



[www.modelsconference.org](http://www.modelsconference.org)

MODELS 2016 Conference Booklet

**MODELS 2016** 

Saint-Malo, France, October 2-7, 2016.

ACM/IEEE 19<sup>th</sup> International Conference  
on Model Driven Engineering Languages and Systems

# Conference Booklet

[www.modelsconference.org](http://www.modelsconference.org)



# Welcome to MODELS 2016,

ACM/IEEE 19<sup>th</sup> International Conference on  
Model Driven Engineering Languages and Systems

We cheerfully welcome you to MODELS 2016, the ACM/ IEEE 19<sup>th</sup> International Conference on Model Driven Engineering Languages and Systems, October 2-7, 2016 in Saint-Malo, France, the *corsair* city! The walled town is built like a stone ship facing out to sea, with its ramparts standing proudly over long beaches and a lively port.

MODELS is the premier conference series for model-based software and systems engineering. It covers all aspects of modeling, from languages and methods to tools and applications since 1998. MODELS 2016 challenges the modeling community to promote the magic of modeling by solidifying and extending the foundations and successful applications of modeling in areas such as business information and embedded systems, but also by exploring the use of modeling for new and emerging systems, paradigms, and challenges including cyber-physical systems, cloud computing, services, social media, security, and open source.

We managed to put together an exciting program for researchers, industrial practitioners, students, and educators in the field of model-driven engineering. MODELS 2016 comprises two main tracks: the *Foundations* track with subcategories *technical papers*, *new ideas papers* and *visions papers*, and the *Practice and Innovation* track. Both tracks invited full, scholarly papers of the highest quality, and submissions were reviewed in accordance with the highest established standards of scientific rigor applied in peer review.

Each paper was reviewed by at least three members of the program committee. The reviewers assessed the submissions in terms of research problem formulations, novelty and sophistication of proposed solutions, clarity and significance of hypotheses, proper design and execution of experimental or analytical assessments, sound interpretation of data, and correct characterization of work in relation to existing knowledge. The review discussions were overseen by members of the program board, and decisions were finalized

# ORGANIZING COMMITTEE

during a physical program board meeting on July 1<sup>st</sup> and July 2<sup>nd</sup> in Vienna, Austria. This year, out of 118 papers submitted to the Foundations Track, the PC and the PB accepted 28 (acceptance rate 23.7%). Out of the 27 papers submitted to the PI Track, 10 were accepted (acceptance rate 37%). The main conference also hosts 14 workshops, 9 tutorials, the educator and doctoral symposia, an ACM Student Research Competition, and the SAM conference.

The conference program includes demo sessions, a panel on “User Experience (UX) in Model-Based Software Engineering”, and the presentation of four papers that had first been published in the predominant journal in the field, the Journal of Software Systems Modeling, or SOSYM. We are honored to furthermore feature three distinguished keynotes: Gordon Blair will reflect on “Grand Challenges, Grand Responses”, Jim Coplien will argue that “The Straight Line is Ungodly”, and Edward A. Lee will argue for “Resurrecting Laplace’s Demon: The Case for Deterministic Models”.

MODELS 2016 would not have been possible without the significant contributions of many individuals and organisations. The MODELS Steering Committee provided invaluable assistance and guidance, whilst the Program Committee and the Program Board undertook with dedication the critical tasks of reviewing and discussing the submissions. We are also grateful to members of the Organising Committee for making the necessary arrangements and helping to publicize the conference and prepare the proceedings. We thank the authors for their efforts in writing and revising their papers in accordance with feedback from the reviewers.

We would also like to thank our numerous sponsors: the platinum sponsor Thales, the gold sponsor Eclipse, the silver sponsors Obeo, Tata Consultancy Services, Diversify and Papyrus IC, and the bronze sponsors GEMOC, Plugbee, HEADS and Polarsys, in addition to our sustainable sponsors ACM, ACM Sigsoft, IEEE and IEEE Computer Society, our supporting publisher Springer, and our institutional sponsors Inria, University of Rennes 1 and its foundation, the Brittany region and the city of Saint-Malo.

We hope you will enjoy the conference!

**Jörg Kienzle, Alexander Pretschner, Benoit Baudry and Benoit Combemale**

## General Chairs:

**Benoit Baudry**, Inria, France  
**Benoit Combemale**, Univ. of Rennes 1, France

## Program Chair (Foundations Track):

**Jörg Kienzle**, McGill Univ., Canada

## Program Chair (Practice & Innovation Track):

**Alexander Pretschner**, TU München, Germany

## Workshop Chairs:

**Houari Sahraoui**, Univ. of Montréal, Canada  
**Manuel Wimmer**, Vienna Univ. of Technology, Austria

## Tutorial Chairs:

**Martin Gogolla**, Univ. of Bremen, Germany  
**Geri Georg**, Colorado State Univ., USA

## Tool / Demonstration Chairs:

**Juan de Lara**, Univ. of Madrid, Spain  
**Peter J. Clarke**, Florida International Univ., USA

## Poster Chair:

**Mehrdad Sabetzadeh**, Univ. of Luxembourg, Luxembourg

## Panel Chair:

**Don Batory**, Univ. of Texas, Austin, USA

## ACM Student Research Competition Chairs:

**Jeff Gray**, Univ. of Alabama, USA  
**Ruth Breu**, Univ. of Innsbruck, Austria

## Doctoral Symposium Chairs:

**Rick Salay**, Univ. of Toronto, Canada  
**Shiva Nejati**, Univ. of Luxembourg, Luxembourg

## Educator Symposium Chairs:

**Gunter Mussbacher**, McGill Univ., Canada  
**Henry Muccini**, Univ. of L’Aquila, Italy

## Clinic Chair:

**Gaël Blondelle**, Eclipse, France

## Publication Chair:

**Julien DeAntoni**, Univ. of Nice, France

## Publicity Chairs:

**Jeff Gray**, Univ. of Alabama, USA  
**Alessandro Garcia**, PUC-Rio, Brasil  
**Richard Paige**, Univ. of York, UK  
**Zhenjiang Hu**, NII, Japan  
**Jim Steel**, Univ. of Queensland, Australia

## Sponsorship Chair:

**Jordi Cabot**, Open Univ. of Catalonia, Spain

## Local Arrangements Chair:

**Elisabeth Lebret**, Inria, France

## Administrative Assistant:

**Tifenn Donguy**, Inria, France

## Multimedia Chair:

**Olivier Barais**, Univ. of Rennes 1, France

## Social Media Chair:

**Mathieu Acher**, Univ. of Rennes 1, France

## Student volunteers Chairs:

**Arnaud Blouin**, INSA, France  
**Johann Bourcier**, Univ. of Rennes 1, France

## Website Chairs:

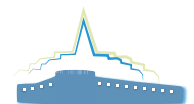
**Guillaume Bécane**, Univ. of Rennes 1, France  
**Dorian Leroy**, Inria, France

## Communication Chair:

**Nathalie Lacaux**, Inria, France

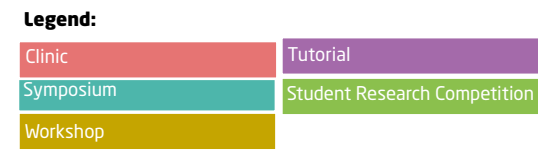
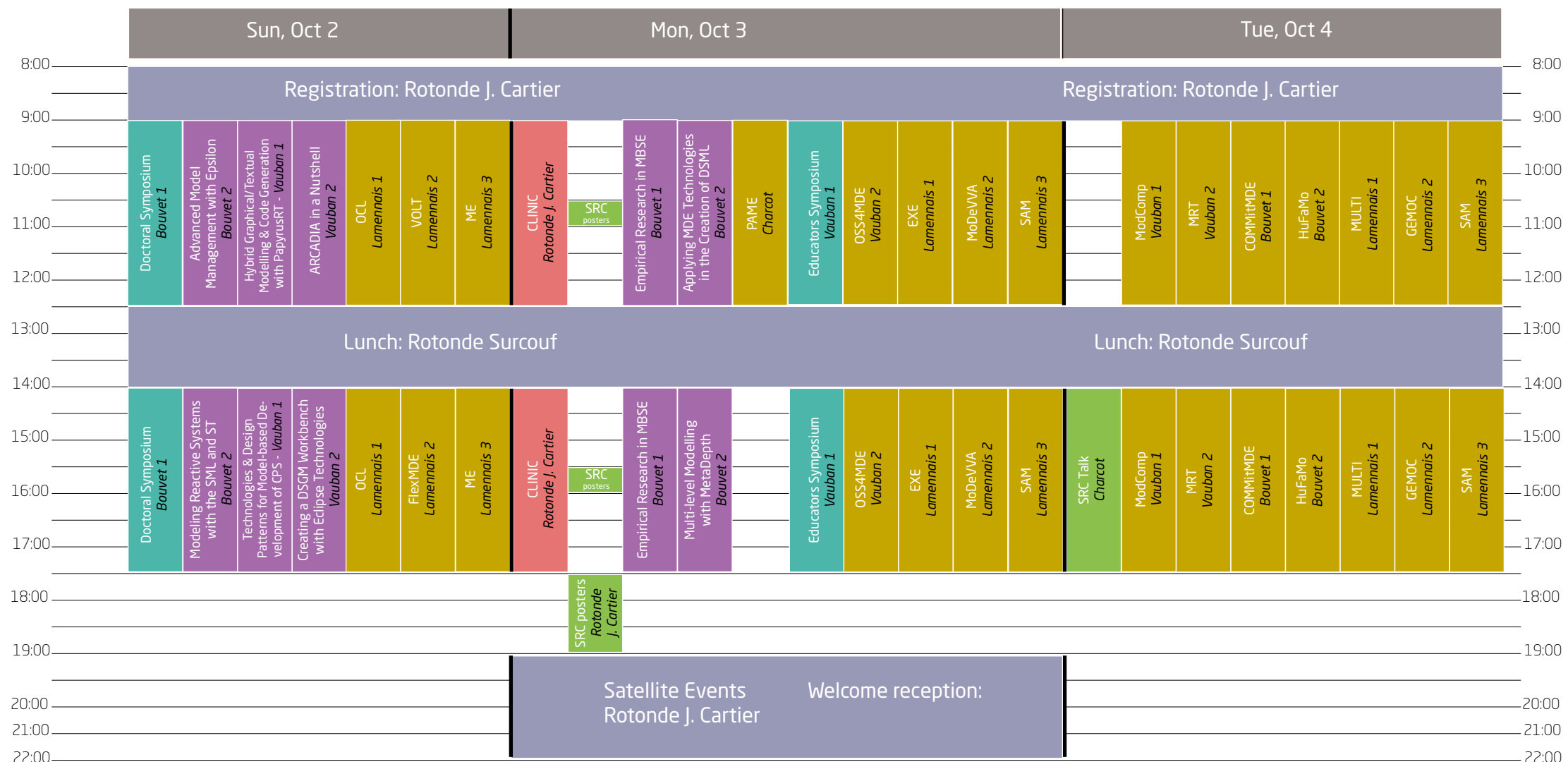
## Photos:

**Noël Plouzeau**, Univ. of Rennes 1, France



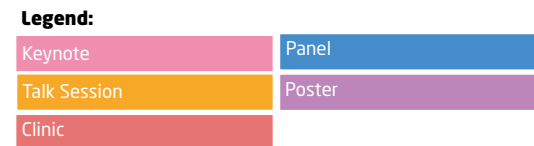
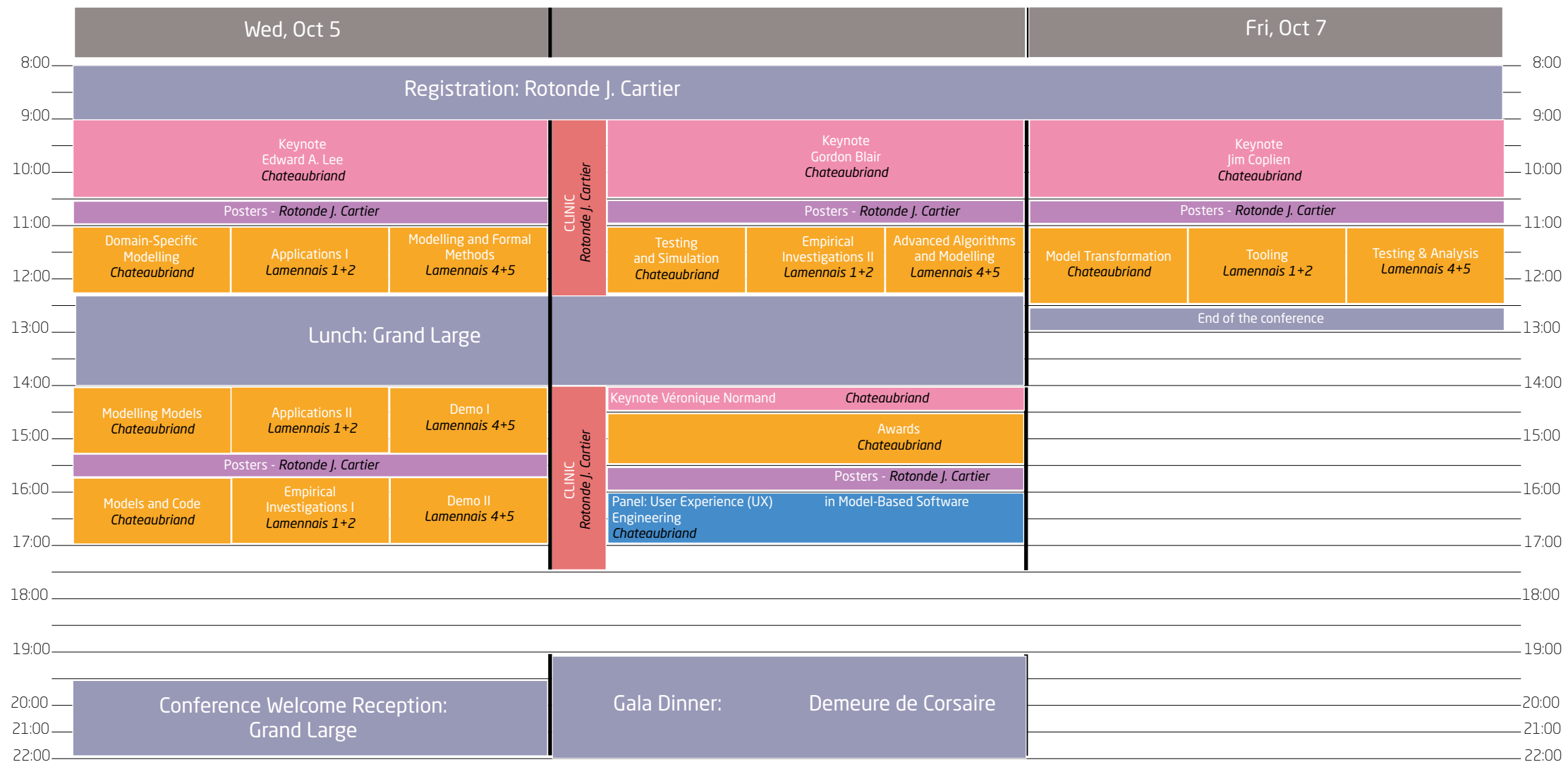
# PROGRAM AT-A-GLANCE

## SATELLITE EVENTS



# PROGRAM AT-A-GLANCE

## MAIN CONFERENCE





## SUNDAY, OCTOBER 2

**8:00 - 9:00 Registration** (Rotonde J. Cartier)

**9:00 - 10:30**

### Doctoral Symposium (Bouvet 1)

Website: <http://models2016.irisa.fr/doctoral-symposium>

#### Tutorial: Advanced Model Management with Epsilon (Bouvet 2)

Organizers: *Richard Paige, Dimitris Kolovos, Antonio Garcia-Dominguez, Nicholas Matragkas, Horacio Hoyos*

Abstract : Model management in MDE is all about manipulating models: transforming them, checking that they satisfy constraints, updating them, etc. This tutorial will focus on advanced model management - moving beyond simply building and executing transformations or constraints - illustrated with the Eclipse Epsilon platform. The tutorial will include a brief introduction to the principles and architecture of the Epsilon platform, especially its extensibility features. It will then illustrate advanced features, including developing new Epsilon languages, using annotations, extension via grammars, and developing new drivers.

#### Tutorial: Hybrid Graphical/Textual Modelling and Code Generation with PapyrusRT (Vauban 1)

Organizers: *Ernesto Posse, Nicolas Hili*

Abstract: Many MDE tools rely on graphical notations to design models but in recent years there has been an increased interest in textual and mixed graphical/textual approaches to modelling. In this tutorial we present mixed graphical/textual modelling in PapyrusRT, an open-source industrial-strength modelling development environment for real-time and embedded systems based on the UML-RT language. We also introduce the tool's code generator and present how to customize and extend the code generator, for example to provide code instrumentation or generate alternative code patterns. We will illustrate the tool with an extension of the code generator that enables web-based simulation and monitoring and model animation of an Arduino board model.

#### Tutorial: ARCADIA in a Nutshell (Vauban 2)

Organizer: *Pascal Roques*

Abstract: The ARCADIA/Capella Domain Specific Modeling Language (DSML) is inspired by UML/SysML and NAF standards, and shares many concepts with these languages. It is the result of an iterative definition process driven by systems and software architects working in a broad spectrum of business domains (transportation, avionics, space, radar, etc.). It enforces an approach structured on successive engineering phases which establishes clear separation between needs (operational need analysis and system need analysis) and solutions (logical and physical architectures), in accordance with the IEEE 1220 standard. The Capella workbench is an Eclipse application (Polarsys project) implementing the ARCADIA method providing both a DSML and a dedicated toolset. This tutorial will demonstrate the benefits of using both ARCADIA and Capella on a simple case study. It will guide you into the first steps of using ARCADIA, starting with the Analysis levels of the case study. It will then show you how the Capella tool, with the help of the ARCADIA method, will help you design more efficiently both Logical and Physical Architectures.

#### Workshop: OCL - 16<sup>th</sup> International Workshop on OCL and Textual Modeling (Lamennais 1)

Organizers: *Achim D. Brucker, Jordi Cabot, Adolfo Sanchez-Barbudo Herrera*

Abstract: Limitations of graphical notations encourage the development of text-based modeling languages that either integrate with or replace graphical notations for modeling. Typical examples of such languages are OCL, textual MOF, Epsilon, and Alloy. The goal of this workshop is to create a forum where researchers and practitioners interested in building models using OCL or other kinds of textual languages can directly interact, report advances, share results, discuss appropriate standards and showcase tools on any aspect of textual modeling and analysis.

Website: <http://oclworkshop.github.io/2016>

#### Workshop: VOLT - 5<sup>th</sup> International Workshop on the Verification of Model Transformation (Lamennais 2)

Organizers: *Moussa Amrani, Eugene Syriani*

Abstract: Model transformations are everywhere in software development, implicitly or explicitly. They have been described as "the heart and soul of Model-Driven Development (MDD)". Several experts have identified the verification of model transformations as one of the grand challenges of MDD. Despite some recent activity in the field, the work on the verification of model transfor-

mations remains scattered and a clear perspective on the subject is still not in sight. Furthermore, current model transformation tools most often lack verification techniques to support such activities. The Fifth International Workshop on the Verification Of model Transformation is one of the most accurate venues to offer researchers a dedicated forum to classify, discuss, propose, and advance verification techniques dedicated to model transformations. VOLT promotes discussions between theoreticians and practitioners from academy and industry, given its ideal co-location with MODELS. VOLT's interest spans both to academic and industrial practices. One of the goals of the forum is to collect enough industrial case studies so that those problems can be stated at a theoretical level.

Website: <http://www-ens.iro.umontreal.ca/~syriani/volt2016>

### **Workshop: ME - 10<sup>th</sup> International Workshop on Models and Evolution (Lamennais 3)**

Organizers: *Dalila Tamzalit, Alfonso Pierantonio, Bernhard Schätz, Tanja Mayerhofer*

Abstract: Software artefacts constantly increase in complexity, variety and novelty. Environment and business constraints, user requirements and new insights put additional pressure on their adaptability, availability, reliability and quality: they continuously need to be up to date and up to level. However, evolution issues are critical, complex and costly to manage. They concern requirements, architecture, design, source code, documentation, integration as well as deployment. They also typically affect various kinds of models (data, behavioural, domain, source code or goal models). Addressing and managing these varieties of changes is essential. Models and meta-models, the cornerstone of complex software systems' abstraction, represent a powerful mean for facing software evolution challenges by ensuring a more abstract and expressive modelling of software evolution. They can help and guide software evolution, and can enforce and reduce critical risks and important involved resources. The workshop puts the focus on Models and Evolution by considering two main sides: (1) Managing software evolution needs by relying on the high-level abstraction power of models and meta-models. (2) Managing models and metamodels evolution needs by putting attention to their increasing evolution issues as they become primary artefacts and to the need of co-evolution of all related software artefacts.

Website: <http://www.models-and-evolution.com>

**10:30 - 11:00 Coffee break** (Rotonde J. Cartier)

**11:00 - 12:30**

### **Doctoral Symposium (Bouvet 1)**

Website: <http://models2016.irisa.fr/doctoral-symposium>

**Tutorial: Advanced Model Management with Epsilon (Bouvet 2)**

**Tutorial: Hybrid Graphical/Textual Modelling and Code Generation with PapyrusRT (Vauban 1)**

**Tutorial: ARCADIA in a Nutshell (Vauban 2)**

**Workshop: OCL - 16<sup>th</sup> International Workshop on OCL and Textual Modeling (Lamennais 1)**

**Workshop: VOLT - 5<sup>th</sup> International Workshop on the Verification of Model Transformation (Lamennais 2)**

**Workshop: ME - 10<sup>th</sup> International Workshop on Models and Evolution (Lamennais 3)**

**12:30 - 14:00 Lunch** (Rotonde Surcouf)

**14:00 - 15:30**

### **Doctoral Symposium (Bouvet 1)**

Website: <http://models2016.irisa.fr/doctoral-symposium>

**Tutorial: Modeling Reactive Systems with the Scenario Modeling Language and ScenarioTools (Bouvet 2)**

Organizers: *Joel Greenyer, Daniel Gritzner*

Abstract: Software-intensive systems in many domains consist of multiple cooperating reactive components. The distributed and concurrent nature of these systems makes the software development difficult. Key to avoiding the costly iterations is having a precise and consistent specification. In this tutorial, we present a powerful formal, scenario-based method for modeling reactive system specifications. Software engineers can specify the inter-component behavior by a set of scenarios. Each scenario describes what the system must or must not do in a certain situation and in reaction to certain events. This fits how engineers conceive and communicate the behavior during the early design. Specifications can be executed, which allows engineers to understand the interplay of the scenarios. Inconsistencies can be detected through formal synthesis algorithms. For curious beginners, but also for experienced reactive systems modelers, we introduce scenario-based modeling and give a hands-on experience on its strengths and challenges. In part 1 we overview the modeling methodology and intro-

duce Live Sequence Charts (LSCs) and a textual variant, the Scenario Modeling Language (SML). We also introduce ScenarioTools, which supports the modeling and analysis of SML specifications. In part 2, we interactively model parts of a car-to-x system. We reflect on the method and discuss research opportunities.

### **Tutorial: Technologies and Design Patterns for Model-based Development of Cyber-physical (Vauban 1)**

Organizer: *Bran Selic*

Abstract: Cyber-physical systems (CPS) are complex engineering systems that interact directly with the physical world. They generally combine different engineering technologies, (e.g., mechanical, electrical) with embedded software, which is primarily responsible for monitoring and control functions. Traditional design approaches for such systems were based on an early decomposition into technology-centric subsystems, which were developed separately and then integrated towards the end of the development cycle. In contrast, modern CPS design takes a more holistic approach, which allows for increased flexibility in allocating functional responsibilities to the most appropriate technologies. This is made possible through more extensive and more effective use of computer-based engineering models. A key engineering challenge is how to construct and analyze models of such complex systems. To that end, a new generation of computer-based modeling languages has emerged. In this tutorial, we consider two industry standard modeling languages from this category, SysML and MARTE. We explore the rationale behind them, the relationships between them, and how they can be combined for effective and agile CPS design. Practical examples are used throughout to illustrate the various language concepts and their usage.

### **Tutorial: Creating a Domain-Specific Graphical Modeling Workbench with Eclipse Technologies (Vauban 2)**

Organizers: *Frederic Madiot, Cedric Brun*

Abstract: This tutorial will explain how to create a domain-specific graphical modeling workbench by using Eclipse Sirius. The tutorial will start with the definition of the metamodel by using Ecore Tools. Then, several diagrams and tabular representations with their tools (edition, navigation, complexity management, ...) will be created with Sirius. Finally we will show how to combine this workbench with other Eclipse Modeling technologies such as Xtext to persist the models into a human-readable textual format and Acceleo to generate code.

### **Workshop: OCL - 16<sup>th</sup> International Workshop on OCL and Textual Modeling (Lamennais 1)**

### **Workshop: FlexMDE - 2<sup>nd</sup> Flexible MDE Workshop (Lamennais 2)**

Organizers: *Davide Di Ruscio, Alfonso Pierantonio, Juan De Lara*

Abstract: Over the last years, numerous modeling platforms have been developed to simplify and automate many steps of Model Driven Engineering (MDE) processes. However, still several challenges have to be solved for enabling a wider adoption of MDE. One of the most important impediments in adopting MDE tools is related to the reduced flexibility of existing modeling platforms that do not permit to relax or enforce their rigidity depending on the stages of the applied development process. For instance, EMF does not permit to enter models which are not conforming to a metamodel. On one hand this allows only valid models to be defined, but on the other, it makes the corresponding pragmatics more difficult. Thus there is an increasing need for techniques supporting flexibility in a wide range of modeling activities, including metamodel, model, and model transformation development and reuse. The workshop aims at identifying the difficulties in the current practice of MDE related to the lack of flexibility, and soliciting contributions of ideas, concepts, and techniques also from other areas of software development which could be useful to revise certain MDE fundamental typing concepts, to facilitate flexible reuse of MDE artefacts, and to define agile model sketching techniques.

Website: <http://www.di.univaq.it/flexmde>

### **Workshop: ME - 10<sup>th</sup> International Workshop on Models and Evolution (Lamennais 3)**

**15:30 - 16:00 Coffee Break** (Rotonde J. Cartier)

**16:00 - 17:30**

### **Doctoral Symposium (Bouvet 1)**

Website: <http://models2016.irisa.fr/doctoral-symposium>

### **Tutorial: Modeling Reactive Systems with the Scenario Modeling Language and ScenarioTools (Bouvet 2)**

### **Tutorial: Technologies and Design Patterns for Model-based Development of Cyber-physical (Vauban 1)**

### **Tutorial: Creating a Domain-Specific Graphical Modeling Workbench with Eclipse Technologies (Vauban 2)**



**Workshop: OCL** - 16<sup>th</sup> International Workshop on OCL and Textual Modeling (Lamennais 1)

**Workshop: FlexMDE** - 2<sup>nd</sup> Flexible MDE Workshop (Lamennais 2)

**Workshop: ME** - 10<sup>th</sup> International Workshop on Models and Evolution (Lamennais 3)

## MONDAY, OCTOBER 3



**8:00 - 9:00 Registration** (Rotonde J. Cartier)

**9:00 - 10:30**

**Tutorial: Empirical Research in Model Based Software Engineering (Bouvet 1)**

Organizers: *Michel Chaudron, Regina Hebig, Maria Teresa Baldassarre*

Abstract: Modelling is applied in many different ways in software engineering: for facilitating communication, for analyzing systems, for generating code and tests. Thus, the evaluation of modelling techniques, languages and tools is needed in order to assess their advantages and disadvantages, to ensure their applicability to different contexts, their ease of use, and other issues such as skills and costs. However, many papers submitted to the MODELS conference lack empirical validations of their proposed methods/techniques. This tutorial offers an introduction to empirical methods in software engineering and thereby aims to equip researchers in the MODELS community with knowledge required to perform evaluations. This tutorial is offered by a group of people with broad experience in several types of empirical studies (including experiments, surveys, case studies, action research).

**Tutorial: Applying Model Driven Engineering Technologies in the Creation of Domain Specific Modeling Languages (Bouvet 2)**

Organizers: *Bruce Trask, Angel Roman*

Abstract: Model Driven Engineering (MDE) brings together multiple technologies and critical innovations and formalizes them into the next wave of software development methods. This tutorial will cover the basic patterns, principles and practices of MDE. The three main MDE categories include the development of Domain Specific Languages (DSL), Domain Specific Editors (and Views), and Domain Specific Transformation Engines or Generators. Expressed in terms of language development technology, these mirror the development of the Abstract Syntax, Concrete Syntax and Semantics of a new Domain Specific Language. This tutorial will cover the basic effective patterns, principles and practices for developing these MDE software artifacts. The tutorial will show how to apply these concepts as effective means with which to both raise levels of abstraction and domain specificity and thus increase power and value of tools and languages that allow developers to tackle the complexities of today's software systems. It will also show how to effectively leverage abstraction without sacrificing the ability to robustly and precisely refine these abstractions

to solve complex real world problems. To show these patterns and principles in action, this tutorial will cover the details of how to leverage MDE Language Workbenches and frameworks in support of robust software development.

### Workshop: PAME - 2<sup>nd</sup> International Workshop on Patterns in Model Engineering (Charcot)

Organizers: *Eugene Syriani, Richard Paige, Steffen Zschaler, Huseyin Ergin*

Abstract: PAME is intended to be the first forum for practitioners in MDE to discuss patterns that occur often during the different modeling activities. The aim of this workshop is to provide an arena for proposing and discussing good practices, patterns, pattern-based modeling, as well as start the initiative of developing a "language" for discussing and describing relevant problems and their solutions in the form of patterns.

Website: <http://www-ens.iro.umontreal.ca/~syriani/pame2016>

### Educators Symposium (Vauban 1)

Website : <http://models2016.irisa.fr/educators-symposium/>

### Workshop: OSS4MDE - 2<sup>nd</sup> International Workshop on Open Source Software for Model Driven Engineering (Vauban 2)

Organizers: *Juergen Dingel, Francis Bordeleau, Jean-Michel Bruel,*

*Sebastien Gérard, Sebastian Voss*

Abstract: Just like the previous versions of the workshop, OSS4MDE'16 workshop will bring together researchers, educators and industry representatives interested in modeling and MDE with open source tools. However, compared to previous incarnations, OSS4MDE'16 will be less formal and more interactive, and place more emphasis on promoting open source by inspiring and encouraging potential users and contributors, and supporting existing users and contributors.

Website: <http://mase.cs.queensu.ca/oss4mde>

### Workshop: EXE - 2<sup>nd</sup> International Workshop on Executable Modeling (Lamennais 1)

Organizers: *Tanja Mayerhofer, Philip Langer, Ed Seidewitz, Jeff Gray*

Abstract: Executable models have the potential of bringing major benefits to the development of complex systems, as they provide abstractions of complex system behaviors and allow for the performance of early analyses of that behavior. Despite the potential benefits of executable models, there are still many challenges to solve, such as the lack of maturity in the definition of and tooling for executable modeling languages, and the limited experience with executable modeling in much of the software development industry. The objective of this workshop is to draw attention to the potentials and challenges of executable

modeling and advance the state-of-the-art in executable modeling. We aim at bringing together researchers working towards overcoming challenges in executable modeling, as well as practitioners from different application domains and application contexts of executable modeling. The workshop intends to provide a forum for exchanging recent results, ideas, opinions, requirements, and experiences in executable modeling.

Website: <http://www.modelexecution.org>

### Workshop: MoDeVVa - 13<sup>th</sup> International Workshop on Model Driven Engineering, Verification and Validation (Lamennais 2)

Organizers: *Michalis Famelis, Daniel Ratiu, Gehan M. K. Selim*

Abstract: MoDeVVa offers a forum for researchers and practitioners who are working on Verification & Validation and Models-driven Engineering. The major questions of interest in MoDeVVa concern the mutual benefits of MDE and V&V: How can models-driven engineering improve V&V?, and How can V&V leverage the techniques around models-driven engineering? In 2016 we put an emphasis on making the V&V activities of MDE artefacts a systematic process. This includes modeling the V&V activities, investigating the synergies between them or composing different V&V activities to increase the confidence in the verification results.

Website: <https://sites.google.com/site/modevva>

### Conference: SAM (Lamennais 3)

The System Analysis and Modelling (SAM) conference provides an open arena for participants from academia and industry to present and discuss the most recent innovations, trends, experiences and concerns in modelling, specification and analysis of distributed, communication and real-time systems using ITU-T Specification and Description Language and Message Sequence Chart notations, as well as related system design languages (including but not limited to UML, ASN.1, TTCN, SysML and the User Requirements Notation (URN)).

Clinic (Ronde J. Cartier)

**10:30 - 11:00 Coffee Break** (Ronde J. Cartier)

Clinic (Ronde J. Cartier)

SRC poster (Ronde J. Cartier)

**11:00 - 12:30**

Tutorial: Empirical Research in Model Based Software Engineering (Bouvet 1)

**Tutorial:** Applying Model Driven Engineering Technologies in the Creation of Domain Specific Modeling Languages (Bouvet 2)

**Workshop: PAME** - 2<sup>nd</sup> International Workshop on Patterns in Model Engineering (Charcot)

**Educators Symposium** (Vauban 1)

Website : <http://models2016.irisa.fr/educators-symposium/>

**Workshop: OSS4MDE** - 2<sup>nd</sup> International Workshop on Open Source Software for Model Driven Engineering (Vauban 2)

**Workshop: EXE** - 2<sup>nd</sup> International Workshop on Executable Modeling (Lamennais 1)

**Workshop: MoDeVVa** - 13<sup>th</sup> International Workshop on Model Driven Engineering, Verification and Validation (Lamennais 2)

**Conference: SAM** (Lamennais 3)

**Clinic** (Rotonde J. Cartier)

**12:30 - 14:00 Lunch** (Rotonde Surcouf)

**14:00 - 15:30**

**Tutorial:** Empirical Research in Model Based Software Engineering (Bouvet 1)

**Tutorial:** Multi-level Modelling with MetaDepth (Bouvet 2)

Organizers: *Juan De Lara, Esther Guerra*

Abstract: Model-Driven Engineering (MDE) promotes models as the primary artefacts in the software development process, from which code for the final application is derived. Standard approaches to MDE (like those based on MOF or EMF) advocate a two-level meta-modelling setting where domain-specific modelling languages are defined through a meta-model, which is instantiated to build models at the meta-level below. Multi-level modelling – also called deep meta-modelling – extends the standard approach to meta-modelling by ena-

bling modelling at an arbitrary number of meta-levels, not necessarily two. This approach leads to simpler models in situations where the type-object pattern or some of its variants arises. In this tutorial, we will discuss the motivation for multi-level modelling and explain its basic concepts. These will be illustrated in practice with the MetaDepth tool, developed by the lecturers. The tutorial will also cover the use of constraint and model management languages (e.g., for code generation or model-to-model transformation) in a multi-level setting, and will finish by introducing more advanced multi-level concepts.

**Educators Symposium** (Vauban 1)

Website : <http://models2016.irisa.fr/educators-symposium>

**Workshop: OSS4MDE** - 2<sup>nd</sup> International Workshop on Open Source Software for Model Driven Engineering (Vauban 2)

**Workshop: EXE** - 2<sup>nd</sup> International Workshop on Executable Modeling (Lamennais 1)

**Workshop: MoDeVVa** - 13<sup>th</sup> International Workshop on Model Driven Engineering, Verification and Validation (Lamennais 2)

**Conference: SAM** (Lamennais 3)

**Clinic** (Rotonde J. Cartier)

**15:30 - 16:00 Coffee Break** (Rotonde J. Cartier)

**Clinic** (Rotonde J. Cartier)

**SRC poster** (Rotonde J. Cartier)

**16:00 - 17:30**

**Tutorial:** Empirical Research in Model Based Software Engineering (Bouvet 1)

**Tutorial:** Multi-level Modelling with MetaDepth (Bouvet 2)

**Educators Symposium** (Vauban 1)

Website : <http://models2016.irisa.fr/educators-symposium>

**Workshop: OSS4MDE** - 2<sup>nd</sup> International Workshop on Open Source Software for Model Driven Engineering (Vauban 2)

**Workshop: EXE** - 2<sup>nd</sup> International Workshop on Executable Modeling (Lamennais 1)

**Workshop: MoDeVVa** - 13<sup>th</sup> International Workshop on Model Driven Engineering, Verification and Validation (Lamennais 2)

**Conference: SAM** (Lamennais 3)

**Clinic** (Ronde J. Cartier)

**17:30 - 19:00**

**SRC poster** (Ronde J. Cartier)

**19:00 - 22:00 Satellite Events Welcome reception**  
(Ronde J. Cartier)

## TUESDAY, OCTOBER 4



**8:00 - 9:00 Registration** (Ronde J. Cartier)

**9:00 - 10:30**

**Workshop: COMMitMDE** - 1<sup>st</sup> International Workshop on Collaborative Modelling in MDE (Bouvet 1)

Organizers: *Henry Muccini, Ivano Malavolta, Sébastien Gérard, Dimitrios S. Kolovos*

Abstract: Nowadays, collaborative model-driven software engineering (MDSE) is gaining a growing interest in both academia and practice. Goal of COMMitMDE 2016 is to bring together researchers and practitioners in order to investigate together (i) the potential impact of collaborative software engineering methods and principles into MDE practices and (ii) how MDE methods and techniques can support collaborative software engineering activities. Also, COMMitMDE aims at assessing the state of the research and practice on collaborative MDE, creating new synergies between tool vendors, researchers, and practitioners.

Website: <http://cs.gssi.infn.it/commitmde2016>

**Workshop: HuFaMo** - 2<sup>nd</sup> International Workshop on Human Factors in Modeling (Bouvet 2)

Organizers: *Harald Störrle, Michel Chaudron*

Abstract: Modeling is a genuinely human enterprise, so many of the questions related to modeling can only be answered by empirical studies of human factors. The HuFaMo workshop series is the premier venue for early stage empirical research involving human factors in modeling. Our goal is to improve the state of the science and professionalism in empirical research in the Model Based Engineering community. Typical examples of such questions might consider the usability of a certain approach such as a method or language, or the emotional states or personal judgements of modelers. We invite submissions regarding empirical studies of emotion, cognition, personality traits of modelers as well as studies about activities and communities of modelers, their culture and capabilities. Beyond conventional papers, we also seek to publish study designs, negative results, and, in fact, suggestions for actual studies to be carried out at the workshop.

Website: <http://hufamo.compute.dtu.dk>

### **Workshop: ModComp - 3<sup>rd</sup> International Workshop on Interplay of Model-Driven and Component-Based Software Engineering (Vauban 1)**

Organizers: *Federico Ciccozzi, Ivano Malavolta*

Abstract: Model-Driven Engineering (MDE) and Component-Based Software Engineering (CBSE) have been proven to effectively reduce software development complexity by (i) shifting the focus from source code to models and (ii) breaking down the set of desired features and their intricacy into smaller sub-modules, respectively. Moreover, the interplay of MDE and CBSE approaches is gaining recognition as a very promising means to boost the development of software systems by reducing costs and risks and shorten time-to-market. While several attempts to effectively combine MDE and CBSE have been documented, there are still unsolved clashes raising when exploiting interplay of MDE and CBSE, mostly due to mismatches in the related terminology as well as to differences in their basic essence. As satellite event of MoDELS, the goal of ModComp'16 is to gather researchers and practitioners to share opinions, propose solutions to open challenges and generally explore the frontiers of interweaving between MDE and CBSE.

Website: <http://www.mrtc.mdh.se/ModComp16>

### **Workshop: MRT - 11<sup>th</sup> International Workshop on Models@runtime (Vauban 2)**

Organizers: *Sebastian Götz, Nelly Bencomo, Gordon Blair, Hui Song*

Abstract: The complexity of adapting software during runtime has spawned interest in how models can be used to validate, monitor and adapt runtime behaviour. The use of models during runtime extends the use of modeling techniques beyond the design and implementation phases. The goal of this workshop is to look at issues related to developing appropriate model-driven approaches to managing and monitoring the execution of systems. We aim to continue the discussion of research ideas and proposals from researchers who work in relevant areas such as MDE, software architectures, reflection, and autonomic and self-adaptive systems, and provide a "state-of-the-art" research assessment expressed in terms of challenges and achievements.

Website: <http://st.inf.tu-dresden.de/MRT16>

### **Workshop: MULTI - 3<sup>rd</sup> International Workshop on Multi-Level Modelling (Lamennais 1)**

Organizers: *Colin Atkinson, Tony Clark, Georg Grossmann*

Abstract: As interest in multi-level modelling grows, and the range of multi-level modelling tools expands, there is growing interest in consolidating the key principles of the paradigm and clarifying the essential differences between

heterogeneous approaches. Although multi-level modelling has now been used successfully in a variety of industrial projects and standards initiatives, there is still no clear consensus on what the paradigm actually entails and how it should be applied. For example, there are different views on whether it is sound to combine instance facets and type facets into so-called cljects, whether strict metamodelling is too restrictive, and what tool architectures provide the best framework for modelling with multiple classification levels. This lack of a foundational consensus is mirrored by the lack of a common focus in current multi-level tools. The goal of MULTI 2016 is to address these challenges and continue the community building established in the previous workshops. In particular, the goal is to encourage the community to delineate different approaches to multi-level modelling and define objective ways to evaluate their respective strengths/weaknesses.

Website: <http://swt4.informatik.uni-mannheim.de/multi-2016>

### **Workshop: GEMOC - 4<sup>th</sup> International Workshop On the Globalization of Modeling Languages (Lamennais 2)**

Organizers: *Julien Deantoni, Jeff Gray, Eugene Syriani*

Abstract: To cope with complexity, modern software-intensive systems are often split in different concerns to serve the needs of diverse stakeholders. These different concerns are often associated with specialized description languages and technologies, which are based on concern-specific problems and solution concepts. Software developers are thus faced with the challenging task of integrating the different languages and associated technologies used to produce software artifacts in the different concern spaces. The proposed GEMOC 2016 will be a full-day workshop that brings together researchers and practitioners in the modeling languages community to discuss the challenges associated with integrating multiple, heterogeneous modeling languages. The languages of interest range from requirements, to design and runtime languages, and include both general-purpose and domain-specific languages. Challenges related to engineering composable languages, well-formed semantic composition of languages and reasoning about systems described using heterogeneous languages are of particular interest. Following the three previous editions, a major objective is to continue collaborations and to expand a community that is focused on solving the problems arising from the globalization of modeling languages; i.e., the use of multiple DSLs to support coordinated development of diverse aspects of a system.

Website: <http://gemoc.org/gemoc2016>

### **Conference: SAM (Lamennais 3)**

**10:30 - 11:00 Coffee Break (Rotonde J. Cartier)**

## 11:00 - 12:30

**Workshop: COMMitMDE** - 1<sup>st</sup> International Workshop on Collaborative Modelling in MDE (Bouvet 1)

**Workshop: HuFaMo** - 2<sup>nd</sup> International Workshop on Human Factors in Modeling (Bouvet 2)

**Workshop: ModComp** - 3<sup>rd</sup> International Workshop on Interplay of Model-Driven and Component-Based Software Engineering (Vauban 1)

**Workshop: MRT** - 11<sup>th</sup> International Workshop on Models@run.time (Vauban 2)

**Workshop: MULTI** - 3<sup>rd</sup> International Workshop on Multi-Level Modelling (Lamennais 1)

**Workshop: GEMOC** - 4<sup>th</sup> International Workshop On the Globalization of Modeling Languages (Lamennais 2)

**Conference: SAM** (Lamennais 3)

**12:30 - 14:00 Lunch** (Rotonde Surcouf)

## 14:00 - 15:30

**Workshop: COMMitMDE** - 1<sup>st</sup> International Workshop on Collaborative Modelling in MDE (Bouvet 1)

**Workshop: HuFaMo** - 2<sup>nd</sup> International Workshop on Human Factors in Modeling (Bouvet 2)

**SRC Talk** (Charcot)

**Workshop: ModComp** - 3<sup>rd</sup> International Workshop on Interplay of Model-Driven and Component-Based Software Engineering (Vauban 1)

**Workshop: MRT** - 11<sup>th</sup> International Workshop on Models@run.time (Vauban 2)

**Workshop: MULTI** - 3<sup>rd</sup> International Workshop on Multi-Level Modelling (Lamennais 1)

**Workshop: GEMOC** - 4<sup>th</sup> International Workshop On the Globalization of Modeling Languages (Lamennais 2)

**Conference: SAM** (Lamennais 3)

**15:30 - 16:00 Coffee Break** (Rotonde J. Cartier)

## 16:00 - 17:30

**Workshop: COMMitMDE** - 1<sup>st</sup> International Workshop on Collaborative Modelling in MDE (Bouvet 1)

**Workshop: HuFaMo** - 2<sup>nd</sup> International Workshop on Human Factors in Modeling (Bouvet 2)

**SRC Talk** (Charcot)

**Workshop: ModComp** - 3<sup>rd</sup> International Workshop on Interplay of Model-Driven and Component-Based Software Engineering (Vauban 1)

**Workshop: MRT** - 11<sup>th</sup> International Workshop on Models@run.time (Vauban 2)

**Workshop: MULTI** - 3<sup>rd</sup> International Workshop on Multi-Level Modelling (Lamennais 1)

**Workshop: GEMOC - 4<sup>th</sup> International Workshop On the Globalization of Modeling Languages (Lamennais 2)**

**Conference: SAM (Lamennais 3)**

## WEDNESDAY, OCTOBER 5



**8:00 - 8:45 Registration** (Ronde J. Cartier)

**8:45 - 9:00 General Chairs Opening** (Chateaubriand)

**9:00 - 9:15 Program Committee Opening** (Chateaubriand)

**9:15 - 10:30**

**Keynote: Resurrecting Laplace's Demon: The Case for Deterministic Models** (Chateaubriand)

Speaker: *Edward A. Lee* / Chair: *Alexander Pretschner*

**10:30 - 11:00 Coffee break** (Ronde J. Cartier)

**Posters** (Ronde J. Cartier)

**11:00 - 12:15**

**Domain-Specific Modelling** (Chateaubriand)

Chair: *Eugene Syriani*

> **Multi-Variability Modeling and Realization for Software Derivation in Industrial Automation Management**

Authors: *Miao Fang, Georg Leyh, Joerg Doerr, Christoph Elsner*

Abstract: The systems of industrial automation management (IAM) are in the domain of information systems. IAM systems have software components that support manufacturing processes. The operational parts of IAM coordinate highly plug-compatible hardware devices. These functions lead to process and topology variability, which result in development and reuse challenges for software engineers in practice. This paper presents an approach aiming at improving the development and derivation of one IAM software family within Siemens. The approach integrates feature modeling with domain-specific modeling languages (DSMLs) for variability representation. Moreover, by combining code generation techniques, the configuration of variability models can be used to automate the software derivation. We report on a case study of applying the approach in practice. The outcome shows the enhancement of variability representation by introducing DSMLs and the improvement on automating software derivation.

Finally, we present the lessons learned during the execution of this case study.

### > A Model-based Approach for Multi-Device User Interactions

Authors: *Christian Prehofer, Andreas Wagner, Yucheng Jin*

Abstract: This paper presents an approach for modeling multi-device user interactions, based on task models. We use ConcurTaskTrees (CTTs) as a domain-specific language, which we extend here by a labeling mechanism to model multi-device interactive applications. While CTTs are used to specify temporal and causal relations between tasks, we add operators to specify the device mapping in a flexible and expressive way. The main novelty is the introduction of the two new operators, Any and All, to specify if a task should be executed on any or on all of a set of devices. We show that this is applicable in scenarios of connected, smart devices where a task can be executed on a multitude of devices. We present formal semantics for our extension of CTTs as well as a tool chain based on the Qt toolkit for generating code for distributed UIs. This includes a mapping from high-level tasks to concrete UI controls and a distributed execution model based on state machines. The new concepts are validated in several case studies.

### > Using Free Modeling as an Agile Method for Developing Domain Specific Modeling Languages

Authors: *Fahad R. Golra, Antoine Beugnard, Fabien Dagnat, Sylvain Guerin, Christophe Guychard*

Abstract: Mostly the development of domain specific modeling languages (DSML) follows the traditional model driven engineering practices. First the syntax and semantics of the language are defined (at meta-level) and then it is used for the development of user models. In certain situations, it is hard even to conceptualize the demands of the user, let alone the definition of the language. Agile methods for software development suggest that the development activities should be performed alongside a client stakeholder for incremental development of the system. This approach helps in the elicitation of requirements in parallel to the actual development of the system. We followed this approach for developing a domain specific modeling language and its tooling for a local government project, Brest Metropole. The project aimed at filling the communication gap between the elected representatives (politicians) and the bureaucracy (government officers). We used a modeling methodology that does not restrict a modeler's interaction to a single abstraction level. Thus a modeler can develop both models and metamodels at the same time, where the definition of one helps in defining the other. In this article, we explain our experiences from this project and share the lessons learnt.

## Applications I (Lamennais 1+2)

Chair: *Bernhard Rumpe*

### > Supporting the Model-Driven Development of Real-time Embedded Systems with Run-Time Monitoring and Animation via Highly Customizable Code Generation

Authors: *Nondini Das, Suchita Ganesan, Leo Jweda, Mojtaba Bagherzadeh, Nicolas Hili, Juergen Dingel*

Abstract: This paper presents a vision that allows the combined use of model-driven engineering, run-time monitoring, and animation for the development and analysis of components in real-time embedded systems. Key building block in the tool environment supporting this vision is a highly-customizable code generation process. Customization is performed via a configuration specification which describes the ways in which input is provided to the component, the ways in which run-time execution information can be observed, and how these observations drive animation tools. The environment is envisioned to be suitable for different activities ranging from quality assurance to supporting certification, teaching, and outreach and will be built exclusively with open source tools to increase impact. A preliminary prototype implementation is described.

### > Model-driven Performance Prediction of Systems of Systems (SoSyM First)

Authors: *Katrina Falkner, Claudia Szabo, Vanea Chiprianov, Gavin Puddy, Marianne Rieckmann, Dan Fraser, Cathlyn Aston*

Abstract: Systems of systems exhibit characteristics that pose difficulty in modelling and predicting their overall performance capabilities, including the presence of operational independence, emergent behaviour, and evolutionary development. When considering systems of systems within the autonomous defence systems context, these aspects become increasingly critical, as constraints on the performance of the final system are typically driven by hard constraints on space, weight and power. System execution modelling languages and tools permit early prediction of the performance of model-driven systems; however, the focus to date has been on understanding the performance of a model rather than determining whether it meets performance requirements, and only subsequently carrying out analysis to reveal the causes of any requirement violations. Moreover, such an analysis is even more difficult when applied to several systems cooperating to achieve a common goal—a system of systems. In this article, we propose an integrated approach to performance prediction of model-driven real-time embedded defence systems and systems of systems. Our architectural prototyping system supports a scenario-driven experimental platform for evaluating model suitability within a set of deployment and real-time performance constraints. We present an overview of our performance prediction system, demonstrating the integration of modelling, execution and performance analysis, and discuss a case study to illustrate our approach.



### > Automatic Generation of Detailed Flight Plans from High-level Mission Descriptions

Authors: *Davide Di Ruscio, Ivano Malavolta, Patrizio Pelliccione, Massimo Tivoli*

Abstract: Drones are increasingly popular since they promise to simplify a myriad of everyday tasks. Currently vendors provide low-level APIs and basic primitives to program drones, making mission development a task-specific and error-prone activity. As a consequence, current approaches are affordable only for users that have a strong technical expertise. Then, it emerges the need for software engineering techniques supporting the definition, development, and realization of missions involving swarms of autonomous drones while guaranteeing the safety today's users expect. In this paper we consider mission specifications expressed through a domain-specific modeling language which can be effectively used by end-users with no technical expertise, e.g., firefighters and rescue workers. Our generation method automatically derives the lower level logic that each drone must perform to accomplish the specified mission, prevents collisions between drones and obstacles, and ensures the preservation of no-fly zones.

### Modelling and Formal Methods (Lamennais 4+5)

Chair: *Daniel Varro*

#### > Towards a Categorical Approach for Meta-Modelling Epistemic Game Theory

Authors: *Fazle Rabbi, Yngve Lamo, Ingrid Chieh Yu*

Abstract: In order to optimize the use of resources of interdependent systems we need to perform strategic analysis of resources. Game theory is the discipline of science that studies strategy. Epistemic game theory explores how individuals reason about others choices for decision making. This theory can play a vital role for optimizing the use of distributed resources since our systems are continuously providing support for decision making where the outcome of a decision is dependent on other systems. We use a model driven approach to build a bridge between software models and epistemic game theory. In this initial work, we have shown how software models such as entity models may be used for building epistemic models. We propose an algorithm for constructing epistemic models where conflict situations are represented with the use of diagrammatic constraints. We use examples from the healthcare domain to explain the proposed technique.

#### > OCL2MSFOL: A Mapping to Many-Sorted First-Order Logic for Efficiently Checking the Satisfiability of OCL Constraints

Authors: *Carolina Dania, Manuel Clavel*

Abstract: In this paper we propose a mapping from OCL to many-sorted first-or-

der logic, called OCL2MSFOL. This new mapping significantly improves our previous results in two key aspects. First, it accepts as input a larger subset of the UML/OCL language; in particular, it supports UML generalization, along with generalization-related OCL operators. Secondly, it generates as output a class of satisfiability problems that can be efficiently handled by SMT solvers with finite model finding capabilities. We report on a non-trivial case study and draw comparisons with related tools.

#### > On the Synthesis of Protocol State Machines from Contracts

Author: *Piotr Kosiuczenko*

Abstract: Contractual specifications and UML state machines belong to the basic means for the specification and modelling of object-oriented system behaviour and are the subject of active research. However, the problem of state machines synthesis from contracts has not been researched. In this paper, this problem is investigated and a suitable procedure for protocol state machine generation is presented. This procedure is based on a method used in specification-based testing; it is formally defined, stepwise and based on a well-defined mathematical model. Its applicability is demonstrated on a bank account example often used in the literature. It is shown that resulting protocol state machines help to grasp the meaning of specifications and, as a side effect, to identify flaws in the specification such as unreachable states.

**12:30 - 14:00 Lunch** (Grand Large)

**14:00 - 15:15**

### Modelling Models (Chateaubriand)

Chair: *Gregor Engels*

#### > Towards the Characterization of Realistic Models: Evaluation of Multidisciplinary Graph Metrics

Authors: *Zsolt Kovari, Agnes Salanki, Gabor Szarnyas, Daniel Varro*

Abstract: Custom generators of graph-based models are used in MDE for many purposes such as functional testing and performance benchmarking of modeling environments to ensure the correctness and scalability of tools. However, while existing generators may generate large models in increasing size, these models are claimed to be simple and synthetic, which hinders their credibility for industrial and research benchmarking purposes. But how to characterize a realistic model used in software and systems engineering? This question is investigated in the paper by collecting over 17 different widely used graph metrics taken from other disciplines (e.g. network theory) and evaluating them on 83

instance models originating from six modeling domains. Our preliminary results show that certain metrics are similar within a domain, but differ greatly between domains, which makes them suitable input for future instance model generators to derive more realistic models.

### > Unifying Explanatory and Constructive Modeling

Author: *Thomas Kühne*

Abstract: The universal agreement regarding modeling as a useful endeavor can hide the large divide that runs through the modeling community. The differences between explanatory and constructive modeling give rise to two almost disjoint modeling universes, each based on different, mutually incompatible assumptions, rules, and tools. This division is undesirable as it prevents modelers from fluently transitioning between these worlds and denies them the benefits afforded by the underpinnings of the opposite camp. In this paper I characterize the typing disciplines underlying these different schools of thought, identify their respective trade-offs, and propose a unified approach which treats the different world views as modes of modeling that one may transition into in either direction. I present a unifying typing framework that can form the basis for a mutual fertilization between the hitherto rather separated worlds of explanatory versus constructive modeling.

### > Metamodel Specialization for Graphical Modeling Language Support

Authors: *Audris Kalnins, Janis Barzdins*

Abstract: Most of current modeling languages are based on graphical diagrams. The concrete graphical syntax of these languages typically is defined informally - by text and diagram examples. Only recently, starting from UML 2.5, a formalism is offered for defining the graphical syntax of UML. This formalism is based on Diagram Definition standard by OMG, where the main emphasis is on enabling diagram interchange between different tools implementing the given language. While this is crucial for standardized languages such as UML, this aspect is not so important for domain specific languages. In this paper an approach is offered for simple direct definition of concrete graphical syntax by means of metamodels. Metamodels are typically used for language definition, but mainly the MOF-inspired approach via metametamodel instantiation is used. We offer an alternative approach based on core metamodel specialization, which leads to a more direct and understandable definition, staying at the same meta-layer. In addition, our approach permits a natural extension - a facility for graphical editor definition for the given language, which is vital in the world of DSLs. In contrast to most DSL development platforms which are based on abstract syntax metamodel of the language and a mapping to graphics our facility is based directly on the graphical syntax.

## Applications II (Lamennais 1+2)

Chair: *Richard Paige*

### > Visual Modeling of RESTful Conversations with RESTalk (SoSyM First)

Authors: *Ana Ivanchikj, Cesare Pautasso, Silvia Schreier*

Abstract: The cost savings introduced by Web services through code reuse and integration opportunities have motivated many businesses to develop Web APIs, with ever increasing numbers opting for the REST architectural style. RESTful Web APIs are decomposed in multiple resources, which the client can manipulate through HTTP interactions with well-defined semantics. Getting the resource in the desired state might require multiple client-server interactions, what we define as a RESTful conversation. RESTful conversations are dynamically guided by hypermedia controls, such as links. Thus, when deciding whether and how to use a given RESTful service, the client might not be aware of all the interactions which are necessary to achieve its goal. This is because existing documentation of RESTful APIs describes the static structure of the interface, exposing low-level HTTP details, while little attention has been paid to conceptual, high-level, modeling of the dynamics of RESTful conversations. Low-level HTTP details can be abstracted from during the design phase of the API, or when deciding which API to use. We argue that, in these situations, visual models of the required client-server interactions might increase developers' efficiency and facilitate their understanding. Thus, to capture all possible interaction sequences in a given RESTful conversation, we propose RESTalk, an extension to the BPMN Choreography diagrams to render them more concise and yet sufficiently expressive in the specific REST domain. We also report on the results obtained from an exploratory survey we have conducted to assess the maturity of the field for a domain-specific language and to obtain feedback for future improvements of RESTalk.

### > Formalizing Knowledge in Multi-Scale Agent-Based Simulations

Authors: *Endre Somogyi, James P. Sluka, James A. Glazier*

Abstract: Multi-scale, agent-based simulations of cellular and tissue biology are increasingly common. These simulations combine and integrate a range of components from different domains. Simulations continuously create, destroy and reorganize constituent elements causing their interactions to dynamically change. For example, the multi-cellular tissue development process coordinates molecular, cellular and tissue scale objects with biochemical, biomechanical, spatial and behavioral processes to form a dynamic network. Different domain specific languages can describe these components in isolation, but cannot describe their interactions. No current programming language is designed to represent in human readable and reusable form the domain specific knowledge contained in these components and interactions. We present a new hybrid programming

language paradigm that naturally expresses the complex multi-scale objects and dynamic interactions in a unified way and allows domain knowledge to be captured, searched, formalized, extracted and reused.

### > Process Mining Using BPMN: Relating Event Logs and Process Models (SoSyM First)

Authors: *Anna A. Kalenkova, Wil M. P. van der Aalst, Irina A. Lomazova, Vladimir A. Rubin*

Abstract: Process-aware information systems (PAIS) are systems relying on processes, which involve human and software resources to achieve concrete goals. There is a need to develop approaches for modeling, analysis, improvement and monitoring processes within PAIS. These approaches include process mining techniques used to discover process models from event logs, find log and model deviations, and analyze performance characteristics of processes. The representational bias (a way to model processes) plays an important role in process mining. The BPMN 2.0 (Business Process Model and Notation) standard is widely used and allows to build conventional and understandable process models. In addition to the flat control flow perspective, subprocesses, data flows, resources can be integrated within one BPMN diagram. This makes BPMN very attractive for both process miners and business users, since the control flow perspective can be integrated with data and resource perspectives discovered from event logs. In this paper, we describe and justify robust control flow conversion algorithms, which provide the basis for more advanced BPMN-based discovery and conformance checking algorithms. Thus, on the basis of these conversion algorithms low-level models (such as Petri nets, causal nets and process trees) discovered from event logs using existing approaches can be represented in terms of BPMN. Moreover, we establish behavioral relations between Petri nets and BPMN models and use them to adopt existing conformance checking and performance analysis techniques in order to visualize conformance and performance information within a BPMN diagram. We believe that the results presented in this paper can be used for a wide variety of BPMN mining and conformance checking algorithms. We also provide metrics for the processes discovered before and after the conversion to BPMN structures. Cases for which conversion algorithms produce more compact or more complicated BPMN models in comparison with the initial models are identified.

### Demo I (Lamennais 4+5)

Chair: *Juan de Lara*

#### > txtUML

Authors: *Gergely Dévai, Tibor Gregorics, Melinda Tóth, Domonkos Asztalos*

Abstract: The name txtUML stands for textual, executable, translatable UML. It is an Eclipse-based tool built on top of JDT, Xtext/Xbase and Papyrus UML. The tool is designed for textual model editing. This makes storage, version control, compare and merge processes, editing and searching easier and more efficient. The tool supports two textual syntaxes for modeling: the standalone syntax, which is designed to be clean and short, and alternatively, the txtUML Java API, which can be used to define models as standard Java programs. The tool supports the generation of graphical UML diagrams from the textual descriptions: class- and state machine diagrams. The layout of the diagrams can be controlled by a simple textual diagram layout language. Models can be seamlessly integrated into Java programs: they can be executed and debugged. Generated state machine diagrams can be animated during model execution to further enhance comprehension of model dynamics. Compatibility with other tools is ensured by generating standard UML models in EMF-UML2 format. This representation is the input for our model compiler, which generates C++ code.

#### > iOCL: A Interactive Tool for Specifying, Validating and Evaluating OCL Constraints

Authors: *Hammad Muhammad, Tao Yue, Shaukat Ali, Shuai Wang*

Abstract: The Object Constraint Language (OCL) is frequently used to specify additional constraints on models, in addition, to the ones enforced by semantics of the models. It is a well-known fact that due to the lack of familiarity with OCL, practitioners and even researcher to some extent are reluctant in using OCL. To help practitioners and researchers in writing OCL constraints for their specific problem at hand, we developed a tool called interactive OCL (iOCL) for interactively specifying constraints on a given model. The basic philosophy behind the tool is to present only those details (e.g., operations) of OCL to modelers that are valid at a given step of constraint specification process, in addition to helping modelers with its syntax. Our ultimate aim is to reduce the effort required to specify constraints, subsequently lowering down training cost and increasing the correctness of the constraints. iOCL is a web-based application that integrates other tools including Eclipse OCL for validation and evaluation of OCL constraints, and EsOCL for automatically generating valid instances of models that satisfy the specified constraints.

### > SAC-OCL: A Tool for A Semi Automatic Co-evolution of OCL Constraints

Authors: *Djamel Eddine Khelladi, Reda Bendraou, Marie-Pierre Gervais*

Abstract: Object-Oriented Models (OOM) are widely used in Model-Driven Engineering (MDE). As a complement, OCL constraints are used to specify business rules and detailed aspects of the business domain, e.g. more than 750 constraints come with the UML metamodel (an OOM). Automatically co-evolving OCL constraints w.r.t. the evolved OOM is challenging since alternative resolutions can be applied but also a resolution cannot be applied to any arbitrary constraint. In this paper, we present SAC-OCL an Eclipse-based tool to automatically co-evolve OCL constraints when an OOM evolves. In contrast to existing tools, SAC-OCL propose alternative resolutions for an impacted OCL constraint and propose only the appropriate resolutions that can be applied on the impacted constraint. Our evaluation on six case studies shows an average correct co-evolution rate of 92%.

### > Scenario-Based Modeling and Synthesis for Reactive Systems with Dynamic System Structure in ScenarioTools

Authors: *Joel Greenyer, Daniel Gritzner, Guy Katz, Assaf Marron*

Abstract: Software-intensive systems such as communicating cars or collaborating robots consist of multiple interacting components, where physical or virtual relationships between components change at run-time. This dynamic system structure influences the components' behavior, which again affects the system's structure. This dynamic system structure and the often distributed and concurrent nature of the software bring substantial complexity that must be mastered during system design. For this purpose, we propose a specification method that combines scenario-based modeling and graph transformations. The specifications are executable and can be analyzed via simulation. We furthermore developed a formal synthesis procedure that can find inconsistencies or prove the specification's realizability. This method is implemented in ScenarioTools, an Eclipse-based tool suite that combines the Scenario Modeling Language, an extended variant of LSCs, and graph transformations modeled with Henshin. The particular novelty is the synthesis support for systems with dynamic structure.

**15:15 - 15:45 Coffee Break** (Rotonde J. Cartier)

**Posters** (Rotonde J. Cartier)

**15:45 - 17:00**

### Models and Code (Chateaubriand)

Chair: *Jürgen Dingel*

#### > ThingML: A Language and Code Generation Framework for Heterogeneous Targets

Authors: *Nicolas Harrand, Franck Fleurey, Brice Morin, Knut Eilif Husa*

Abstract: A key selling point of MDE is the increase in productivity by automatically generating code from models. However, the practical adoption of code generation remains relatively slow and limited to niche applications. Tooling issues are often pointed out but more fundamentally, experience shows that: (i) models and modeling languages used for other purposes are not necessarily well suited for code generation and (ii) code generators are often seen as black-boxes which are not easy to trust and produce sub-optimal code. This paper presents our experiences applying ThingML to different domains. ThingML includes a modeling language and tool designed for supporting code generation and a highly customizable multi-platform code generation framework. The approach is implemented in an open-source tool providing a family of code generators targeting heterogeneous platforms. It has been evaluated through several case studies and is being used for in the development of a commercial ambient assisted living system.

#### > Modern C++ as a Modeling Language for Automated Driving and Human-Robot Collaboration

Authors: *Daniel Tuchscherer, Alexander Weibert, Frank Tränkle*

Abstract: Signal-flow diagrams, state-space models and finite-state machines are established modeling concepts in embedded controller software development. However, in the emerging areas of automated driving and human-robot collaboration, the dynamic management of system and environmental objects is mandatory. For this, object-oriented concepts are required in addition to the established modeling concepts. This paper demonstrates the application of signal-flow diagrams together with object-oriented models in Modern C++ for the software development in the area of submicroscopic traffic control. Both the vehicle dynamics and the longitudinal controllers are modeled as signal-flow diagrams and state-space models. Above this control layer, the dynamic creation and removal of individual vehicles and environmental objects are modeled in Modern C++. Together with Boost odeint these models are directly represented on a high abstraction level. Modern C++ is no longer limited to programming but is used as an object-oriented modeling language both for reliable embedded software and simulation environments.

## > Handling Index-Out-Of-Bounds in Safety-Critical Embedded C Code Using Model-based Development

Author: *Gunter Blache*

Abstract: Embedded C code for safety critical systems faces some substantial challenges: like every other embedded SW code it must be efficient in terms of code size, data size and execution time, but it must also behave safely under all circumstances, without a user or operator who could handle the errors. One kind of problem is array index accesses where the index is outside the specified value range. The C language does not specify the behaviour in such cases, which clearly violates the requirements for safe code. In this paper, the approach of the model-based development tool 'ASCET' is explained, and the experiences of two case studies that describe the adoption of index protection are presented.

## Empirical Investigations I (Lamennais 1+2)

Chair: *Jon Whittle*

### > Controlled Experiment on the Comprehension of Runtime Phenomena Using Models at Runtime

Authors: *Michael Szvetits, Uwe Zdun*

Abstract: Utilizing models for software construction is a well-studied research topic. Recent research investigates the integration of models into running systems to provide additional information about the system configuration at runtime. While this additional information enables innovative self-adaptive mechanisms, it is still an open research question if the information provided by models can also improve the analysis capabilities of human users where manual intervention is inevitable for investigating runtime phenomena. This paper contributes to fill this gap by conducting a controlled experiment where the correctness and completion time of tasks regarding runtime information are assessed. A control and experiment group had to analyze the output of a software system, and the experiment group additionally received traceability links between models and associated runtime records. The results show that improvements of the analysis can especially be observed where model elements emphasize relationships between system parts that are hardly recognizable in the implementation code.

### > Technical Debt in MDE: A Case Study on GMF/EMF-Based Projects

Authors: *Xiao He, Paris Avgeriou, Peng Liang, Zengyang Li*

Abstract: Technical Debt (TD) is a metaphor referring to immature software artifacts that can hurt the long-term maintenance of a system. Model-Driven Engineering (MDE) is a model-centric software development approach, which promises better maintainability. However, there is a lack of empirical evidence

on the existence and influence of TD in the context of MDE. This paper investigates the code-level TD in MDE projects, which is incurred during code generation. We evaluated 16 open-source and non-trivial GMF/EMF-based MDE projects using bad smells, which are widely-accepted TD indicators. The results demonstrate that MDE is not TD-free, and code generators also incur TD, similarly to developers. In fact, the generated code usually contains more TD than hand-written code, which influences significantly the maintenance of MDE projects.

### > The Quest for Open Source Projects that Use UML: Mining GitHub

Authors: *Regina Hebig, Truong Ho Quang, Gregorio Robles, Michel Chaudron, Miguel Angel Fernandez*

Abstract: Context: While industrial use of UML was studied intensely, little is known about UML use in Free/Open Source Software (FOSS) projects. Goal: We aim at systematically mining GitHub projects to answer the question when models, if used, are created and updated throughout the whole project's life-span. Method: We present a semi-automated approach to collect UML stored in images, .xmi, and .uml files and scanned ten percent of all GitHub projects (1.24 million). Our focus was on number and role of contributors that created/updated models and the time span during which this happened. Results: We identified and studied 21316 UML diagrams within 3454 projects. Conclusion: Creating/updating of UML happens most often during a very short phase at the project start. For 12% of the models duplicates were found, which are in average spread across 1.88 projects. Finally, we contribute a list of GitHub projects that include UML files.

## Demo II (Lamennais 4+5)

Chair: *Peter Clarke*

### > C Code Verification based on the Extended Labeled Transition System Model

Authors: *Dexi Wang, Chao Zhang, Guang Chen, Ming Gu, Jianguang Sun*

Abstract: C programming language is widely used in safety-critical software systems. Together with its large appliance and increasing complexity, ensuring the correctness is urgent. This paper presents Ceagle, a fully automated program verifier for finding assertion violations in C programs. It is decent in both accuracy and efficiency by using a semantically equivalent program model language that is specifically designed for C program, together with various optimizations that make the satisfiability checking faster and memory-friendly. More specifically, Ceagle uses LLVM clang as front-end parser, an extended labeled transition system as program model, and Z3 SMT solver as the back-end satisfiability checker. Ceagle is designed to be fully automatic and requires no

user interaction as long as the assertions are provided. For evaluation, we compare Ceagle with existing C program verifiers based on open benchmarks. Ceagle outperforms others in terms of accuracy, and time and memory consumption.

#### > NeoEMF: a Multi-database Model Persistence Framework for Very Large Models

Authors: *Gwendal Daniel, Gerson Sunyé, Amine Benelallam, Massimo Tisi, Yoann Vernageau, Abel Gomez, Jordi Cabot*

Abstract: The growing use of Model Driven Engineering (MDE) techniques in industry has emphasized scalability of existing model persistence solutions as a major issue. Specifically, there is a need to store, query, and transform very large models in an efficient way. Several persistence solutions based on relational and NoSQL databases have been proposed to achieve scalability. However, existing solutions often rely on a single data store, which suits a specific modeling activity, but may not be optimized for other use cases. In this article we present NeoEMF, a multi-database model persistence framework able to store very large models in key-value stores, graph databases, and wide column databases. We introduce NeoEMF core features, and present the different data stores and their applications. NeoEMF is open source and available online.

#### > ModifRoundtrip: A Model-Based tool to reuse legacy transformations

Authors: *Paola Vallejo, Jean-Philippe Babau, Mickaël Kerboeuf*

Abstract: The legacy transformations dealing with domain specific data gathers important expertise. Nevertheless, in many cases, have to be rewritten in order to make them apply to semantically equivalent but structurally incompatible data. According to the complexity of the transformation, rewriting them can quickly become a difficult and error-prone task. We propose a coevolution approach to enable the reuse of legacy transformations instead of their rewriting. In this approach, the data conforming to the reuse context coevolve into data conforming to the legacy transformation context. Legacy transformation is applied and the result is migrated back to the reuse context. In this paper, we introduce ModifRoundtrip, a plug-in for the Eclipse development environment. It promotes the reuse of legacy transformations, providing guidance for the user during reuse process. Reuse process is done automatically, but ModifRoundtrip provides interaction points to the user to indicate custom reuse scenarios.

#### > Tsmart-BIPEX: An Integrated Graphical Design Toolkit for Software Systems

Authors: *Huafeng Zhang, Yu Jiang, Han Liu, Ming Gu, Jiaguang Sun*

Abstract: To help build reliable software systems efficiently, the component based model-driven design approach is widely used, and lots of modeling lan-

guages have been designed. In this paper, we propose an integrated graphical development toolkit Tsmart-BIPEX in support of building complex systems in the BIP modeling language, which features a rich semantics for composing sub-systems. First, we build a graphical interface for model construction and simulation, which is more intuitive than the existed command-line based tool-chain. Furthermore, to enhance the original BIP verification tool RTD-Finder, we translate the graphical model to a labeled transition system for a thorough verification in verifier VCS. Finally, we can generate executable C++ code directly from the graphical model. Tsmart-BIPEX has been successfully applied in the development of a real-world train network controller.

#### > ArchFeature: A Modeling Environment Integrating Features into Product Line Architecture

Authors: *Gharib Gharibi, Yongjie Zheng*

Abstract: An important task in product line architecture (PLA) modeling is developing the involved variation points and maintaining their conformance to product line features. However, existing modeling tools and approaches still require manual development of variation points and manual maintenance of feature-PLA relations, which is expensive and error prone. In this paper, we introduce a new PLA modeling environment named ArchFeature. It can automatically manage variation points in the PLA model, create and maintain feature-PLA relations, and derive new architectural instances. The key idea of ArchFeature is to develop the product line features and PLA side-by-side in the same environment, and integrate their specifications in a single model. The goal is to reduce the modeling effort and increase the quality of the PLA models.

#### > Reifier: Model-Driven Engineering of Component-Based and Service-Oriented JEE~Applications

Authors: *Jérôme Rocheteau, David Sferruzza*

Abstract: This paper aims at presenting Reifier, a tool for prototyping web modules of JEE applications by the means of a model-driven development. Code generation is driven by domain-specific models in which web services are defined by parametric components. Reification of JEE applications is obtained thanks to a model-to-text approach. The code generation covers every model elements but the basic components that should be developed manually and provided throughout libraries. This meta-model allows us to define web service patterns, to verify them formally and to apply them on different data model entities.

**19:00 - 22:00** Conference Welcome reception (Grand Large)



**8:00 - 9:00 Registration** (Ronde J. Cartier)

**9:00 - 9:15 General Chairs Opening** (Chateaubriand)

**9:15 - 10:30**

**Keynote: Grand Challenges, Grand Responses?** (Chateaubriand)  
Speaker: *Gordon Blair* / Chair: *Benoit Combemale*

**10:30 - 11:00 Coffee break** (Ronde J. Cartier)

**Posters** (Ronde J. Cartier)

**Clinic** (Ronde J. Cartier)

**11:00 - 12:15**

**Testing and Simulation** (Chateaubriand)

Chair: *Joel Greenyer*

> **Incremental Diagram Layout for Concrete Syntax Migration**

Authors: *Ulf Rügge, Rajneesh Lakkundi, Ashwin Prasad, Anand Kodaganur, Christoph Daniel Schulze, Reinhard von Hanxleden*

Abstract: A range of successful modeling tools to develop complex systems use node-link-style diagrams as their underlying language. Over the years such languages can change, for instance as part of a tool update. When migrating existing models, changes in syntax directly affect the placement of elements in their diagrams. Increasing the size of certain nodes may for example result in node overlaps. In this paper we propose two methods based on graph drawing techniques to adjust the layout of existing diagrams after migration. Although we designed these techniques for diagram migration, they are applicable to other scenarios as well, such as users interactively adding or resizing nodes. We evaluate the techniques based on real world diagrams from the LabVIEW suite and discuss the scenarios each technique seems best suited for.

> **A Generic Framework for Model-Set Selection for the Unification of Testing and Learning MDE Tasks**

Authors: *Edouard Batot, Houari Sahraoui*

Abstract: We propose a generic framework for model-set selection for learning or testing Model-Driven Engineering tasks. We target specifically tasks that apply to or manipulate models, such as model definition, model well-formedness checking, and model transformation. In our framework, we view the model-set selection as a multi-objective optimization problem. The framework can be tailored to the learning or testing of a specific task by firstly expressing the coverage criterion, which will be encoded as a first optimization objective. The coverage is expressed by tagging the subset of the input metamodel that is relevant to the considered task. Then, one or more minimality criteria are selected as additional optimization objectives. We illustrate the use of our framework with the testing of metamodels. This case study shows that the multi-objective approach gives better results than random and mono-objective selections.

> **Towards the Verification of Industrial Communication Protocols through a Simulation Environment Based on QEMU and SystemC**

Authors: *Calypso Barnes, Jean-Marie Cottin, François Verdier, Alain Pegatoquet*  
Abstract: This paper aims at presenting an approach to validate, verify and debug a wireless communication protocol through the use of simulated models. We discuss the main issues in validating a communication protocol, as well as the merits and limitations of the existing solutions to verify network protocol stack binary codes by using simulation. We then describe the development of a simulation framework where the node's hardware platform is modeled with QEMU and SystemC, and the development of an observer module which analyzes the frames exchanged to detect anomalies. This approach is validated with a protocol named OCARI based on the IEEE 802.15.4 (LR-WPAN) standard, which is currently in its pre-industrialization phase. The experimental results demonstrate the functional correctness of our node model implementation, and show how a protocol property can be checked during simulation with the developed simulation framework.

**Empirical Investigations II (Lamennais 1+2)**

Chair: *Shaukat Ali*

> **Descriptive vs Prescriptive Models in Industry**

Authors: *Rogardt Heldal, Patrizio Pelliccione, Ulf Eliasson, Jonn Lantz, Jesper Derehag, Jon Whittle*

Abstract: To understand the importance, characteristics, and limitations of modeling we need to consider the context where models are used. Different organizations within the same company can use models for different purposes and modelling can involve different stakeholders and tools. Recently, several papers discussing how industries use MDE have been published and they have contradictory findings. In this paper we report lessons learned from our collaborations

with three large companies. We found that it is important to distinguish between descriptive models (used for documentation) and prescriptive models (used for development) to better understand the adoption of modelling in industry. Our findings are valuable for both academia and industry. A better understanding of modeling in large companies can help academia conceiving innovative MDE solutions that can have a real impact in industry. On the other hand, industry can better understand how to properly exploit MDE and what to expect from it.

#### > The Problems with Eclipse Modeling Tools: A Topic Analysis of Eclipse Forums

Authors: *Nafiseh Kahani, Mojtaba Bagherzadeh, Juergen Dingel, James Cordy*

Abstract: Eclipse offers a wide range of tools supporting various aspects of modeling and Model-Driven Engineering (MDE). Arguably, the Eclipse ecosystem has been and continues to be one of the most important modeling tool repositories and sources of information about these tools, with, for example, more than 180,000 posts in the modeling forums since 2002. In this paper, we collect and analyze the content of the 30 most widely used Eclipse forums associated with different modeling and MDE tools, such as EMF, Xtext, ATL, Epsilon, and GMF. Using state-of-the-art text mining techniques coupled with manual analysis, we explore these forums with respect to two important questions: What are the primary issues, problems, and challenges raised in the use of these tools? And, perhaps even more important: Which of these issues are most commonly faced by newbies in the MDE community?

#### > Model-Driven Software Engineering in the openETCS Project: Project Experiences and Lessons Learned

Authors: *Stefan Karg, Alexander Raschke, Matthias Tichy, Grischa Liebel*

Abstract: Model-driven software engineering in industrial practice has been the focus of different empirical studies and experience reports. Particularly, positive effects of model-driven software engineering have been reported in the domain of embedded and safety-critical systems. We report in this paper on the experiences of the openETCS European research project whose goal was to formalize the System Requirements Specification and to develop an open source reference implementation of the European Train Control System including open source modeling tools. Furthermore, we will discuss lessons learned, e.g., about using open source modeling toolchains in safety-critical contexts and about using the SCADE Suite for the development of the safety-critical parts.

## Advanced Algorithms and Modelling (Lamennais 4+5)

Chair: *Peter Herrmann*

#### > Extracting Domain Models from Natural-Language

##### Requirements: Approach and Industrial Evaluation

Authors: *Chetan Arora, Mehrdad Sabetzadeh, Lionel Briand, Frank Zimmer*

Abstract: Domain modeling is an important step in the transition from natural-language requirements to precise specifications. For large systems, building a domain model manually is a laborious task. Several approaches exist to assist engineers with this task, whereby candidate domain model elements are automatically extracted using Natural Language Processing (NLP). Despite the existing work on domain model extraction, important facets remain under-explored: (1) there is limited empirical evidence about the usefulness of existing extraction rules (heuristics) when applied in industrial settings; (2) existing extraction rules do not adequately exploit the natural-language dependencies detected by modern NLP technologies; and (3) an important class of rules developed by the information retrieval community for information extraction remains unutilized for building domain models. Motivated by addressing the above limitations, we develop a domain model extractor by bringing together existing extraction rules in the software engineering literature, extending these rules with complementary rules from the information retrieval literature, and proposing new rules to better exploit results obtained from modern NLP dependency parsers. We apply our model extractor to four industrial requirements documents, reporting on the frequency of different extraction rules being applied. We conduct an expert study over one of these documents, investigating the accuracy and overall effectiveness of our domain model extractor.

#### > Incremental Backward Change Propagation of View Models by Logic Solvers

Authors: *Oszkár Semeráth, Csaba Debreceni, Ákos Horváth, Dániel Varró*

Abstract: View models are key concepts of domain-specific modeling to provide task-specific focus (e.g., power or communication architecture of a system) to the designers by highlighting only the relevant aspects of the system. View models can be specified by unidirectional forward transformations (frequently captured by graph queries), and automatically maintained upon changes of the underlying source model using incremental transformation techniques. However, tracing back complex changes from one or more abstract view to the underlying source model is a challenging task, which, in general, requires the simultaneous analysis of transformation specifications and well-formedness constraints to create valid changes in the source model. In this paper we introduce a novel delta-based backward transformation technique using SAT solvers to synthesize valid and consistent change candidates in the source model, where only forward transformation rules are specified for the view models.



> Feature Location in Models through a Genetic Algorithm Driven by Information Retrieval Techniques

Authors: *Jaime Font, Lorena Arcega, Øystein Haugen, Carlos Cetina*

Abstract: In this work we propose a feature location approach that targets models as the feature realization artifacts. The approach combines Genetic Algorithms and Information Retrieval techniques. Given a model and a feature description, model fragments extracted from the model are evolved using genetic operations. Then, Formal Concept Analysis is used to cluster the model fragments based on their common attributes into feature realization candidates. Finally, Latent Semantic Analysis is used to rank the candidates based on the similarity with the feature description. As a result, the genetic algorithm evolves the population of model fragments to find the set of most suitable feature realizations. We have evaluated the approach with an industrial case study, locating features with precision and recall values around 90% (baseline obtains less than 40%). Finally, we provide recommendations on how to provide the input to the approach to improve the location of features over the models.

Clinic (Rotonde J. Cartier)

**12:30 - 14:00 Lunch** (Grand Large)

**14:00 - 14:30**

Clinic (Rotonde J. Cartier)

**Sponsor talk:** Models in industry, 20 years after UML 1.0 - Reflecting on the Thales experience

Speaker: *Véronique Normand* / Chair: *Benoit Baudry*

**14:30 - 15:30**

Clinic (Rotonde J. Cartier)

**Awards**

Chairs: *Lionel Briand, Juergen Dingel*

> Merging Models with the Epsilon Merging Language - A Decade Later (Most Influential Paper Award)

Authors: *Dimitris Kolovos, Richard Paige, and Fiona Polack*

> What Went Right: The Secret History of UML and Related Matters (Career Award)

Author: *Bran Selic*

Model-driven Abstract: Model-driven reflections on modeling, model-driven careers, and all that.

**15:30 - 16:00 Coffee break** (Rotonde J. Cartier)

Clinic (Rotonde J. Cartier)

Posters (Rotonde J. Cartier)

**16:00 - 17:00**

Clinic (Rotonde J. Cartier)

**Panel:** User Experience (UX) in Model-Based Software Engineering (Chateaubriand)

Moderator: *Jon Whittle*

Panelists: *Betty Cheng, Richard Paige, Harald Stoerrle, Francis Bordeleau*  
Most MDE tools are horrible to use. It well-known that UX is a key criterion affecting the successful adoption of new technologies. Despite this, there is almost no research in the MDE community on usability and UX for MDE. And commercial vendors also seem to pay little heed to the needs of their users. Although it is now common for MDE research papers to include "user studies" as part of the evaluation, UX is often not the focus. In contrast, UX in the software development industry is a hot topic, with most companies investing heavily in UX teams. Key questions which this panel would address are: (1) What does UX mean for MDE? (2) Why are most MDE tools so horrible to use? (3) What can be done about it?

**17:00 - 18:30**

Clinic (Rotonde J. Cartier)

**19:00 - 23:00 Gala Dinner** (Demeure de Corsaire)



**8:00 - 9:00 Registration** (Ronde J. Cartier)

**9:00 - 9:15 General Chairs Opening** (Chateaubriand)

**9:15 - 10:30**

**Keynote: The Straight Line is Ungodly** (Chateaubriand)

Speaker: *Jim Coplien* / Chair: *Jorg Kienzle*

**10:30 - 11:00 Coffee break** (Ronde J. Cartier)

**Posters** (Ronde J. Cartier)

**11:00 - 12:40**

**Model Transformation** (Chateaubriand)

Chair: *Friedrich Steimann*

> **A Generic Transformation Algorithm to Simplify the Development of Mapping Models**

Authors: *Matthias Freund, Annerose Braune*

Abstract: Declarative mapping models aim at simplifying the development of model transformations by separating (1) the configuration of mappings between elements of the source and target meta-model and (2) the execution of these mappings. Existing solutions however require an extended definition of the mappings that, e.g., also describes how generated elements need to be connected. In this paper, we propose a generic transformation algorithm that is able to execute mappings that do not specify such extended information by analyzing the structure of the target meta-model. This limits the effort necessary for the definition of mappings and ensures a valid target model already at early stages of development. After analyzing the tasks that model transformations need to perform, we present our approach towards generic transformation rules for models that are based on the Eclipse Modeling Framework and illustrate a concrete implementation by means of an integration into our own model transformation framework.

> **Automated Refactoring of ATL Model Transformations: A Search-Based Approach**

Authors: *Bader Alkhazi, Terry Ruas, Marouane Kessentini, Manuel Wimmer, William Grosky*

Abstract: Model transformation programs evolve through a process of continuous change. However, this process may weaken the design of the transformation programs and make it unnecessarily complex, leading to increased fault-proneness. Refactoring improves the software design while preserving overall functionality and behavior. However, very few studies addressed the problem of refactoring model transformation programs. These existing studies provided an entirely manual or semi-automated refactoring support to transformation languages such as ATL. In this paper, we propose a fully-automated search-based approach to refactor model transformations based on a multi-objective algorithm that recommends the best refactoring sequence (e.g., extract rule, merge rules, etc.) optimizing a set of ATL-based quality metrics (e.g. number of rules, coupling, etc.). To validate our approach, we apply it to a comprehensive dataset of model transformations. The statistical analysis of our experiments over 30 runs shows that our automated approach recommended useful refactorings based on a benchmark of ATL transformations and compared to random search, mono-objective search formulation and a semi-automated refactoring approach not based on heuristic search.

> **VMTL: a Language for End-User Model Transformation (SoSyM First)**

Authors: *Vlad Acretoaie, Harald Störrle, Daniel Strüber*

Abstract: Model transformation is a key enabling technology of Model-Driven Engineering (MDE). Existing model transformation languages are shaped by and for MDE practitioners—a user group with needs and capabilities which are not necessarily characteristic of modelers in general. Consequently, these languages are largely ill-equipped for adoption by end-user modelers in areas such as requirements engineering, business process management, or enterprise architecture. We aim to introduce a model transformation language addressing the skills and requirements of end-user modelers. With this contribution, we hope to broaden the application scope of model transformation and MDE technology in general. We discuss the profile of end-user modelers and propose a set of design guidelines for model transformation languages addressing them. We then introduce Visual Model Transformation Language (VMTL) following these guidelines. VMTL draws on our previous work on the usability-oriented Visual Model Query Language. We implement VMTL using the Henshin model transformation engine, and empirically investigate its learnability via two user experiments and a think-aloud protocol analysis. Our experiments, although conducted on computer science students exhibiting only some of the characteristics of end-user modelers, show that VMTL compares favorably in terms of learnability

with two state-of-the-art model transformation languages: Epsilon and Henshin. Our think-aloud protocol analysis confirms many of the design decisions adopted for VMTL, while also indicating possible improvements.

### > Ground Setting Properties for an Efficient Translation of OCL in SMT-based Model Finding

Authors: *Nils Przigoda, Robert Wille, Rolf Drechsler*

Abstract: Model Finding is an established method to increase the confidence in the correctness of a UML/OCL model, e.g., by automatically determining valid system states or counterexamples. In the recent past, numerous approaches have been proposed for this purpose. In order to cope with the underlying complexity, approaches based on satisfiability solvers have been found promising. They require a translation of all OCL constraints of the model for a corresponding solver. In this paper, SMT-based model finding is investigated. It is shown that certain OCL operations are causing huge SMT formulations which harm the solving process. However, this is not necessary if a fixed structure of the model can be assumed. Motivated by this, a new concept called ground setting properties is introduced which allows for an efficient translation of OCL into SMT. This concept is illustrated by means of a running example and compared to existing solutions.

## Tooling (Lamennais 1+2)

Chair: *Jean-Marc Jézéquel*

### > Query-based Access Control for Secure Collaborative Modeling Using Bidirectional Transformations

Authors: *Csaba Debreceni, Gábor Bergmann, István Ráth, Dániel Varró*

Abstract: Large-scale model-driven system engineering projects are carried out collaboratively. Engineering artifacts stored in model repositories are developed in either offline (checkout- modify-commit) or online (GoogleDoc-style) scenarios. Complex systems frequently integrate models and components developed by different teams, vendors and suppliers. Thus confidentiality and integrity of design artifacts need to be protected by access control policies. We propose a technique for secure collaborative modeling where (1) fine-grained access control for models can be defined by model queries, and (2) such access control policies are strictly enforced by bidirectional model transformations. Each collaborator obtains a filtered local copy of the model containing only those model elements which they are allowed to read; write access control policies are checked on the server upon submitting model changes. We illustrate the approach and carry out an initial scalability assessment using a case study of the MONDO EU project.

### > PrefetchML: A Framework for Prefetching and Caching Models

Authors: *Gwendal Daniel, Gerson Sunyé, Jordi Cabot*

Abstract: Prefetching and caching are well-known techniques integrated in database engines and file systems in order to speed-up data access. They have been studied for decades and have proven their efficiency to improve the performance of I/O intensive applications. Existing solutions do not fit well with scalable model persistence frameworks because the prefetcher operates at the data level, ignoring potential optimizations based on the information available at the metamodel level. Furthermore, prefetching components are common in relational databases but typically missing (or rather limited) in NoSQL databases, a common option for model storage nowadays. To overcome this situation we propose PrefetchML, a framework that executes prefetching and caching strategies over models. Our solution embeds a DSL to precisely configure the prefetching rules to follow. Our experiments show that PrefetchML provides a significant execution time speedup. Tool support is fully available online.

### > Towards Partial Loading of XMI Models

Authors: *Ran Wei, Dimitris S. Kolovos, Antonio Garcia-Dominguez, Konstantinos Bampis, Richard Paige*

Abstract: XML Metadata Interchange (XMI) is an OMG-standardised model exchange format, which is natively supported by the Eclipse Modeling Framework (EMF) and the majority of the modelling and model management languages and tools. Whilst XMI is widely supported, the XMI parser provided by EMF is inefficient in some cases where models are read-only (such as input models for model query, model-to-model transformation, etc) as it always requires loading the entire model into memory. In this paper we present a novel algorithm, and a prototype implementation (SmartSAX), which is capable of partially loading models persisted in XMI. SmartSAX offers improved performance, in terms of loading time and memory footprint, over the default EMF XMI parser. We describe the algorithm in detail, and present benchmarking results that demonstrate the substantial improvements of the prototype implementation over the XMI parser provided by EMF.

### > Integration of a Graph-Based Model Indexer in Commercial Modelling Tools

Authors: *Antonio Garcia-Dominguez, Konstantinos Bampis, Dimitrios Kolovos, Marcos Aurelio Almeida, Antonin Abherve, Alessandra Bagnato*

Abstract: Softeam has over 20 years of experience providing UML-based modelling solutions, such as its Modelio modelling tool, and its Constellation enterprise model management and collaboration environment. Due to the increasing number and size of the models used by Softeam's clients, Softeam joined the MONDO FP7 EU research project, which worked on solutions for

these scalability challenges and produced the Hawk model indexer among other results. This paper presents the technical details and several case studies on the integration of Hawk into Softeam's toolset. The first case study measured the performance of Hawk's Modelio support using varying amounts of memory for the Neo4j backend. In another case study, Hawk was integrated into Constellation to provide scalable global querying of model repositories. Finally, the combination of Hawk and the Epsilon Generation Language was compared against Modelio for document generation: for the largest model, Hawk was two orders of magnitude faster.

## Testing and Analysis (Lamennais 4+5)

Chair: *Silvia Abrahao*

### > Towards Mutation Analysis for Use Cases

Authors: *Huihui Zhang, Tao Yue, Shaukat Ali, Chao Liu*

Abstract: Use case modelling is a widely accepted requirements specification method in practice; therefore, inspecting defects in use case models in a cost-effective manner is an important challenge. However, it does not exist a systematic mutation analysis approach for evaluating inspection techniques for use case models. In this paper, we present the methodology we followed to systematically derive mutation operators for use case models. More specifically, we proposed a defect taxonomy defining 94 defect types, based on the IEEE Std. 830-1998 standard; we systematically applied the basic guide words of the standardized Hazard and Operability Study (HAZOP) methodology to define 191 mutation operators; we defined a set of guidelines for devising defect seeding strategies. The proposed approach was evaluated by a real world case study and results show that the derived mutation operators are feasible to apply and the defect taxonomy is the most comprehensive one to compare with the literature.

### > A Model Management Approach for Assurance Case Reuse due to System Evolution

Authors: *Sahar Kokaly, Rick Salay, Valentin Cassano, Tom Maibaum, Marsha Chechik*

Abstract: Evolution in software systems is a necessary activity that occurs due to fixing bugs, adding functionality or improving system quality. Systems often need to be shown to comply with regulatory standards. Along with demonstrating compliance, an artifact, called an assurance case, is often produced to show that the system indeed satisfies the property imposed by the standard (e.g., safety, privacy, security, etc.). Since each of the system, the standard, and the assurance case can be presented as a model, we propose the extension and use of traditional model management operators to aid in the reuse of parts of the assurance case when the system undergoes an evolution. Specifically, we present a model management approach that eventually produces a partial evol-

ved assurance case and guidelines to help the assurance engineer in completing it. We demonstrate how our approach works on an automotive subsystem regulated by the ISO 26262 standard.

### > Automatic Detection of Incomplete Requirements via Symbolic Analysis

Authors: *Byron DeVries, Betty H.C. Cheng*

Abstract: The usefulness of a system specification depends in part on the completeness of the requirements. However, enumerating all necessary requirements is difficult, especially when requirements interact with an unpredictable environment. A specification built with an idealized environmental view is incomplete if it does not include requirements to handle non-idealized behavior. Often incomplete requirements are not detected until implementation, testing, or worse, after deployment. Even when performed during requirements analysis, detecting incomplete requirements is typically an error prone, tedious, and manual task. This paper introduces Ares, a design-time approach for detecting incomplete requirements decomposition using symbolic analysis of hierarchical requirements models. We illustrate our approach by applying Ares to a requirements model of an industry-based automotive adaptive cruise control system. Ares is able to automatically detect specific instances of incomplete requirements decompositions at design-time, many of which are subtle and would be difficult to detect, either manually or with testing.

### > A Requirement Driven Testing Method for Multi-disciplinary System Design

Authors: *Martial Chabot, Laurence Pierre, Alexandre Nabais-Moreno*

Abstract: In cyber-physical systems, the operations of various physical entities are controlled by computing cores. Therefore the design of these systems involves multi-disciplinary teams, for the development of the electronic devices and embedded firmware, but also for the design of the physical components. This intimate coupling of disparate elements makes correctness analysis very complex. Composite requirements have to be verified. In many application domains some of these requirements come from standardization documents. One of the main challenges is to make the variety of experts coordinate towards the satisfaction of these requirements, in spite of the fact that they are accustomed to focusing on their domain-specific issues, with their specialized tools. The aim of the method proposed here is to provide a unified testing framework to enable the validation of cross-disciplinary requirements. Since we target a general-purpose solution, usable by all disciplines, the method is specified using an abstract modeling language, namely SysML.

**12:40 End of the conference**

### EDWARD A. LEE

University of California at Berkeley

#### Resurrecting Laplace's Demon: The Case for Deterministic Models

In 1814, Pierre-Simon Laplace published an argument for determinism in the universe, arguing that if someone (a demon) were to know the precise location and momentum of every atom in the universe, then their past and future values for any given time are completely determined and can be calculated from the laws of classical mechanics. This principle, of course, has been roundly invalidated by quantum mechanics, and yet the laws of classical mechanics continue to be extremely useful for prediction.

In this talk, I will argue that models play different (complementary) roles in engineering and science, and that deterministic models have historically proved even more valuable in engineering than in science. Moreover, I will show that deterministic models for cyber-physical systems, which combine computation with physical dynamics, remain elusive. I will argue that the next big advance in engineering methods must include deterministic models for CPS, and I will show that such models are both possible and practical.



#### BIOGRAPHY

**Edward A. Lee** is the Robert S. Pepper Distinguished Professor in the Electrical Engineering and Computer Sciences (EECS) department at U.C. Berkeley. His research interests center on design, modeling, and analysis of embedded, real-time computational systems. He is the director of the nine-university TerraSwarm Research Center (<http://terraswarm.org>), a director of Chess, the Berkeley Center for Hybrid and Embedded Software Systems, and the director of the Berkeley Ptolemy project. From 2005-2008, he served as chair of the EE Division and then chair of the EECS Department at UC Berkeley. He is co-author of nine books (counting second and third editions) and numerous papers. He has led the development of several influential open-source software packages, notably Ptolemy and its various spinoffs. He received the B.S. degree in Computer Science from Yale University, New Haven, CT, in 1979, the S.M. degree in EECS from the Massachusetts Institute of Technology (MIT), Cambridge, in 1981, and the Ph.D. degree in EECS from the University of California Berkeley, Berkeley, in 1986. From 1979 to 1982 he was a member of technical staff at Bell Telephone Laboratories in Holmdel, New Jersey, in the Advanced Data Communications Laboratory. He is a co-founder of BDTI, Inc., where he is currently a Senior Technical Advisor, and has consulted for a number of other companies. He is a Fellow of the IEEE, was an NSF Presidential Young Investigator, and won the 1997 Frederick Emmons Terman Award for Engineering Education.

Professor Lee's research group studies cyber-physical systems, which integrate physical dynamics with software and networks. Specifically, his group has made major contributions in models of computation with time and concurrency, model-based design and analysis, domain-specific languages, architectures for real-time computing, schedulability analysis, and modeling and programming of distributed real-time systems. His group has been involved with parallel and distributed computing, including models of computation with distributed real-time behaviors, partitioning and scheduling algorithms, backtracking techniques for fault tolerance and recovery, dataflow models of computation, and modeling of sensor networks. His group has made key contributions in semantics of timed and concurrent systems, including domain polymorphism, behavioral type systems, metamodeling of semantics, and comparative models of computation. His group has also worked on blending computing with continuous dynamics and hybrid systems. Prof. Lee himself has an extensive background in signal processing and physical-layer communication systems, and has co-authored five books on these subjects, in addition to four books on embedded systems technologies.

### Grand Challenges, Grand Responses?

The world is facing a period of unprecedented change and the resultant grand challenges demand a coordinated and significant response from all parties including scientists and engineers, academics, policy makers and citizens. Environmental change is arguably the greatest challenge and this talk will focus on the role of digital technology in both the understanding of the complexities of the natural environment and also in determining well-founded adaptation and mitigation strategies for a range of environmental problems including climate change. The talk builds on over five years of experience in working with earth and environmental scientists in providing tools to help move towards a new kind of science as demanded by areas such as climate change, a science that is more open, integrative and collaborative for example. The research includes the application of contemporary areas of digital innovation including cloud computing, Internet of Things technology and emerging areas of data science. But what does this have to do with Models? The systems we are building are highly complex both in terms of the underlying digital technologies and also in the phenomena being observed. New techniques are urgently required to help us to master this complexity and the Models community is the keeper of one of the most powerful tools in this area - namely abstraction. Is the Models community focusing on the right problems though at the right scale and does it have the ambition to take on such grand challenges? Grand challenges demand grand responses - through this keynote, and building on the insights last year from Steve Easterbrook, I would like to provoke a discussion over what this might mean for Models going forward.

### BIOGRAPHY

**Gordon Blair** is a Distinguished Professor of Distributed Systems in the School of Computing and Communications at Lancaster University and is also an Adjunct Professor at the University of Tromsø in Norway. He has published over 300 papers in his field and is on the PCs of many major international conferences in middleware and distributed systems. He is also chair of the steering committee of the ACM/ IFIP/ Usenix Middleware series of conferences. His current research interests include distributed systems architecture, complex distributed systems, middleware (including reflective and adaptive middleware), model-driven engineering techniques applied to adaptive distributed systems, and the applicability of contemporary distributed systems technologies (including cloud computing and the Internet of Things) to environmental science. He is co-author of the highly successful book *Distributed Systems: Concepts and Design* by Coulouris, Dollimore, Kindberg and Blair with the 5th edition published in 2011. He is also Director of the HighWire Centre for Doctoral Training, a PhD program taking a cross-disciplinary perspective on innovation as it relates to the digital economy, and is co-editor in chief of Springer's *Journal of Internet Services and Applications*.



## The Straight Line is Ungodly

Model-based approaches are not thriving, and the blame is usually laid at the feet of the unsophistication of software engineers. Yet software engineers may tacitly know something that the formal folks seldom discuss: Software systems are complex, and it is only simple problems that yield to formal approaches, including most modeling approaches—especially the analytical and computer-supported ones.

A system is complex proportional to its number of distinct, meaningful tops. However, these “tops” are rarely separable, so independent models based on such formalisms are relatively impotent. And such models are abstractions (i.e., they discard information) to the degree they are formal: and Gödel, Heisenberg, Rosen and a host of others note that there’s always a ghost in the machine. This matters more and more as we face increased complexity.

I will propose that modeling efforts be redirected to the more realistic, logically inconsistent, human ways of understanding ourselves and our interactions with computers. Object-orientation started with Kay’s operational models that would become objects; we see them again in Model-View-Controller-User. Both of these approaches emphasize the need to mix multiple concurrent perspectives (called roles) when analyzing a system. DCI is one paradigm that provides a single computational model while accommodating “tops” for both the left and right brain, and it bridges the abstraction of modeling with concrete implementation. I will argue that design is less about reifying extrinsic, abstract models than it is about creating a “habitable” reality close to the implementation, guided by human mental models. Last, I’ll touch on the kinds of socially constructed complex models as we find in patterns, which were explicitly created out of a dissatisfaction with the ability of formal models to add value.



## BIOGRAPHY

**Jim (“Cope”) Coplien** has academic degrees in engineering and Computer Science, as well as a Ph.D in Computer Science and a Doktorat i Wetenschappen from Vrije Universiteit Brussel (VUB). He has been a professor at North Central College in the U.S. and a visiting professor at University of Manchester and Flinders University, and held the 2001-2002 Vloebergh Endowed Chair at VUB. He is currently supervising graduate work at RPI in New York. He has enjoyed a broad career that included more than 20 years at AT&T Bell Laboratories as well as subsequent work in electronic design automation, academia, and consulting. He is currently a partner with Gertrud & Cope in Denmark, where his ongoing work covers a wide range of topics including organisational design, lean development process, system and software architecture, and management consulting. His industry contributions include being a co-founder of the software pattern discipline and the introduction of organisational patterns, and his organisational research is one of the foundations of Scrum and of XP. For this work he was also a recipient of the 2013 Rakuten Technology Award in Japan. In the modeling area he is known for his broad work in architecture patterns as well as for being a co-creator, together with Trygve Reenskaug, of the Data-Context-and-Interaction paradigm, whose models hark back to MVC (the “M” indeed stands for “model”) and the operational models of Piaget that gave Alan Kay the initial inspiration for object-oriented programming. He is widely published with several critically acclaimed books to his name as well as scores of articles and papers. More importantly, he still writes code, and his most recent passion is the implementation of the trygve programming language. He lives with his wife Gertrud and son Janos in Denmark. When he grows up, he wants to be an anthropologist.

## VÉRONIQUE NORMAND

Thales

### **Models in industry, 20 years after UML 1.0 - Reflecting on the Thales experience**

As we are about to celebrate the 20th anniversary of the UML, industry has never been so close to fully harnessing the potential of model-based engineering (MBE). Never so close, yet not fully there, still struggling on the path towards transforming the engineering of complex, long-lived critical systems.

Thales is a major player in the domains of defense, security, aerospace and transportation systems. Over the past 20 years, Thales has been actively developing internal as well as open innovation modelling ecosystems able to sustainably support engineering transformation stakes - know-how and training, organisation and processes, concepts and methods, technology and tooling. Actual roll out of industrial-strength systems model-based engineering has been underway since 2006, with significant business achievements.

The challenges we are tackling today partly reflect the growing complexity of the systems that we need to produce, deliver, maintain and evolve, and a growing complexity of the organisations and workflows to address these developments. Those challenges also reflect a possibly emerging « post-MBE » situation where models of various types become a common practice, and more and more data are being produced and shared, leading to stringent global data management issues.

Key challenges include scale and heterogeneity; effective abstraction and semantics management; cross-discipline human collaboration,

design exploration and decision making; effective development chains for complex systems-on-chip; risk management; verification enhancement, including better integration of simulation capability and industrially tractable correct-by-design.

This talk will be looking at the Thales experience and lessons learned, and will try and point at current industry challenges where more focus from the research community could be of help.

### **BIOGRAPHY**

Véronique Normand is in charge of the research & technology strategy in the domain of systems and software advanced engineering methods and tools at the Thales Group Technical Directorate.



## Merging Models with the Epsilon Merging Language: A Decade Later

**Authors:** *Dimitris Kolovos, Richard Paige, and Fiona Polack*

**Abstract:** In our 2006 MoDELS paper titled "*Merging Models with the Epsilon Merging Language*", we introduced the Epsilon Merging Language (EML), a new domain-specific transformation language tailored for model merging. Ten years later, EML is still alive and actively maintained as part of the Eclipse Epsilon project (<http://www.eclipse.org/epsilon>).

This talk will provide an overview of the evolution of the syntax, semantics, and capabilities of the language and its underlying platform over the last decade. It will also present applications of EML, and reflect on the role of a dedicated model merging language in the Model-Driven Engineering toolbox.

Monday, October 3 & Thursday, October 6

All day

Rotonde J. Cartier

For the first time this year at MODELS'16, you have the opportunity to participate to the MODELS Clinic, a space where you have a specific face to face meeting with experts in your preferred modeling technology who will help you to solve specific difficulties that might face.

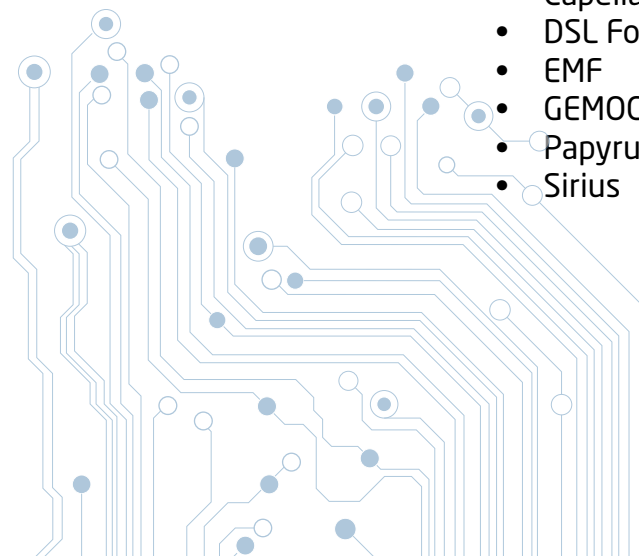
### How it works

It can take a minute to an expert to fix a model or a tool extension, while the adopter may be completely lost for the same fix. The Clinic is a dedicated zone where experts have a table and dedicate a part of their time for face to face appointments with users who come with their model, their tool extension and their issue.

### The modeling experts

We selected recognized experts for the following technologies:

- Capella
- DSL Forge
- EMF
- GEMOC Studio / Sirius Animator
- Papyrus
- Sirius



# WORKSHOP KEYNOTES

## OCL Workshop

**Edward D. Willink** (Willink transformations), *"OCL Specification Progress Report"*.

## ME Workshop

**Philip Langer** (EclipseSource), *"Version Control for Models: From Research to Industry and Back Again"*.

## FlexMDE Workshop

**Dimitris Kolovos** (University of York), *"Flexible Modelling: Opportunities, Challenges, and Next Steps"*.

## PAME Workshop

**Jeff Gray** (University of Alabama), *"Design Patterns across the Modeling Process"*.

## EXE Workshop

**Stephen Mellor** (University of Essex), *"Executable Modeling: Retrospective and Prospective"*.

## MoDeVVa Workshop

**Bernhard Schätz** (University of Munich), *"Formal Verification in Model-Based Engineering: Perceived Potentials, Best Benefits"*.

## COMMitMDE Workshop

**Davide Di Ruscio and Mirco Franzago** (University of L'Aquila), *"Collaborative Model-Driven Software Engineering: a Systematic*

*Mapping Study"*.

**Eugene Syriani** (University of Montreal), *"Framework to Model Collaboratively"*.

**Vinay Kulkarni** (Chief Scientist, Tata Consultancy Services Research), *"Scaling up MDE to support large geographically distributed teams - an experience report"*.

**Vincent Aranega** (GenMyModel | R&D Project Manager), *"MDE Collaboration: Temporality and Ergonomics in the Cloud, the GenMy-Model Solution"*.

## HuFaMo Workshop

**Bran Selic** (Malina Software Corp.), *"What's Wrong with 'Users'?"*

## ModComp Workshop

**Kung-Kiu Lau** (University of Manchester), *"CBSE and MDE: Fitting the Pieces Together"*.

**Jan Carlson** (Mälardalen University), *"CComponent Models and Models of Components"*.

## MULTI Workshop

**Ulrich Frank** (Universität Duisburg-Essen), *"Designing Models and Systems to Support IT Management: A Case for Multilevel Modeling"*.

## GEMOC Workshop

**Tijs van der Storm** (Centrum Wiskunde & Informatica), *"Towards Live DSLs"*.

Sunday, October 2  
Bouvet 1

**8:45-9:00** - Opening  
& Introduction

**Speakers:** Rick Salay and Shiva Nejati

**9:00-9:45** - Gamification of Software  
Modelling Learning

**Speaker:** Alfa Yohannis

**9:45-10:30** - Chronos-Scalable Model  
Versioning, Querying &  
Persistence

**Speaker:** Martin Haeusler

**10:30-11:00** - Coffee Break

**11:00-11:45** - Decomposition of  
Design Space Exploration Problems in  
the Context of model-based Develop-  
ment

**Speaker:** Sergey Zverlov

**11:45-12:30** - A DSL for Model  
Mutation and its Applications to  
Different  
Domains

**Speaker:** Pablo Gómez-Abajo

**12:30-14:00** - Lunch

**14:00-14:45** - Traceability of  
Information Flow Requirements in  
Cyber-Physical Systems Enginee-  
ring

**Speaker:** Christopher Gerking

**14:45-15:30** - Constructing Scalable  
Domain-Specific Graphical Modelling  
Languages

**Speaker:** Antonio Garmendia

**15:30-16:00** - Coffee Break

**16:00-16:45** - Early timing analysis  
of vehicular systems: the road from  
single-core to multi-core

**Speaker:** Alessio Bucaioni

**16:45-17:55** - Panel

**Speaker:** TBD

**17:55-18:00** - Closing

**Speakers:** Shiva Nejati and Rick Salay

Monday, October 3  
Vauban 1

**9:00-9:15** - Opening

**9:15-10:30** - Keynote: "Teaching  
Modeling at the time of disillusion-  
ment from code generation to model  
management"

**Speaker:** Alfonso Pierantonio

**10:30-11:00** - Coffee Break

**11:00-11:20** - Towards a Corpus of  
Use-Cases for Model-Driven Enginee-  
ring Courses

**Speakers:** Dimitris Kolovos and Jordi  
Cabot

**11:20-11:40** - Quantitative Concep-  
tual Model Analysis for Evaluating  
Simple Class Diagrams made by  
Novices

**Speaker:** Mizue Kayama, Shinpei  
Ogata, David K. Asano and Masami  
Hashimoto

**11:40-12:00** - Teaching Domain-  
Specific Language Engineering  
and Model-Driven Software Deve-  
lopment - A competence-oriented  
approach

**Speaker:** Volkhard Pfeiffer

**12:00-12:30** - Discussion

**12:30-14:00** - Lunch

**14:00-14:30** - iOCL: An Interactive  
Tool for Specifying, Validating and  
Evaluating OCL Constraints

**Speakers:** Muhammad Hammad, Tao  
Yue, Shaukat Ali and Shuai Wang

**14:30-14:50** - Constructive Align-  
ment in Teaching Modeling

**Speaker:** Birgit Demuth

**14:50-15:30** - Discussion

**15:30-16:00** - Coffee Break

**16:00-17:30** - Shared Discussion  
with the OSS4MDE Workshop

# SOCIAL PROGRAM

Original, traditional and cultural places of Saint-Malo pave the ground of a promising social program. Besides all the lunches, we offer you the following social program.

MONDAY, OCTOBER 3

## SATELLITE EVENTS WELCOME RECEPTION

Palais du Grand Large, Rotonde J. Cartier  
19:00 to 22:00

For this welcome reception it will be our pleasure to let you discover the huge diversity of French cheeses. A wine steward and his crew will also be there to guide you through the diversity of wines and their associations with cheeses, meats and smoked fishes.



## WEDNESDAY, OCTOBER 5 CONFERENCE WELCOME RECEPTION

Palais du Grand Large, Grand Large room  
19:00 to 22:00

sponsored by  **eclipse**

A cocktail sponsored by Eclipse will be served in the Grand Large room. This evening will feature several events: the MODELS'16 SRC awards, different interactive demos and animations offered by our sponsors, and a live musical show by Radiovox!

Radiovox: vocal harmonies with a definite swing to it. A cocktail to be sipped in a comfortable armchair, dressed in tweed or nylon stockings.



# THURSDAY, OCTOBER 6

## GALA DINNER

Demeure de Corsaire - Hotel Magon

19:00 to 22:00

All registered people will find their Gala ticket in their conference kit.

Welcome to Hotel Magon.

This house was built by François Auguste Magon de la Lande, Privateer with the Royal Seal of Approval, merchant trader of Saint-Malo, one of the most powerful shipowners of this town, and not only that but also one of the directors of the East India Company of Saint-Malo.

This Particular Building is placed at the very heart and center of the honor courtyard This is very rare in Saint-Malo and according to the Historians, it is a testament to the great wealth and power of its owner. Inasmuch as there was very little space indeed inside the walls, all the Merchants town houses were tall perpendicular buildings with their frontages directly facing the road. (as in the construction of the houses on rue d'Orléans)

To-day this house is classed as an Historic Monument, and as such is a Listed Building both inside and on the outside; this was to preserve its authentic caracter and to guarantee that during restoration and its subsequent upkeep, no significant historic faults would creep in. This house has 60 rooms in all on 8 floors, 12 stairs inside...



### LOCATION

Demeure de Corsaire - Hotel Magon

23, rue de Chartres - Saint-Malo Intra Muros -



8 minutes



# GENERAL INFORMATION



## REGISTRATION AND INFORMATION DESKS

### Location:

All the MODELS 2016 service desks are located in Rotonde Jacques Cartier on the first floor of the convention center.

### Opening hours:

- Sunday 2<sup>nd</sup>: 7:30-18:00
- Monday 3<sup>rd</sup>: 8:15-22:00
- Tuesday 4<sup>th</sup>: 8:15-18:00
- Wednesday 5<sup>th</sup>: 7:30-22:00
- Thursday 6<sup>th</sup>: 8:00-18:00
- Friday 7<sup>th</sup>: 8:45-14:00

MODELS 2016 staff will be available to offer you on-site assistance and advice. Should you require further information, please contact anyone at the registration desk.



## SECURITY

As part of enforced security measures in France, you will be asked to present a photo id at the entrance of the convention center. We will also ask you to open your bags for a visual check.

Once you will have retrieved your badge, we will ask you to keep it visible at all time while in the convention center. You will also have the possibility to use the badge instead of a photo id to access the convention center in the following days.



## NAME BADGE

Please wear your conference name badge at all times. Access to the conference location and social events will not be granted without it.



## DISABLED ACCESS

The entire venue is wheelchair accessible. Please ask at the convention center reception for the location of the lifts.



## FIRST AID

In case of problems, please contact any member of the MODELS 2016 staff; there is a team of trained first-aiders and cardiac first-responders on site at all times.



## FOOD ALLERGIES

If you have any questions about the food served at the conference, please contact the staff, they will be able to advise you regarding the food and any particular requirements you may have.



## SMOKING POLICIES

The Palais du Grand Large is a non-smoking area. Smoking is only possible outside.



## PERSONAL PROPERTY

The participants are invited to take good care of their personal belongings, and to not leave them unattended. Neither the organizers nor the

staff will be responsible for any loss or damage of the personal property of the participants. Please contact the MODELS 2016 information desk in any case if something is lost.



## FREE WIFI

Free wireless internet service (SSID: MODELS - Password: models2016) is accessible throughout the entire venue.



## BANKING

The convention center has no ATM in the building. A cash machine is available in the Casino, just next to the Palais du Grand Large. An identity card is requested to enter the Casino.



## ELECTRICAL OUTLETS

Electricity is supplied at 220 to 230V 50Hz. Outlets are CEE7/5 (protruding male earth pin) and accept either CEE 7/5 (Grounded), CEE 7/7 (Grounded) or CEE 7/16 (non-grounded) plugs. Older German-type CEE 7/4 plugs are not compatible as they do not accommodate the earth pin found on this type of outlet. However, most modern European appliances are fitted with the hybrid CEE 7/7 plug which fits both CEE 7/5 (Belgium & France) and CEE 7/4 (Germany, Netherlands, Spain, Sweden and most of Europe) outlets.

Plugs Travellers from the UK, Ireland, Australia, New Zealand, Denmark, Italy, Switzerland and other countries using 230V 50Hz which use different plugs simply require a plug adaptor to use their appliances in France. Plug adaptors for plugs from the US and UK are available from electrical and «do-it-yourself» stores such as Bricorama.

Voltage: Travellers from the US, Canada, Japan and other countries using 110V 60Hz may need a voltage converter. However, some laptops, mobile phone chargers and other devices can accept either 110V or 230V so only require a simple plug adaptor. Check the voltage rating plates on your appliances before connecting them.



## WATER STATIONS

Water Stations are available in the Conference Area. Please help to make our conference green: re-use your water bottle by refilling it at the water stations.



## PHONE NUMBERS

Universal european emergency number 112

SOS médecins Saint-Malo +33 826 46 35 35  
*(to ask for a physician night and day)*

ABC Taxis +33 610 03 18 86

Saint-Malo Taxis +33 223 18 11 81  
[www.taxi-st-malo.com](http://www.taxi-st-malo.com)

Taxis Malouins +33 299 81 30 30

Taxi C. Lalouette +33 299 88 63 04  
+33 686 91 68 95

Police 17 or 112 (from a mobile phone)

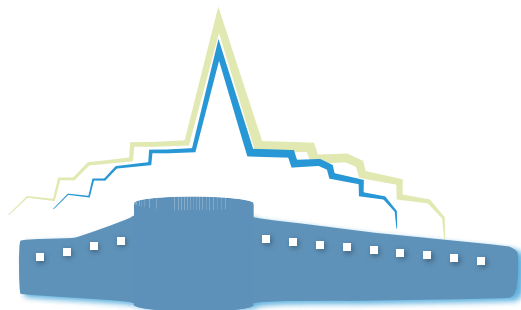
## USEFUL INFORMATION ABOUT ST-MALO

Saint-Malo is located on the north coast of Brittany, western part of France. Its outstanding landscapes and rich historical heritage make Saint-Malo a unique destination. With its 52,000 inhabitants, this city offers a varied and healthy economic activity. Its international trade port, traveler's port, fishing port and sailing port add up to an economic activity definitely open to the world.

The official site of the town (<http://www.ville-saint-malo.fr>) provides a number of information and panoramic views. The area offers a number of places for tourism.

The website of the tourism board (<http://www.ville-saint-malo.fr/tourisme/decouvrir-la-ville/intra-muros/#googtrans/fr/en>) collects useful brochures and addresses for building up the program of a unique stay.

More generally, Brittany offers a variety of amazing landscapes, each part of the coastline having its own identity. The official website for tourism in Brittany (<http://www.brittany-tourism.com>) provides numerous information, brochures, photos and maps.



Download SAINT-MALO TOUR,  
the free and real time mobile application  
of Saint-Malo Tourist Office.

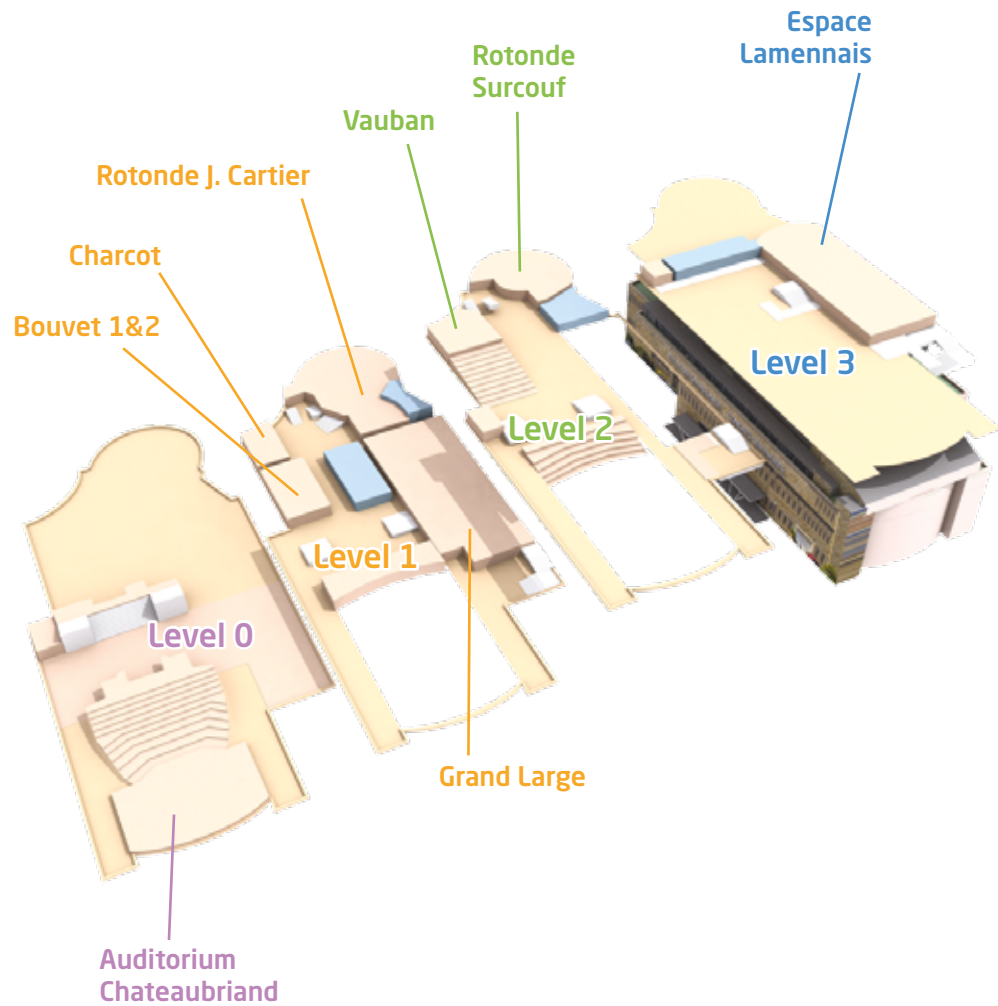


LE GRAND LARGE - Palais des Congrès de Saint-Malo

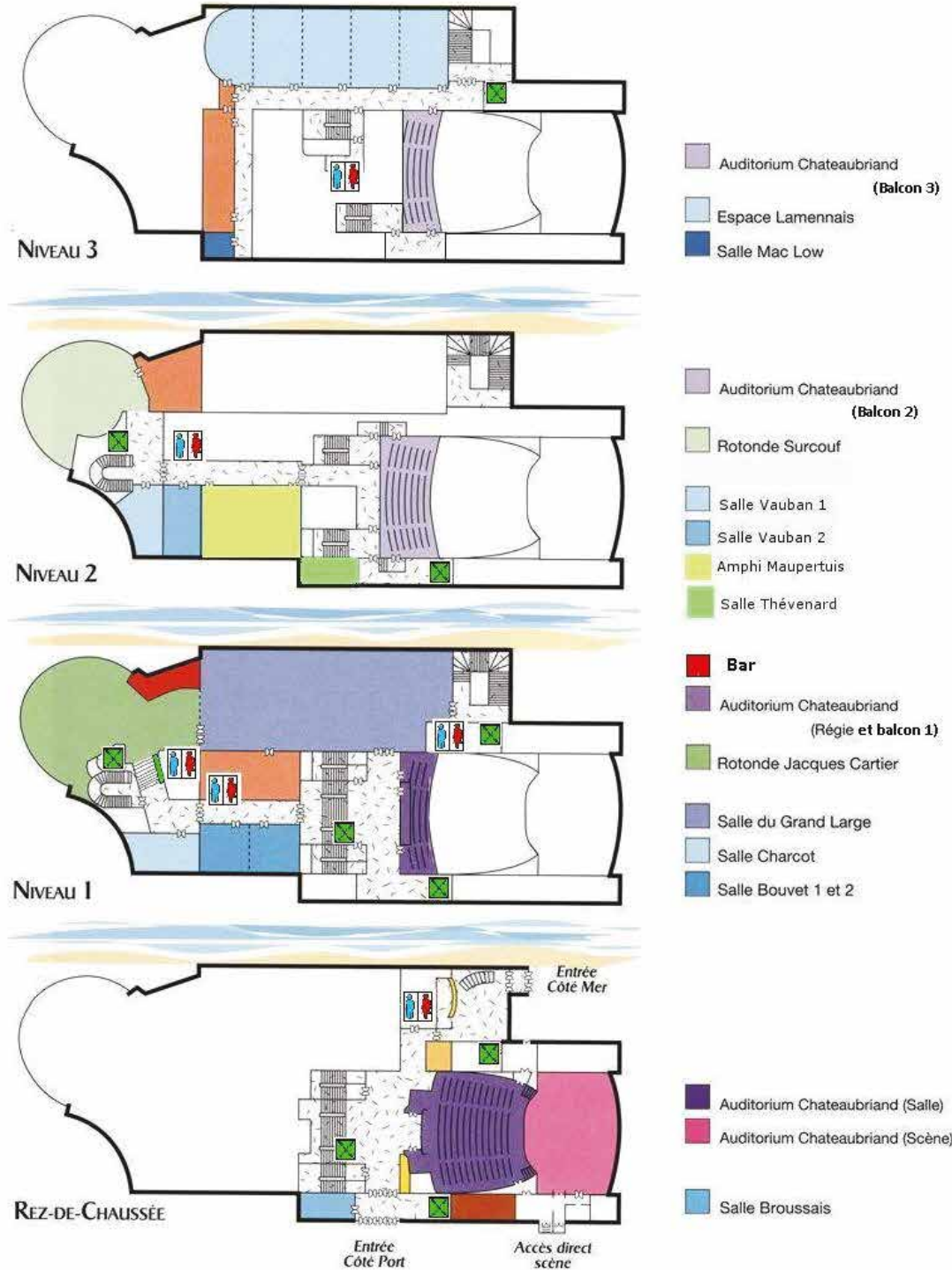
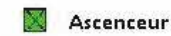
1 quai Duguay-Trouin - B.P. 109 - 35407 Saint-Malo Cedex - Tél.: 02 99 20 60 20  
contact@legrandlarge-congres.com - www.pgl-congres.com



# CONFERENCE VENUE: MAPS



## Plan général :



# RESTAURANTS & BARS

## RESTAURANTS

### A la Duchesse Anne €€€

*Gourmet cuisine*

5 place Guy La Chambre  
restaurant-duchesse-anne.com  
02 99 40 85 33

### Les 7 Mers €€€

*Gourmet cuisine - Facing the sea - EXTRA-MUROS*

64 chaussée du Sillon  
02 99 20 81 41  
<http://www.hotel-le-nouveau-monde.fr/restauration>



### Le 5 - Hôtel France et Chateaubriand

*Panoramic view*

*(closed Monday, Tuesday)*  
12 place Chateaubriand  
le5-restaurant.com  
02 99 56 66 52

### Le Chalut €€€

*Gourmet cuisine - Fish & seafood specialized*

*(closed Monday, Tuesday)*  
8 rue de la Corne de Cerf  
02 99 56 71 58



### Le St-Placide €€€

*Gourmet cuisine - Taxi mandatory - EXTRA-MUROS*

*(closed on Monday)*  
6 place du Poncelet  
02 99 81 70 73



### Gilles €€€

*Gourmet cuisine*

*(closed on Wednesday)*  
2 rue de la Pie qui boit  
02 99 40 97 25



### Le Cambusier €€€

*Gourmet cuisine*

*(closed on Wednesday)*  
6 rue des Cordiers  
cambusier.fr  
02 99 20 18 42



### L'Absinthe €€€

*Gourmet cuisine*

1 rue de l'Orme  
02 99 40 26 15  
restaurant-absinthe-cafe.fr



### Le Cap Horn - Les Thermes Marins €€€

*Gourmet cuisine - Facing the sea - EXTRA-MUROS*

100 boulevard Hébert (Sillon)  
Restaurant-caphorn.fr  
02 99 40 75 40



### Le Bistro de Jean €€

*Ambiance bistro*

*(closed on Sunday)*  
6 rue de la Corne de Cerf  
02 99 40 98 68



### Bouche en Folie €€

*Seasonal food*

*(closed Tuesday, Wednesday)*  
14 rue du Boyer  
06 72 49 08 89



### Bistro Autour du Beurre €€

*Seasonal food*

*(closed Sunday, Monday)*  
7 rue de l'Orme  
02 23 18 25 81  
lebeurrebordier.com

### L'Entre Deux Verres €€€

*(closed on Tuesday)*

7 rue des Grands Degrés  
02 99 40 18 91  
<http://www.restaurant-lentredeuxverres.com>

## Texture €€€

Restaurant & Wine Bar

(closed on Monday)

8 rue des Cordiers  
02 99 48 10 00  
<http://texture-restaurant.fr>

## Timothy €€

(closed Monday, Tuesday)

7 rue de la Vieille Boucherie  
02 99 40 35 36

## La Bisquine €€

Traditional food

(closed on Thursday)

Rue Jacques Cartier  
02 99 40 97 40

## Coquille d'Oeuf €€

Traditional food

20 rue Corne de Cerf  
02 99 40 92 62

## Le Lion d'Or €€

Traditional food

Place Chateaubriand  
02 99 56 36 02

## La Porte Saint-Pierre €€

Traditional food

(closed on Tuesday)

2 place du Guet  
02 99 40 91 27



## CRÊPERIES

### Crêperie Grand-Mère Alice €

(closed Sunday, Monday)

5 rue de Dinan  
02 99 40 88 37  
<http://creperie-grandmere-alice.jimdo.com>

Gault & Millau

### Le Comptoir Breizh Café €€

(closed Monday, Tuesday)

6 rue de l'Orme  
02 99 56 96 08  
[creperielatouline.fr](http://creperielatouline.fr)



### La Touline €

(closed Tuesday, Wednesday)

6 place de la Poissonnerie  
02 99 40 10 98  
[creperielatouline.fr](http://creperielatouline.fr)

### Crêperie des Lutins €

(closed Sunday, Tuesday, Wednesday)

7 Grand'Rue  
02 99 40 07 29

### Margaux €

3 pl. Marche aux Légumes  
02 99 20 26 02

### La Brigantine €

(closed Sunday, Tuesday, Wednesday)

13 rue de Dinan  
02 99 56 82 82  
[la-brigantine.fr](http://la-brigantine.fr)

Gault & Millau



### Chantal €

2 place aux Herbes  
02 99 40 93 97

### Le Gallo €

21, rue de Dinan  
02 99 40 84 17  
<http://www.creperie-gallo.com>

Gault & Millau



## Le Corps de Garde €

*See view*

3 Montée Notre Dame

02 99 40 91 46

<http://www.le-corps-de-garde.com>

## Gault & Millau



## Les Korrigans €

*(closed Sunday, Thursday)*

18 rue des Cordiers

09 81 06 13 77

[www.creperieleskorrigans.com](http://www.creperieleskorrigans.com)

## Sainte-Barbe €

14, rue Sainte-Barbe

02 99 40 98 11

## Le Tournesol €

*(closed on Thursday)*

4 rue des Marins

02 99 40 36 23

<http://www.creperie-saint-malo.com>

## WORLD CUISINE

### Tanpopo €€€

*Japanese restaurant*

*(closed on Monday)*

5 Place de la Poissonnerie

02 99 40 87 53

<http://tanpopo.gandi.ws>

### Le Penjab €€

*Indian restaurant*

7, rue Thévenard

02 99 56 80 12

### La Trattoria Malouine €€

*Italian restaurant*

*(closed on Monday)*

4 rue des Marins

02 99 40 95 88

## Le Borsalino

*Italian restaurant*

*(closed on Monday)*

6 rue de la Vieille Boucherie

02 99 40 87 80

## Pubs

### L'ALAMBIC

*Open from 22:00 to 1:00*

8 rue du Boyer

02 99 40 86 41

[Lalambiccafe.com](http://Lalambiccafe.com)

### L'UNIVERS

*Place Chateaubriand*

02 99 40 89 52

<http://www.hotel-univers-saintmalo.com/bar-des-legendes.php>

### Le Café du coin d'en bas de la rue du bout de la ville d'en face le port - La Java

*Open from 8:23 to 20:42*

3 rue Sainte-Barbe

02 99 56 41 90

[Lajavacafe.com](http://Lajavacafe.com)

### Irish Pub Le Saint-Patrick

*Open from 12:00 to 2:00*

24 rue Sainte-Barbe

02 99 56 66 90

### L'Equinoxial

3 Rue du Puits aux Braies

02 99 40 82 89

### Le Hiss et Oh

7 rue de Chartres

02 99 40 98 11

### L'Aviso

*Open from 18:00 to 1:30*

12 Rue du Point du Jour

07 68 15 01 07

## SPONSORS

PLATINUM

**THALES**

GOLD

 **eclipse**

SILVER

 **OBEO**

 **Papyrus IC**

**TATA  
CONSULTANCY  
SERVICES**

 **DIVERSIFY**

BRONZE

**GEMOC**

 **POLARSYS**  
Open Source Tools for Embedded Systems

**plugbee**

 **HEADS**  
Heterogeneous and Distributed  
Services for the Future Computing Continuum

## SUSTAINING SPONSORS

 Association for  
Computing Machinery  
*Advancing Computing as a Science & Profession*

**SIGSOFT**

 IEEE  
computer  
society

 **IEEE**

## INSTITUTIONAL SPONSORS

*Inria*  
INVENTEURS DU MONDE NUMÉRIQUE

UNIVERSITÉ DE  
**RENNES 1**

 SAINT-MALO  
AGGLOMÉRATION

 Région  
**BRETAGNE**

 fondation

PUBLISHING SPONSOR

 **Springer**

*Please refer to the conference program on our website <http://models2016.irisa.fr> for any changes.*

*You can freely download the proceedings during the conference:*

**<http://models2016.irisa.fr/proceedings>**