Research Report
2005-2009
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Télécom ParisTech / LTCI

juillet 2009

Laboratoire Traitement et Communication de l'Information - UMR 5141
Télécom ParisTech - CNRS

Chapter 1

General Survey of Research Activities

This report presents the activities of Télécom ParisTech in research between January 2005 and June 2009. A general outline of research is given in the first chapter along with consolidated figures giving resources allotted and the results obtained collectively. In the four following chapters are listed and analysed the scientific achievements of each of the research teams of the four departments of Télécom ParisTech. A separate document will develop what is projected in research over the next four years.

1.1 Background

Successor to the Ecole Supérieure de Télégraphie (EST), founded in 1878, Télécom ParisTech's names were, in order, the Ecole professionnelle supérieure des postes & télégraphes (EPSPT) and later on, the Ecole supérieure des postes & télégraphes (ESPT), the Ecole nationale supérieure des postes, télégraphes et téléphones (ENSPTT), Ecole nationale supérieure des télécommunications (ENST), Télécom Paris, and to emphasize its connection with ParisTech, of which it is a founding member since 1991, Télécom ParisTech, when ParisTech became a "PRES"[1] in 2008.

Télécom ParisTech has occupied its current site on rue Barrault in the 13^{th} arrondissement of Paris since 1934. A unit of the school was set up within EURECOM in Sophia Antipolis in 2003. A number of its departments and services later migrated to two annexes on the rue Dareau (in the 14^{th} arrondissement).

Under the authority of the Direction générale des telélécommunications (part of the Ministry of PTT), and later of France Télécom in 1991, ENST became part of the Groupe des Ecoles des Télécommunications (GET) in 1996, which had the status of an "établissement public administratif" (EPA), and which was placed under the minister responsible for telecommunications. The GET became Institut Télécom in 2008.

Up to 1968, ENST did not develope its own research labs, taking advantage of the Ministry's facilities. In 1968, C. Gueguen opened the first lab rue Barrault.

In 1982, the signal processing and digital communications teams made the first joint ERA (Equipe de Recherche Associée) with CNRS. It has become an URA (Unité de Recherche Associée) and then an UMR (Unité Mixte de Recherche) by progressively associating reserch teams in computer science, networking, applied physics for telecoms, image processing and, at last, management and social sciences. Today the UMR 5141 LTCI (see Section 1.2.3) covers all the research activity of Télécom ParisTech.

[1] PRES= "Pôle de Recherche et d'Enseignement Supérieur" is a regional cluster of institutes and universities for research in higher education

1.2 Administration and Organization

1.2.1 Télécom ParisTech As a Member of Institut Télécom

The Institut Télécom, which in addition to Télécom ParisTech, includes Télécom Bretagne and Télécom & Management SudParis, federates and coordinates its research activities in the separate schools within a "Comité Directeur de la Recherche" (= Research Management Committee). This body is under the authority of the Research Director of the Institut (Francis Jutand) and includes Télécom ParisTech's own Research Director and Director of Innovation and Development.

A "Conseil Scientifique" (scientific council) has also been set up within the Institut Télécom to examine at regular intervals the research carried out in the Institut's programmes. For example, in October 2008 the "Conseil Scientifique" took up research carried out within the programme "Contents and Multimedia Services". In November 2009 it will be the turn of research done within the area "Réseaux du Futur" (Future Networks). All the research activities of the Institut are thereby brought up for review every four years.

The "Comité Directeur de la Recherche" (Research Management Committee) has also set up for the researchers within the Institut Télécom various "alliance projects" to bring the schools together on a limited number of keynote subjects: these are called the "Future Communication Labs". Three such institutes are currently functioning: *Network of the Future Lab*, *Digital Health Lab*, *Digital Life Lab* anda fourth in in preparation on Multimedia. These will be taken up below when treating individual themes.

Within the Institut Télécom research has been structured by thematic projects in such a way as to bring together every two years all of the researchers working in a particular area so as to redefine future work. The size and the scope of these projects varies greatly, sometimes including an entire group, sometimes only one or two teachers. This report takes up such projects whenever this is pertinent.

The Fondation Télécom supports research at the Institut Télécom by providing financing, most notably in calls made for projects (for example, the various projects under the name of "Futur and Ruptures" (the future and breaks with tradition). The Institut Télécom has also concluded framework agreements with some major partners: Orange, Alcatel-Lucent, Thalès, all of these agreements directly serving the interests of Télécom ParisTech. Lastly, the Institut Télécom (with EURECOM) was certified as an Institut Carnot from the very first year of Carnot campaigns and as such makes regular returns to the member schools (Télécom ParisTech included). These points will be taken up in Section 1.4.4.

The Institut Télécom has set up its research strategy for the five years from 2008 to 2012, where it claims its intent to become one of the major actors of research in IT in the field of communications (and more specifically on the topics of Telecommunications, Contents and Usages), as well as its engagement to serve for the economic and innovation development in these domains.

1.2.2 The Organization of Research Within Télécom ParisTech

Within Télécom ParisTech, research is basically within the purview of the Director of Research (Henri Maître) and the Director of Innovation and Development (Armand Lévy), but also of the Director of Research Courses (Bernard Robinet) who is responsible for the Ecole doctorale (ED 130 Edite), thanks to which Télécom ParisTech is entitled to deliver its own doctoral diploma.

Research activities are discussed by a "commission interne de la recherché" (a local research commission) and examined by a "Comité de la recherche" (research committee), an official body containing an equal number of representatives of the school's administration and of researchers themselves, plus outside personalities. The "Comité de la recherche" meets three times a year[2].

[2]The present external experts of the Comité de la Recherche are: Olivier Audouin (Alcatel-Lucent), Michel Beaudouin-Lafon (LRI, Orsay), Jean-Marc Chassery (Gipsa-Lab, Grenoble), Dominique Cotte (IDIST, Lille), Cédric Demeure (Thalès), Claude Girault (LIP6, Paris), Michel Lemonier (OSEO), Alain Rallet (ADIS-Orsay).

Télécom ParisTech contributed to the research strategy of the Institut. It will be presented in the ”Project” booklet of this report. Its main objectives are to compensate for some heterogeneity of the different teams, to increase our international action and, therefore our recognition outside French borders, to take the best from our flexible administrative context to increase our ability to react.

Télécom ParisTech takes benefit from its favourable environment: the ParisTech PRES (a founding member of which we are) and the Universities from Paris area (and overall UPMC, our closest neighbour), which are elected partners for teaching and research as well (cf. Paragraph 1.4.4).

1.2.3 LTCI (Laboratory for Communication and Processing of Information) as a CNRS Lab

The UMR[3] 5141 or LTCI is part of the INST2I, ”Institut des sciences et technologies de l'information et de l'ingénierie” of CNRS and also of the ”INSMI” (Institut des sciences mathématiques et de leurs interactions).

The LTCI is attached administratively to the Paris-A delegation of the CNRS.

The LTCI is a firm actor of CNRS life. Its participation to the GdRs[4] (and especially to GdR ISIS) to expert committees (M. Riguidel for Security, O. Cappé for Signal and Image, C. Licoppe for Social Sciences), and to governing boards (H. Maître, E. Moulines and I. Bloch served as members of the Section 07 of the National Committee, and C. Pélachaud of the CID 45), and the animation of the department and then of the Institut INST2I (E. Moulines), is constant and resolute.

The evolution of the LTCI with respect to the evolution of the CNRS structure will be developed in the prospective part of this report.

1.2.4 The Organization of LTCI

As said, the LTCI at the same time covers all the research of Télécom ParisTech, and only it. It is a rather singular situation in the national framework. It favours a strong synergy between teams and allows a good coordination of the alloted means, focusing all the ressources on a single objective: the advancement of the modern techniques of communication. However it constrains that efforts be made to reduce double commands in the management, to share the long term objectives and to coordinate the decisions.

The Director of the UMR (Henri Maître) is aided by a Deputy Director (Olivier Cappé). The ”Conseil de Laboratoire” (laboratory council) is an official body in which all members are represented equally. It takes up all aspects concerning everyday activities of the UMR. Attention is paid to keep the Conseil de Laboratoire and the Commission de la Recherche well informed of their respective conclusions and many opportunities are found for them to work together.

Although at the starting times of the LTCI, different scientific structures were living in LTCI and in Télécom ParisTech, the organization of LTCI is nowdays exactly the same as Télécom ParisTech's, i.e. the department structure.

1.2.5 The Organization by Departments

Research is carried out within the four departments of Télécom ParisTech, each of which includes all those playing a role in research:

- Department of Communications and Electronics (Comelec), headed by Bruno Thédrez,

[3] UMR = ”Unité Mixte de Recherche”, joint research unit between CNRS and an education or research centre.
[4] GdR = Groupement de Recherche = French thematic research network under the aegis of CNRS

- Department of Computer Science and Networks (Infres), headed up to May 2009 by Michel Riguidel, then by Gérard Memmi,
- Department of Economics and Social Sciences (SES), headed up to end of 2008 by Laurent Gille, then by Christian Licoppe,
- Department of Signal and Image Processing (TSI), headed by Yves Grenier.

Department heads are members of the "Comité de la Recherche", of the "Commission de la Recherche" and of the "Conseil de Laboratoire". It is within the departments that the thematic organization of research at Télécom ParisTech is worked out. Interdisciplinary activities are the result of initiatives started by researchers, the "Instituts de communication du futur" (Future Communication Labs) and the direction of Télécom ParisTech.

The report that follows adheres to the organization by departments except for this chapter, which takes up some interdisciplinary activities.

1.3 Resources in the Service of Research

1.3.1 Personnel

The official status of those contributing to research at Télécom ParisTech can be very varied ; permanent employees of Institut Télécom or of the CNRS, teaching staff, researchers or research assistants. Among non-permanent staff can be found professors on sabbatical or on assignment, post-docs, thesis students, engineers on short-term contracts and trainees (cf. Table 1.1).

Permanent Members of the Staff

In January 2009, contributing to research were the following permanent members of the staff:

- **141 Teachers** ("enseignants-chercheurs" or EC) of the Institut Télécom: these members of the teaching staff contribute significantly to research, as is attested by regular submissions to international journals or conferences that include editorial committees and proceedings: 47 Professors, 73 Associate Professors, 10 Directors of Studies, 5 Assistant Directors of Studies, 6 Lecturers.
- **15 Teachers** ("enseignants-chercheurs") of the Institut Télécom who have expressed the desire to take part in research projects (participation in working groups, managing trainees, developing software) but who do not publish regularly.
- **10 Engineers or technicians of the Institut Télécom**: permanent members of the staff (Directors of Studies, Deputy Directors of Studies, Lecturers) who have chosen to take part in the research activities of the LTCI within a department by contributing to the development or maintenance of scientific or technical units (including equipment and software).
- **26 Permanent researchers from the CNRS** (8 Research Directors, 18 Research Assistants), representing various sections of the CNRS' National Commitee: 07 (7 researchers), 34 (3), 01 (2), 08 (2), 27 (2);
- **2 Engineers of the CNRS** both of them assigned to functions on the computer and networking systems.
- **2 Researchers from INRIA** (1 Director of Research and 1 Research Assistant, assigned to work on research in the social sciences;

- **5 Outside adjunct researchers:** these researchers belong neither to the Institut Télécom or the CNRS but nonetheless carry out most of their research with teams working within Télécom ParisTech. They often co-author articles with members of the permanent staff of the Institut Télécom and members of the CNRS working within our institution.

Télécom ParisTech				**CNRS (+INRIA)**		
Prof + Dir Studies	Ass. Prof + Ass. Dir. S.	supporting Ass. Prof.	Engineers	CR	DR	Engineers
57	78	15	10	18	8	2

Table 1.1: Numbers of teachers and researchers in January 2009

Research at Télécom ParisTech draws on the extensive indirect support it receives from the technical and administrative staff of the institution (infrastructures, human resources, missions, library and documentation, printing shop, etc.). This will be taken up in Section 1.3.2.

Thesis Students

The doctoral students constitute an important part of Télécom ParisTech's research potential. The institution currently has 270 doctoral students working on a thesis under the direction of one of the school's teachers. 250 of these doctoral students are enrolled in the "EDITE de Paris" doctoral school (and thereby will receive their doctorate from Télécom ParisTech). 50 other students will receive their doctorate from Télécom ParisTech but are carrying out their thesis at EURECOM. Two hundred of our doctoral students are working on their thesis in laboratories of Télécom ParisTech and their results will be presented within this report. The other students, often because of a "Cifre agreement", carrying out their research in the laboratories of our industrial partners, their work will be presented in this report only to the extent that there is a significant connection with the research programmes of Télécom ParisTech.

A relatively small number of our doctoral students receive institution funding (23 holding ministerial bursaries, 31 on contract with research institutes or agencies, 15 receiving scholarships from foreign governments). The other students are often engaged on contracted research projects or are financed by our various partners.

Post-Docs, Engineers on Short-Term Contracts, Sabbatical Professors, Visiting and Associate Professors

These people are mainly assigned to contracted research done by Télécom ParisTech and principally with the status of employees of Télécom ParisTech or, occasionally, of the CNRS. They are taken up in Table 1.2, which gives both the numbers of people employed and the months per man during which they are present at Télécom ParisTech.

	2006	2007	2008	2009
Sabbatical professors		1 (12)	2 (22)	
Post-docs	12 (106)	20 (227)	18 (197)	
Short term Engineers	35 (380)	23 (254)	28 (296)	
Technicians	2 (5)	5 (21)	1 (3)	

Table 1.2: Short term personnel: numbers and (numbers of man x month).

Recent Developments

The world of information and communication technologies is changing rapidly. Rather great demands have been made on the school both for teaching and for research and it has been necessary to make considerable additions in staffing during the period running from 2005 through 2009. This increase has also appeared on the side of the CNRS, a very attractive source of recruitment for the young researchers coming in by the CNRS' competitive recruitment examination and by transfers: 4 "Directeurs de Recherche" from the CNRS, 1 "Directeur de Recherche" from INRIA, 2 "CR" from the CNRS and 1 "CR" from INRIA (see Table 1.3).

	Telecom ParisTech					**CNRS (+INRIA)**				
	Ass. Prof + Ass Dir Stud.		Prof. + Dir Studies		promoted	CR		DR		promoted
	leav.	enter.	leav.	enter.	Prof.	leav.	enter.	leav.	enter.	DR
2006	6	5	1	2	2		1	1		
2007	7	10	3	3	3	1	3	1	1	1
2008	7	8	2	4	3		3 (+1)		1 (+1)	
2009		2	1	1					2	
Total	20	25	7	10	8	1	8	2	5	1
Balance	+ 5		+ 3			+ 7		+ 3		

Table 1.3: Evolution of the numbers of faculties during the period. From 2006 through 2009, Télécom ParisTech has had 8 promoted Associate Professors to Professors (for each of them the above table shows +1 for leaving Ass. Prof and +1 for entering Prof).

Summary About Research Personnel

Table 1.4 indicates the average distribution of the personnel by team and department, depending on its origin over the last five years. For the purpose of measuring the personnel present in the lab, the PhD candidates which are mostly not in the lab (for instance because they are in a company) are counted for $1/2$ only. Table 1.4 also proposes a "Full time research equivalent" (FTRE) to measure the personnel available for research in each team. It counts teachers for one half (since they should participate to teaching), and PhD candidates for two thirds, since they spend a part of their time for their education.

1.3.2 Services of Télécom ParisTech Providing Support for Research

Nearly 500 people all told are involved in research at Télécom ParisTech, 200 of these engaged in research on a permanent basis. To carry out its mission, the effort in research draws on an institution (Télécom ParisTech) with a permanent staff of 340. It also draws on the resources made available basically by the "Direction Scientifique" of the Institut Télécom (division of research management plus some support services) and those of the "Paris-A Delegation" of the CNRS (human resources, contracts, financial services). The divisions of Télécom ParisTech most closely associated with research are described in the following lines.

Computers, Network, Audio-Visual and Information Systems

Télécom ParisTech has a centralized computer centre that, outside of its role in management and administration and the resources it provides for students (classrooms set up for courses in computer science, aid to users, audiovisual materials, etc.) offers to all units of the institution involved in research certain shared services (network, internet, e-mail, security, large-scale

Dept	Team	Personnel				
		teacher Institut Télécom	researcher CNRS (and INRIA)	PhD students	Post doc, Eng, Sabb.	total FTRE
TSI	AAO	7,5	1,5	10	1,5	13,4
	MM	7	2,3	11	2	15,1
	TII	12	2,5	27,4	3,5	30,3
	STA	5,5	5,3	7,2	1,4	14,3
	total	32	11,6	55,6	8,4	73,1
INFRES	MIC2	9,5	2,5	13	2	17,9
	RMS	14		30,9	5,3	32,9
	IC2/S3	14,3	0,7	12,6	7	23,3
	total	37,8	3,2	56,5	14,3	74,1
COMELEC	GTO	6		13,8	1,5	13,7
	COMNUM	5,8	0,7	13	1,25	13,5
	ELECRF	9,5		13,8	2,5	16,5
	SEN	8,5	2	8	5,5	17,1
	total	29,8	2,7	48,6	10,75	60,8
SES	total	19,7	1,8	17	19	42,0
Total		119,3	19,3	177,7	52,5	249,9

Table 1.4: Distribution of personnel in the different teams and departments. The figures are average man.year. The column FTRE ("Full time research equivalent") is the weighted sum of the 4 previous columns, with the following coefficients: teachers are weighted with $.5$, researchers, postdocs, engineers and sabbatical are weighted with 1, PhD students are weighted with $2/3$. PhD students in a company are weighted with $2/3 \times 1/2 = 1/3$.

contract agreements, etc.). The departments have their own separate networks, that can work entirely independently but that can, of course, be coordinated when need be.

A centralized information system is being set up to make it possible to more easily follow research projects at different levels of responsibility (top management of the institution, individual departments, groups, project leaders) by offering consolidated views of resources, allotments made, expenditures and timetables, all of this contract by contract. This information system is under the responsibility of the Institut Télécom.

Technology Transfer, Relations with Industry and Intellectual Property

The Director of Innovation and Development relies on a team assigned to relations with industry, technology transfer, and the defense of intellectual property of Télécom ParisTech's teachers and researchers. This division of Télécom ParisTech provides the administrative and legal follow-up of all the agreements and contracts made by the institution and that guarantees the conformity of financial agreements with the policies and practices of the Institut Télécom. This division maintains close contact with the Paris-A delegation of the CNRS.

General Services of Télécom Paristech: Finances, Human Resources, Logistics (Norms of Security and Hygiene) and Communication

The general services of Télécom ParisTech are closely intertwined with research programmes, as for example with the management of non-permanent members of the institution (a notable instance would be the assistance provided to foreigners for their various dealings with the national administration), dealings with financial matters, billing, missions, inventories. The logistics unit of Télécom ParisTech is responsible for the maintenance and security of the buildings and meeting the norms of security and hygiene.

The service of communication promotes various research activities of Télécom ParisTech.

The service of documentation is entrusted with providing documentation (in paper and electronically) for all those working in research at Télécom ParisTech. It relies for parts on the resources provided by the French consortium Couperin around CNRS (the portals of INST2I and

INSHS). Staff and students alike can consult the online resources of the major scientific journals of our domains or nearly a total of 20000 journals available from their desk[5]. The service of documentation is also responsible for publicizing the theses done at Télécom ParisTech via the portal Pastel of ParisTech. It also publishes on line the various annual reports issued from various services of Télécom ParisTech.

1.3.3 Budget

Research at Télécom ParisTech depends on two sources: the Institut Télécom and the CNRS. In both cases, the budgets are coordinated.

Institut Télécom provides the most extensive support and the main sources of resources. The total expenses of Télécom ParisTech for 2008 amount at 44 Meuros to fulfil its four main missions: (i) Undergraduate and Graduate Education, (ii) Life Long Learning Studies, (iii) Research, (iv) Entrepreneurship.

A fine analytical accounting allows to dispatch these expenses to the missions. When only direct expenses are taken into consideration, Research counts for 41.8 % of the total expenses. When the costs of indirect services are distributed over the missions, this part rises to 43.3 %, because of the impact of research on Human Resources and Financial Services.

When consolidated expenses are taken into account (i.e. with salaries of permanent staff), the distribution of Research costs is the following:

wages and personnel budget	77.7 %
operating budget	15.0 %
capital budget	7.3 %

1.3.4 Budgetary Allotments and Basic Support

Télécom ParisTech supports its research in part by the salaries given to its teaching and research staff, by the various services described above and by covering expenditures common to the entire infrastructure (electricity, water, telephone, networks, maintenance, etc.) but does not however contribute to the regular annual budgets of research teams for investments or standard expenses. Budgetary allocations for these teams are made by the coordinated effort of the Direction of Research and the Direction of Innovation and Development, these resources coming from the returns due to our participation in the Institut Carnot and programmes of the ANR[6]. Such sums are dependent on the amount of contracted research and can vary greatly, too, according to policy decisions made nationally. Télécom ParisTech also supports research by encouraging the stays of sabbatical professors and the organization of research seminars at school. On occasion, specific appeals are made when extensive investment is necessary (as, for example, in 2006 and 2007 for quantum communications, in 2008 for investment in infrastructures for scientific computation and in 2009 for platforms).

The Institut Télécom plays an active role financially in launching appeals for projects (incentive fund research initiatives or for the programme ”Futur et Ruptures” (the future and breaks with tradition) that was supported by the Fondation Télécom. The Institut Télécom finances most notably doctoral dissertations, sabbatical stays, postdocs and also investment in specific campaigns (as in 2009 for platforms).

The CNRS contributes to the activities of the LTCI with a basic allotment of 192 keuros (for 2009 as for 2008) of which 162 comes from the INST2I, 20 keuros from the INSHS and 10 keuros

[5] the IEEE, ACM, OSA, Science Direct, Mathscinet, Kluwer-Springlink, SJSTORE, Factiva, Le Kompass, les Techniques de l’Ingénieur, Safari and Netlibrary, etc.

[6] the so-called ”abondement Carnot” and ”Preciput ANR.

from the INMSI. The CNRS pays the salaries of its researchers who are assigned to our laboratories and provides administrative backup (human resources, managing contracts, intellectual property).

Contracted Resources

Table 1.5 presents the net annual product of contracted resources over the period. This table will be discussed in Section 1.4.2.

Télécom ParisTech attributes to its research teams the free use of contracted monies received, apart from a small standard withdrawal (5 % in mean) that is redistributed later on to research teams via specific appeals. These contracted ressources are most notably used for non-permanent staff hiring (about 75 % to cover salaries or scholarships for some PhD students and post-docs, all the engineers and master's internships), then two equal parts cover the travelling expenses and the technical investment).

Contracted resources (in Meuros)	managed by Télécom ParisTech	managed by CNRS	Total
2005	4,42	0,55	4,97
2006	5,63	0,62	6,25
2007	7,30	0,65	7,95
2008	7,79	0,47	8,26

Table 1.5: Contracted resources: net annual research products.

The employment of contracted resources is the following:

wages, studentships, salaries, ...	65.1 %
travels and conferences	12.3 %
furnitures (books, software consumables, ...)	11.8 %
investment	11.8 %

1.4 Scientific Ranking and Figures

1.4.1 Publications and Scientific Communication

The evolution of our scientific output in scientific media is presented in Table 1.6 for a general view of our scientific production and in Table 1.7 for distributed view over the teams. It appeals some remarks here. At first these figures are not the exact sum of the team figures, since, for instance, a joint paper may be claimed simultaneously by 2 teams. On the contrary, the total number of doctoral theses is higher than the cumulated number of theses by teams, because we count here the total number of diplomas which have been awarded by Télécom ParisTech, some being made outside the lab (in particular, those at Eurecom).

In the recent years, the Lab payed attention to the way its scientific production impacts the scientific literature. This attention is expressed from one side by an active incitation to publish in the best journals, and from the other by imposing a fixed referencing of the Lab in every publication. As a result, the average reference to our work is steadily increasing as expressed in Table 1.8.

	2005	2006	2007	2008	2009	Total
Journals	118	165	191	190	60	724
Peer reviewed conferences with proceedings	355	355	457	386	103	1656
Books	5	8	10	16	5	44
Edition of Proceedings or a Collection of Papers	21	15	27	16	7	86
Parts or Chapters of a Book	8	23	20	24	20	103
Theses	59	55	50	76	38	271
Patents	4	4	6	15	9	38
Proposition to normalisation	4	15	7	10	9	45

Table 1.6: Scientific production in the last five years (year 2009 ends at 1 July).

Dept	Team	Scientific diffusion						contracts in k€			
		defended PhD	defended HdR	Journals	conferences	books & chapters	patents & softwares	public	private	Europe	total
TSI	AAO	18	2	58	136	10	2	560	755	356	1671
	MM	16	2	42	135	15	3	1778	833	1322	3933
	TII	37	1	86	302	26	1	2705	662	97	3464
	STA	19	3	105	140	1	2	822	497	7	1326
	total	90	8	291	713	52	8	5865	2747	1782	10394
INFRES	MIC2	14	1	77	62	15	4	892	120	419	1431
	RMS	37	3	45	273	19	16	4246	2301	2349	8896
	IC2/S3	20	1	33	273	32	15	2553	1325	254	4132
	total	71	5	155	608	66	35	7691	3746	3022	14459
COMELEC	GTO	22		73	101	1	2	808	512	120	1440
	COMNUM	22	1	44	98	3	10	377	512	95	984
	ELECRF	19	2	25	125	3	9	799	420	38	1257
	SEN	7	1	19	86	3	13	2747	458	164	3369
	total	70	4	161	410	10	34	4731	1902	417	7050
SES	total	7	3	145	72	60		1715	2748	196	4659
Total		**238**	**20**	**752**	**1803**	**188**	**77**	**20002**	**11143**	**5417**	**36562**

Table 1.7: Distribution of the scientific production in the different teams and departments. The figures are the sums over the 4.5 years of reference.

1.4.2 Research Contracts and Technology Transfer

The school has an important contractual activity. For instance, in 2008, 91 new contracts have been signed 57 of which are bilateral[7] (22 of which are for PhD students) and 34 are contracts with public administrations (ANR, Clusters, FUI[8], Region) or European. The financial support obtained by the contracts in 2008 amounts at 8.26 Meuros (16 % for European, 37 % for public and 47 % for bilateral). It must be pointed out that in recent years this last ratio is fastly growing. Table 1.5 presents the consolidated figures of the last five years. After an important growth in 2006 and 2007, our contracted ressources are now more stable.

European Projects

Mid 2009, we are partners of 30 FP6 European projects, for a cumulated amount of 6,2 Meuros, distributed in: 13 Networks of Excellence, (one of which we are prime), 6 Integrated Projects, 4 STREPs, 5 Coordination Actions, 1 Specific Support Action et 1 Marie Curie Fellowship. We are involved in 10 of the Call 1 and 2 FPT7 program (for 3 Meuros). Figure 1.1 displays the distribution of resources in the 5 last years.

ANR (National Research Agency)

We participated with 62 answers to the 2009 ANR Calls, 21 of which have been selected for a total (provisional) amount of 4 Meuros. Among them, 3 supported by program VERSO, 6 by

[7] bilateral contract = direct contract with a company

[8] FUI = "Fonds Unique Interministériel"

date	nunber of h-index ≥ 10	maximum h-index	average of 10 best h-index
December 2007	27	32	19.6
July 2009	50	35	25.4

Table 1.8: Evolution of the impact of our publications as expressed in Google Scholar. This table presents the number of scientists from our lab, whose h-index is greater or equal to 10, the highest h-index, and the average of the top 10 h-index.

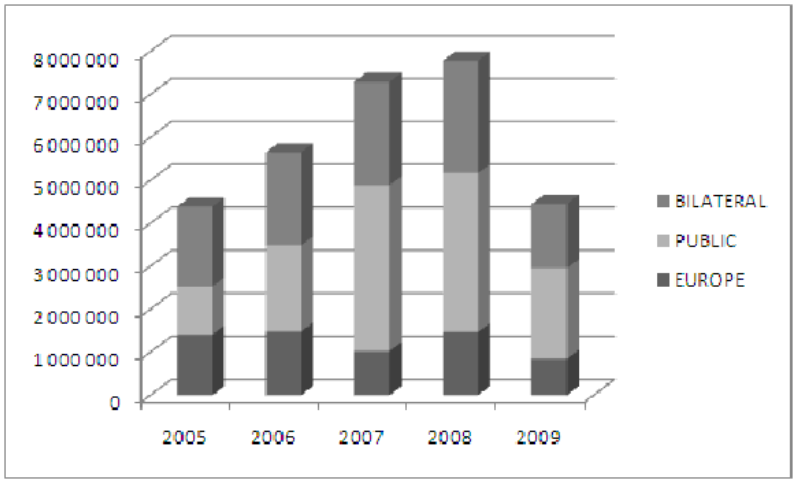

Figure 1.1: Distribution of resources on time.

CONTINT, 2 by ARPEGE, 7 Non-Thematic, 2 for Young Researchers and 1 International Junior Chair.

French Clusters ("Pôles de Compétitivité")

As an engineering school and part of Institut Télécom, Télécom ParisTech plays an important role in the French Clusters. Well armed in software engineering, networks, embedded systems, it was a partner of *System@tic* in Ile de France and of *Solutions Communicantes Sécurisées* in the Provence Côte d'Azur. It contributed to the emergence of *Cap Digital* in the field of Multimedia, games, data management and usages in Ile de France too, where it participates to its management. It also conducts actions in several other clusters (as for instance *Transactions Economiques Sécurisées* in Normandy) as shown in Table 1.9.

Cluster	Region	Number of awarded projects	Financial supports (Meuros)
System@tic	Ile de France	11	2,46
Cap Digital	Ile de France	11	4,72
SCS	PACA	2	0,45
TES	Normandy	2	0,42
Medicen-Santé	Ile de France	1	0,19
Aerospace Valley	Midi-Pyrénées	1	0,12
Total		28	8,37

Table 1.9: Participations to French Clusters (*Pôles de Compétitivité*).

1.4.3 Joint Scientific Activities

Joint scientific activities are carried out essentially within the separate departments in the inhouse seminars that they organize, on a regular basis or from time to time depending on those outside visitors who can attend. These seminars are often open to colleagues in other laboratories in Paris working in the same or related fields.

There are currently active seminars in the following fields:

- seminar in analog and mixed integrated systems,
- the ”Monday workshop” in sociology and information and communication sciences,
- mathematics seminar for those working in Computer Science and Networks,
- seminar in medical imagery and fuzzy logic,
- seminar in encoding and video compression,
- seminar in synthetic aperture radar image processing,
- seminar on information theory and statistics,
- the ”Business Intelligence” seminar of BILab,
- seminar on audio signal processing,
- seminar on perception, indexing and learning
- introductory seminar to a quantum treatment of information,
- interdisciplinary research seminar in management, social sciences and the sciences of information technology,
- seminar in digital communications,
- a seminar in economics and management.

Research teams from Télécom ParisTech participate very actively in the following seminars held in Paris and the Paris area:

- the Paris seminar in statistics
- the Machine Learning reading group of ParisTech (along with ENS)
- the LEOS (Laser and Electro-Optics Society) of the IEEE France chapter
- the MeFoSyLoMa (”Méthodes Formelles pour Les Systèmes Logiciels et Matériels” = Formal Methods for Logical Systems and Materials) with the CNAM, IBISC, LIP6 and Lamsade,
- the Quantum Information in Paris ”QuPa” seminar with ENS, Paris 7, LRI, IOGS.

Télécom ParisTech is also one of the favourite meeting places for the GdR ”Groupement de recherche” (research group) ISIS (Information, Signal and Images) which holds more than 20 meetings a year here, meetings at which our researchers play a very active part.

Lectures in scientific or general areas are regularly organized at Télécom ParisTech and are open to all our teachers and research staff, to our doctoral students and students in general[9].

Lastly, Télécom ParisTech as a laboratory of the CNRS has an annual general meeting at which new members of the staff are introduced.

[9] Among the prestigious speakers we have received: Benoît Mandelbrot, Jacques Attali, Pascal Lamy, Claude Berrou, Joseph Stiglitz, Charles Benett, Michael Leyton, etc.

1.4.4 Partnerships

Member Schools of the Institut Télécom

Within the network that makes up the Institut Télécom, Télécom ParisTech is a privileged partner of our sister schools of Evry, Brest and Sophia-Antipolis. This often takes the concrete form of collaborative activities on European projects or within the "ANR". As members of the same Institut Carnot, the sister schools make joint proposals to the business partners that are members of the Fondation Télécom: Orange, SFR, Alcatel-Lucent and BNP-Parisbas most notably.

With the arrival of associate schools within the Institut Télécom, Télécom ParisTech has extended its partnerships, most notably with the ENSPS in Strasbourg (particularly in the field of medical robotics) and with Télécom Saint Etienne.

ParisTech as a "PRES"

Télécom Paris Tech is an active (and founding) member of the PRES ParisTech[10], which is made up of 12 "grandes écoles" in the region of "Ile-de-France". With a potential in teaching and in research very much like that of a technological university, possessing as well resources in economics and management, ParisTech coordinates the actions of its constituent institutions, among other things in the field of doctoral studies and research activities. ParisTech constitutes most notably a means for providing coordinated responses to the KIC (Knowledge Innovation Communities) of Europe. ParisTech has proposed major projects in themes that are transversal within member institutions (energy, the environment, etc.). In this respect, Télécom ParisTech is responsible for activities in the field of information science and technology. It also participates to programs in Economy (PIMREP project: ParisTech Innovation Management Research and Education Programme launched in June 2008), in bio-engineering (with University Paris 5) and in Machine Learning (with ENS Ulm).

The GIS: e-Sys and PariStic

Télécom ParisTech is a founding member of two GIS[11] with an active regional role.

There is, first of all, the **GIS PariStic**, in partnership with the LIP6 (Pierre et Marie Curie University) and the CNRS. This GIS unites more than 300 permanent researchers and teachers working in Paris in the the fields of computer science, networks, information processing and multimedia, and about 400 thesis students. The GIS PariStic has been the opportunity for a huge number of collaborative activities ranging from teaching to advanced research. The GIS PariStic has made it possible to draw together in shared projects the personnel of member institutions and the financial support that they provided and to present a united approach to information and communication sciences and technologies in the Ile-de-France region[12]. PariStic is deeply involved in the Cap Digital cluster that both laboratories helped to create.

Télécom ParisTech is also a member of the **GIS eSys**[13] created to favour collaborative efforts between teams working in electronical systems[14]. eSys' scientific domain is devoted to hybrid electronics system conception and microsystems in order to feel the gap from sensors to actuators, with an internal stage of smart digital decision. This GIS is developing in narrow collaboration with the System@tic cluster taking advantage of its exceptional industrial IT context (Thales, NXP, EdF, Schlumberger, TI).

[10] site of ParisTech: http://www.paristech.fr/en/index.html
[11] GIS = "Groupements d'intérêt scientifique", scientific interest groups
[12] site of GIS PariStic: http://www.gis-paristic.fr/
[13] aside with Supélec, Esiee, Isep and the University Paris Sud
[14] site of GIS eSys: http://www.esys.fr/

Long Term Collaborations

In several fields, Télécom ParisTech, in order to establish stronger collaborations with its most faithful partners, has built joint labs or chairs which are guaranteeing living exchanges on a period from 3 to 5 years. The present agreed collaborations are shown in Table 1.10, two or three more being yet to be signed.

Name	Academic Partners	Companies
ComNum joint lab in digital communications		Altran
BILab, Business Intelligence Lab		EDF
Chaire Economie des Médias et des Marques	Ecole des Mines ParisTech	Vivendi
Chaire Innovation & Régulation	Polytechnique	Orange
Chaire TIC et développement durable	Télécom & Mangt SudParis	Orange & CDC
CoC Centre of Competence		CNES & DLR
Wave-Human Interaction & Telecom Interface	Télécom Bretagne	Orange
UbiMedia Lab	Institut Télécom	Alcatel-Lucent

Table 1.10: Long term collaborations with industrial partners or agencies: CoC is the Center Of Competence on Information Extraction and Image Understanding for Earth Observation. It is both a chair and a lab. DLR is the "Deutsches Zentrum für Luft- und Raumfahrt" i.e. the German Aerospace Center. Ubi Media Lab is a joint lab dedicated to the development of the next generation medias.

1.4.5 Recent Remarkable Results

In June 2009, Clément Genzmer, prepared by Pierre Senellart, wins the SIGMOD/Pods First Annual Programming Contest.

In January 2009, a joint laboratory is created by Alcatel-Lucent and Institut Télécom, on Multimedia over the Net. Télécom ParisTech plays an important role in this Lab.

In December 2008, Isabelle Bloch, received the Blondel Medal from SEE, for her original work on mathematical morphology, fuzzy sets, data fusion, spatial reasonning and brain imaging.

In October 2008, inauguration of the COM'NUM joint laboratory between Altran and Télécom ParisTech

In April 2008, the European Bugyo project, dedicated to secure platforms for e-business, received the Excellence Award from the Eureka CELTIC Agency for outstanding performance and excellent results.

In December 2007, Ghaya Rekaya-Ben Othman received the Young Woman Scientist Award from the Ville de Paris for her contribution to the invention of Golden Codes.

In December 2007, Jean-Claude Belfiore, received the Blondel Medal from SEE, for his contribution to digital communications, information theory and error-correcting codes.

In August 2007, was created the EDF - Télécom ParisTech BiLAB (Business Intelligence Laboratory), joint laboratory devoted to the management of large flow of data issued from warehouses.

In October 2007, Lucille Denoeud-Belgacem received the Simon-Régnier Prize from the French Classification Society for her work on distance defined over partitions of a finite set.

In October 2007 was inaugurated the TélécomParisTech - Polytechnique - FranceTelecom Chair on *Innovation and Regulation of Digital Services*.

In December 2005, Jean-Sébastien Lantz received the Turgot Prize for the Best 2005 book on Financial Economy.

in June 2005, creation of the CNES - DLR - Télécom ParisTech Centre of Competence and Chair on *Information Extraction and Image Understanding for Earth Observation*.

1.5 An Overview on Research

1.5.1 In the Departments

As said before, research is mostly done within the departments. Departments being in charge of both research and education are designed to cover four broad thematic fields without too much overlap. The thematic research provided by departments will be presented in details in the rest of this report. It is distributed in the following way.

Communication and Electronics: COMELEC

This department is dedicated to a domain going from Applied Physics to Electrical Engineering. A part of its developments is based on laboratory experiments either made in its own laboratories or in partners' facilities. Physics is concerned with microwaves, antenna, propagation, opto-electronics, guided optical systems, optical devices and quantum cryptography. An important part of its research is devoted to the conception of electronic devices and systems, in analogical, digital or hybrid technologies, systems on chips, software radio and nano-technolgy. Its favourite constraints are for low energy devices, secure architectures, efficient packaging and of course with high bit rates. It also has a long research tradition in information and coding theories.

The COMELEC department consists of four teams:

- digital communications (COMNUM),
- complex digital electronic systems (SEN),
- electronics and radio frequencies systems (ELECRF),
- optical communication systems (GTO).

Computer Science and Networks: INFRES

The Computer Science and Networks department covers fields from software and system engineering (component modelling, middleware, reconfigurability, adaptability) to network technologies (internet, optical networks, administration, traffic modelling, QoS) and from artificial intelligence (natural languages processing, databases, semantic web) to security (critical infrastructure protection, quantic networks, ad hoc and active network security, privacy, cryptology, PKIs, protection of services).

Its presentation is structured around three teams:

- interaction, cognition and complexity, systems, software and services (IC2&S3),
- mathematics of information, communications and computation (MIC2),
- network, mobility and security (RMS).

Economics and Social Sciences: SES

This department is the last one created to cover the various fields of humanities, social sciences and management related to high technologies. The domains of interest are related to industrial economics of information systems, analysis of competition in leading edge industries, critical studies of interpersonal communication models and analysis of situations and strategies in communication.

This department is presented as one team only, with three main directions of research:

- regulation and innovation,
- industry evolution and cultural creation,
- interaction, technology and activity.

Signal And Image Processing: TSI

This department is mostly concerned with processing the new medias: audio signals (with a specific interest to music), biomedical signals, images (mostly for remote sensing, medical and cultural heritage applications), graphics and video. It also pays attention to the statistical aspects of signal processing, to machine learning and to signal and image modelling.

The TSI department consists of four teams:

- audio, acoustical and optical waves (AAO),
- multimedia (MM),
- statistics and applications (STA)
- image processing and interpretation (TII).

1.5.2 Multidisciplinary

Apart from the disciplinary research, Télécom ParisTech also develops an important activity in the transdisciplinary domains, activity which, by nature will not be so much evidenced in the next chapters written team by team. Therefore a brief presentation is made here emphasizing the active exchanges between the departments, and underlining existing links.

Pervasive Digital Life

The role of computer technologies in the society is growing in a seemingly unbounded way thanks to the impressive progress of networking, mobile communications, protocols and middlewares. But the contribution of technological components (antennas, RFID, contactless connexions, sensors and actuators, ...) should not be underestimated when evaluating the progress of the *Internet of things*. In this domain, a continuity of research may be found in the INFRES and COMELEC departments, and these two departments share with TSI a similar interest for the field of multisensor networking which obviously links together the various *smart* objects and guarantees their inter-operability.

Moreover, the SES department is interested in analyzing the acceptability of these pervasive technologies in a society which is more and more aware of ethics, health and welfare. As a consequence of interdepartemental discussions, Télécom ParisTech is proposing solutions in the public's best interest, even if those solutions oppose technological progresses.

Security

Here again exists a continuity of actions between the COMELEC department (the research of which is strongly focussed on the security of devices and components) and the INFRES departement which is concerned with cryptography, protocols, networks and infrastructure safety. The physical aspects of security are taken into account with thermal and electromagnetic manifestations of computing (the so called *hidden-channel effects*) for smart cards, processors and devices in the COMELEC/SEN team, while privacy, cryptology, PKIs, authentication and protection of services are the core research of the INFRES/RMS team. TSI department intervenes when biometry as well as when watermarking (with audio signals, images, video or objects) are concerned. Again the SES department is an unreplaceable partner because privacy and security are major components of the business model of any novel technology entering the market.

Quantum Communication

Because they are based on the physical foundations of quantum information, quantum communications are treated at Télécom ParisTech by the two departments who maintain optical facilities: COMELEC and TSI. Because of the specific problem of elaborating a protocol competing with usual cryptographic approaches, they are also developed in INFRES department. Collaborations between teams are intense and diverse going to models of bipartite or multipartite links, to the construction of memories, establishment of protocols, construction of specific quantum codes on networks.

Data Management in the Knowledge Society

Information management systems are developed both in INFRES department where their connexions with data bases and with knowledge representation are exploited, and in TSI department where machine learning mechanisms are applied in narrow relationship with media processing: analysis and description of audio-signal, images or video. Here again comes the SES department, concerned with efficient interactions, ergonomy and user-centered developments.

Chapter 2

Communications and Electronics (COMELEC)

The research led in the **Communications and Electronics** department is devoted to the physical layer of ICT (Information and Communication technology). A useful concept for depicting the department main research concern is that of "physical information", where the information content is actually reached through some physical properties and manipulated using physical laws such as Maxwell electromagnetic equations or Quantum Hamiltonians. The department covers both the field of communication and that of information processing (electronics).

The department accounts for 36 permanent research staff and hosts about 90 non permanent researchers, including PhD students. The research activity is covered by four different teams. While fixed communications are dealt with by the **Optical communication group**, the **Electronics and RF systems team** concentrate on the transformation from analog to digital information and to its transmission through wireless means. The **Digital communications team** works on the digital coding of the information, and prepare for the future digital communication breakthrough in MIMO system, multi-hop communications or multi-users wireless communications. Processing information requires extremely sophisticated Silicon chips (processors, FPGAs, SOCs), the architecture of which is central to the **Complex Digital Electronics system team**. Transverse to all these activities, one may also find security as a main topic.

The department research policy claims for a research effort that spreads from fundamental physics to applied results. One may for example note the use of quantum dots for optical clock recovery (see the optical communication team) or that of photonic crystal (also called metamaterial) for advanced antennas (Electronics and RF Systems team). The balance between exploratory research and market oriented results is well expressed by the 1:4 ratio between our private partners funding and our total research contract income (7 Meuros cumulated over the period). Because of an innovation minded research taking its roots in fundamental theories, the department was granted 29 patents while publishing over 550 papers in journals and conferences in the evaluation period.

The department is also strongly involved in educating students for research. This is reflected by the 70 defended PhD thesis over the period. A budget of about 75 keuros is also spent yearly for master student internships in the department research groups, with a total of about 150 man.month of internship generated every year. Besides its contribution to the "ingenieur courses" of TELECOM ParisTech, the department researcher's participate to master courses with ParisVI, ParisXI, as well with the University of Nice.

In terms of outreach, the department was strongly involved in a number of initiatives both at local, national and international levels. Among other actions, one may notice the Electronics and RF systems team involvement in the creation of the GIS Esys "Groupement pour l'Electronique des Systèmes" led by Supelec. The Complex Digital Electronics system team initiated the Sophia-Antipolis Formal Analysis group SAFA and recently animated its first workshop. The Electronics

and RF systems team was also a recognized actor in the launching of the joint IEEE Newcas-TAISA conference. Of interest, a world open contest on electronics attacks was launched by the Complex Digital Electronics system team at the CHESS meeting. In order to help for a better European visibility, the department head created and chaired the IDEA League (Imperial College, Delft University, Eth Zurich, Aachen RWTH) ICT cluster. As an international impact indicator, the department teams are currently involved into two European STREPS, three European NOE's, one Eureka program and lead a Carnot-Fraunhofer project.

Faculty [IT, CNRS]	[29.75, 2.75]
PhD students	48.5
Post-docs, engineers and sabbaticals	10.75
Defended PhD theses	70
Defended HDR	4
Journal papers [published, in press]	[143, 18]
Papers in conference proceedings	410
Chapters and books	10
Patents and software	[29, 5]
Grants [public, private, european] (k€)	[4731, 1902, 417]

Chapter 3

Network and Computer Science (INFRES)

During the period of this evaluation, the Networks and Computer Sciences Department was averaging about 50 permanents including faculty and engineers. Its growth stayed modest with an increase of one or two faculty or engineer each year. However in the same period of time its revenue growth was at a remarkable rate of over 30%. As for this year ending, despite the economic crisis, we are forecasting a 5% growth in revenue. As a consequence, counting in term of FTFE (Full Time Faculty Equivalent, who are clearly responsible for getting most of our research contracts and grants), the ratio revenue per FTFE has been growing similarly to reaching nearly 150k€ this year from about 80k€ at the beginning of this evaluation.

The Networks and Computer Sciences Department has a long tradition of studying complex network or software system architectures. Both complex network systems and complex software systems are constrained by a series of classical common high level requirements including: scalability, quality of service, availability, maintainability, safety, security, dependability, usability, and of course performance and cost saving. Today, energy saving and durability would certainly have to be added to the list, even if they are not really as new as it would seem. Fortunately, this list changes very slowly. However, system elements change fundamentally and at a fast pace: links between nodes became optical or wireless. This allowed nodes to become mobile, to appear, disappear, and reappear at another end of the network. Networks are becoming networks of 'things' as they include all kind of cell phones, sensors, RFIDs or even robots (like drones). These things can be more or less ubiquitous, more or less autonomous. Let's stop here for a moment and describe later our vision for the research in the Department; this rapid landscape should be sufficient to explain how research is led in the Department. For instance, one specific category of system could have been chosen and thoroughly studied under the entire variety of high level requirements. Instead, it has been chosen to focus on the various 'Gordian' knots found in complex software systems and networks that have high scientific value and make these systems or networks difficult to develop, maintain, and control.

For instance, how to process and analyze a large amount of data 'on the fly' as they arrive from multiple nodes? How to efficiently search through a vast heterogeneous set of data more or less reliable over the web? How to rapidly develop and verify a real time system re-using existing components? What kind of middleware can support collaborative applications over a wireless self-configuring network? How to broaden the interaction with a computing device using solely the movement of a thumb? All these various questions are illustrating part of the research led in the **Information Systems and complex systems (IC2&S3) Group**.

Sometimes good common sense and solid methodologies are just not enough. When it is about pushing the constraints over the requirements described above to the limits of what physics can offer, for instance using quantum theory to establish the highest level of security possible. When it is about providing with the best tools possible allowing designing the best network ar-

chitecture to fight in the fierce economy of the telecommunication industry, for instance making some advance in probability theory using the Malliavin calculus. When it is about optimizing an optical network using graph theory or linear programming elevating drastically technology barriers. Discrete or not, mathematics are impassable and are a key component in the research led in the Department. Members of the **Mathematics of Information, Communication, and Computation (MIC2) Group** are dedicated to this critical effort.

Last but not least, the members of the **Networks, Mobility, and Security Group** are studying a broad variety of network architectures (P2P, mobile, mesh, or hybrid,...) going from the core layers of the communication network to the service layers: establishing how congestions can be avoided, looking at various architectures and making contributions to new protocols able to transport data, voices, images, or video; analyzing QoS or performance; managing mobility or radio resource; revisiting scheduling or failover algorithms. At last, in order to conduct its research in the domain of security, the group is mastering a large array of technologies spanning from novel usages of the smart card to game theory.

To succeed, the Department is demanding more than *just* publishing even important books like the J. Sakarovitch's one. To reach critical mass, it is participating to common labs like UBI-Media with Alcatel-Lucent, BiLab with EdF today extended to France Telecom and Inria, or more recently with the LInC with UPMC, Inria, and Thomson. It has constant and noticeable contributions to many industry standards (AADL just to pick one in the domain of embedded systems), an increased number of patents and public domain software. It also has a strong contribution to the Telecom ParisTech curriculum as well as the program of continuing education. At last, the Department has been able to create two start-ups SeQureNet and Ether Trust both in the domain of security.

Faculty [IT, CNRS]	[37.8, 3.2]
PhD students	56.5
Post-docs, engineers and sabbaticals	14.3
Defended PhD theses	71
Defended HDR	5
Journal papers	155
Papers in conference proceedings	608
Chapters and books	66
Patents and software	35
Grants [public, private, european] (k€)	[7691, 3746, 3022]

Chapter 4

Economics and Social Sciences (SES)

The department of economics and social sciences (which composes one single “team” for the purposes of this evaluation document) is an interdisciplinary department for teaching and research, At the 1st of July, 2009, it is composed of 30 permanent members in teaching and/or research positions (among which 3 researchers from CNRS and 2 from INRIA), 8 associate researchers, 33 ongoing Ph.D projects, 16 non permanent members and post-doc (among which four visiting professors from abroad for various durations), and 3 persons employed in administrative capacities.

It is original in the French landscape by being highly multi-disciplinary: it involves researchers in economics, management sciences, sociology, information and communication sciences, cognitive psychology and ergonomics, liable to several sections of the CNRS, 29, 34, 36, 37, 40 and 44, as well as CNU section 71 (not represented in CNRS). Its focus is therefore not disciplinary but thematic. It aims to cover the Information and Communication Technology (ICT) “human”-oriented perspectives, with two sets of equally stringent, and sometime cross-cutting exigencies: operating at the cutting edge of each disciplinary field, while also participating to collaborative and innovative research projects (involving cooperation either between social sciences or between social science and more “technology-oriented” departments and industries) which directly benefit from the involvement of multiple disciplines. But in this particular domain, trying to satisfy both exigencies as much as possible is a key to original, innovative research which may shed new light on the uses of ICTs, for these are usually oriented with respect to multiple normative orders, economic, social, technological, etc.

For management purposes, the department is organized in three research groups, two in Paris and one in Sophia Antipolis. Its research activities are structured around three axes which are deliberately not congruent with the boundaries of the three groups (because they aim towards stimulating various forms of interdisciplinary collaboration). These three research axes each explore significant issues regarding mediated interactions and transactions, but at several scales. At the “macro level” Axis 1 one looks at regulation and innovation-related phenomena in the telecommunication sector. At the “meso level”, Axis 2 studies the production, circulation and reception of media and cultural contents with an eye towards the blurring of the boundaries between producers and consumers, professional and amateurs, etc. At the “micro level” Axis 3 focuses on mediated interactions and the local management of situations and activities relying on communication technologies and services.

Social sciences are essential to the development of the IT sector for IT-based technologies and services mediate the way we collectively inhabit in “Information Ecologies”. Putting such technologies to work in actual settings cannot be separated from social issues related to various forms of “living together”. The scientific recognition level of the laboratory can be seen in several ways:

- in the number and quality of its publications;
- in its growing attractivity (several well known researchers from CNRS and INRIA have joined us in the last three years; the number of foreign researchers asking for visitor's status is also increasing);
- in the growing network of its teaching and research partners (EHESS and MSH Paris, Paris I, X and XI universities, University of Nice Sophia Antipolis, the ENSCI school of Industrial design). In each case this implies co-habilitated master formations, and significant teaching commitments.
- in the striking progression in the participation of the laboratory to collaborative research project (with a good success rate on ANR-deposed projects) and its growing ability to get funding from various sources (state agencies, "collectivités locales" and particularly the Ile de France and PACA regions, ministries – culture, justice- research programs) and stimulate additional teaching and research activity (post-doctoral and doctoral positions) complementary to the one of its permanent members.
- in its efforts to sustain cooperation with the industry. The laboratory is committed to maintain and develop relationships with the industrial research sector, either through direct contractual research, or indirectly through the participation of its researchers to several competivity poles (Cap Digital in Ile de France, SCS and IRI in PACA, NFC in Normandy). It also aims at developing "chaires" funded by key firms in the sector. Two were launched in the evaluation period ("Regulation and Innovation", with Ecole Polytechnique and Orange; on "ICTs and Sustainable Development", with Orange and Caisse des Dépôts et Consignations),and one more is in its final stages of elaboration (on the "Imaginary of Technology" with Dassault Systems, Ubisoft and L'Oreal). The laboratory is also involved in several joint research initiative with the industry (it participates significantly to the joint research laboratory between Institut telecom with Alcatel, and to the joint Paristech initiative with Renault around the "Institut de la mobilité Durable" project).
- In its international orientations on top of a specific training for African regulators and operators, members of the Department are greatly involved in cooperative research with Asian and African regulators and operators about regulatory issues in emerging markets (in more than ten countries). An important level of international cooperation has also developed around the issue of electronic money, and in the frame of the research "chaires" managed by the Department (Particularly on "innovation and regulation").

Permanents [IT, CNRS, INRIA]	[19.7, 1.4, 0.4]
Doctorants	17
Postdocs, ingénieurs contractuels, sabbatiques	19
Thèses soutenues	7
HDR soutenues	3
Articles de revues	145
Articles de conférences	72
Livres et chapitres de livres	[20, 40]
C.A. contrats (k€) [privés, publics, européens]	4 659 [2 748, 1 715, 196]

Chapter 5

Signal and Image Processing (TSI)

The research topics covered by the Signal and Image Processing department at TELECOM ParisTech are: the study of image processing in its various formats, digital, optical... for different applications like medical imaging, remote sensing, fine arts..., the study of speech, music and sound.

After its reorganization at the beginning of 2007, the department is now organized into four groups:

- "Statistics and applications" - STA - is a group that is devoted to the applications of statistics and probability to the field of information processing. The research area covers a wide spectrum from the development of new techniques and new algorithms to various applications. The activities of the group comprises the following topics: statistical learning, independent data and complex random systems, methods and algorithms for cosmological data analysis, Markov Chain Monte-Carlo techniques, sequential Monte-Carlo techniques (particle filters), array processing, geolocalization, models estimation.

- "Image Processing and Interpretation" - TII - has, as its main purpose, the development of methodologies and theoretical tools for image processing, scene analysis and 3D objects. This implies global treatment of complex image processing problems, integrating multiple techniques that cover the path from raw data to high-level interpretation. The concerned applications are art items (sculptures, paintings), biomedical images, satellite images, natural scenes.

- "Audio, Acoustics and Waves" - AAO - conducts activities in signal processing having strong connections with the physical phenomenon that is at the source of the signals, whether acoustical or optical. In digital audio signal processing, the activities span the entire acquisition chain, from capture to analysis or transformation, transmission up to its restitution, with the goal of proposing solutions to the main problems centered around the sound, speech or music, in multimedia applications. In optical information processing, the group contribute to new detection schemes and to the characterization of new materials.

- "Multimedia" - MM- is a group that covers the life cycle of multimedia documents in the framework of a complete chain going from authoring tools for on-line and offline production of multimedia contents to multimodal interaction for the final user; this also includes automated processing like enhancement of degraded pictures, verification of the identity of the user, modification of auditive and visual appearance, image segmentation and pattern recognition. The group also works on techniques that allow the analysis, compression and robust transmission of these media in heterogeneous networks. It also works on the dynamic and distributed adaptation of the transmitted data flow (including meta-data and in particular those concerning the digital rights management) with respect to context, transport conditions and terminal type.

One research topic is common to all groups, this is indexation and data mining. Summarizing and extracting informations from multimodal databases requires statistical tool for learning and mining, which are among the activities of the STA group with a particular focus on text indexation and retrieval. Indexing satellite images, extricating informations from primitives to semantic annotations is the main goal of the “Center of Competence”, a joint lab between CNES, DLR and the TII group. This group also develops the same kind of tools for biomedical images and for 3D objects. The AAO group is concerned by many aspects of music information retrieval: identification of rhythms, main melodies, instruments, styles, moods, tonalities either from plain audio or from mixed audio and video. Video signals are also a core activity in the MM group together with complex documents analysis (mixing printed texts, handwritten texts, pictures, graphics) and with multimodal analysis for biometry (voice, faces, fingerprints).

Our most recent recruitments were aimed towards the reinforcement of two topics: the first one is distributed sensor processing; the second one is 3D images and virtual worlds.

Permanent staff [*Institut ; CNRS*] ; post-docs	[32 ; 11.6] ; 8.4
PhDs	55.6
Defended PhDs	90
Defended HDR	8
Journal papers	291
Chapters and books	52
Conference papers	713
Patents and software	8
Contractual income 2005–2009 (june) [Private ; Public ; European] (k€)	[5865; 2747 ; 1782]


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