

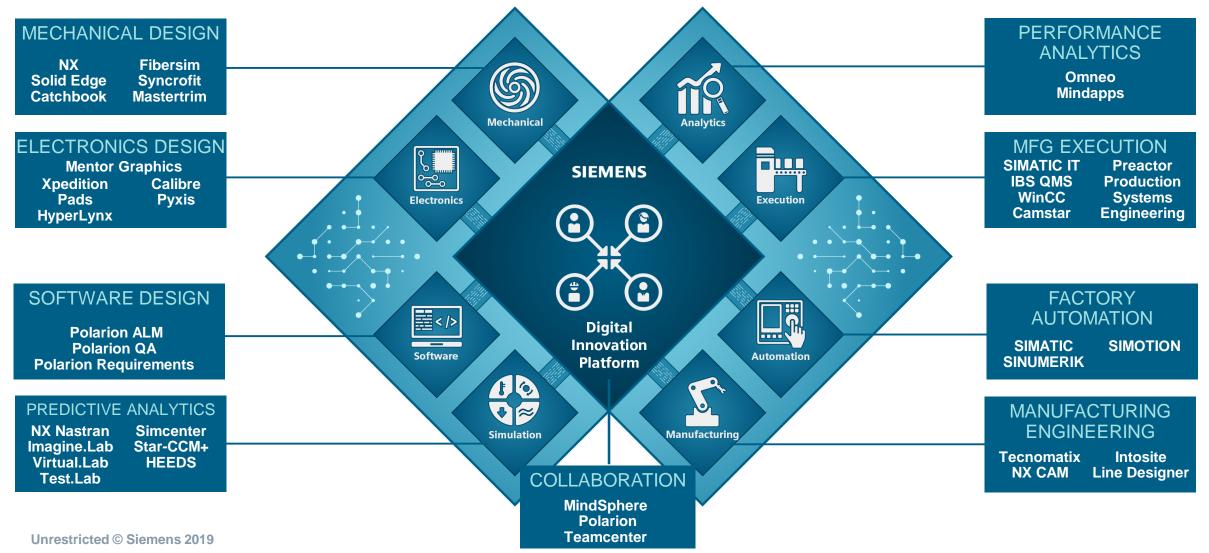
Meta model application for consistency management of models for avionic systems design J. Stegen, S. Dutre, J. Guo, M. Zeller, S. Rothbauer

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Realize innovation.

Siemens Industry Software Tool portfolio





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The Aviation Industry is Quickly Evolving





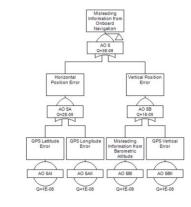
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Systems Thinking Typical Current Processes

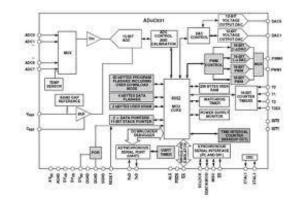
Requirements Documents

2	Ger	eneral Business Requirements					
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Safety Assessment

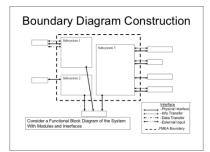


Functional Definitions & Diagrams



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Logical Architectures



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



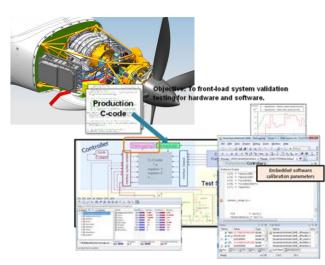
Integration testing





Virtual Verifications and validation Siemens Digital Industries Software

Physical Designs



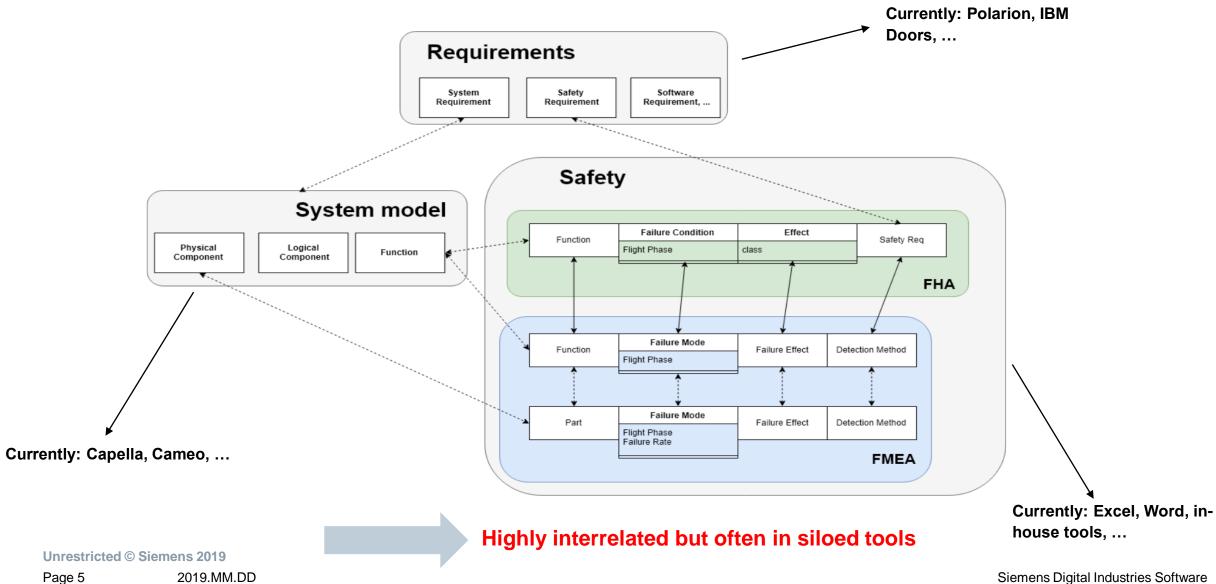
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Unit testing



Interdependence of modelling artefacts aerospace example





What is Polarion



- 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

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F	Show Backlinked • Work Items having Any • role expanded to 2 • levels Inclu	ude Commits Filter Linked Items
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Q Search	INES-2588 When the spoilers are deflected, they shall be deflected in the same direction	on as the aileron.
Jef Stegen	co Nesseiller shall only move in upwards direction.	
My Polarion	co ▼ @ INES-2651 The pwm signal shall have a frequency of 50Hz and duty cycle between 5 a	and 10 percent.
Panure Enect Detection Method	← ← INES-3866 TEMPLATE: signal_to_servo_pwm_pos	signal_to_servo_pwm_p
FMEA Sheet	🖙 🔄 🔹 💿 INES-2593 The maximum spoiler deflection shall be 30 degrees (0.523599 rad).	
🖸 Effect	← INES-3773 TEMPLATE: spoiler_actuator	spoiler_actuator
💰 Measure	The maximum aileron deflection shall be 30 degrees (0.523599 rad).	
Safety Requirements	INES-2577 The aileron actuator input signal shall be derived from the FCS's calculated	desired control surface angles. aileron actuator
 Failure Condition FHA Sheet 		
High-Level Requirement	Edit 🐼 - 🔄 Save - 🕞 Cancel	
Non-functional Software Requirement		<i>+ 0 0</i> 1 0
Low-Level Requirement	t == • INES-3976 - The output from the FCS shall be the left aileror	Created: 2019-08-28 14:34, Updated: 2
Verification Suite	spoiler actuator position and the right spoiler actuator positio	actuator position, the right aileron actuator position, the left n

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Polarion: from ALM to integrated data management

- 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 Function Name/Part

FMEA Sheet						۲	Failure Mode	
Object	Failure Mode	Flight Phase	Mode Failure Rate	Failure Effect	FHA Effect	Detection Method		Failure Effect Detection Method
INES-2685 - FCS & pilot interface 2	INES-2686 - FCS & pilot interface 2 does not provide value to computer (Taxi)	∦ Taxi		NES-2656 - No significant impact on the airplane	MINES-2405 - No impact	✓ INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val	F	FMEA Sheet
	INES-2687 - FCS & pilot interface 2 does not provide value to computer (Take off)		2	INES-2401 - Elevator run away airplane could crash	, MINES-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	MINES-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)		9	RES-2401 - Elevator run away airplane could crash	, MINES-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		NES-2656 - No significant impact on the airplane	MINES-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)	Image: Second secon	9	INES-2401 - Elevator run away airplane could crash	, MINES-2409 - Loss of plane possible	✓ INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val		

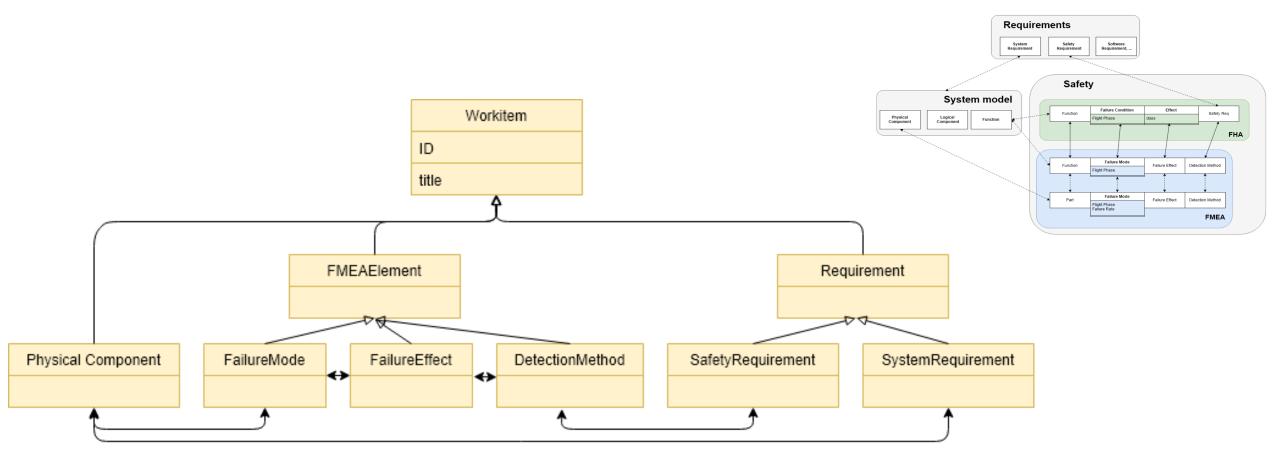
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Polarion: from ALM to integrated data management



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



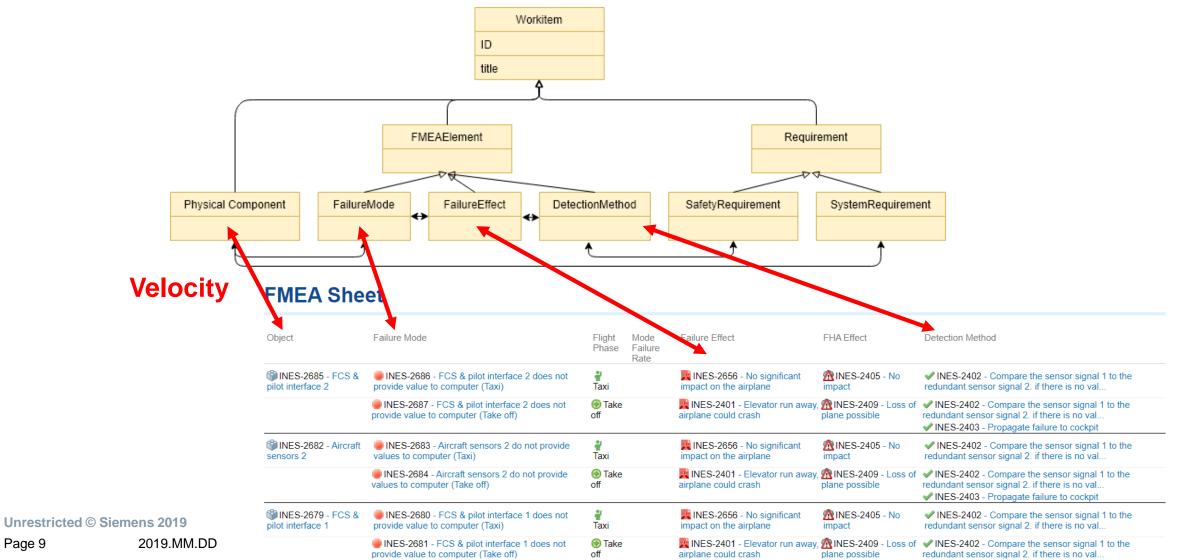
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Underlying Meta model

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- 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

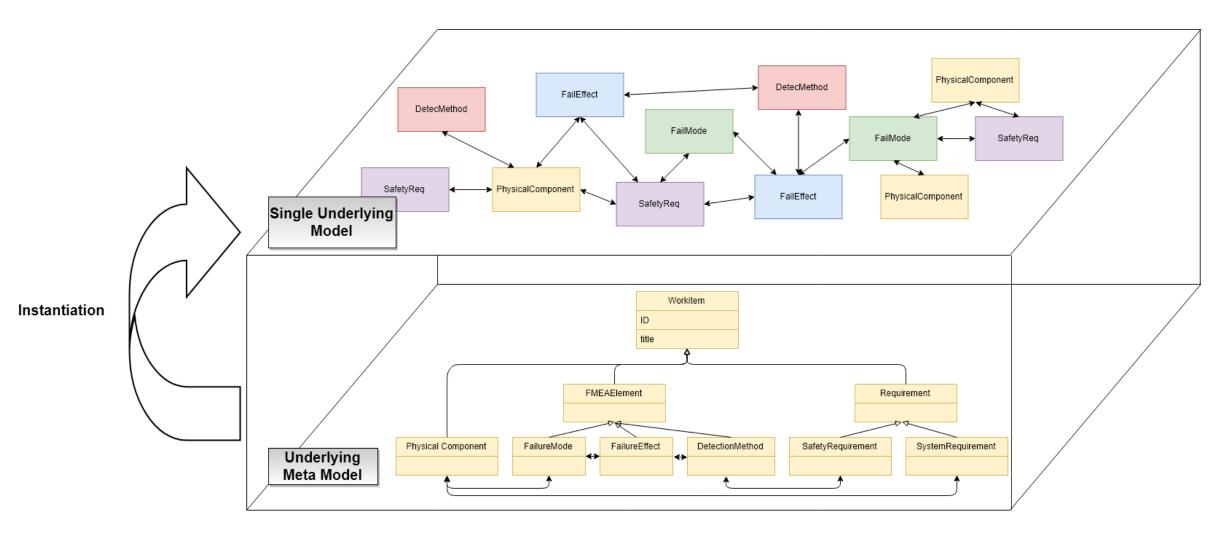


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SUM instantiation from Meta Model

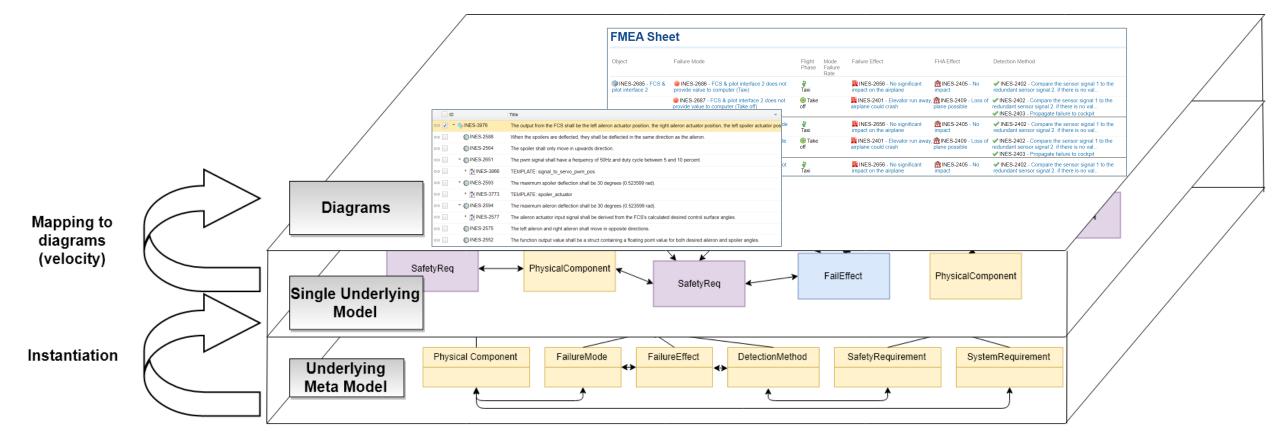




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Polarion visualizations on top of SUM





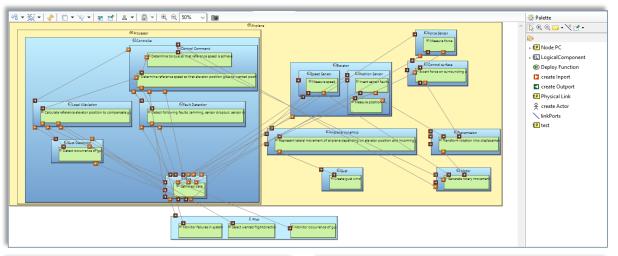
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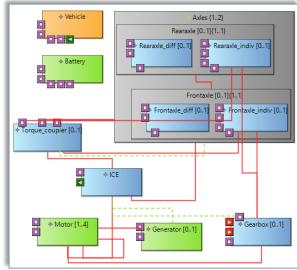




- Eclipse-based tool, made by Obeo, which allows to create graphical modeling workbenches (eg. Capella)
- Based on Eclipse Modelling Framework (EMF) and Graphical Modelling Framework (GMF)
- Different Custom diagrams have been created for Safety Assurance (FHA, FMEA, GSN), Physical architecture and Functional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



	Parent	Children	Validated	Safetydoc
🐻 MYPR-648	0	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	0	false	
🖆 INES-1989	0	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	0	✓ true	ssa
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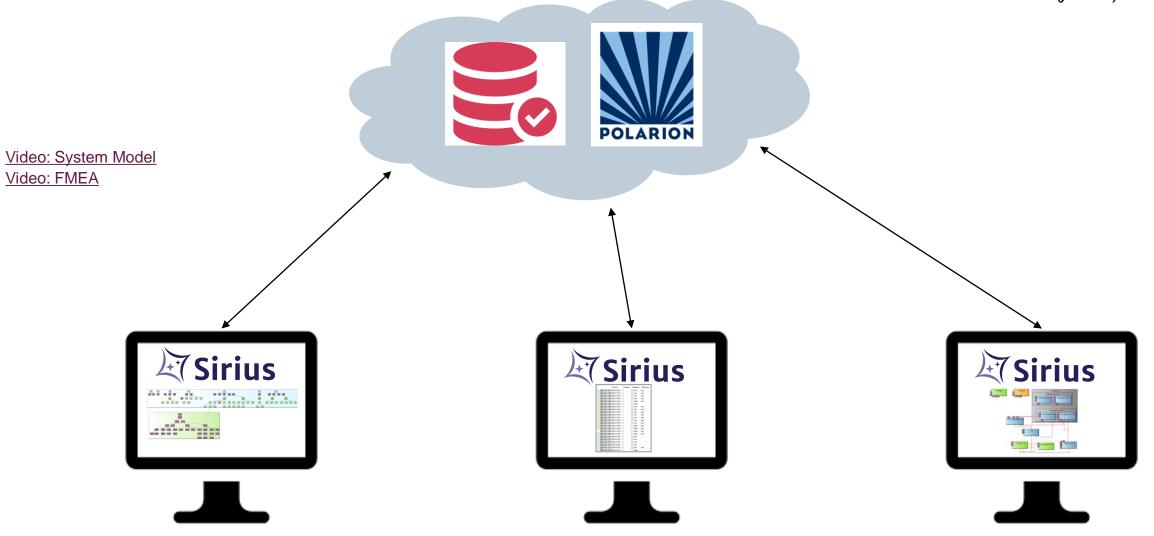
Sirius-Capella relationship



Sirius Tool for creation of graphical workbenches Customized graphical **Capella** Graphical workbench workbench that can interact with Polarion POLARION

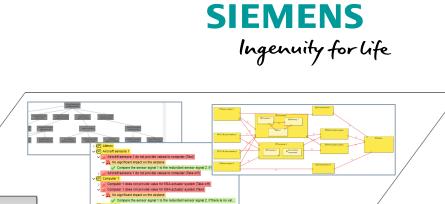
Sirius as graphical interface for Polarion

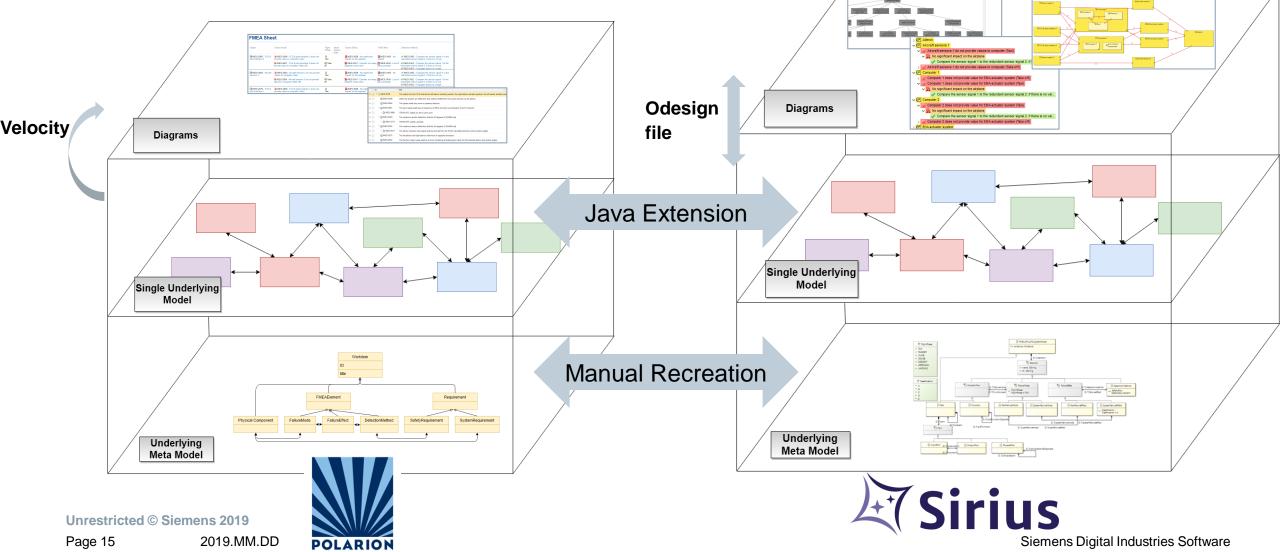




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Sirius – Polarion interaction

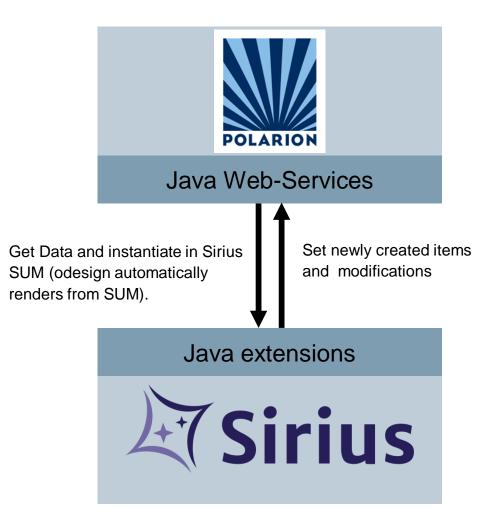




Connection between Polarion and Sirius

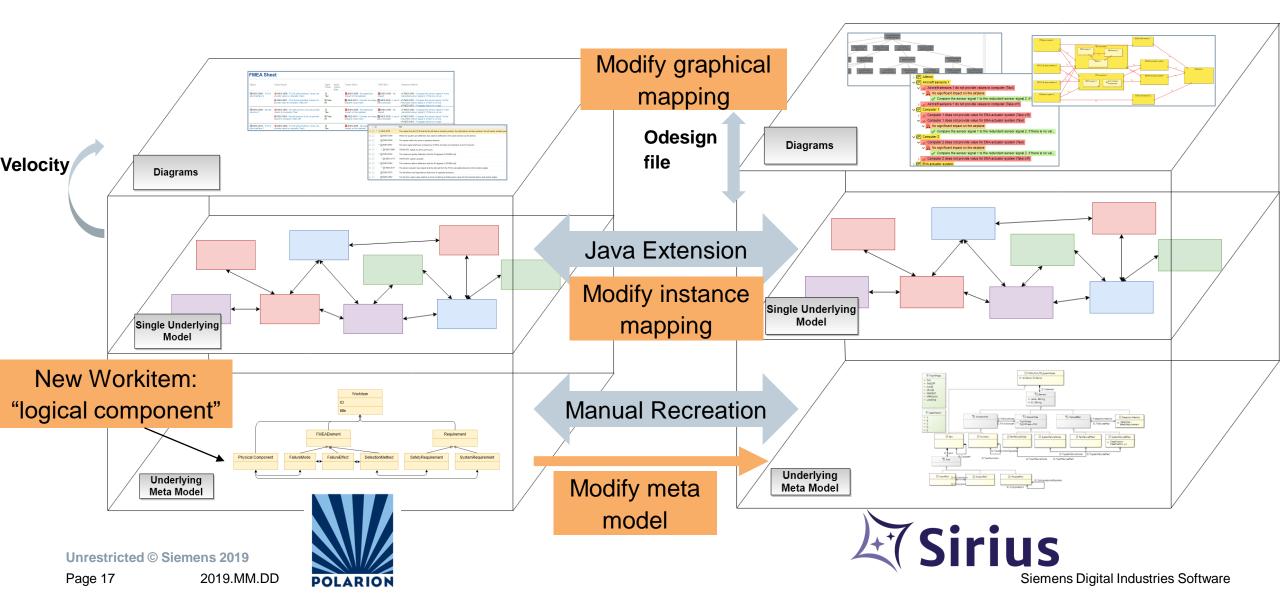


- Sirius supports Java extension points that are triggered when actions are performed on the Sirius diagrams
- Polarion Web-services (SOAP) are used to retrieve, create and modify data on the Polarion repository
- Disadvantages:
 - Maintainability, mapping between Polarion workitems and Sirius elements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





Distributed development



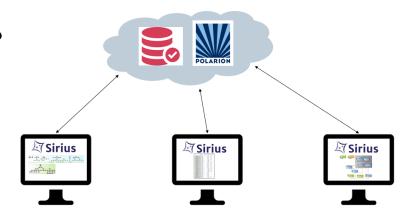
- All data is maintained in Polarion: central source of truth
 - Changes in Sirius are immediately pushed to Polarion

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)

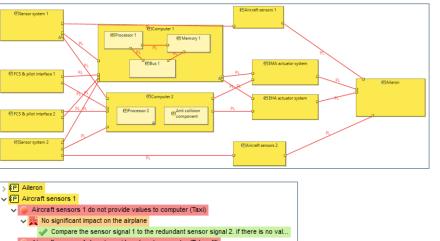
Solution:

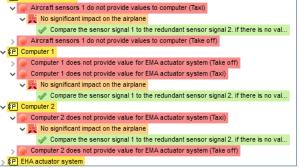
- Locking mechanism
 - Lock resources that are being modified
 - Supported by Obeo Designer team (not within current setup)



Conclusions

- 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.





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)	a xi		RES-2656 - No significant impact on the airplane	MINES-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	MINES-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)	a xi		RES-2656 - No significant impact on the airplane	MINES-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			MINES-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)	a Taxi		RES-2656 - No significant impact on the airplane	MINES-2405 - No impact	✓ INES-2402 - Compare the sensor signal 1 to the redundant sensor signal 2. if there is no val

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Thanks for your attention