

VERIMAG

A LEADING RESEARCH CENTRE IN EMBEDDED SYSTEMS SINCE 1992

AWARDS

- 2011: Election of Joseph Sifakis to the French Academy of Science
- 2009: Best scientific publication award of the National Foundation of Research in Aeronautics and Space to Saddek Bensalem
- 2007: Turing award, the highest recognition in Computer Science, to Joseph Sifakis, shared with Ed Clarke and Alan Emerson
- 2004: Michel Monpetit Prize of the French Academy of Science to Paul Caspi and Nicolas Halbwachs
- 2002: CNRS Silver Medal to Joseph Sifakis



Joseph Sifakis

TECHNOLOGY TRANSFER

- The Lustre programming language and its compilation principles are integrated into the SCADE tool (Esterel Technologies) which is an international de facto standard for critical real-time software.
- Use of the BIP formalism and tool box for programming the PROBA satellite (ASTRIUM).



Automatic Transfer Vehicle (ATV)

IMPACT ON RESEARCH

Pioneering role in several domains:

- Model-checking (Turing Award)
- Synchronous languages (Michel Monpetit Prize)
- Timed and hybrid systems modelling and verification
- Predicate abstraction and invariant generation - taken up and further developed e.g. in SAL (SRI) and Slam (Microsoft)

STRUCTURING THE RESEARCH COMMUNITY

- 1989: Co-founder of the Conference on Computer-Aided Verification (CAV), top conference in its domain
- 1998: Co-founder of the Conference on Hybrid Systems: Computation and Control (HSCC)
- 2001: Co-founder of the EMSOFT conference, one of the main conferences on foundations for embedded software development
- 2002-2011: Coordination of the ARTIST European Network of Excellence on the Design of Embedded Systems gathering 35 major European teams in the area
- 2003: Co-founder of the Conference on Formal Modelling and Analysis of Timed Systems (FORMATS)
- Since 2007: Direction of the CARNOT Institute «Intelligent Software and Systems» in Grenoble



VERIMAG : KEY PARTICIPANT IN :

- CARNOT Institute LSI
- Cluster of excellence PERSYVAL -lab
- PILSI Integration Research Center of the International Software and Smart Systems Cluster

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VERIMAG

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research laboratory

Grenoble: the capital of the French Alps, is one of the main research and high technology centres in Europe:

- 21.000 researchers, 60.000 students
- 4 international research centres, ESRF, ILL, IRAM, EMBL
- 5 national research centres: CNRS, INRIA, CEA, INSERM, IRSTEA
- 2 international competitiveness clusters: Minalogic and Tenerrdis

leading centre in Information and Communication Technologies:

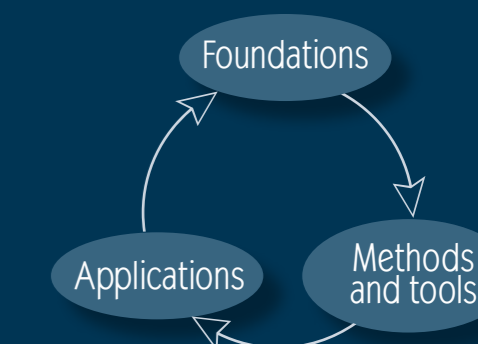
- 35000 direct industrial and academic positions, including 2000 researchers, engineers, postdocs and PhD students
- 1000 engineering and master students graduating every year
- 2 Carnot Institutes: LSI and CEA LETI
- Several major companies in Information and Communication



Université Joseph Fourier GRENOBLE



Methods and tools for building embedded systems of guaranteed quality



Conception : CNRS Alpes | Service Communication | LRF © Verimag | Crédit Photo : CSG Service Optique/ NASA / Airbus Computer Graphics by BM CNRS Photothèque - GRIMAUD | Emmanuel | ACM

SYNCHRONE

From language design to modelling, implementation and formal validation methods for embedded systems and networks of embedded systems; with a focus on energy consumption and deterministic timing; with applications in critical hard real-time control systems, systems-on-a-chip, and sensor networks.

TEMPO

Verification methodology to domains and disciplines where models involve real-time clocks or continuous systems defined by differential equations.

DISTRIBUTED AND COMPLEX SYSTEMS

Abstraction and tools for the design and implementation of distributed and complex systems with extra-functional properties: hard and soft real-time, security, performance.

PUBLICATIONS

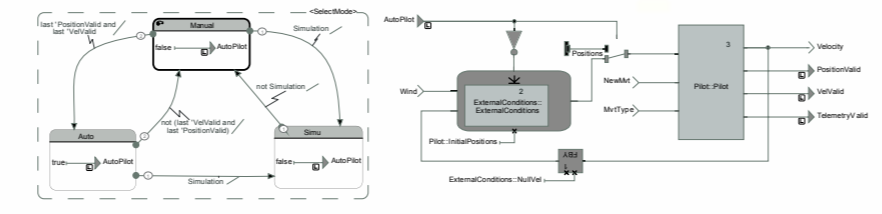
About 90 publications annually, including 15 international journals and 60 international conferences. Participation in about 15 projects funded by local, national or European grants or by industrial partners.

BUDGET (2011)

Annual global budget (excluding statutory salaries): about 2 MEuros, over 90% of which is from national or international funding agencies or direct industrial contracts.

HUMAN RESOURCES

90 persons including:
 31 permanent researchers
 30 PhD students
 23 Postdocs and research engineers
 6 support staff



A380: software development with SCADE

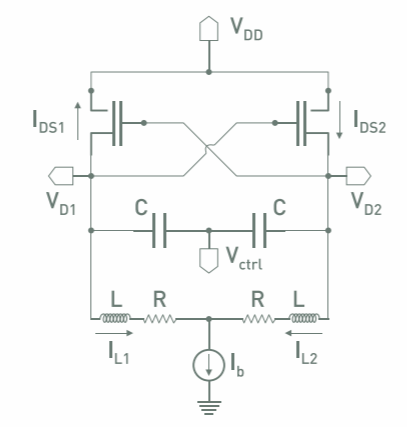


WIRELESS SENSOR NETWORKS

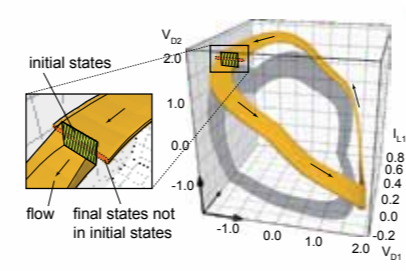
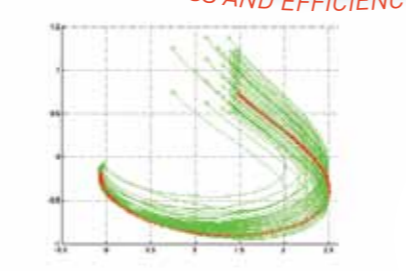
Providing formal models and virtual prototyping tools for studying energy consumption in wireless sensor networks:
 • Protocols and distributed algorithms for WSNs
 • Energy-efficient programming of sensor nodes
 • Simulators for energy consumption and security properties

IMPLEMENTATION OF EMBEDDED SYSTEMS

Architecture-aware techniques:
 • Support for correct-by-construction integration of components
 • Multi-threaded, distributed and multicore implementations of real-time applications
 • Synchronous programming of device drivers for global resource control



Analogue circuit – Trajectory based verification – Set based verification of oscillation properties



COMPUTER-AIDED PROVABLE SECURITY

- Foundations of security
- Computer aided verification of cryptographic systems
- Software engineering for security
- Tools for common criteria verification
- Information flow and non-interference analysis
- Testing and monitoring of security properties
- Secure e-voting

VERIFICATION AND VALIDATION TECHNIQUES

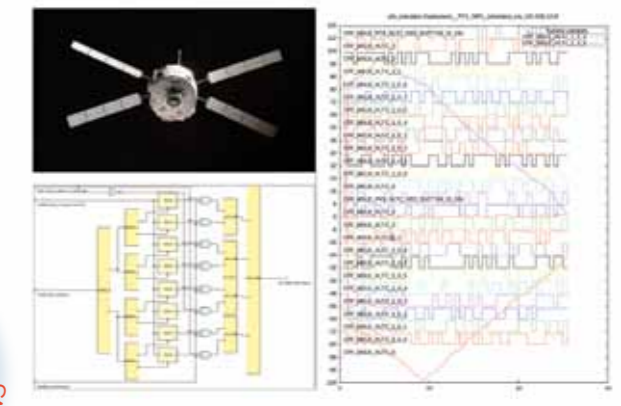
Verification and validation methods are crucial throughout the design cycle:
 • Foundations and applications of model-checking, abstract interpretation, and mixed methods
 • Simulation and early execution
 • System-level verification

HYBRID SYSTEMS

Enriching the analysis toolbox for engineers and scientists in various domains:
 • Theoretical and algorithmic foundations
 • Reachability analysis for continuous and hybrid systems
 • Scheduling and performance evaluation
 • Monitoring temporal properties
 • Systematic simulation and test generation
 • Applications: control, analog circuits, multi-core computing, system biology

SYSTEMS-ON-A-CHIP

Virtual prototyping of systems-on-a-chip based on Transaction-Level-Modelling (TLM):
 • Validation methods and tools for SystemC
 • Efficient simulation principles
 • Modelling energy consumption at the TLM level
 • Faithfulness of TL modelling



Automatic Transfer Vehicle (ATV): Early simulation of the execution of the embedded code (in Scade) on a distributed architecture described in AADL

SOFTWARE VERIFICATION

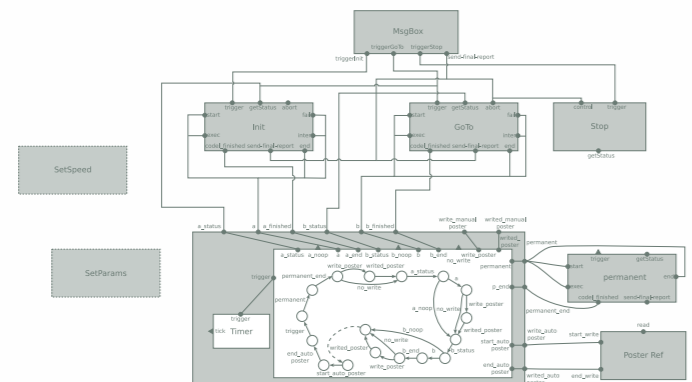
Developing theory and tools for scalable software verification:
 • Multi-threading and dynamic recursive data structures
 • Verification tools for real-world C/C++/Java programs
 • Complexity analysis of verification problems
 • Assertion checking and termination proofs

LANGUAGE DESIGN FOR EMBEDDED SYSTEMS

Coping with the growing complexity of embedded hardware and software systems thanks to high level languages:
 • Languages and tool support for parallel programming
 • Non-deterministic languages for virtual prototyping and simulation
 • Component-based modelling and programming languages
 • Synchronous languages

COMPONENT-BASED DESIGN OF EMBEDDED SYSTEMS

Modular component framework for Behaviour - Interaction - Priority (BIP):
 • Structural and compositional verification of programs
 • Component-based design of multi-core systems
 • Property enforcement and controller synthesis



Data robot - BIP component-model - Verification of a BIP model with D-finder, code generation with BIP, and integration into existing software

ABSTRACTION AND TOOLS FOR DEFINING EFFECTIVE SOLUTIONS

EFFICIENT AND PREDICTABLE DISTRIBUTED ALGORITHMS AND EMBEDDED CODE

CORRECTNESS AND EFFICIENCY BY CONSTRUCTION

NEW FRONTIERS FOR VERIFICATION TECHNOLOGY

GUARANTEED QUALITY

FROM UNDECIDABILITY TO PRACTICE

THINK PARALLEL

MASTERING HETEROGENEITY

FROM ART TO SCIENCE

$Pri(A) \leq m!$

$S := S \rightarrow S := (S+1) \% K$

$[*]p[x+1]=q$

$\exists x+kx=0$

$\exists P \Rightarrow \Leftrightarrow Q$

$x=0 \Rightarrow pre(x)+1$

$wait(5, SC_MS)$

$C=C||C2$