A Tool-Supported Approach for Omniscient Debugging and Concurrent Execution of Heterogeneous Models

Final workshop of the ANR project GEMOC
March 17th, 2016

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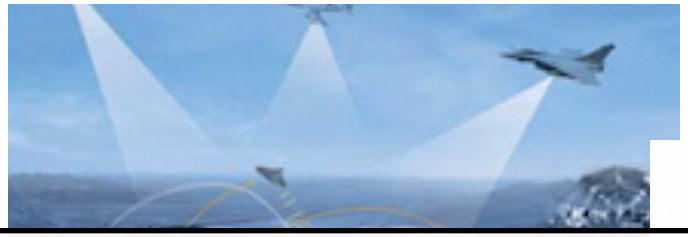
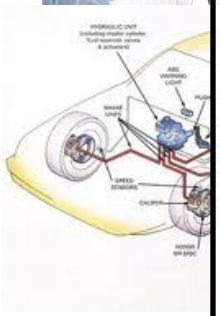
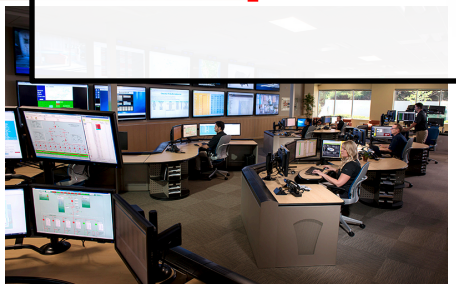
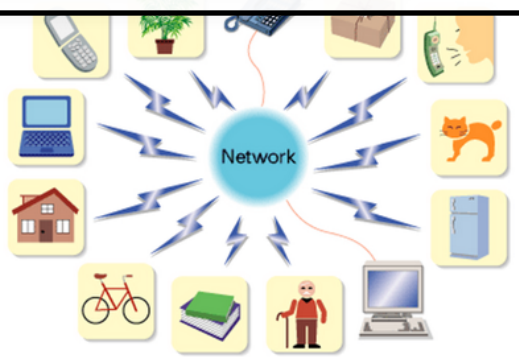
ANR-12-INSE-0011 ANR Gemoc
Inria
i3S sophia antipolis
IRIT CNRS INPT UPS UT1 Institut de Recherche en Informatique de Toulouse
ENSTA Bretagne
OBEO
THALES

Complex Software-Intensive Systems

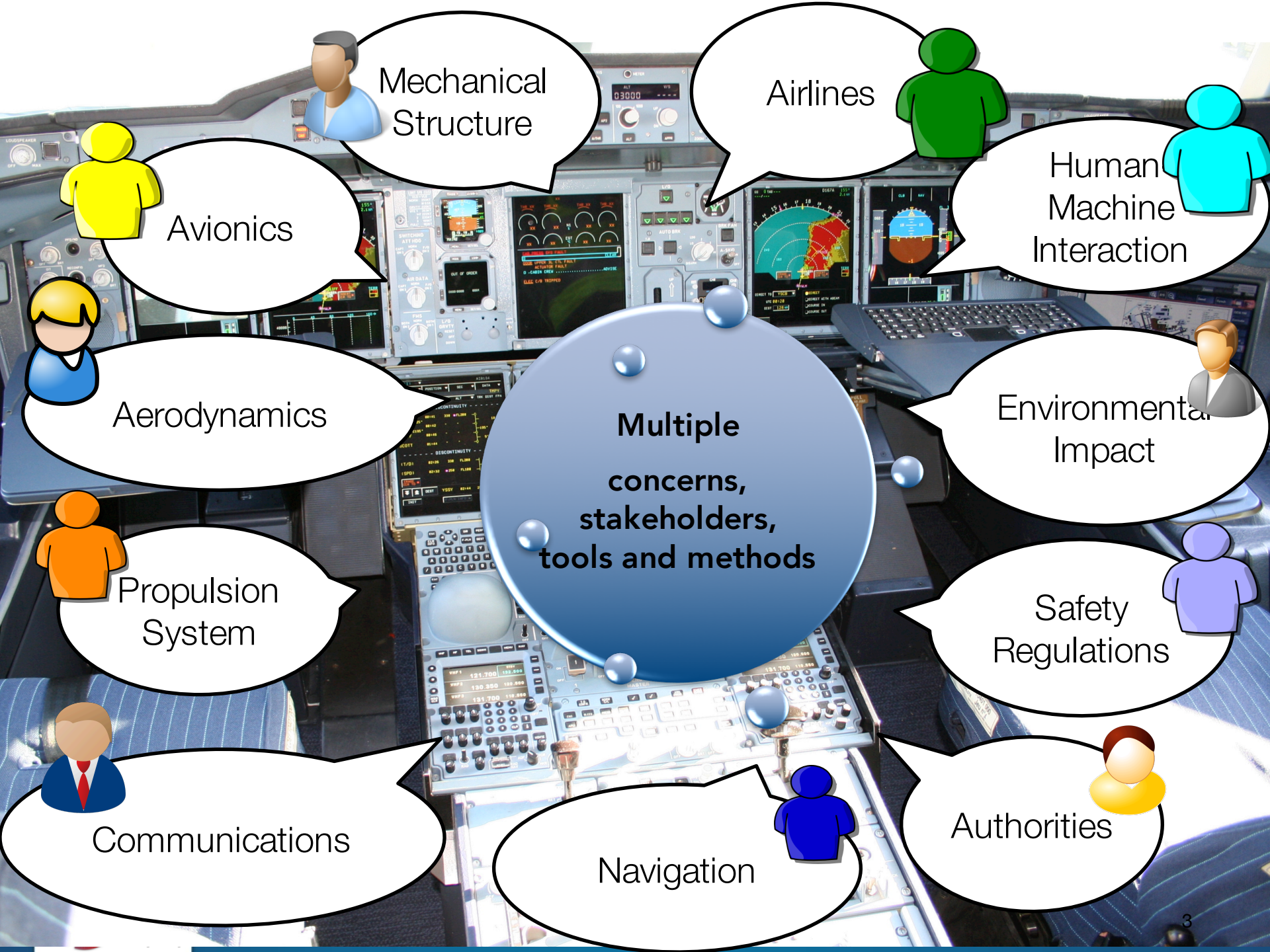




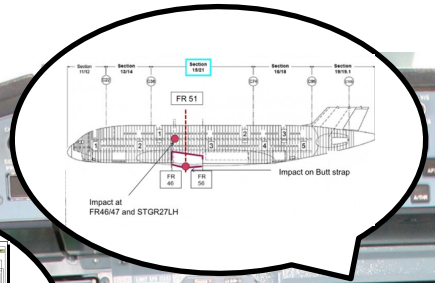


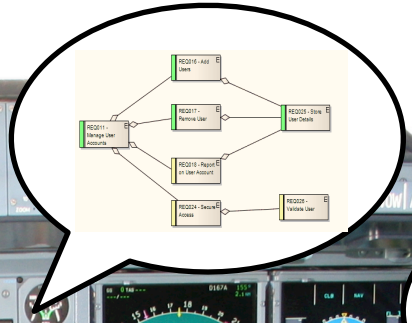


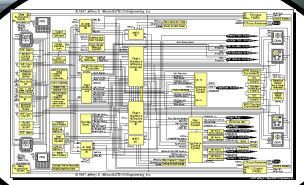
- Multi-engineering approach
- Domain-specific modeling
- Software as integration layer
- Openness and dynamicity

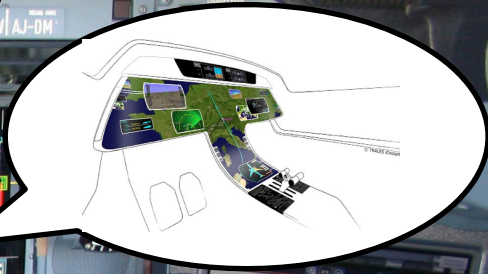

Mechanical Structure
Airlines
Avionics
Human Machine Interaction
Aerodynamics
Multiple
concerns, stakeholders, tools and methods
Environmental Impact
Propulsion System
Safety Regulations
Communications
Navigation
Authorities

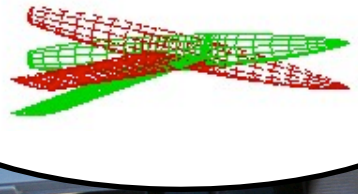
Heterogeneous Modeling

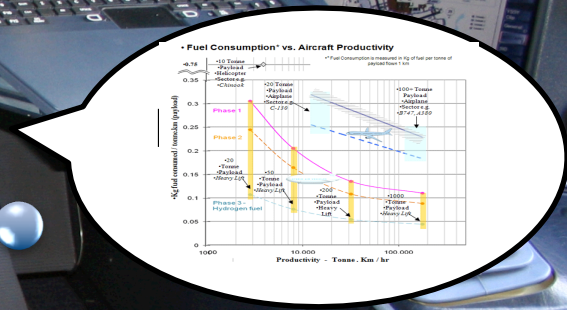


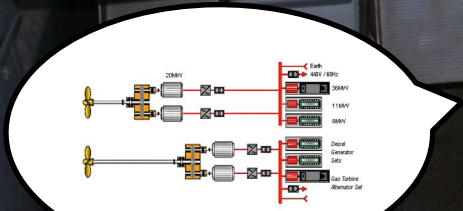


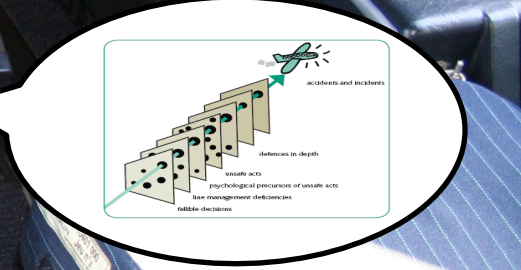


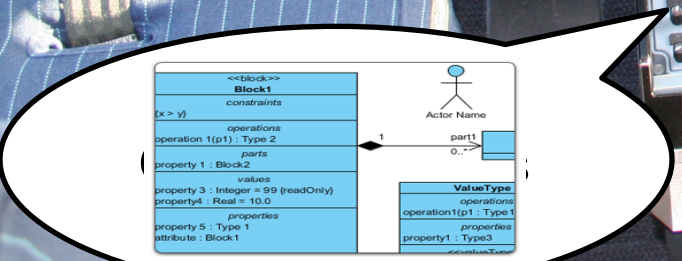


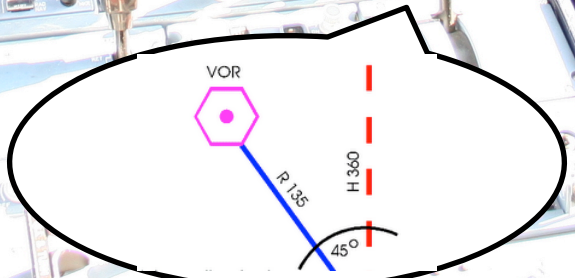


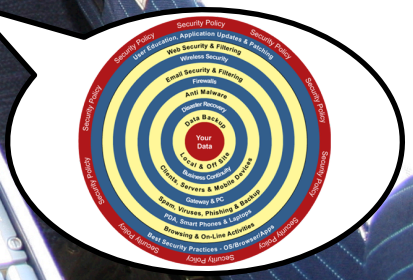












Globalization of Modeling Languages

- DSMLs are developed in an independent manner to meet the specific needs of domain experts,
- DSMLs should also have an associated framework that regulates interactions needed to support collaboration and work coordination across different system domains.

Benoit Combemale, Julien DeAntoni, Benoit Baudry, Robert B. France, Jean-Marc Jezequel, Jeff Gray, "*Globalizing Modeling Languages*," Computer, vol. 47, no. 6, pp. 68-71, June, 2014

Globalization of Modeling Languages

Supporting coordinated use of modeling languages leads to what we call the globalization of modeling languages, that is, the use of multiple modeling languages to support coordinated development of diverse aspects of a system.

Benoit Combemale, Julien DeAntoni, Benoit Baudry, Robert B. France, Jean-Marc Jezequel, Jeff Gray, "*Globalizing Modeling Languages*," Computer, vol. 47, no. 6, pp. 68-71, June, 2014

Globalization of Modeling Language

- Context: new emerging DSML in open world
  - ⇒ impossible *a priori* unification
  - ⇒ require *a posteriori* globalization

- Objective: socio-technical coordination to support interactions across different system aspects
  - ⇒ Language-based support for technical integration of multiples domains
  - ⇒ Language-based support for social translucence

"*Globalizing Domain-Specific Languages*," Combemale, B., Cheng, B.H.C., France, R.B., Jézéquel, J.-M., Rumpe, B. (Eds.). Springer, Programming and Software Engineering, Vol. 9400, 2015.

The GEMOC Initiative

An open and international initiative to

- coordinate (between members)
- disseminate (on behalf the members)

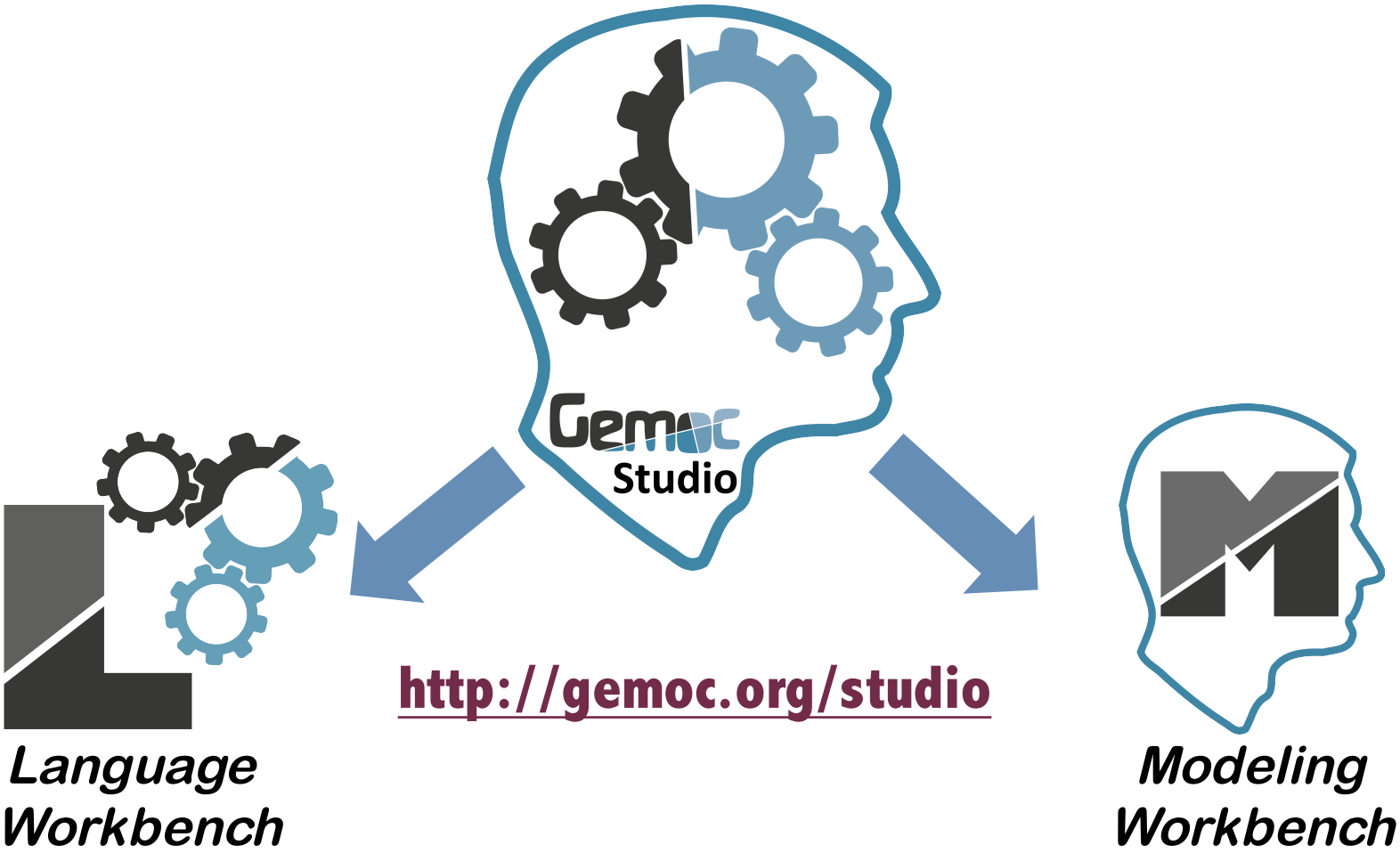
worldwide R&D efforts

on the globalization of modeling languages

http://gemoc.org

@gemocinitiative

The GEMOC Studio



Design and compose your executable DSMLs

Edit, simulate and animate your heterogeneous models

The GEMOC Community

GEMOC: The Projects

CNRS GDR GPL Specific Action 2011

- Survey of the techniques and tools to compose DSMLs and their respectives MoCs
- *Partners: IRISA (TriskeII), I3S (Aoste)*
- *Cf. http://gemoc.org/as2011*

CNRS PICS MBSAR 2013-2015

- Travel funds for permanent staff and PhD students
- *Partners: IRISA (DiverSE), CSU*
- *Cf. http://gemoc.org/mbsar*

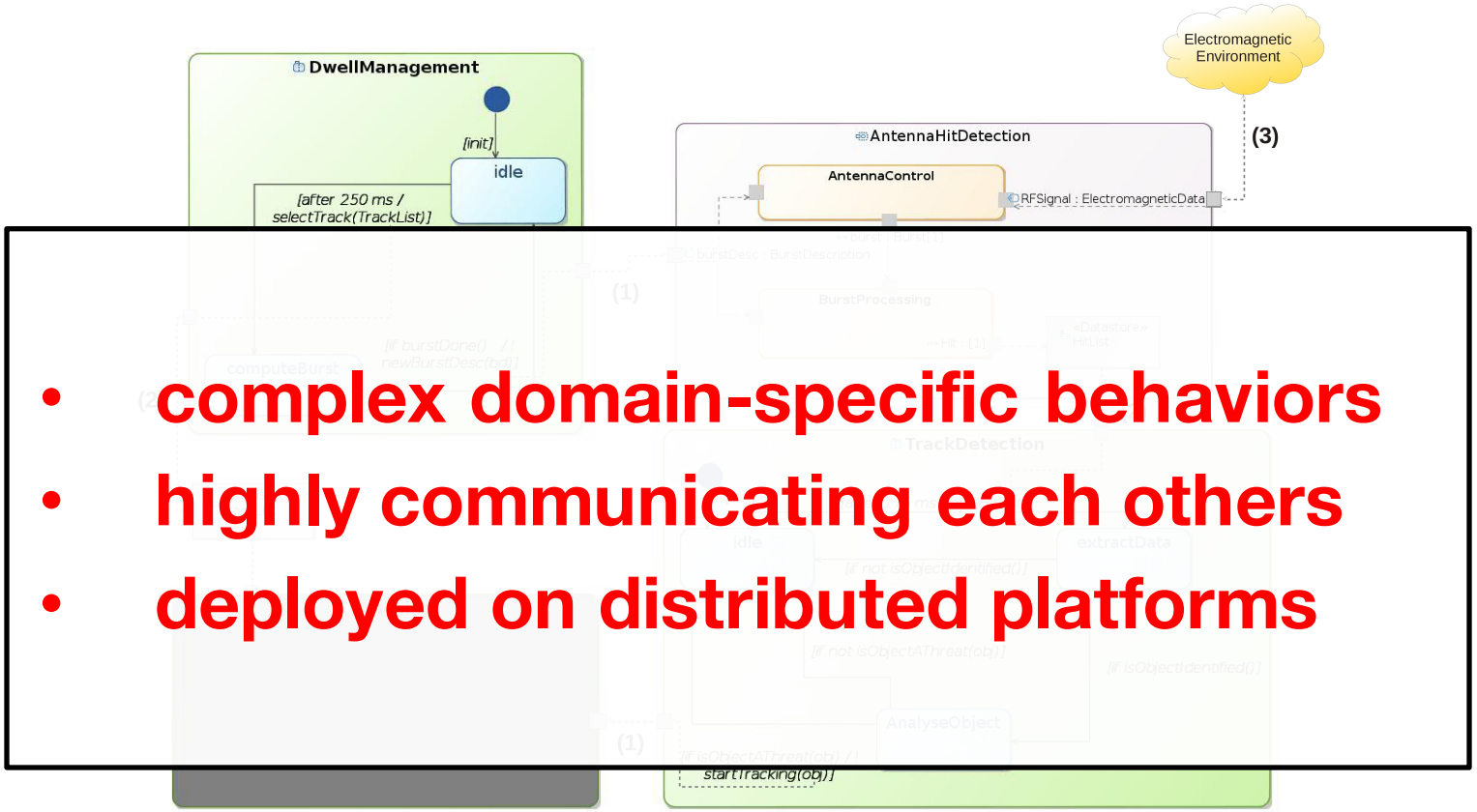
ANR INS GEMOC 2012-2016

- A Language Workbench for Heterogeneous Modeling and Analysis of Complex Software-Intensive Systems
- *Partners: Inria (DiverSE), I3S (Aoste), IRIT, ENSTA-Bretagne, Thales, Obeo*
- *Cf. http://gemoc.org/ins*

ICT COST Action MPM4CPS 2014-2018

- Promote the sharing of foundations, techniques, and tools and to provide educational resources, to both academia and industry
- *Cf. http://www.cost.eu/COST_Actions/ict/Actions/IC1404*

Concurrent Execution of Heterogeneous Models



Le nouveau défis de la coordination des langages de modélisation. Gestion de l'hétérogénéité des modèles dans le développement et l'exécution de systèmes logiciels complexes (Benoit Combemale, Julien Deantoni, Ali Koudri, Jérôme Le Noir), In Génie logiciel et ingénierie de système (GL & IS), 2013.

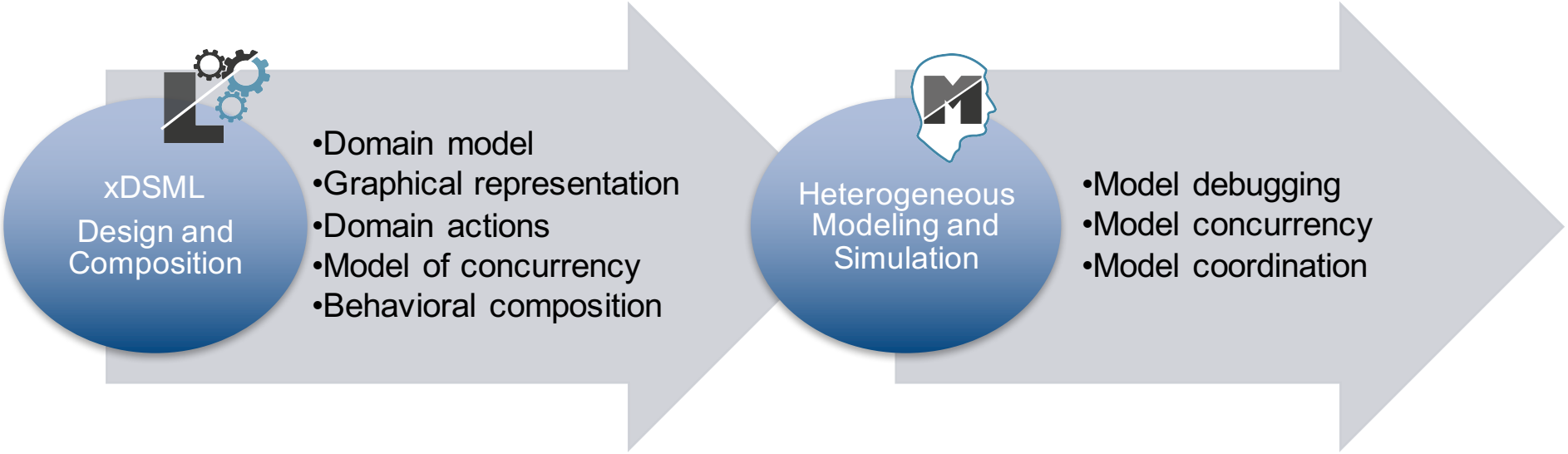
Concurrent Execution of Heterogeneous Models
Current practices and existing tools

- UML modelers (e.g., rhapsody, magic draw, fuml engine) support model execution: hardcoded semantics without coordination of heterogeneous models (usually replace by different diagrams in the same model)

- Stateflow?

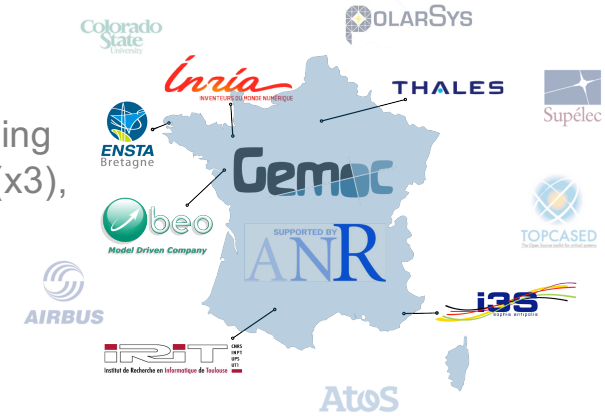
- Tools for heterogeneous modeling
  - Coordination of discrete models (e.g., Ptolemy, Modhel'X): specific coordination pattern between predifined models of concurrency, or defined at the implementation level.
  - Coordination of discrete and continue models (i.e. hybrid approach): we focus on discrete model only, but for any domain-specific languages

Concurrent Execution of Heterogeneous Models (ANR Project GEMOC, #ANR-12-INSE-0011)



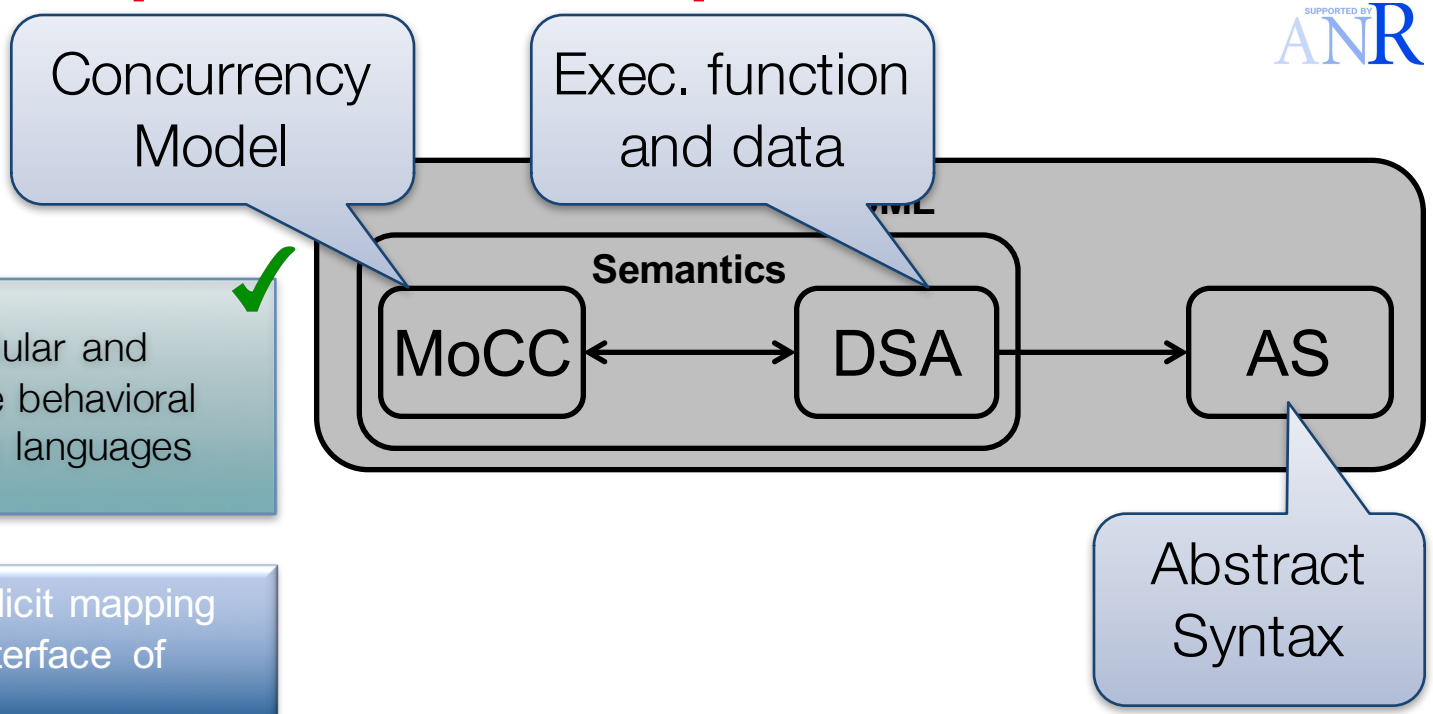
Breakthroughs:

- modular and explicit definition of the behavioral semantics of modeling languages, incl. concurrency [APSEC'12, SLE'12, SLE'13, SLE'15 (x3), DATE'15, SoSyM'15]
- explicit behavioral interface of modeling languages [GEMOC'13]
- reification of the coordination concerns at the language level [MODELS'15, Computer'14, Dagstuhl #14412]



Visit http://gemoc.org/ins

xDSML Development and Composition



Breakthrough #1: modular and explicit definition of the behavioral semantics of modeling languages

Breakthrough #2: explicit mapping used as behavioral interface of modeling languages

Breakthrough #3: integration of modeling languages for heterogeneous model coordination

xDSML Development and Composition

Breakthrough #1: modular and explicit definition of the behavioral semantics of modeling languages ✓

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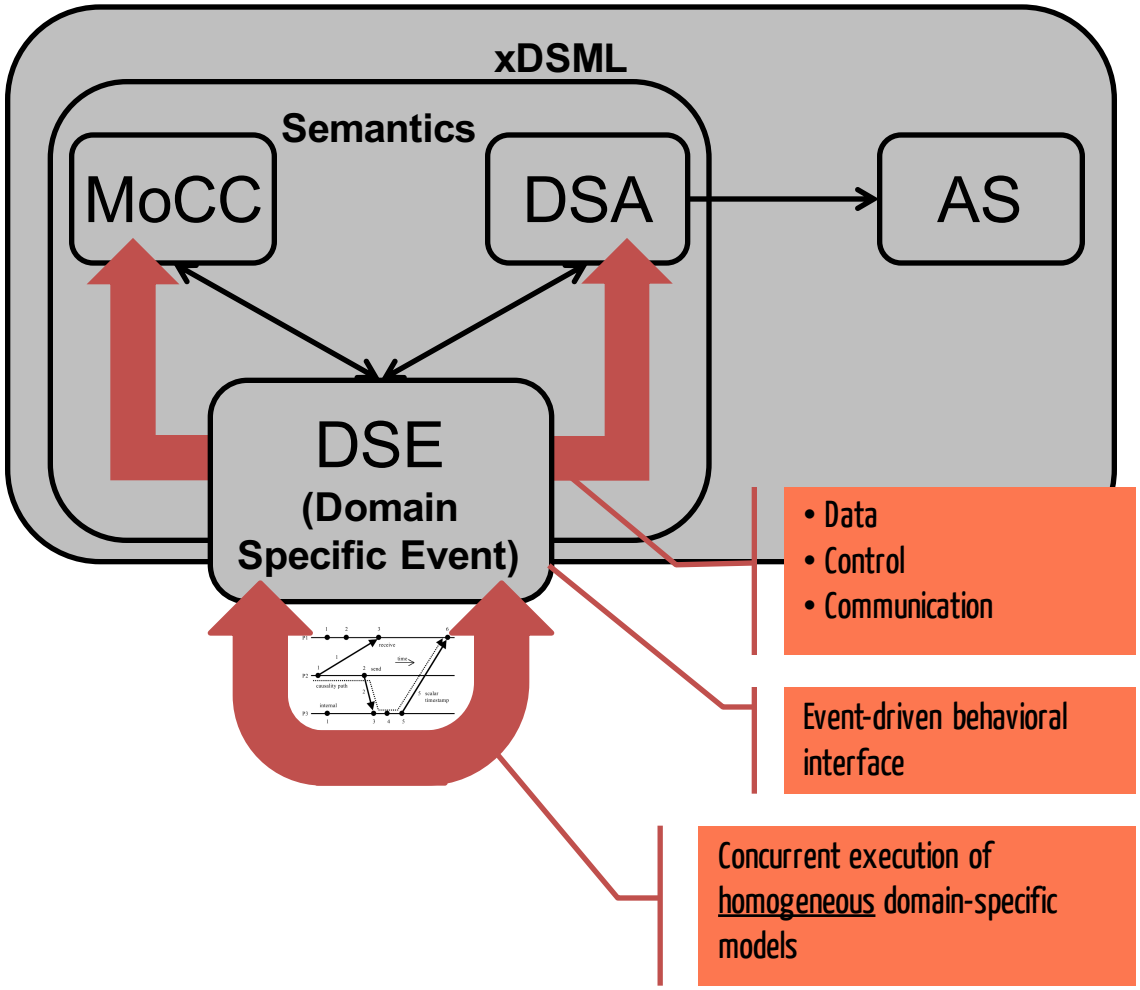

xDSML Development and Composition

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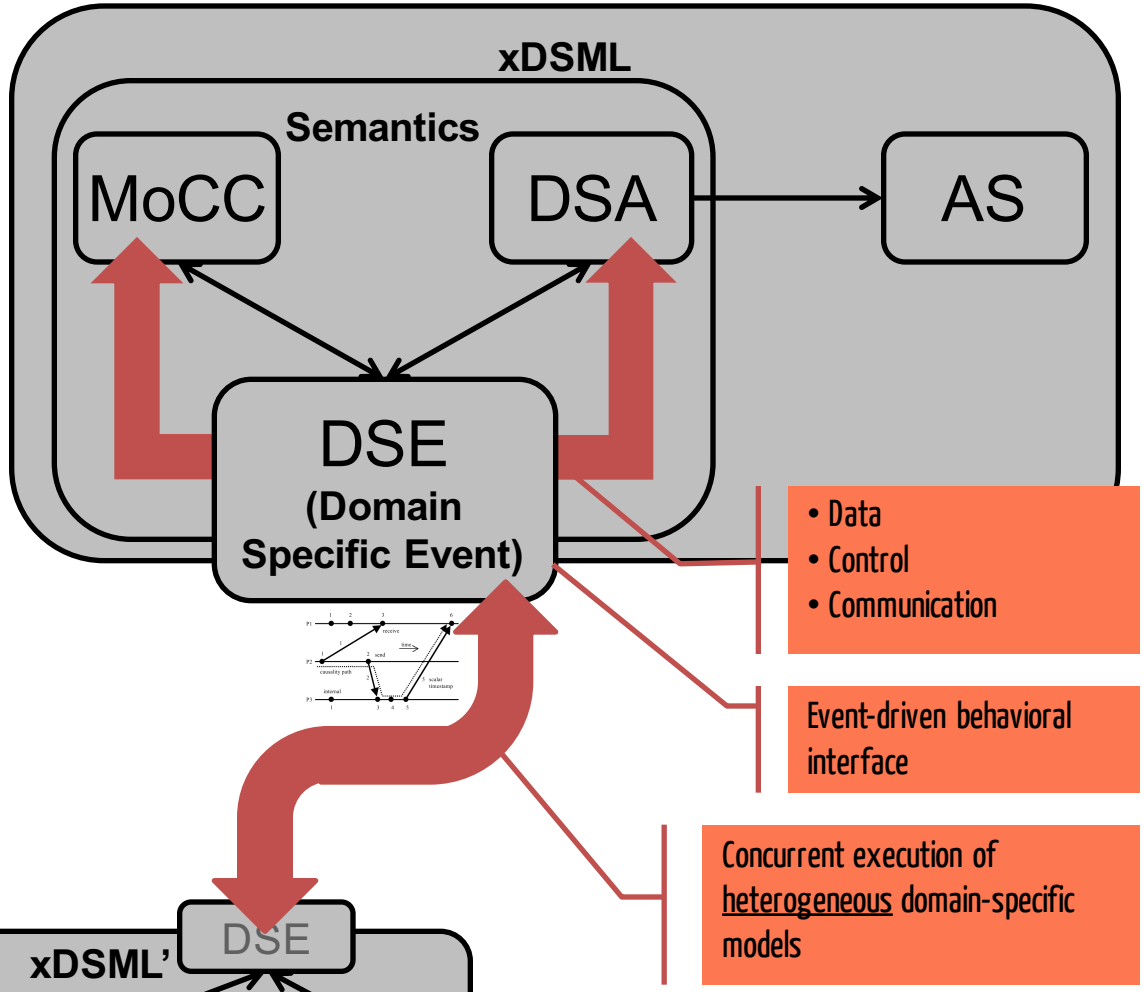
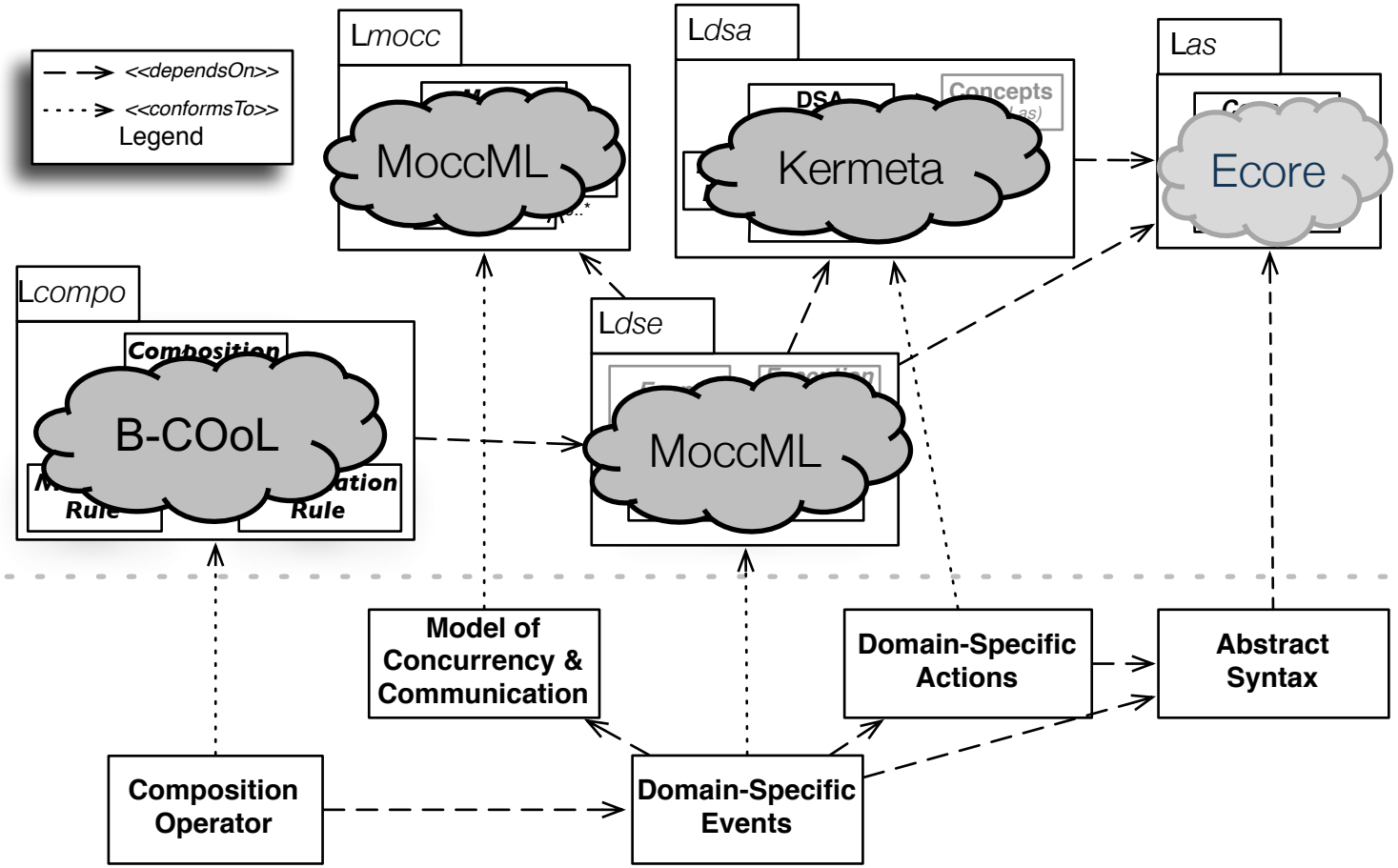
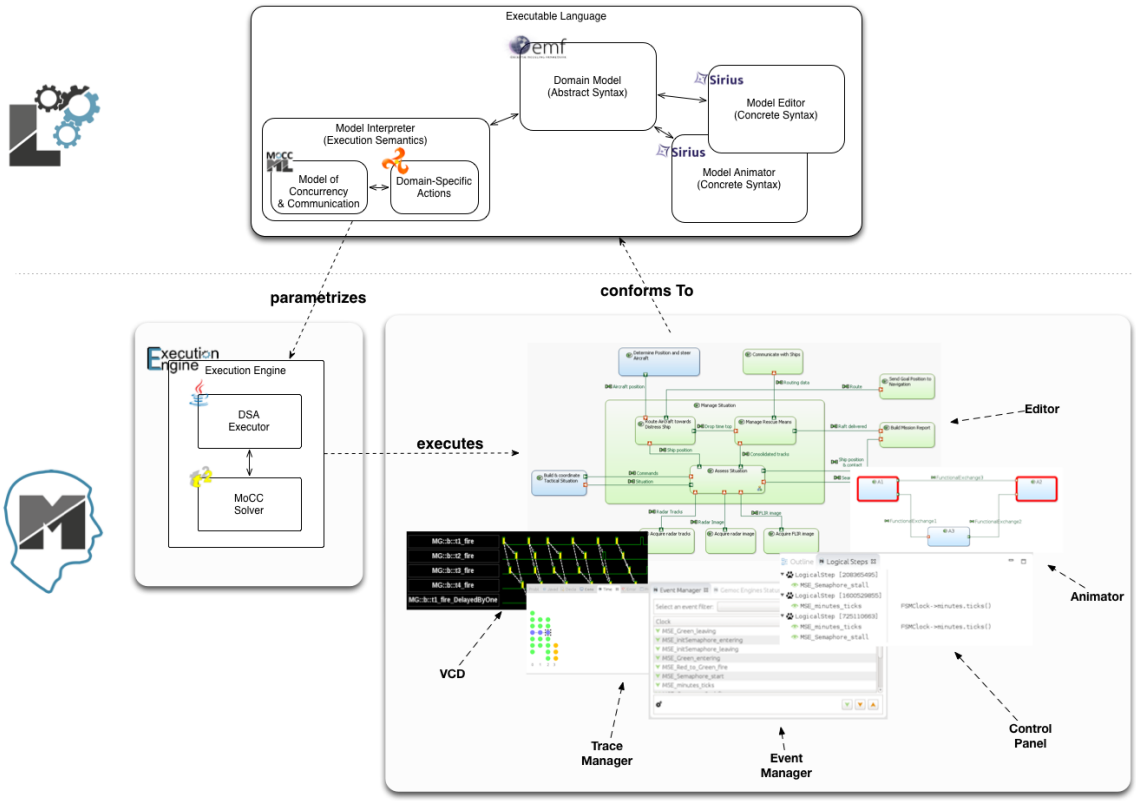


Reifying Concurrency and Coordination in xDSML



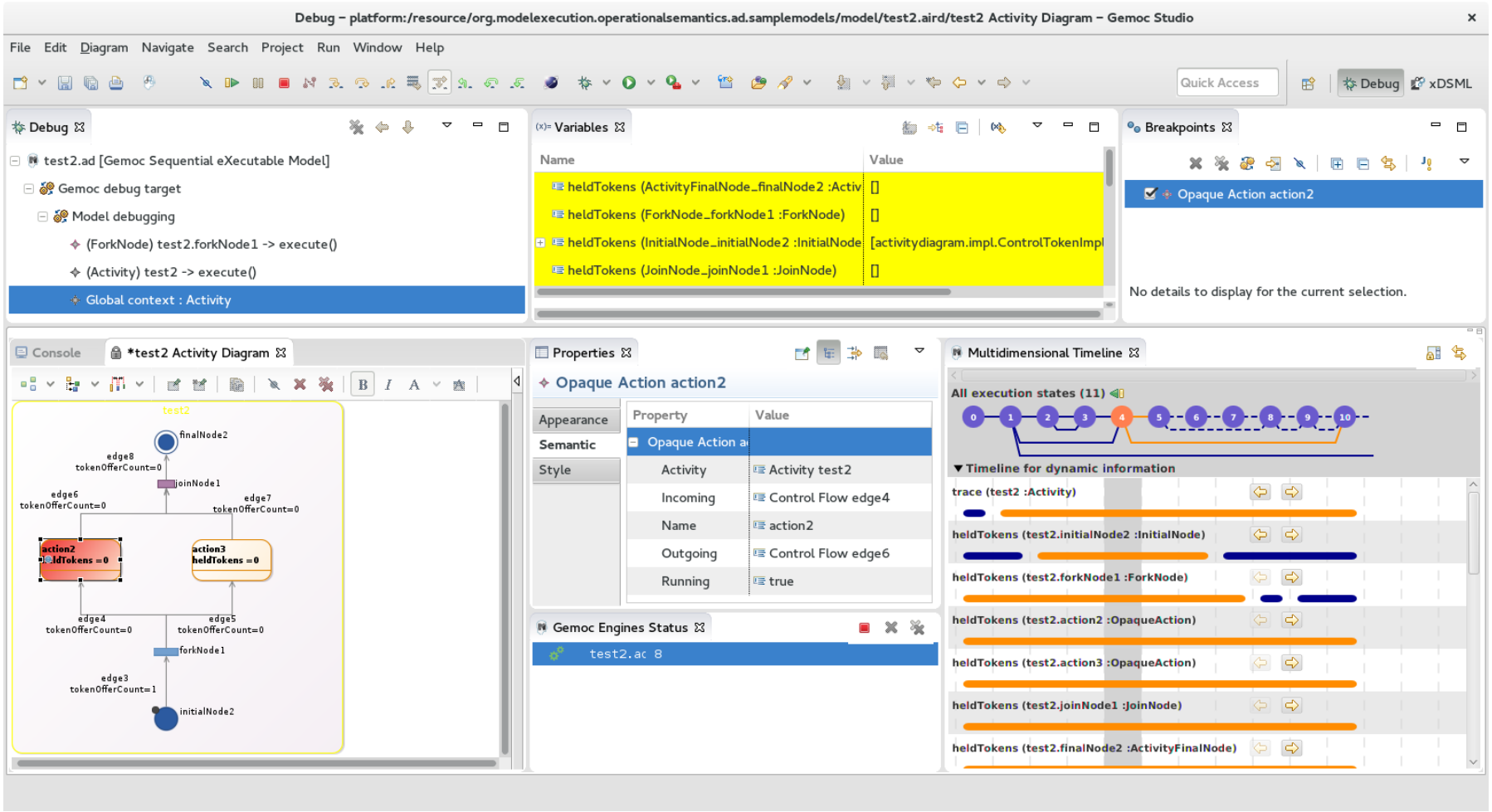
The GEMOC Studio



Benoit Combemale, Julien Deantoni, Olivier Barais, Arnaud Blouin, Erwan Bousse, Cédric Brun, Thomas Degueule and Didier Vojtisek, "A Solution to the TTC'15 Model Execution Case Using the GEMOC Studio," In 8th Transformation Tool Contest (TTC), 2015. **Overall Winner**

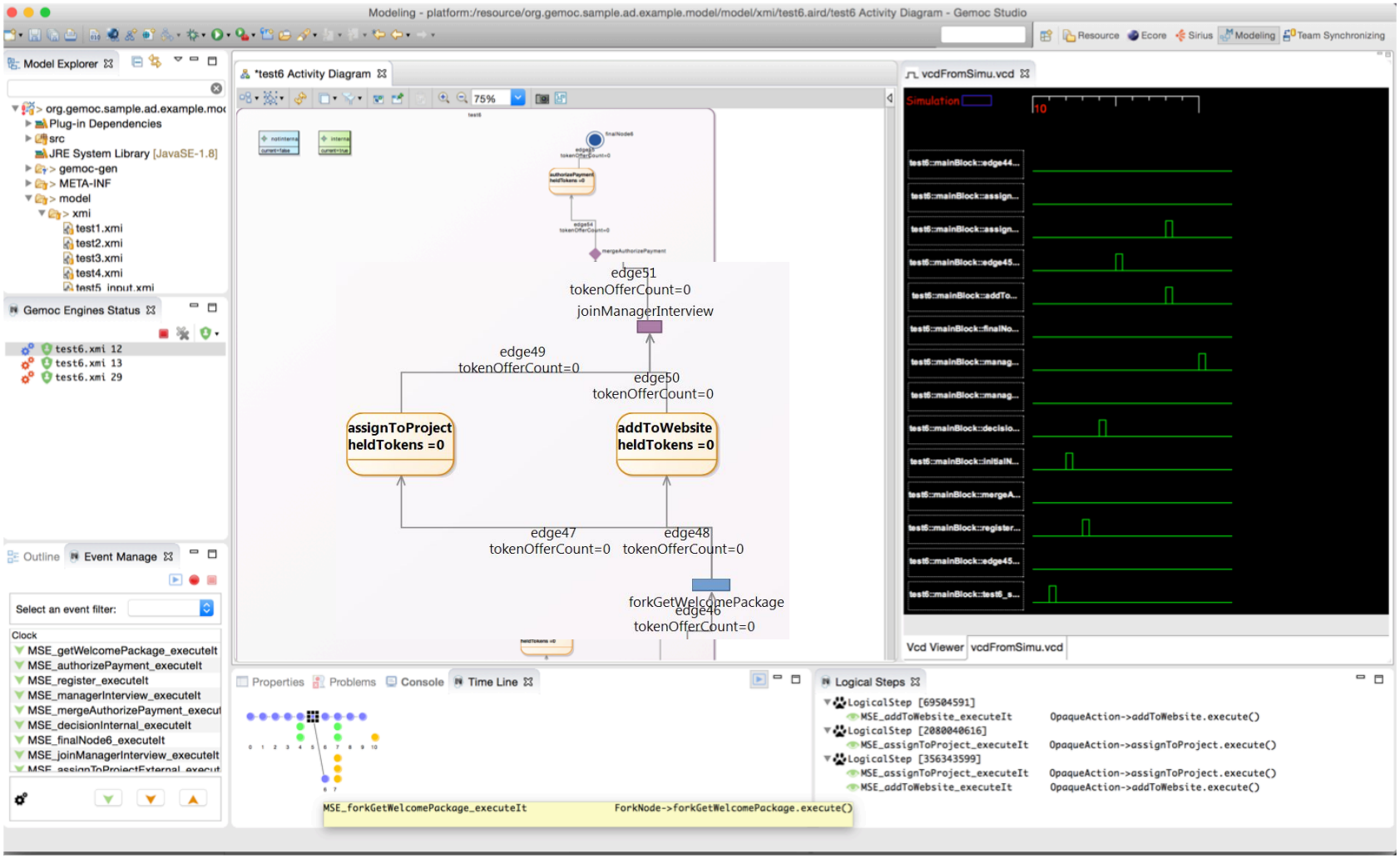
http://gemoc.org/studio/

Activity Diagram Debugger



https://github.com/gemoc/activitydiagram

Activity Diagram Debugger



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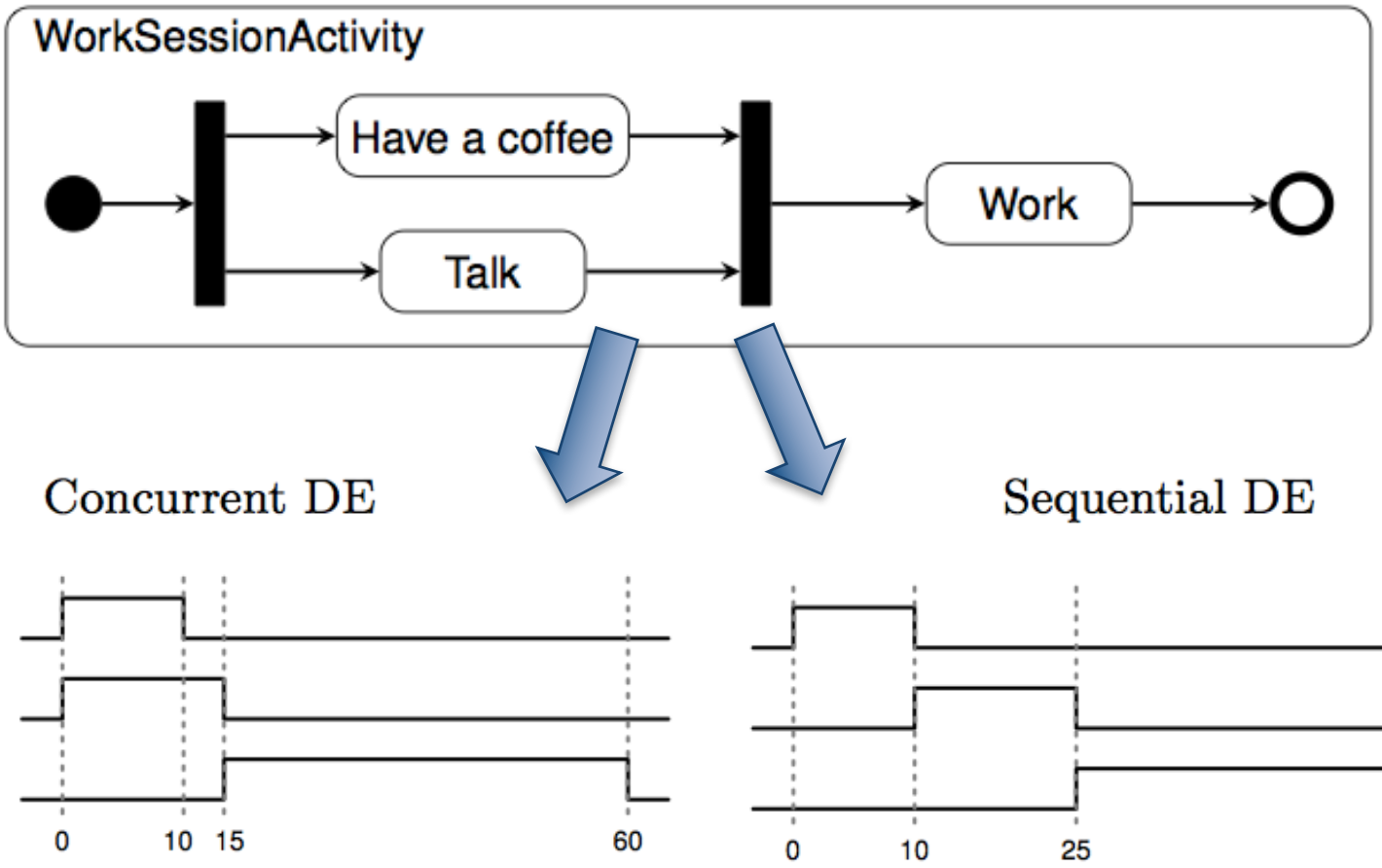
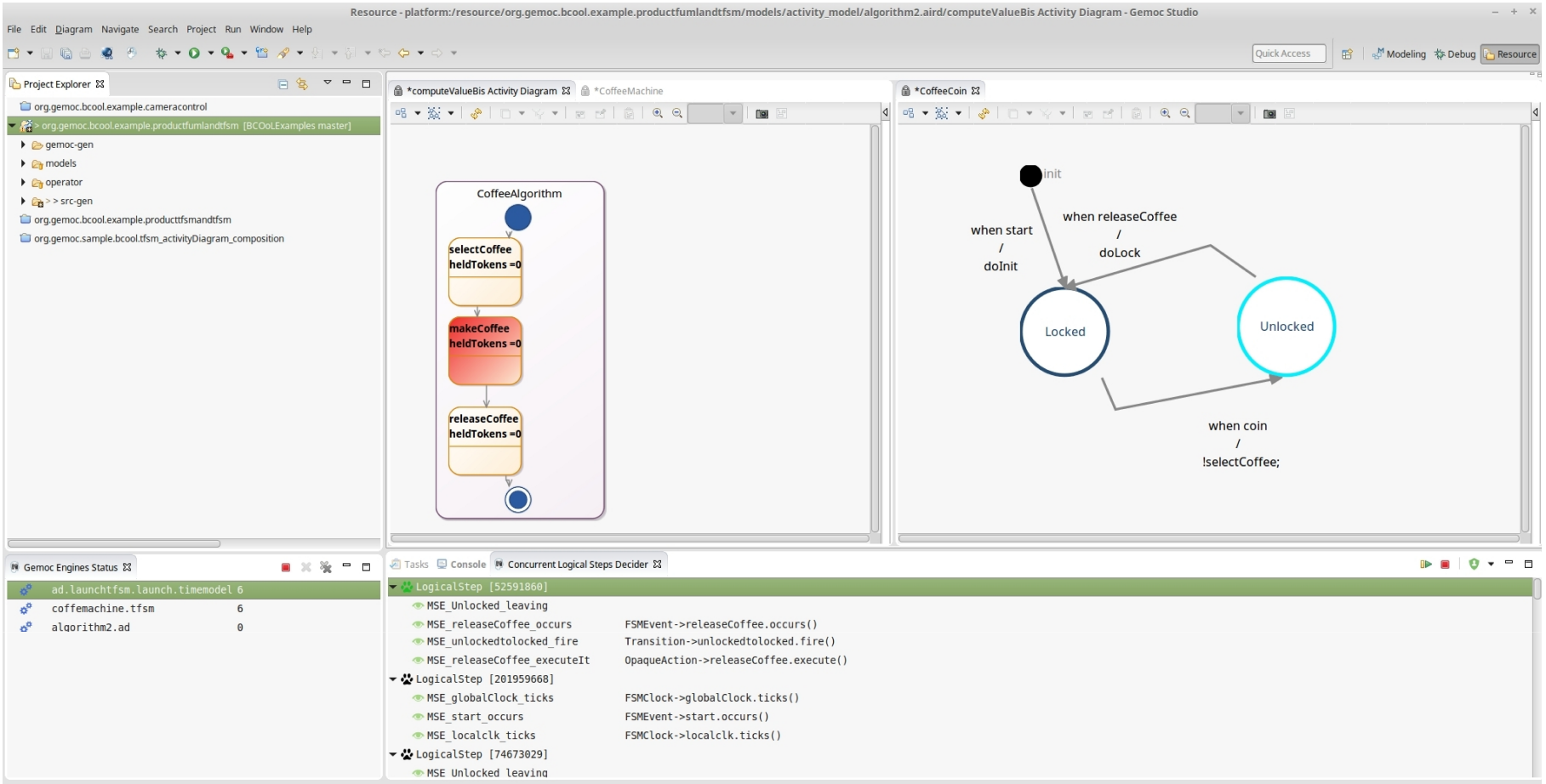
Coping with Semantic Variation Points



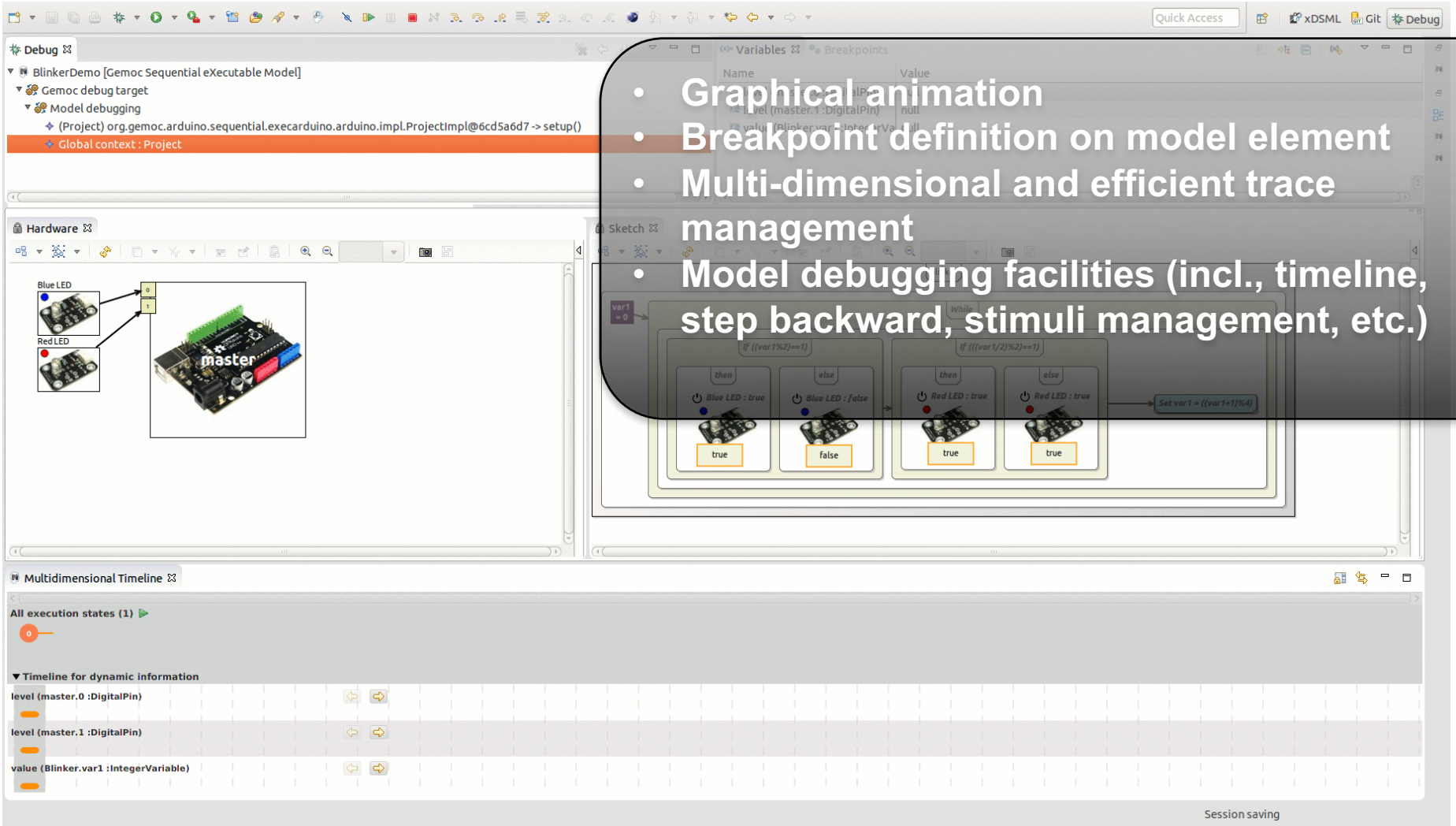
Florent Latombe, Xavier Crégut, Julien Deantoni, Marc Pantel, Benoit Combemale, "Coping with Semantic Variation Points in Domain-Specific Modeling Languages", In EXE@MoDELS 2015.

Behavioral Model Coordination



https://github.com/gemoc/coordination

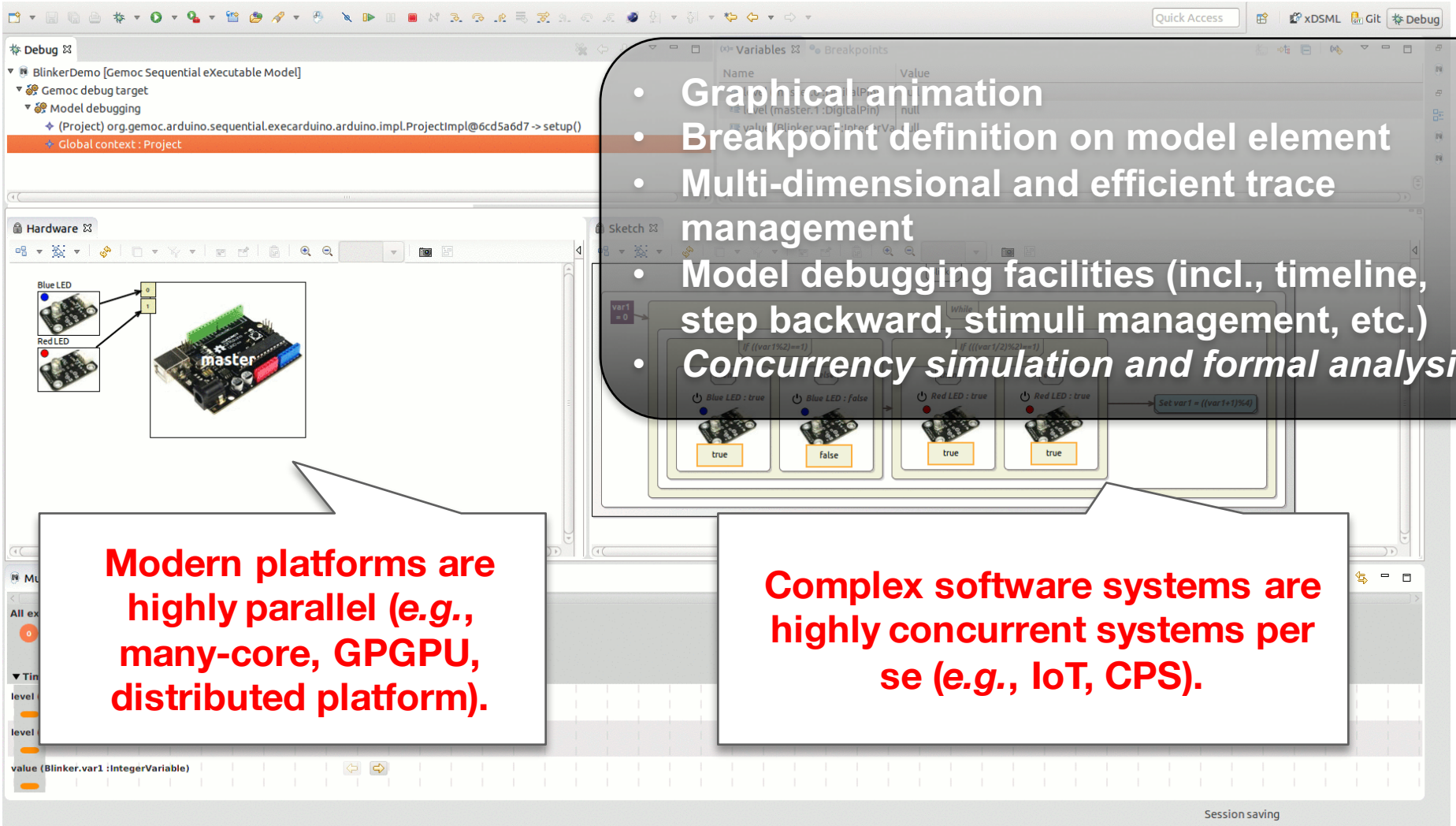
Arduino Designer (& Debugger)



- Graphical animation
- Breakpoint definition on model element
- Multi-dimensional and efficient trace management
- Model debugging facilities (incl., timeline, step backward, stimuli management, etc.)

https://github.com/gemoc/arduinomodeling

Arduino Designer (& Debugger)



- Graphical animation
- Breakpoint definition on model element
- Multi-dimensional and efficient trace management
- Model debugging facilities (incl., timeline, step backward, stimuli management, etc.)
- *Concurrency simulation and formal analysis*

Modern platforms are highly parallel (*e.g.*, many-core, GPGPU, distributed platform).

Complex software systems are highly concurrent systems per se (*e.g.*, IoT, CPS).

https://github.com/gemoc/arduinomodeling

Program of the workshop

- 10:00-10:30: Workshop introduction and project overview
- 10:30-11:00: **Engineering xDSMLs for model executability, animation and debugging**
- 11:00-11:30: **Reifying the concurrency concern into xDSML specifications**
- 11:30-12:00: **Coordination of xDSMLs for concurrent execution of heterogeneous models**
- 12:00-12:30: **Experimentations, transfer and development**
- 12:30-12:45: Wrap-up and perspectives
- *12:45-14:00: lunch buffet and discussions*
- 14:00-16:00: **Demonstrations and hands-on with the GEMOC studio**
- *16:00-16:30: Closing snack*

Program of the workshop

This is YOUR seminar!

- *Ask questions*
- *Provide feedback*
- *Make it interactive*