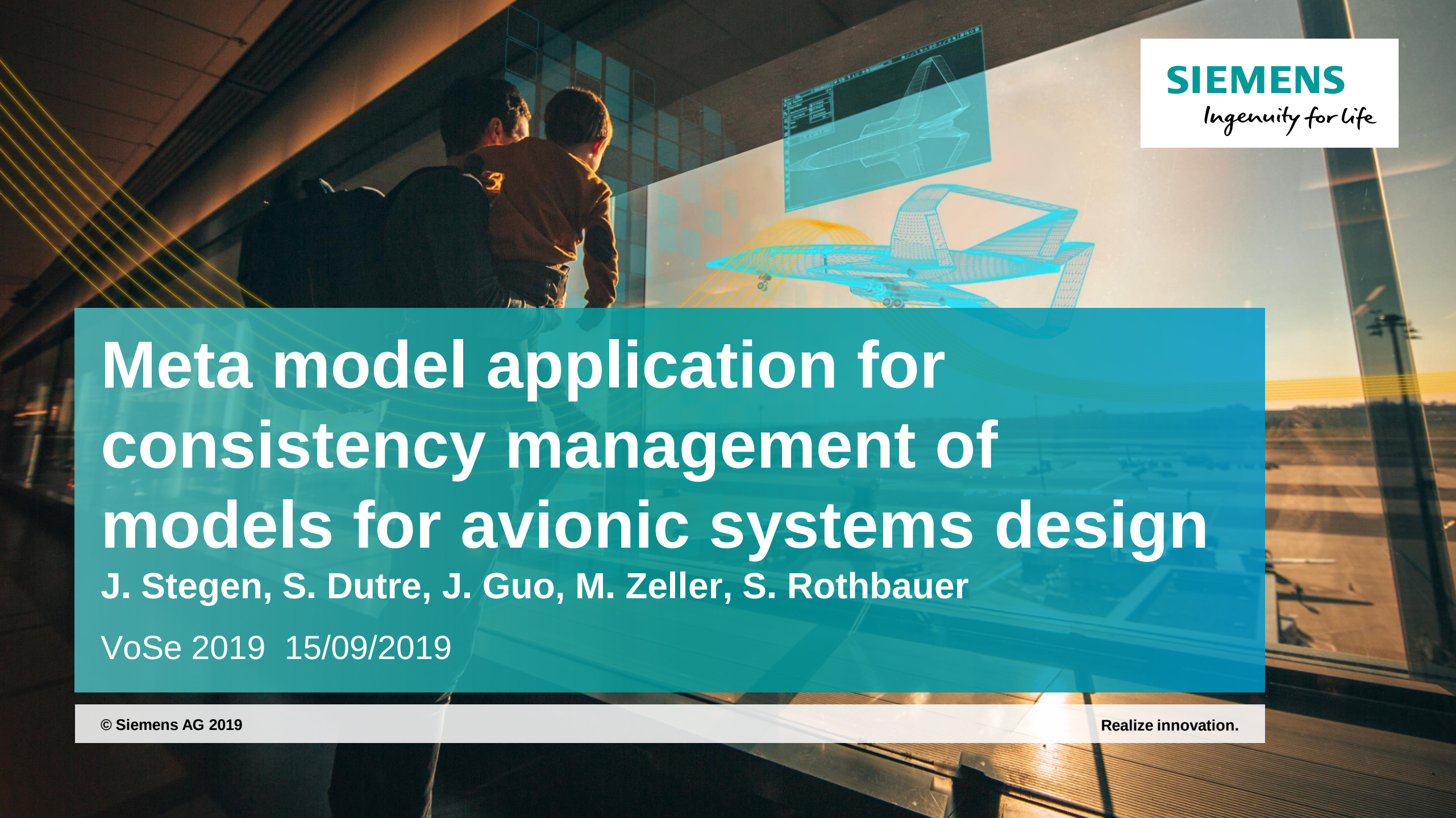

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Meta model application for consistency management of models for avionic systems design

J. Stegen, S. Dutre, J. Guo, M. Zeller, S. Rothbauer

VoSe 2019 15/09/2019

Siemens Industry Software
Tool portfolio

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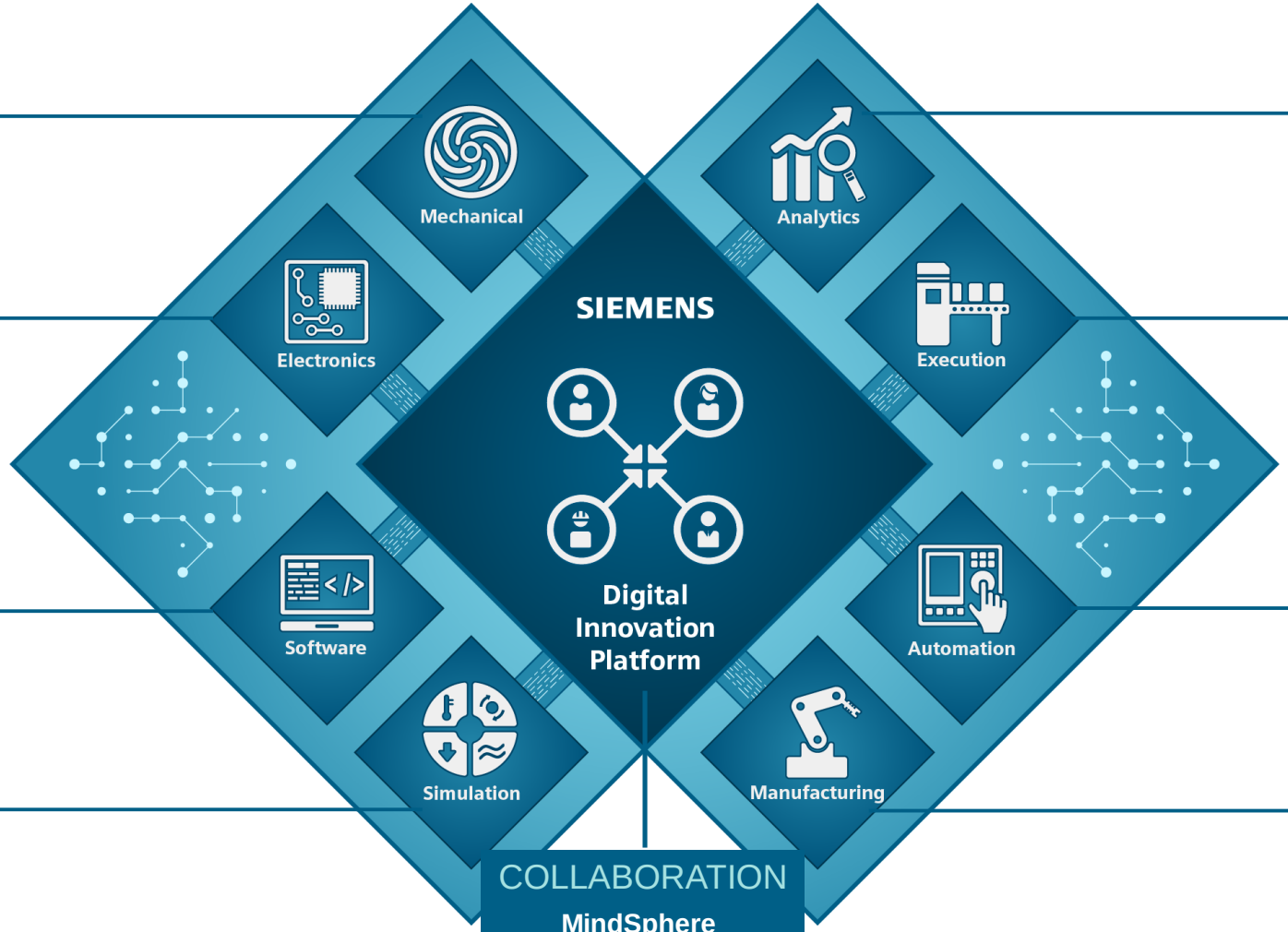
MECHANICAL DESIGN
NX
Solid Edge
Catchbook
Fibersim
Syncrofit
Mastertrim

ELECTRONICS DESIGN
Mentor Graphics
Xpedition
Pads
HyperLynx
Calibre
Pyxis

SOFTWARE DESIGN
Polarion ALM
Polarion QA
Polarion Requirements

PREDICTIVE ANALYTICS
NX Nastran
Imagine.Lab
Virtual.Lab
Test.Lab
Simcenter
Star-CCM+
HEEDS



COLLABORATION
MindSphere
Polarion
Teamcenter

PERFORMANCE ANALYTICS
Omneo
Mindapps

MFG EXECUTION
SIMATIC IT
IBS QMS
WinCC
Camstar
Preactor
Production
Systems
Engineering

FACTORY AUTOMATION
SIMATIC
SINUMERIK
SIMOTION

MANUFACTURING ENGINEERING
Tecnomatix
NX CAM
Intosite
Line Designer

The Aviation Industry is Quickly Evolving

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Stricter Regulations

Increased Competition

From mechanical to cyber-physical

New Aircraft and Propulsion Concepts

Systems Thinking
Typical Current Processes

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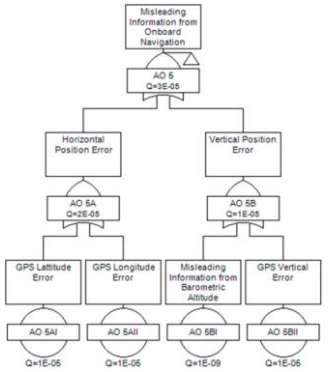
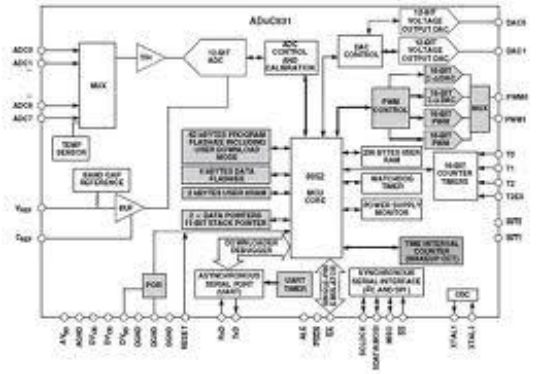
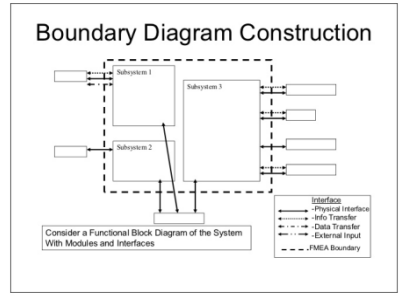
Safety Assessment



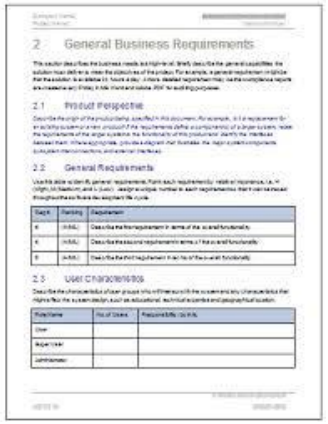
Functional Definitions & Diagrams



Logical Architectures

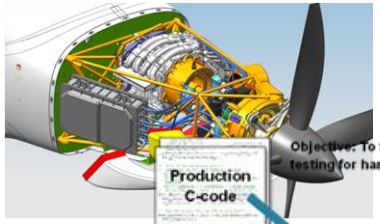


Requirements Documents

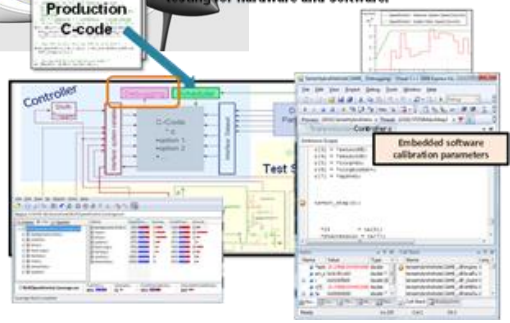


…Systems Engineering processes are in place in many areas, but they are typically not systematically integrated…

Physical Designs



Integration testing



Unit testing

Virtual Verifications and validation

Interdependence of modelling artefacts
aerospace example

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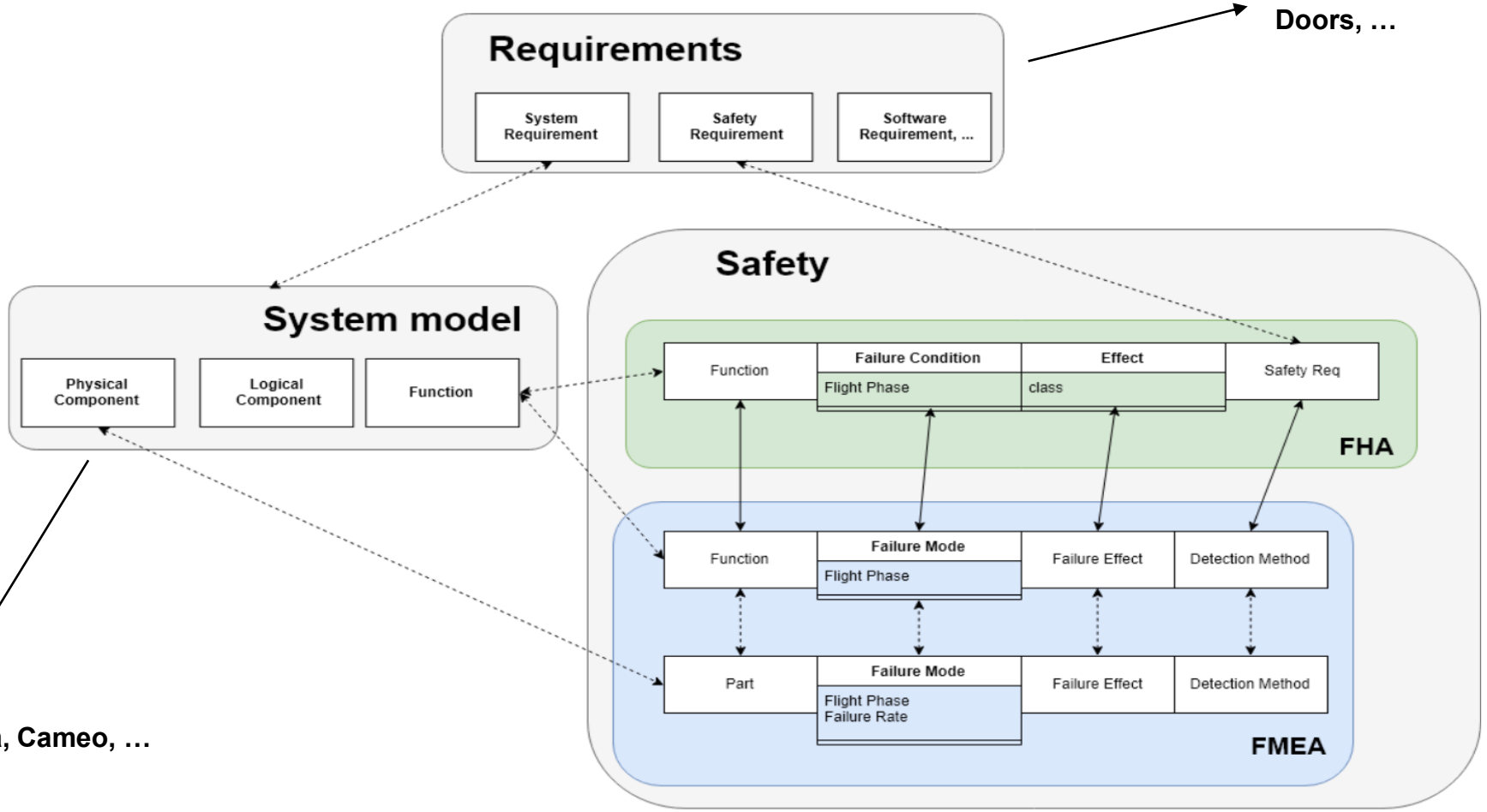
Currently: Polarion, IBM Doors, …



Currently: Capella, Cameo, …

Currently: Excel, Word, in-house tools, …

Highly interrelated but often in siloed tools

What is Polarion

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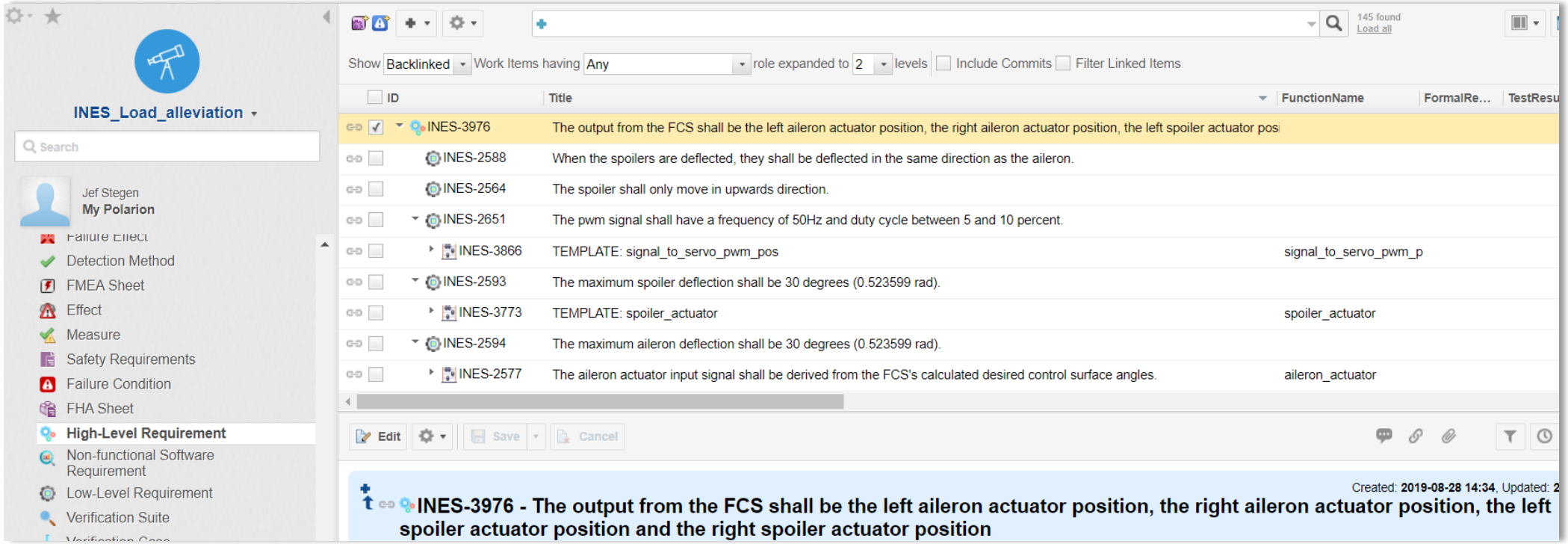
- Application Lifecycle Management (ALM) tool with requirements, test cases, live documents, …
- Browser-based
- On top of SVN repository
- Uses the concept of workitems for its instances of data
- Highly customizable



Polarion: from ALM to integrated data management

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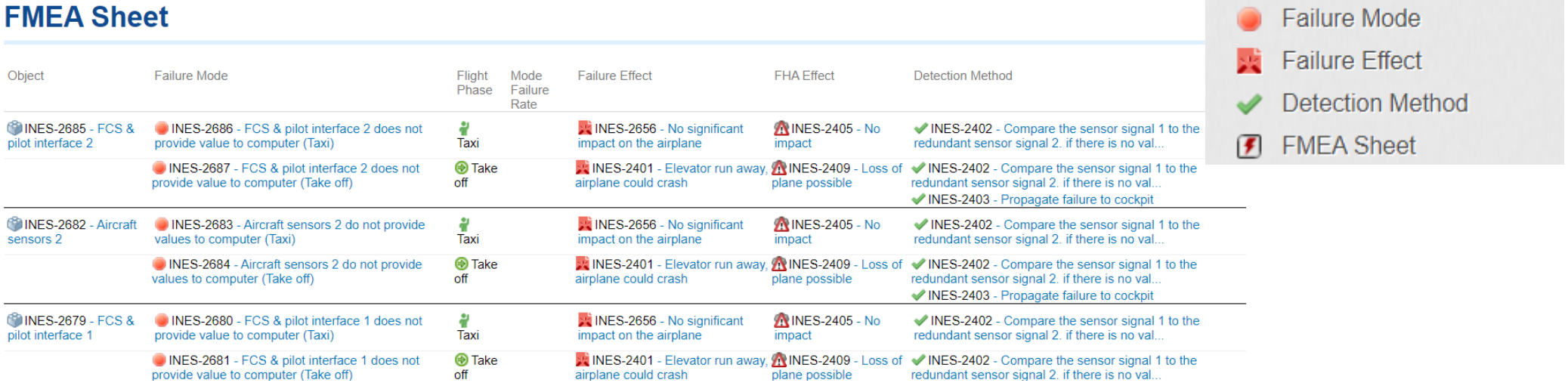
- Polarion has been customized to contain next to requirements also system modelling and safety modelling artefacts:
  - System:
    - Physical components and physical links between them
  - Safety:
    - FMEA: Failure Mode, Failure Effect, Detection Method
    - FHA : Function, Failure Condition, Effect, Measure
- Data that is often contained in siloed tools (such as word, excel, Cameo, …) is created here and maintained in central tool



Polarion: from ALM to integrated data management

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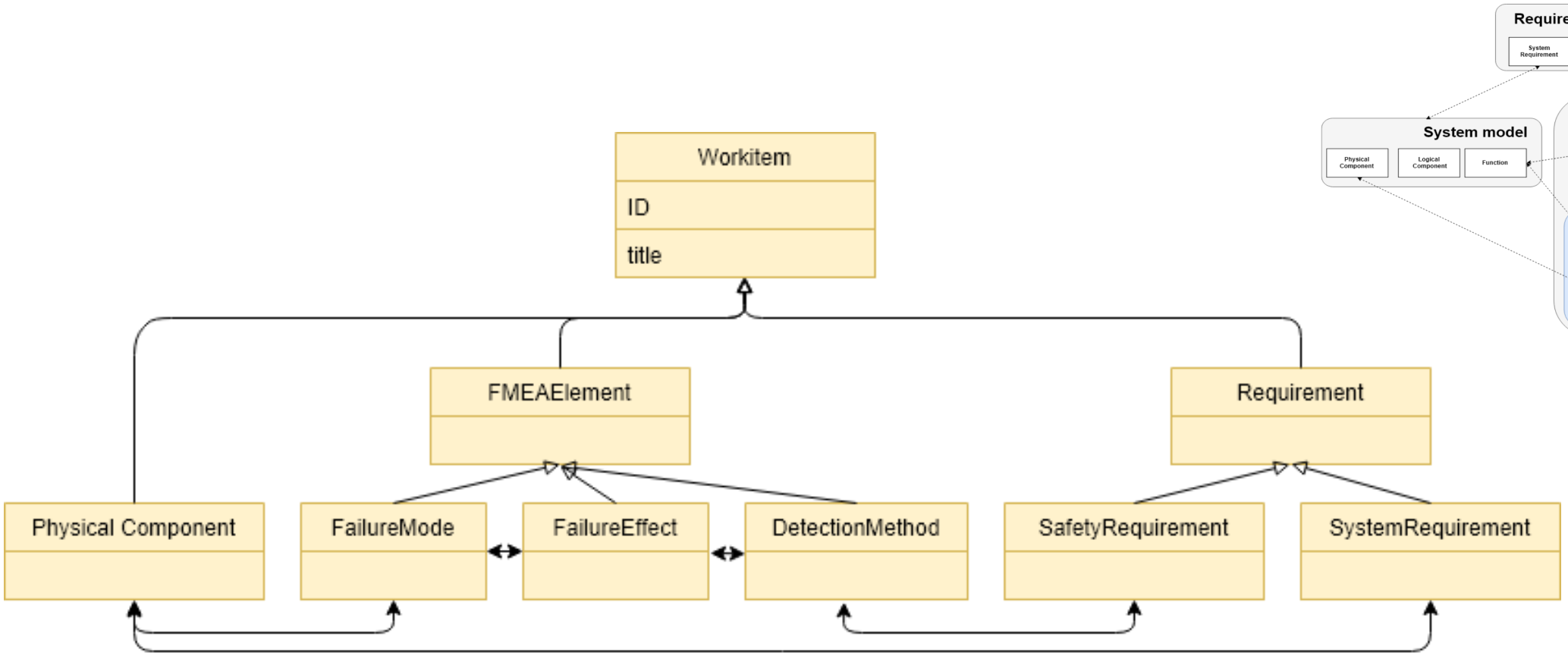
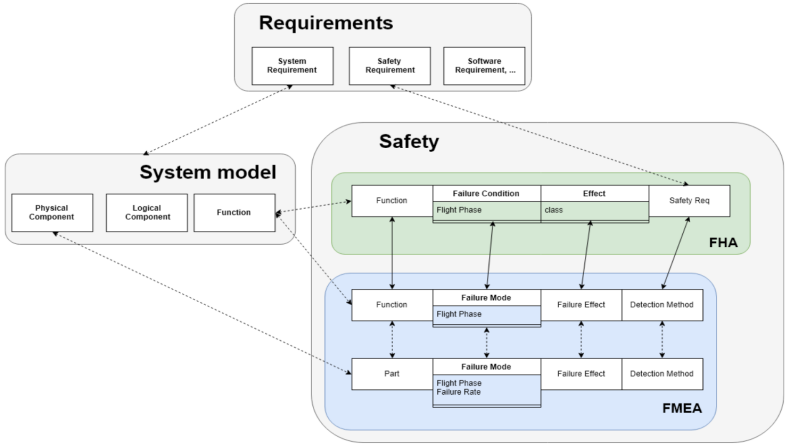
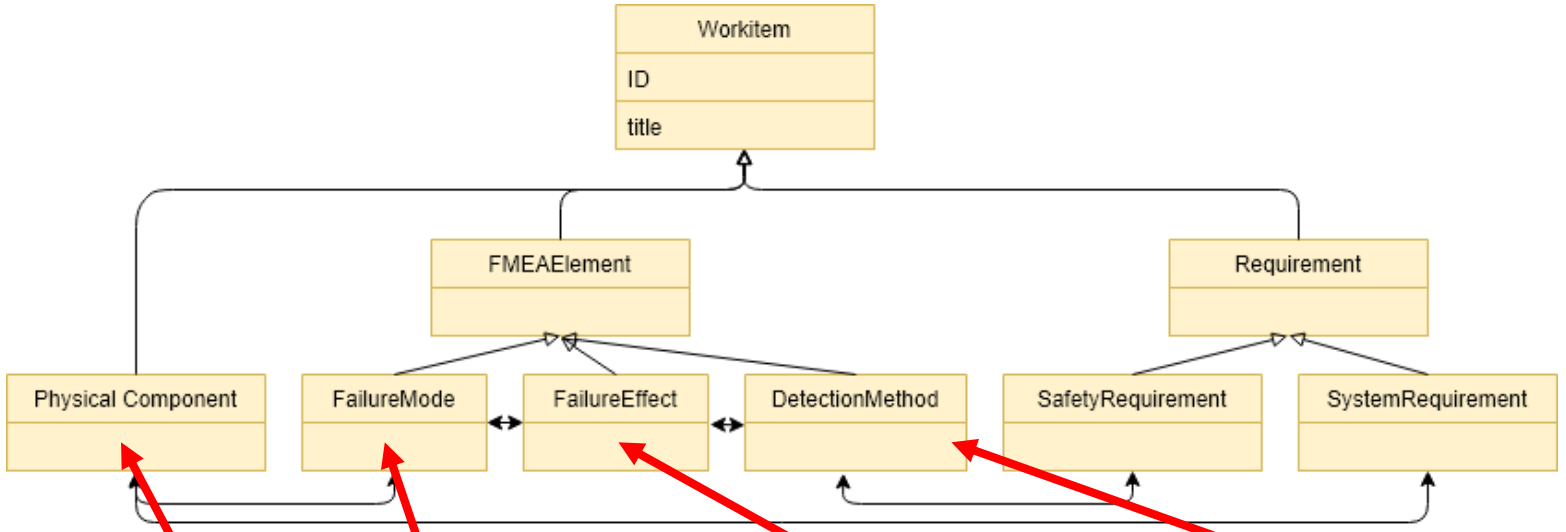
- Polarion setup is basically a meta model on data types and relationships between them





Underlying Meta model

- Data in Polarion fits to certain setup which is similar as a meta model
- All workitem types in Polarion are basically classes in meta model

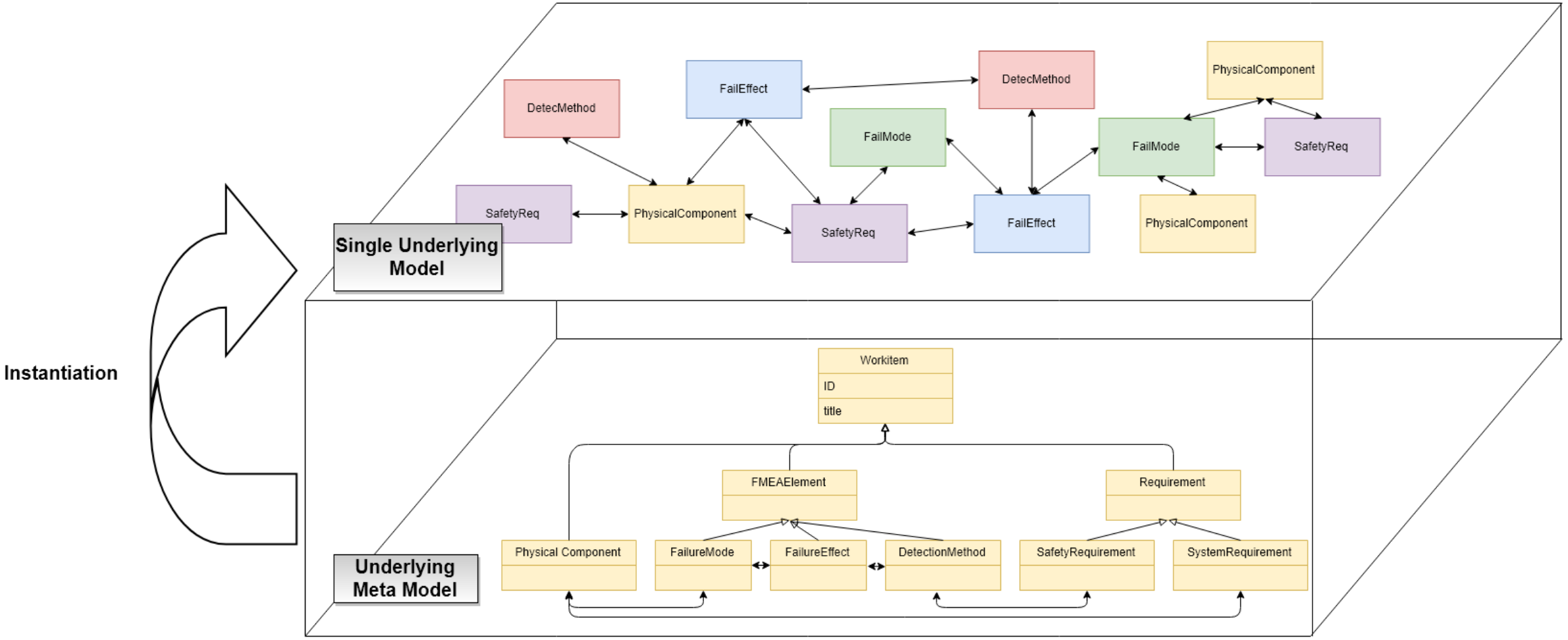


Velocity

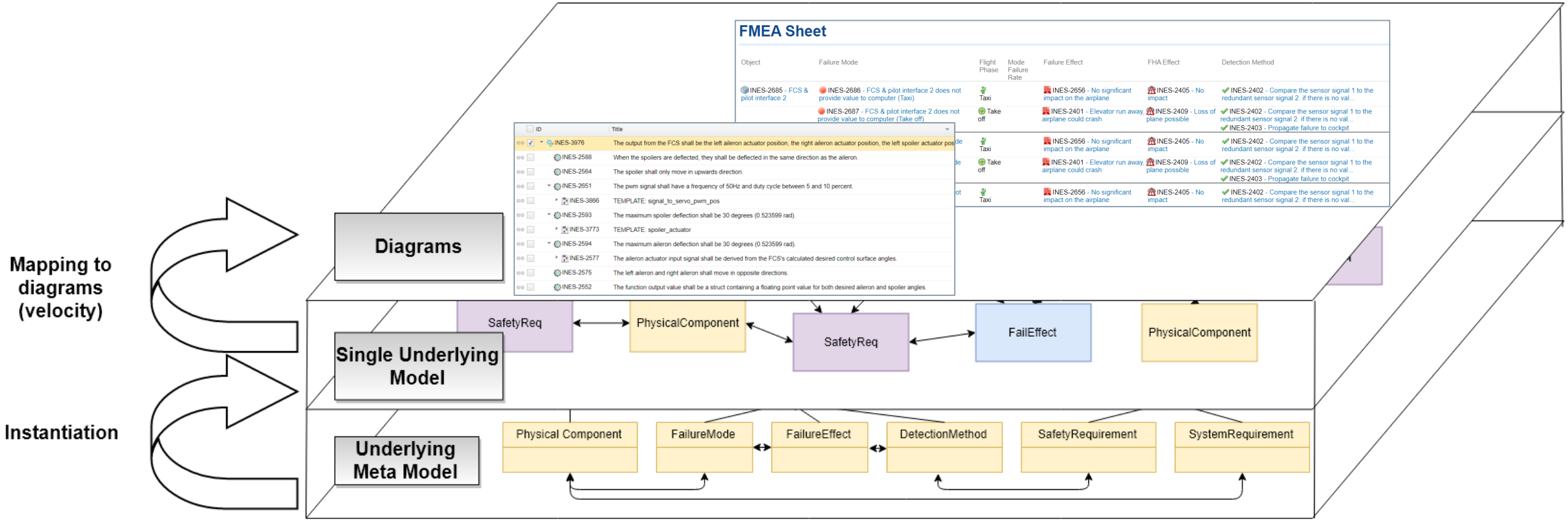
FMEA Sheet

Object	Failure Mode	Flight Phase	Mode Failure Rate	Failure Effect	FHA Effect	Detection Method
INES-2685 - FCS & pilot interface 2	INES-2686 - FCS & pilot interface 2 does not provide value to computer (Taxi)	Taxi		INES-2656 - No significant impact on the airplane	INES-2405 - No impact	INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val...
	INES-2687 - FCS & pilot interface 2 does not provide value to computer (Take off)	Take off		INES-2401 - Elevator run away, airplane could crash	INES-2409 - Loss of plane possible	INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val... INES-2403 - Propagate failure to cockpit
INES-2682 - Aircraft sensors 2	INES-2683 - Aircraft sensors 2 do not provide values to computer (Taxi)	Taxi		INES-2656 - No significant impact on the airplane	INES-2405 - No impact	INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val...
	INES-2684 - Aircraft sensors 2 do not provide values to computer (Take off)	Take off		INES-2401 - Elevator run away, airplane could crash	INES-2409 - Loss of plane possible	INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val... INES-2403 - Propagate failure to cockpit
INES-2679 - FCS & pilot interface 1	INES-2680 - FCS & pilot interface 1 does not provide value to computer (Taxi)	Taxi		INES-2656 - No significant impact on the airplane	INES-2405 - No impact	INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val...
	INES-2681 - FCS & pilot interface 1 does not provide value to computer (Take off)	Take off		INES-2401 - Elevator run away, airplane could crash	INES-2409 - Loss of plane possible	INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val...

SUM instantiation from Meta Model

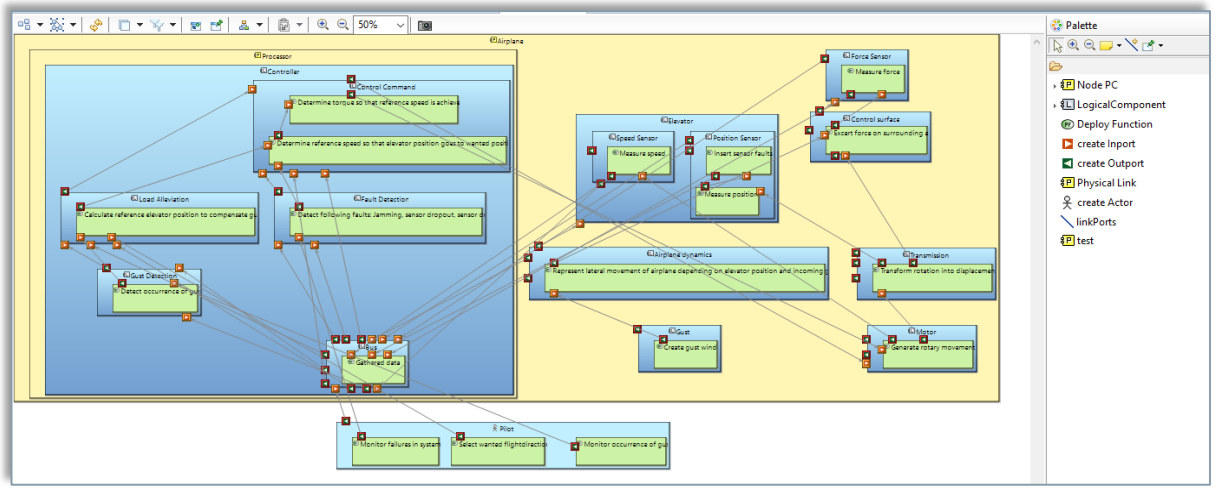


Polarion visualizations on top of SUM

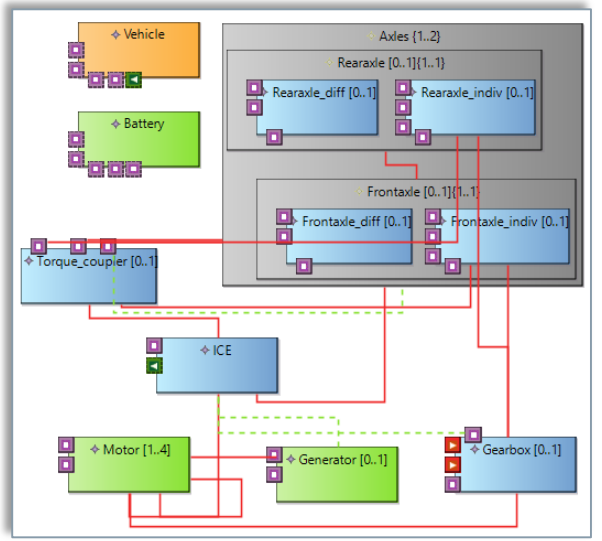


Sirius

- Eclipse-based tool, made by Obeo, which allows to create graphical modeling workbenches (eg. Capella)
- Based on Eclipse Modelling Framework (EMF) and Graphical Modelling Framework (GMF)
- Different Custom diagrams have been created for Safety Assurance (FHA, FMEA, GSN), Physical architecture and Functional breakdown
- Polarion integration has been developed for bidirectional interaction



	Parent	Children	Validated	Safetydoc
MYPR-648	[]	1	false	
MYPR-649	[MYPR-648]	1	false	
MYPR-650	[MYPR-649]	1	false	
MYPR-651	[MYPR-650]	0	false	
INES-1997	[INES-2282]	0	true	ssa
INES-1998	[INES-2305]	5	true	ssa
INES-1999	[INES-1970]	0	true	ssa
INES-1986	[INES-1963]	0	true	ssa
INES-1987	[INES-1962]	0	true	ssa
INES-1988	[]	0	false	
INES-1989	[]	0	true	ssa
INES-1990	[INES-1963]	0	false	ssa
INES-1991	[INES-1965]	0	false	
INES-1993	[INES-2147]	0	false	
INES-1994	[INES-1970]	0	true	ssa
INES-1995	[]	0	true	ssa
INES-1996	[INES-1966]	0	true	ssa



Sirius-Capella relationship

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Sirius Tool for creation of graphical workbenches

Capella Graphical workbench

Customized graphical workbench that can interact with Polarion

POLARION

Sirius as graphical interface for Polarion

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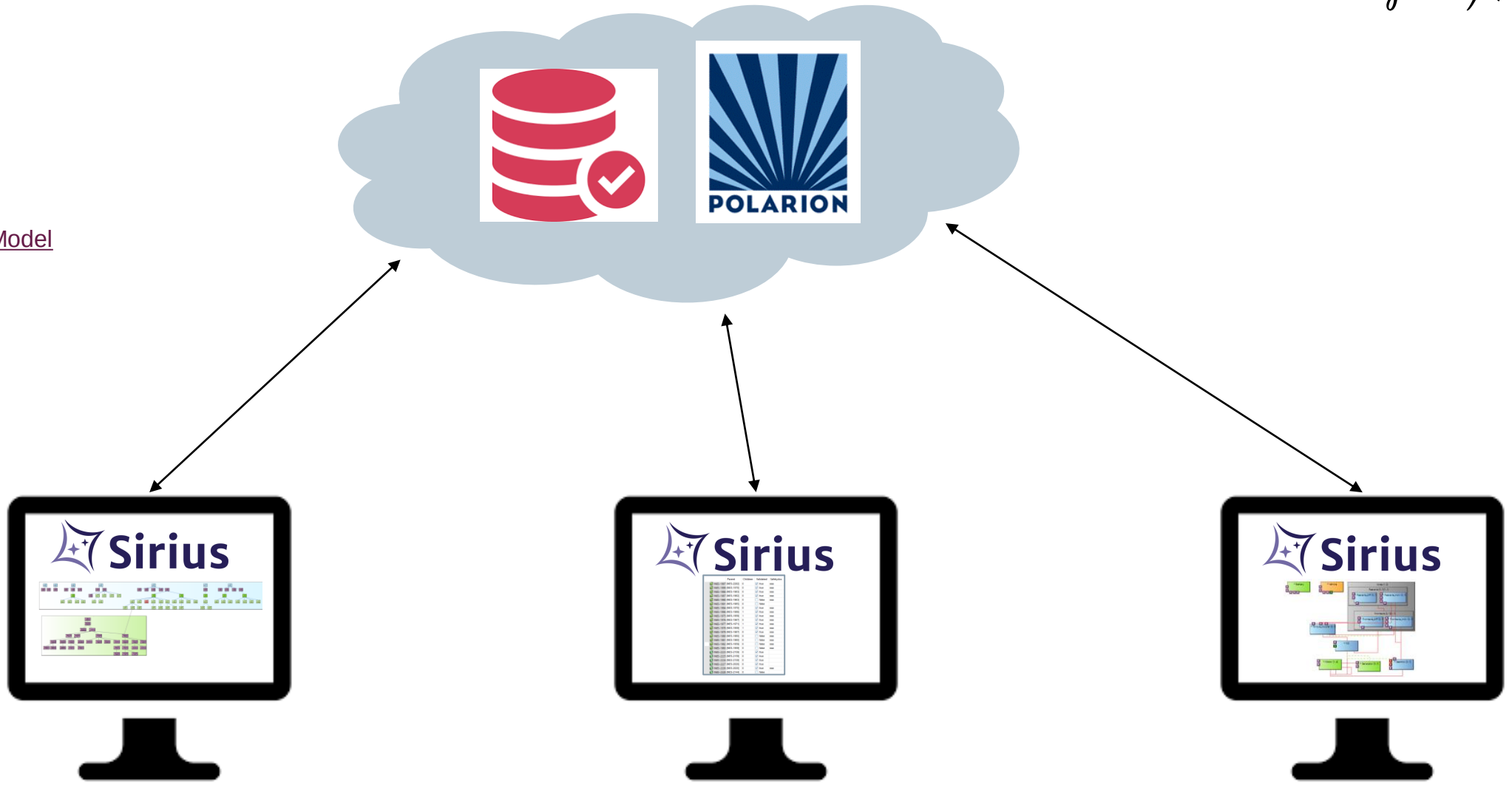
Video: System Model
Video: FMEA



Sirius – Polarion interaction

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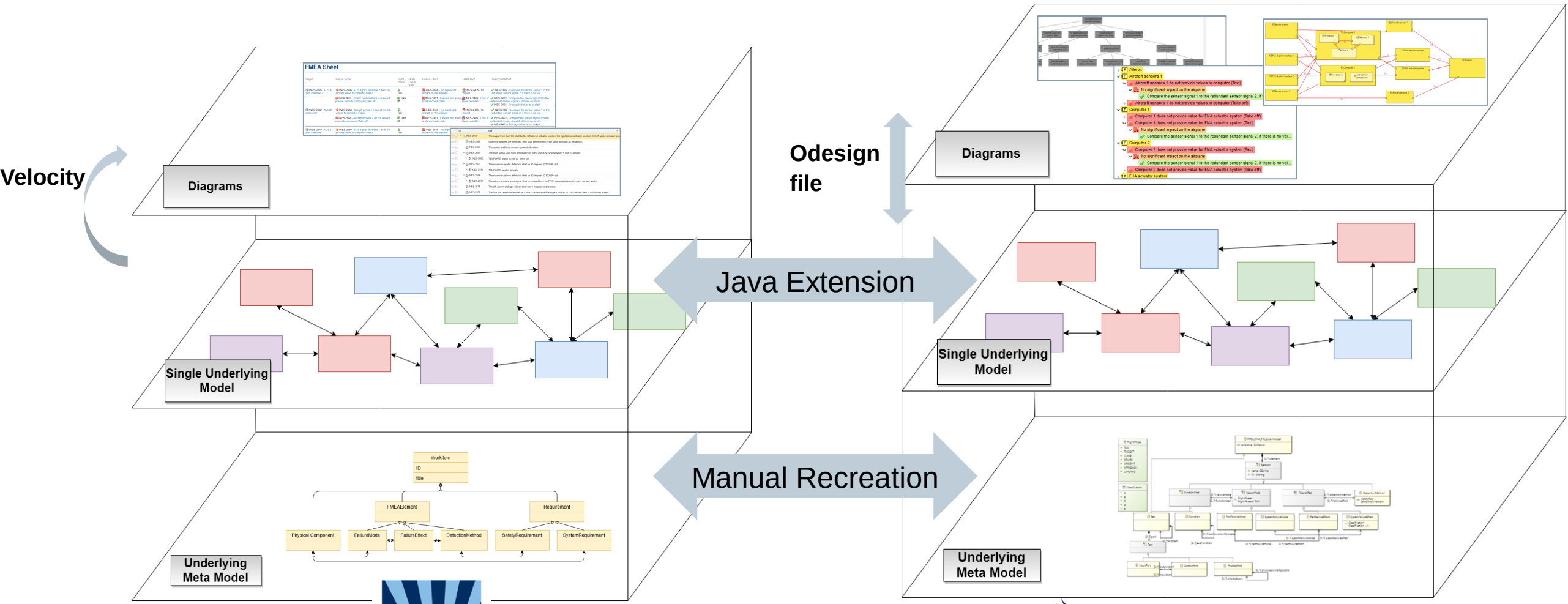


POLARION

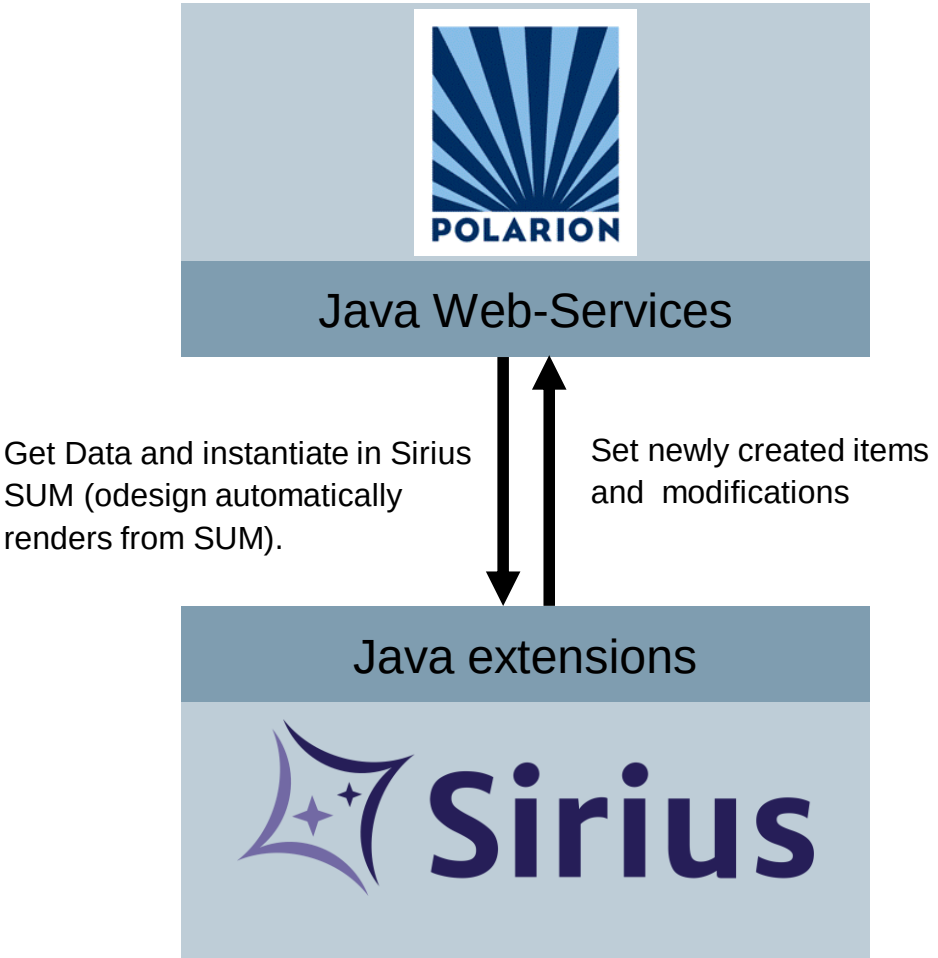
Sirius

Connection between Polarion and Sirius

- Sirius supports Java extension points that are triggered when actions are performed on the Sirius diagrams
- Polarion Web-services (SOAP) are used to retrieve, create and modify data on the Polarion repository

- Disadvantages:
  - Maintainability, mapping between Polarion workitems and Sirius elements are hardcoded, changes in meta model lead to modification in code

- Solutions/Improvements:
  - Data mapping in separate document
  - Automatic mapping based on Class name, ….
  - Use of standards such as OSLC



Maintainability issue

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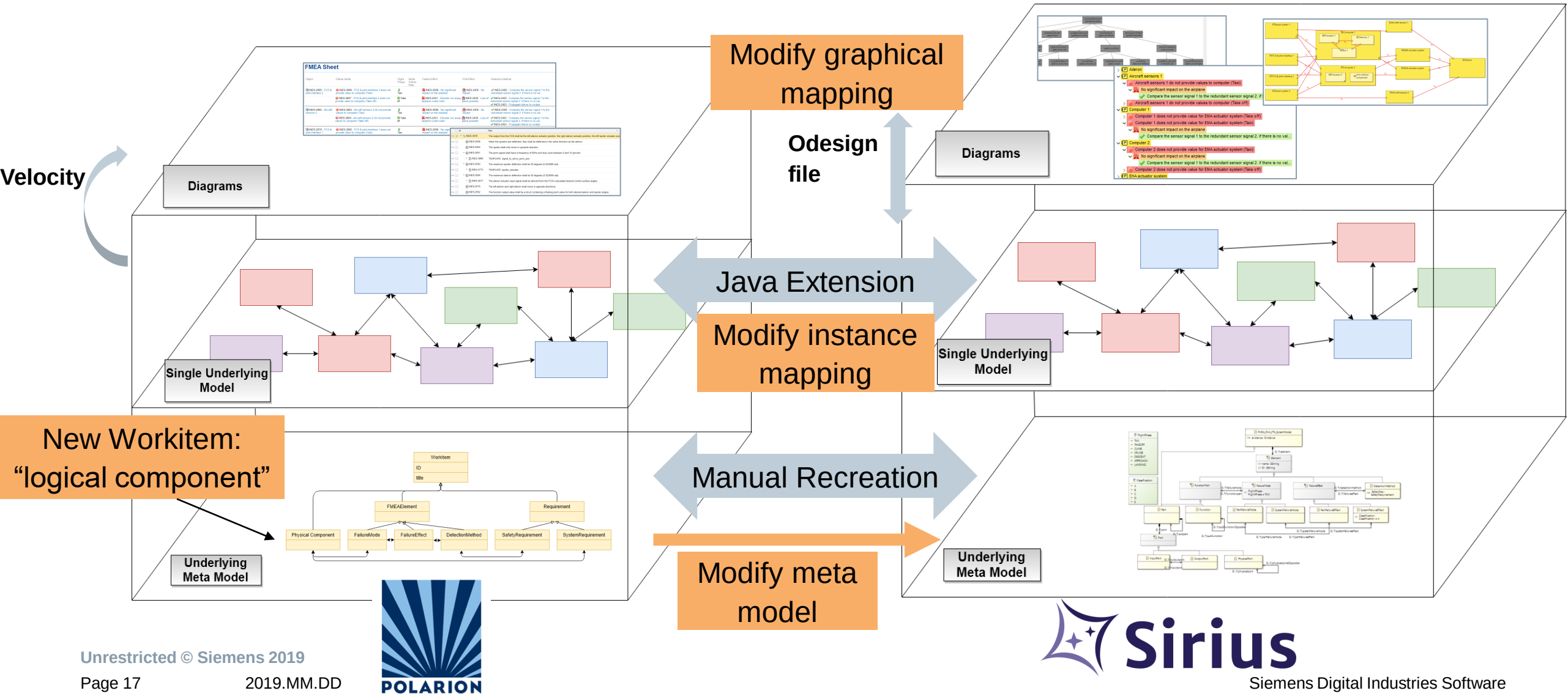

Distributed development

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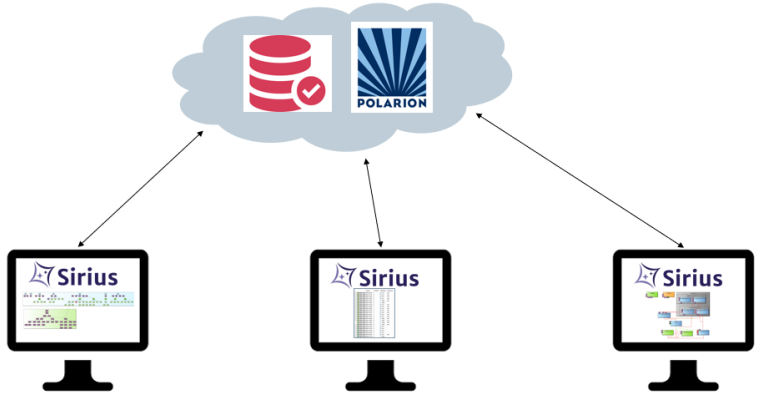
- All data is maintained in Polarion: central source of truth
  - Changes in Sirius are immediately pushed to Polarion

Problem:
- Multiple people working concurrent on same data, how to maintain both?
  - Both versions are stored under SVN repo. Older commits can be retrieved if needed (not ideal)

Solution:
- Locking mechanism
  - Lock resources that are being modified
  - Supported by Obeo Designer team (not within current setup)



Conclusions

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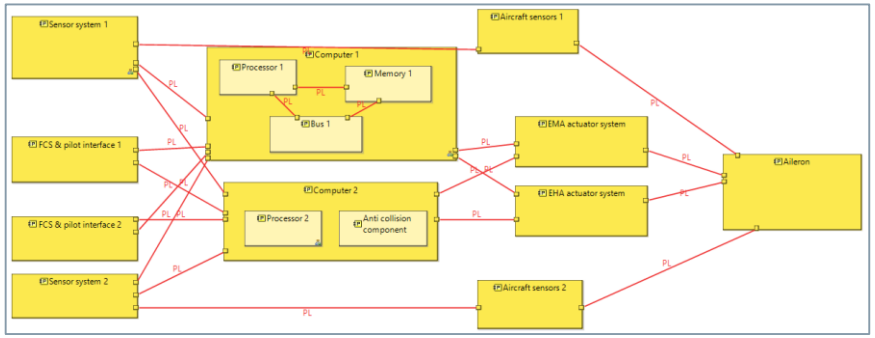
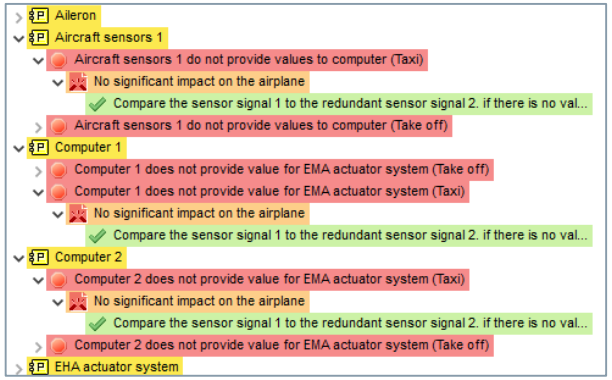
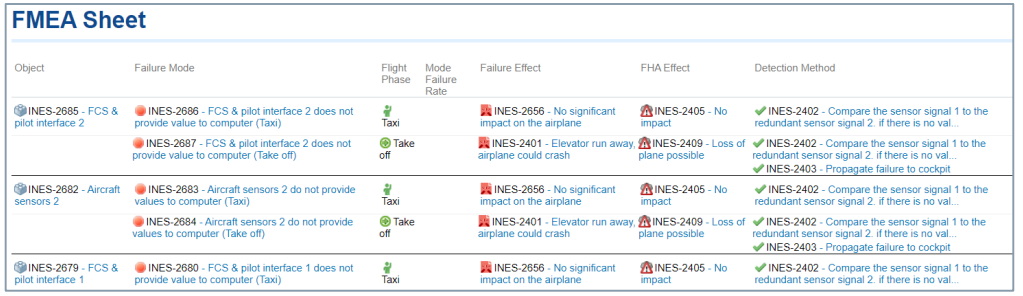
- The proposed methodology shows the applicability of an underlying meta model to an avionic system case study
- By moving from a document-centric to an integrated model-based approach, different interrelated data artefacts can be integrated
- A plugin has been developed to interface data from a central Polarion repository with Sirius, a graphical workbench development tool.







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Thanks for your attention