

Year 3 Review
Paris, December 14th, 2007

Achievements and Perspectives :

Real Time Components

Cluster leader : Bengt Jonsson
Uppsala University

Outline

- Cluster organization and goals
- Technical progress and Integration
 - Concepts and theories
 - Tool integration
 - Launched common projects
 - Standardization
- Assessment
- Future plans

Core Partners

- Univ. of Cantabria (Julio Medina)
- CEA (Sebastien Gerard, Francois Terrier)
- EPFL Lausanne (Tom Henzinger)
- France Telecom R&D (Jacques Pulou, Thierry Coupaye)
- INRIA (Albert Benveniste, Jean-Marc Jezequel)
- OFFIS (Werner Damm, Bernhard Josko)
- PARADES (Alberto Ferrari, Alberto Sangiovanni-Vincentelli)
- Uppsala University (Bengt Jonsson, Wang Yi)
- VERIMAG (Paul Caspi, Susanne Graf, Joseph Sifakis)
- TU Vienna (Wilfried Elmenreich, Hermann Kopetz)

Structure of Cluster at Y0+2

Forum with Industrial Affiliates

Seeding new Research Directions

- High-quality seminars with well stated objectives
- Detailed minutes, seen as a scientific tool,

Platform for Component modeling and Verification

- Integration of Tool chains

Development of UML for Real-Time Embedded Systems

- Submission to OMG Standard for UML profile MARTE

Structure of Cluster at Y0+2

Forum with Industry

Seeding

Reporting problems:
Deliverables do not match activities

on Directions

- High level seminars with well stated objectives
- Detailed minutes, seen as a scientific tool,

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Structure of Cluster in Y3

Component- Based Design of Heterogeneous Systems

- Design of Heterogeneous Systems
- Interfaces and Compatibility
- Industrial Liaison

Platform for Component modeling and Verification

- Integration of Tool chains

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Industrial Relevance

- Industrial situation

- Automotive

- Electronics contribute 40% of total costs and 20% of value creation;
 - Development costs for embedded software constitute 50 - 70% of total development costs of ECUs
 - 70 - 90% of all innovations in automotive rest on embedded systems,

- Avionics

- Embedded Systems represent about 40% of Systems price
 - Costs per single line of certified level A SW Code is 100€.

- Industrial needs:

- Reduce development time despite increase of size and complexity
 - Increase quality and reliability of products and services with new functionalities for end user.
 - **PriceWaterhouseCoopers:** Achieving continuous **cost reduction** and **performance improvement** will continue to be a challenge and a key focus for both the Automotive OEMs and their suppliers.

Industrial Challenges

Component-Based Development

Aims to provide techniques and methods

- to guide, optimise and assess systems architecture choices
 - against business and operational criteria (cost, minimization of system interfaces, mass, safety, reliability ...)
- to design, validate, verify, certify/qualify products
 - by assembling predefined or specific building blocks (components)
- to reduce development effort and cost
 - by enabling reuse and structuring

Industrial Activities

- Automotive: Autosar
- Avionics: IMA

Aims for Integration

Component- Based Design of Heterogeneous Systems

- Design of Heterogeneous Systems
 - Develop foundation for Component-Based Heterogeneous Systems
- Interfaces and Compatibility
 - Develop generic techniques for handling QoS and resource properties
- Industrial Liaison

Platform for Component modeling and Verification

- Synchronize European efforts on development tools

Development of UML for Real-Time Embedded Systems

- Contribute our view in UML standardization

Design of Heterogeneous Systems

- BIP: a semantic-level framework [VERIMAG]
 - Formalization of the algebra of connectors
 - Timed component model [w. INRIA]: used as semantic level formalisms in several tool connections, collaboration projects.
- Comparison and cross-fertilization between different frameworks (BIP, Metropolis) [PARADES]
 - Metropolis II now handles foreign heterogeneous components
- Architecture for heterogeneous systems [Vienna]
 - Targeting error containment and diagnosis, for SoC.
- Specialization of UML for heterogeneous systems [CEA]

Interfaces and Composability

- Meta model for HRC (Heterogeneous Rich Components) [INRIA, OFFIS, PARADES, VERIMAG]
 - Central technology in IP SPEEDS, and other projects (Combest)
 - Basis for design space exploration techniques [OFFIS, PARADES]
- Implementation technology for timed components
 - Based on KerMeta [INRIA], BIP [VERIMAG], targeting Giotto [EPFL].
- Hierarchical coordination language for RT tasks [EPFL, PARADES]
- Scalable timing analysis [Uppsala, ETHZ] -> CATS tool
- Synthesizing behavioral interfaces [EPFL, Uppsala, Dortmund]
- Adapter synthesis [INRIA, I'Aquila]
- Other component models [Cantabria, MdH, Uppsala]

Industrial Liaison

- Workshop “Beyond AUTOSAR”,
 - Finalization of reporting
- Workshop on “Integrated Modular Avionics”
 - Rome, Nov. 2007, proceedings on the WWW.
- Establishment of SafeTRANS
 - Key German players in transportation domain.
 - Mission: maintain high safety levels.
- Launching of several European projects with significant industrial participation
 - Airbus, Bosch, Esterel Technologies, IAI, SAAB, Telelogic, Thales, ...

Platform f. Component Modeling&Verification

- Aims:
 - Promotion of common exchange formats and generic tools
 - Sharing development effort
 - Obtain wider applicability of existing tools
 - Build up new initiatives
 - projects that connect tools into complete tool chains
 - Integration with the Platform for Testing&Verification

Tools concerned by Platform

Modelling tools: Papyrus (*CEA*), some commercial tools

Meta-modeling and model-transformation techniques: Kermeta,
ATL (*INRIA*)

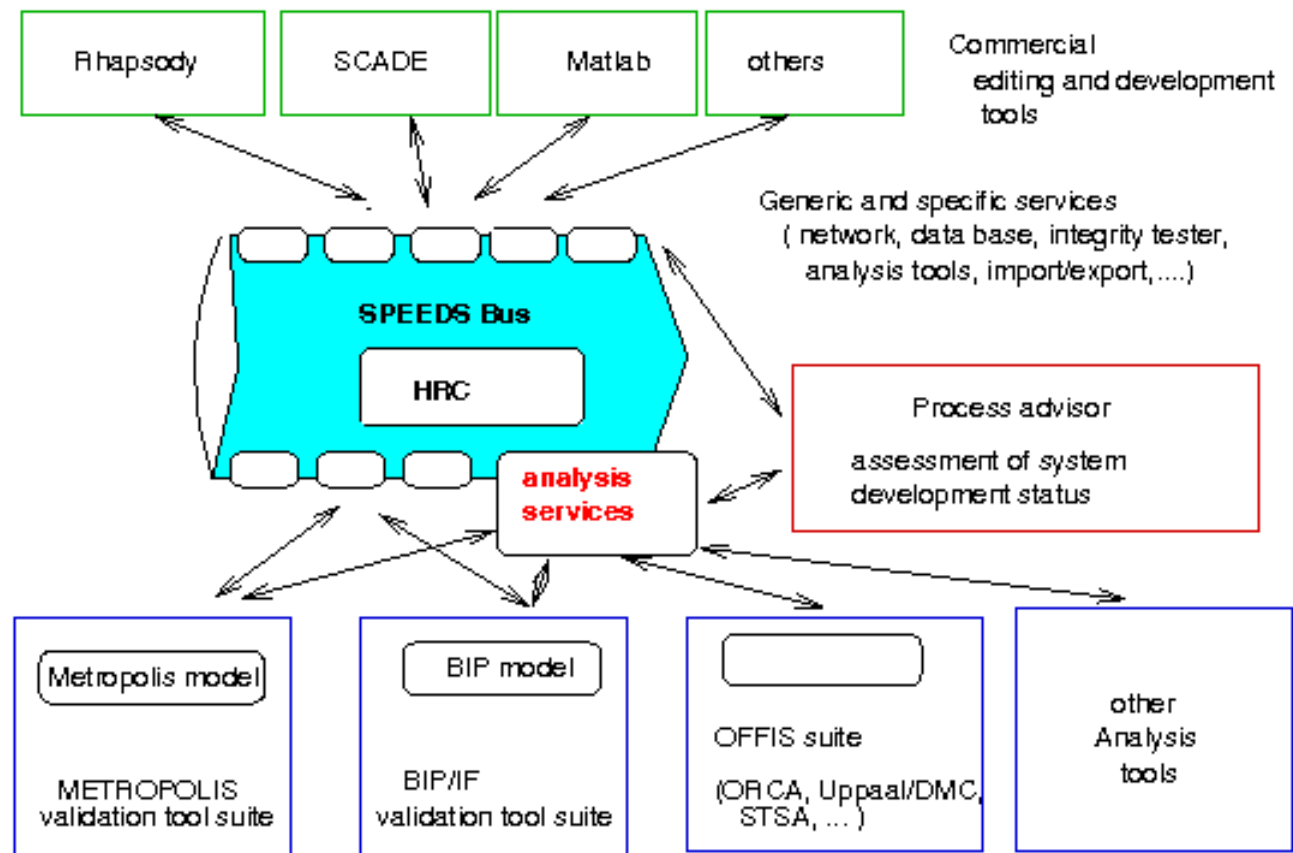
Integration of existing analysis, verification and testing methods &
tools: Agatha (*CEA*), BIP/IF (*Verimag*), MAST (*Cantabria*),
Metropolis (*Parades*), *OFFIS* analysis toolset, UPPAAL, Times
(*Uppsala/Aalborg*), ...

Implementation techniques for components: Fractal/Think (*FTRD*),
Giotto (*EPFL*)

Integration Frameworks: Eclipse, jETI (*Dortmund*)

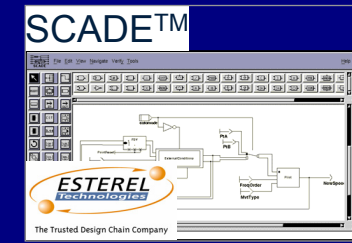
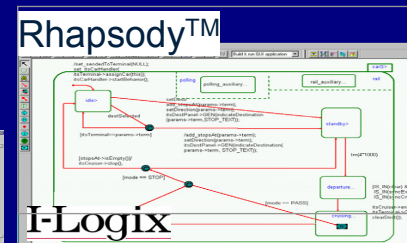
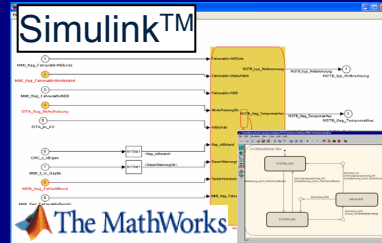
SPEEDS

- SPEEDS: definition of a global infrastructure and tool flow for analysis and hosted simulation between different tools.

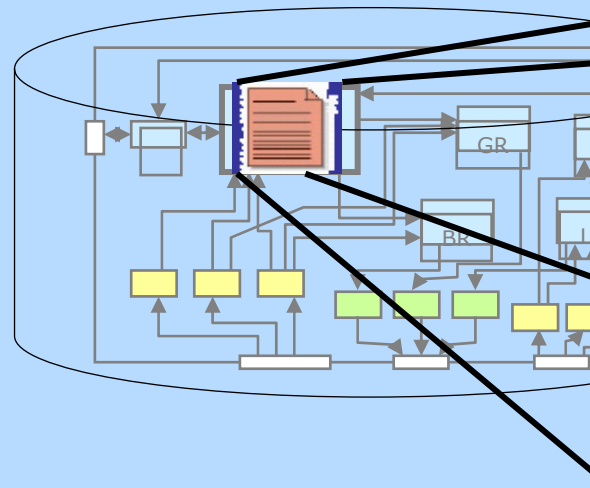


SPEEDS

User's View:
COTS
modeling
tools



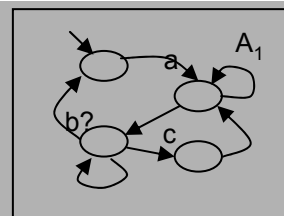
Speeds
Metamodel



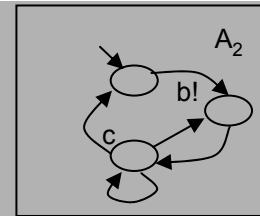
```

component C
begin
  interface I
  begin
    ...
  end
  view functional
  begin
    ...
  end
  view safety
  begin
    ...
  end
end
  
```

Speeds
Semantic Foundation



||

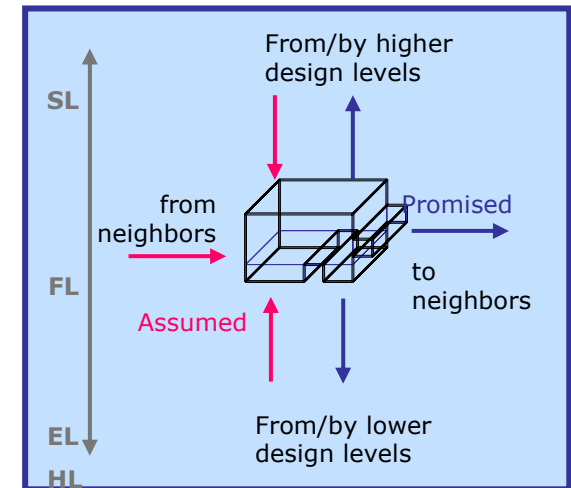


for all viewpoints v :
 $\cap L(A(\text{OutI.v.pr}_j)) \subseteq$
 $\cap L(A(\text{InI.v.assm}_i))$

SPEEDS HRC Meta-model

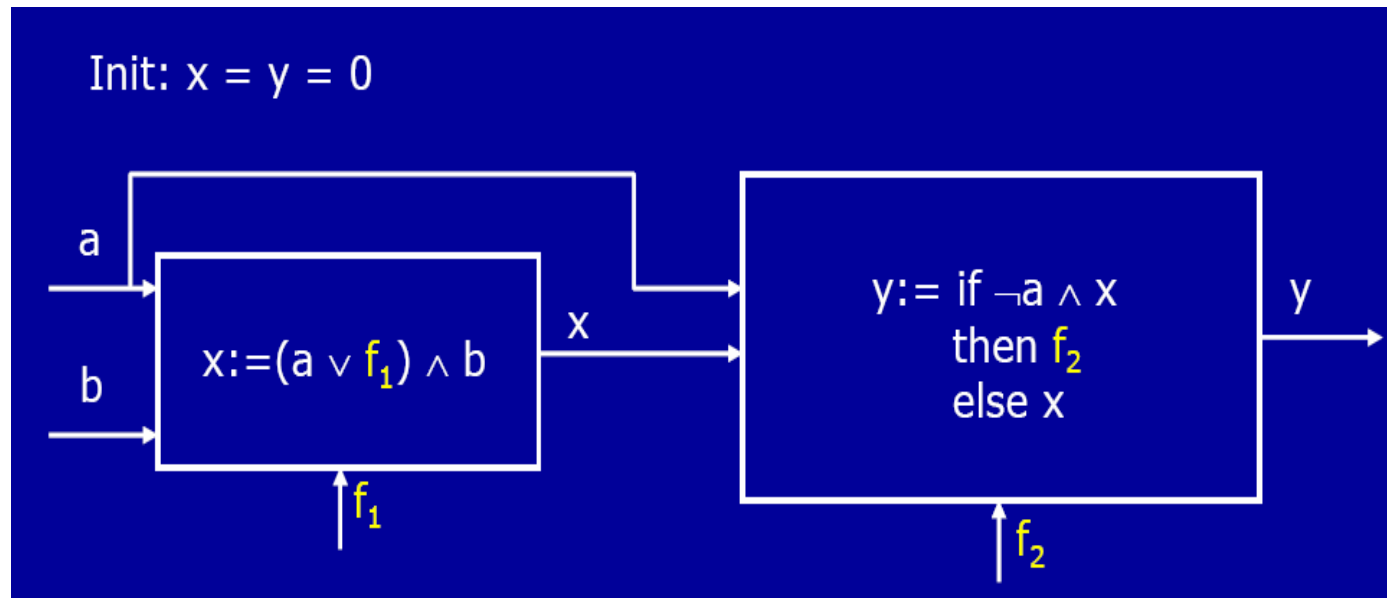
To provide a characterization of components of electronic components

- supporting **all phases, levels, and viewpoints** of electronic system design
- Allowing **complete re-use** (across multiple platforms, across multiple organizations, and/or as part of design libraries)
- Allowing **characterization** of allowed/assumed **environments** of component (for all viewpoints)
- Basis for (de-facto) standardization, compatible with standards like SysML
- As basis for **tool-independent meta-model** for capturing and validating function networks
- Supporting **semantic based integration** of industry standard System & SW **design tools** (UML, Matlab-Simulink/Stateflow, ASCET, ...)
- Supporting view-point specific and cross viewpoint **requirement capturing, modeling, analysis and design**



Semantic Basis for Contract-based safety analysis

INRIA, OFFIS



CONTRACT:

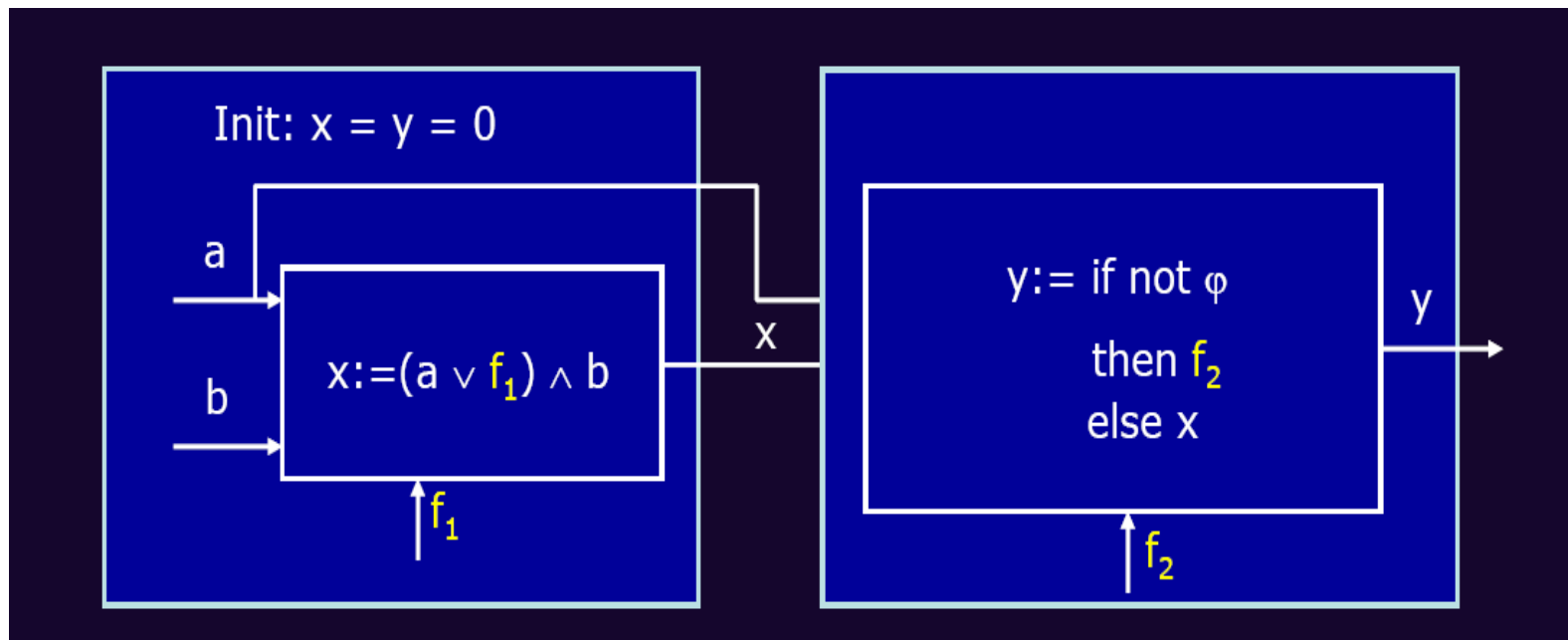
two failures f_1 and f_2 , with probability distributions P_1 and P_2

Top Level Exception resulting from double failure (TLE): $\neg a \wedge y$

$C = (A, G) = (\text{TRUE} , \text{never}(\text{TLE}))$

$M \models C$ with probability at least $1 - \beta$,

Compositional Approach



f_1 probability P_1
 $C1 = (\text{TRUE}, \text{always}(\varphi))$
 where: $\varphi = \text{not}(\text{TLE})$
 $= a \text{ or not } x$

f_2 probability P_2
 $C2 = (\text{always}(\varphi) ,$
 $\text{always}(\varphi) \text{ implies } \text{always}(y=x))$
If I get proper service,
then I shall deliver proper service

Composition: C1 and C2 implies C

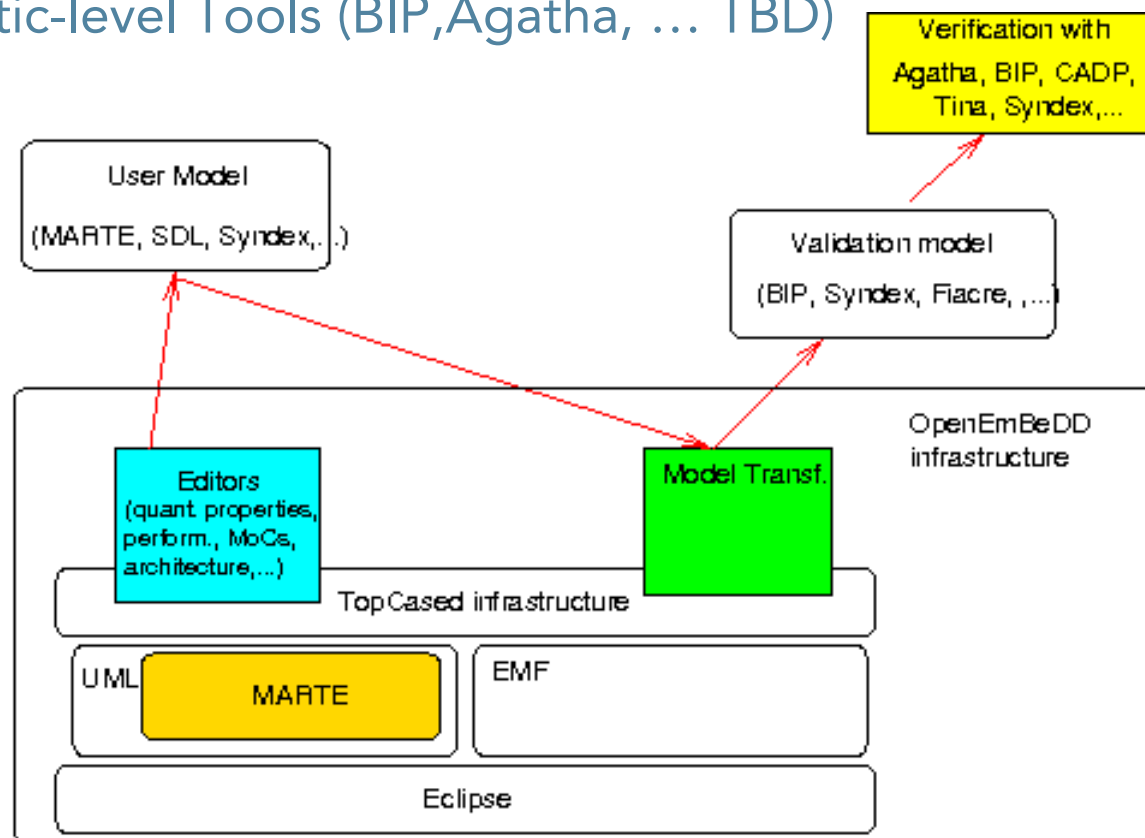
HRC Status

- Development of theoretical infrastructure for SPEEDS based on Heterogeneous Rich Components (HRC)
 - definition of the first version of the SPEEDS metamodel covering the main aspects of
 - contracts (assumption/promise specifications) and
 - viewpoints (functional behaviour, real-time, safety, ...)
 - based on a formal compositional semantics.
 - accomplished by a survey and assessment of standards
 - SysML, AUTOSAR, MARTE, AADL
- Elaboration of contracts (A/P) concepts in systems design
 - Studies on specification examples (Water flow control; UTOPAR)
- First implementation experiences of the metamodel (Kermeta).
- First concepts for tool integration
 - Initial work on hosted simulation

Involved Artist2 partners: INRIA, OFFIS, PARADES, VERIMAG

OpenEmBeDD

- Editors (Papyrus)
- Model transformation technology (KerMeta, ATL)
- Semantic-level Tools (BIP, Agatha, ... TBD)

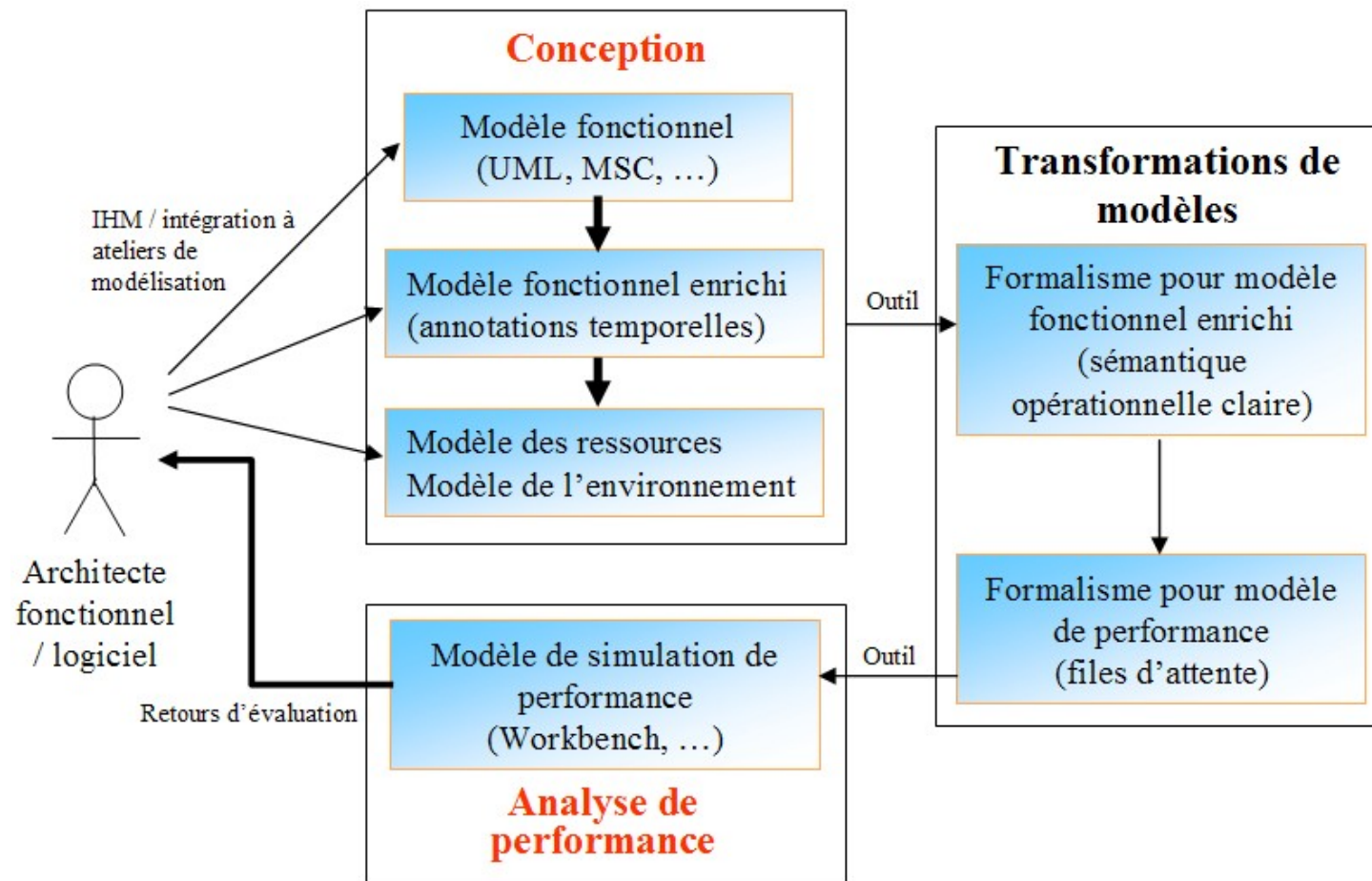


Other Tool Integration Chains

- Persiform [VERIMAG, INRIA, France Telecom]
 - UML modeling tools -- Performance Analysis tools
- BIP/Fractal/Think [INRIA, VERIMAG]
 - Generation of Code from BIP Models
- Papyrus/IF/BIP/KerMeta/Giotto [CEA, INRIA, VERIMAG, EPFL]
 - from UML models (MARTE profile) to implementation on MindStorm
- EDEN-2 [VERIMAG, CEA]: IF/Agatha
 - Verification and Certification for Smart Cards

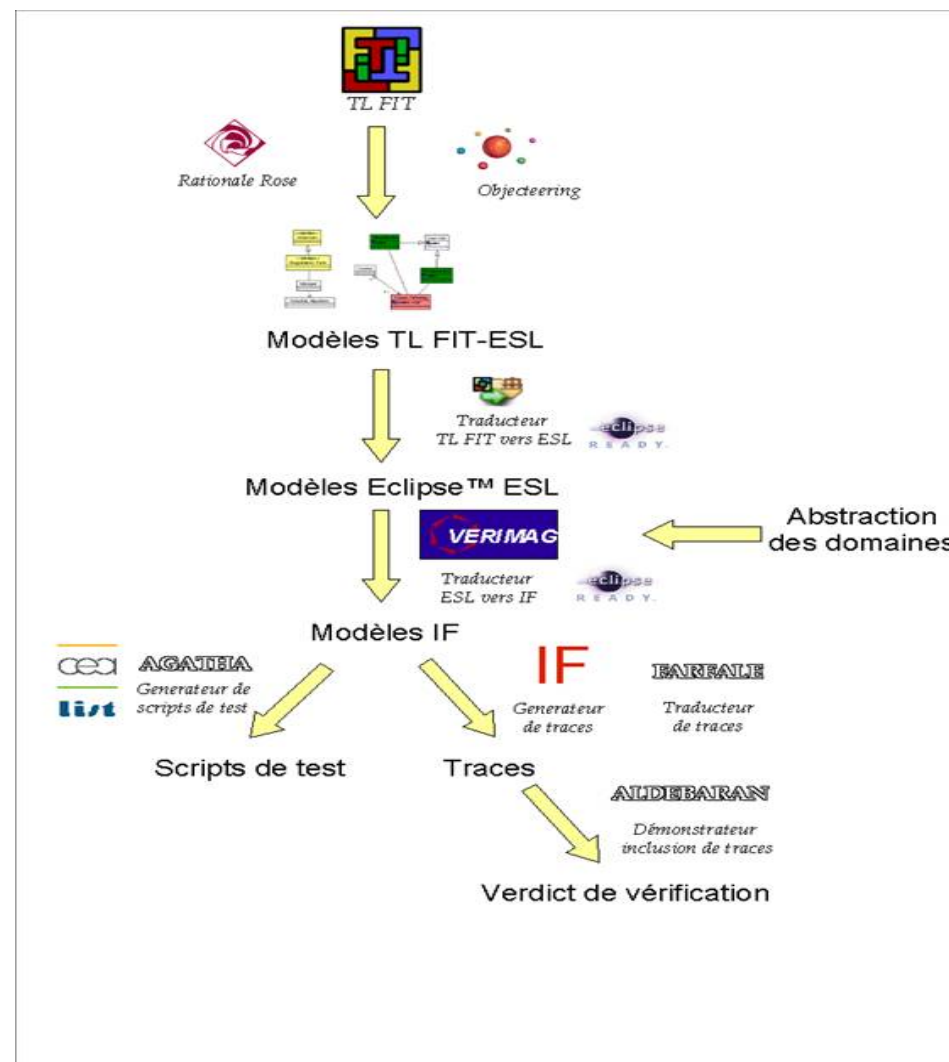
Persiform

- Complete tool chain formed by reusable components is implemented and tested
- Future work: adaptation of tool chain to MARTE in OpenEmBeDD



EDEN-2

- The architecture of a complete tool chain
- For certification of smart cards.



Standardization of UML for RTES

Goal:

- Prepare submission to OMG for UML profile for MARTE (Modeling and Analysis of Real-Time and Embedded Systems)

Results:

- MARTE proposal [CEA, Cantabria, INRIA, Thales] has been prepared.
- Final vote achieved in June 2007
- Finalization Task force launched by OMG to provide version 1 by July 2008.

Integration catalyzed by ARTIST2

- Launching new collaboration projects between ARTIST2 partners and industry
 - SPEEDS, OpenEmBeDD, Combest, EDEN-2, SPICES, AMAES, ATESSST,
- Integration of tools for Modeling and Analysis of CBES
 - SPEEDS [INRIA, OFFIS, PARADES, VERIMAG]
 - BIP/Fractal/Think [INRIA, VERIMAG]
 - Papyrus/IF/BIP/KerMeta/Giotto [CEA, INRIA, VERIMAG, EPFL]
 - IF/Agatha [VERIMAG, CEA]
 - ,
- Joint organization of workshops (list on later slides)
- Joint publications: > 25
- Overseas collaboration: UC Berkeley, ISI@Vanderbilt, Monash Univ., SEI, Carleton, ...

Events

Schools:

- Model Driven Development f. RTES (Brest, Sept 06)
- MOTIVES Winter School, (Trento, Feb. 07)
- Artist2 / UNU-IIST School in China, August, 2007

Workshops

- Foundations and applications of Component-Based Design: (EMSOFTE workshop, Seoul, Oct. 06)
- MARTES + MODEVA Workshop (at Models/UML Conference), Italy, Oct. 2006.
- MARTES + MODEVA Workshop (at Models/UML Conference), USA, Oct. 2007.
- Models of Computation and Communication (MoCC), Nov. 2006, Zurich.
- Basic Concepts in Mobile Embedded Systems, Dec. 2006, Vienna
- Building Automation and Building Security Using embedded Systems Technology, Feb. 2007, Italy
- Foundations and Applications of Component-based Design (EMSOFTE, Salzburg, Sep. 07)
- Integrated Modular Avionics, Nov. 2007, Rome

Events (ctd.)

Workshops

- SLAP (*Model-driven High-level Programming of Embedded Systems*), Portugal, March 2007
- Synchron (International Open Workshop on Synchronous Programming), Bamberg, Nov. 2007
- FMCO (Formal methods for Components and Objects), Amsterdam, Nov. 2006,
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- FMGALS'07 (Formal Methods for GALS), May 2007, Nice.
- CBSE (Components Based Software Engineering Symposium), July 2007, Boston, MA
- Euromicro CBSE, Aug. 2007, Lubeck.
- DATE Workshop "Towardes a Systematic Approach to Embedded System Design", March 2007
- Tool platforms for embedded systems modeling, analysis and validation, (CAV Satellite workshop, July 2007)
- "Modeling and Safety Standards – how to get it right" (satellite event of SafeTronic) Nov. 2006, Munchen.

Overall Assessment and Vision at Y0+3

- Restructuring of activities beneficial
 - Better emphasis on continuous longer-term research
- Much increased integration between ARTIST2 partners,
 - New projects
 - SPEEDS, OpenEmBeDD, Combest, EDEN-2, SPICES, AMAES, ATESSST,
 - Integration of tools for Modeling and Analysis of CBES
 - SPEEDS Bus [INRIA, OFFIS, PARADES, VERIMAG]
 - BIP/Fractal/Think [INRIA, VERIMAG]
 - Papyrus/IF/BIP/KerMeta/Giotto [CEA, INRIA, VERIMAG, EPFL]
 - IF/Agatha [VERIMAG, CEA]
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Plans for Year 4

- CBD of Heterogeneous Systems
 - Theories for interfaces, “Abstract design”
 - Further development of HRC Model -> in SPEEDS and COMBEST projects
 - Study Integration of tools, e.g., BIP and Metropolis
- Platform for Components Modeling and Verification
 - Link MARTE to analysis tools thanks to Papyrus, Kermeta
 - Link commercial modeling tools through HRC and hosted simulation (SPEEDS)
 - Further tool integrations in projects: SPEEDS, Combest, AVACS, OpenEmBeDD,

Plans for Year 4 (ctd.)

- Standardization
 - MARTE Finalization Scheduled for June 2nd , 2008
- Dissemination
 - ARTIST2 Summer School, Aug(?) 2008,
 - Predictability of hardware in Embedded Systems, June (?) 2008.
 - MARTES + MODEVA Workshop (at Models/UML Conference), Toulouse, France , Oct. 2008.
 - Tutorials on MDE for RTS (ICSE08, MODELS08)
 - SLAP (Model-driven High-level Programming of Embedded Systems), Budapest, April 2008
 - UML&AADL 2008, Belfast, April 2008
 - Foundations and Applications of CBD (EMSOFT 2008)