesis director. They are validated by the official in charge of the doctoral training. The doctoral seminars or a few weeks' stay in a company may be validated as complementary training qualifications. The Doctoral College of Grenoble INP and the Doctoral College of UJF offer non-scientific courses opening up to the entrepreneurial world, facilitate professional insertion, the acquisition of foreign languages or personal development.

4.5 Financial resources

The financial resources of the laboratory originate from the endowments of the partner establishments of the UMR (CNRS, UJF, Grenoble INP, UPMF). Regarding the own resources of the teams stemming from research contracts, LIG does not make any withdrawals. The total of the grants represents approx. 500 k€ per annum. The indirect assistance of INRIA via its support for the accommodation expenses of both INRIA project teams should also be borne in mind on the site of Montbonnot-Ensimag, as well as INRIA grant support to the EPI. The 2008 consolidated budget is given by the pie chart 4.9.

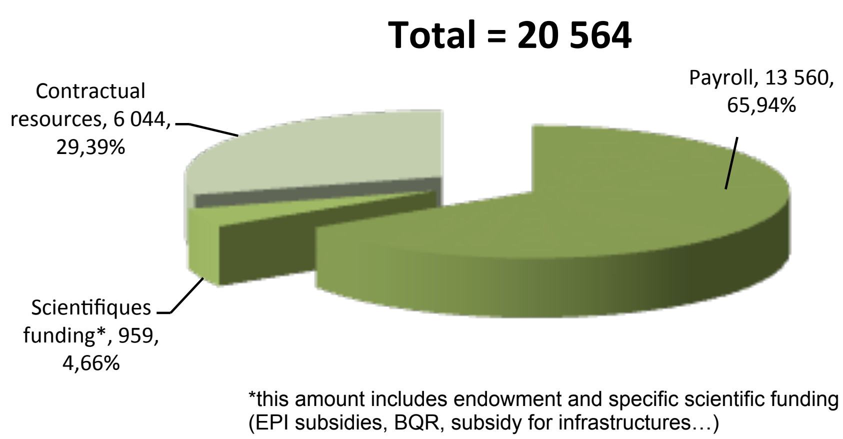

Figure 4.9: Consolidated budget for 2008 (in K€)

4.6 Contracts

4.6.1 The activity in figures

The contractual activity of LIG supervised by its 24 research teams consists in average of **51 contracts accepted per annum** generating an **annual average financial volume of 6.2 M€**. The average aid per contract is approximately **120 k€**. The financings originate for 60% from national bodies on a par with the French National Research Agency (ANR) and major ministries in particular the General Direction of Companies.

We may quote among the major projects supported by these organisations the **NOMAD** project on the future Man-machine interfaces on embedded systems or still **SMART ELECTRICITY** on the convergence of the domains of electricity, automations and communication. The NOMAD project is controlled by the IIHM team in the context of man-machine interfaces breaking away from current usages, it represents a budget of 725 K€. The SMART ELECTRICITY project is controlled using the ADELE team in the context of the developments of the smart building granted with a total budget of 500 K€. Both these projects have been labelled by the MINALOGIC competitive cluster. To this day, the laboratory has undertaken 13 contracts labelled by this pole and 8 teams take part therein.

The European contracts represent 25% of the financing received on contracts. LIG is present in major European projects such as the **QUAERO** program supported by the industrial innovation agency for 1.5 M€ as well as the **Open Interface** project granted with a total financing amount of 2.4 M€.

LIG works in close collaboration with the industrial world and major companies such as France Telecom, Schneider, Thalès, Thomson via research contracts and doctoral students' theses. As such, LIG is partner of the Carnot LSI Institute (Software and Intelligent Systems). The laboratory has executed more than 50 contracts with the industrial world over that period for an amount of 1.7 M€.

This research is supported by the recruitment of post-doc staff members or engineers on a contract basis. Since 2006, more than 180 employment contracts could thus be completed. Projects have emerged from this research, leading to the creation of start-up companies as shown in section 3.8.3.

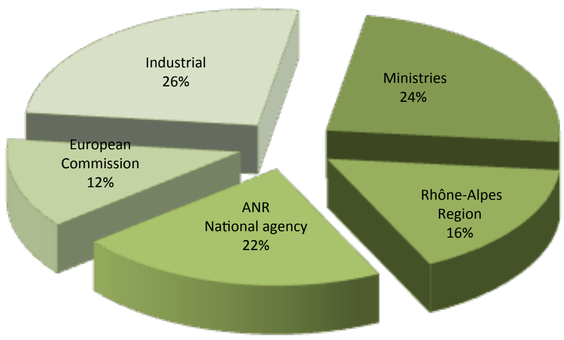

Figure 4.10: Number of contracts

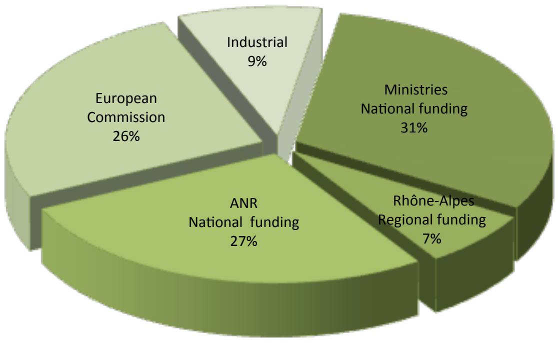

Figure 4.11: Funding

Apportionment of resources by type of contract for the 2005–2008 period

4.6.2 A particular observation of financing schemes derived from ANR projects

The year 2008 is a significant benchmark for ANR project submissions in LIG. Among the 76 projects filed during the year 2008, 32 were filed with ANR which represents 46% of the submissions of the laboratory. This observation enables to assert that ANR is becoming the major actor in the financing process of the research projects and generates 2.4 M€ for 15 accepted projects. For the year 2008, the average financing per retained project is 160 K€, an amount above the national average. It is interesting to note that, for LIG, the success rate in 2008 is in net progression. On the financial aspect, we note a constant et regular increase of the order of 6% per annum from 2005 in the subsidies obtained with this agency.

Part II

Scientific Project

Chapter 5

Scientific project

5.1 Ambient and sustainable computing

Since it was created, LIG has set itself as a scientific objective to meet the challenges of *ambient computing*, to propose theoretical underpinnings, software models, languages and components for implementing digital systems, which are:

- multi-scale autonomous, possibly emergent (but mastered),
- evolving in sound, reliable and secure fashion in heterogeneous, dynamic and unpredictable environments,
- manipulating complex, distributed and multi-shape knowledge spaces,
- interacting with the user in an appropriate manner and respecting ethical values.

In the continuation of the four-year contract coming to an end, LIG wishes to widen its research by emphasising *sustainability* as one of the major stakes for environment-aware ambient computing, concerned by its role facing emerging economic and societal models, supported by ethical issues.

Ambient computing finds its innovative underpinnings in the rapprochement between computer science and disciplines prone to major evolutions such as micro and nanotechnologies, telecommunications, but also, which is more recent still, the alliance with human and social sciences. The objective is the creation of smart services, facilities and environments, capable of properly meeting individual, collective or societal needs under all circumstances and in all the sectors of activities, with particular care to sustainability. Our vision of sustainability is wide, beyond the preservation of the environment, as it encompasses aspects associated with security for the control of risks, with confidentiality and with ethical values.

Sustainability within the computer tool (*green-IT*) ought to be distinguished from sustainability thanks to computer science which is then a "serviceable" tool (*green-by-IT*).

Green-IT: to preserve the environment, the idea is to mobilise all of the hardware as well as software technologies and the usages of computer science which enable saving resources of the computer tool itself. The study of energy efficiency extends from mobile and embedded technologies, to multi-core architectures, to recycling for re-using chips whose manufacturing is energy expensive (e-waste processing), to the management of the energy in data centres and in supercomputers (`www.thegreengrid.org` initiative), to the development of new algorithms saving energy while maintaining the expected service quality. As for the security aspect, the idea is to mobilise several approaches in synergy, such as approaches based upon models, cryptography, redundancy, testing tools and proof assistants. As for aspects associated with confidentiality, the purpose is to develop in particular confidence models on uncertain data. *Green-IT*, also means to improve accessibility to communication infrastructures, to promote the circulation of information and mobility, to mutualise and optimise the use of resources ("cloud computing" and virtualisation technologies), possibly to perpetuate documents and digital developments, finally, to defend diversity as necessary for creativity.

Green-by-IT: this research is multidisciplinary and hypothesises that the green-IT challenges are solved or at least taken into account. It covers major problematics (see European documents[1]) from the preservation of the planet's resources thanks to software intelligence and the dematerialised circulation of objects and people

[1] `http://ec.europa.eu/information_society/eeurope/i2010/index_en.htm`

(e-services, collaborative work, shared resources) to enhanced quality of life and improved security of goods and people. It encompasses access to knowledge and the transmission of knowledge corpora, the emergence of new forms of socialisation via so-called Web 2.0 or web 3.0 technologies, and of new economic models for all kinds of software packages and digitalised data.

All in all, *ambient and sustainable computing* raises numerous scientific stakes, in its societal, technological and conceptual dimensions, with multiple socio-economic and environmental spin-offs. Deeply anchored in the dynamics of its teams and in-line with the works of the previous four-year contract, these stakes will be handled thanks to the skills of the four scientific themes of the laboratory —Infrastructures, Software, Interaction and Knowledge— which are the pillars of LIG (see Figure 5.1).

The priorities of LIG are the following key scientific challenges: the convergence of the physical and digital, multi-scale, autonomy, adaptation, genericity, quality and sustainability.

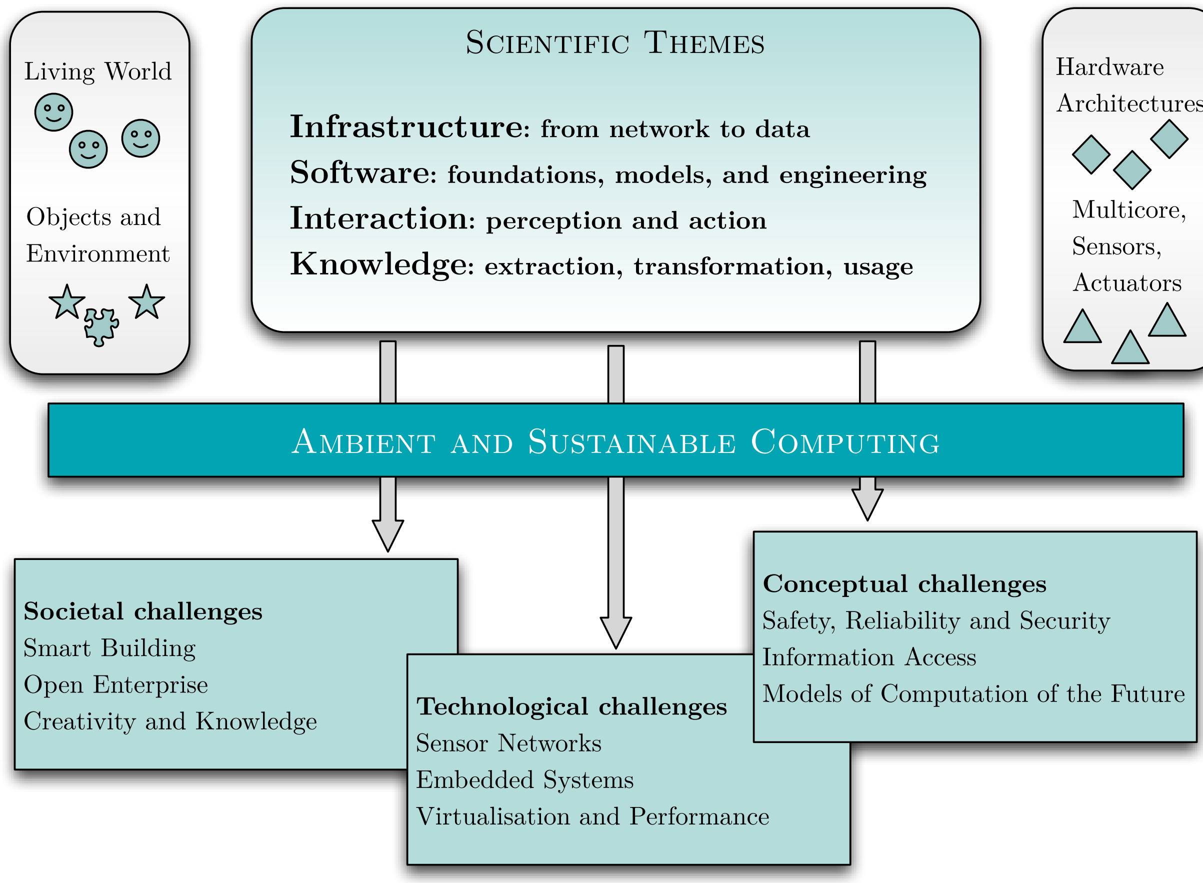

Figure 5.1: Scientific project of LIG

In the following sections, we present the 9 challenges that LIG will address in the next four-year contract. Table 5.1 shows the teams involved in these 9 challenges.

- 3 challenges of societal dimension: **Smart Building, Open Enterprise, Creativity and Knowledge**, which open up to the problems raised by the place of man in his life environment, in his social and working environment, and finally amidst knowledge and learning.
- 3 challenges of technological dimension: **Sensor Networks, Embedded Systems, Virtualisation and Performance**, which, in view of the recent evolutions of ubiquitous networks and of miniaturisation, direct research to software problematics of adaptivity, autonomy, virtualisation and fine management of resources and of the energy in particular.
- 3 challenges of conceptual dimension: **Safety, Reliability and Security, Information Access, Models of Computation of the Future**. The purpose is to tackle the difficult problems of tomorrow's computer science, to fathom the underpinnings thereof and to search for potentially fruitful models and approaches: which models and technologies for proven software packages? Which models for accessing information in

a mass of dynamic and multilingual data? The aim is also to probe the relevance of alternative calculus models, or derived from physical or biological models.

Each of these challenges also addresses problematics associated with sustainability: energy savings and the protection of private life in the "smart building", data and processing security as well as confidentiality for the "open enterprise", energy savings and security in "embedded systems" where the solutions will depend on the applicative context. "Virtualisation and performance" will lend their skills to these problematics with decision-making assistance tools by solving optimisation problems, distribution tools or complex modelling tools in climatology, epidemiology, etc. "Access to information" will get involved in the domains of health and media. "Creativity and knowledge" is emblematic since "humans" must be absolutely central, with their freedom and their right to personal development.

The approach adopted by LIG is a double angle of attack, simultaneously by the fundamentals of the discipline and by fields of application liable to meet societal and economic stakes. This approach is potentially complementary and fecund. The fundamental aspects of the discipline can be broken down into the major themes of LIG: computer infrastructures, software, interaction in all its modalities and processing complex systems of knowledge. They address research in terms of calculus models, algorithms and their complexity, abstractions and compositions, heuristics and proof. This disciplinary vision is completed by all the fecund interactions with biology, mathematics (algebra, statistics, logics, ...), automation and signal processing, physics and nano-materials, human and social sciences (neurosciences, cognition, linguistics, ...) on the "paths of computational thinking" (sic, The computational thinking, Jeannette WING, Bulletin SPECIF).

This scientific programme, derived from our reflections and which is the steadfast anchor of our skills is in line with the following:

- site dynamics with the elements of the campus project and particularly the PILSI aspect (Innovation Pole in Software and Intelligent System), research federative structures INNOVACS (Innovation, Knowledge and Society), COGNITION, CIMENT (Supercomputing, Modelling, Digital Experimentation and Technology) and House of Modelling and Digital Simulation, Nano-Sciences and Environment. It is also coherent with the project of the INRIA Grenoble Rhône-Alpes Research Centre. The implication of LIG in these structures will be detailed below in the document.
- moved by national dynamics, our project
- moved by international dynamics, through our numerous collaborations and also within the European research strategy. This will be detailed at a later stage.

5.2 Societal challenge: Smart Building

Domain and stakes

The domain of Smart Building (BI)[2] concerns any usage form of Information Sciences and Technologies (IST) to improve the quality of buildings but also the quality of life of their occupiers: energy efficiency, air quality and comfort, maintenance, cleaning, security, health, autonomy of elderly or handicapped people, family life, leisure, professional activities, logistics and many more examples. A place for living and exercising professional activities (we spend 90% of our time in closed spaces), the building lends itself particularly well to the implementation of the concept of ambient and sustainable computing.

Among the numerous stakes and challenges associated with the BI, LIG focuses on energy efficiency and comfort, working environments linked to knowledge economy and personal services. **energy efficiency** is a major stake for buildings, either new or to be renovated (cf. The Round Table on Environment, the "Eco-Responsible and ITC" report). Evolution toward ambient computing generates growing interest from the industry, exploring new models, new services, so as to provide the user and the operator of a building with optimal energy performances according to numerous dynamic parameters — climate, local energy production, in particular solar, consumption, ventilation, preferences in terms of thermal comfort... If public decisions may influence, possibly regulate, collective behaviours, the individual nevertheless will seek to maximise his values (his comfort, for instance) in contradiction to societal sustainable development objectives. From then on, LIG wishes to take up this double stake: to reconcile, through ambient computing, individual quality of life and collective interest for preservation of the environment.

It seems particularly fecund, simultaneously from scientific, economic and ethical viewpoints, to explore the concepts of ambient soft and sustainable computing in **working environments linked to knowledge economy**. Unicity of time, place, working structure is not valid any longer: mobility is now governing our work, in all places, wherein working times combine with private time – both spheres overlap each other frequently, and flexible project structures have replaced fixed hierarchical structures. There is a link here with the concept of **open enterprise**.

Ambient computing has a major societal role to play in **personal assistance services** for maintaining in particular the autonomy of fragile people in their own homes, for breaking their isolation, regardless whether they are elderly people, people suffering from cognitive deficits or handicapped people. The issue is to provide services capable of detecting, without false alarms, as well as **in a reliable and secure manner** any potentially dangerous situation and of triggering the appropriate palliative means. It is crucial to monitor activity (actimetry), to bring comfort and remedy isolation while **respecting private life**. The aim is to assist daily life activities without rendering the person dependent. The list of the expected functions is widely open.

Approach and strengths of LIG

Our approach is to consider **building as a service provider**. These services will result from the dynamic federation of facilities exhibiting capacities of Perception, Action, Communication and Processing. The services today demanding explicit user intervention, will be replaced with services based upon a set of facilities capable to perceive the environment and of acting thereon autonomously. They will use the notion of context, i.e. structured and dynamic information spaces which will enable them to grasp the situation, to act relevantly and to interact with people suitably. They should be able to run in dynamic environments where the occupiers' objectives as well as the computing and interaction resources and the means of communication will evolve unpredictably.

This vision of building as a service provider is made possible by recent breakthroughs in four domains: the **embedded systems** integrating, in daily objects, **sensors and actuators** as well as communication and processing means, underpin the creation of new services. Low cost **high frequency digital communication** eliminates closed-ended facilities and configurations, hence unsuitable for dynamic environments. Enhancements in **networks and distributed systems** provide new tools for dynamic adaptation and configuration. The **cognitive systems**, issued from the convergence of computer science, neurosciences and cognitive sciences, open up new avenues for the realisation of artificial systems exhibiting capacities of perception, action, learning, reasoning and hence adaptation to the unpredicted. The convergence of these technologies raises new challenges and opportunities for ambient computing.

Our vision of building as a service provider encompasses the four scientific themes of the laboratory: in-

[2] This challenge is a continuation of the "pioneering domain" of the same name and initiated during the four-year period 2007-2010.

frastructures, software, interaction and knowledge. In infrastructures, the DRAKKAR team brings its skills in sensor networks and HADAS in distributed management of data and in interoperability. In software, ADELE in middleware for the construction and the administration of autonomous distributed systems in heterogeneous dynamic environments and SIGMA applies its know-how to context modelling for adaptation of services, VASCO designs of secure systems. In interaction, PRIMA brings its skills in artificial perception for identifying human activities, IIHM studies, designs and produces interactive spaces, while MULTICOM evaluates usages and GETALP, in its research in automatic speech recognition, is involved in the identification of risky or stress situations. E-MOTION brings skills in multisensory fusion and robot systems. In knowledge, EXMO studies the exchange of structured and formalised knowledge, MAGMA works on the notion of services in a multi-agent approach, AMA develops the necessary learning techniques. At the crossroad of the knowledge and interaction themes, METAH addresses the services linked to teaching and learning, E-MOTION models sensorimotor systems using Bayesian and learning techniques for analysing and predicting dynamic behaviours of diverse entities (pedestrians, mobile systems, video game players, etc.) and WAM experiments with the use of sensors and mobile phones for assisting handicapped people in finding their way around in buildings.

National and international positioning

The smart building is the subject of numerous research actions and experiments at international, national and local levels. Many global players in the industry are taking part in the development of this concept. In the USA, the NSF finances research on improving the quality of life (theme also encountered among the recommendations of the SNRI). This domain is covered by the *Assisted Living* program at the European level as well as at the national level via ANR.

Platform initiatives around the smart building have been launched in the Grenoble region: PREDIS of the Carnot Institute for the Energy of the future, DOMUS of the LSI Carnot Institute, INTEGRA of the CSTB, INCAS of the CEA/INES in Chambéry, HOMES (Habitat and Optimised Building, Energy and Security Control) run by Schneider Electric as well as the CEA-driven HELIOS demonstration platform project. The programme of the works of LIG is in line with in these dynamics.

Programme of the works

The applicative coverage of the BI concept is wide. Moreover, we have adopted 3 programmes based upon local dynamics, which require a true cooperation between disciplines and which concern three distinct socio-economic sectors:

1. Comfort in the habitat. Research will be conducted within the framework of the HELIOS platform project, financed by the FUI, being put together in partnership with the CEA. Our challenge is to ally individual values (quality of life) and collective interests (preservation of the environment).

2. Health and maintaining people in their own homes. Research will be conducted in collaboration with the health pole of the Grenoble campus as well as Orange Labs.

3. Working environment associated with knowledge economy. Within the PILSI framework, we propose to build facilities accommodating academic and industry researchers, and students, to create, explore and validate concepts. The originality lies in that the creators of these concepts will be living amidst their own creations. We shall start with teaching supporting tools.

The deployment model of these programmes will be in compliance with the recommendations transmitted to the MESR for the ambient intelligence plan: we shall form resolutely a multidisciplinary consortium working in parallel on the three kinds of jobs around the BI. Each of these jobs will be embodied by a network of experimental platforms enabling to switch gradually from demonstrators to proven solutions and from then on, to test the genericity of the concepts and solutions[3].

[3] This work on the Smart Building challenge is led by James L. Crowley.

5.3 Societal challenge: Open Enterprise

Domain and stakes

To meet the increasingly volatile and demanding expectations (costs and quality) of the clients, the companies extend and/or become organised in a network. The organisations combine their resources for offering products or services which they could not afford individually. Expressions such as extended enterprise, virtual enterprise, network enterprise, etc. may be mentioned. These terms include various meanings and forms of organisation. We encompass them in the notion of open enterprise[4] in its widest vision.

With digital development, products and services become immaterial. The business process is thus disrupted, with a form of continuum taking shape along the whole processing chain, from the raw material to the final service, and which also integrates all the actors of the enterprise. The information system is then at the heart of the company's life. All this creates new challenges and stakes for information processing sciences. The idea is to propose models, algorithms, software infrastructures for easier design and implementation of collaborative process on data, documents, services and "business" knowledge.

Needs for new computer media are raised at all levels: for modelling and collaborative management of business processes, for person-person "business" oriented communication, for sharing and building on "business" knowledge, for implementing cooperative applications distributed using network infrastructure tools.

The stakes are numerous. For economic watch and strategic watch, which are key sectors for modern enterprises, the stake is the verification of the information sent back by automatic research tools. The idea is to be able to cross-reference information, to confront it, to detect inconsistencies between different information sources, so as to locate erroneous information and to recognise information both reliable and worthy of confidence.

For sharing and building on knowledge, the stake is to provide interrogation, classification, visualisation, browsing, annotation, translation services which are customised and adapted to the needs of the different actors involved in the life of the enterprise. The idea is to provide heavy-duty, flexible et generic data mining tools which are adapted to heterogeneous data and to various needs.

To reconcile supply and demand, needs and skills, the discovery and the composition of services are stakes for which heavy-duty and efficient tools may provide a significant gain in productivity. The purpose is to discover matches between pieces of information whose description is often heterogenous and to qualify the degree of adequacy as accurately and fairly as possible for efficient and informed decision-making.

Approach and strengths of LIG

The contemplated approach consists in mobilising around applicative scenarios the complementary skills of a large number of the teams of LIG for the construction of infrastructures and of innovating information systems adapted to the new needs of open enterprises and organisations.

The ADELE, MAGMA, SIGMA, STEAMER teams together contribute to modelling innovating collaborative processes by making use of their skills in models for (*workflows* participative design, co-design, coordination in multi-agent systems) and meta-models.

The AMA, GETALP, HADAS, MRIM, STEAMER and WAM teams bring complementary skills (learning, multilingualism, data mining, data processing, representation of knowledge and semantics) particularly useful for the construction of automatic watch tools capable of monitoring the Web, of extracting and synthesising useful information for the enterprise and its strategy, of annotating semantically the documents found and of organising them for easier and targeted search for information.

Finally, the ADELE, EXMO, HADAS, MAGMA, MRIM, STEAMER, WAM teams are interested in the implementation, at different levels and different scales, of mediation infrastructures (data, knowledge, services, processes) as well as the discovery and the composition of resources. All of these skills are central to the interoperability of information systems for companies wishing to network.

The IIHM team offers new interfaces enabling the different actors (customers, users, suppliers, designers, developers, decision makers, salespeople) to collaborate by using video, sound, a table and application sharing.

[4]This challenge is a continuation of the "pioneering domain" of the same name initiated during the four-year period 2007-2010.

National and international positioning

The open enterprise is a pioneering domain at the European level as shown for instance by the "ITC for supporting networked enterprise" objective in the FP7-ICT call, or the INTEROP-NoE network of excellence (*Interoperability Research for Networked Enterprise Applications and Software*, FP6 508011) which has led to INTEROP-Vlab, the *European virtual laboratory for Enterprise Interoperability*, as well as the ERANET action of coordination around Future Enterprise[5]. INTEROP-VLab[6] is organised in geographical poles, whereof the Grand South-West France Pole with 15 institutions, private as well as State-owned, implanted in 7 French regions. It supports research-industry projects in connection with competitive clusters, as for example the ISTA3 project whose aim is to improve Aeronautics sub-contractors' competitiveness or the ASICOM project, "Interoperable information system architecture for commerce industries".

Programme of the works

We have chosen to structure our work around a "research platform" whose total or partial implementation will depend on the means and partnerships then available. In collaboration with the G-SCOP computer integrated manufacturing laboratory as well as the CERAG (centre for management study and research), our first objective relates to computer instrumentation of social networks for organisations.

Importing social networking tools and practices into enterprise information systems opens up perspectives for setting up new collaborative solutions and impulsing innovating projects by exploiting the dynamics and the economic potential of emerging communities thereby abolishing partitions between business experts, decision makers, managers, suppliers and customers. The emergence of coalitions and dynamic alliances for leading and structuring projects becomes possible. The information system is becoming emergent and malleable, based on the incremental construction of a skill database, by relying on innovating communication devices and tools. These new problematics make it compelling to reexamine economic, growth and confidence models. It requires finding both flexible and reliable means for sensitive information communication, verification of exchanged information as well as formalisation of collaboration agreement[7].

[5] http://www.networked-enterprise-era.eu/
[6] http://interop-vlab.eu
[7] This work on the Open enterprise challenge is led by Marie-Christine Rousset.

5.4 Societal challenge: Creativity and Knowledge

Domain and stakes

Creativity and knowledge[8] maintain complementary and necessary relations, whether for mobilising knowledge and supporting fecund creation or for offering original creativity and coining new knowledge or letting existing knowledge evolve. The activities wherein this complementarity is expressed are numerous, from design to learning, from playing to scientific or artistic innovation or invention. Creativity and knowledge, involved in cultural, educational, playful activities share the characteristic of participating in the global development of the person and of moving his/her senses (emotion, pleasure, aesthetics. . .) beyond "utilitarian" or "productive" functions. Together, creativity and knowledge are involved in all human activities, individual or collective, with both societal and economic significant stakes. Creativity and knowledge are the foundations for a blossoming space whose impact is most often hardly measurable ; the actual value of creativity can rarely be appreciated instantly and it is rather advisable to consider the dynamics of creativity with interacting with knowledge (taste for knowing and discovering, aesthetic emotion, joy, tears. . .) which depends on the degree of commitment, on motivation, on expectation, on cultural and social anchoring and on the context of the action or of the activity.

Computer science has increased, and sometimes vastly changed, the nature of creative and cognitive activities by introducing new mediations which modify our relation to time and space, by introducing new instruments and new possibilities of expression, by modifying the producers' (to whom it provides powerful design tools) and the users' relationships. In return, computer science finds new scientific and technological challenges opening up renewed possibilities of interaction with other disciplines, in particular in the sector of living sciences as well as human and social sciences. It encounters new barriers when taking into account human dimensions whose modelling remains an open problem (learning dynamics, emotion, aesthetics), in support to creation (in particular artistic, but also in individual or collective design) and to educational innovation, in the convergence of media and access modalities (multilingualism, ubiquity, nomadism and mobility, embedded phenomena, tangible access to abstract concepts) and in the search for environments meeting higher expectations in terms of personalisation, socialisation (social software). Finally, the activities requiring tight links between creativity and knowledge are characteristically backed up by strong individual stakes, including when inserted in contexts of social interaction, let alone when they gain in meaning through these interactions. This commitment of the individual raises particularly sensitive problems in terms of ethics and deontology, security and confidence, respect of the private sphere and of the protection of personal data, which must be given technological responses.

All these characteristics will consequently confer equal prominence to functional and non-functional aspects of software packages and their interfaces. Indeed, these software packages must comply with a specification sheet as to what should be done but also as to the way they should behave when running. Both these types of requirements are conventional in human-centred software engineering, but are of particular significance in case when creativity plays a key role by reason of its non-directly instrumental, high value and of its peculiar relation to affects, feeling of interest, pleasure or other forms of blossoming.

Approach and strengths of LIG

Some LIG teams have a scientific and technological research activity, sometimes rather old, in several sectors where creativity and knowledge are strongly associated, and more particularly: education, training, multilingualism, museography and games. Six teams have a scientific programme which addresses important aspects of the challenges thrown by supported and developed interactions between creativity and knowledge: AMA (analysis and exploration of complex data), GETALP (multilingualism, ubilingualism, linguistic and cultural patrimony), IIHM (museography, emotion and enhanced reality for dancing, multimodal games on mobile media), MAGMA (support to human creativity, artistic creation, educational collaborative games, personal services), METAH (educational scenarios, learning and scientific teaching, medical and surgical training, *learning games*, dynamics geometry) and MULTICOM (museography, mobile systems for leisure, surgical learning, tangible and acoustic table) and WAM (environments for creating and sharing multimedia educational contents).

The greatest part of these research works is characterised by empirical exploratory phases then experimental approaches necessary to validation of the studied concepts. Thus, one of the common concerns for the involved teams is the search for new experimentation fields and original methods taking into account the nature of these fields. Indeed, the technical (acquisition and simulation devices) and methodological breakthroughs gradually enable to venture on fields which are very close to users and relevant situations (operating block, museum, simulation of a hospital department, theft simulation, etc.).

[8]This challenge is a continuation of the "pioneering domain" "Education, Culture, Leisure" initiated during the four-year period 2007-2010. The change in name reflects the fine-tuning of the objective pursued.

National and international positioning

The teams of LIG have occupied a leading position at national and international level in several of the applicative domains associated with the challenges thrown by links between creativity and knowledge, mainly education and culture. In the 80s, the invention of dynamic geometry saw the birth of a research programme of the DIAM team in collaboration with the Cabrilog start-up. The rapprochement of the researchers in computer science and in didactics, now gathered into the single METAH team within the laboratory, has enabled to form in Grenoble the first French pole with a particular impact in Europe as demonstrated by the creation and the control of the FP6 Kaleidoscope network of excellence (now pursued by the Stellar network in the context of the FP7).

In the field of multilingualism, the GETALP team has an old and recognised capital with breakthroughs on original issues such as those raised by intercultural understanding (Hindi-Urdu transliteration, Punjabi transliteration machine) and that of under-resourced languages (organisation by the team of the first international workshop in Hanoi). In the field of culture and leisure, whose development is historically more recent, regional and national projects: in collaboration with the Biarritz Ballet, the works of the IIHM team on dancer's emotion recognition and enhancement of the ballet scene (CARE www.careproject.fr ANR project and co-supervised thesis), the methodological works of the IIHM team on the design of enhanced objects with the museum of Toulouse (CARE www.careproject.fr ANR project), the design, the realisation and the evaluation of several collaborative and enhanced reality multimodal games of the IIHM team (OpenInterface www.oi-project.org European project coordinated by IIHM, STIC-Asia MOSAIC project), the experimentation of the MUTLICOM team in the context of the Rhône-Alps region IMERA projects (ubiquitary environment in the Museum of Lyon) and Franco-Finnish RNTL ADAMOS (mobile system for skiers), the collaborations of the MAGMA team with the University of South Denmark around game and in connection with the Center for Art and Science (Robo Days[9], organised by the city of Odense).

Programme of the works

The works are organised in close relation with the scientific programmes of the teams and at their interfaces. They will address in particular (1) educational and training issues, in particular in problematics implementing simulations, *learning games* and involving the orchestration of learning processes, (2) issues associated with access to culture, either creation or access of the public with especially a strong commitment on multilingualism (creation of texts in multilingual context, multilingual access to cultural patrimony, support to under-resourced languages).

Two types of problems common to the projects of the teams will be addressed: acquisition, formalisation and analysis of usage traces, conceptualisation and modelling of usage contexts to study their impacts on usages. Both these aspects are in close interaction and are, in specific forms, studied in the different teams (learning environment and situation, environment in multi-agent systems, multilingual context, usage context in ergonomics). Seminars and common projects will enable to understand the relations between the various approaches and to extract the aspects critical to Creativity and knowledge problematics. More precisely, the common concern is understand which characteristics of the context have an impact on technologies and users' behaviours, and how these characteristics should be adjusted for obtaining a given effect and guarantee the sought-after efficiency.

The acquisition of usage traces and their processing is a difficult problem in itself. It is made complicated since traces accounting for an activity non-biased by observation should be available. To that end, it is necessary to make sure that everything unfolds as if the user acted in a "real" environment either because the conditions for eliminating laboratory effects are met, or because we may take our bearings on the field little intrusively (e.g. school, museum, tourism). The challenge is simultaneously technical, methodological and conceptual. Indeed, to tear down the walls of conventional confined experimental platforms, technical means for guaranteeing interference-free observation are absolutely necessary. Since experimentation is plagued with lesser control, new methodologies must be set up and validated.

To that end, we shall adopt a *Laboratorium* type approach characterised in particular by its anchoring in a "natural" environment. A *Laboratorium* differs for usage and usability laboratories by its strong anchoring in real context and operators' intervention. It differs from *Living labs* inasmuch as the researcher is not the operator at the same time. The implementation of this portion of the research programme will rest upon the *Laboratoria* experiments set up in LIG (*Laboratorium* un the Medical UFR of Grenoble in collaboration with the

[9] `http://www.robodays.dk`

CHU (University Hospital), the experiments in the Museum of Lyon, the Smart Home, etc.) by granting priority to the federation of these experiments so as to improve the common design and operation methodology[10].

[10] This research on the Creativity and knowledge challenge is led by Nicolas Balacheff.

5.5 Technological challenge: Sensor Networks

Domain and stakes

The next generation of information technologies will probably be linked with the "Internet of Things"[11], composed of myriads of RFID tags identifying objects and people, and of sensors measuring their environments. Recent technological breakthroughs, with the production of very small objects, using little energy and filled with sensors and triggers, leads to the idea of using an ad hoc sensor network to accomplish certain applicative tasks. For instance, tight air-conditioning control enables to save very large quantities of energy often wasted due to non-optimal air-conditioning management. Initiatives in intelligent buildings extend this approach to applications where their close environment is controlled tightly by the inhabitants. The interpretation of sensor data and modeling of the environment are mandatory to design and manufacture assistance robots (semi-automated wheelchair for instance) or intervention robotics (mine exploration robot or rescue robot in hostile environments). Other recent applications include: monitoring industrial processes, applications in transports and logistics, measuring vital constants for monitoring ill or elderly people, traffic control, monitoring air pollution, observing and controlling farming operations.

The services derived from the exploitation of these informations are more commonly called M2M ("Machine-to-Machine"). These M2M services provide companies with new opportunities of economic models (i.e. *pay as you use*), for improving the quality of service given to their clients (individuals or companies) and compliance with legal or contractual obligations. They have become essential as the new efficiency tool (i.e. *just-in-time*) and the new productivity tool for e-agile enterprises and organisations. We shall review the most important scientific challenges in this field.

Energy optimisation in sensor networks. This most often requires switching to standby mode as long as possible which raises the problem of synchronous awakening between communicating entities. Another way is to integrate data so as not to transfer spurious or too detailed information. Using sensor networks increasingly requires integration with Internet protocols.

Coordination and self-organisation in sensor and actuator networks. This objective requires proposing distributed algorithms for coordination and distributed control of the topology and of the structure. Another aspect is linked with localisation and follow-up protocols. Sensor and actuator networks raise a challenge of autonomous operation — the detection of certain events then causes the reaction of the actuators.

Mobile sensor networks. Sensor nodes or wells of data are increasingly mobile and positioning protocols then become of paramount importance. These thematics are also linked with the development of biometric sensors and their interconnection for the collection of information.

Multimedia sensor networks. A sensor network may provide data in the form of video streaming or images which raises problems associated with supporting service quality and communication protocols with real-time constraints or which renders data merging necessary, the detection of salient features or of events.

Sensor networks as a database. In this view, the information collected by the sensors can be seen as a vast distributed database which answers and evaluates requests relating to the information that the well of data or the user wishes to recover. Numerous works on the sensor data management have been dedicated to the evaluation of requests on transient data flows and to dynamicity management (*plug-and-play* aspect).

Design methodology, prototyping and systems of development. The development of a sensor node and the deployment of a network are currently rather artisanal processes. Moreover, it is necessary to find new methods for test development, debugging as well as rapid prototyping based on new programming abstractions (socket layer for sensor networks).

Integration with the Internet. Several research activities aim to integrate sensor networks into the Internet. The IETF offers an approach based on the application of the IPv6 protocol and its adaptation for extending the IP connectivity to a sensor node (6LowPAN work group). Another work group of the IETF ROLL considers routing protocols for sensor networks while taking their specificities into account (energy constraints, high error rate on radio links etc.). Sensor networks can also be seen as an opportunity to re-examine the architecture of the Internet and to study which communication model is best suited in this context. A direction to explore consists in adopting the Publication-Subscription model and the content-based approach (*Content-Based Networking*).

[11] This challenge is new with respect to the four-year period 2007-2010 and demonstrates our will to get involved in the Internet of Objects.

M2M services engineering. M2M services rest essentially upon the integration of real-world data in non-critical "real-time" enterprise information systems (i.e. *online* or *near-realtime*). The current state of the art in the field of software engineering and middleware does not enable rapid and open-ended setup of powerful, yet simple to administer services which requires research on software engineering tools and associated middleware intended for business experts of the domains of application.

Interpretation of sensor data and modelling of the environment. An intelligent system is defined as an artificial system designed for perceiving the surrounding world and acting therein. The interpretation of raw and noise-corrupted sensor data and the modelling of the environment play a fundamental part in the construction of an intelligent system since it forms the first component thereof and supplies information to the other components.

Approach and strengths of LIG

The theme of sensor networks concern several teams of LIG. Let us mention here a few subjects of research on which we collaborate within the PILSI initiative:

Mobile sensor networks (DRAKKAR, E-MOTION). Sensor nodes and wells of data are increasingly mobile. Research has been initiated in order to find new protocols for routing and collecting information while saving on energy and taking the mobility of the nodes into account.

Multimedia sensor networks (DRAKKAR, IIHM, MULTICOM, PRIMA). The multimedia data traffic imposes real-time constraints on communication protocols. This aspect raises research problematics regarding the support a sensor network may provide for video streaming or images.

Data-oriented sensor networks (DRAKKAR, HADAS, SIGMA). This axis concerns the unification of data management with the management of the network itself through declarative request languages as used in databases. Such a language will enable easy selection of the information collected by sensors. A challenge in this field is also to enable fine and dynamic configuration of data management services, meeting the service quality constraints while mastering the constraints of the sensor networks, such as short-lived surveillance based intense samplings, conversely an operation for extended duration. Another objective is the definition and the construction of sensor data management systems.

Middleware for RFID sensors, M2M communications (ADELE). This aspect will address the definition and the development of a middleware in the field of free software for supporting RFID applications. It will enable the deployment of RFID applications in a simple way, without resorting to low level programming.

Sensor networks for the habitat and the town (AMA, DRAKKAR, IIHM, PRIMA). The aim is to instrument the close environment of a user and the infrastructure of his/her daily life to control them and to adapt them to his/her preferences and needs. By using suitable multimodal interfaces, the user will be able to influence his/her environment and model it at will.

Interpretation of sensor data and modelling of the environment (E-MOTION). The first difficult point is to identify the nature of the objects present in the environment: static —to construct a map of the environment, a problematic known as "simultaneous localisation and mapping"— or dynamic —to identify the mobile objects in the environment and to monitor them: this problematic is generally known as "multi-object detection and monitoring". The data merger problematic, since there is no "perfect" sensor and sensor type has different physical properties, is crucial and difficult.

National and international positioning

LIG is one of the leaders in this domain at national level. This has translated in a participation in several collaborative research projects. The ANR ARESA project "Buried Systems and Sensor Networks" which unites FTRD, Verimag, LIG, TIMA, Coronis and INSA Lyon may be mentioned first of all. Its prominence has been confirmed with the ARESA2 suite selected in 2009 for the three years to come. It suggests exploring the integration of sensors in the Internet and to define adequate safety mechanisms for environment observation of urban networks. A few new partners have joined the project: CEA-LETI, INRIA PLANETE and Institut Télécom Bretagne. LIG is also a partner in the national RECAP platform of CNRS.

LIG also takes part in projects such as: the TRANSCAP junior researchers ANR project, *Transactional operations in sensor environments* (SIGMA), projects of the Minalogic SAMEE competitive cluster, *Smart*

Advanced display Monitoring Energy Efficiency (Schneider, LIG, MAYA, E2V, Nemoptic, Alpwise) and SensCity (FTRD, Coronis, LIG, others).

At international level, the FP7 Aspire project may be mentioned, *Advanced Sensors and lightweight Programmable middleware for Innovative RFID Enterprise applications*[12]) with the participation of the ADELE team. The DRAKKAR team is putting together a collaborative FP7 project on the thematics of the Future Internet of Objects — how to integrate sensors and actuators in the current and future architecture of the Internet. The vision of the project is to explore a new approach to communication based on the principle of *Content-Centric Networking* which corresponds perfectly to the domain of sensors while enabling measured data aggregation and their efficient transport.

Programme of the works

In the context of the PILSI initiative, we propose to found a centre of excellence in sensor networks integrating several aspects discussed above. Without going into detail, the thematics covered are quite extensive, from MAC protocols and routing for low-rate or high error-rate wireless links to the representation of measurements as a database model and the evaluation of continuous requests on data via the infrastructure of services for sensors in intelligent buildings. The integration of sensors in the Internet will also enable to widen the influence of such type of networks on possible applications and to handle an increasingly wide spectrum of users. The research activities are not limited to academic actors, but also include industrial partners. PILSI maintains privileged links with the industry through projects of the Minalogic competitive cluster, European projects and bilateral contracts. Our research activities within PILSI already involve Schneider, Orange Labs, Coronis, CALAO, ATIM Radiocommunications and Cisco[13].

[12] `http://www.fp7-aspire.eu/`

[13] This work on the Sensor Networks challenge is led by Andrzej Duda.

5.6 Technological challenge: Embedded Systems

Domain and stakes

Embedded computer equipment[14] covers a very wide spectrum of applications: industrial control-command systems, transports (avionics, space, railway sector, automotive), energy production and distribution, up to general public electronic equipment (mobile phones, photo cameras, digital television, electric household appliances, chip cards. . .). The economic and societal importance of these applications is colossal and growing rapidly. Computerisation plays a major part therein.

Data-processing is not confined to conventional computers any longer, but is sneaking into an increasing number of manufactured objects. Embedded computer equipment has become part of the development of ubiquitous computing. Its aim is to provide autonomous processing capacities, while communicating with the other machines and interacting with the environment and the users.

Embedded systems generally interact with their physical environment which they seek to control. Moreover, they usually result from the combination of software and hardware. On these grounds, it is a domain at the crossroad of three disciplines: automation, software and hardware.

Embedded systems exhibit specific characteristics:

Autonomy – Embedded systems must generally be self-sustaining, that is to say able to fulfill their mission over long periods with limited human intervention. Such autonomy is necessary when human intervention is impossible, but also when human reaction is too slow or insufficiently reliable.

Interaction – Embedded systems interact with the physical and human environment. They must be able to accommodate embedded systems capable of managing the multiple sources of interaction (and of communication) and the different possible time scales.

Reactivity – Embedded systems are deployed in a physical environment, with which they are interacting constantly. This implies that they are submitted to real-time constraints linking their running times to the reaction times of the environment. As the environment cannot wait, the system and the environment cannot be synchronized.

Non-functional constraints – Beyond real-time constraints, embedded systems are very often subjected to non-functional constraints, regarding for instance memory occupation, energy consumption or operating safety parameters (safety, reliability, availability, . . .).

Criticity – Embedded systems are often critical. Indeed, as such a system acts on a physical environment, the actions carried out are irremediable. The degree of criticity depends on the consequences of the deviations relative to a rated behavior, consequences which may affect people's and goods' safety, security, the accomplishment of missions, economic profitability. . . . .

Robustness, security and reliability – The environment is often hostile, for physical (shocks, variations in temperature, impact of heavy ions in space systems, . . .) or human reasons (malevolence). Therefore, security – in the sense of resistance to abuse – and reliability – in the sense of service continuity – are often connected to the problematic of embedded systems.

Communication – Although the first characteristic of embedded systems is autonomy, hence local processing capacity, the part of information exchanges with the other systems is increasingly essential in the operation of all data-processing systems.

In Grenoble, within the MathSTIC pole, the theme of embedded systems is treated in 4 laboratories: TIMA, Verimag, LIG and GIPSA.

Approach and strengths of LIG

LIG brings answers to numerous problems raised when designing embedded systems. Its expertise indeed covers the following domains, with the contributions in progress now put forward:

[14] This challenge is a continuation of the "pioneering domain" of the same name initiated during the four-year period 2007-2010.

OS and middleware aspects. The component-based model and the Fractal/Think generation chain, co-developed by the SARDES team, for easier assembly, instrumentation and system reconfiguration operation and embedded applications; the production lines, designed by the ADELE team, for development business workshops and for the composition of large-scale deployed service with heterogeneous applications of OSGi-type embedded dynamic gateways.

Embedded protocol and network aspects. The energy optimisation techniques for sensor networks of the DRAKKAR team; the smart devices fitted with small embedded systems with memory and computing power (e.g., RFID) of the MULTICOM team; the declarative approach for integrated management of networks and data of the HADAS team.

Design techniques using formal methods. The multicriteria scheduling and optimisation techniques of the MESCAL, MOAIS and POP ART teams, enabling deployment on heterogeneous platforms (MPSoC) with guaranteed reaction times, reliability or electrical consumption; the E-LOTOS asynchronous language of the VASY team; the synchronous component-based programming models of the POP ART team.

Formal validation techniques. The on the fly model—checking techniques of the VASY team and the fine-tuning proven design techniques as well as the test generation techniques of the VASCO team; the rewriting and semi-automatic demonstration techniques for validation of pointer-based programs of the CAPP team; the abstract interpretation tools and the compositional verification techniques of the POP ART team.

User interactions. The decision-making techniques for autonomous browsing in dynamic environment and the ProBT library for Bayesian programming of embedded applications of the E-MOTION team; the embedded remanent vision circuit for mobile phones and the face and people viewing and monitoring embedded software packages of the PRIMA team; the new forms of interaction for mobile devices fitted with sensors (widgets for small screens) the multiplatform man-machine interfaces on mobile devices and the multimodal and collaborative interfaces for clusters of military drones of the IIHM team; the capture and the interpretation of signals from objects interacting with their environment and the inter-object dialogue of the MULTICOM team ; the desktop multilingual terminals (speech translation, gap-fill phrasebooks) on which the GETALP team has been working.

Data aspects. The merger of sensors and the robust analysis of dynamic scenes of the E-MOTION team ; the image database interrogation embedded software of the MRIM team ; the mining and analysis of environmental data for decision-making assistance of the AMA team; the multimedia data processing in the embedded systems (XML) of the WAM team; the complete and coordinated processing of the data relative to large parks of sensors and heterogeneous devices by the SIGMA team; the learning-based distributed optimisation of data merger/aggregation schemes in opportunist networks (sensor networks) by the HADAS team.

National and international positioning

This theme is treated:

- by the EmSoC cluster of Minalogic[15] ;
- by the EmSoC-Research project of the ISLE cluster of the Rhône-Alpes[16].

At national level, it is concerned by a succession of actions of the RRITs and of the National Research Agency: recurring theme of the RNTL calls (axis 1 of the 2007 call), RNRT (since 1998), ACI Data-processing Security (2003-04), ARA SSIA (2005) and SETIN (2006) Data-processing Security and Safety Program (2007) and of ANR (Embedded Systems and Large Infrastructures Program — "ARPEGE" 2008-2010).

Finally, at European level, it is handled by the ARTIST[17] (coordinated by the Verimag laboratory), and the ARTEMIS[18].

[15] `http://www.minalogic.org`
[16] `http://www.grenoble-universites.fr/isle`
[17] `http://www.artist-embedded.org/artist/`
[18] `http://www.artemis-office.org/`

Programme of the works

Two main tracks have been identified, with connections with other PILSI themes: the design of systems on multi-core architectures, and the design of critical control-command systems, with research conducted in the following areas and having numerous industrial collaborations, in particular within Minalogic[19]:

- Execution platform and architecture models; dedicated architectures, for instance multi-core,
- Programming models and languages; compilation,
- Operating systems, middleware and networks,
- Optimisation and scheduling; resource and performance management: time, energy, memory, core variability,
- Validation and verification,
- Regulation of the adaptive and reconfigurable systems by automation techniques (continuous and discrete).

[19]This work on the Embedded Systems challenge is led by Eric Rutten.

5.7 Technological challenge: Virtualisation and Performance

Domain and stakes

In terms of performance, breakthroughs can be seen at both ends of the spectrum: fine-grain parallelism within multi-core architectures and distributed parallelism within grids or systems called *cloud computing*[20].

Multi-core processors. The computer landscape has been marked over the last few years by the emerging multi-core processor concept. Several independent cores cohabit and share access to caches and memory within a single chip. This concept meets the performance requirements set by the Moore's law, but also satisfies the concern of limiting energy consumption to a reasonable level. Within less than 4 years, multi-core chips have worked their way into our workstations, into graphic cards, into supercomputing platforms, but also into embedded systems (MPSoC, mobile phones, ...). Numerous challenges are raised today for system designers and more generally software designers who must be capable of exploiting them efficiently:

- The adaptation of software packages to multi-core technologies requires a significant development effort. An approach which seems particularly promising is that of applicative domain specific languages *Domain Specific Languages*, DSL). The implementation of these languages must involve specialists in the domain, languages and parallel computing.
- Processors with several hundreds, possibly thousands of cores are envisioned today. One of the difficulties to overcome for such mass parallelism processors will concern access to memory and data. New memory architectures, such as stack memory components (*3D Stack Memory*) enable access to parallel memory at the level of the various cores raising problems similar to those of NUMA-type multiprocessor architectures (*Non Uniform Memory Access*).
- Energy consumption has become within a few years one of the important criteria for assessing computer systems in the broadest sense. Multicore constitutes a first response element at architectural level for minimising the energy consumption, another element being the various software layers.

Clusters, grid computing and cloud computing. With the recent evolutions in the domain of networks, processor architectures and software technologies for the construction of operating systems and applications, significant tendencies can be observed today:

- The dematerialisation of computer systems. This dematerialisation has been made possible by virtualisation technologies which enable several instances of an operating system to run on the same machine and by the possibility to migrate said instances on demand over the machines in the network. Such virtualisation affects the whole software stack, from network to access to data and is accompanied by strengthened security mechanisms.
- An unprecedented scaling. computers are now fitted with a large number of cores and the number of interconnected machines is increasing quite rapidly (for instance, Google clusters).
- New application programming and construction paradigms. Initiatives for combining components and services differently are emerging today. The deployment technologies offered will enable easy setup of applications in a distributed environment.

These tendencies will fundamentally change the way data-processing is used. Data-processing will become a service, with transparent access to computing resources, providing *utility computing*, on a par with water or electricity, with the same ubiquitous character. The stakes are: to design and adapt virtualisation technologies with the possibility to efficiently migrate virtual machines between remote sites in complete safety; to offer storage systems using replication and cache mechanisms for efficient access; to combine software components and services; to dynamically allocate networks on demand causing evolutions of infrastructures but also of communication protocols; to take into account the failure problems inherent to large scale distributed systems; to control and globally to reduce the electrical consumption of the infrastructure; to structure into components and services and to secure the whole.

[20]This challenge is a continuation of the "pioneering domain" entitled "computing for sciences and technologies" initiated during the four-year period 2007-2010. The change in name reflects a change in orientation rather towards underlying technologies, even if the applications are not ignored.

Approach and strengths of LIG

The adaptation of software packages to multi-core technologies requires a sizable development effort which ought to be limited and factorised. Implementation of specific languages (*Domain Specific Languages*, DSL) involves specialists in domain, languages and parallel computing. This approach is under investigation as regards data mining (HADAS team) and nano sciences (MESCAL team). New scientific thematics, such as for example information search or geomatics are quite demanding in computing and memory resources. Parallel algorithms, powerful in terms of complexity and accuracy, are developed by the MRIM and STEAMER teams. The VASY team develops massively parallel verification algorithms on grids. These new algorithmic approaches will be integrated in the DSLs.

Three teams of LIG (MOAIS, MESCAL, SARDES) are in the centre of the thematics of operation and efficient programming of these processors and grids. The SARDES team is focused on the programming model for component-based systems. The MOAIS team is concerned with the algorithmic and scheduling aspects. The MESCAL team is concerned with the performance evaluation aspects of middleware and applications and collaborates on this theme with the MAGMA team.

National and international positioning

Numerous research actions on high performance computing thematics are conducted at international, national and local levels. In the USA, the recent installation of the **ParLab**[21] in the University of Berkeley. It should be noted that American companies (Intel, Microsoft) are closely associated with this laboratory. A similar initiative is conducted in the University of Illinois in Urbana Champaign with **UCPRC**[22]. With regards to the university of Illinois and **UPCRC**, a joint laboratory with INRIA has just been created officially (official execution in June 2009). MESCAL and MOAIS INRIA project-teams of LIG take part in the first works of this joint laboratory.

At European level, the **PRACE** project concerns the settling and exploitation of petaflop platforms in several countries, among which France. In collaboration with the CEA INAC, the MESCAL team will take part in the deployment of a reference application on the next platforms of the PRACE project. Still at European level, we shall also mention the ITEA2 ParMA project (*Parallel Multicore Architectures*) LIG indirectly takes part in this project through several CIFRE BULL doctoral students.

LIG is involved at national level in several ANR projects of the programmes (COSINUS, ARPEGE). LIG is also highly involved in the national grid Grid'5000[23] through the Aladdin Technological Development Action of INRIA. Grid'5000 closely collaborates with the Grid Institute of CNRS, focused on scientific applications as well as with the CEA and its Teratec centre.

The French community has been a prominent actor of the CoreGRID network of excellence, dedicated to grid computing. The European Commission has initiated, in the context of the 7th frame programme, a large initiative, called FIRE, around experimentation platforms for the Internet of the future. Two major projects have been accepted: Panlab and Onelab. The objective of Panlab is to federate experimental platforms at European level by providing an interoperability framework. OneLab is based upon PlanetLab Europe and hence follows the same principle established by the designers of PlanetLab. Grid'5000 is complementary to both these infrastructures with its offering of reconfigurable software stacks.

On the Grenoble pole, LIG is highly involved in the CIMENT platform. Almost all the clusters in CIMENT are managed by the OAR software developed by the MESCAL and MOAIS teams. OAR is also used for the national grid Grid'5000.

Programme of the works

The work will globally be structured around the following directions[24]:

- Programming and efficient and ecological exploitation of multi-core processors in infrastructures from embedded systems (MPSoC) up to large scale clusters and grids,

[21] *Parallel Computing Laboratory* will be mentioned for instance: `http://parlab.eecs.berkeley.edu/`
[22] *Universal Parallel Computing Research Center* : `http://www.upcrc.illinois.edu/`
[23] `http://www.grid5000.fr`
[24] This work on the Virtualisation and Performance challenge is led by Jean-François Méhaut.

- Design of application domain specific programming environments. These may be DSLs (*Domain Specific Languages*) or DESs (*Domain Specific Environments*),
- Validation and experiments with actual applications targeting the various types of platforms (embedded, HPC, clusters, grids). Multidisciplinary research actions, strongly linked with the industry, will be conducted,
- Designing resources administrators for clusters and grids, supporting virtualisation, energy setpoints (energy throughput and saving) and scalings (number of resources, number of jobs and number of users),
- Designing tool and methodology for experimenting large distributed systems and for large infrastructures. Fine-tuning and evaluation of distributed systems are becoming increasingly complex. This implies setting up dedicated experimentation methodology and tools.

5.8 Conceptual challenge: Safety, Reliability and Security

Domain and stakes

The thematics "Safety, Reliability and Security"[25] have been identified as transversal within the PILSI project. The work group has identified three major categories of challenges linked to these thematics:

1. Challenges associated with hardware and its interactions with software.
2. Challenges associated with the size and the complexity of real systems.
3. Challenges linked to ubiquitous computing, interconnection of information systems and the user's implication.

Challenges associated with hardware and its interactions with software. Within the framework of the PILSI project, several challenges are associated with the hardware impact on the reliability of software/hardware systems, or on the security role played by the hardware. On the one hand, hardware constraints have a strong impact on the non-functional aspects (running time, reliability, consumption...) of the systems and must be taken into account as of the designing activities and, later on, during verification. This may lead to compromises in terms of security and performance and possibly to guarantee minimum levels in these domains. On the other hand, technological miniaturisation causes accelerated reliability loss, which proves a challenge for evaluating said reliability as well as for building heavy-duty architectures, and in particular the exploitation of multiprocessor systems-on-chip associated with fault tolerance.

Challenges associated with the size and the complexity of real systems. The Moore's law of hardware, which sets forth that performances and integration follow an exponential law, has been acknowledged for numerous years. A similar law applies to software, whose size and complexity are relentlessly growing as hardware offers more memory space. Software packages have thus become the most complex objects of engineering disciplines and the complexity of embedded software will quite frequently surpass that of the hosting hardware. This exponential increase in size and complexity of the real software packages raises permanent challenges at all the phases of their development (from the analysis of the needs to production launch).

The complexity of the software packages may lie:

- In the size of their source code (several million lines of code).
- In the data structures and the algorithms.
- In the scattering of processing and processing elements (for instance sensor networks).
- In the complexity of the environment with which it interacts.
- In the variety and the dynamicity of the configurations a piece of software may have, during operation — dynamic reconfiguration, according to a changing environment — as well as during its evolution — patches deployed at runtime — or when used in various forms within a line of products.
- In the variety, the number and the geographical distribution of the participants at each phase of the development.

Mastering such complexity involves in particular breaking down the system into components and sub-systems, often developed by independent teams or organisations.

In the context of the "Safety, Reliability and Security" thematics, the idea is first of all to adapt the design and verification techniques to these modular paradigms (components and systems) to take into account the new challenges associated with dynamicity of the configurations and to scale them to real case situations.

A portion of these problems has been studied for numerous years in the academic circles and solutions have been brought. Transferring these solutions into industrial practice remains however a challenge since the idea is to adapt the tools and their underlying models to the industrial requirements and demands.

[25] This challenge is a continuation of the "pioneering domain" entitled "Security" initiated during the four-year period 2007-2010. The change in title indicates a wider problematic.

Challenges linked to ubiquitous computing, interconnection of information systems and the user's implication. Computer systems today follow two strong tendencies. On the one hand, the integration of organisations translates in growing interconnection of all types of information systems. On the other hand, the development of micro and nano technologies fosters substantial breakthroughs in ubiquitous computing. If these technological breakthroughs provide new services to users and to organisations, they also arouse fears facing omnipresent and omniscient computer systems. The challenges here essentially relate to the quantity and the diversity of information controlled using such systems, and more particularly the user's confidence with respect to such systems and her capacity to keep the upper hand on her personal information and private life. But the problem goes beyond computing and encompasses legal and organisational aspects.

The solutions involve the definition and implementation of security policies, the development of secure infrastructures, the provision of content protection and the capacity to carry out quantitative and qualitative measurements of the user's confidence. The development of secure infrastructures must take into account the challenges associated with the complexity and the size of the real applications — see previous challenge. Theses techniques will rely on the progress made in the development of cryptographic solutions — design and analysis of cryptographic protocols, deployment of cryptographic solutions, methods and tools dedicated to these developments.

Approach and strengths of LIG

In Grenoble, within the PILSI project, the thematics "Safety, Reliability and Security" mobilise 19 teams, belonging to 8 laboratories with 115 permanent staff members. Nine teams of LIG, including 26 permanent staff members, are focused on these thematics: CAPP, MAGMA, MOAIS, MULTICOM, POP ART, SARDES, VASCO, VASY and WAM. All are active in the field of security and most of them are also active in safety and/or in reliability.

Most of these teams (CAPP, SARDES, VASCO, VASY, WAM) work on analysis, verification or validation. They use automated reasoning, proving techniques, static or dynamic validation, model-checking or test. The WAM team focuses on the verification and validation of particular programs, those processing XML data. The MOAIS and POP ART teams are also affected by the challenges raised by hardware, with the development of scheduling techniques, of parallel and distributed programming, of fault tolerance and reliability estimation. Finally, the MULTICOM team is concerned with usages security and the MAGMA team with the insertion of security and confidentiality properties into agents.

These thematics, and in particular data-processing security, have a transversal character and are thus applied in several of the pioneering domains of LIG, in particular Smart Building, Embedded systems and Sensor networks[26].

[26] This work on the Safety, Reliability and Security challenge is led by Yves Ledru.

5.9 Conceptual challenge: Information Access

Enterprise information access refers to information systems that allow for enterprise search; content classification; content clustering; information extraction; taxonomy creation and management; information presentation (for example, visualisation) to support analysis and understanding; and desktop or personal knowledge search (`wikipedia. org`).

Domain and stakes

The number of documents produced every year in the world is growing relentlessly. These documents may be simple texts, images, documents incorporating text and images, sometimes simple soundtracks or videos. They may exhibit an explicit structure, as is the case for XML documents, or be unstructured, as is the case for PDF documents for instance, where the structure, if any, is not given explicitly by tags. The importance of document collections, a volumetric but also strategic significance inasmuch as documents are a privileged vehicle for information sharing between people, has led to the development of methods and tools for better access to the information contained in such collections. These methods and tools generally relate to one or several following thematics: information retrieval, machine-learning (document classification, clustering), data analysis, comprehension aid[27]. Moreover, the capacity to store large masses of temporal data (open-ended) has caused over the last years the arrival of a large number of applications relating to open-ended data and a growing interest for descriptive or exploratory analysis methods of temporal (so-called temporal data mining) data.

At the moment we can observe a true change in information access practices, a change associated with emerging interaction networks wherein information is not isolated any longer but interconnected: each user is connected to other users and may access documents themselves connected to one another, written according to several modalities and in several languages. In practice, interconnections exist at various degrees and sometimes only affect users — as in the case of a standard LinkedIn[28] usage — or only documents — as in the case of the Web. More and more networks, in particular within companies, still involve interconnections at all levels — moreover, research work shows that it is possible, and beneficial in the context of information search, to induce links between documents, for instance on the basis of a content similarity, when the former do not exist.

In view of these elements, it becomes important to be able to exploit, within social networks or at individual level, collections of multimedia, multilingual, (semi-)structured and open-ended data, for improved access to and processing of the information contained in these collections. These objectives require re-examining the standard information access methods developed in mono-media frameworks — texts on their own or images on their own for instance — which are almost static and hardly connected, to extend them to multimedia, highly connected and time-evolving data.

Approach and strengths of LIG

Several teams of LIG already contribute to the problematics of access to information contemplated here: AMA works on access to information (filtering, classification, clustering) in socio-professional networks; EXMO explores the problematics of description and semantic request problematics; HADAS takes an interest in structured data mining so as to analyse the information contained in these data and in the use of data semantics for easier access to information and techniques for co-ordinating operators or services for accessing information (to handle a request); GETALP works on multilingualism, i.e. the tools and models enabling to treat multilingualism in textual and speech data, and the acquisition of fine data necessary to the development of resources in various domains; MAGMA is focused on multi-agent systems, and the interactions between agents and network type environment in this context; METAH endeavours to understand the forms, the nature, the impact of the computer support to the individual, collective, interactive build-up of knowledge; MESCAL proposes algorithms for processing large masses of data; MRIM takes an interest in multimedia information search and develops systems to retrieve information in multimedia and semi-structured collections; SIGMA focuses on personalisation, contextualisation, sensitive data confidentiality; STEAMER addresses information access problematics in geographical databases, structured or not.

Beyond LIG, at local scale, other research teams work on the information access thematics, at the GIPSA laboratory, where one of the research problematics is in line with modelling of human perception for access to

[27] This challenge is a novelty relative to the plans of the four-year period 2007-2010. Such problematic seems to be gaining in prominence and has led in LIG to the organisation of a portion of our research around this challenge and also around the proposed creation of a new team.

[28] `http://www.linkedin.com/`

information in collections of images, or in the INRIA/LJK LEAR team, focusing on automatic learning models for image processing. Finally, the TIMC-IMAG teams are concerned with automatic learning and data mining models which ought to be developed for accessing information in dynamic collections existing within interaction networks. These teams suit with PILSI in this pioneering domain.

National and international positioning

This problematic is also of interest to the industry, some internationally renown companies being established locally. Xerox, with the Xerox Research Centre Europe: certain projects at XRCE are dealing with information access models and acquisition of fine data. Yahoo! is also highly involved in information access thematics in social networks. Representatives of these companies are part of the reflection group which we have set up around access to information.

At national scale, two ambitious projects fit within the thematics of information access: Infomagic and QUAERO. The purpose of both these projects is to develop information access systems encompassing a wide range of functionalities in France: information research and extraction, visualisation, semantic annotation... In both these cases, the effort is placed on multimedia collections, but weakly or not interconnected (in the sense of interaction networks). There is here a major difference with what interests us inasmuch as we endeavour to reexamine the information access models and methods for taking into account underlying interaction networks at best.

Programme of the works

To meet the stakes mentioned previously, it is important to have models, methods and tools to exploit the information contained in collections of multimedia, multilingual, (semi-)structured and open-ended data, within social networks or at individual level. This ambitious objective requires re-examining the standard information access methods, which are generally defined for a static framework wherein the data are not interconnected. We intend to come back to these limitations and to propose new models and algorithms by developing the following directions.

Scaling. The problematics on which we concentrate our efforts require developing information access systems manipulating large masses of data. In many cases, this development rests upon automatic learning models and methods, generally well founded theoretically but which are often plagued with limitations at practical level due to the size and the highly noise-corrupted nature of these data. This often implies redefining the basic models, but also coming back to the related algorithms. Several avenues ought to be explored in parallel:

- Parallelisation of certain algorithms;
- Approximation of complex models by models which can be deployed more easily;
- Heuristic exploration of complex research spaces;
- Using little supervised data (semi-supervised learning, transductive learning, active learning).

Modelling. As mentioned previously, one of the problematics of interest is that of access to information in interaction networks where the methods and the models used in the standard frameworks must then be revamped entirely.

Indeed, data collections are generally represented in the form of matrices and the embedding of these data in interaction networks leads to resting on more complex representations, such as sets of matrices or tensors. These extensions, which may be qualified as algebraic, can be found within a probabilistic framework or two-mode and co-occurrence models, like PLSA — Probabilistic Latent Semantic Analysis. The purpose here is to simultaneously develop new data models to account for all the interactions but also new methods and new algorithms for exploiting these models at best — for instance, tensors decomposition. Moreover, the growth of video services, on the web and in enterprise or individual information systems, slightly changes the problematic since we are now dealing with highly time-related data. We want to focus here on three thematics enabling to handle these data at best:

- The abstraction of multivariate temporal data;

- Measuring the proximity between multivariate temporal data;
- Classifying multivariate temporal data.

Fine data acquisition. Another major axis of information access implies using fine data, whether on text, for instance to translate a passage or retrieve a document written in a foreign language, or on images, to improve conceptual clustering and thereby to reduce the semantic gap.

The acquisition of these data generally involves semi-automatic procedures and must facilitate large-scale deployment of comprehension aid systems. In the context of multilingualism, the current stake is to develop resources and methods for systems involving a "pivot" semantic representation. For written language in generalist context, the UNL linguistico-semantic representation has proven its interest and deserves to be extended — semantic hypergraphs where the attributes and relations are interlingual, but which are associated with English as a reference point understandable by all developers. A particularly high stake connected to the previous one is to combine an "abstract pivot"-based linguistic architecture with an empiric computational architecture with automated learning for as many phases as possible.

Major issues derived from the above are hence: the development (or collection) of large-size lexical (multilingual) and "corporal" (multilingual multimedia multi-annotated parallel corpus) resources, as well as the construction of Web platforms for collaborative development, improvement and use of such resources[29].

[29]This work on the Information Access challenge is led by Eric Gaussier.

5.10 Conceptual challenge: Models of Computation of the Future

Domain and stakes

Calculate is the basic action around which computing is built[30]. This action has taken on several forms through time: from pebbles (*calculus*), for counting goods in the Antiquity, to current supercomputers whose power is as high as several petaflops (millions of billions of operations per second) via of course more or less sophisticated "calculators" such as the abacus, the mechanical, analog and then electronic calculators. The evolution of the means of calculation has always been strongly associated with scientific and technological breakthroughs as well as the needs of the different civilisations.

The notion of *calculation* has coincided for a very long time with simple operations on numbers (integer, rational, algebraic, infinitesimal...). It is only in the 20^{th} century that the notion of *model of computation* appeared as a formal and more generic means to define different kinds of information processes and transformations. Thus, a model of computation is the basic datum of objects for a given calculus and entails the transformation rules of these objects. The models of computation are often differentiated by their properties such as for instance *expressiveness*, that is to say their capacity or not to express solutions to problems, or the *complexity* of their transformations, such as the time and/or space resources needed to execute a calculation.

Several kinds of models of computation may be differentiated. Some are intended for studying the intrinsic properties of certain calculus forms. These models are often rather simplified such as the Turing machine, π-calculus, etc. Other very high level models are intended for expressing/specifying computation and form the basis for programming or specification languages which may be general-purpose (e.g., ADA, Java, Prolog, ML, Lotos etc.) or dedicated to specific domains (Lustre, Datalog, HTML etc.).

Today, computing has become pervasive and ubiquitous, giving birth to the cyber-society. Information is henceforth within the users' reach with a few clicks, and software is distributed over the network, its development relying on *cloud computing* and *net computing*. On the other hand, the computation technologies are mutating, the miniaturisation of microprocessors is approaching its physical limits and other technologies inspired from natural sciences will be added in the future to the different calculus paradigms already existing, enriching in turn these computing clouds. Some of these technological breakthroughs are already in application, but are unfortunately plagued with the lack of theoretical bases: which computing models underlie these new applications and computing paradigms? How to guarantee that the data is secure in such applications? How to ensure good properties of operation, especially for critical applications, whose failure may have a harmful repercussion as far as man, economy and/or ecology is concerned? We are barely at the dawn of these questionings. The responses will certainly involve the elaboration of new models, which will reflect these new ways of computing and programming, as well as theoretical tools for reasoning on these models.

Approach and strengths of LIG

Within LIG, several teams design, study and experiment new calculus models which prepare the fundamental aspects of tomorrow's computing. Several approaches are under study, from simplified models such as process algebra, to very high level programming languages or logic programming languages.

The MOAIS and SARDES teams possess acknowledged expertise in the field of parallel and distributed calculations. CAPP, POP ART and VASY work on different declarative models: functional, logic, concurrent, synchronous, asynchronous, aspect-based programming, etc. CAPP, SARDES, POP ART and VASY teams also look into models for specification and modelling — different conventional or modal logics, UML-type formalisms. Other models are also under study within LIG, as for example reasoning on the ontologies studied by the HADAS team, or models inspired by statistical or quantum physics studied by the CAPP and AMA teams.

National and international positioning

Studying the underpinnings of the computing models and their applications constitutes the very basis of computer science. These themes appear at educational level as well as at the level of research projects in the most prestigious universities. The US National Science Foundation (NSF) supports these studies through the Division of *Computing and Communication Foundations*[31]. ANR also contributes to this effort through var-

[30] This challenge is the will to display original and quality research in LIG in the field of Fundamental Computer science and which are the melting-pot of tomorrow's computing. It is new relative to the plans of the four-year period 2006-2010

[31] `http://www.nsf.gov/div/index.jsp?div=CCF`

ious programmes — white projects, upstream research (ARA), embedded systems (ARPEGE) etc. INRIA emphasises seven priorities in its strategic plan[32] among which *modelling*, *programming*, *communicating* and *interacting* which are at the core of the developments of the computation models of the future.

Programme of the works

Today, we tend to focus on multi-paradigm, multi-scale, distributed, highly dynamic heterogeneous computation. Mastering the computation power and the complexity of the environments at hand constitutes one of the major challenges of our cyber-society. The field of investigation is vast. The teams of LIG will contribute to the developments of the following areas:

Semantic models. In order to master the underpinnings of the languages and of the necessary tools to their development as well as to the validation of the programs, it is necessary to develop abstract formalisms modelling the different aspects of the studied computations. We intend to develop several semantic models: process algebra will be studied for modelling distributed, reflexive and concurrent programming. Rewriting systems will be studied in the perspective of model transformation and rule-based declarative language semantics. Type systems and logics will be developed for the analysis and the verification of programs. Automata variations (stochastic, infinite, boolean equations systems) will also be studied. Coupling certain of these models, in particular the integration of quantum aspects within conventional models, will also be studied, so as to obtain more expressive, more flexible and more powerful hybrid models. On the other hand, most embedded systems possess a functional specification but also a non-functional specification — for instance for security, availability, fault tolerance aspects... There are several approaches to design the functional part independently of the non-functional aspects, among which aspect-oriented programming and contract-based programming. We shall study both these approaches and we shall formalise them on the basis of well defined (in particular synchronous) computation models.

Languages. The idea is to contribute to the development of very high level programming and specification languages. Several paradigms will be addressed from programming dedicated to a specific domain — e.g. synchronous programming (Lucid Synchrone), asynchronous programming (Lotos, Lotos NT), GALS, etc. — up to multiparadigm programming. One of the major challenges that we intend to take up relates to "dynamic modularity", that is to say the modular construction of systems which may evolve and be reconfigured when running. The concept of dynamic modularity covers a wide range of techniques and concerns, such as (i) modular programming, with the notions of objects, modules, components, aspects; (ii) deployment, updating and on-line reconfiguration of software systems; (iii) physical and logical distribution and mobility. This challenge will be taken up through several areas of research. The aim is, on the one hand, to elucidate the semantic underpinnings (in particular operational models, notions of equivalence and simulation, logics and types) and to develop, on the other hand, programming and assembly languages allowing for modular design of dynamically reconfigurable systems, combining several programming paradigms and diverse concerns among which distribution, fault tolerance and security.

Verification tools. The aim is to develop tools for the construction of reliable systems. These systems will be described in the computation models aforementioned. Several methods will be studied. We intend, on the one hand, to contribute to the scaling of certain program validation techniques with a very large number of states, possibly using high performance computers (HPC). On the other hand, new program validation methods will be studied — conventional and non-conventional logic, etc. We propose logic programming languages that will lead to the implementation of potentially more efficient computation models, thanks to better representation of information[33].

5.11 Conclusion

It should be born in mind that the scientific project of the laboratory does not substitute for the teams' dynamic. This project underlies these dynamic, creating a transversal link throughout the laboratory, actuating collaborations between the teams and with the outside, and finally displaying a programme for best possible assessment of LIG by our industrial partners and our academic supervisory authorities.

Table 5.1 shows the positioning of the teams relative to this project.

[32] `http://www.inria.fr/inria/strategie/index.fr.html`
[33] This work on the Models of computation of the future challenge is led by Rachid Echahed.

	Societal Challenges			Technological Challenges			Conceptual Challenges		
	Smart Building	Open Enterprise	Creativity and Knowledge	Sensor Networks	Embedded Systems	Virtualisation and Performance	Safety, Reliability, and Security	Information Access	Models of Computation of the Future
WAM	X	X	X		X		X		
VASY					X	X	X		X
VASCO	X				X		X		
STEAMER		X				X		X	
SIGMA	X	X		X	X			X	
SARDES					X	X	X		X
PRIMA	X			X	X				
POP ART					X		X		X
MULTICOM	X		X	X	X		X		
MRIM		X			X	X		X	
MOAIS					X	X	X		X
METAH	X		X					X	
MESCAL					X	X		X	
MAGMA	X	X	X			X	X	X	
IIHM	X	X	X	X	X				
HADAS	X	X		X	X	X		X	X
GETALP	X	X	X		X			X	
EXMO	X	X						X	
E-MOTION	X			X	X				
DRAKKAR	X			X	X				
CAPP					X		X		X
AMA	X	X	X	X	X			X	X
ADELE	X	X		X	X				

Table 5.1: Teams supporting the project

Chapter 6

Conclusion

6.1 Scientific context in Grenoble

In order to implement our scientific project we shall rely on the one hand on the research actions conducted by the teams and on actions carried out in the laboratory properly speaking, and on the other hand on initiatives launched in Grenoble within the scientific project associated with the campus plan and on transversal initiatives within federative research structures.

6.1.1 The INRIA Rhône-Alpes Research Centre

The INRIA Grenoble-Rhône-Alpes Research Centre (designated as CR INRIA below) has three main research areas:

Mastering heterogeneous dynamic resources. from embedded systems to calculation and communication infrastructures. This area is subdivided into 3 themes: powerful infrastructures (MESCAL, MOAIS), Mobile systems and ambient networks (WAM, EXMO), Reliable software packages and embedded systems (SARDES, POP ART, VASY). We have hence 7 joint teams working on that theme.

Modelling and simulation of multiscale and multicomponent phenomena. LIG is not concerned with that scientific area.

Perception and interaction in real and virtual environments. This area is subdivided into two themes: Interaction (PRIMA, E-MOTION), Images and Vision.

There is a coherent intersection with the CR INRIA, on the perimeter of LIG, whereas the perimeter of the CR INRIA is wider. In Grenoble, the CR INRIA has joint teams with the LJK and GIPSA and which are concerned with themes outside the scope of LIG. On the site of Lyon, there are naturally teams concerned with the same themes as LIG and with which we collaborate in the national context. We can also observe that the light thrown by the CR INRIA differs from that of LIG for obvious reasons of global composition and internal dynamics. As LIG does not possess any component in applied mathematics nor in image processing, it has elected to fine-tune the first theme of INRIA into 3 themes: “Infrastructures”, “Software” and “Knowledge”. The “Interaction” theme of LIG is repeated in the third theme of the CR INRIA.

6.1.2 PILSI

The **PILSI pole** for International Pole for Innovation in Intelligent Software and Systems of the campus project of the University of Grenoble has taken up the “intelligent systems engineering” challenge. The objective is to meet the major technological stakes of the software and hardware convergence and the increasing requirements of flexibility, genericity and heterogeneity.

The pole is in line with the societal stakes of energy, health and information society. It has made it its personal mission to create innovation and anticipate usages through accelerated convergence and mutual enrichment of research at different scales (from nanotechnologies to large information systems). This alliance between micro-nanotechnologies and TIC is a strong specificity of the Grenoble ecosystem and confers a specific position thereto at international level.

LIG is at the core of the concerns expressed by the PILSI pole with its capacity to cope with the current challenges of Intelligent Systems Engineering: designing both self-sustaining and usage-oriented systems, working reliably in quite open and high dimensionality hardware and human environments, capable, in spite of increased complexity and heterogeneity, of adapting and meeting a unique demand. Its research is concerned with the most pressing stakes of information society: development of the web and of access to information, environments for human learning, software packages for open enterprises, systems for multilingual and multimodal interaction, infrastructures and software packages for smart building. . .

The PILSI project is organised into a number of areas (approximately fifteen, whereas work is always in progress in continuous dynamics). LIG is the leader in half of them and is highly involved in about ten. We shall present them here with the reading grid of the scientific project of LIG and of the 4 themes of LIG. It should be borne in mind that the scientific dynamics of the PILSI encompass all the Grenoble strengths and hence that the scope of these scientific areas undeniably goes beyond this description.

LIG: Ambient intelligence, Computer science and sustainable environment

Infrastructure: Sensor network and Intelligent sensors, Infrastructure and calculation-oriented service, Embedded systems, Modelling and simulation,

Software: Data-processing Security,

Interaction: Smart building,

Knowledge: Open enterprise, Access to information,

other PILSI areas without implication of LIG: Health technologies, Platform for e-sciences, etc.

In view of the prominence of the PILSI project for LIG, the management closely follows the evolution of this project.

6.1.3 INNOVACS

Certain teams of LIG will take part in the INNOVACS project (Innovation, Knowledge, Society) which is the aspect of the innovation-centred Campus project. This project has also applied for a Federative Research structure. Within said structure, LIG will focus on the computing aspects pertaining to technology or its usage throughout the "life cycle'" of the innovation process: from the upstream design stage to downstream stages, evaluation and even usage follow-up—for instance via trace analysis through obviously developments of methods, solutions and tools for supporting innovation. Three of the societal challenges to which LIG wishes to contribute (Smart building; Open enterprise; Creativity and knowledge) possess links with the HSS communities (Human and Society Sciences) which may express themselves through the INNOVACS project.

Jean Caelen is LIG correspondent for this federative research structure.

6.1.4 The cognition federative research structure

Research in this domain of cognition necessarily involve strong and sustainable synergy between actors from quite diverse disciplines, at the crossroads between information and communication sciences and technologies, systems and living engineering, living and health sciences, human and society sciences.

Within these dynamics, LIG articulates its contribution around the 5 teams: MULTICOM (evaluation of interactive systems, behavioural analysis of human users, and ergonomics), IIHM (man-machine interaction, relations between Interaction, Perception and Motricity), METAH (computer environments for human learning), EIAH (studies of active learning situations and of usages), E-MOTION (probabilistic perception modelling, inference, decision and action for living and artificial systems, Bayesian cognition), GETALP (machine and automated translation ; automatic speech, speaker and sound recognition, communication and emotions).

Muriel Ney is LIG correspondent for this federative research structure.

6.1.5 The CIMENT federative research structure

CIMENT[1] was born further to a call for propositions from the Ministry in 98-99 for providing calculation computer equipment, and was pursued in the context of the CPERs. CIMENT is the calculation mesocentre of Grenoble[2], labelled as intensive calculation platform of the RTRA Nanosciences. The missions of the CIMENT project consist 1) in federating the scientific communities in Grenoble around the scientific calculation activity via training, the exchange of expertise and the development of digital and technological experiments and 2) of contributing to provide these communities with the means and the flexibility of an intensive calculation mesocentre and of promoting articulation with the national calculation for intense production applications such as the "big challenge".

The implication of the teams of LIG in these dynamic (since the very beginning) has been to offer innovative experimental equipment and software packages (large-sized cluster, calculation grid, calculation on hybrid and multi-core architectures). The aim for computer specialists is to work with enlightened users on prototype technologies in order to test them on codes and real datasets. The experience feedback raises unheard-of problems which do enrich the conceptual reflection around organisation models for parallel calculations.

Olivier Richard is LIG correspondent for this federative research structure.

6.1.6 The federative research structure "House for modelling and digital simulation, Nano science and Environment"

The objective of this structure (MaisMoSiNE) is to facilitate the development of modelling and simulation in numerous scientific domains and to prompt interdisciplinary interactions. For the basin of Grenoble, it seemed relevant to organise these dynamics into a House for Modelling. The vocation of this house will be to facilitate interdisciplinary exchanges on the wide theme of modelling and to come within a national network to be created.

In these dynamics, LIG is involved, via optimisation of nanostructure simulations, in multi-core architectures as well as in the installation of a software catalogue.

The CIMENT (previous section) and MaisNoSiNEe federative structures are quite close, wherein CIMENT is more oriented to calculation parallel infrastructure issues for sciences and MaisMoSiNe is more oriented to modelling problematics.

Jean-François Méhaut is LIG correspondent for this federative research structure.

6.1.7 The strategic directions of our universities

UJF is structured into 4 research poles:

- "Earth - Universe - Environment – Society" pole (TUNES) : the TUNES pole strengthens the synergies and collaborations around societal issues associated with environmental hazards, whether natural or anthropic.
- "Chemistry, Living and health sciences, Bio-engineering" pole (CSVSB) gathers the different health actors, doctors, pharmacists, biologists, chemists and the STAPS lecturers-researchers from fundamental aspects to clinical applications, thanks to fruitful collaboration with the University Hospital Centre of Grenoble and the French Blood Establishment.
- "Mathematics, Information and Communication Sciences and Technologies" pole (MSTIC) covers three thematics: 1-Computing, software and systems- 2- Mathematics, modelling, calculation, -3- Signals, systems and automatics.
- "Matter sciences and engineering" pole (SMING) translates the will of UJF to reinforce already close links between the following disciplines: physics, chemistry, mechanics, electrical engineering and engineering sciences

LIG is clearly part of the MSTIC pole.

UJF sets itself as a target to develop with its partners of the site the following ambitious multidisciplinary projects, backed up by the Campus operation:

[1] https://ciment.ujf-grenoble.fr
[2] http://calcul.math.cnrs.fr/

- PILSI: “Intelligent software packages and systems” international pole - in the domain of information and communication sciences and technologies, promoting in-depth research partnership between industrial and academic sectors.
- EDD: Environment and Sustainable Development - in the domain of earth sciences and environment engineering (clean processes, remediation, acute hazards, climate), in connection with the “grand instrument for toxicology and ecotoxicology” project in Rovaltain and the GIS Envirhonalp.
- Energy: An international research pole on the Energies of the Future
- BISy: Integrative and Systemic Biology - in the domain of fundamental biology and for understanding the complex mechanisms underlying living systems.
- SANTINNOV: Improving health through Innovation – a project aiming at federating the research potential in Grenoble in health care and health technologies for promoting innovation at the service of health.

LIG is quite active, as detailed above in the PILSI project.

The Grenoble INP is structured around 4 major disciplinary sectors:

- Computing and mathematics;
- Electrical Engineering, Signals and Systems;
- Mechanics and Geosciences;
- Materials and Process engineering.

LIG is the largest laboratory of the first sector which includes LJK, TIMC-IMAG, LCIS, GSCOP and VERIMAG. Besides, Grenoble INP displays 3 priority directions:

- Energy and sustainable development;
- Software packages, miniaturised, intelligent systems;
- Innovation management.

LIG is predominantly active in area 2, and takes part in both others (through actions on Smart building and Open enterprise)

UPMF supports INNOVACS as a priority project, and we have explained our above investment.

6.2 National scientific context

The project of LIG is in coherence with a number of strategic actions developed at national level.

6.2.1 The “Ambient Intelligence” plan

The “Ambient Intelligence” plan is derived from a joint reflection document of the “Ambient Computing” experts committee of the ST2I department of CNRS and of the “Ambient Intelligence” Workgroup of the Sectorial concertation group (GCS3) of the Superior Education and Research Ministry, DGRI A3. This plan is also used in the reflection conducted to define the National Research and Innovation Strategy (NRIS) which aims to make research efforts consistent and to coordinate them around orientations shared at country level.

The proposed research plan aims to take up a number of challenges of organisational, scientific and ethical types posed by ambient intelligence. At the scientific level, the challenges are motivated by the necessity to invent the concepts, the methods, the models and the technologies for[3]:

- services evolving correctly in heterogeneous, dynamic, highly constrained and multiscale environments;

[3] Joëlle Coutaz and James Crowley. *“Ambient Intelligence” plan: Challenges and Opportunities.* Joint reflection document of the “Ambient computing” experts committee of the ST2I department of CNRS and of the “Ambient intelligence” Workgroup of the Sectorial concertation group (GCS3) of the Superior Education and Research Ministry, DGRI A3. 75 pages, 2008. `http://iihm.imag.fr/publs/2008/RapportIntellAmbiante.V1.2finale.pdf`

- self-sustaining, possibly emerging, but mastered services;
- sure, reliable and secured services;
- intelligent services;
- services suitably interacting with the user;
- services adhering to ethical values.

These scientific challenges concern the four scientific themes of LIG and are at the heart of the societal, technological and conceptual challenges that we propose. The experts group who stated these propositions was led by two team leaders of LIG (Joëlle Coutaz and James Crowley)

6.2.2 The "Grand Emprunt" projects[4]

One of the major ambitions of this project is to promote campuses of excellence, with a "multidisciplinary campuses" vision and a "campus of innovation" vision. It is clear that LIG wishes to be part of these dynamics within the University of Grenoble.

Besides the document entitled "strategic investment priorities and national loan" defines five applicative areas for developing projects mainly for easier emergence of tomorrow's economy sectors, compatible with ecological ambitions. Among these areas, three are directly or indirectly concerned with the research performed in LIG:

- to develop decarbonated energies and efficiency in resource management. The report underlines that new technological solutions must be invented by acting on all the levers among which enhanced energy efficiency of buildings and mobility mastery.
- to invent the mobility of the future. The report underlines the importance of the development of new technologies in particular intelligent vehicles, a domain wherein several teams of LIG are involved (E-MOTION, IIHM).
- to invest in digital society. This area concerns our "Open enterprise" societal challenge, relating to that increasing demand for innovating services and for new digital usages.

6.2.3 The strategic directions of CNRS

In its strategic plan "horizon 2020", CNRS sets 12 objectives associated with scientific, societal and organisational considerations. Several of these objectives are connected to the project of LIG:

- to move the knowledge front forward. Research in computer sciences and their interactions at LIG take part in the development of these sciences strongly impacting other disciplines.
- to take up the major challenges of the planet. Among the five themes with high interdisciplinary potentiality that CNRS wishes to develop, sustainable development and the security of complex computer systems interconnected with operating safety mastery are prominent subjects.
- to reconcile concepts and pioneering technologies.
- to federate disciplines and competences. CNRS defines 6 federative themes among which Information, image and communication regarding a number of the teams in the laboratory.

6.2.4 The strategic directions of INRIA

In its strategic plan 2008-2012, INRIA has set 7 scientific priorities:

- Modelling, simulation, optimisation of complex dynamic systems;
- Programming: security and reliability of computer systems;

[4] National loan to fund the country's strategic priorities over the period to 2030

- Ubiquitous communication, information and calculation;
- Interaction with the real and virtual worlds;
- Digital engineering;
- Digital sciences;
- Digital medicine.

Among these priorities, LIG is heavily involved in "Ubiquitous communication, information and calculation", "Interaction with the real and virtual worlds" and "Programming: security and reliability of computer systems". Obviously, such implication is realised using our 10 INRIA project teams but also using other teams of the laboratory. One of the strengths of the laboratory is to promote such interaction between teams from multiple parent organisations.

6.3 European scientific context

At European level, the reflection work on the strategy 2010-2015 is in progress but it seems that although the sustainable development and energy efficiency aspects were already present in the strategy 2010, the environmental aspects should be put forward in the post-2010 strategy. This analysis relies in particular on the "Priorities for a new Strategy for a European Information Society (2010-2015)" report which highlights "a green knowledge society". As regards the FP7, who covers the 2007-2013 period, seven strategic directions are emphasised[5]:

- Pervasive and trusted network and service infrastructures;
- Cognitive systems, interaction and robotics;
- Components, systems and engineering;
- Digital libraries and content;
- Sustainable and personalised healthcare;
- Mobility, environmental sustainability and energy efficiency;
- Independent living and inclusion.

It is clear that the scientific program of LIG has a prominent place in the majority of these areas. Moreover, the contractual activity of LIG who generates 6.2 M Euros per annum among which a quarter from European projects demonstrates the high implication of LIG in these programmes.

[5] ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/ict-wp-2009-10_en.pdf

This document presents the LIG in two parts.The first part (Volume 1) presents three aspects of the LIG: (1) organisation, (2) results obtained in the first four-year period, and (3) the scientific projects for the next five years. The second part (Volume 2) presents the 23 teams of the laboratory.

The Grenoble Informatics Laboratory (Laboratoire d'Informatique de Grenoble - LIG) is a laboratory of quite some scale, the academic partners being the Université Joseph Fourier, Grenoble INP, the Université Pierre-Mendès-France, the CNRS, and INRIA Grenoble Rhône-Alpes. The LIG brings together almost 500 researchers, professors and associate professors, doctoral students, and research support personnel. They belong to different organisations and are located at one of the two LIG sites (the Grenoble university campus or in Montbonnot).

The scientific project of the LIG is "ambient and sustainable IT". The goal is to leverage the complementary nature and recognised quality of the 23 research teams of the LIG to contribute to fundamental aspects of the discipline (modelling, languages, methods, algorithms) and to create a synergy between the conceptual, technological and societal challenges that surround this theme.

This scientific project is a continuation of that of the previous four-year period regarding ambient IT. The challenges to be addressed are indeed numerous and far-reaching. The diversity and dynamism of data, services, interaction methods, and contexts of use require an evolution of systems and software to guarantee essential properties such as reliability, performance, autonomy and adaptability. In rising to these challenges, there is a resonance between the various research areas explored by the LIG: infrastructure, software, interaction, and knowledge.

For the second four-year period, the LIG will address, with conviction, the issues around the theme of sustainable computing. While ambient computing is a lever, without precedent, for freedom and openness of information with a tremendous potential for individual and social applications in many domains (for example healthcare, education, environment, transport and intelligent buildings), it also poses the question of its thoughtful and ethical use in the context of new problems confronting society:

- managing energy for ambient computing.
- improving quality of life and the security of goods and people.

The LIG laboratory is focused on the fundamentals and the development of IT science, maintaining an high degree of openness to society to rise to new challenges. I wish all those working at LIG, collaborating with LIG, or hoping to join us, an environment conducive to the calm and efficient practise of research, as we work together to achieve our goals.

Hervé Martin
LIG Director

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