



ECSA
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Investigating the Model-Driven Development for Systems-of-Systems

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Agenda

- Introduction
- Systematic Review
- Discussion
- Conclusions

Introduction

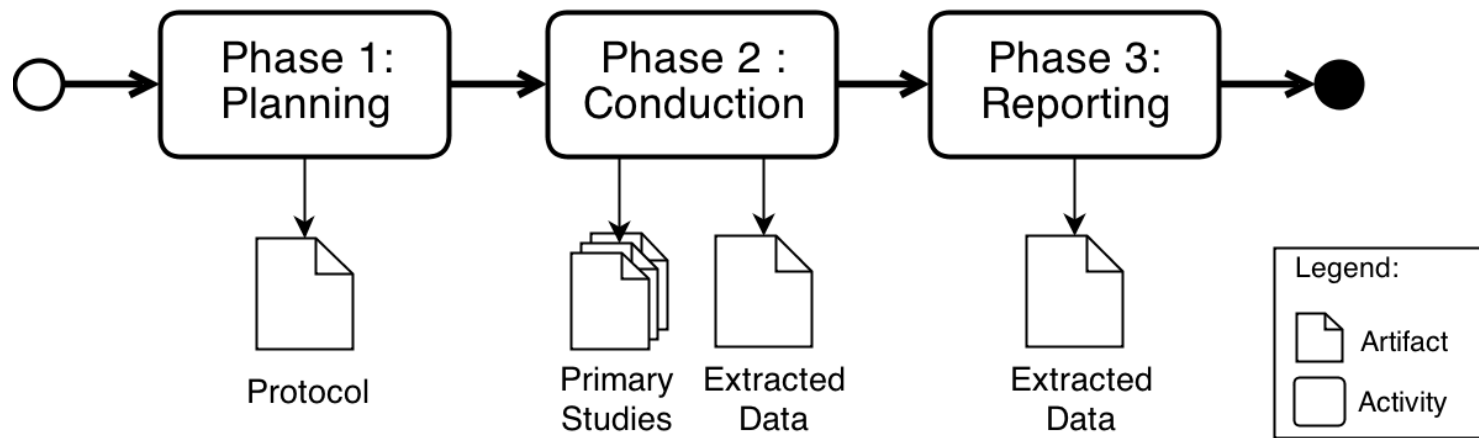
- Systems-of-Systems (SoS) use capabilities of existing systems to synergically provide new functionalities
- SoS are large, complex, and physically distributed
- SoS characteristics lead to a model-centric development approach
- Model-Driven Development (MDD) can support the creation of SoS with better quality
- Motivation:
 - Lack of a complete and broad overview on the use of MDD for developing SoS

Introduction

- Main objective is to:
 - **Investigate how MDD has been applied for developing and maintaining SoS**
- Method: Systematic Literature Review (SLR)
- Expected results:
 - Panorama of the topic of research
 - Research perspectives
 - Promotion of MDD into the context of SoS

Systematic Review

- Phase 1 - Planning
- Phase 2 - Conduction
- Phase 3 - Reporting



Systematic Review: Planning

- Research Questions (RQ):
 - RQ 1: Which model-driven approaches have been applied in software-intensive SoS?
 - RQ 2: Which models have been used to represent software-intensive SoS in model-driven approaches?
 - RQ 3: Which tools and technologies have been developed or applied to use model-driven approaches into the context of software-intensive SoS?
 - RQ 4: Which quality attributes of SoS are addressed through a model-driven perspective?

Systematic Review: Planning

- Search sources:
 - ACM Digital Library
 - IEEEXplore
 - ISI Web of Knowledge
 - Scopus
- Search string:

(system of systems OR system-of-systems OR systems of systems OR systems-of-systems) AND (Model-Driven Development OR Model-Driven Engineering OR Model-Driven Architecture OR Model-Based System Engineering OR Model-Based Software Development OR Model-Driven Software Development OR MDA OR MDE OR MDD OR MDSD OR Model-Driven OR Model-Based OR Model Based)

Systematic Review: Planning

- Inclusion Criteria (IC):
 - IC 1: The primary study **uses** MDD to automatically generate software-intensive SoS from models
 - IC 2: The primary study **proposes** a model-driven approach to automatically generate software-intensive SoS from models
 - IC 3: The study is a literature review
- Exclusion criteria
 - Exclude primary studies not associated to MMD for SoS synthesis
 - Exclude primary studies in other languages than English
 - Exclude primary studies without abstract or that do not add evidences (invited talk description, conference description, etc.)

Systematic Review: Conduction

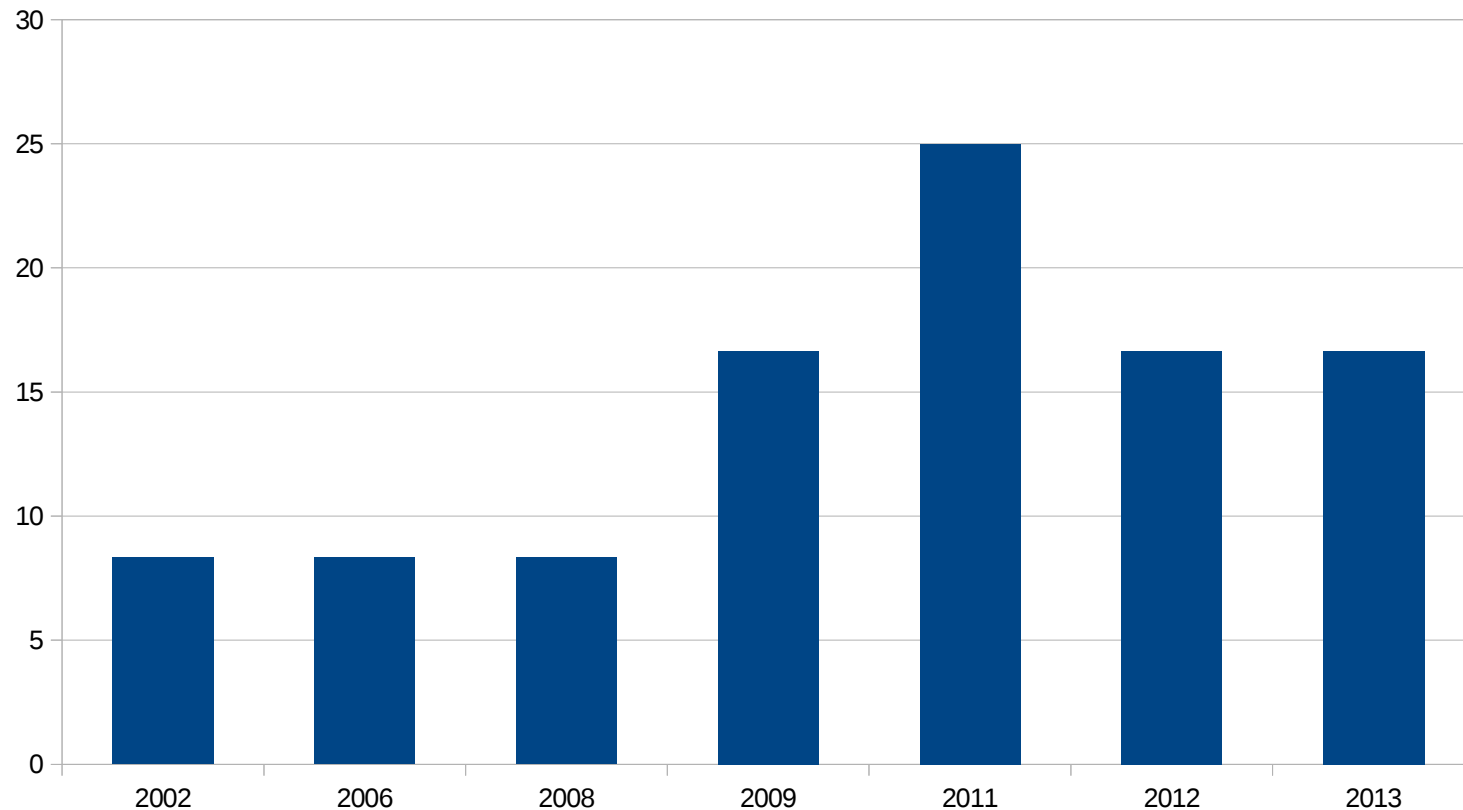
- Obtained studies: 177
- First selection: 67
- Second selection: 12
- Each study was independently evaluated by two reviewers

Systematic Review: Conduction

Included	IC
Bay	IC3
Feiler et al.	IC3
Gokhale et al.	IC1
Lang and Schreiner	IC2
Neema et al.	IC2
Lewis et al.	IC1
Tu et al.	IC2
Pavon et al.	IC2
Barbi et al.	IC2
Ramos et al.	IC3
Mittal and Risco Martin	IC2
Bryans et al.	IC2

Systematic Review: Conduction

- Publication of primary studies per year:



Systematic Review: Reporting

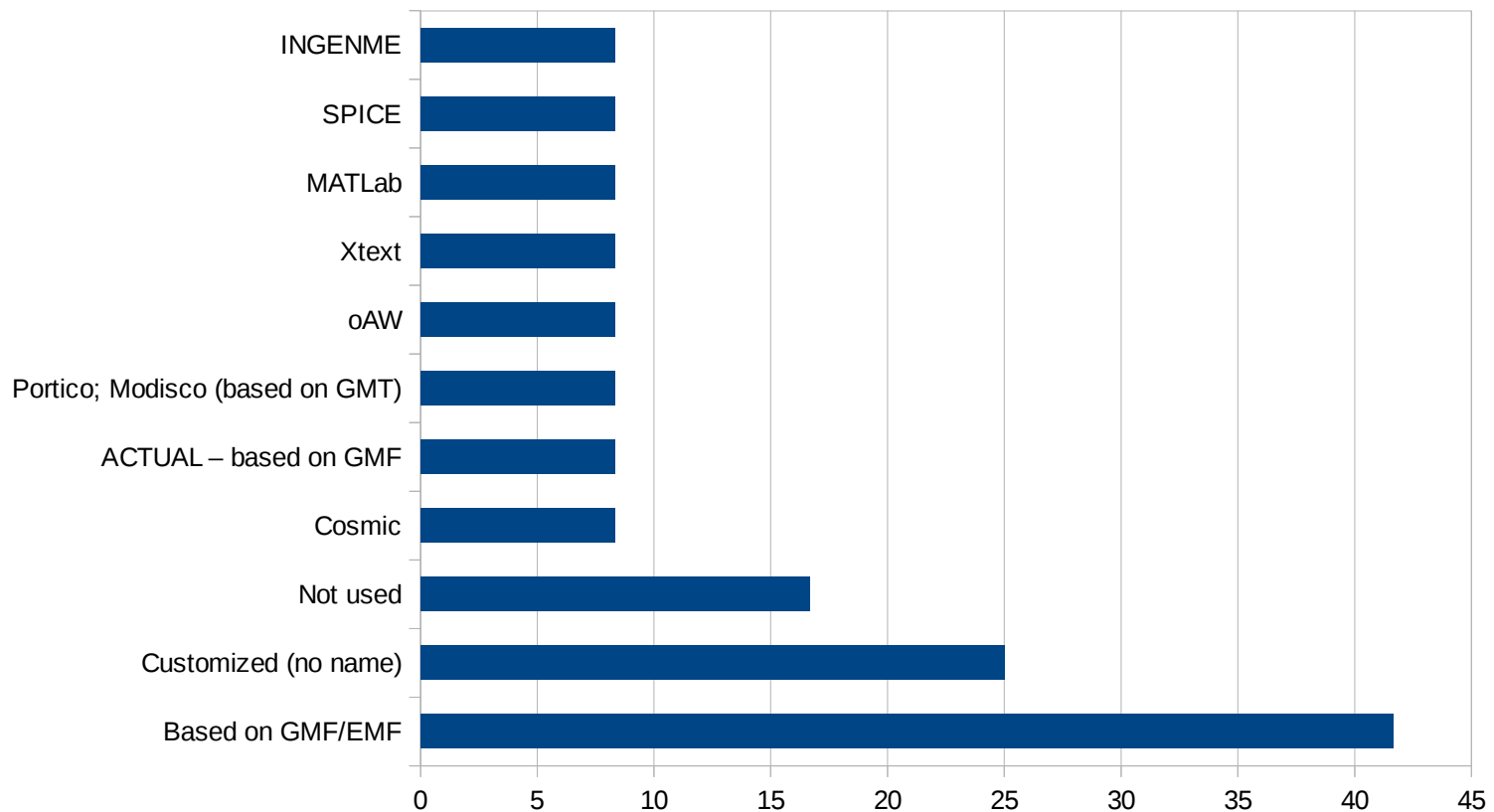
- RQ 1: Which model-driven approaches have been applied in software-intensive SoS?
 - Four studies (~33%) focused on SoS software code generation
 - Two studies (~17%) used MDD to manage interoperability among constituents
 - Four studies (~33%) focused on both code generation and interoperability
 - One study (~8%) used MDD for interface generation
 - One study (~8%) proposed the use of an Architecture Description Language (ADL) to support code generation

Systematic Review: Reporting

- RQ 2: Which models have been used to represent software-intensive SoS in model-driven approaches
 - UML (50%)
 - OCL (25%)
 - DoDAF or MoDAF (25%)
 - SysML (25%)
 - DEVS, BPMN, AADL, SelfMML, OCML, and XML (~8%)

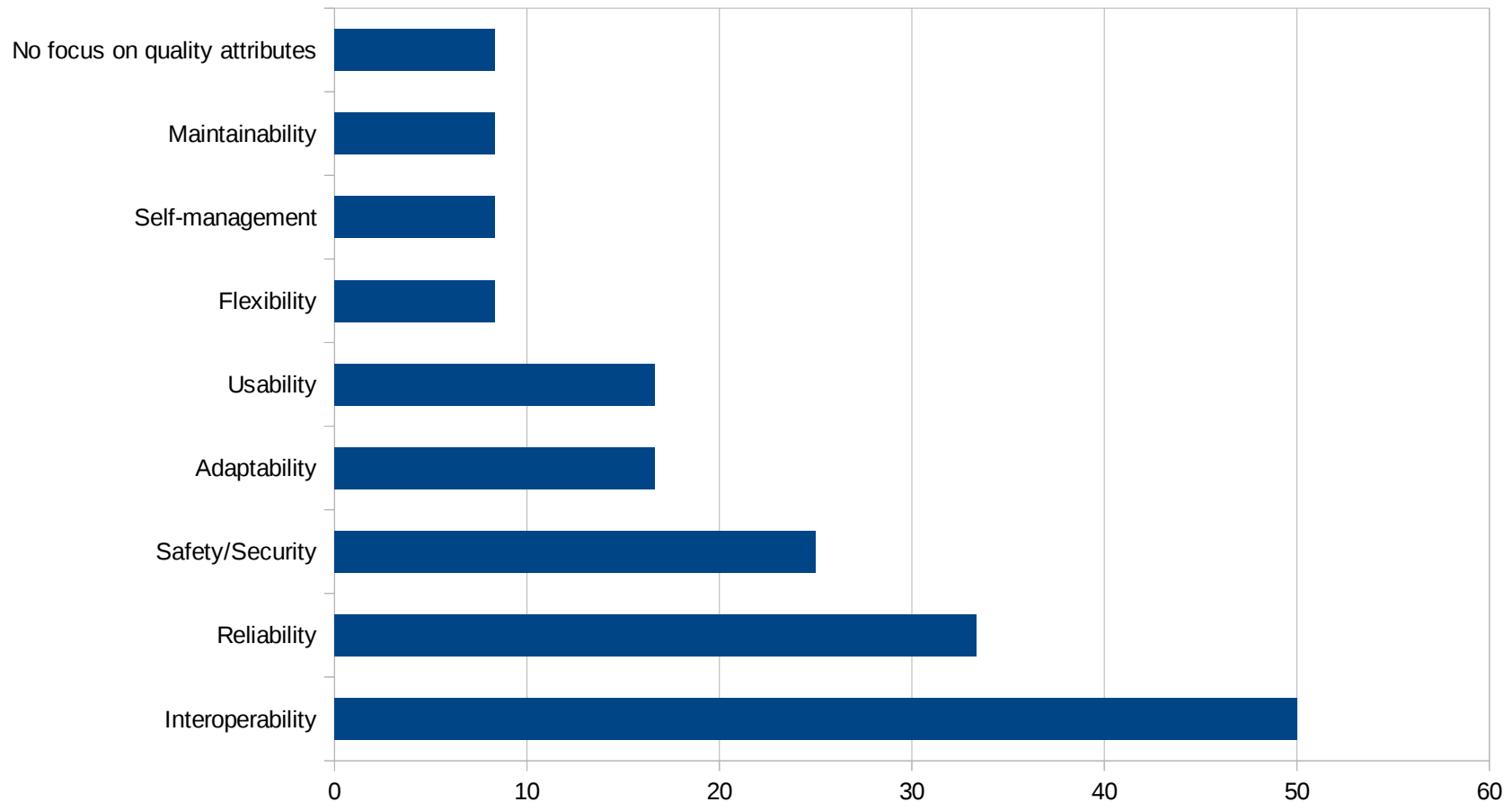
Systematic Review: Reporting

- RQ 3: Which tools and technologies have been developed or applied to use model-driven approaches into the context of software-intensive SoS?



Systematic Review: Reporting

- RQ 4: Which quality attributes of SoS are addressed through a model-driven perspective?



Discussion

- Perspectives of research:
 - Application of processes, tools, techniques, methods, models, and practices from MBSE to an MDD-SoS
 - Investigation of how middleware can be engineered to SoS
 - Extension of MDD techniques to SoS software engineering
 - Application of solutions from Model-Driven Middleware community to ease interoperation of constituents

Conclusions

- MDD has good perspectives in supporting the development of SoS
- We observed a recent, increasing interest in this research area
- Nonetheless, more studies are still necessary to consolidate MDD in the context of SoS
- Open research perspectives on the use of MDD for SoS development



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