Model-Based System Engineering in Practice: Document Generation - MegaM@Rt Project Experience

Presented by **Andrey Sadovykh**, Innopolis / Softeam

Andrey's Background

- Experience
  - Project Manager, Coordinator – 14 years
- Worked for
  - SWsoft, AIRBUS, SOFTEAM
- Worked with
  - European Space Agency
  - Thalès, Scania, Volvo, Nokia, SAP, Bombardier, ATOS, IBM, SIEMENS, EDF

MSc MIPT

PhD AIRBUS / Sorbonne Uni.

MBA HEC Paris

- Areas of Interest
  - Distributed Systems
  - Model-driven Engineering applied …
    - Software and services
    - Cyber-physical systems
  - Digital Innovation

Outline

- Why documentation?
- MegaM@Rt2 project
- Documentation for Requirements, Architecture, Roadmap and Traceability
- Modelio Demo
- Conclusion and discussion
- Backup
  - Requirement Management Approach
  - Architecture Management Approach

Introduction

How much (%) of project time do you spend on documenting?

Why documentation?

What are the main difficulties in documenting your project?

Why documentation?

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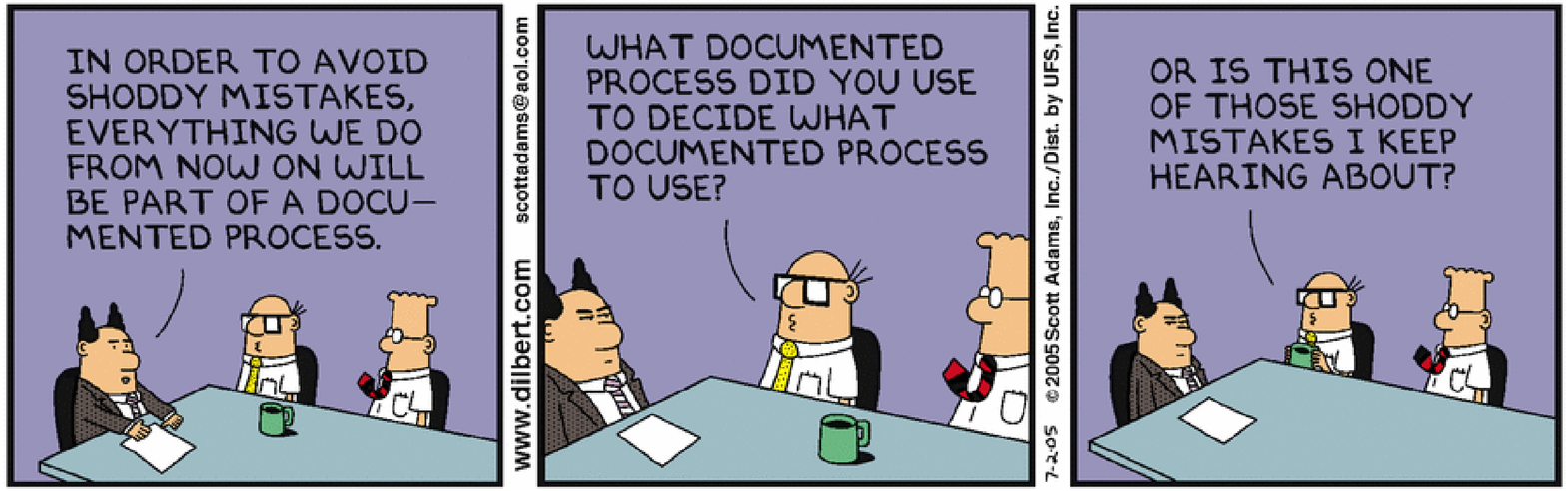
Purpose

- Communication
  - Requirements
  - Architecture
  - Design
  - Test plans
  - Reviews and reports
- Contractual, legal means
- Required by process to instill quality

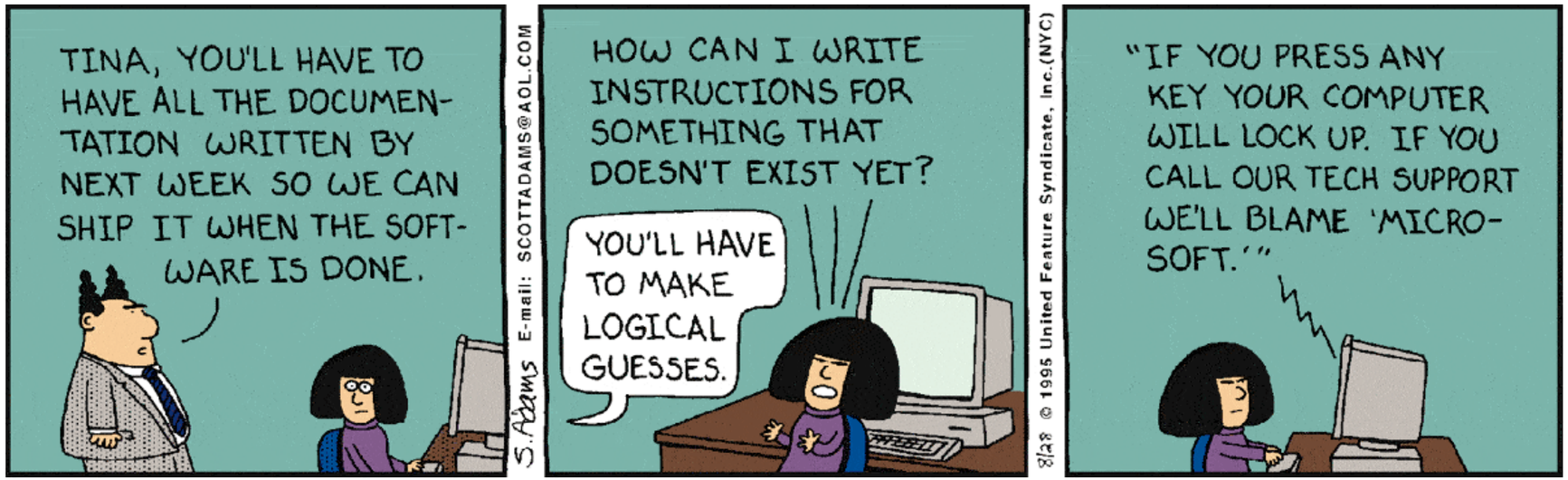
Properties

- Readers / Stakeholders
- Reading style – story or dictionary
- Traces and references, diagrams
- Formats

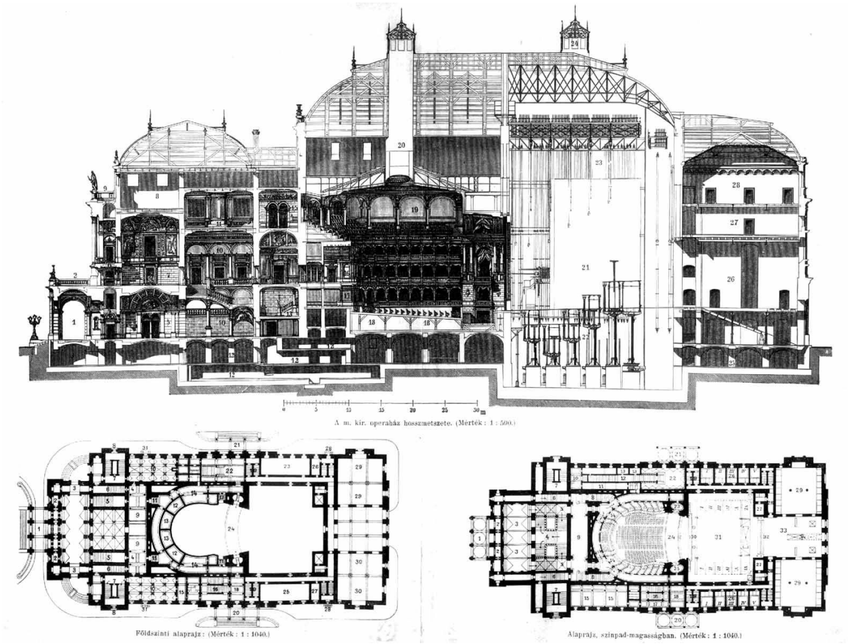


Problems with the documenting
Takes productive time/cost!

- Consistency and synchronization
- Outdating
- Maintaining references
- Formatting and presenting
- Reusing

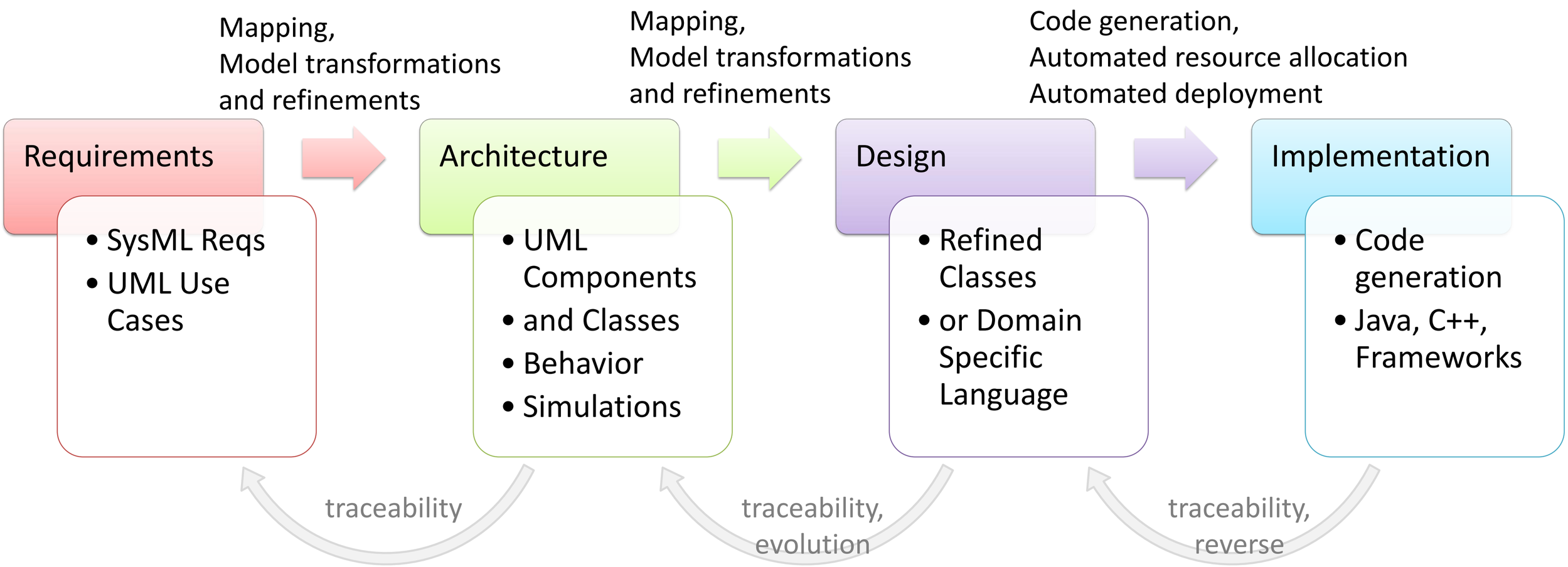


Model as a blueprint to produce things



- Models
  - Descriptive
  - Prescriptive
- Fowler distinguish models as
  - Sketches – for communication
  - Blueprints – for development
  - Programs – for execution
- Why modelling in software engineering?
  - Increase in productivity
  - Less errors
  - Cut coding
- Drivers
  - More complex software to be developed including
  - Increasing need to evolve the software
  - Lack of software engineering skills
  - Need to understand the domain problem to support with soft

We can produce documents from models too



MegaM@Rt2 project and its challenges

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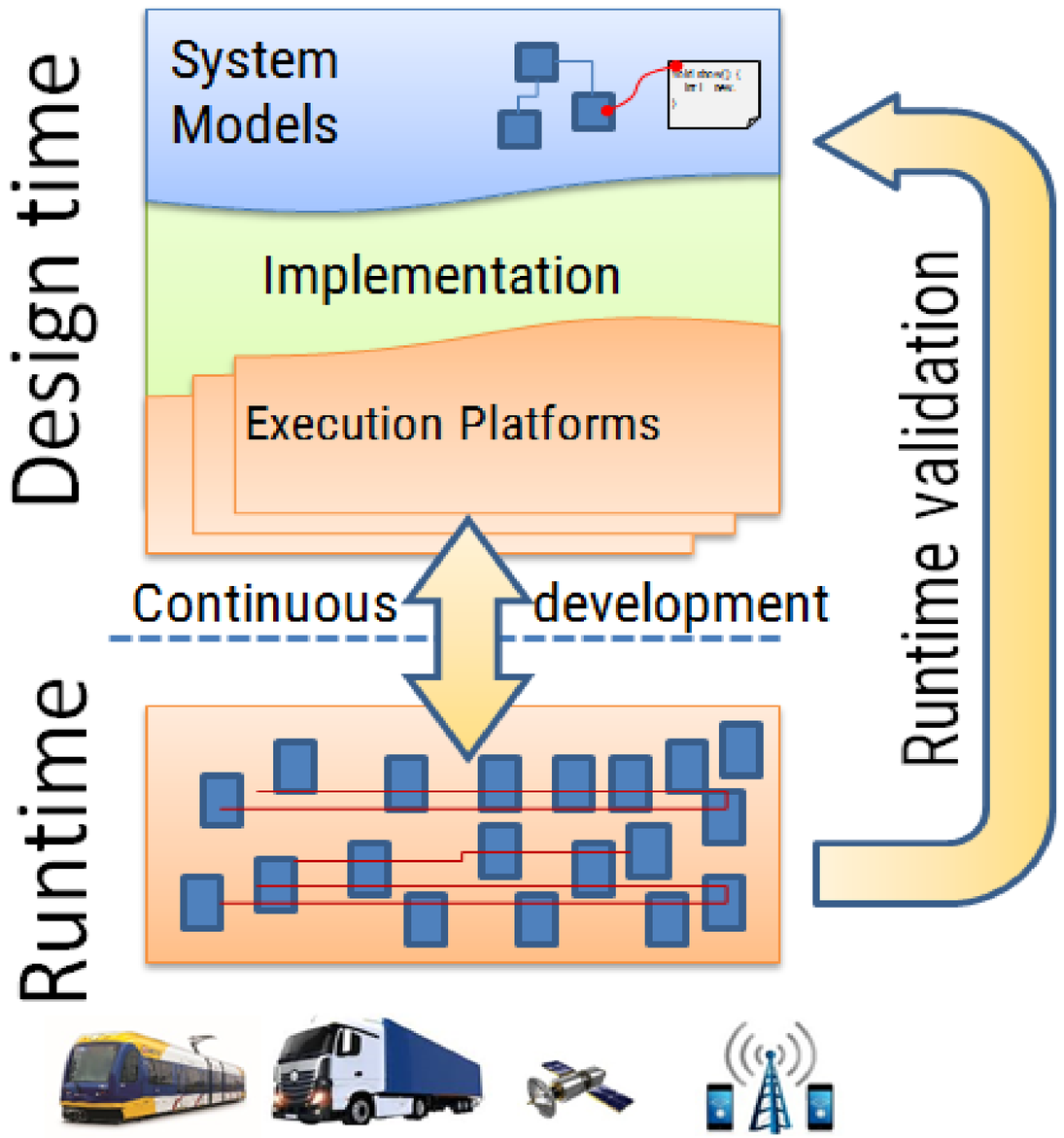
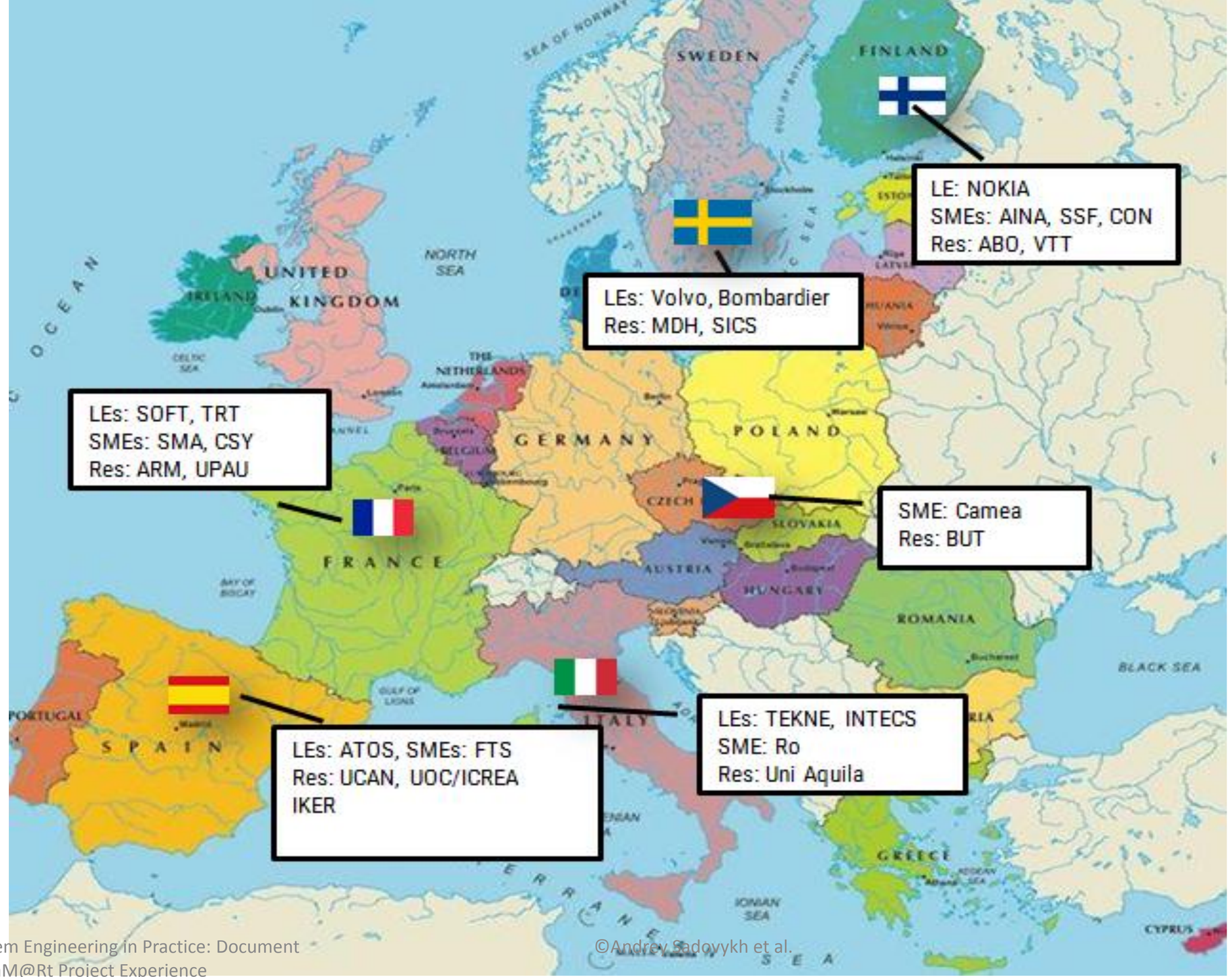
Scope - MegaM@Rt2 tool box:



- Design time:
  - Holistic system engineering
  - Team collaboration over distributed models
  - Global traceability
- Runtime:
  - Tracing / Monitoring
  - Models@Runtime

Size



Collaboration, Complementarities and Differences

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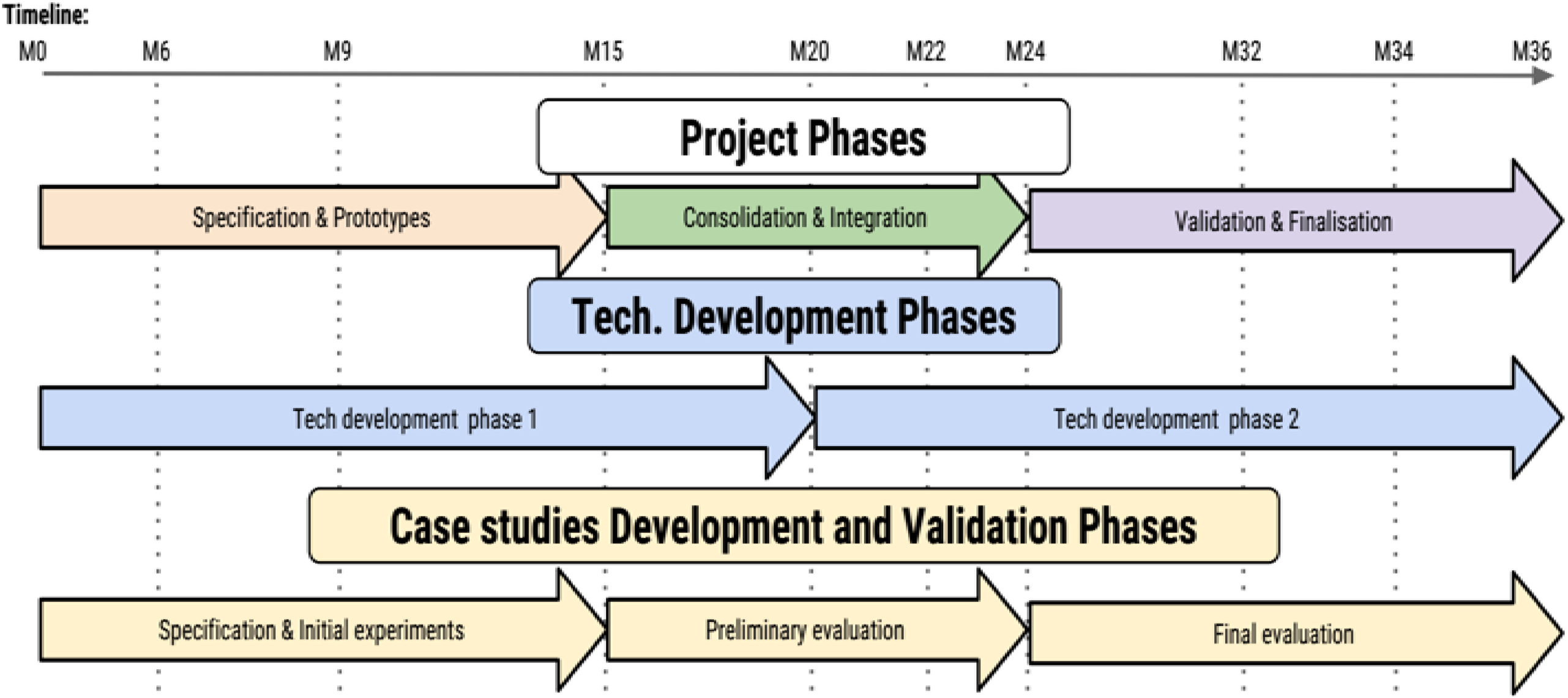
		Case study providers									Technology providers (Tools and Methods)																		
		TRT	CSY	IKER	TEK	NOK	VCE	BT	CAM	AINA	SOFT	SMA	ARM	UPAU	ATOS	UCAN	UOC	FTS	UAQ	INT	RO	ABO	SSF	VTT	CON	MDH	SICS	BUT
Application Domain	Transportation	x	x				x	x	x		Modelio suite	Smartesting Tools (CertifyIt / MBeetle)	AM3, EMFViews, Neo4EMF, ATL	Model execution (PauWare, SCXML)	EMF, ATL, Acceleo, OCL, UML2, Profiles		EMFtoCSP, Collaboro		EMF, MOSES, ATL, Acceleo, MARTE, UML2	CHESS (Modeling) & MOSES (Performance Analysis)	Completeness/Consistency Requirements check		LIME toolset		rmiq De			
	Smart warehouse			x																									
	Telecom				x	x				x																			
	Industrial Control			x					x																				
Innovation topics	Domain specific languages	x	x			x			x		x	x	x	x	x	x	x					x						x
	Requirements modeling	x			x	x	x	x			x					x		x		x	x					x		
	Aspect oriented modeling	x									x				x							x						x
	MB Verification	x	x			x	x	x		x					x	x	x	x		x	x	x				x	x	x
	MB Performance Analysis				x					x						x			x	x								
	Simulation	x		x	x	x		x						x		x										x		
	MB Validation	x	x			x	x	x		x		x			x		x	x	x			x			x	x	x	
	(MB) Runtime verification	x		x	x	x	x	x	x	x				x								x	x	x		x	x	x
	MB testing (online &offline)			x	x	x	x	x	x	x		x				x						x	x		x	x	x	x
	Requirements/system traceability			x		x	x	x			x		x			x		x		x		x			x	x		
	MB collaboration and governance						x	x			x		x				x	x										
	Continuous Development			x	x	x				x	x	x	x	x	x	x		x				x	x	x				x
	Anti-pattern detection	x													x		x		x									
	Root-cause analysis					x	x	x		x													x	x		x	x	
	Model Management & Storage					x					x		x					x	x									

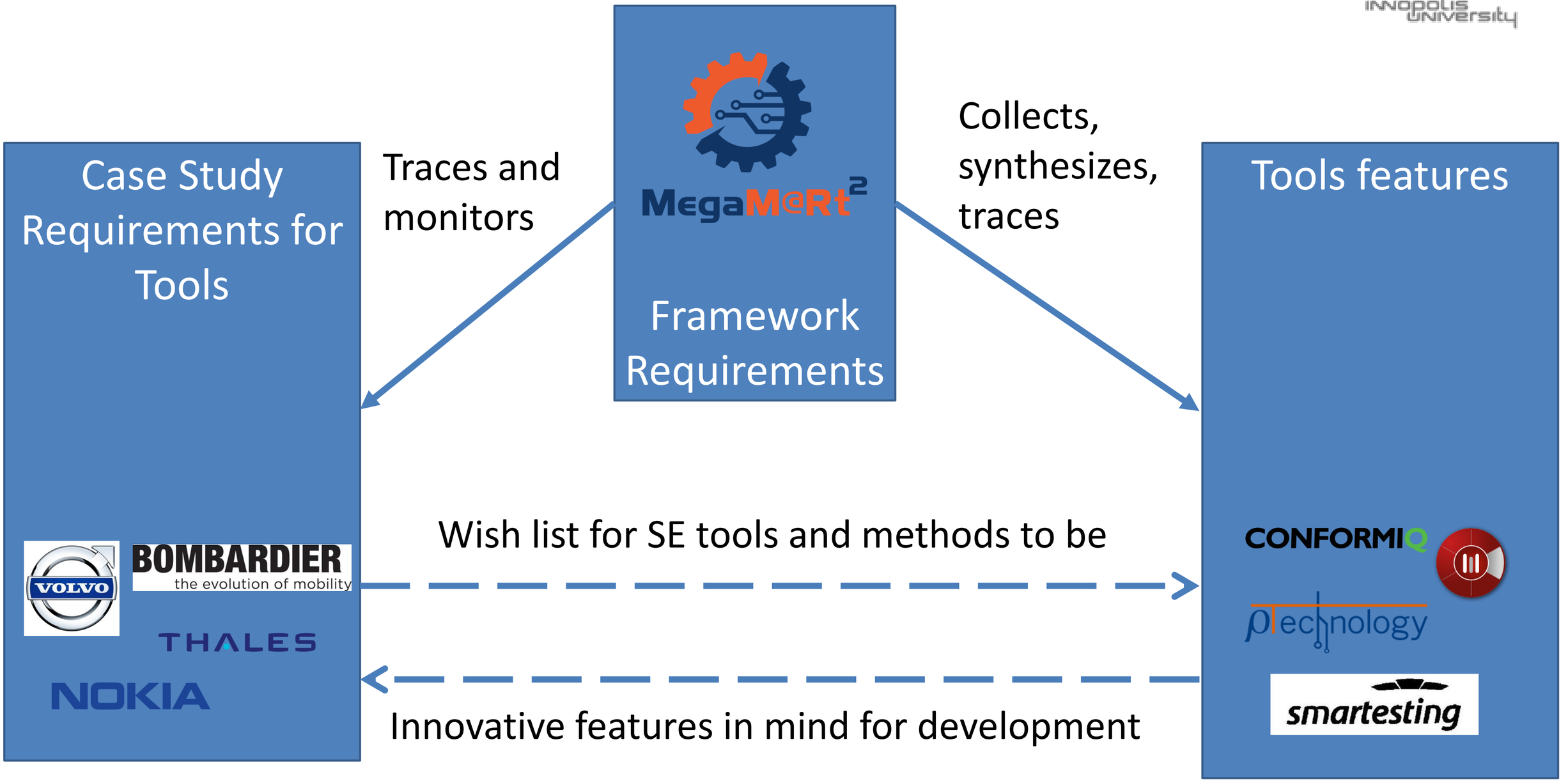
Process



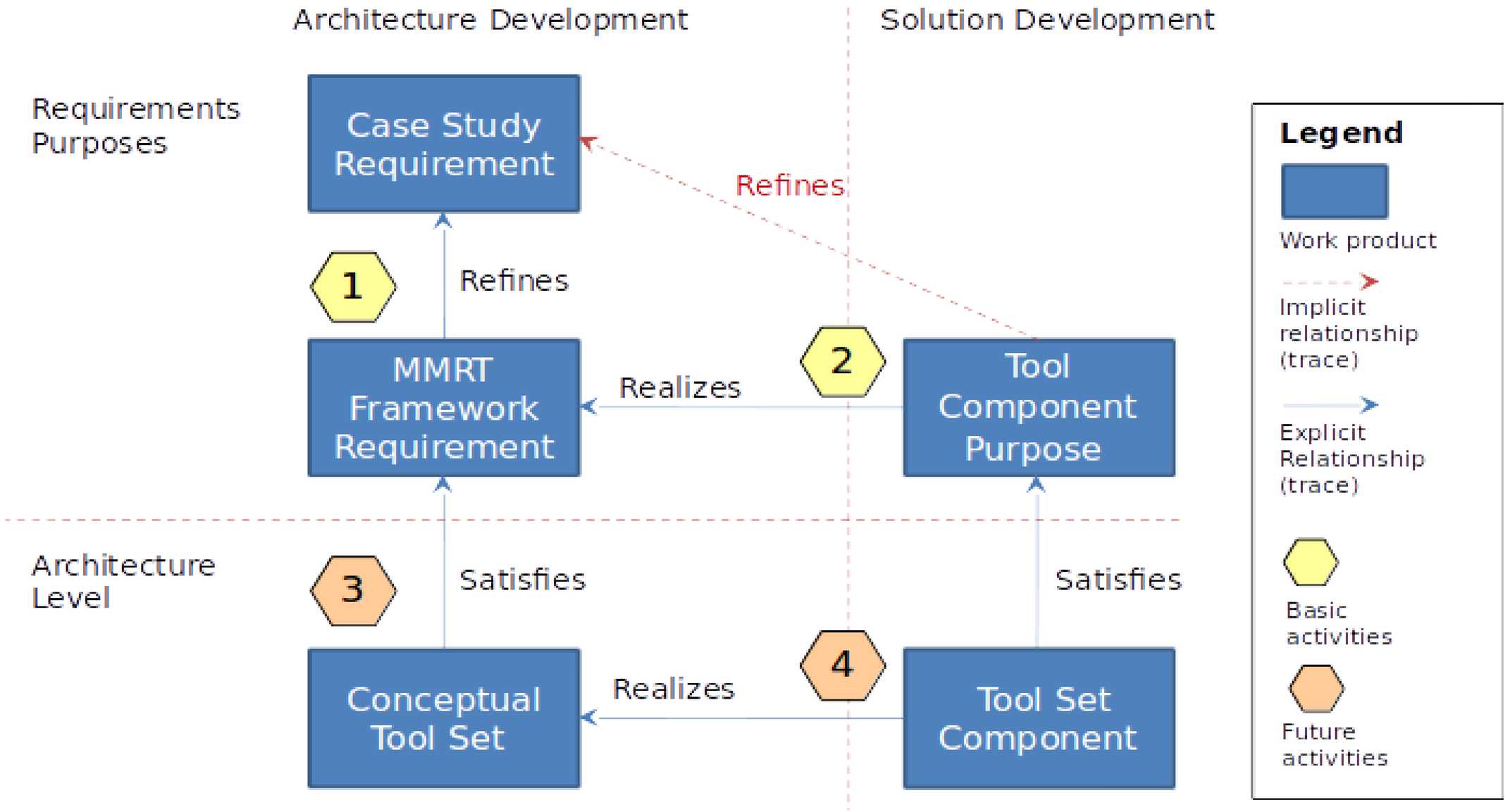
Automating Documentation in MegaM@Rt

Requirement, Architecture, Traceability

MegaM@Rt2 Approach

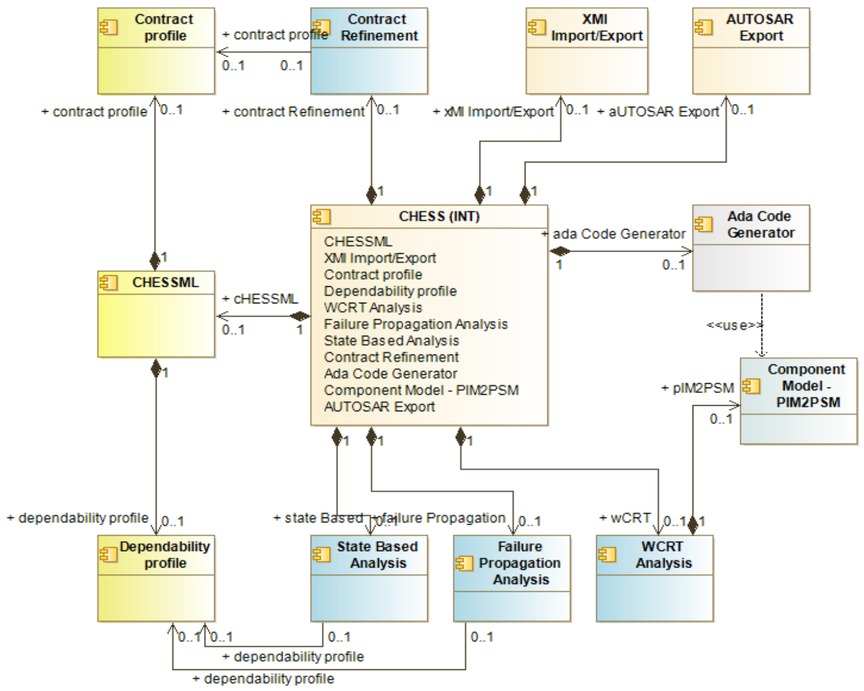


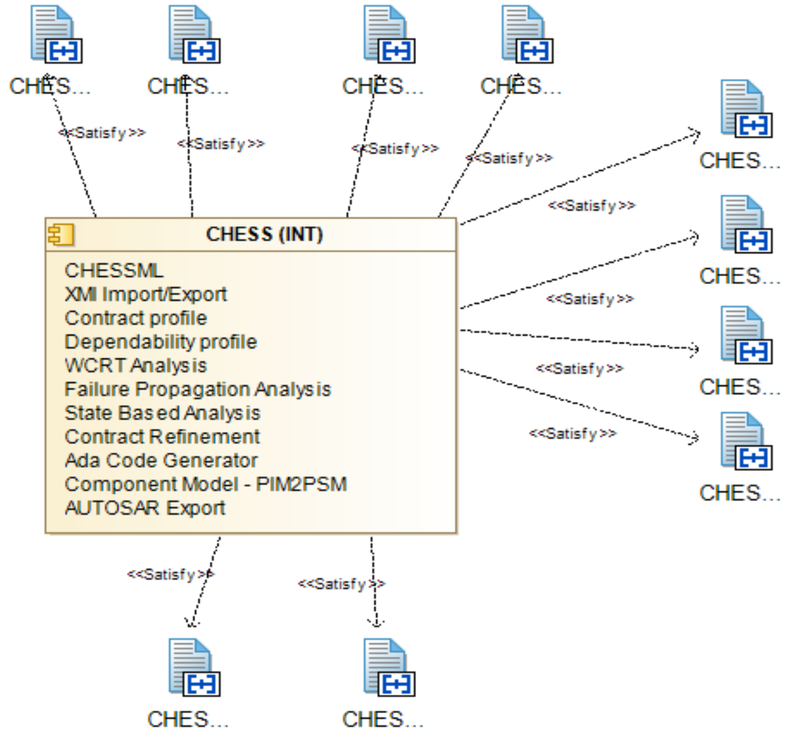
MegaM@Rt2 Approach

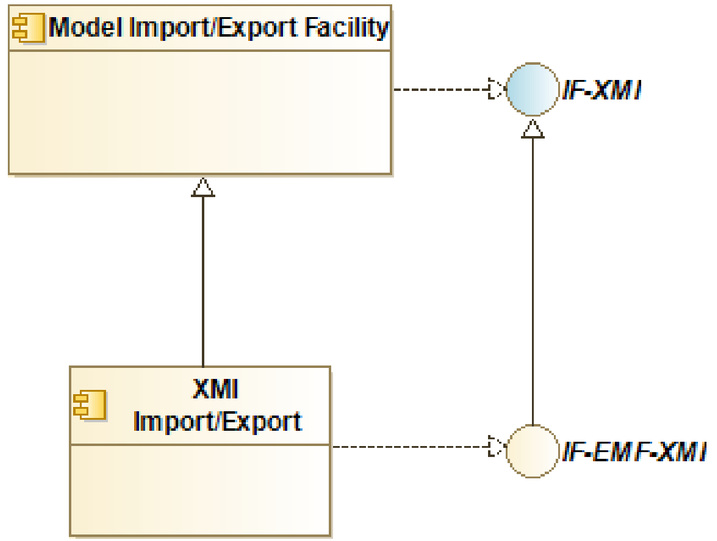


Individual tools modelling

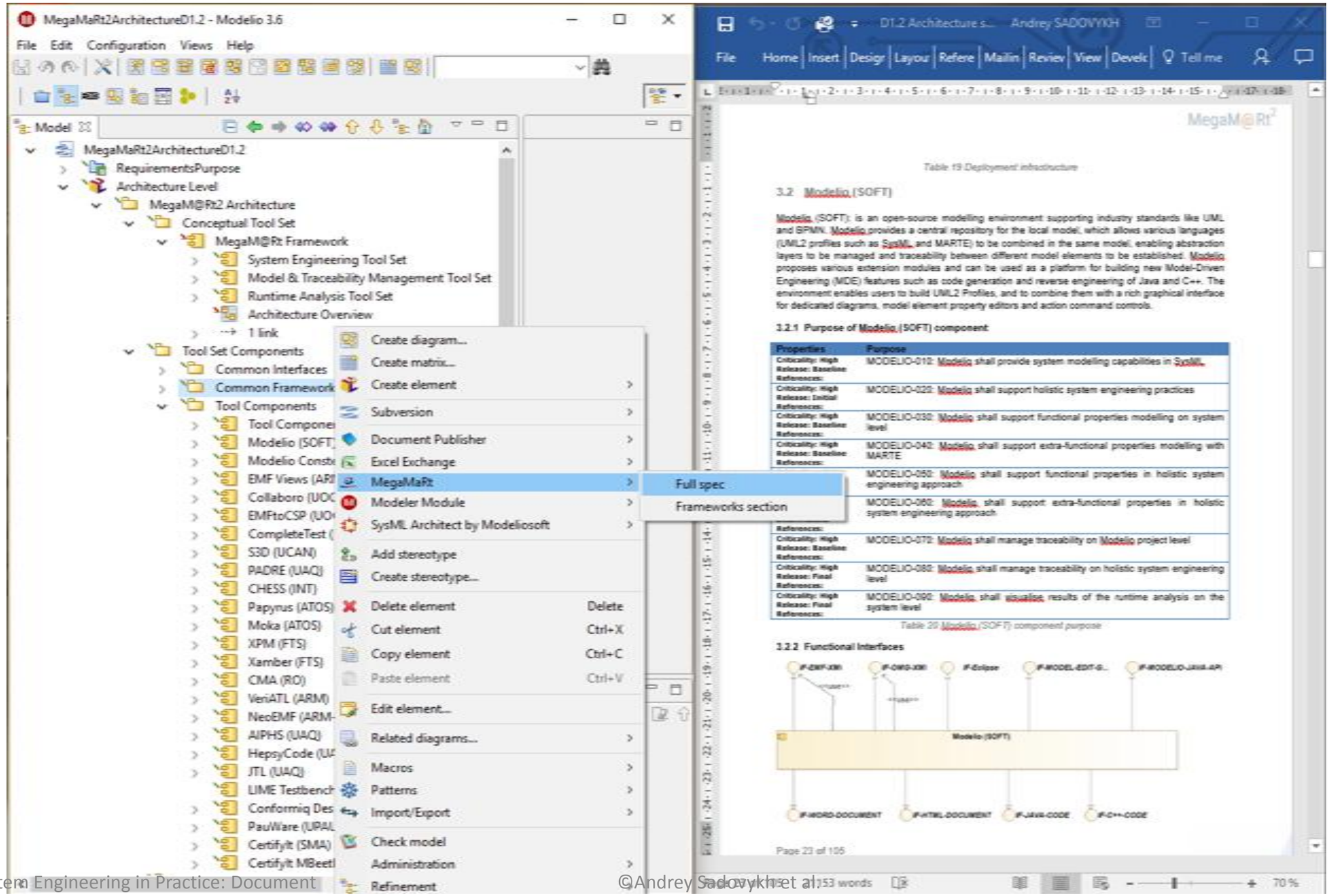
- Each conceptual tool set sub-component and relevant interfaces have been refined to better satisfy the refined framework architecture and requirements



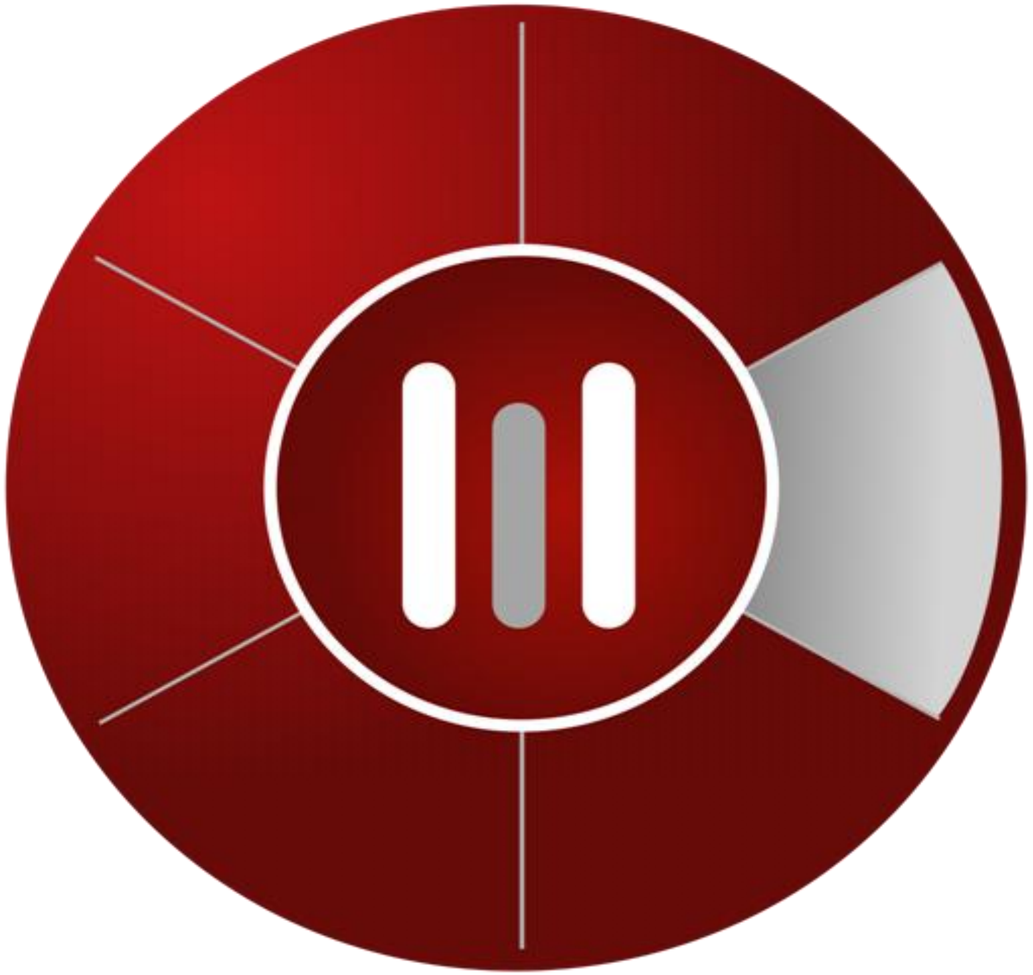




Document generation



Demo with Modelio



Conclusions and discussion

Discussion of the MegaM@Rt approach

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Advantages

- Technical coordination support
  - Requirements traceability
  - Live architecture document
  - Single model for everything
- Managing integrity of the project
  - Collaboration support
  - Common understanding
  - Common tool
  - Single reference
- Synchronization among WPs
  - Sharing specification approaches
  - Sharing document generators
  - Sharing document structures
- Useful tools
  - Document generation
  - Document templates
  - Traceability live view

Limitations

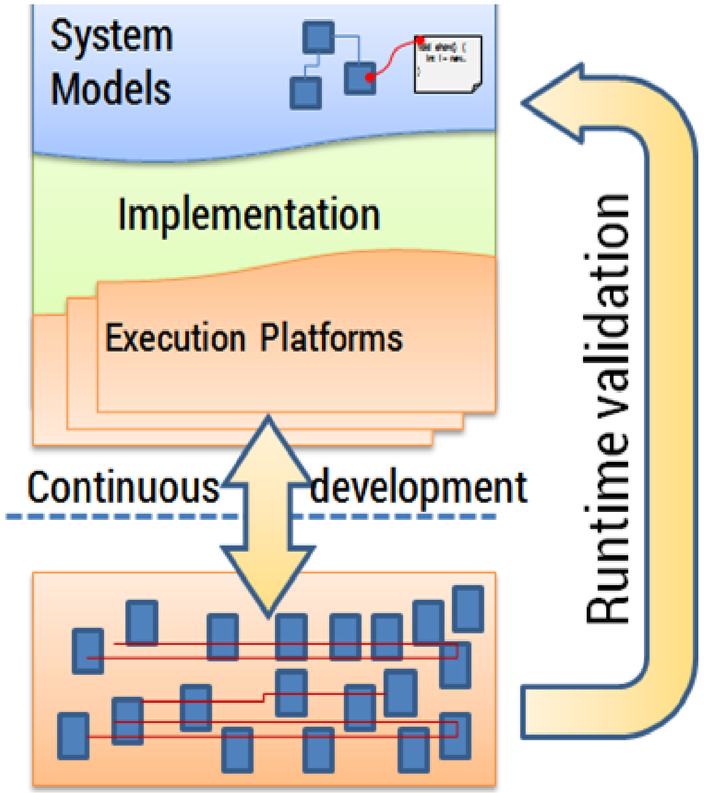
- Very high-level modelling
- Learning curve
- Synchronizing contributions
- Styling of documents
- Still manual effort needed

Conclusions: Overall useful

- Can be used in many other similar projects
  - Uniformity, consistency for many contributors
- Approach is implementable in many tools

Thank you

- Contact info:
  - andrey.sadovykh@softeam.fr
  - a.sadovykh@innopolis.ru
- Useful links:
  - https://megamart2-ecsel.eu/
- More about tool
  - http://www.ModelioSoft.com
  - http://www.modelo.org



Conclusions: Overall useful

- Can be used in many other similar projects
  - Uniformity, consistency for many contributors
- Approach is implementable in many tools

Future work

- Specifying integration means
- Specifying tool chains for validation scenarios (eg BPMN)

Backup

MMRT Framework Requirements Specification

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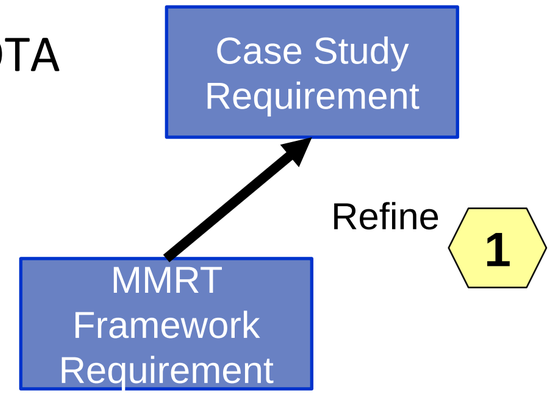
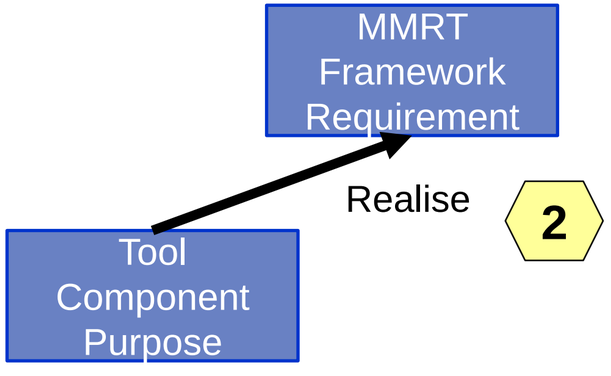
A Top-Down approach

- From Case Studies Requirements (a total of 106 CSRs from 9 case study providers)
- To MMRT Framework Requirements
  - Additional input form: initial proposal, SOTA



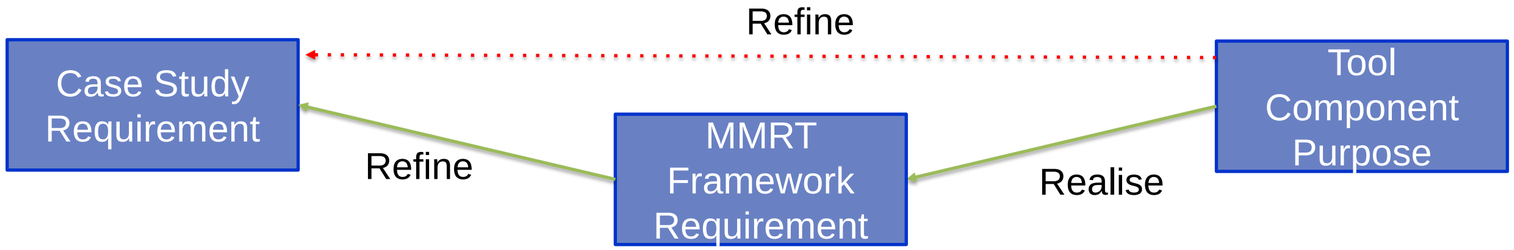
A Bottom-up approach

- Tools Components Purposes (28 tools with a total of 223 different TPs)
- Realise MMRT Framework Requirements
  - Framework requirements (FRs) bridge between CSRs and TPs

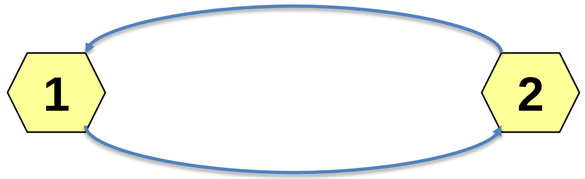


Meet in the Middle

- Framework requirements (FRs) bridge between CSRs and TPs Purposes



- Refinement iterations



- Tool support:
  - Modelio modeling tool to collect CSRs, TPs, create traceability matrices, and generate documentation

Mapping requirements by traceability matrix

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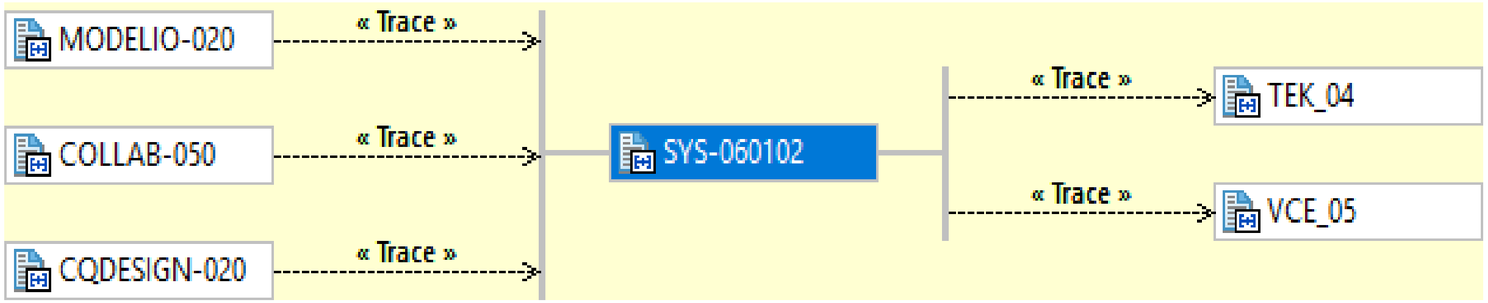
	RTA-00004	RTA-00005	RTA-00006	RTA-00007	RTA-00008	RTA-00009	RTA-0
NeoEMF-040							
AIPHS-010				↗	↗		
AIPHS-020				↗	↗		
AIPHS-030				↗	↗		
AIPHS-040							↗
AIPHS-050							
AIPHS-060				↗			
HepsyCode-010							
HepsyCode-020							
HepsyCode-030							
HepsyCode-040							
JTL-010	↗						
JTL-020	↗						
JTL-030			↗				
JTL-040			↗				
JTL-050			↗				
JTL-060						↗	↗

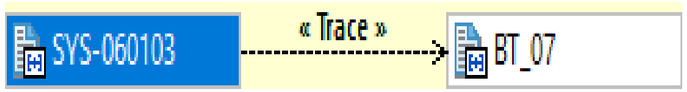
Gap Analysis

- Looking for:
  - CSRs coverage

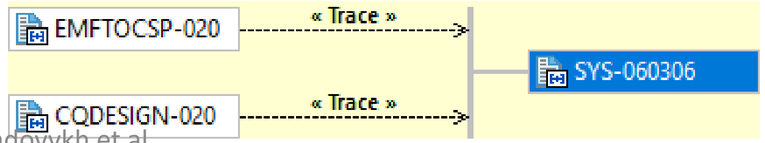


    - Multiple tools satisfying a requirement: alternative available

  - Unsatisfied CSR to define mitigation actions (e.g. sharing results from other projects, including additional tools, etc..)



  - Added values by additional TPs unrelated to CSRs (i.e. suggestion to industrial partners for process improvement)



Gap Analysis Results - Overview

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	#FRs	FRs not mapped to any CSRs	CSRs not satisfied by any TPs	TPs not mapping to any FR
WP2	**37**	3	1	0
WP3	**39**	4	1	10
WP4	**15**	0	0	2

Roadmap Analysis

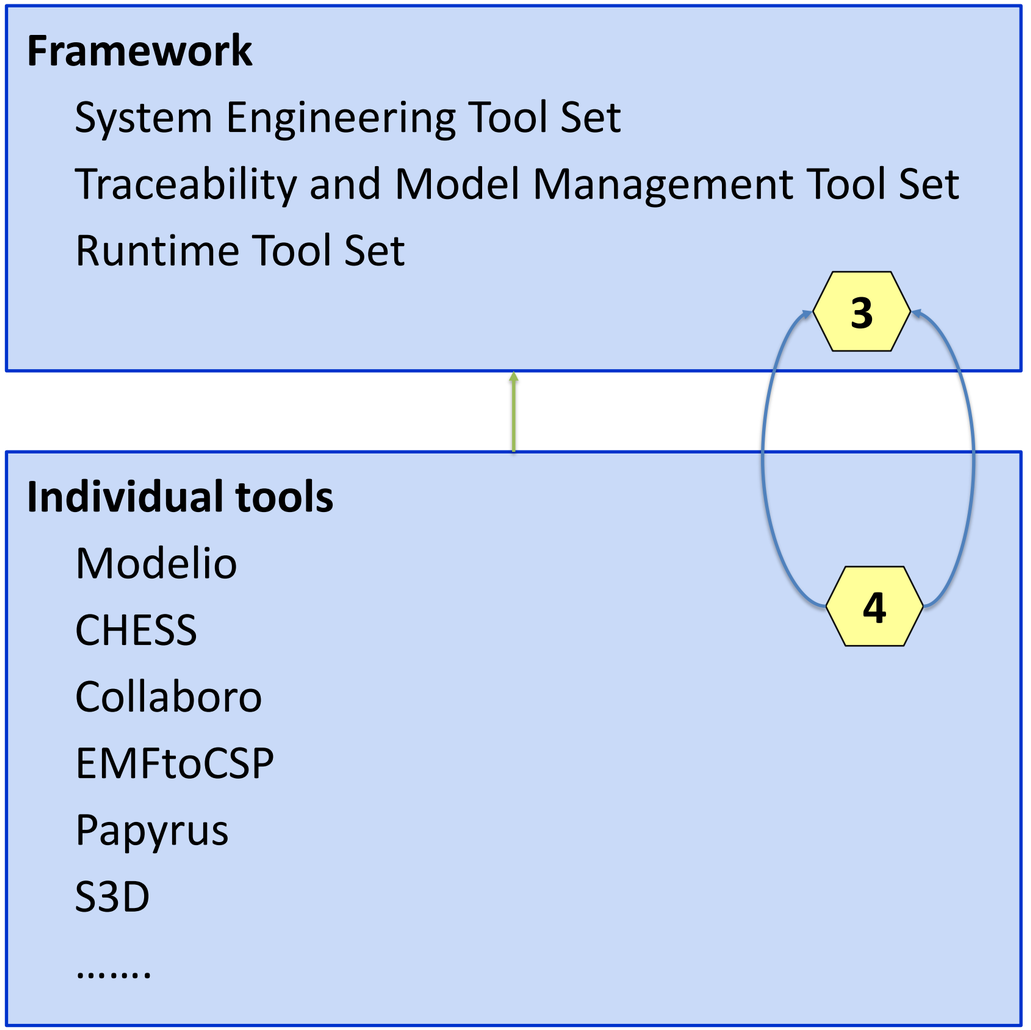
- Project management can have a global vision over the tool sets
- Tool providers can plan their developments in the project
- Case study providers can plan the evaluation of tools

ID	Baseline (M0)	Initial (M15)	Intermediate (M20)	Final (M32)
RTA-00001	MODELIO-150		PAPYRUS-170, MODELIO-130	PAU-020, PAPYRUS-180, MODELIO-140
RTA-00002	CERTIFYIT-070, CQDESIGN-020, CQDESIGN-110			MBEETLE-010, PAU-020
RTA-00003	CERTIFYIT-010, RCRS-010, RCRS-020, RCRS-030, RCRS-040	LIME-010, LIME-020	LIME-030, RCRS-050, RCRS-080	MBEETLE-010, MODELIO-100, LIME-040, RCRS-060, RCRS-070
…	…	…	…	…

Architecture Management Approach

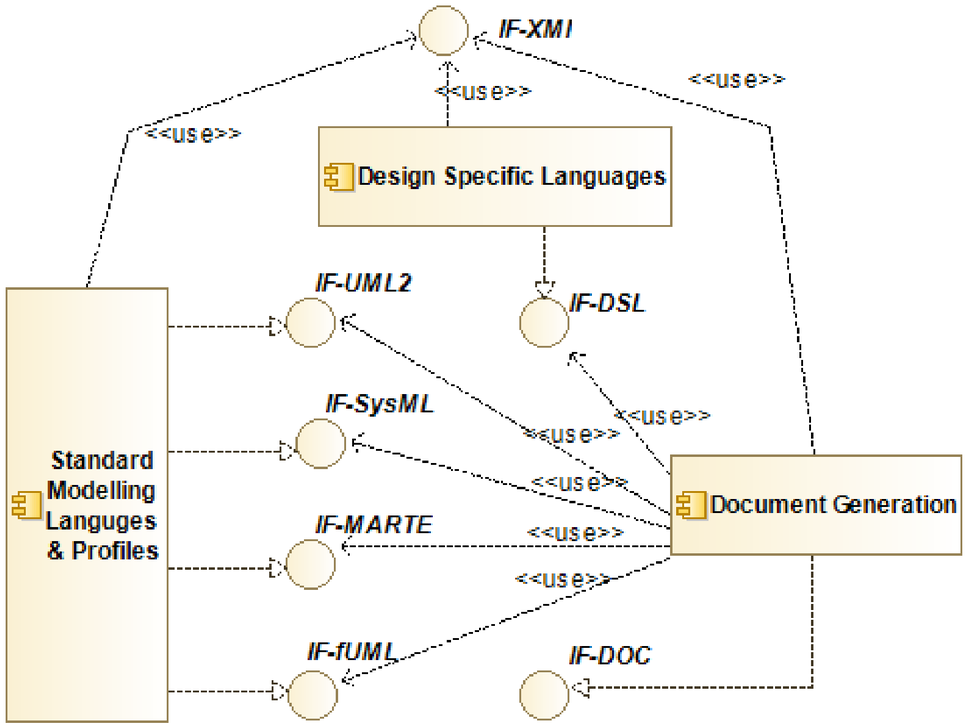
Approach for high-level architecture

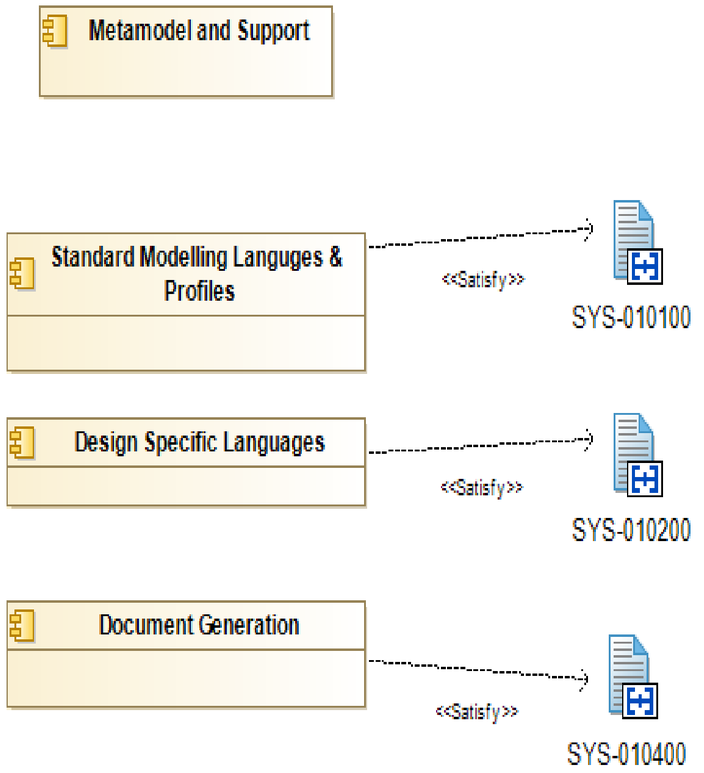
- Major element = Tool component
- Services
  - Purposes
  - Functional interfaces
  - Subordinate components
- Integration means and Deployment
  - Interfaces / data exchange
  - Deployment
- Relation to the Framework



Framework Modelling

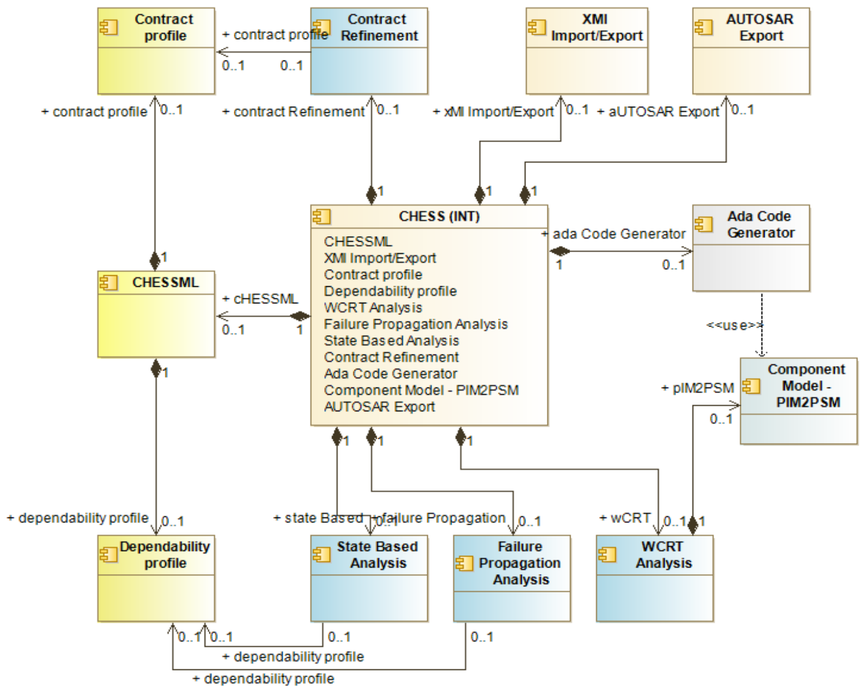
- MegaM@Rt Framework highlight interfaces to support tools integration and traceability to requirements to guarantee and allow checking model consistency

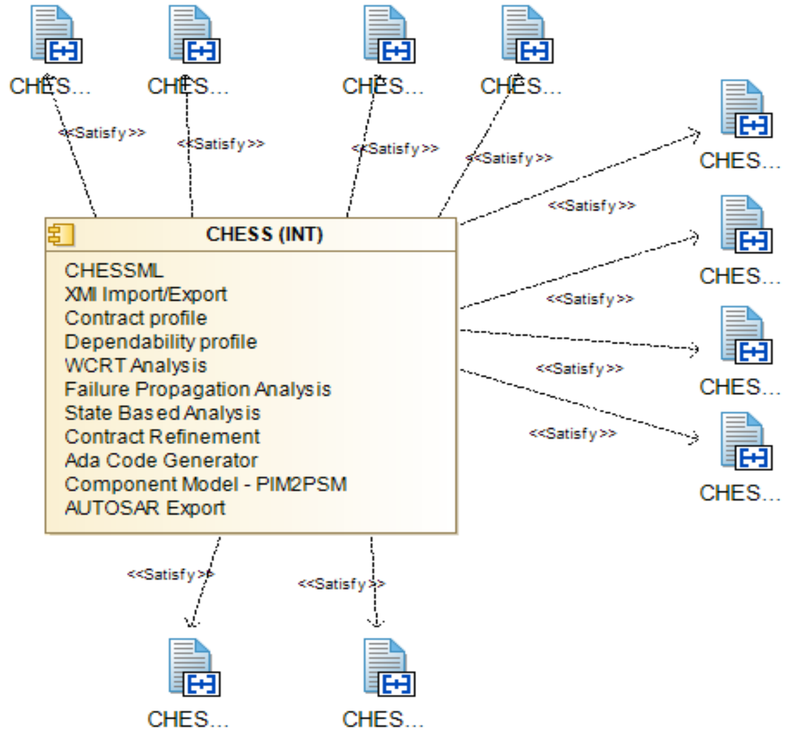


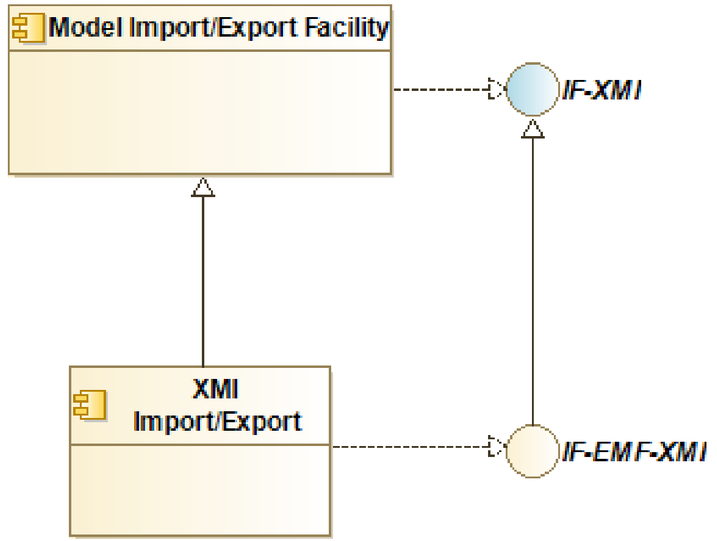


Individual tools modelling

- Each conceptual tool set sub-component and relevant interfaces have been refined to better satisfy the refined framework architecture and requirements



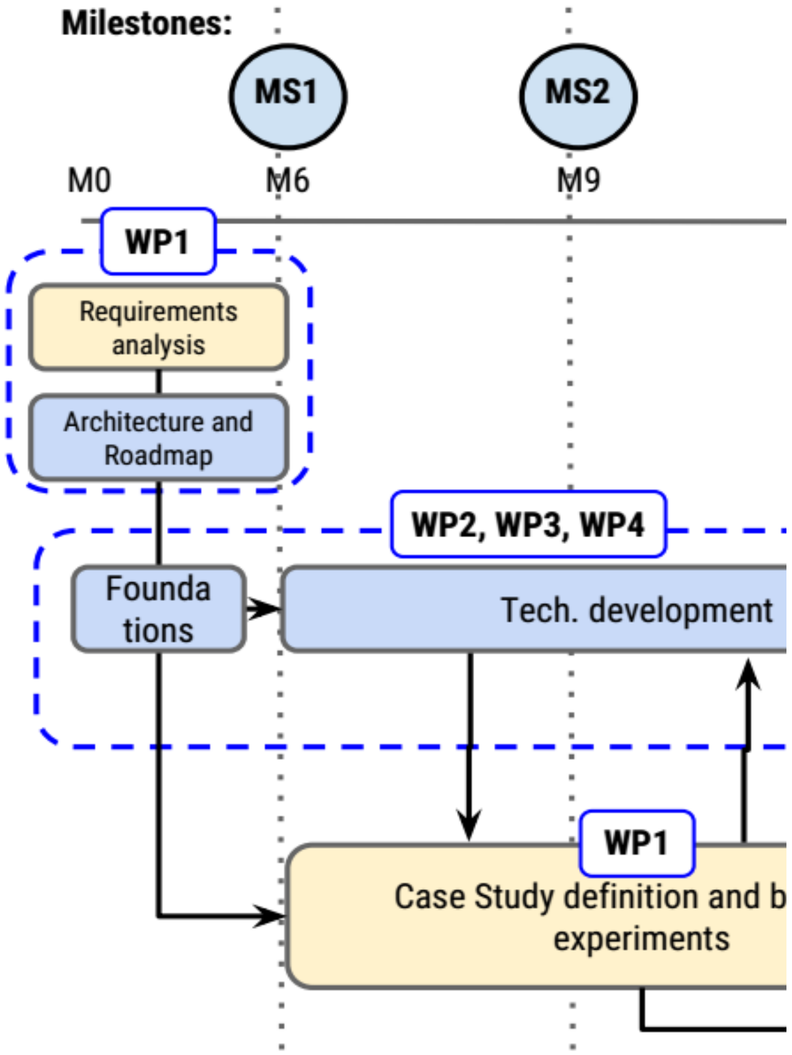




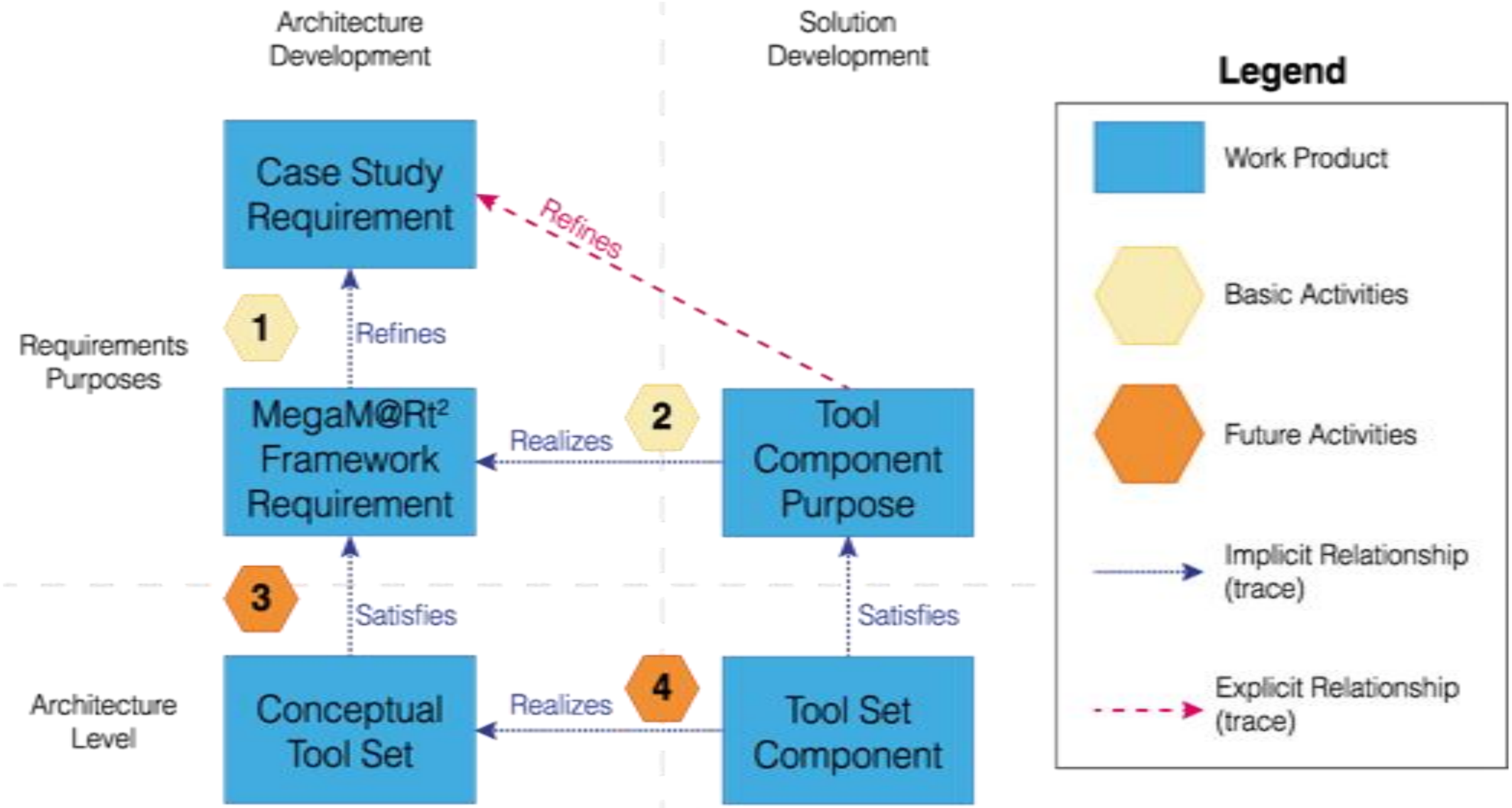
Questions?

D1.2 Architecture specification and roadmap - initial version

- Framework
  - Conceptual tools as described in the FPP
  - Individual tools by partners
- Properties
  - High-level requirements help to identify the features, goals and objectives
  - Functional interfaces and services
  - Subordinates
  - Deployment



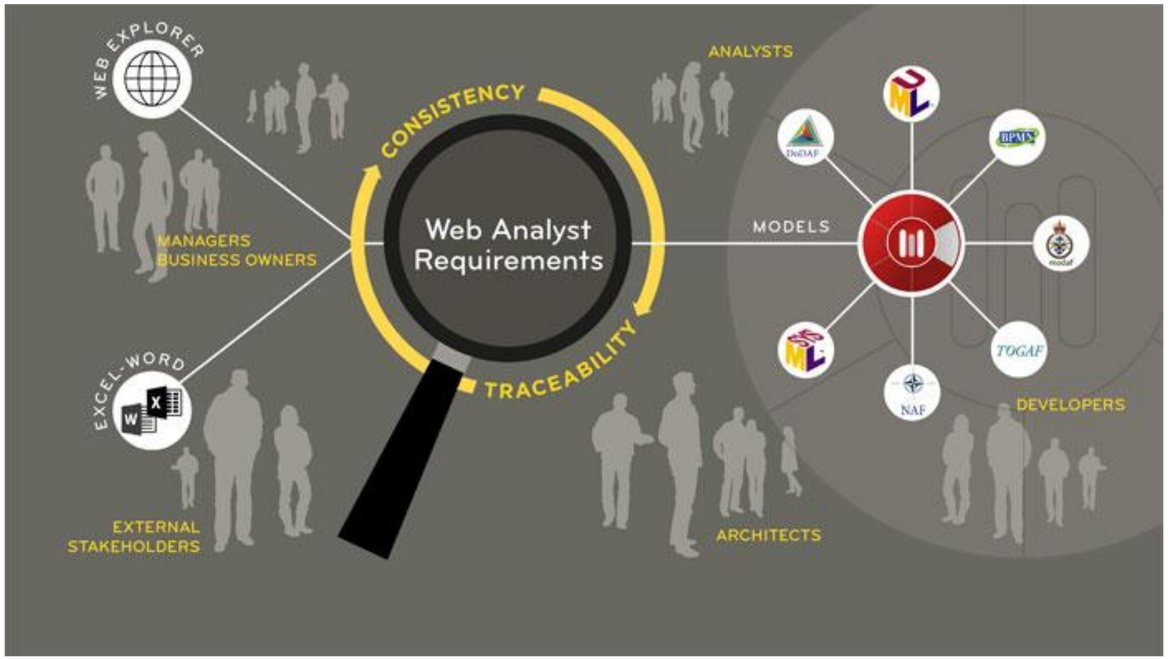
Specification process



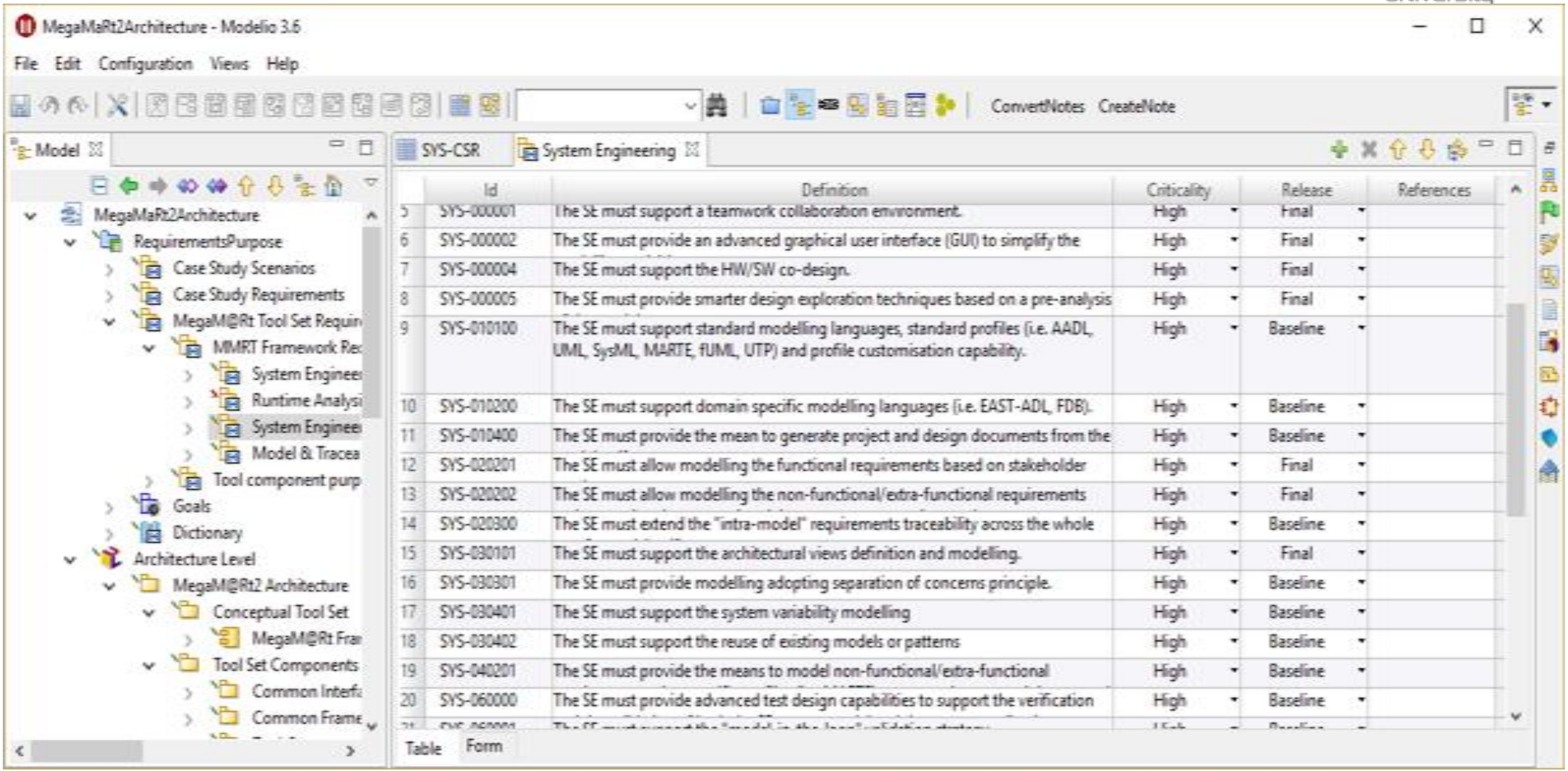
Tooling

- Modelio
- Analyst
- Document publisher

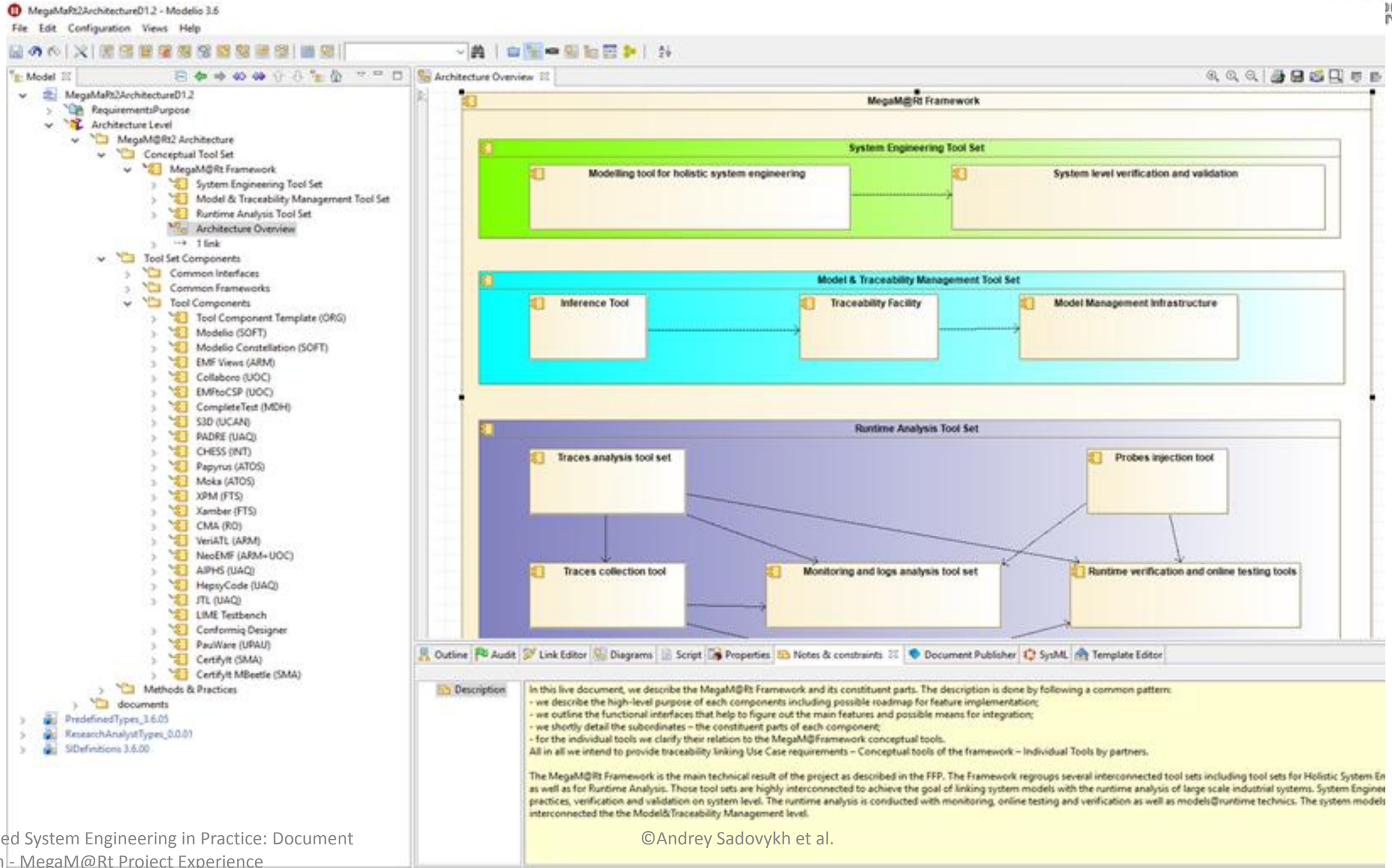
- Constellation
- Collaborative modelling
- Configuration management



Requirements editing



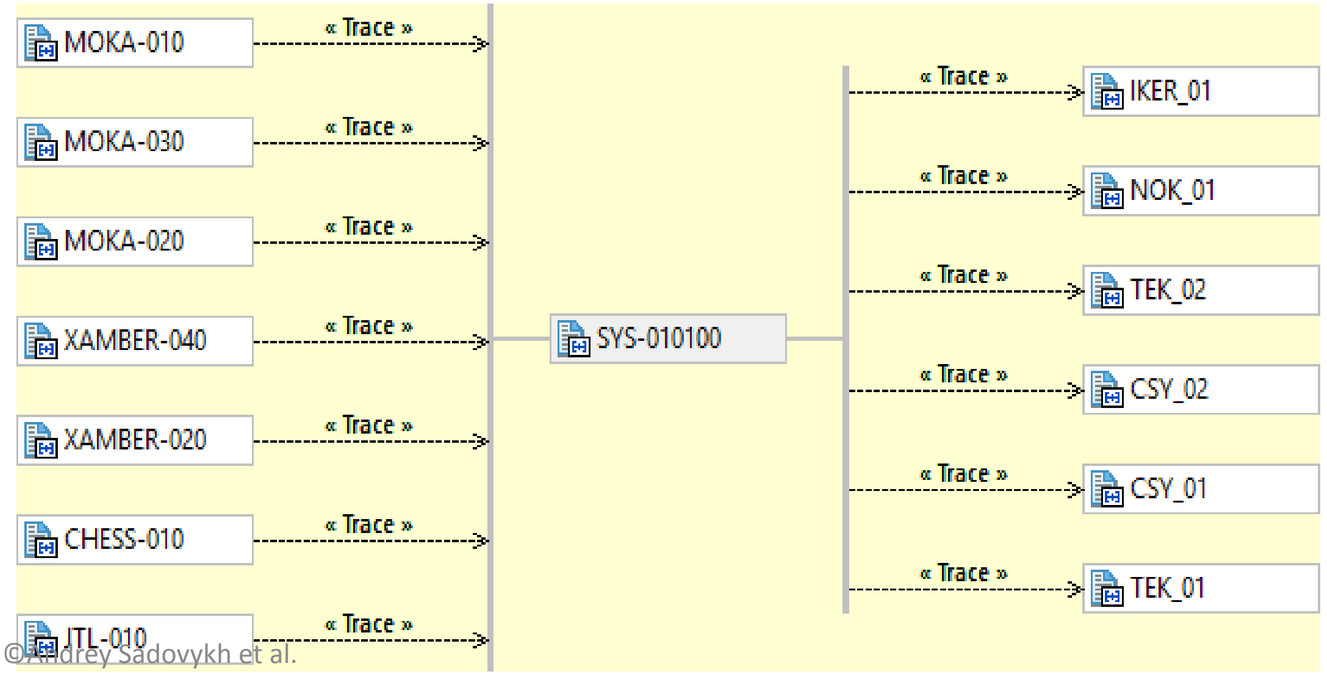
Architecture



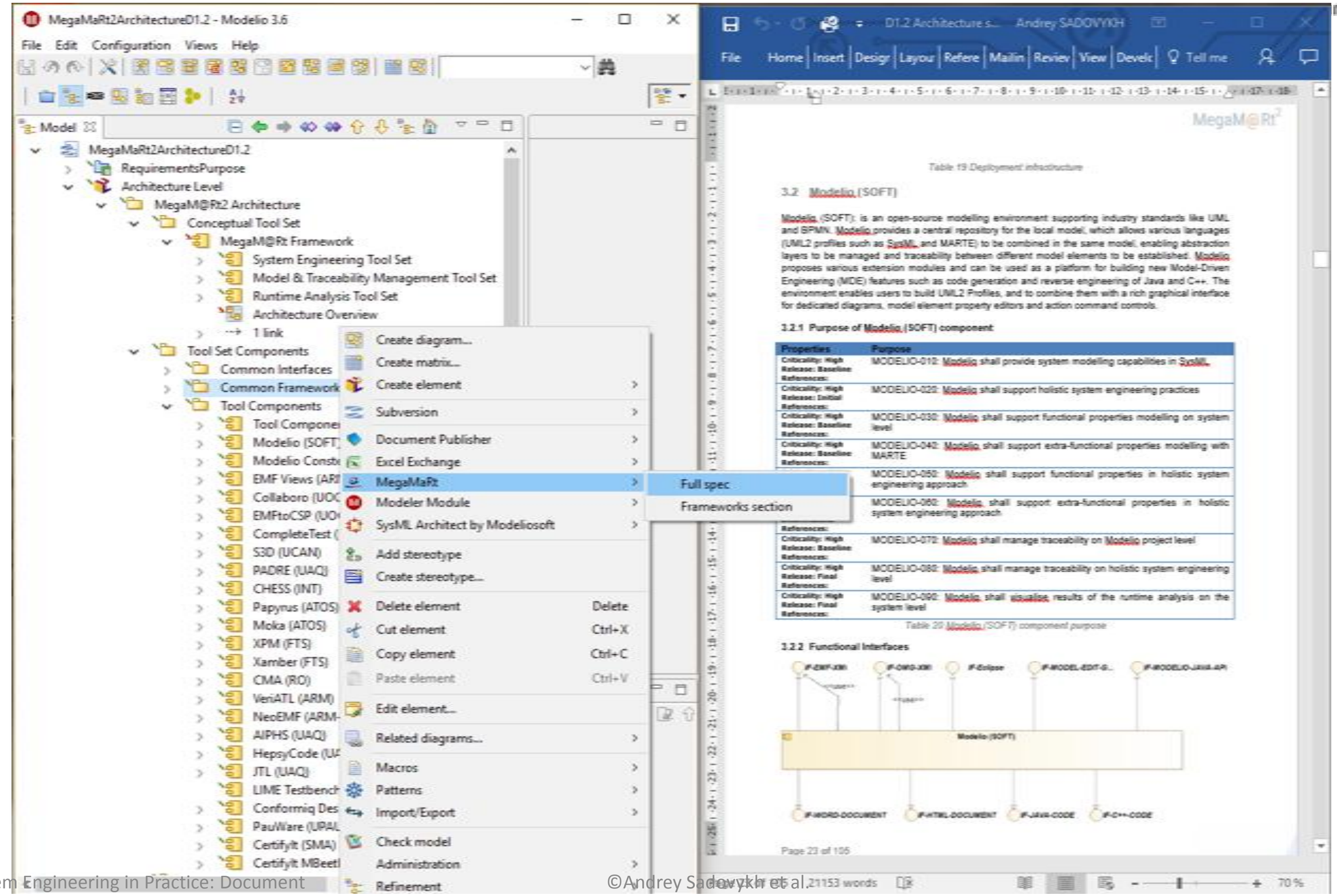
Traceability

SYS-CSR

	SYS-010100	SYS-010200	SYS-010400	SYS-020201
CSY_01	↙			
CSY_02	↙	↙		
CSY_03				
CSY_04				
CSY_05				
IKER_01	↙	↙		
IKER_04		↙		
IKER_16				
IKER_18				
NOK_01	↙	↙		
NOK_02				↙
NOK_03		↙		
NOK_04				



Document generation



Additional slides

Example: System Development Lifecycle

Analysis:

- Who are the stakeholders? What is their business? How new system can improve this business?
- What is their current system? What system do they need?
- Initial design and a prototype

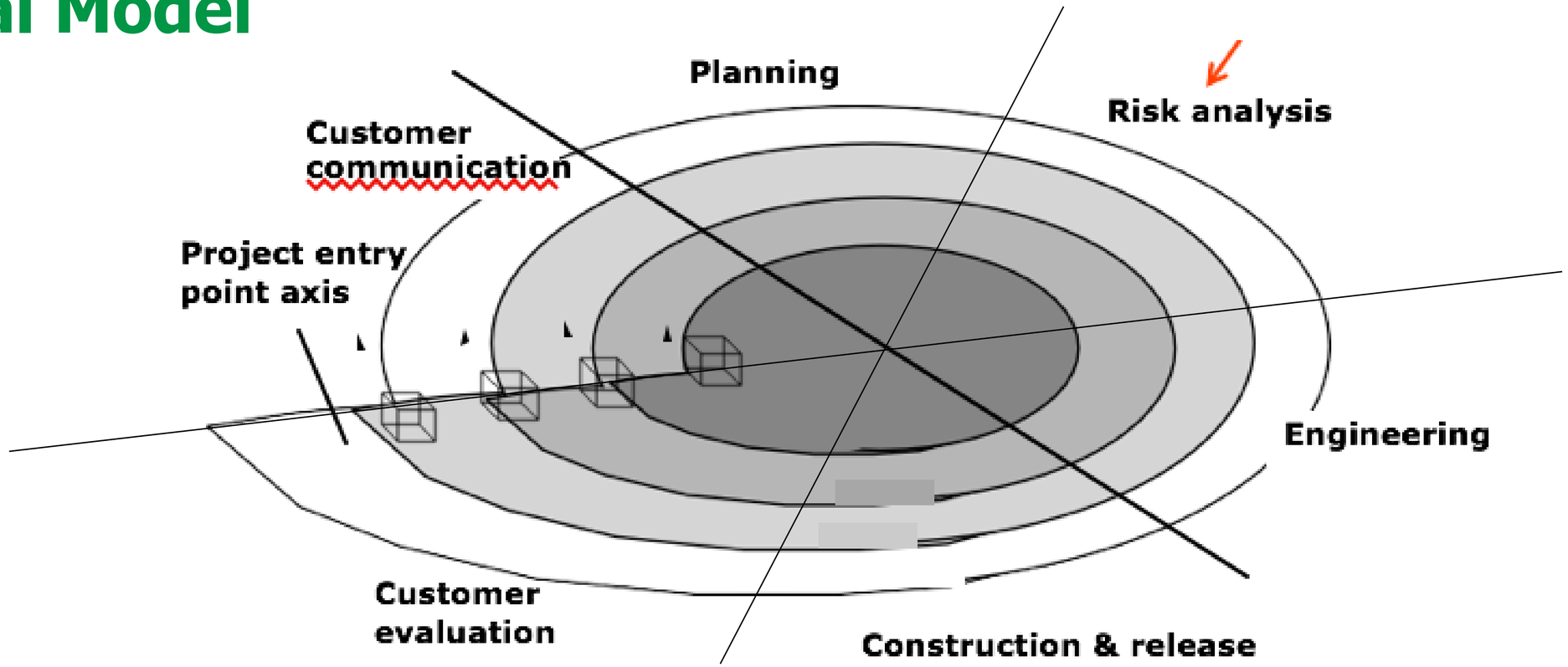
Design:

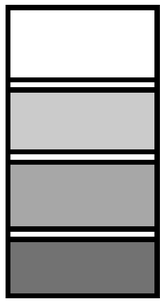
- How the system should operate?
- Programs? Hardware? Networking? Databases? User Interfaces?

Implementation:

- Development, Integration, Testing
- Deployment
- Support

Spiral Model





Product maintenance projects

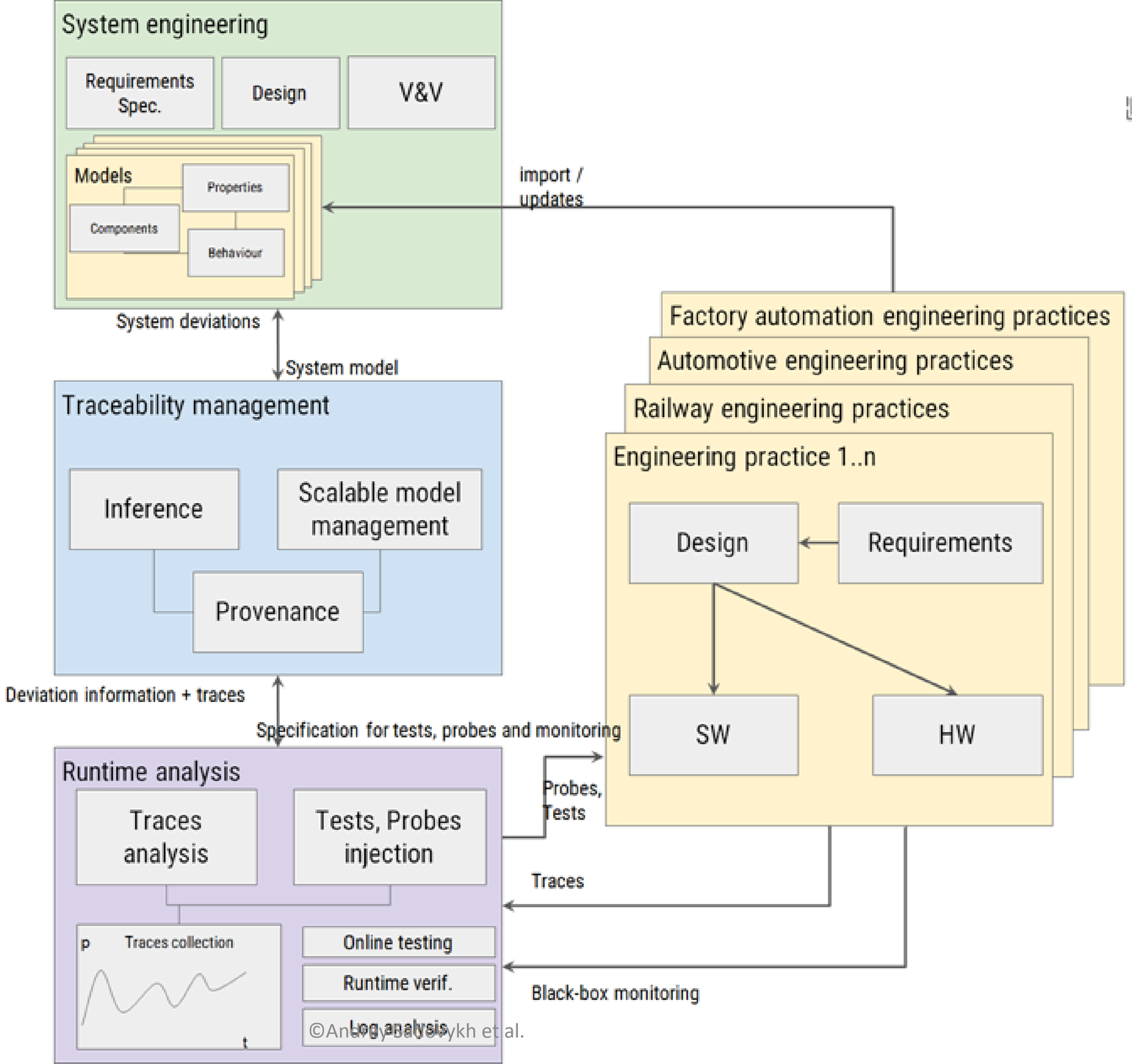
Product enhancement projects

New product development projects

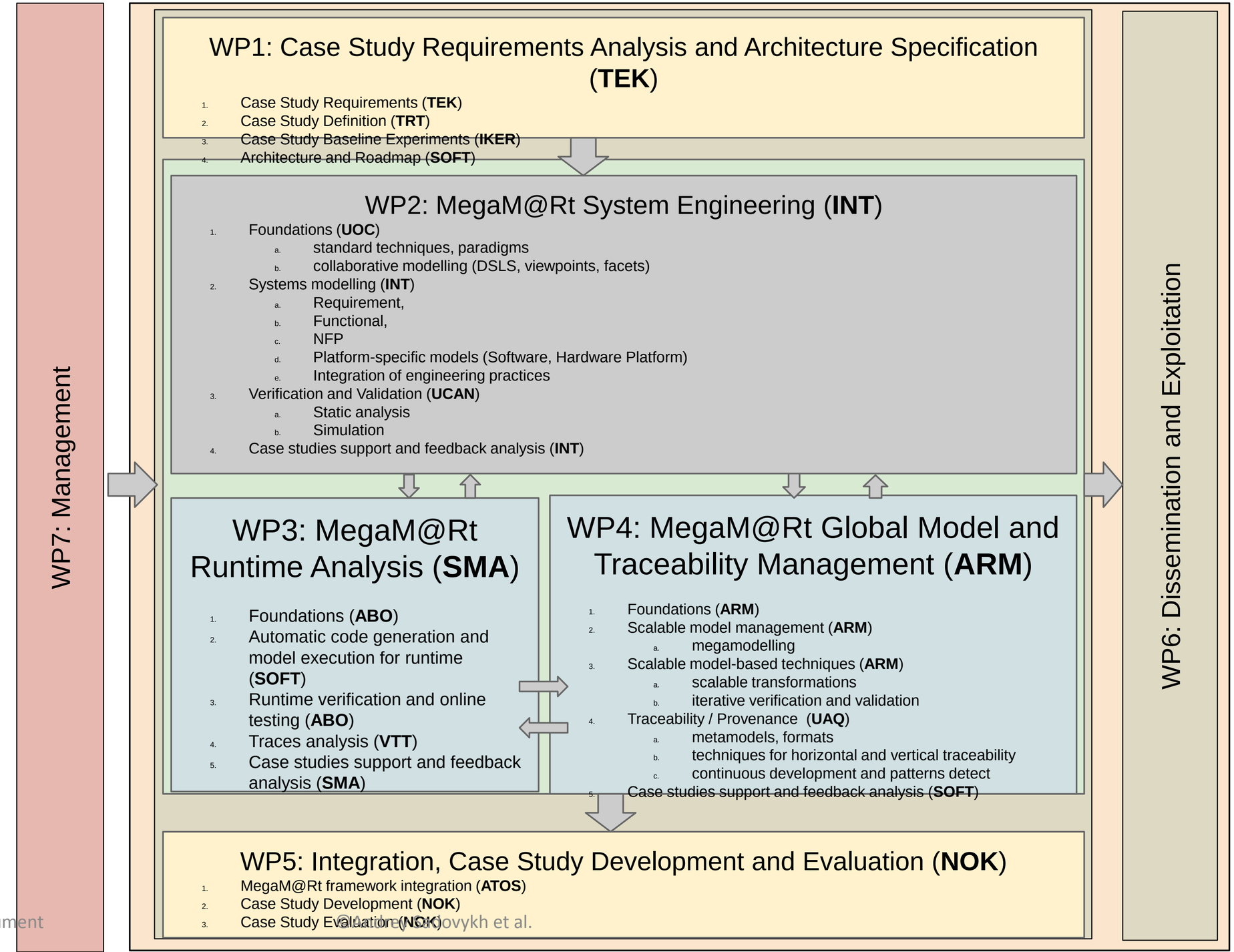
Concept development projects

Roger S. Pressman's "Software Engineering, a Practitioners Approach"

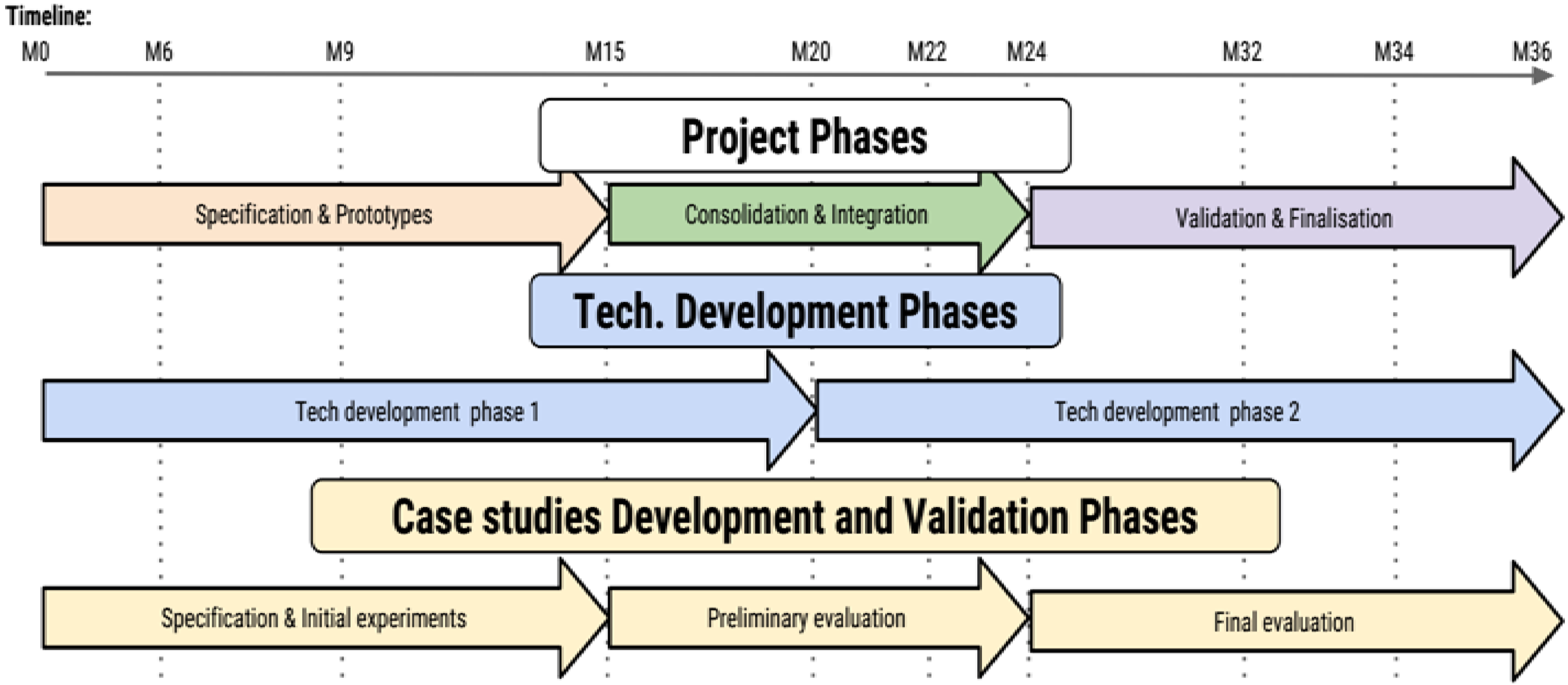
Overall approach



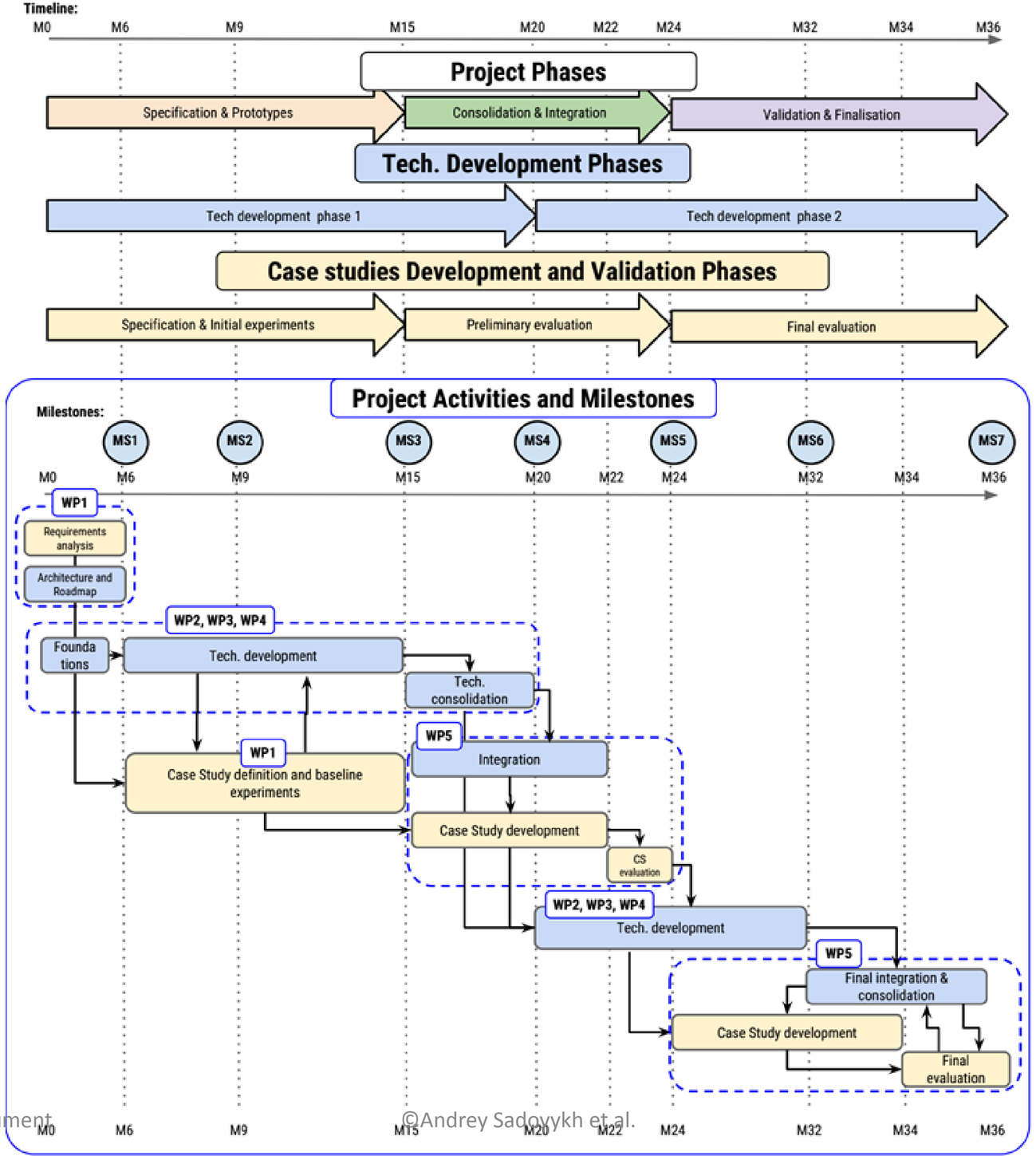
Work packages



Phases



Process



Next steps for MegaM@Rt modelling approach

- Matchmaking for Case Studies and Tools
- Baseline experiments and refinement of requirements, purposes, roadmap and architecture
- Tracing status on features delivery
- Planning integration
- Case study requirements coverage monitoring

Hackathon session

- Boost collaboration
- Speed-up baseline experiments and prototyping
- Base for validation scenarios activities
- Early evaluation and results
- Feedbacks to design