

# Verimag Laboratory

[www-verimag.imag.fr](http://www-verimag.imag.fr)

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- 1 History, Research Topics
- 2 Organization: 4 teams
- 3 Trends and Hot Topics

# Verimag: History

- **1993**: Creation by Joseph Sifakis, as a mixed industrial/academic research unit with main activities: model-checking, and synchronous programming language Lustre (Caspi & Halbwachs).
- **1996-now**: Academic Research lab (CNRS, UGA, Grenoble INP)
- **1993-1996**: Industrial transfer of Lustre (now the core of SCADE, ANSYS/Esterel Technologies)
- **1993-now**: New topics (security, hardware modeling, hybrid systems, ...) and wide extension of initial topics
- **2002-2012** ARTIST Network of Excellence on Embedded Systems (led by J. Sifakis, Turing award in 2008)

# Verimag: Some Key Points

- Contributors to and informed users of: **theoretical** aspects of computer science
- Mastering the **“big picture”** on systems, thanks to:
  - a horizontal view on several application domains
  - a vertical view from theoretical models to implementations
- A good balance between theory and practice
- Long-term objectives, tool development and industrial transfer (*Lustre/SCADE, IF Toolbox, Argosim.com, SpaceEx, Stator, BIP*)
- A small, thematically coherent lab

# Domains of Expertise

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## Formal Validation (exhaustive or not)

Abstract Interp., model-checking  
theorem-proving, symbolic exec.,  
Autom. Test, monitoring, ...  
Code analysis, model extraction  
Certification

# Domains of Expertise

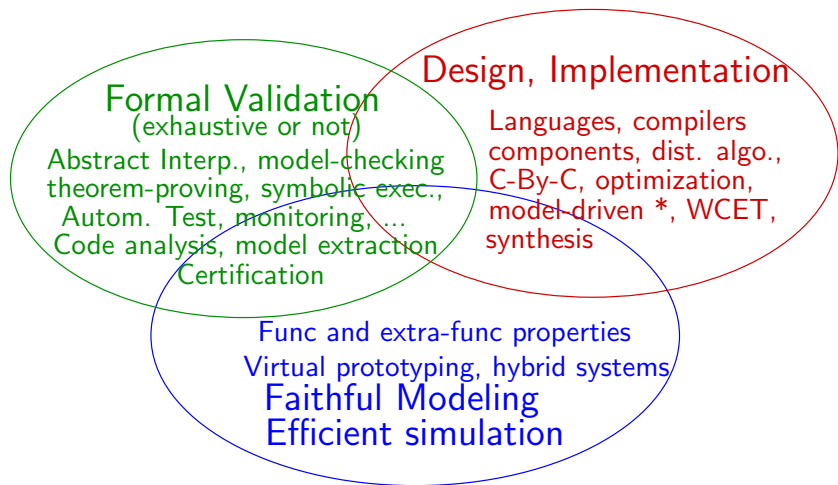
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## Design, Implementation

Languages, compilers  
components, dist. algo.,  
C-By-C, optimization,  
model-driven \*, WCET,  
synthesis

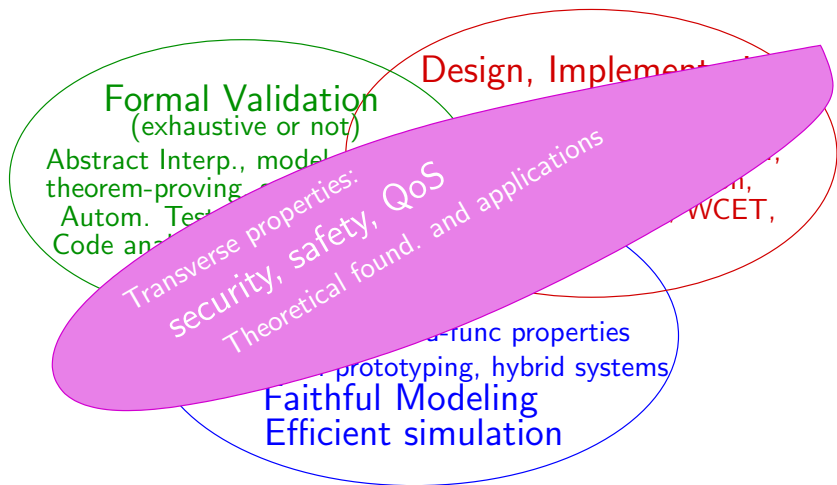
# Domains of Expertise





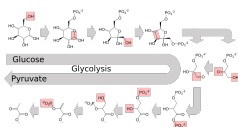
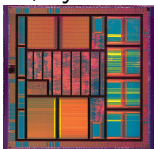
# Domains of Expertise

+ 1 transverse topic



# Application Domains

Embedded control systems, protocols, manycore architectures, analog circuits, biology, smartcards, security (protocols), vulnerability analysis, sensor networks, systems-on-a-chip, smart cities, IoT, ...



Many academic and industrial collaborations

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# Organization: 4 teams

- ① Hybrid and Timed Systems (O. Maler)
  - Hybrid automata
  - **SpaceEx tool**: reachability for non-linear systems
  - **Collaborations** with Toyota, Bosh, Atrenta, STMicroelectronics, ...
- ② Synchronous Languages and Critical Systems (P. Raymond)
  - From high-level formal models to Implementations, WCET, safety and certification
  - **Lustre tool suite**: high-level programming correct RT Embedded Systems (see **SCADE**)
  - **Automatic testing** of reactive systems (→ start-up company *Argosim*)

# Organization: 4 teams

- ③ Rigorous System Design (S. Bensalem)
  - **BIP Framework**: incremental and compositional design of ES using multiple DS languages
  - **Scalable verification** techniques and **implementation techniques** for BIP
  - **Collaborations** with Thales, TTTech, PragmaDev, Magillem Design Services, ...
- ④ Proofs and Code Analysis for Safety and Security (D. Monniaux, M.-L. Potet)
  - **Advances in Formal Verification and Certification**, SMT, Abstract interpretation, model-checking, proof assistants, ...
  - **Security**, code analysis for the detection of vulnerabilities, smart cards, industrial applications, ...
  - **Collaborations** with Airbus, AdaCore, ATOS Worldgrid, Seclab, ...

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# Trends in Cyber-Physical Systems Research

- Safety-critical systems must run on modern hardware
- Security and safety aspects have to be designed together
- Formal validation has to use a mixture of all techniques and tools (model-checking, abstract-interpretation, SMT, ...) +  
In order to be used, the tools will have to be certified.
- Embedded and Distributed Systems converge (IoT, complex hardware) and their key problems add up
- New problems appear in systems of systems and their “emerging properties”
- ...