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SESA

An Investigation of Functionalities of Future Tool-chain for Aerospace Industry

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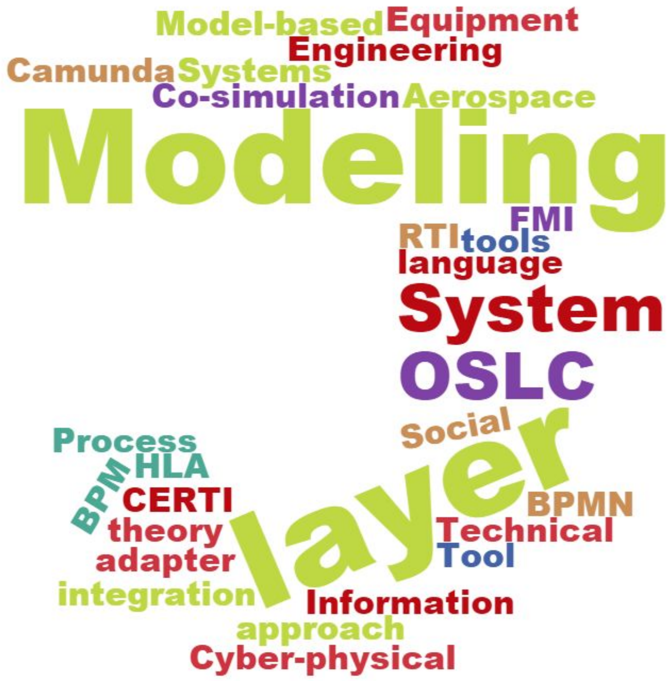
Challenges of CPS Design

CONTENTS



Model-based
Equipment
Engineering
Camunda
Systems
Co-simulation
Aerospace
Modeling
FMI
RTI
tools
language
System
OSLC
Social
Process
HLA
BPM
CERTI
BPMN
theory
layer
Technical
Tool
adapter
integration
Information
approach
Cyber-physical

WHY

Part 1

Including

Background

Challenges and motivations

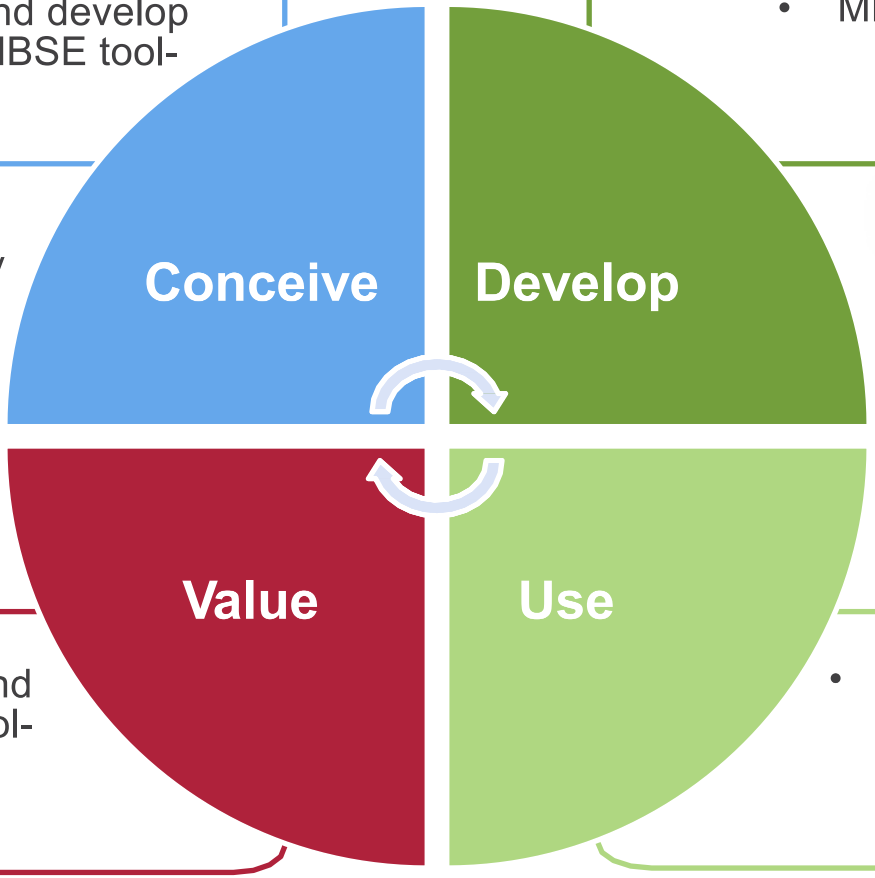
Background

- Investigation of MBSE and develop an open framework for MBSE tool-chains

KTH-Royal Institute of Technology

- MBSE too-chains development

Suzhou Tongyuan Software and Control Technology Company



- Aero-engine modeling and assessment of MBSE tool-chains

- Industrial practices by using MBSE tool-chains

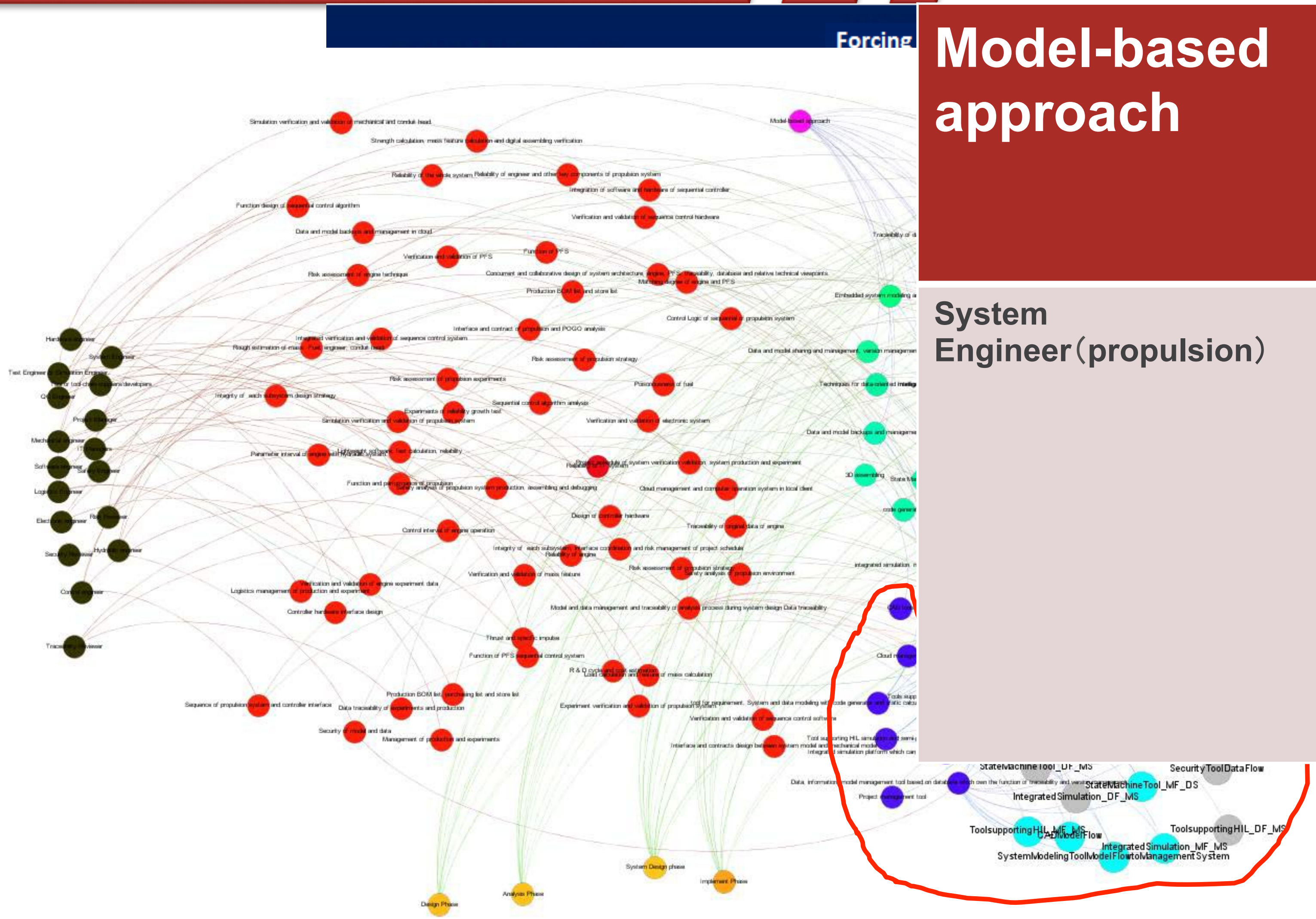
Nanjing University of Aeronautics and Astronautics

Shenyang Engine Design and Development Institute

Business model cited from Wade., Development of 3-Year Roadmap to Transform the Discipline of Systems engineerings

Challenges of Tool-chain Development

- Stakeholders
- Viewpoints
- Techniques
- Tool
- Model Flow
- Data Flow
- Model-based approach
- Process



Source:<<Introduction of Aerospace Technology>>, Yang Bingyuan, Jia Yaoxing, 2009. Page:77

Examples of tool-chains

Model-based approach	Requirements Definition and Analysis Process
System Engineer(propulsion)	Thrust and specific impulse. Techniques: static modelling and calculation, requirement modelling.

Contributions

Support MBSE tool-chains development

First, the purpose of framework addresses the functionalities from a systems engineering perspective before developing a MBSE tool-chains.

Promote the performance of MBSE tool-chains

Secondly, the extended version of framework support to develop MBSE tool-chain promising to support CPS modeling and simulation with better interoperability and integrated capability, - a capability to integrate existing engineering tools and system development platform.

WHAT

Part 2

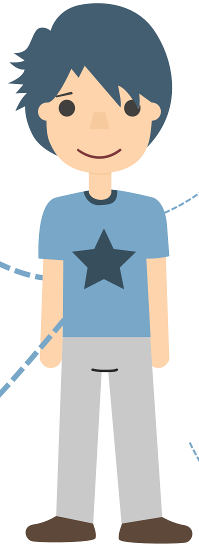
Including

Research Method

Literature reviews

Questionnaire

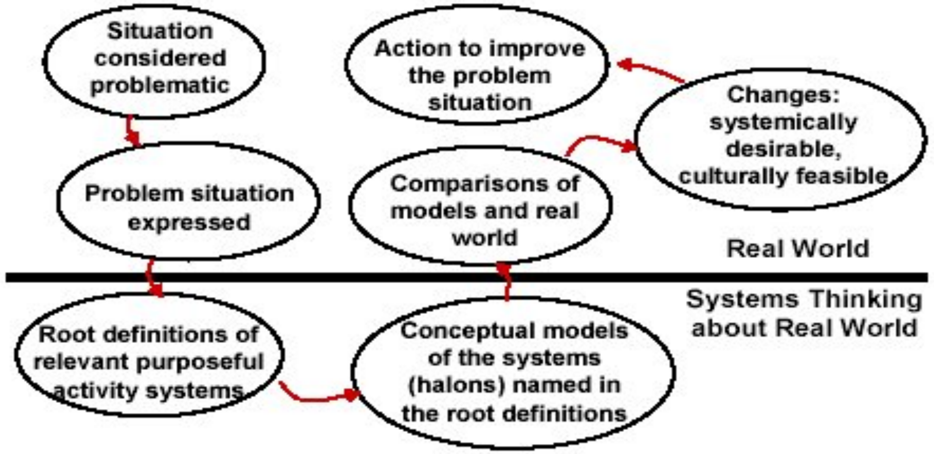
Research Method



Literature Review

Questionnaires

Soft Systems Methodology (SSM)



https://oladoyinbello.wordpress.com/2014/07/05/soft-systems-methodologythe-key-to-structured-systems-analysis-today/

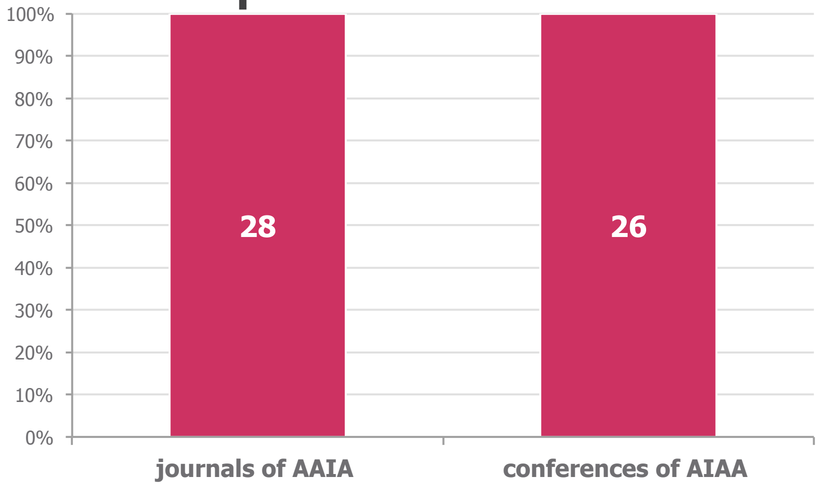
Case study and Problem Solving Methodology

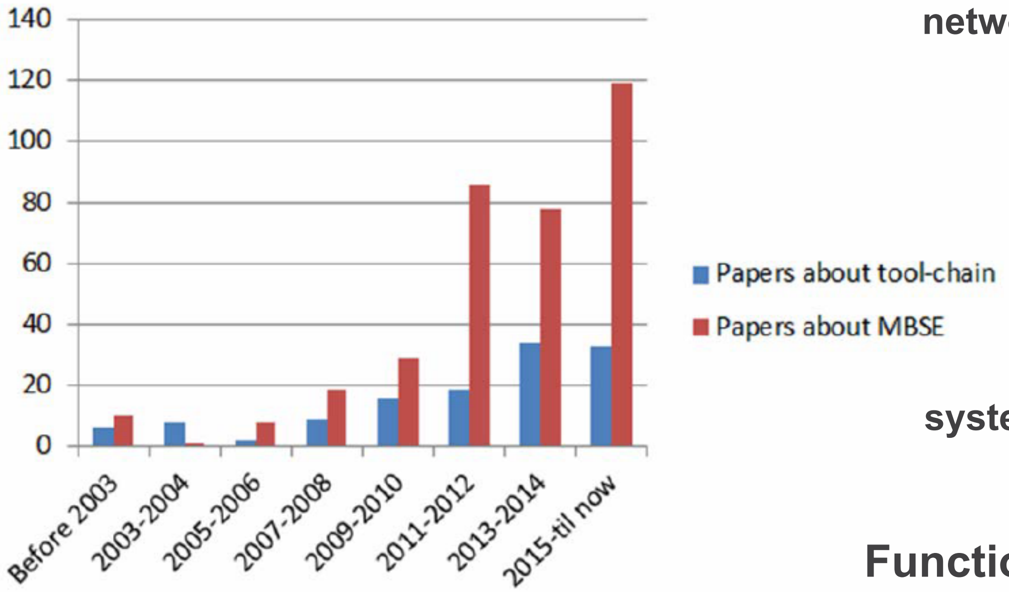
http://rcswww.urz.tu-dresden.de/~kersten/BIT/presentation%20case%20study%20and%20problem%20solving.pdf

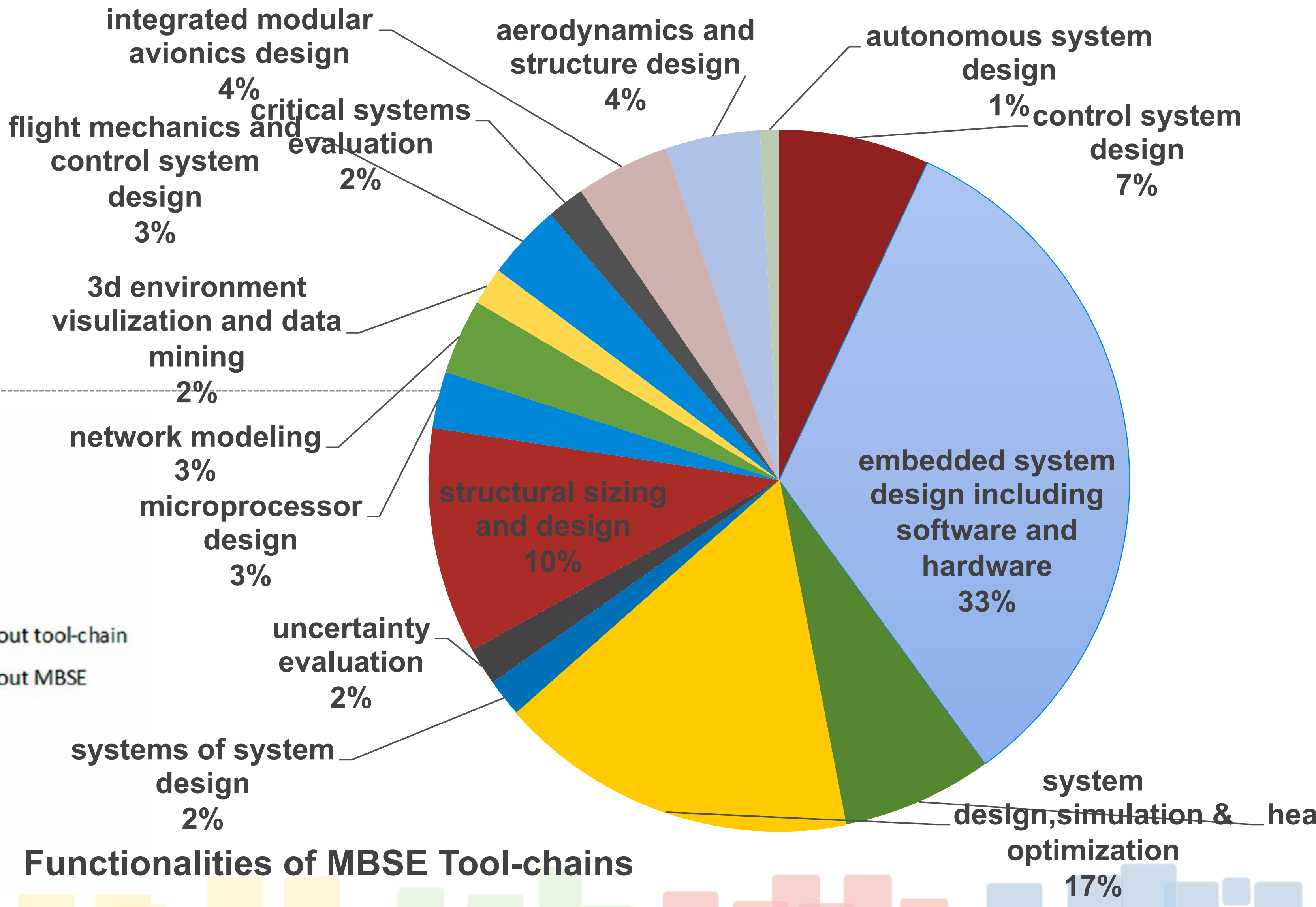
Literature Review

PS: AAIA: The American Institute of Aeronautics and Astronautics

Scope



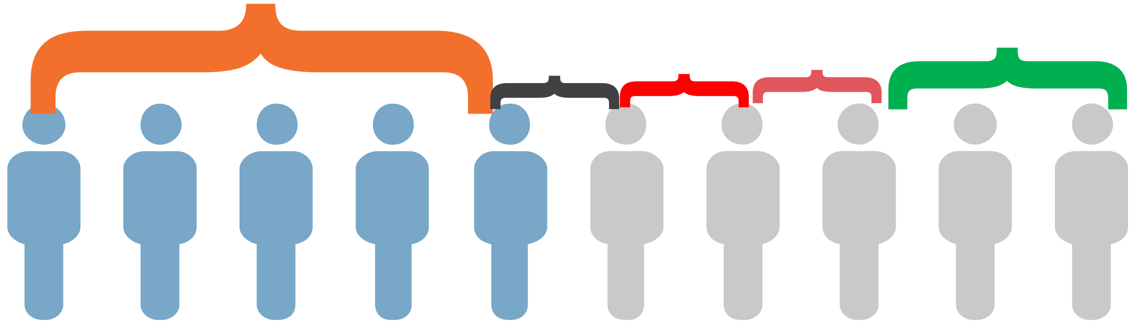




Functionalities of MBSE Tool-chains

Questionnaire Survey

54.55%



Of 44 Responders use MBSE.

43% Aerospace

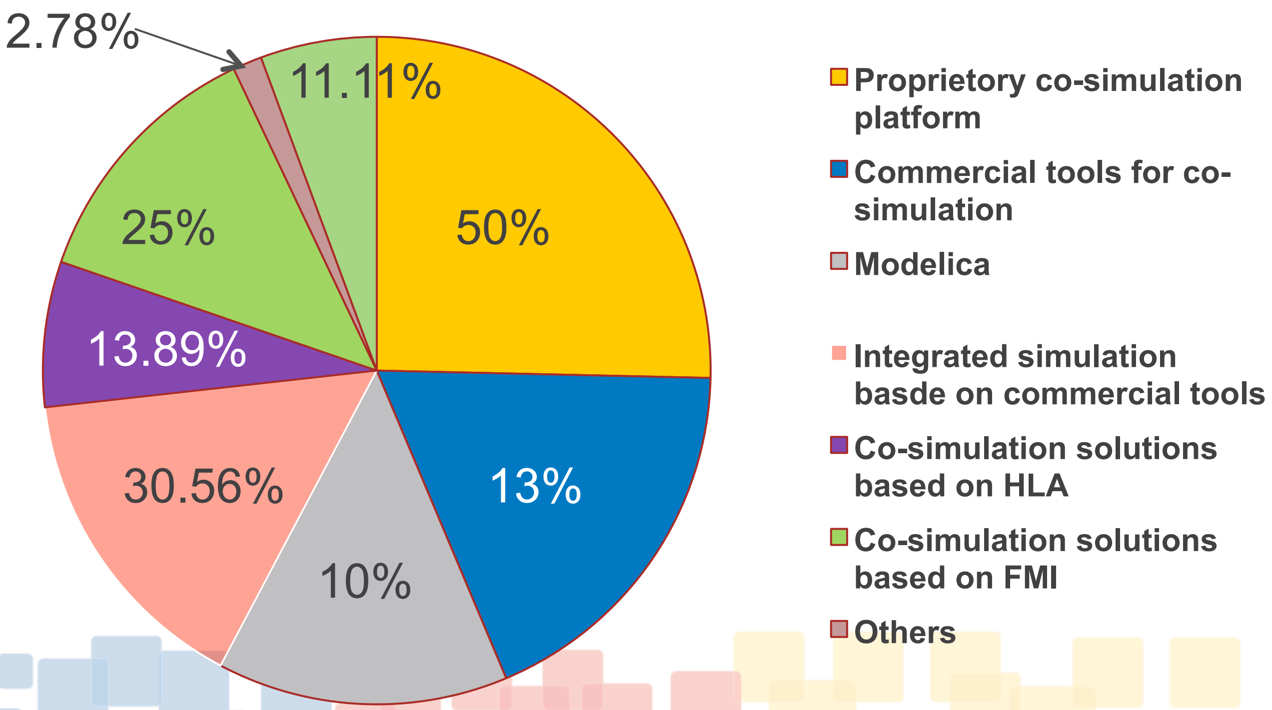
26% Others

11% Automotive

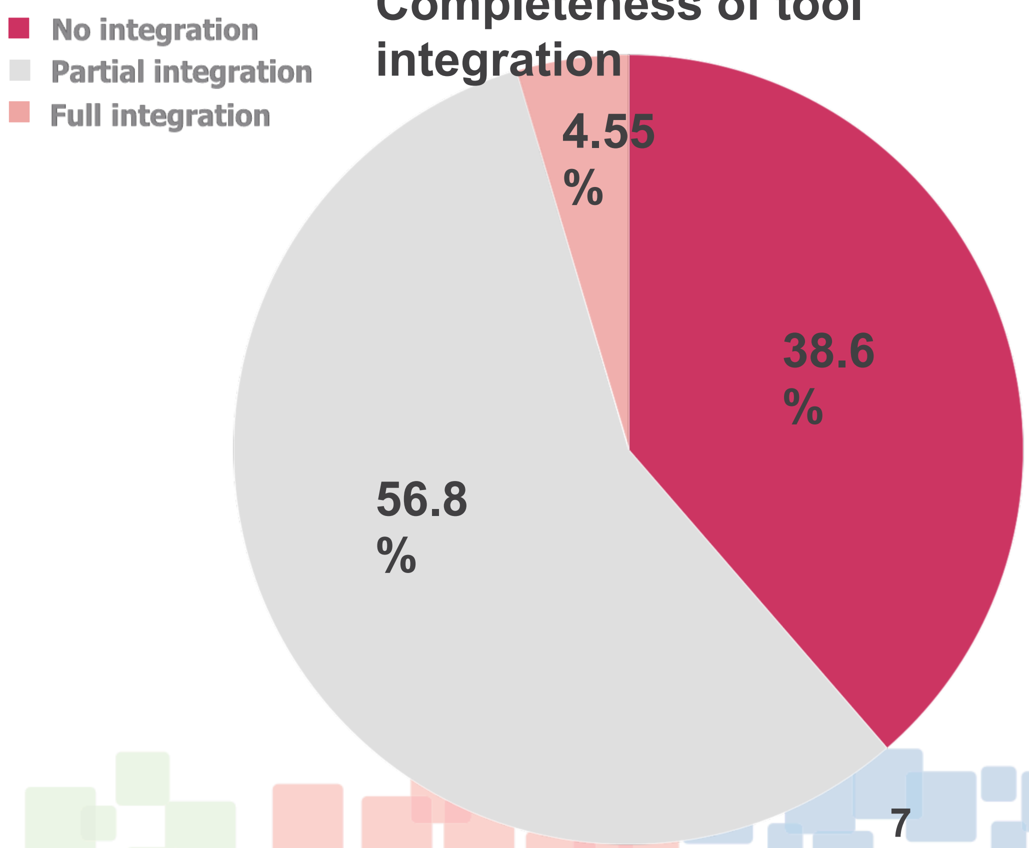
11% DoD

9% Tool supplie

Solutions for integrated simulation platform(Multi)



Completeness of tool integration



MBSE tool-chains V0.1

MBSE tool-chain: more than one modeling tool that, when combined, can support and construct a system engineering workflow, which has the following features:

- The workflow can support system requirements, design, analysis, verification and validation activities through the whole life cycle of product development.
- The workflow supports the stakeholders' view of system functionalities and other extra-functional aspects, like project management, dependability, model management and so on.
- The workflow includes data, knowledge, and information exchange and model transformation.
- The ontology of this workflow can support system engineering.
- The workflow could integrate existing engineering tools and system development platform.
- The workflow could support heterogeneous model integration.

HOW

Part 3

Including

SPIT Framework

Case study

SE approaches

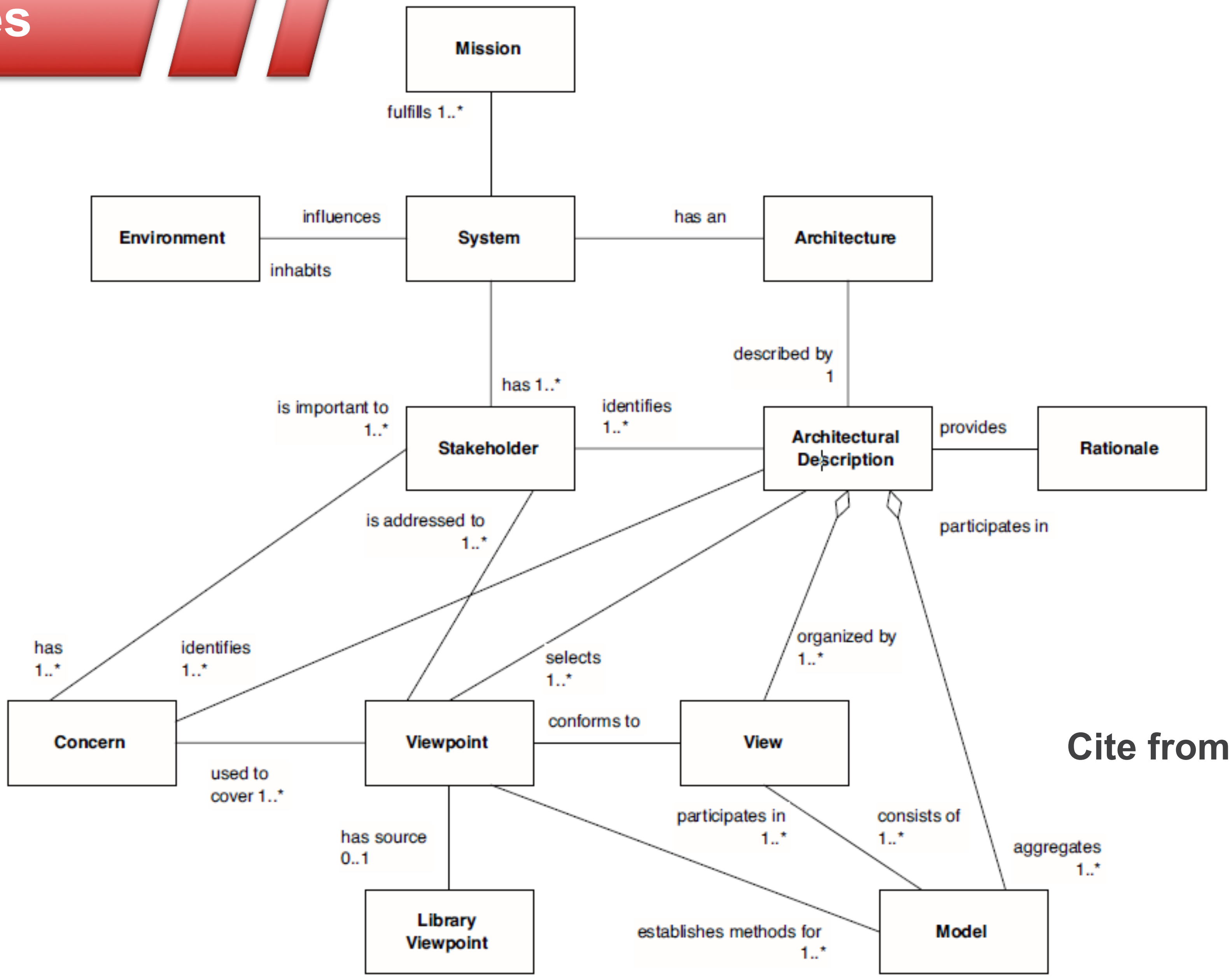
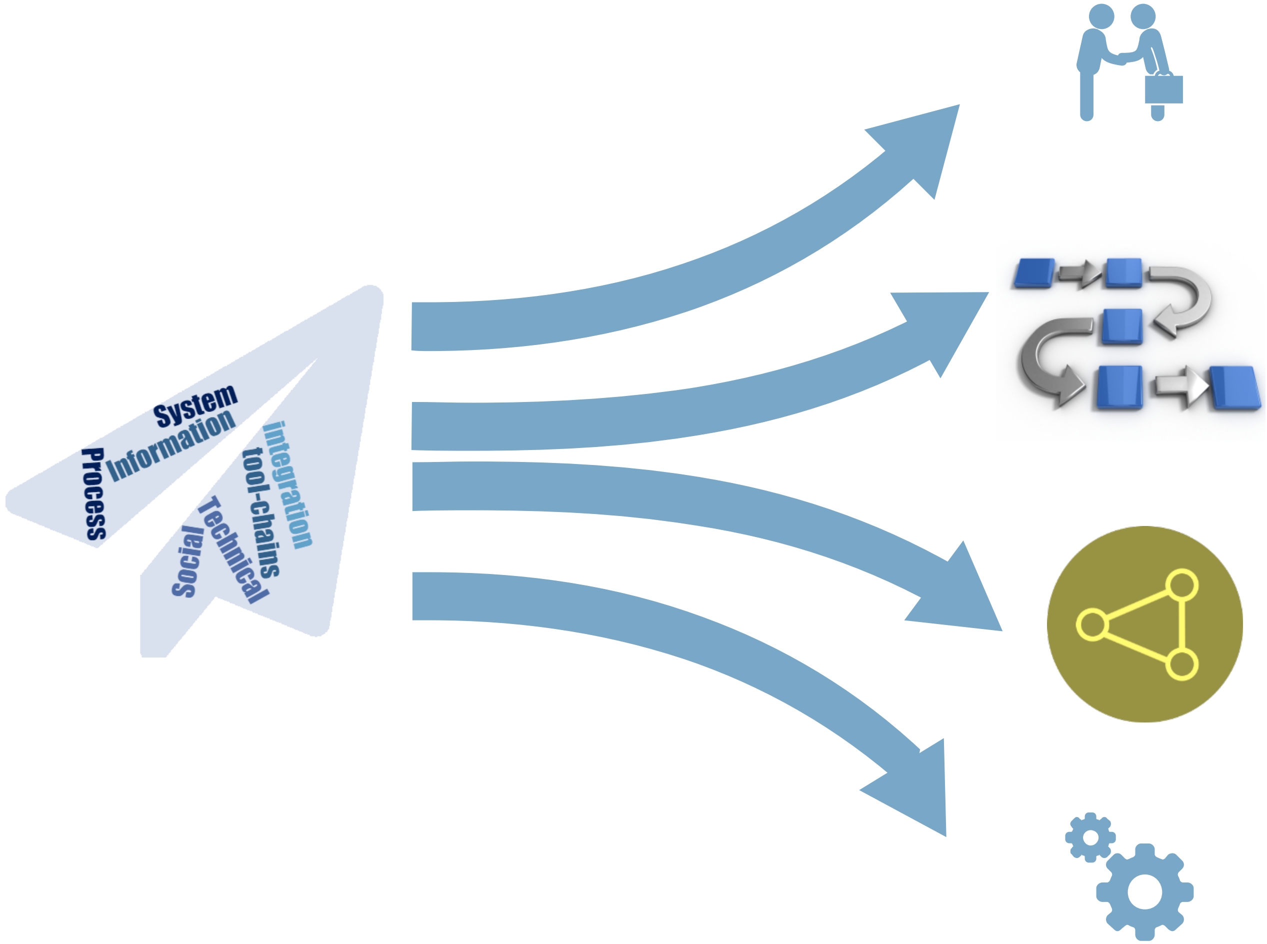


Figure 1—Conceptual model of architectural description

Cite from IEEE 1471

SPIT Framework

SPIT Framework Supporting MBSE Tool-chain Development



In social layer, it concentrates on social factors about MBSE tool-chain's human machine interface and the network of its users: Policies, Standards& Specification, Culture, human machine interface…

In process layer, it concentrates on target product development process: Design Process Management and Control…

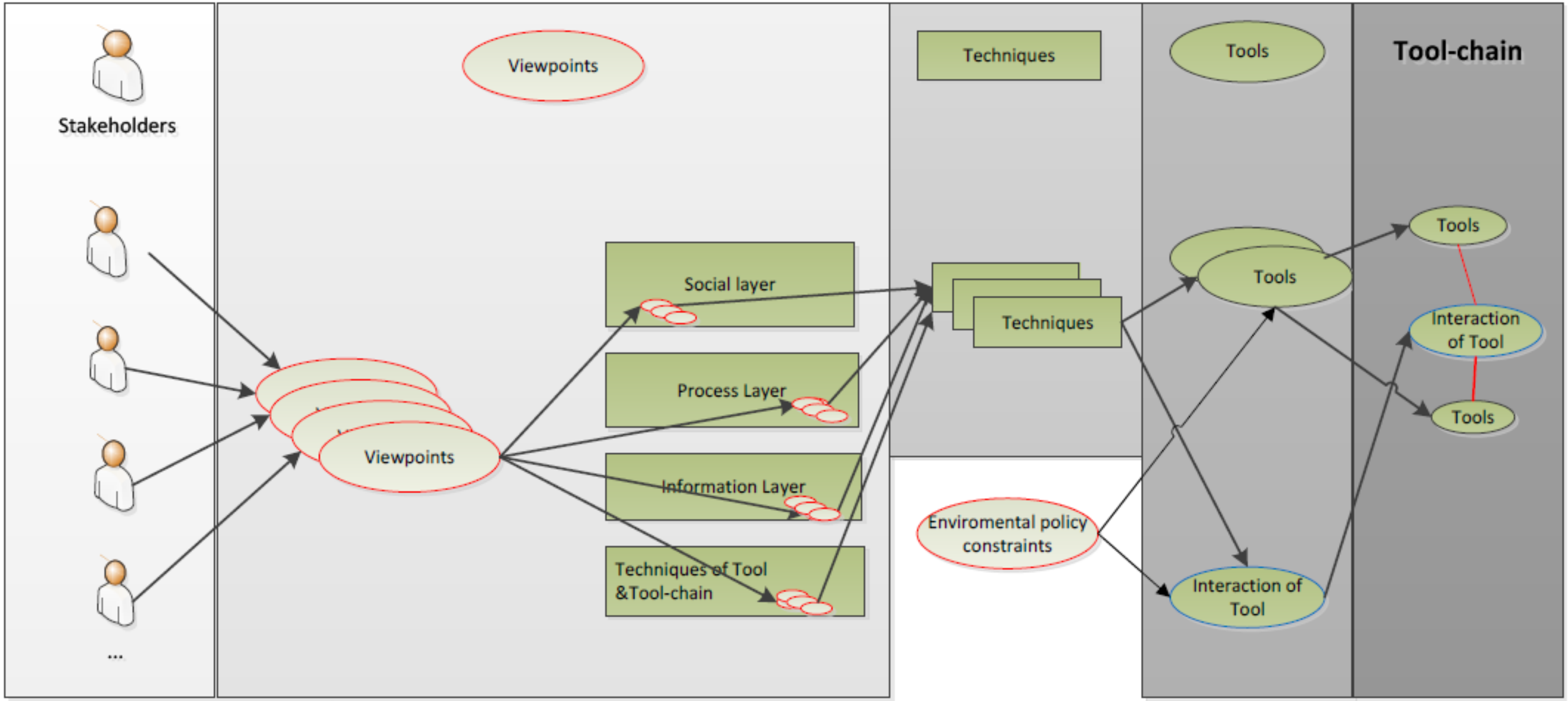
In information layer, it concentrates on functionality about target product systems and information integration from IT aspects:

- Requirement, architecture, verification and validation…
- Tool integration, data flow, service representation, service orchestration…

Technical layer, it concentrates on functionality about technical resources in MBSE tool-chains: model, data, tool, configuration …

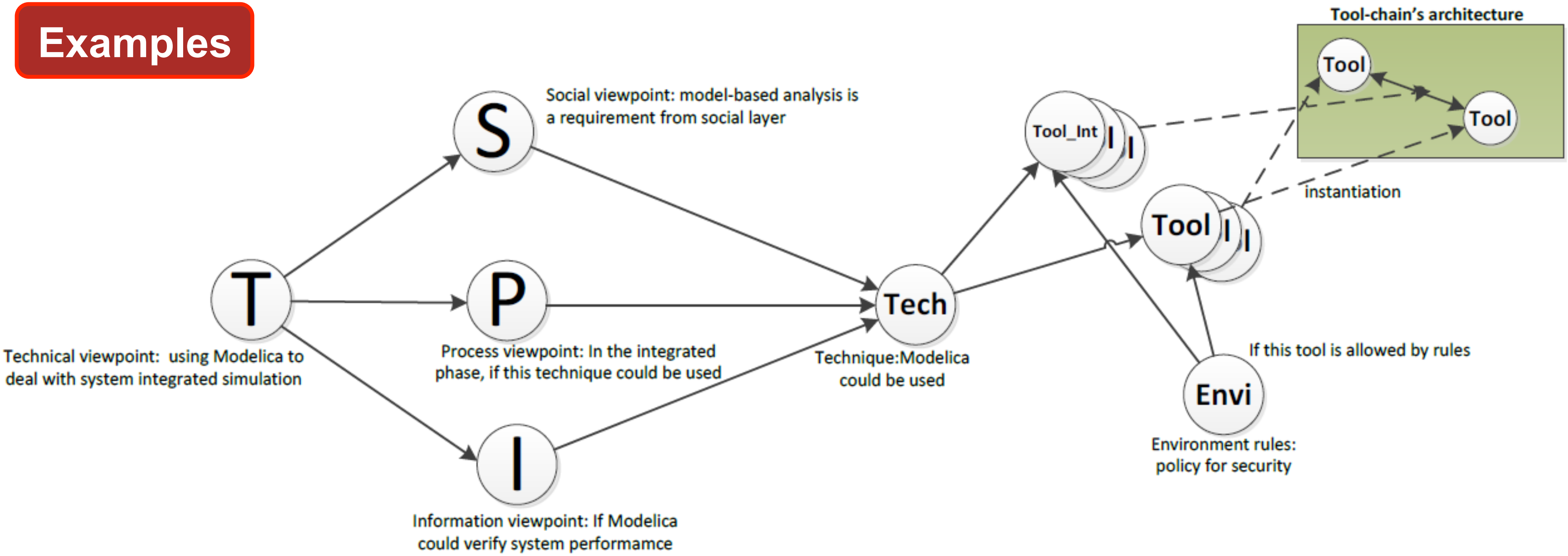
SPIT Framework

A System Engineering Approach Supporting MBSE Tool-chain Development

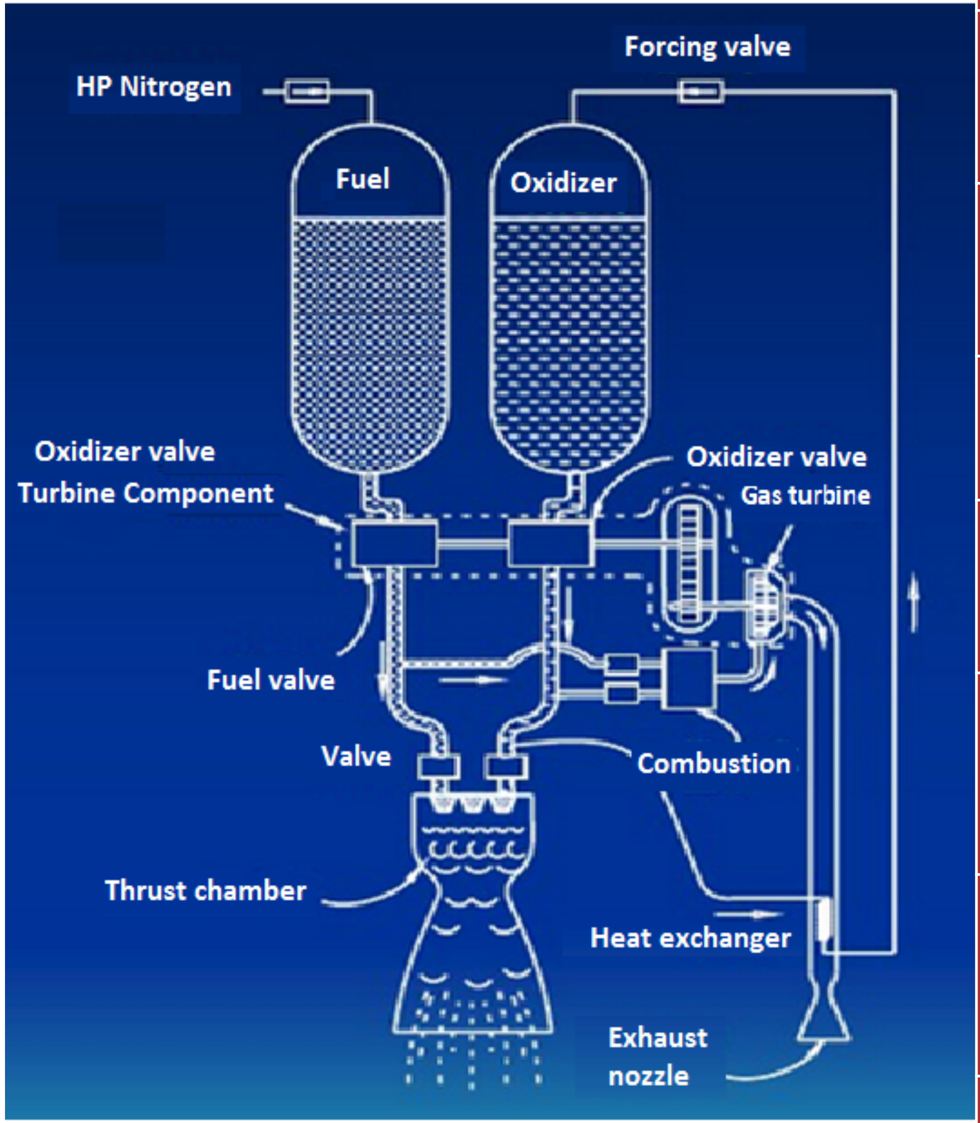


A System Engineering Approach Supporting MBSE Tool-chain Development

Examples



Demos

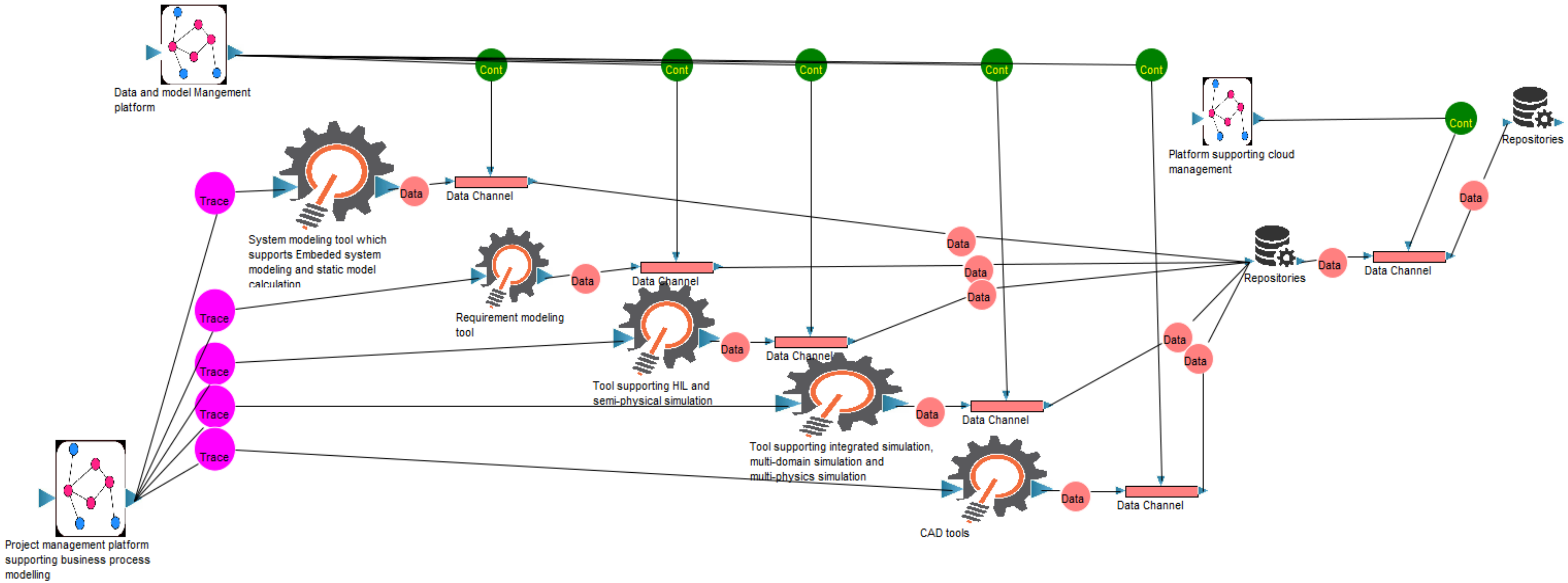


Source:<<Introduction of Aerospace Technology>>, Yang Bingyuan, Jia Yaoxing, 2009. Page:77

Social factor: Model-based approach	Viewpoint example in each phase			
Process / Stakeholders	Requirements Definition and Analysis Process	Architectural Design	Implementation Process and Integration Process	Integration and Verification Process
Tool or toolchain developers	Lightweight software, fast calculation, reliability. Techniques: Readiness level for software.			
	Concurrent and collaborative design of system architecture, engine, PFS, traceability, database and relative technical viewpoints. Techniques: Data and model sharing and management, version management, traceability management, integrated simulation, multi-domain and multi physics simulation.			
	Interface and contracts design between system model and mechanical model. Techniques: General Interface standards, like FMI.			
System Engineer（propulsion）	Thrust and specific impulse. Techniques: static modelling and calculation, requirement modelling.	Interface and contract of propulsion and POGO analysis. Techniques: static modelling and calculation, system modelling, and multi physics simulation.	Function and performance of propulsion. Techniques: static modelling and calculation, system modelling, multi-domain simulation.	Matching degree of engine and PFS. Techniques: Integrated simulation, system modelling.
Software engineer	Not exist.	Sequential control algorithm analysis. Techniques: Embedded system modeling and analysis.	Function design of sequential control algorithm. Techniques: State Machine modeling and code generation.	Verification and validation of sequence control software. Techniques: HIL simulation.
Hardware engineer	Not exist.	Controller hardware interface design. Techniques: Embedded system modeling and analysis.	Design of controller hardware. Techniques: Embedded system modelling and analysis and static modelling and calculation.	Verification and validation of sequence control hardware. Techniques: HIL simulation.
Control engineer	Control interval of engine operation. Techniques: Requirement modelling.	Sequence of propulsion system and controller interface. Techniques: State Machine modelling and system modelling for control system.	Integration of software and hardware of sequential controller. Techniques: State Machine modelling and system modelling for control system and code generation.	Integrated verification and validation of sequence control system. Techniques: HIL simulation.
Mechanical engineer	Rough estimation of mass（Fuel, engineer, conduit head）. Techniques: static modeling and calculation and Requirement modelling.	Load calculation and feature of mass calculation. Techniques: static modeling and calculation.	Strength calculation, mass feature calculation and digital assembling verification. Techniques: static modeling and calculation and 3D assembling.	Verification and validation of mass feature. Techniques: Requirement modeling, system modeling and static modeling and calculation.
Hydraulic engineer	No exist. Techniques: Requirement modelling.	Parameter interval of engine with hydraulic system. Techniques: multi-domain modeling	Function of PFS. Techniques: multi-domain modeling	Verification and validation of PFS. Techniques: system modeling and multi-domain modelling.
Project manager	R & D cycle and cost estimation. Techniques:	Integrity of each subsystem design strategy. Techniques:	Integrity of each subsystem, interface coordination and	Project schedule of system verification validation,

Demos

Domain specific model representing Tool-chains' structure



HOW WELL

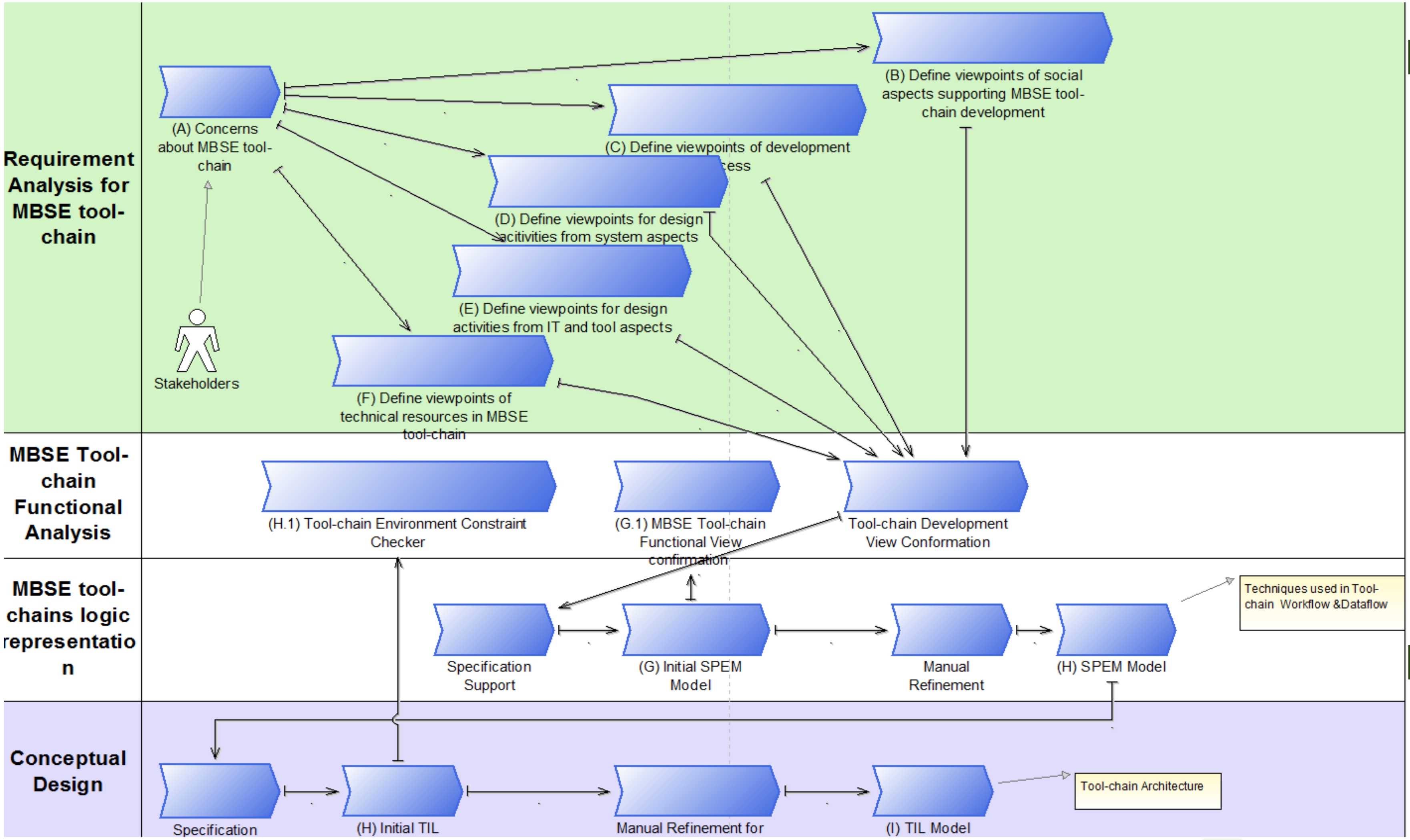
Part 4

Including

Future work

Future work

1. Extend DSL Supporting MBSE Tool-chain Development

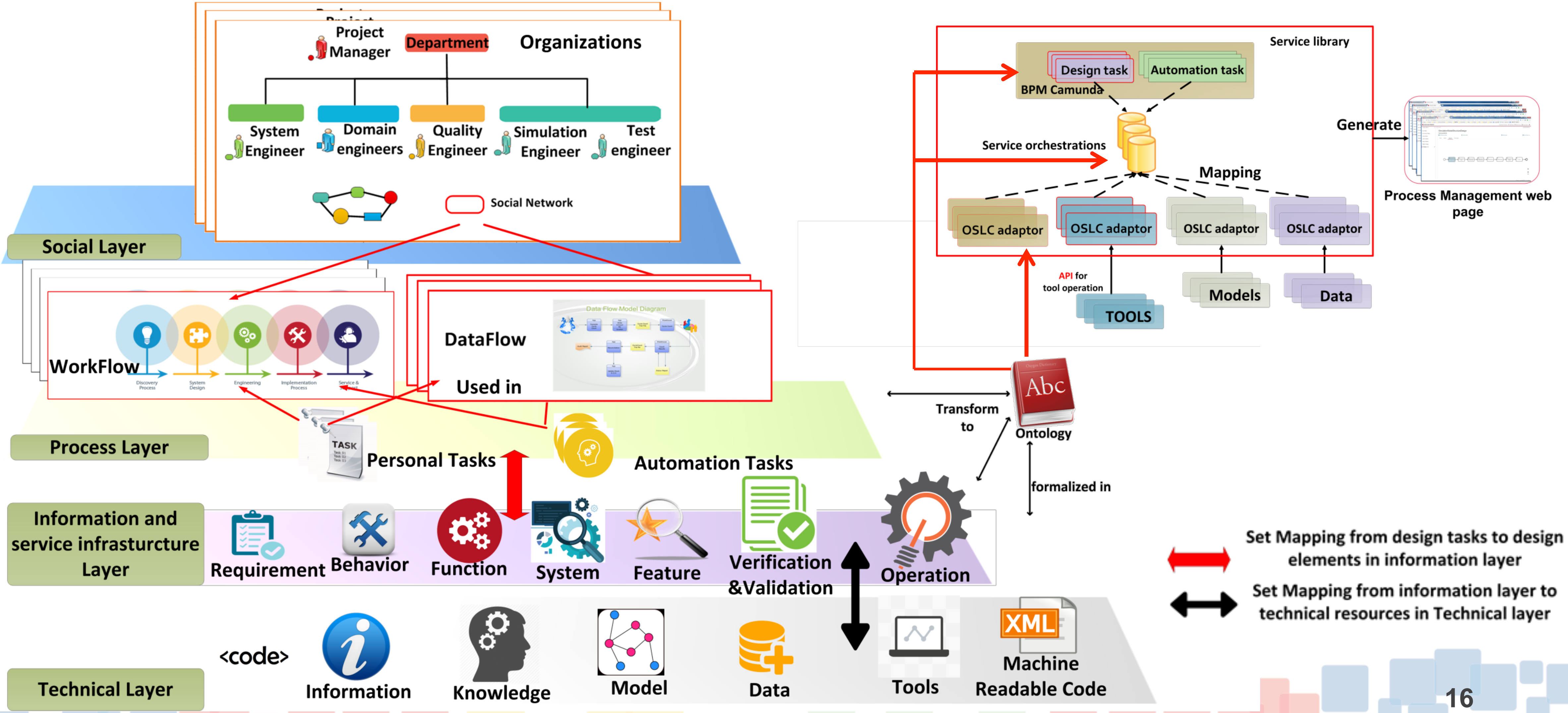


Evaluate extended DSL and specification

Future work

2. Extend SPIT Supporting MBSE Tool-chain

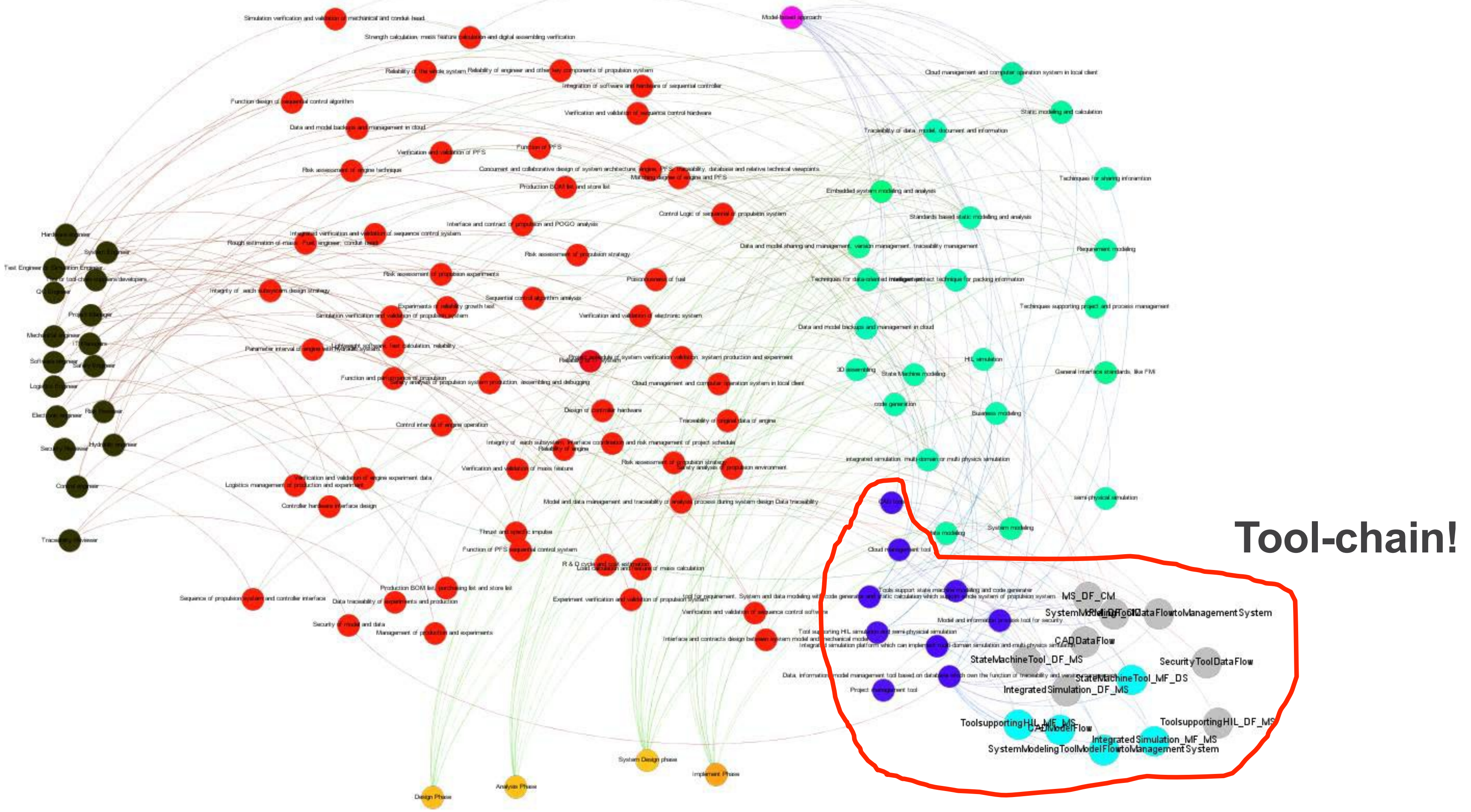
Extend SPIT Framework to SPIRIT Framework



Future work

3. Visualization of MBSE tool-chains

- Stakeholders
- Viewpoints
- Techniques
- Tool
- Model Flow
- Data Flow
- Model-based approach
- Process



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