First International Workshop on Model Management (MoM)

Dominique Blouin[1], Sylvain Guérin[2], Vasco Amaral[3], Anish Bhobe[1], Chahrazed Boudjemila[2], and João Almeida[3]

[1] Télécom Paris, Institut Polytechnique de Paris, France,
(dominique.blouin, anish.bhobe)@telecom-paris.fr
[2] IMT Atlantique, France,
(sylvain.guerin, chahrazed.boudjemila)@imt-atlantique.fr
[3] University Nova, Portugal,
(vma, jcfd.almeida)@fct.unl.pt

Abstract:

Model-Based Systems Engineering (MBSE) is a popular way to specify, design, implement, deploy and maintain complex systems with high quality and lower costs. These systems combine multiple areas of engineering, including mechanical, electrical, hydraulic, biochemical, control, signal processing, and more. To represent all these aspects, a large number of heterogeneous models are required. However, managing these models correctly can be challenging, especially when different teams work on them simultaneously, which is common in collaborative and concurrent engineering. This activity is called Model Management (MoM) and includes activities beyond maintaining model consistency, such as managing model views, model validity, model versions, and development workflows.

MoM is crucial for industries that are moving from traditional engineering methods to MBSE. Therefore, there are many approaches to MoM, both from academia and industry. However, there is still no single theory or approach to tackle this problem. To address this, this MoM workshop's first edition aims to bring together international researchers and practitioners from academia and research for an intense **one-day workshop**. The goal is to further the state-of-the-art in MoM, develop new collaborations, and define future directions.

1 Motivation

Objectives and Scope. Model-Based Systems Engineering (MBSE) is a paradigm for specifying, designing, developing, implementing and maintaining increasingly complex systems at lower costs with better quality throughout their entire life cycle. These systems often combine multi-physics systems (mechanical, electrical, hydraulic, biochemical, etc.) with computational systems (control, signal processing, etc.). In this view, Multi-Paradigm Modeling (MPM), which proposes to model every part and aspect of such complex systems explicitly, at the most appropriate level(s) of abstraction, using the most appropriate formalism(s), offers a foundational framework for gluing the several disciplines together in a consistent way.

Consequently, MBSE supported by MPM requires many heterogeneous models to cover the many aspects or domains of systems, and the many required levels of abstraction. Besides, extended enterprises, which consists of a network of self-organizing firms combining their economic outputs to provide products and services, also require

the manipulation of multiple models. Similarly, the Industry 4.0 and the emergence of Digital Twins must also involve many models.

These models, which represent the same system under study, often have important information overlaps, resulting in many dependencies. As they regularly evolve through modifications or increments by teams from different engineering areas and, often in parallel (collaborative and concurrent engineering), the consistency of these models is difficult to manage. Managing consistency includes managing model mappings, model repairs, model synchronization, but also sometimes temporarily tolerating inconsistencies for a certain amount of time, requiring that at some point consistency will be restored.

Model consistency is a main challenge that this so-called Model Management (MoM) aims to solve, which, when not well addressed, has shown to result in extremely expensive consequences, such as the Airbus cables problem leading to nearly 5.5 billion € of extra cost[4]. But MoM encompasses many other activities beyond preserving model consistency, such as managing model views, model validity, model versions, model changes (especially in the context of collaborative modeling), and development workflows, which orchestrate activities performed on these models.

While several approaches, such as megamodels, model unification, view-based modeling and model federation have been explored, there is yet no unified theory or approach to MoM. Due to the urgent need for MoM, several tools are currently emerging from industry, which is trying to solve the problem on its own, in an ad-hoc way with little or nonexistent MoM theoretical foundations.

Workshop's Purpose. During this workshop, we want to bring together researchers and practitioners in the area of MoM from academia and industry, to identify possible points of synergy, common problems and solutions, tool-building aspects and a vision for the future of this research area. The goal is to organize a **highly interactive workshop**, with a significant portion of the workshop dedicated to **discussions**. **Regular research papers** from academic and industry authors will present novel research results on the workshop's topics of interest. We will also encourage the submission of **out-of-the-box presentations**, which are not deeply researched yet but can lead to new insights, discussions, and future collaborations.

We will also invite the submission of **exemplars**, which consists of use cases of systems development environments made of a set of modeling languages and tools jointly used to support engineering activities. Such papers should explicitly detail the underlying formalisms, languages, tools and workflows deployed to support such activities, all expressed similarly to enable comparison and extract MoM common practices, problems and solutions.

Intended Audience. The intended audience includes researchers and practitioners interested in MoM, primarily in the context of complex / cyber-physical systems development and throughout the whole system life cycle for which models can be used, and in particular at system operation time when digital twins are used. We expect to attract many attendees from the MBSE community, but also from the MPM community of earlier MPM-related events that have been organized by some of the authors of

[4] https://simpleflying.com/airbus-a380-program-software-discrepancies-delay-story/

this proposal. This includes researchers who work on the fundamentals of MoM, tool builders, and users of these tools from industry and academia.

Topics of Interest. A list of topics of interest is given in the CfP available in the appendix. Note that we have explicitly included the *exemplar* topic, as those exemplars showing current MoM practices are key to structure and discuss MoM's future.

Relevance. The MODELS conference provides an excellent platform to conduct the first international workshop on MoM. This is because the conference brings together researchers seeking to enhance the model-driven engineering field and practitioners with valuable application experiences to share. The Industry Day track is likely to provide numerous individuals from MBSE, which have a strong interest in this workshop. Similarly, the MPM4CPS workshop's attendance, which has been quite successful over its past five editions, should find this workshop to be of significant interest, and we also expect a similar strong interest from the ModDiT (MDE for Digital Twins) workshop participants.

Context and Needs. The authors of this workshop proposal have been actively working on the topic of foundations for MPM for several years. They have participated in numerous related events, such as the Computer Automated Multi-Paradigm Modeling (CAMPaM) workshops series, held annually at McGill University's Bellairs campus, Barbados, since 2004. Additionally, they have been part of a European Cooperation in Science and Technology (COST) research network, which has been active since 2015, on the use of MPM techniques for designing Cyber-Physical Systems (CPS). This network has brought together 29 partner countries from Europe.

Although MoM covers a broad range of concerns in MBSE and MPM4CPS, participants from other popular workshops such as ModDiT (MDE for Digital Twins) will also be interested in MoM, as models are used extensively by digital twins. However, ModDiT mainly focuses on the theoretical foundations, MDE techniques, and tools for supporting the design and deployment of digital twins, for which MoM can provide an essential component. We believe all these workshops can complement each other by focusing on different specialized aspects of challenges within the MODELS community.

2 Organization Details

The organization team comprises a good mix of junior and senior researchers. A **tentative** PC is given in the CfP in appendix. We request that MoM be run independently as we plan half a day of discussions. We can merge with another workshop if this is a condition from the MODELS conference organization, and if the topics are similar enough.

Dominique Blouin is an associate professor at the Information Processing and Communications Laboratory (LTCI) of Télécom Paris, Institut Polytechnique de Paris (France). He obtained an M.Sc. in Physics (Canada) and a Ph.D. in Computer Science (France) in 2013. He worked for many years in the industry as a software architect, and was the vice-chair of the Foundational Aspects Working Group in the MPM4CPS COST Action. He co-organized the five international workshops on multi-paradigm modeling for cyber-Physical Systems (MPM4CPS) and has been an active member of the

SAE AADL standardization committee for the past 10 years. His main research interests are model management, multi-paradigm modeling, model transformation and (bi-directional) synchronization, and requirements engineering applied to cyber-physical and embedded systems.

Sylvain Guérin is a research engineer at the IMT-Atlantique engineering school. He worked for many years in the industry as a software architect. He co-founded and managed Openflexo, a software engineering company. He is the main contributor to the Openflexo software infrastructure and obtained a PhD in Computer Science (France) in 2023. His main research interests are model federation, meta-modeling, free-modeling, model-oriented programming, and software security (contract-based security patterns).

Vasco Amaral is an associate Professor at the Department of Informatics at the NOVA School of Sciences and Technology of NOVA University of Lisbon since 2005. He defended his PhD at Mannheim University in 2005. He was the vice-chair of the European research network Multi-Paradigm Modelling for Cyber-Physical Systems (MPM4CPS COST action). He has also organized several Multi-Paradigm Modeling workshops series at MODELS since 2009 (precursor of MPM4CPS). He has been involved as a steering committee of the five editions of the MPM4CPS workshops (an evolution of the MPM. His current research interests cover several topics in Model-Driven Engineering, including Model Management, Modeling Workflows, Model Transformations, Human Factors in Models, Modeling Cyber-physical Systems.

Anish Bhobe is a PhD student at Télécom Paris in the Information Processing and Communications Laboratory (LTCI). His research focuses on improving the reliability of Model Synchronization methods for use in Consistency Management of Heterogeneous Models. With past experience in the industry as well as Free and Open Source Software development, he is enthusiastic about creating effective tools for the development of good software. Before his PhD, he completed his Masters from Institut Polytechnique de Paris in Cyber-Physical Systems (CPS).

Chahrazed Boudjemila is a Ph.D. student at the IMT-Atlantique engineering school. Her PhD thesis focuses on the security aspects of model-based continuous evolution of software systems artifacts using model federation to ensure security consistency among models, even after their evolution. Before her doctoral studies, she obtained a Master's degree in Computer Science at Université de Bretagne Occidentale (UBO) in Intelligent, Interactive, and Autonomous Systems (SIIA).

João Almeida is a PhD student at the NOVA School of Sciences and Technology, where he is part of the NOVA Laboratory for Computer Science and Informatics (NOVA LINCS). His PhD research focuses on exploring the capabilities of Distributed Ledger Technology (DLT) to bolster security and enhance traceability of Model-Driven Engineering (MDE) artefacts in cross-organizational automotive environments, a testament to his passion for version control systems. Parallel to his academic pursuits, João is employed as a Site Reliability Engineer (SRE) at Mercedes-Benz.io, where he applies his expertise to ensure the reliability and efficiency of software systems in the automotive sector. His unique position at the intersection of academia and industry allows him to bring practical insights into his research, particularly in the areas of software security,

distributed systems, and the application of DLTs in enhancing collaborative engineering processes.

3 Workshop Format

Deadlines & Paper Format Cf. CfP in appendix.

Evaluation Process At least three reviewers will evaluate each submission. Full research papers will be reviewed using standard scientific criteria: alignment with the workshop topic(s), novelty, evaluation, and ability to generate discussion. Short papers will be evaluated based on their likelihood to spark lively discussions.

Intended Workshop Format In the ideal case of a full-day workshop, we will host two keynotes, one from academia and the other from industry. A morning keynote will set the stage for the rest of the day, followed by paper presentations. After the lunch break, a second keynote will set the discussion around industry practices such as exemplar presentations and new and provocative ideas, fostering discussions and out-of-the-box ideas. The afternoon will reserve time for discussions around identifiable patterns, common practices, problems and solutions to MoM, etc. The workshop will end with a wrap-up discussion to formulate the workshop's conclusion, identify open challenges, and outline future work. A summarizing publication will be included in the proceedings. Depending on the quality of papers/discussions, we may organize a journal Special Issue based on invitations and open call.

Expected Participants Number 25-35.

Equipment Whiteboard and projector.

4 Additional Material

A draft **Call for Paper** is attached as appendix.

First International Workshop on Model Management
MoM'24

22 – 24 September 2024 – Satellite event at MODELS 2024, Linz, Austria

Organizing Committee

Dominique Blouin, Télécom Paris, Institut Polytechnique de Paris, France
Sylvain Guérin, IMT-Atlantique, France
Vasco Amaral, University Nova, Portugal
Anish Bhobe, Télécom Paris, Institut Polytechnique de Paris, France
Chahrazed Boudjemila, IMT-Atlantique, France
João Almeida, University Nova, Portugal

Program Committee (tentative)

Rima Al-Ali, KB, Czech Republic
Lucas Albertins de Lima, University Federal Rural de Pernambuco, Brazil
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Antoine Beugnard, IMT-Atlantique, France
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Marsha Chechik, University of Toronto, Canada
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Pierre Dissaux, Ellidiss Technology, France
Ruxandra Duca, Wisk Aero, USA
Alexander Egyed, Johannes Kepler University, Austria
Maged Elaasar, NASA Jet Propulsion Laboratory, USA
Ferhat Erata, Yale University, USA
Holger Giese, Hasso-Plattner Institute, Germany
Regina Hebig, University of Rostock, Germany
Robert Heinrich, Karlsruhe Institute of Technology, Germany
Mauro Iacono, University degli Studi della Campina "Luigi Vanvitelli", Italy
Stefan Klikovits, Johannes Kepler University, Austria
Thomas Kühne, Victoria University of Wellington, New Zealand
Thierry Le Sergent, Ansys, France
Letitia Li, BAE Systems, USA
Hassna Louadah, Institute of Railway Research, University of Huddersfield, UK
Salvador Martinez, IMT-Atlantique, France
Sadaf Mustafiz, Toronto Metropolitan University, Canada
Bentley Oakes, University of Montréal, Canada
Ashan Qamar, Ford, USA
Saulius Pavalkis, Dassault Systems, USA
Arend Rensink, University of Twente, The Netherlands
Andy Schürr, Technical University Darmstadt, Germany
Bran Selic, Malina Software Corporation, USA
Hans Vangheluwe, University of Antwerp, Belgium
Andreas Wortmann, University of Stuttgart, Germany

Scope of the Workshop

Model-Based Systems Engineering (MBSE) is a paradigm for specifying, designing, developing, implementing and maintaining increasingly complex systems at lower costs with better quality throughout their entire life cycle. These systems often combine multi-physics systems (mechanical, electrical, hydraulic, biochemical, etc.) with computational systems (control, signal processing, etc.). In this view, Multi-Paradigm Modeling (MPM), which proposes to model every part and aspect of such complex systems explicitly, at the most appropriate level(s) of abstraction, using the most appropriate formalism(s), offers a foundational framework for gluing the several disciplines together in a consistent way.

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While several approaches, such as megamodels, model unification, view-based modeling and model federation have been explored, there is yet no unified theory or approach to MoM. Due to the urgent need for MoM, several tools are currently emerging from industry, which is trying to solve the problem on its own, in an ad-hoc way with little or nonexistent MoM theoretical foundations.

Therefore, this workshop aims to bring together researchers and practitioners in the area of MoM from academia and industry, to identify possible points of synergy, common problems and solutions, tool-building aspects and a vision for the future of this research area.

Topics of Interest (including, but not limited to)

- **Foundations of MoM; challenges, theories, techniques and tools.**
- **MoM with and for MBSE and MPM.**
- **Management of modeling languages, model views, model validity, model changes, model versions, etc.**
- **Applications of MoM techniques in the domains of automotive, aviation, manufacturing, healthcare, enterprise software, etc.**
- **MoM at runtime for digital twins, self-adaptive systems, etc.**
- **MoM for large data models.**

Important Dates

Paper submission deadline: 5 July 2024
Notification of acceptance: 9 August 2024
Workshop dates: 22 -24 September 2024 (exact date TBA)

Submission Procedure

Papers should be submitted electronically in PDF using the ACM formatting instructions available here via EasyChair for one of the following topics. Each submission will be peer-reviewed by at least three PC members.

- **Full research papers** (10 pages max) presenting a novel innovative approach.
- **Exemplar descriptions** (10 pages max) describing a Model-Based Engineering practice, highlighting both the processes at play and the formalisms, languages and/or tools used to support these activities, and the way these artifacts are managed.
- **Short papers** (5 pages max) present new ideas or early-stage research, extensively discuss the experiences of the researchers of practitioners with a MoM approach or tool.

All papers will be published with the main conference's workshop proceedings.