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Perspectives on Software Engineering and Informatics Research in Spain and the IMDEA Initiative

Madrid Institute for Advanced Studies in Software Development Technologies

October 10, 2008, ECSS 2008, ETH Zurich

imdea software

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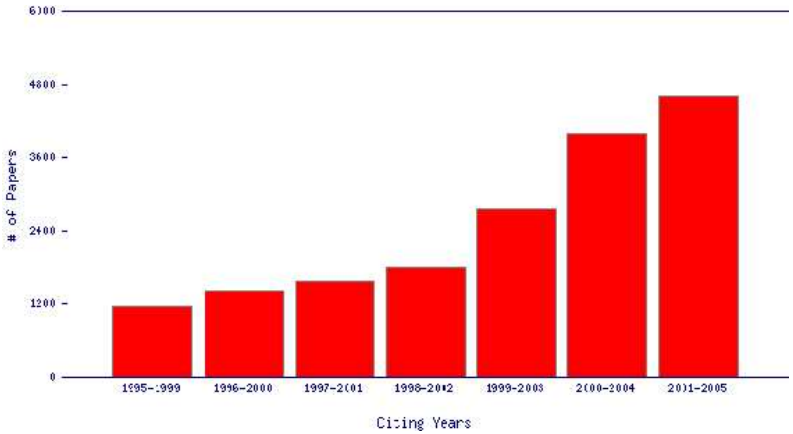
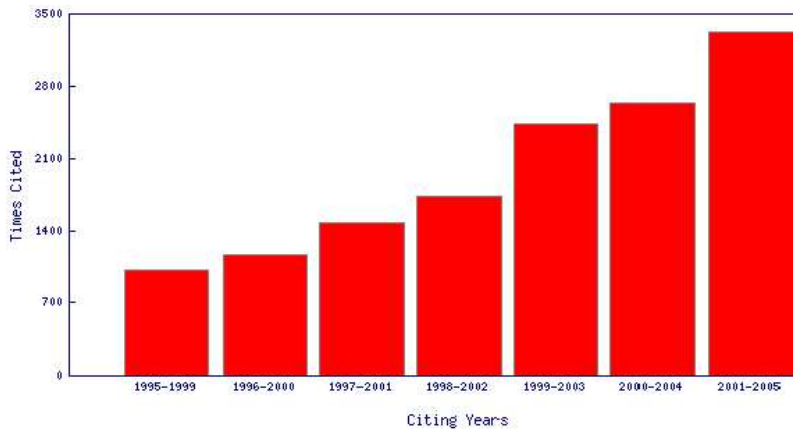
Strengths and Weaknesses of CS in Spain

Strengths and weaknesses of Computer Sci. in Spain

Research production and citations



CS papers published by Spain: evolution.



Citations to Spanish CS papers: evolution.

- *Tenth position* in world and *fifth position* in EU (ISI).
- Similar or better position than in other areas (and rising: 14th in 2001).

Strengths and weaknesses of CS in Spain (Contd.)

Highly cited researchers

- Around 30 *Topmost 10000 cited in CS* (CiteSeer) in Spain.

Research area	**# highly cited researchers**
Software development technologies	15
Intelligent systems and soft computing	8
Computer architecture and high-perf. comp.	4
Software Engineering	4
Concurrency and distributed systems	3
Algorithms and theoretical computer science	1

Strengths and weaknesses of CS in Spain (Contd.)

Funding sources (for CS)

- EU.
- Ministry of Sci. and Innovation: regular, basic research projects:
  - Informatics (TIN) program + Communications and Electronics.
- Ministry of Industry: TSI (Information Society) program.
- INGENIO 2010 program: larger projects in strategic areas.
  - Consolider: strategic / larger (3-5 MEuros) academic projects.
    - 3 – 4 projects funded so far (2 years) in CS.
  - AVANZA I+D: large industry-academia consortia.
- Regional (becoming more important, some w/ national participation):
  - Direct support to competitive groups.
  - Innovation clusters.
  - New: IMDEA institutes and similar approaches.

Note that Spanish Universities are regional; only CSIC is national.

Strengths and weaknesses of CS in Spain (Contd.)

Weaknesses

- R&D funding very *fragmented*.
- Relatively low number of researchers in CS:

Field	# permanent positions	% of total
Economy	4002	8.6 %
Biology	3129	6.7 %
Philology and linguistics	2864	6.1 %
Mathematics	2792	6.0 %
Law	2658	5.7 %
Physics	2397	5.1 %
Computer Science	1635	3.5 %

Strengths and weaknesses of CS in Spain (Contd.)

Weaknesses

- Reduced number of *research* institutes in the area of Computer Science.
  - CSIC (Spanish Sci. Research Council) AI center.
  - Barcelona Supercomputing Center
    (originally computing service, but now also a research institute).
  - Now also: IMDEA (Madrid).

- Difficulties for attracting and retaining top-level researchers.
  - Specially acute for foreigners –significant hiring hindrances.
    $\Rightarrow$ very low numbers hired (up to around the year 2001).
  - But also for keeping top-level researchers in Spain.

Challenges for attracting top-level researchers

Low salaries

- *Uniform* salaries across disciplines.
- PhD grants (in CS) in other countries pay 20-50% higher than in Spain.
- Salaries for full professors (in CS) abroad from 50 to up to 500% higher.
- In industry this difference with other countries is much smaller.

Administrative burden and atomized funding

- High fragmentation in funding –need to manage many complex grants.
- Limited staff: accounting or maintenance often done by researchers.

Hiring hindrances and other issues

- Ph.D. needs “validation,”
- Positions require EU nationality + Spain residence.
- Selection panel can only contain researchers from Spain.
- ...

Challenges for attracting top-level researchers

Towards a solution

A number of measures to solve the hiring problems have been put into place since 2000:

- Ramón y Cajal / Juan de la Cierva:
  - Greatly improved selection process (e.g., international panels).
  - Eliminated hurdles (PhD validation, nationality, ...).
  - Program allows higher salaries.

  Results:
  - Generally perceived as very successful (“changed the landscape”).
  - But:
    - Has not solved the salary problem:
      the hiring universities have not followed suit.
    - This has limited the level of people attracted *in some areas*.
    - In particular, smaller effect in higher-salary areas such as CS.

Challenges for attracting top-level researchers

Towards a solution

- ICREA (Catalonia Regional Government):
  - International selection committees, PhD recognitions, etc. (similarly to Ramon y Cajal program).
  - But researchers hired at competitive, non-uniform salary levels.
  - Hiring made by a single, central foundation.
  - Work at a hosting institution (typically a university).

Results:

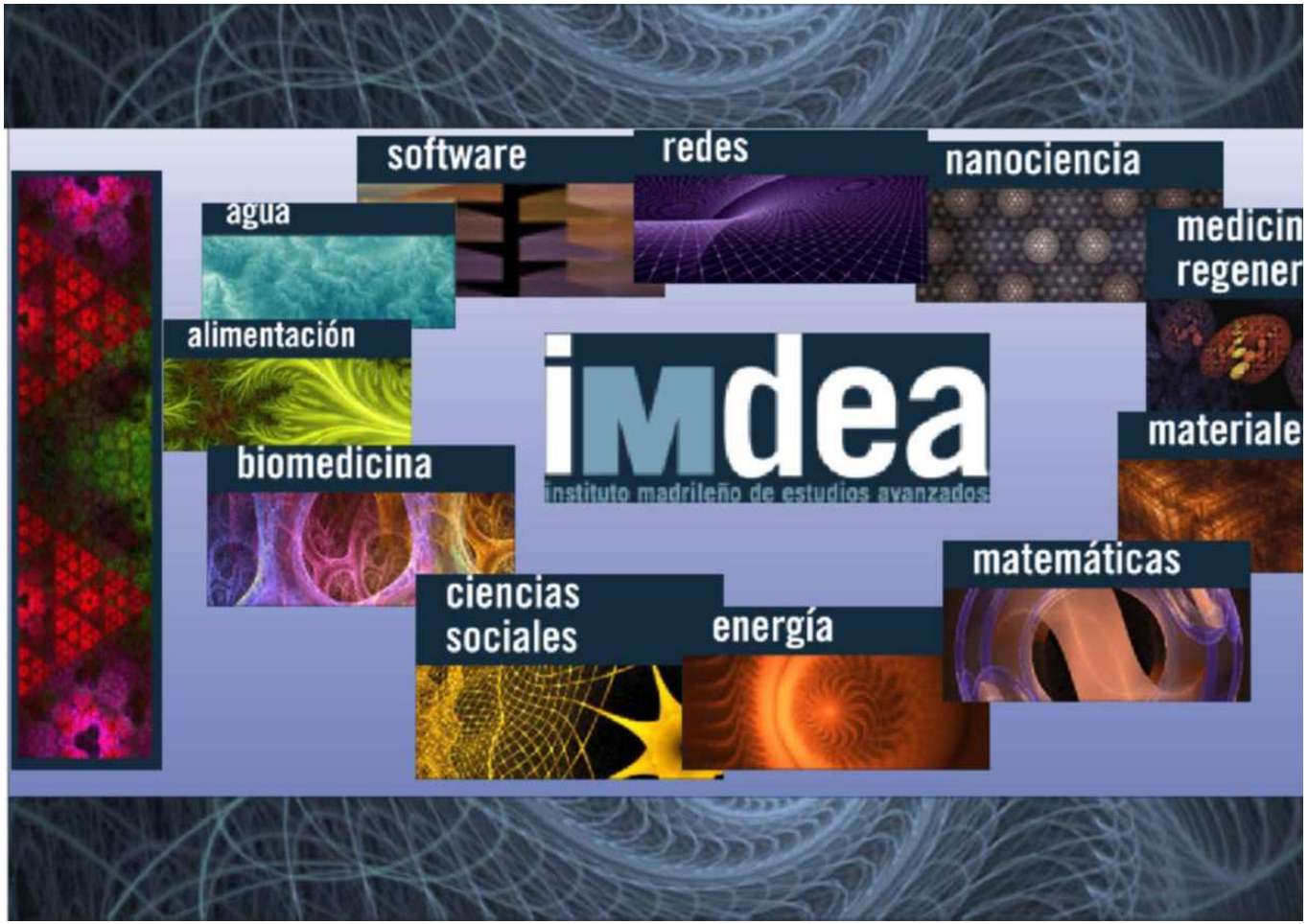
- Effective at attracting higher-level researchers.
- But:
  - Hiring by single foundation can be a limitation: in some cases researcher may not be perceived as part of the hosting institution.

Challenges for attracting top-level researchers

Towards a solution

- **IMDEA** (“Madrid Institute of Advanced Studies”):
  - **Network** of institutes for **research of excellence** in **areas of high economic impact**.
  - Institutes provide home institutions for researchers (vs. ICREA).
  - Each institute is an independent foundation.
  - But collaborates with several Universities, CSIC, MCI, etc.
  - Funded by Madrid Regional Government and (hopefully) partners.

IMDEA:
network of 10 research institutes in different areas



madrid institute of advanced studies in software development technologies

The IMDEA Software Institute

IMDEA Software

- Madrid Institute for Advanced Studies in SW Development Technologies.
- Mission:
  - Research of excellence at the highest international level.
  - Attract world-wide top-level researchers.
  - Create critical mass with the capabilities in the Madrid region.
  - Collaborate with industry interested in the area + similar institutions worldwide.
  - Contribute to (graduate) education in the area.
- Ultimate goal:
  - Be “tractor” for the significant SW research base and industry in Madrid.
  - Become a reference center in Spain and worldwide in the area.
- First research center in SW in Spain (and the 3rd. in Computer Science).
- 100 highly-talented researchers in 5 years; up to 150 beyond.

Software Development as a Key, Enabling Technology

⇒ The cost of development of *correct* SW (writing code, debugging, certifying) is directly at the core of *productivity*, and *competitiveness*.

- Society's dependence on SW systems is increasing.
- However, SW **quality** is very deficient –comes with "anti-warranties"!
- SW **development cost** is in general very high.

⇒ European advantage: selling *high-quality*, SW-rich products, with guarantees, at competitive cost —can be very profitable, also in SW!

⇒ Enabler: **tools** to **lower development & certification costs**.

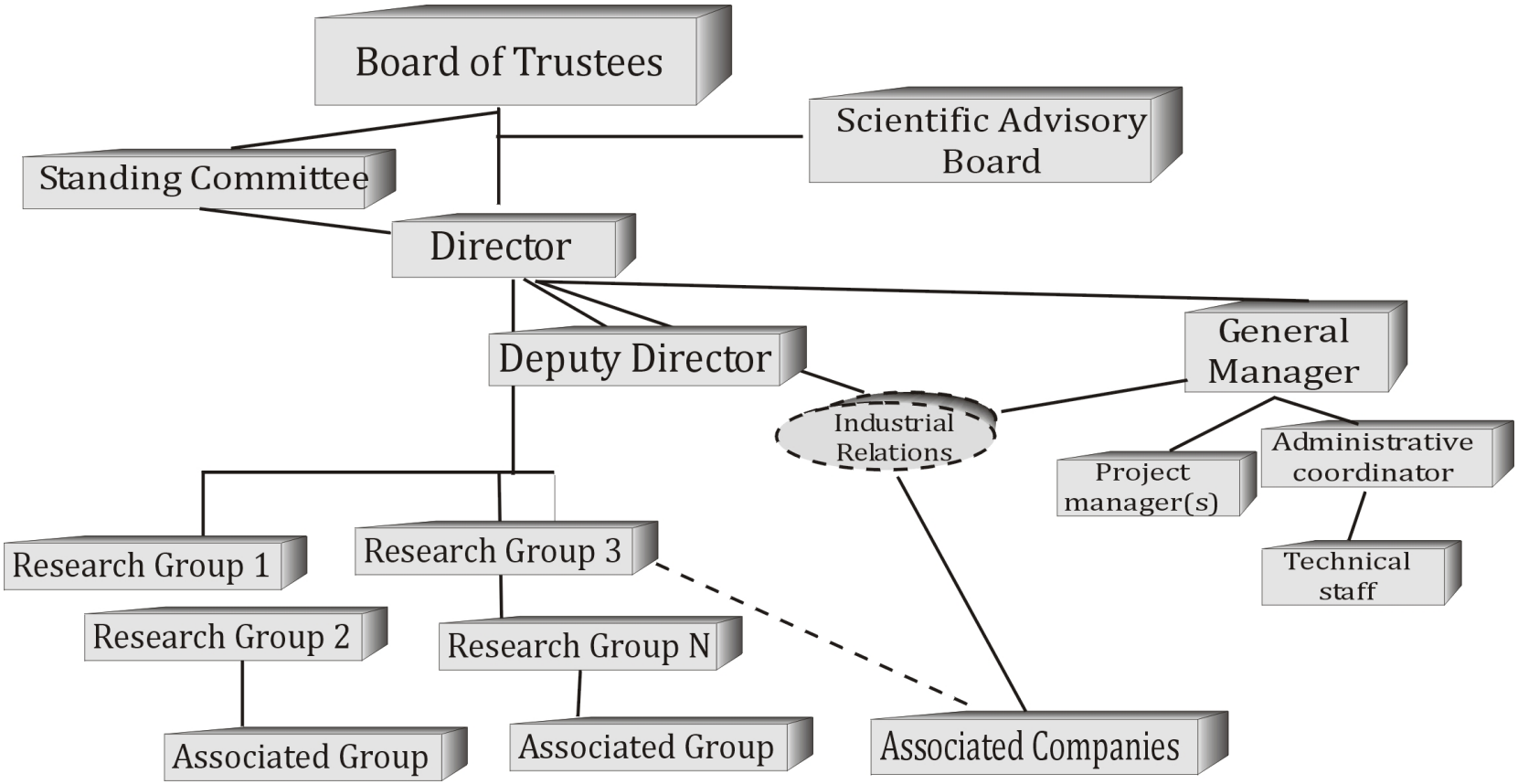
Develop the science, technology, and tools that will allow us to:

- write more *powerful, easy to use, pervasive* software
- that is *reliable* (bug free, *certified*), *adaptable/resilient*, *efficient*, ...
- in a *shorter time and with lower cost*.

- Focus on basic principles but be driven by real practical needs.

Legal Status and Structure

- Private (non-profit) foundation.
- Organizational structure:



Scientific Advisory Board

- David S. Warren (State U. of New York at Stony Brook) – **Chair**
- María Alpuente (Universidad Politécnica de Valencia)
- Patrick Cousot (Ecole Normale Superieure)
- Verónica Dahl (Simon Fraser University)
- Roberto Di Cosmo (Universitè Paris 7)
- Herbert Kuchen (Westfalische Wilhelms-U. Münster)
- José Meseguer (U, of Illinois at Urbana Champaigne)
- Luis Moniz Pereira (Universidade Nova de Lisboa)
- Martin Wirsing (Ludwig-Maximilians U. München)

Attracting the best

- Open, internationally standard selection processes.
  - Rec letters, individual interview, negotiation, ...
- Flexible/competitive retribution/benefits scheme, on an individual basis.
- International research environment.
- State-of-the-art research facilities
  (building, working spaces, equipment, ...)
  on univ. campus with top CS dept.
  (access to top-level students, Ph.D. program, ...)
- Excellent technical and administrative support staff.
- Stability / relative freedom: tenure mechanism.
- Own program of high-quality Ph.D. scholarships, visitors, interns.

- In parallel gradually also involve the top-level researchers in Madrid (keep highly productive researchers in Madrid).

Research positions - I

- Researchers join categories that determine permanence / salary levels.
- Tenured and tenure-track appointments (and promotions) must be approved by the Scientific Advisory Board.
  - Can delegate to subset of its members or suitably appointed committee.
- **Tenured researchers**
  - Hold fixed (tenured) contracts; tenure may be offered:
    - On hiring to currently tenured or equivalent.
    - On promotion from internal tenure-track.
  - Scientific reputation; experience as group/project leaders; funding record.
  - Two basic categories (approx. Full Professor / Associate Professor):
    - **Senior Researcher** and
    - **Principal Investigator**
    - Also, **Distinguished Researcher**

Research positions - II

- **Tenure-track researchers** (**Junior Researchers**)
  - Scientific reputation for his/her age, potential to develop a strong and independent research program, international exposure.
  - Hired on a tenure-track basis for a maximum period of six years.
    - The initial contract will be for two years, renewable up to twice.
    - Mid-term review around end of third year.
    - By the end of the 6-year period, a tenure decision will be made by an internal committee with the support of external peer reviews.
- **Post-doctoral researcher**:
  - PhD, promising, acquire experience within one of the research groups.
  - Max. 4 years.
- **Visiting Researcher** (on sabbatical or other leave from their institutions).
- **Graduate Research Assistant**
  - PhD students in one of the research groups.
  - Typically 4-year contracts.
- **Intern**
  - Generally undergrads, invited for a visit of up to one year to the Institute.

Research positions - III

- "**Associated**" status:
  - As an orthogonal notion to the categories above, *Associated Researchers are researchers that hold a dual appointment with another institution.*
  - Their category and status is regulated by the standard procedures, independently of their status at the other institution.
    - Associated researchers are offered salary conditions equivalent to those of the other researchers at the same level.
  - Conversely, researchers become associated researchers when obtaining a dual-appointment with another institution, but retain their status at the Institute.

Agreements with Univ. and other research institutions

- They provide a legal framework for:
  - Use of space on university campus for temp. location and permanent building.
  - Joint use of scientific equipment and infrastructures.
  - Hiring of personnel from the other institution (associated).
  - Joint participation in graduate programs.
  - Joint participation in research and industrial projects.
  - Association of research units from collaborating institutions with the Institute.
- Agreements with the following universities and research institutions:
  - Universidad Politécnica de Madrid-UPM (November 2007)
  - Universidad Complutense de Madrid-UCM (November 2007)
  - Universidad Rey Juan Carlos-URJC (January 2008)
  - Consejo Superior de Investigaciones Científicas-CSIC (in preparation)
- Other relations with institutions in research policy and funding:
  - MCI, CDTI, European Commission, ERCIM, ...

Industrial Partnerships and Associated Companies

- Some modalities of **collaboration with industry**:
  - Joint participation in mid-/long-term projects within the scope of IMDEA-SW.
  - Education/training of skilled professionals in new technologies in area.
  - Participation of company personnel in IMDEA (e.g., periods of graduate study).
  - Collaborative PhD grants (personnel formed at IMDEA Software).
  - Access to high-level researchers (for consulting and hire), and knowledge.
  - Technology forecast and followup.
  - Joint collaboration in Technological Platforms.
  - *Readiness* towards spin-offs and joint spin-offs.
- Projects must include challenges beyond the current state-of-the-art.
- IMDEA Software **associated companies**:
  - Long-term and stable relationships – strategic alliance for, e.g., joint projects.
  - Special and early access to the activities and results of the Institute.
- Also, some companies as Trustees.

Industrial partnerships

- BBVA agreed to join IMDEA Software Board of Trustees on October 2007
- Representatives of the following companies attend this Board of Trustees as invitees:
  - Atos Origin, TID, Deimos Space, ...
- We have explored (and we will explore) cooperation with other IT companies and institutions which have shown commitment to research and development in the past. Preliminary contacts have been made with departments at:
  - HP
  - EADS (negotiating a two-year industrial contract)
  - Deimos Space
  - INDRA Sistemas
  - TransTools
  - Cámara de Comercio - Madrid
  - SAP
  - ISOCO
- We are actively collaborating with the Industrial Clusters of the Comunidad de Madrid.
- We are looking for joint projects with PROMOMadrid. First meeting in May 2008.

Personnel Evolution - Status

	2008 Estimate	Current situation	
Directors	2.0	2.0	100%
Director	1.0	1.0	100%
Deputy Director	1.0	1.0	100%
Scientific track	17.0	14.0	82%
Senior	3.0	3.0	100%
Junior	3.0	2.0	67%
PostDoc	3.0	2.0	67%
Grad	8.0	7.0	88%
Mgmt. & Support	5.5	3.0	55%
General Mng.	1.0	1.0	100%
Financial Coord.	1.0	1.0	100%
Project Mng.	0.2	0.0	0%
Admin. Staff	1.0	0.0	0%
IT Support	2.3	1.0	43%
Totals	24.5	19.0	78%

Personnel Evolution - Plans

IMDEA Software - Generic Evolution

	Director	Dep Dir	Senior	Junior	PostDoc	Grad	Tot	Acc
2008	1	1	3	3	3	8	19	19
2009			2	3	2	7	14	33
2010			1	4	3	8	16	49
2011			3	6	6	10	25	74
2012			3	6	7	10	26	100
Tot. 2012	1	1	12	22	21	43	100	
Final size	1	1	14	32	32	70	150	

Current Personnel

Scientific Director		
Manuel Hermenegildo	associated UPM	full-time
Deputy Director		
Manuel Clavel	associated UCM	part-time

General Manager	
Antonio Miranda	Computer Scientist and MBA
Adm. and Finan. Coord.	
Maria Alcaraz	Economist and MBA

Senior Researchers		
Gilles Barthe		
Anindya Bannerjee		December 2008
Juan José Moreno	associated UPM	on leave
John Gallagher	associated Roskilde	part-time

Current Personnel

Junior Researchers		
Cesar Sanchez	associated UPM	full-time
CSIC Researchers		
Pedro López		
Post-Doc Researchers		
Mark Marron	U. of New Mexico, USA	
Cesar Kuntz	INRIA	

Visiting Distinguished Researchers		
Deepak Kapur	U. of New Mexico, USA	Spr. 2007 (w/UPM-UCM)
Peter Stuckey	U. of Melbourne, Australia	September 2008
Visiting Senior Researchers		
María García de la Banda	Monash U., Australia	September 2008

Current Personnel

Doctoral Researchers		
Juergen Doser	(from ETH)	full-time
Marina Egea	Associated UCM	full-time
Alvaro García Pérez		
Emilio Gallego	Associated UPM	full-time
Iván Pérez		

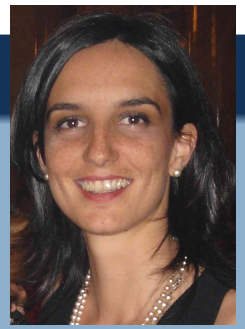
Interns		
Julián Samborsky		(Argentina)
Juan Manuel Crespo		(Argentina)
Daniel Guimaraes		(Brasil, EMCL)
Javier Valdazo		(Argentina)
Leonardo Scandolo		(Argentina)

Management and Administration

Antonio Miranda

Position:	General Manager.
Degree:	Master's in Computer Science and MBA.
Date joining:	April 2007.

María Alcaraz



Position:	Administrative Coordinator.
Degree:	Master's in Economics and MBA.
Date joining:	November 2007.

Gilles Barthe

Position:	Senior Researcher.
PhD:	Mathematics, U. of Manchester, UK, 1993. Habilitation in Computer Sci., U. of Nice, France, 2004.
Previous Pos.:	Senior Researcher at INRIA, France.
Research:	Dependability and Security; Cryptography.
Date joining:	April 1, 2008.

Anindya Banerjee

Position:	Senior Researcher.
PhD:	Computing and Information Sciences, Kansas State University, USA.
Previous Pos.:	Full Prof., Kansas State U..
Research:	Programming Languages and Principles (Productivity); Verification.
Date joining:	December 15, 2008.

John Gallagher

Position:	Senior Res. (part time), (Assoc. Roskilde U.).
PhD:	Trinity College, Dublin, Ireland.
Previous Pos.:	Full Prof., U. of Roskilde Denmark.
Research:	Program Analysis and Transformation.
Date joining:	September 15, 2008 (expected).

Manuel Hermenegildo

Position:	Senior Researcher, (Sci.) Director, (Assoc. UPM).
PhD:	Computer Engineering and Computer Science, U. of Texas at Austin, USA.
Previous Pos.:	P. of Asturias Endowed Chair, UNM, USA; Full Prof., UPM.
Research:	Parallelism; Abstraction-based Programming.
Date joining:	January, 1, 2007.

Manuel Clavel

Position:	Principal Investigator, Deputy Dir, (Assoc. UCM).
PhD:	PhD U. of Navarra, published by Center for Study of Language and Information, Stanford U., USA.
Previous Pos.:	Int. Fellow, CS Lab. of SRI; Visiting Scholar, Stanford University; Assoc. Prof., UCM.
Research:	Constraint Modeling Languages; Modeling Driven Security.
Date joining:	December, 2007.

César Sánchez

Position:	Junior Researcher, (Assoc. UPM, J. de la Cierva).
PhD:	Computer Science, Stanford University, USA.
Previous Pos.:	Postdoc., U. of California at Santa Cruz.
Research:	Embedded Systems; Runtime Verification.
Date joining:	January, 1, 2008.

Juan José Moreno-Navarro

Position:	(Senior Res., Dep. Dir., on leave), (Assoc. UPM).
PhD:	Computer Science from the Technical University of Madrid.
Previous Pos.:	Full Prof., UPM; Leader of BABEL research group.
Research:	Multi-paradigm Programming Languages; Correctness by Construction.
Date joining:	February, 2007.

Pedro López-García

Position:	*Research Scientist*, (Assoc. CSIC).
PhD:	Computer Science from the Technical University of Madrid.
Previous Pos.:	Investigador Científico, CSIC; Adj. Prof., UPM.
Research:	Parallelism; Resource Analysis.
Date joining:	May, 28, 2008.

Mark Marron

Position:	Postdoctoral Researcher.
PhD:	Computer Science, U. of New Mexico; Bach. at Berkeley; USA.
Previous Pos.:	Res. Assist., UNM, USA.
Research:	Program analysis.
Date joining:	June, 2008.

Cesar Kunz

Position:	Postdoctoral Researcher.
PhD:	École des Mines de Paris, INRIA, France.
Previous Pos.:	Internship at INRIA, France.
Research:	Dependability and Security; Proof Carrying Code.
Date joining:	October, 2008.

Regular Evaluation

- Evaluate seriously, by panel, only a few times: hiring, tenure, promotion.
- A (brief) report is prepared every year:
  - Main activities and plans/objectives for the following year.
  - Presented to SAB for advice.
  - Brief progress/plans per group (possible presentation by group leaders).
- Discussed between Director and group leader. Determines:
  - The funding level of the group for the following year.
  - Salary increase for group leader.
- Each researcher issues annual report to group leader.
  - Discuss results and plans for the coming year.
  - Determines objectives and salary increases, within group budget (with Director, possibly committee).
- Annual report is a public document (possibly a subset).

Strategic Evaluation

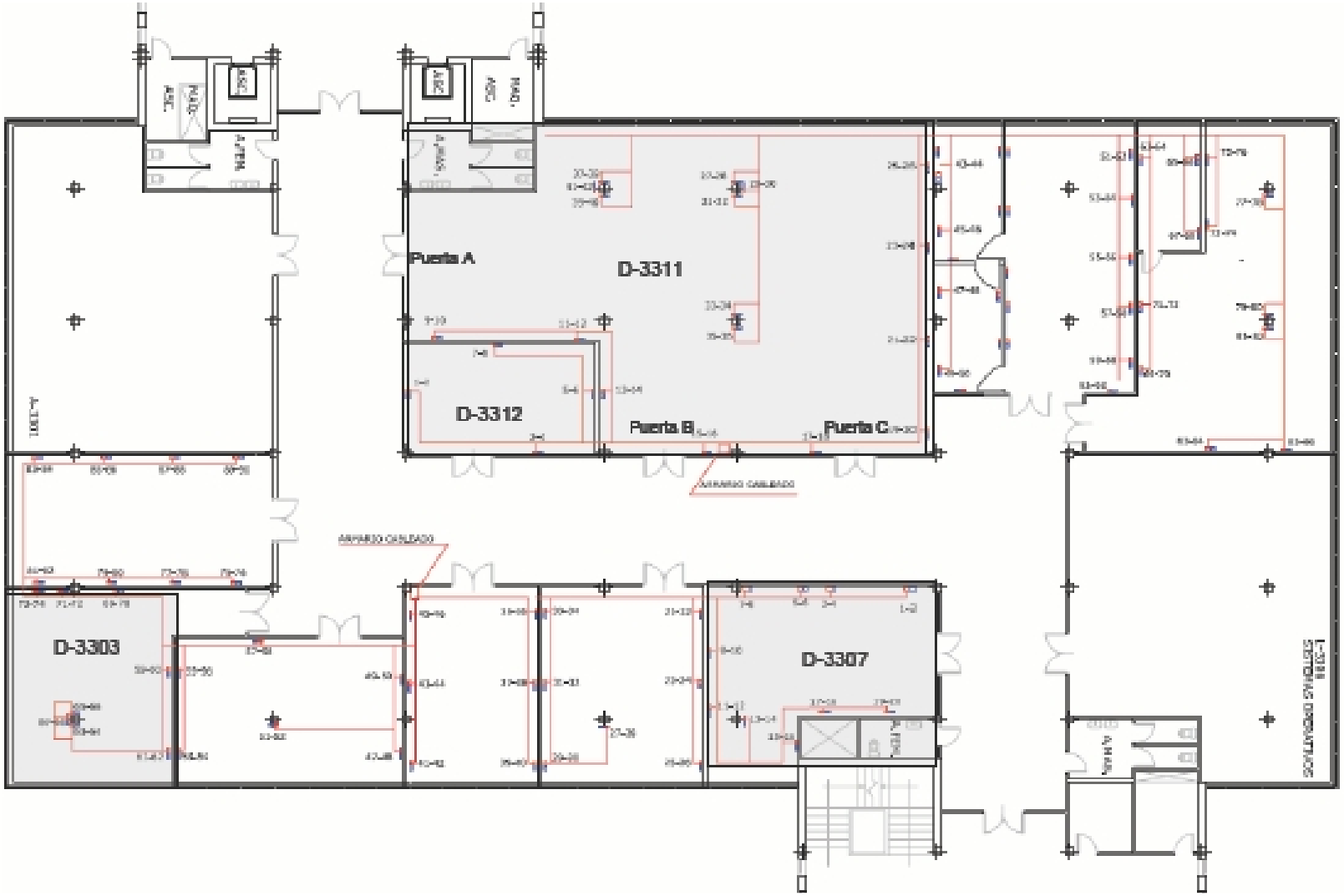
- More strategic evaluations:
  - Every 4-5 years.
  - SAB sets up a review panel (with consultation).
  - Process starts with self-evaluation from internal committee.
  - Review panel issues written report with recommendations.

- Includes:
  - Structural aspects (infrastructure, staff, premises, etc.).
  - Activity-related aspects (relevance of the research, dissemination of results, technology transfer, educational and training activities, etc.).

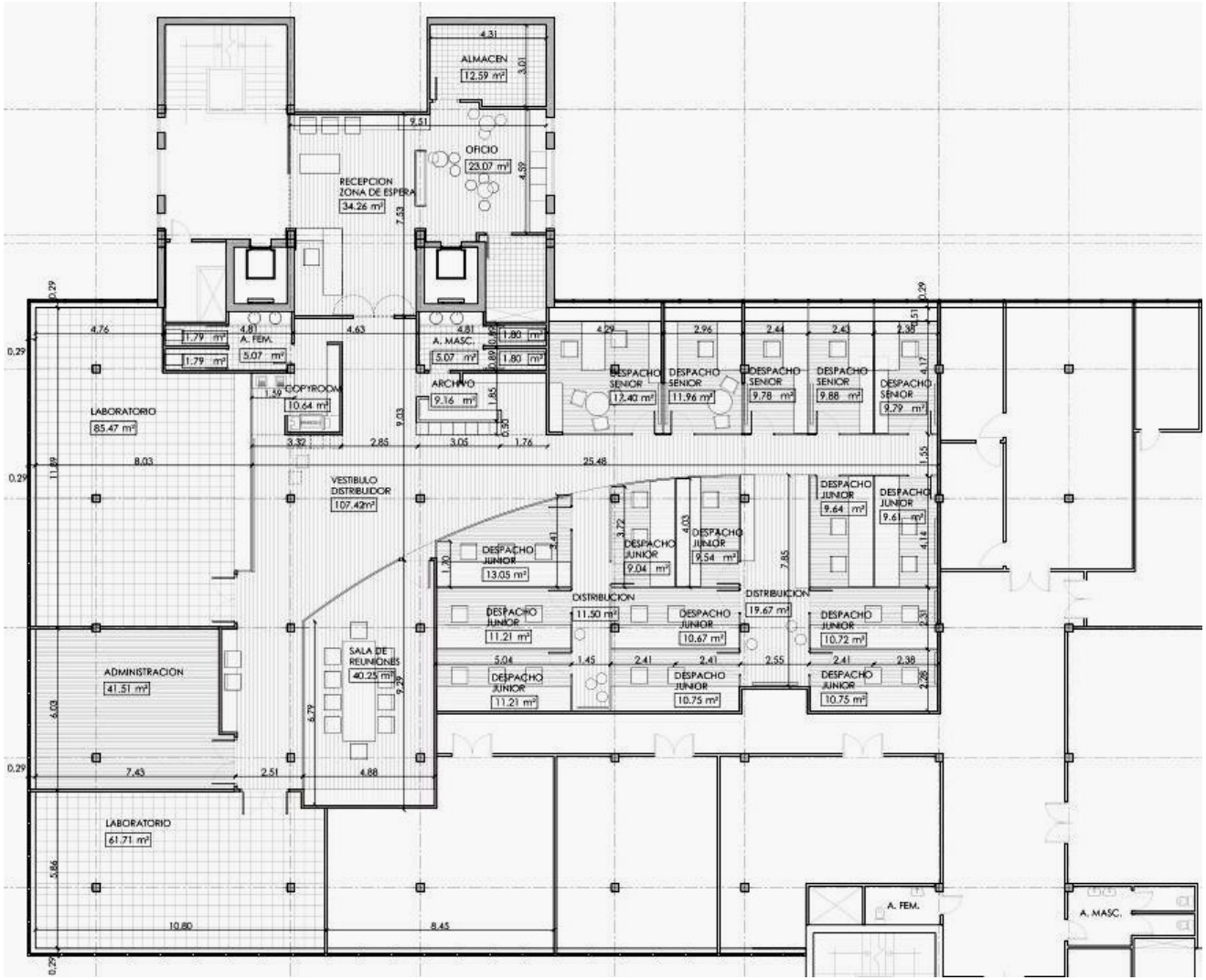
Infrastructure: temporary site

- 350 m^2 temporary location provided by Universidad Politécnica de Madrid at the School of Computer Science (Montegancedo Campus) for 3 years.
- Ongoing remodeling work to fit IMDEA standards and needs.
- Labs of associated units and, specially, *offices of associated personnel* will also be provided to the Institute during this period.
- This will allow locating management and researchers up to 30-40 total (*assuming associated personnel staying in their original locations outside Institute*).

Infrastructure: temporary site, before remodeling



Infrastructure: temporary site, remodeling

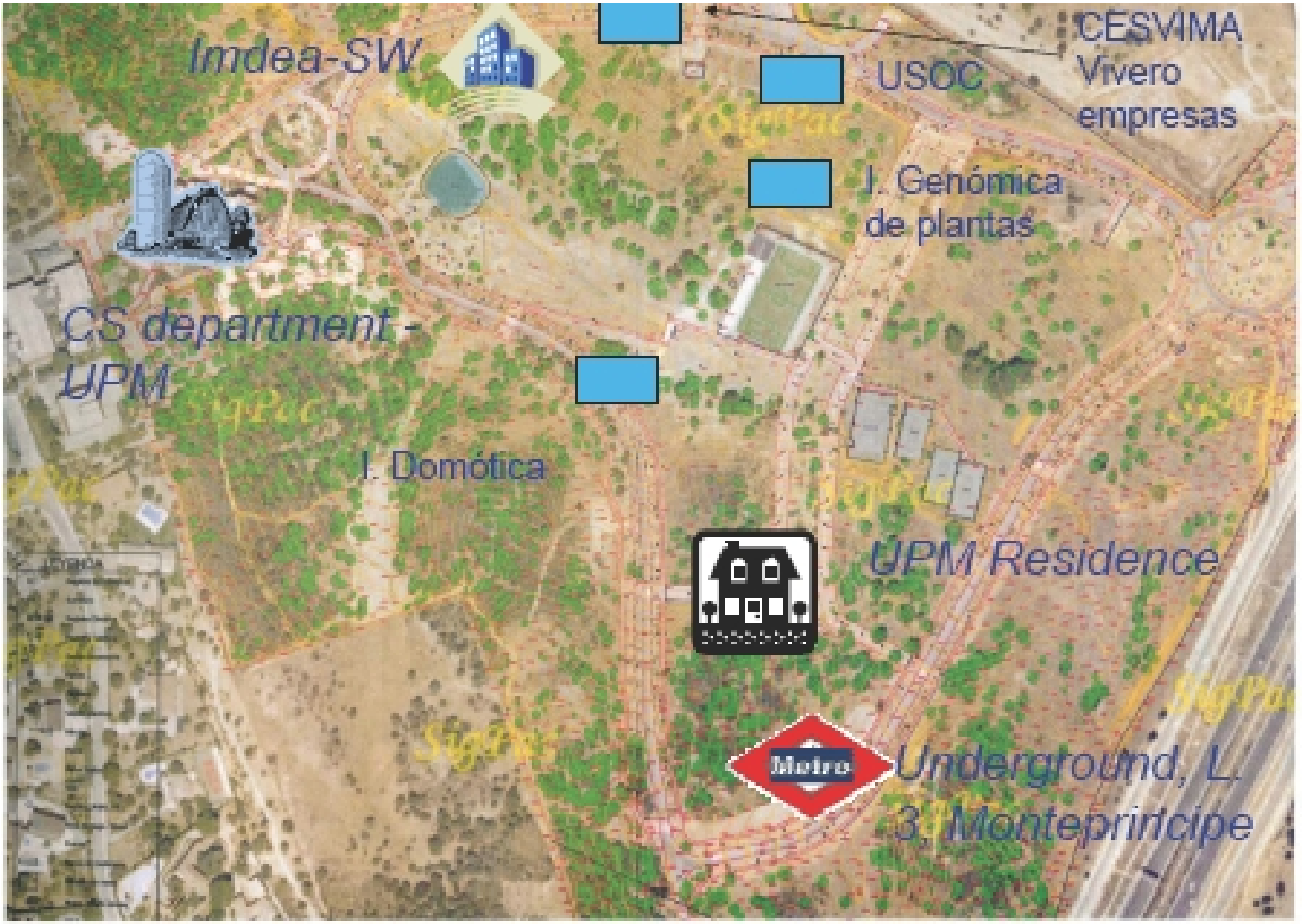


Infrastructure: permanent site

- Plot of 7.500 m^2 assigned to IMDEA Software by U. Politécnica de Madrid in its Montegancedo Campus for 50 years.
- Cession can be renewed by mutual agreement after this period.
- Very close to the School of Computer Science and to other new research centers in the area:
  - CESVIMA (supercomputing).
    - *Magerit* computer, 1200 nodes, 14 Tflops, second in Spain, 46th world.
  - Company incubator.
  - USOC (ESA, microgravity).
  - Institute for plant genomics.
  - Institute for domotics (home automation).
  - New CSIC institutes scheduled, and others planned.
- Convenient new infrastructures:
  - Underground (“Metro”, Montepríncipe stop).
  - Sports facilities.
  - Direct access from M-40 (fast access to airport, etc.).
  - Planned UPM Faculty/Student Residence.

Aerial view of Scientific Park w/Institute location

Institute location w.r.t. other facilities in Scientific Park.



Infrastructures

- We have completed the first phase of the remodeling of the provisional site (furniture, equipment, networking facilities, etc.)
- We have also laaunched the design project competition for the final site (July 2007).
- During the rest of 2008, we expect to:
  - Assign the project to the winning design firm (October 2008).
  - Launch the building project competition (November 2008).
  - Assign the project to the winning builder (January 2009).
- We hope to start construction in early 2009.

IMDEA Software: Scientific Focus

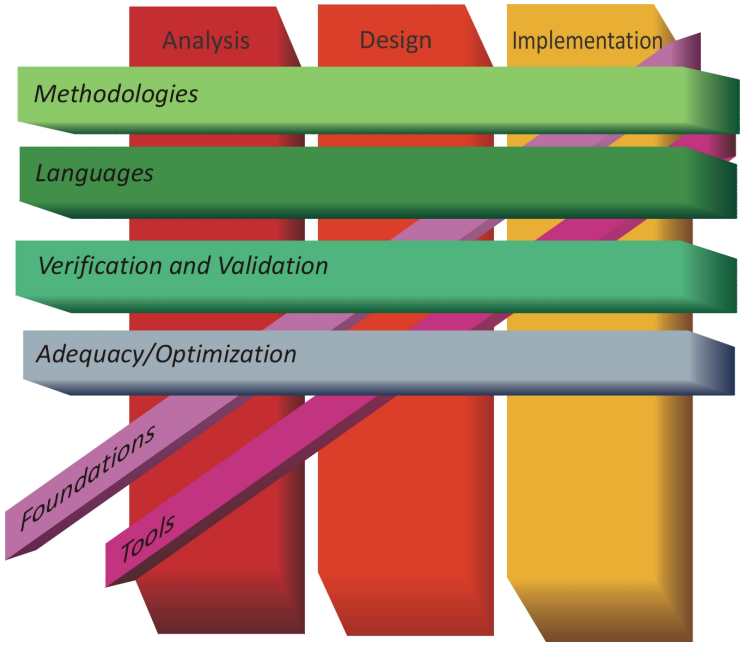
Research Focus

Develop the **science and technology** required for

- **cost-effective development of software**
- with **sophisticated functionality** and **high quality**, i.e., which is *safe*, *reliable*, and *efficient*.

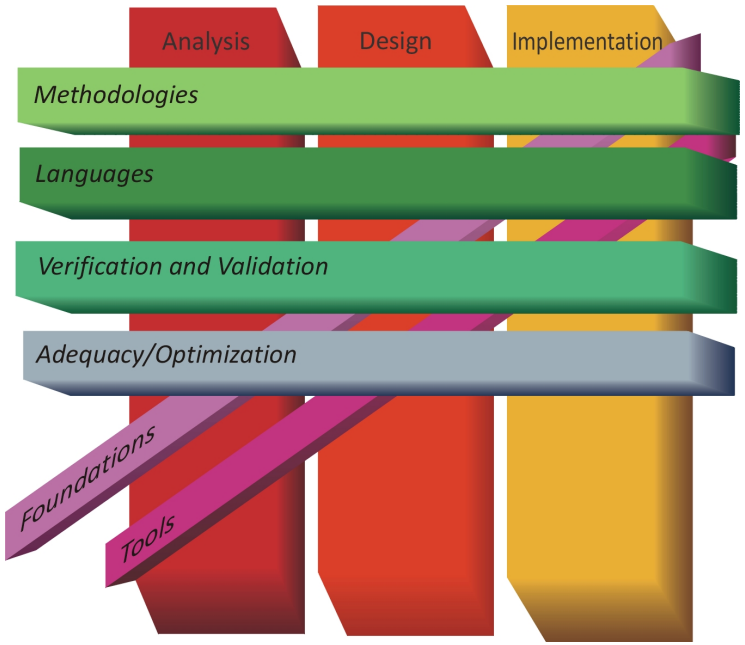
- This area has been chosen because of
  - the importance of SW as an enabling technology in most devices and services
  - the significant problems that software failures bring about
  - the cost involved in developing high quality software
  - the availability of highly qualified researchers in this area in the Madrid region.
- Three main lines of activity:
  - Research of excellence (scientific, technological –precompetitive).
  - Knowledge transfer.
  - Education and training.

Scientific Program – Research Focus



- The research area of the Institute covers all phases in the software development process:
  - **Analysis** — **Design** — **Implementation**.
- At all phases it will address:
  - **Methodologies** — **Languages**
    Verification and validation — **Adequacy / Optimization**.

Scientific Program – Research Focus



- A trademark of the Institute will be to combine:
  - **Rigorous**, **well-founded**, and, at the same time, **practical methods** that are applicable to increasing the level of automation in the development of high-quality software.
  - Well-founded and cost-effective **tools** (prototypes) that help in the automation of high quality software development.

Scientific Program: Background/Foundations

- Modeling.
- Programming Languages Principles, Design, and Implementation.
- Verification, Validation, and Testing.
- Concurrent, Parallel, and Distributed Systems.

Scientific Program: Areas of Application

Aerospace, IST, Banking, Public administration, Automotive, ...

Some Important Relevant Areas:

- Embedded and Real-Time Systems.
- Safety-Critical Systems.
- Service-Oriented Architectures.
- Security.

Including:

- Mobile Code,
- Resource-Aware, Energy-Aware Systems,
- Multicore Platforms,
- Software Families, ...

Scientific Program: Initial Research Lines/Topics - I

Modeling

- Constraint Modeling Languages
- Modeling-Driven Security

Security

- Language-Based Security
- Cryptography

Optimization

- Rigorous Optimization, including Automatic Parallelization

Scientific Program: Initial Research Lines/Topics - II

Programming

- Abstraction-based Programming
- Resource Usage Debugging and Verification
- Runtime Verification
- Synthesis
- Static Analysis-Inspired Programming Language Design

Other topics:

- Component-based design and semantic interoperability.
- Rigorous approaches to Service-Oriented Architectures.
- Rigorous approaches to Semantic Represent./Access (e.g., to the Web).
- Testing. Other topics in model-checking.
- Constraints, constratint-based analysis, SAT-based methods, BDDs.