

TOOL SUPPORT FOR **CREDIBILITY** **ASSESSMENT OF** AIRCRAFT SYSTEM SIMULATORS

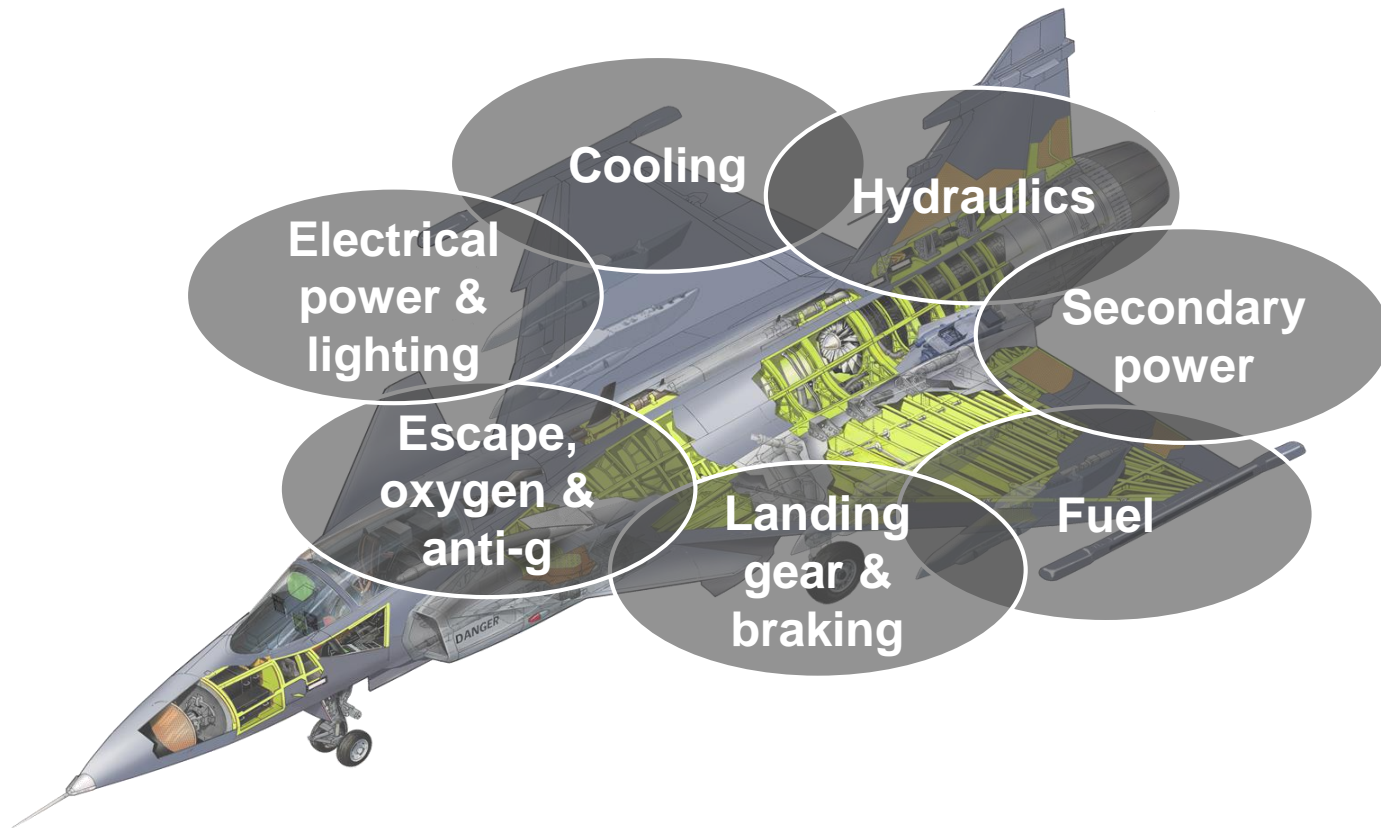
Magnus Eek

The Swedish Aerospace Technology Congress 2016
Solna, 12th October 2016

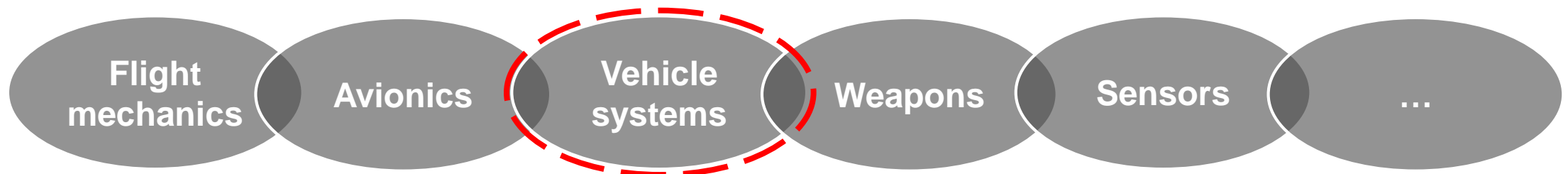


MODELING & SIMULATION IN AIRCRAFT SYSTEM DESIGN

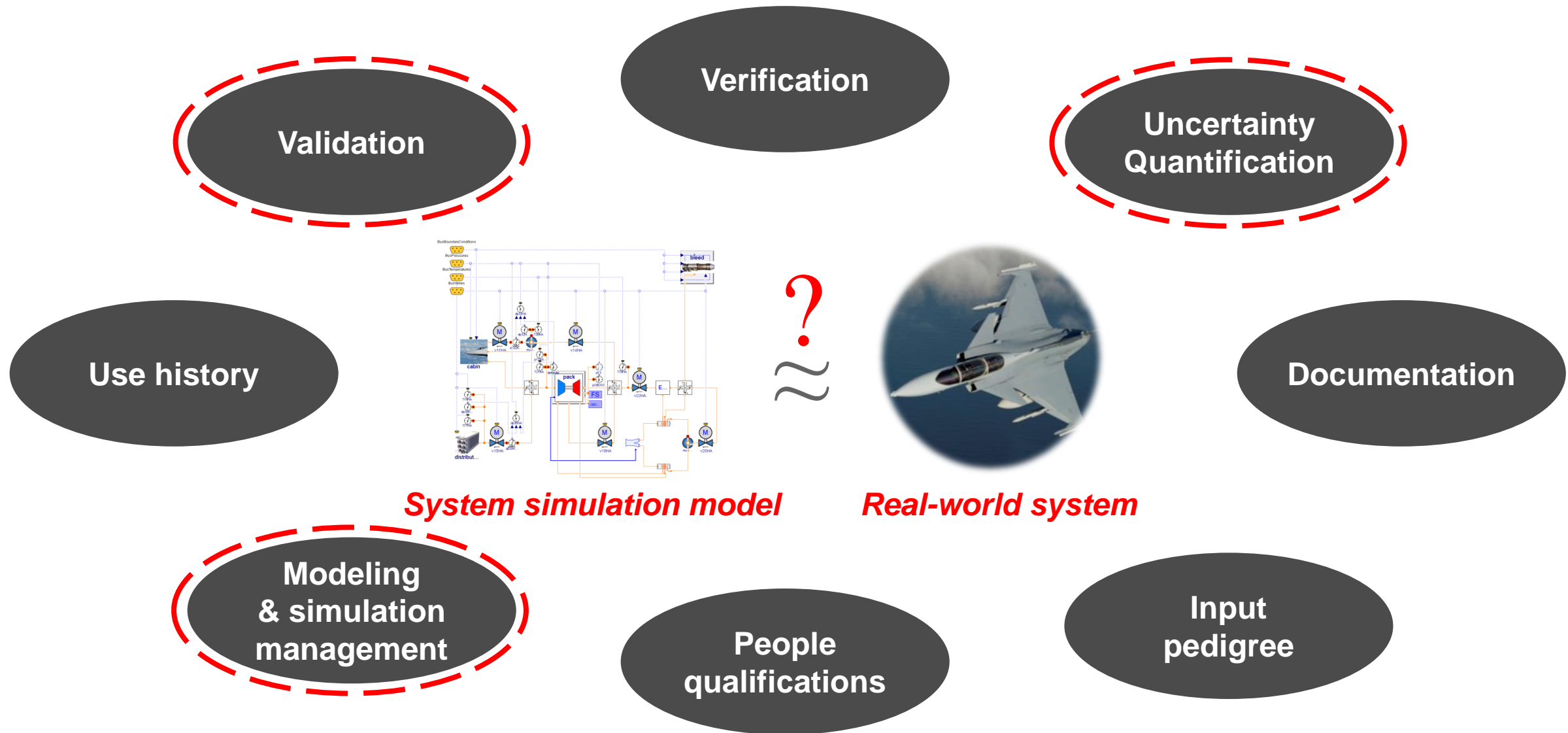
– WHY CREDIBILITY ASSESSMENT?



- System development is based on modeling & simulation
- But can we trust the models?
- Credibility assessment needed
 - **During** system development
 - From **subsystem to system** level
(fuel system) (aircraft)
- Risk reduction
- Improve decision support
- Enable a successful use of M&S

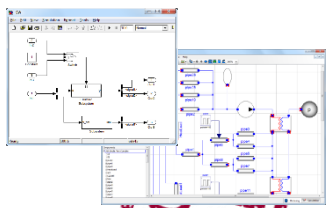


CREDIBILITY ASSESSMENT?



Development
Phases

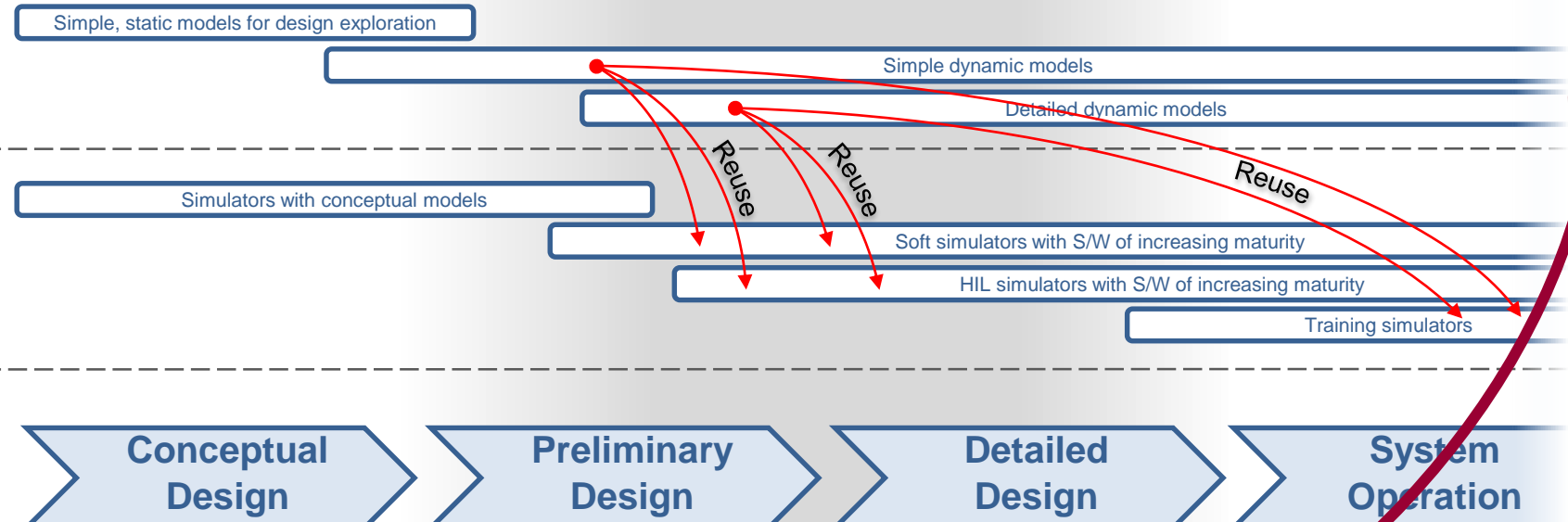




Models

Simulators

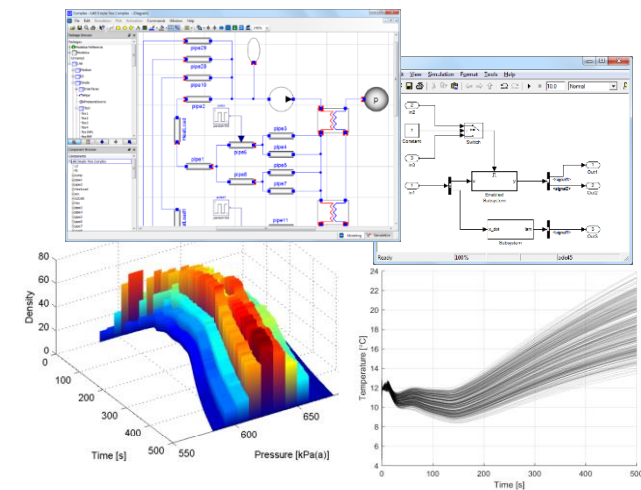
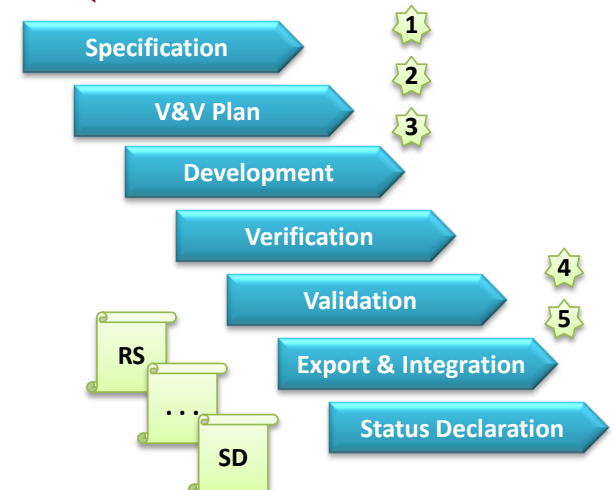
Development Phases



METHODS ON MODEL LEVEL

METHODS ON SIMULATOR LEVEL

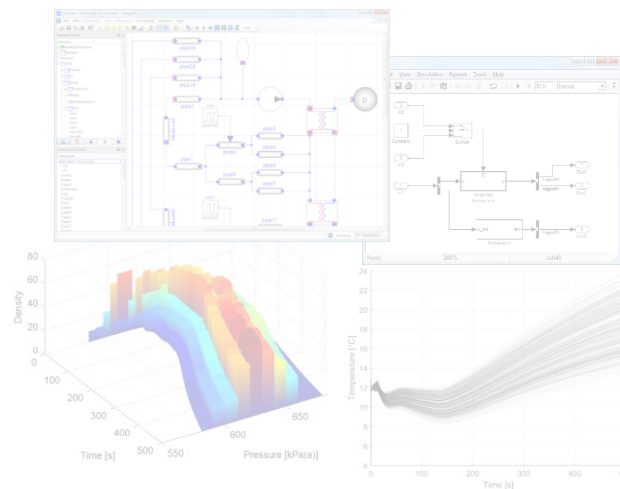
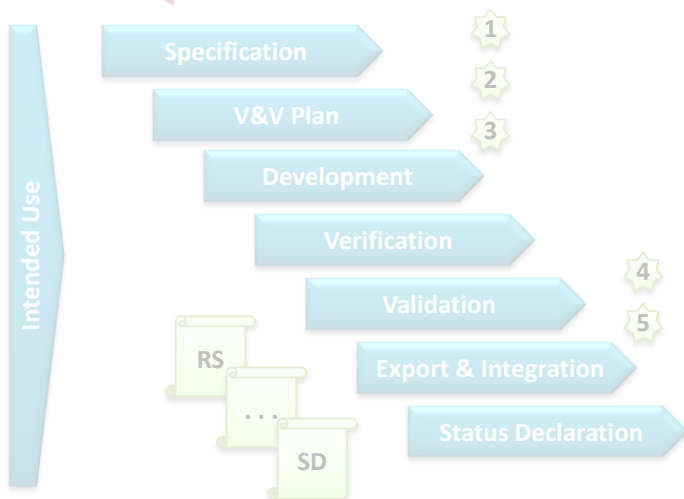
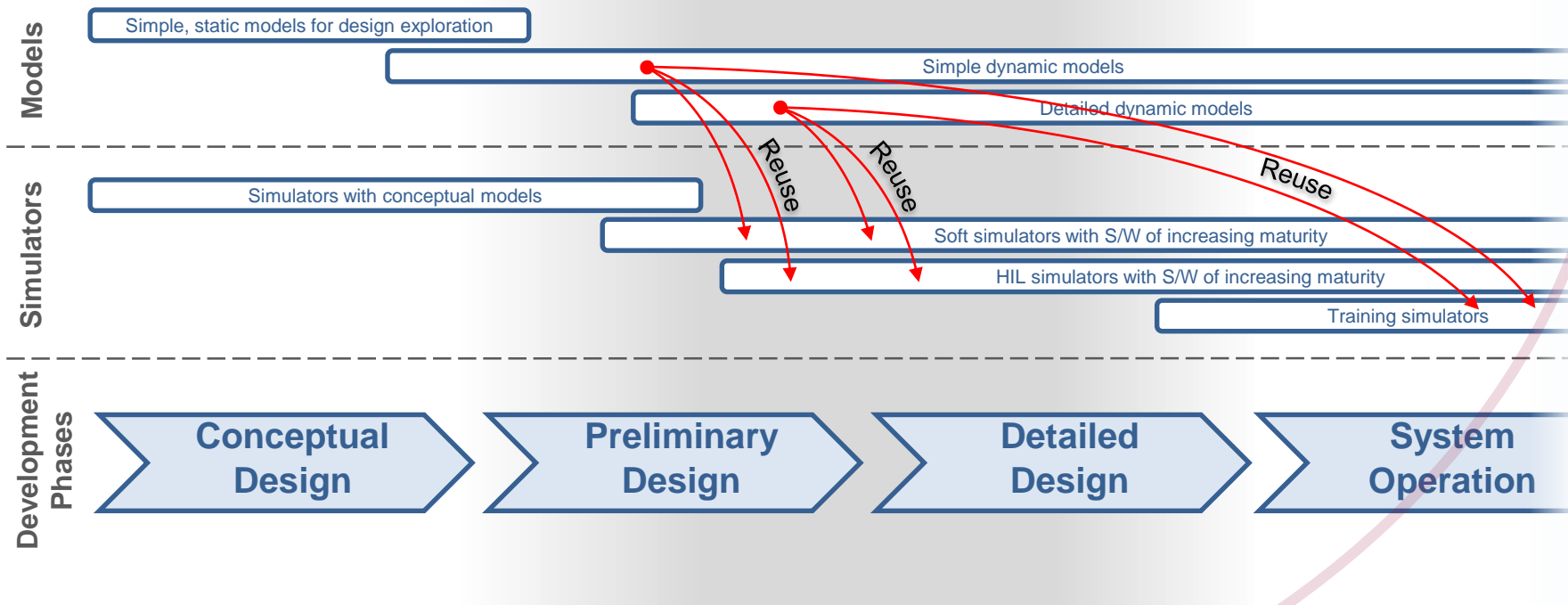
Intended Use



WAY OF WORKING

METHODS ON MODEL LEVEL

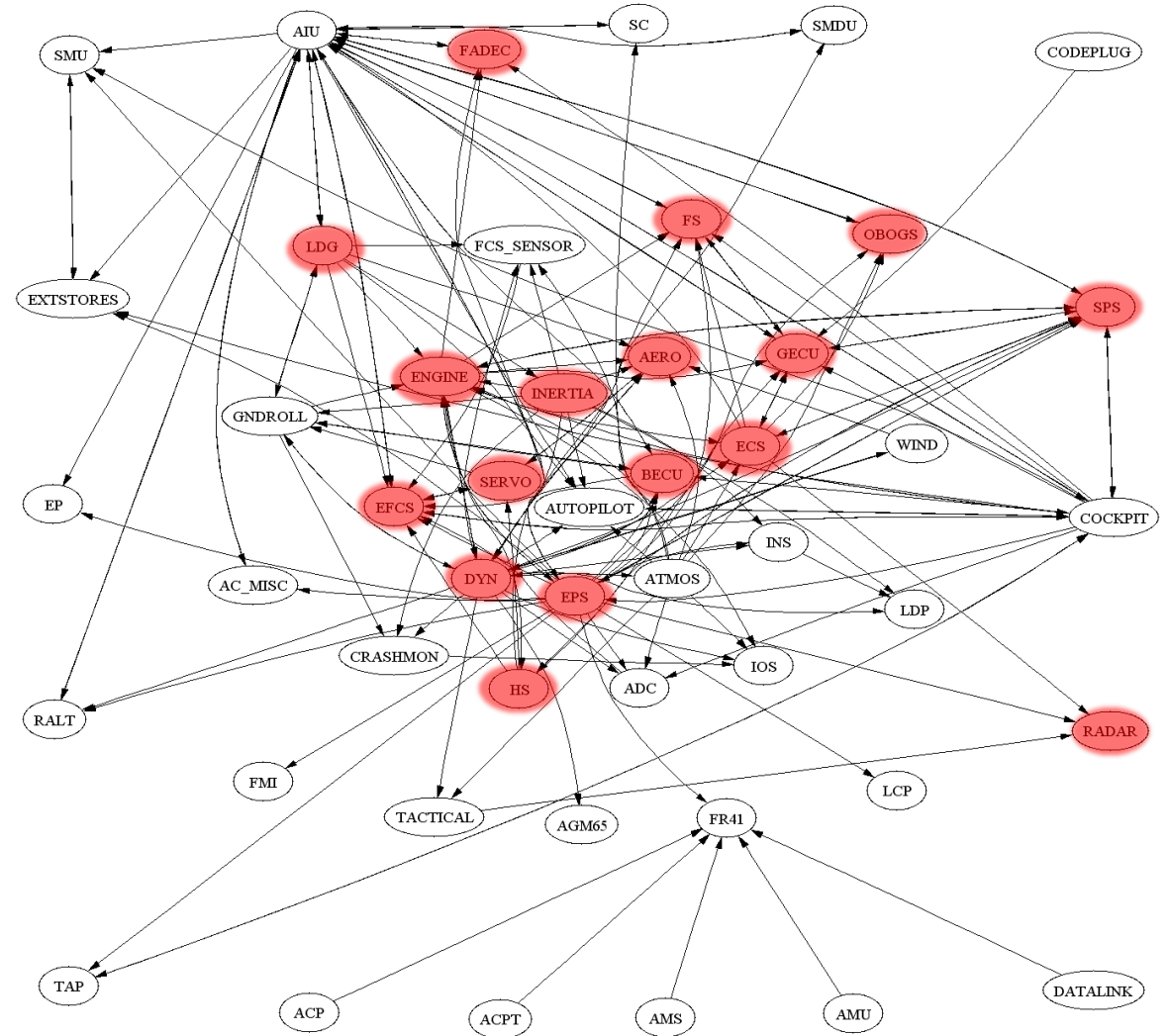
METHODS ON SIMULATOR LEVEL



SIMULATOR CREDIBILITY ASSESSMENT

– NEEDS

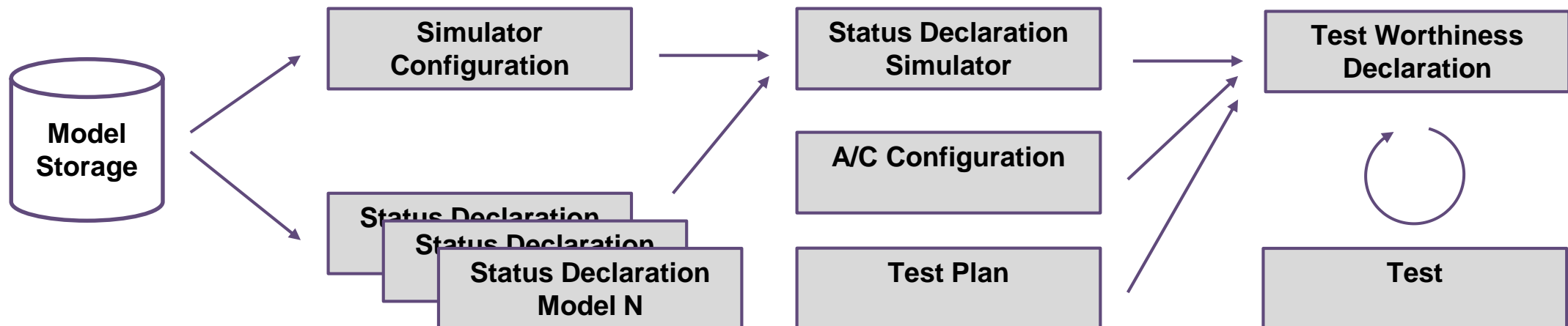
- Provide **user understanding** of what can be expected from a simulation
- Clear and straightforward presentation of **credibility information**
- Support decision makers and simulator users in assessment of **test worthiness**



SIMULATOR CREDIBILITY ASSESSMENT

– NEEDS

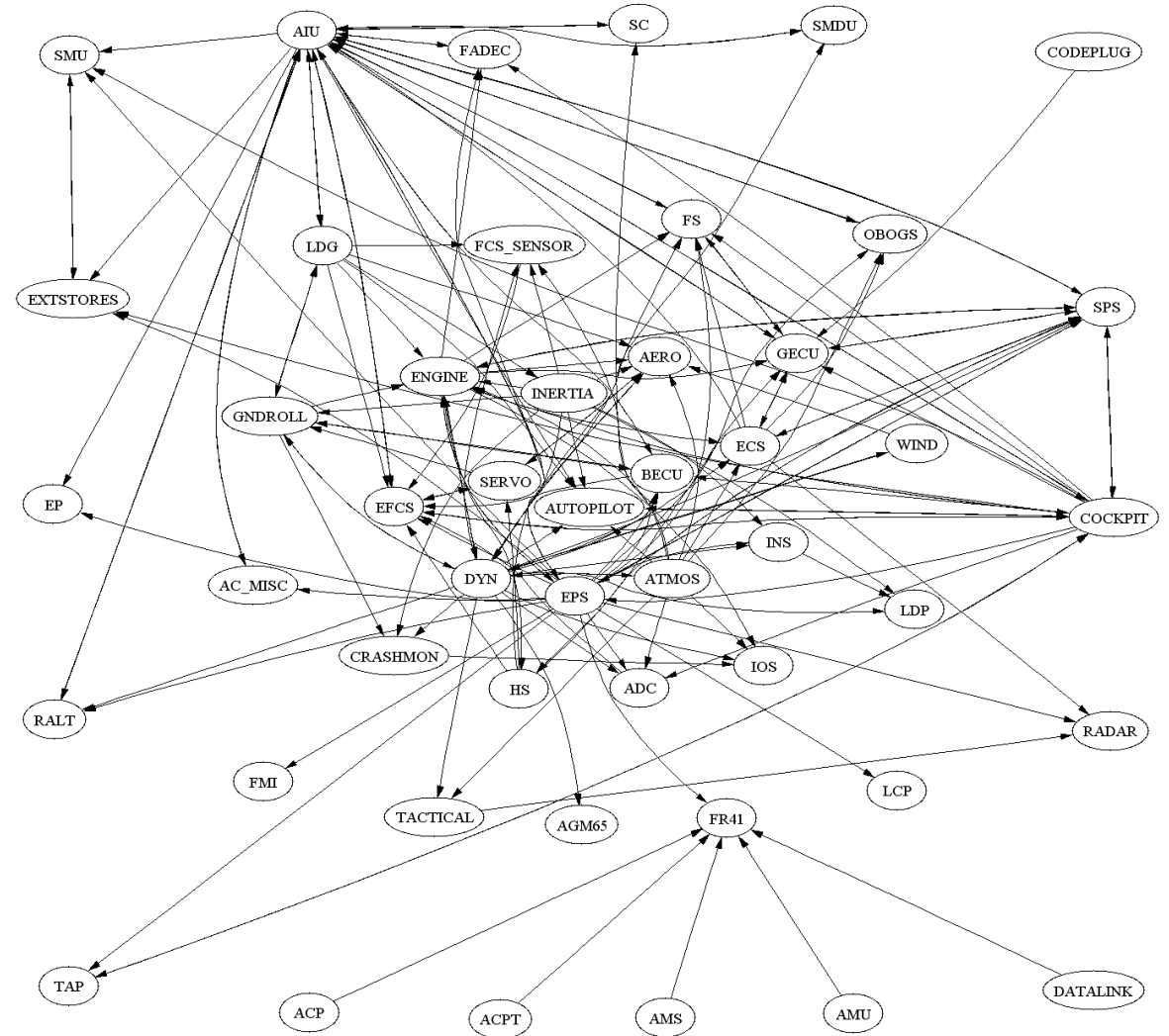
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SIMULATOR CREDIBILITY ASSESSMENT

– SOLUTION PROPOSAL

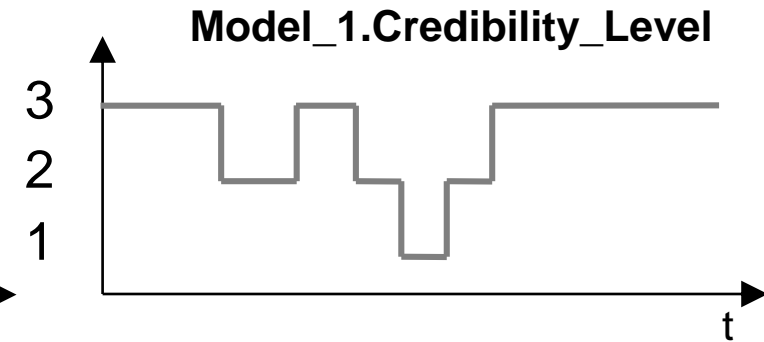
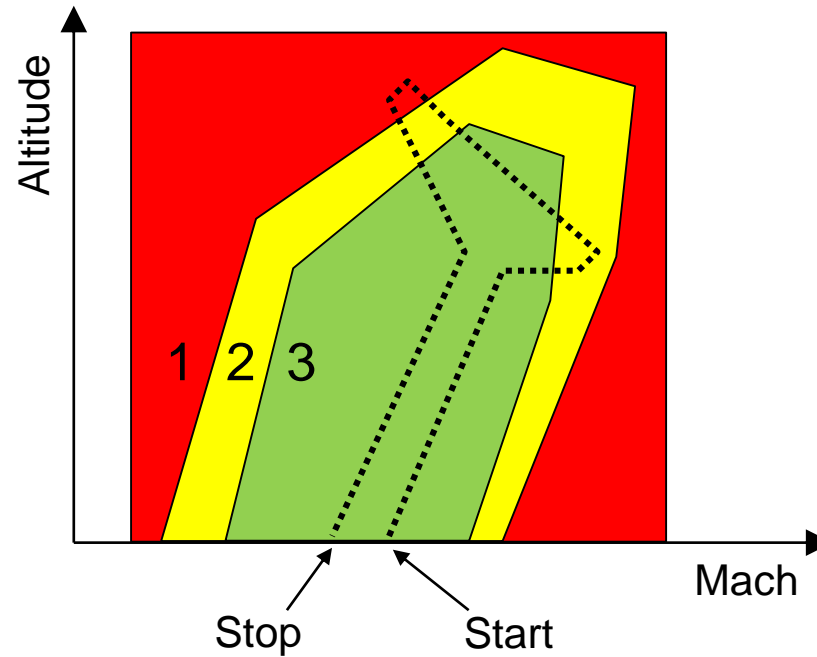
- Define a set of credibility measures for each individual model
 - **Static:**
 - System type (1..5)
 - Detail level (1..3)
 - Signal propagation (1..3)



SIMULATOR CREDIBILITY ASSESSMENT

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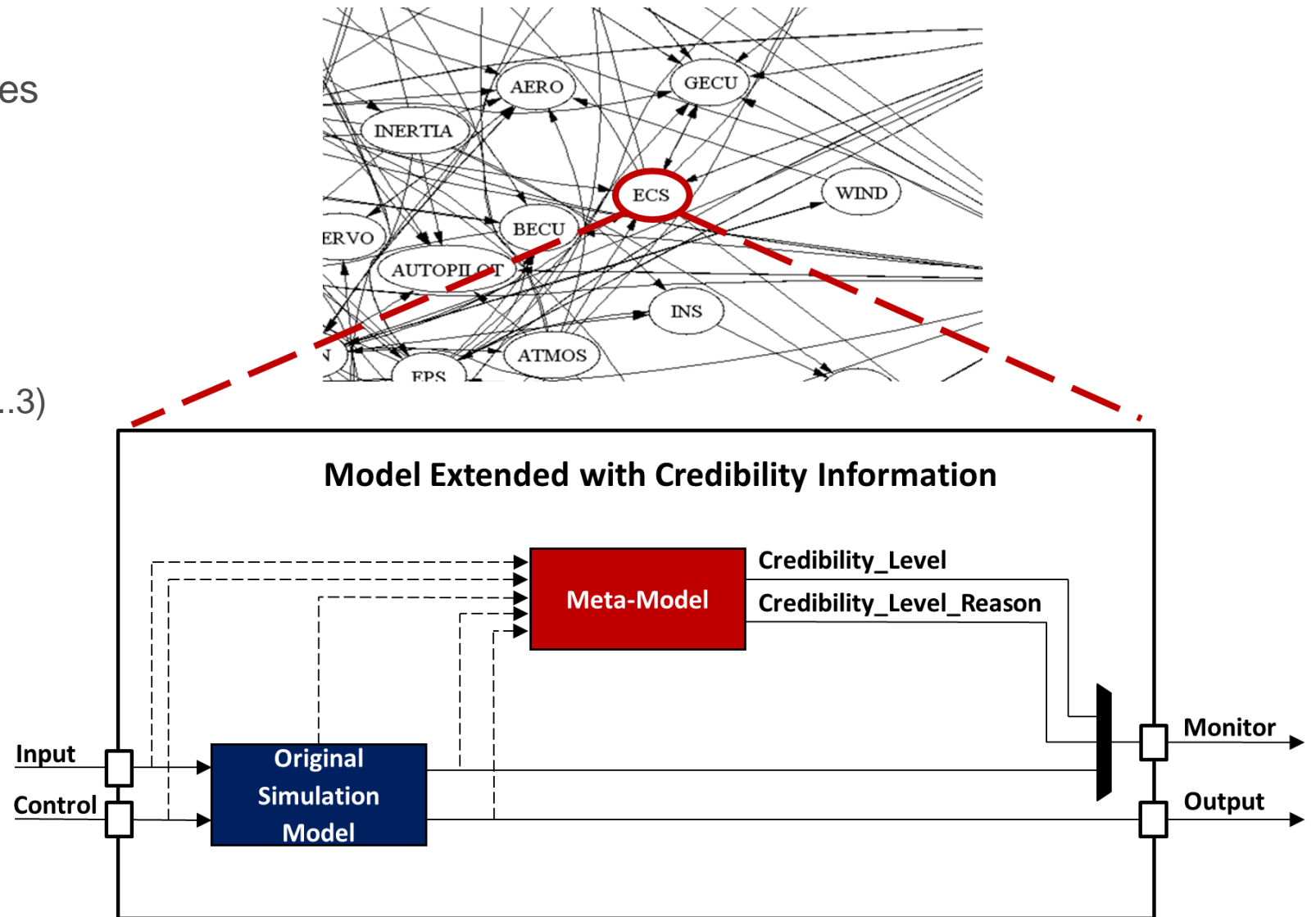
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 - Degraded credibility
 - Normal credibility



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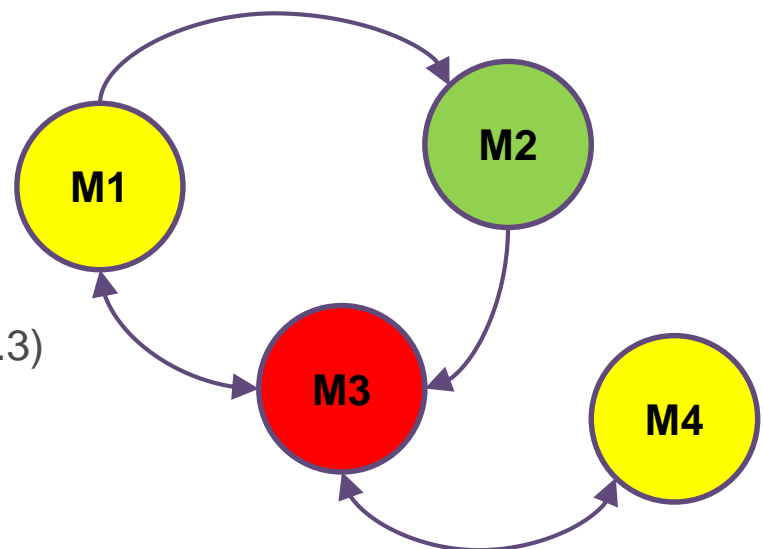
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- Visualization
 - Credibility information
 - Model dependencies



Dependency Graph

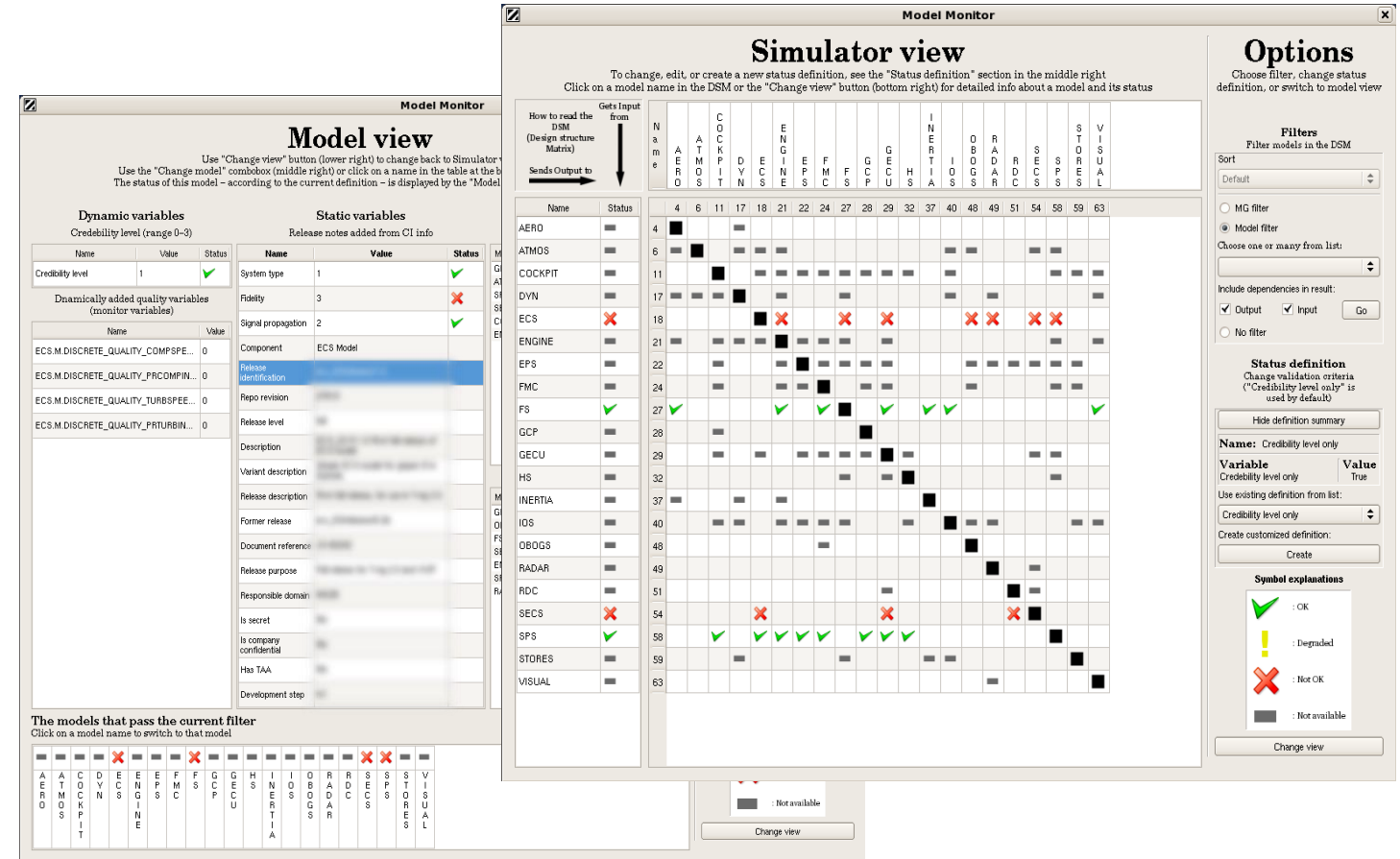
	M1	M2	M3	M4
M1		X	X	
M2			X	
M3	X			X
M4			X	

Design Structure Matrix (DSM).

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- Methods and conceptual tools implemented at Saab and VTI



SIMULATOR CREDIBILITY ASSESSMENT

– EVALUATION RESULTS

- Good complement to existing document-centric process
- **Facilitates continuous model improvement**
- Increased focus on test worthiness in daily practice
- **Provides a clear overview of model dependencies**
- Automatic aggregation and post-processing necessary
- Proper training of model developers, test engineers, and test leaders required
- **Reduce amount of erroneous conclusions from testing**
- **Reduce amount of unnecessary testing and related investigations**
- Increase test platform availability



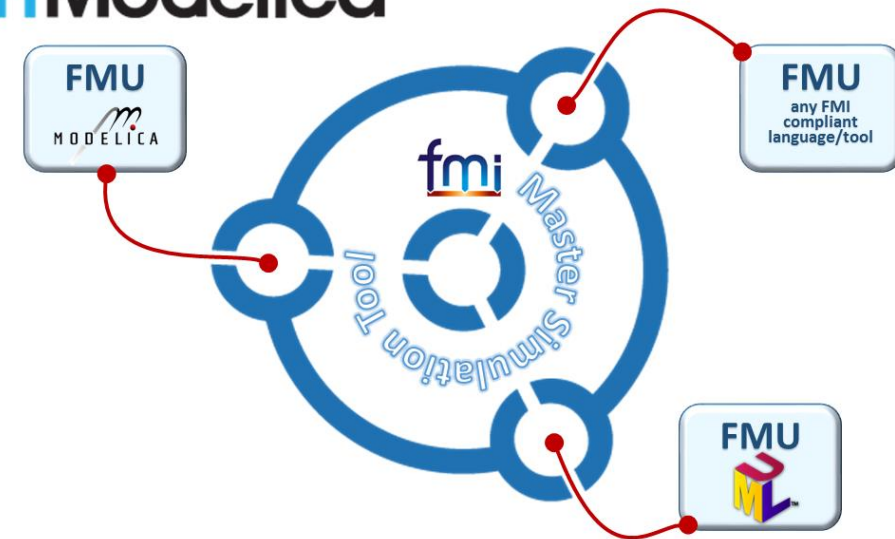
CONCLUSIONS & OUTLOOK

- Well suited for use in large-scale aircraft system simulators:
 - **Reasonable tradeoff**
 - **Industrial implementation** in Gripen E ongoing...
 - Further development: **V&V metrics** (e.g. NASA-STD-7009), **Fidelity levels** (e.g. ICAO 9625)
- Great responsibility on individual model developers, we need to increase:
 - **Collaboration** between model developers
 - **Involvement** of model end-users
 - **Automation** in model integration and V&V
- We need a **dedicated team** to **support** model developers

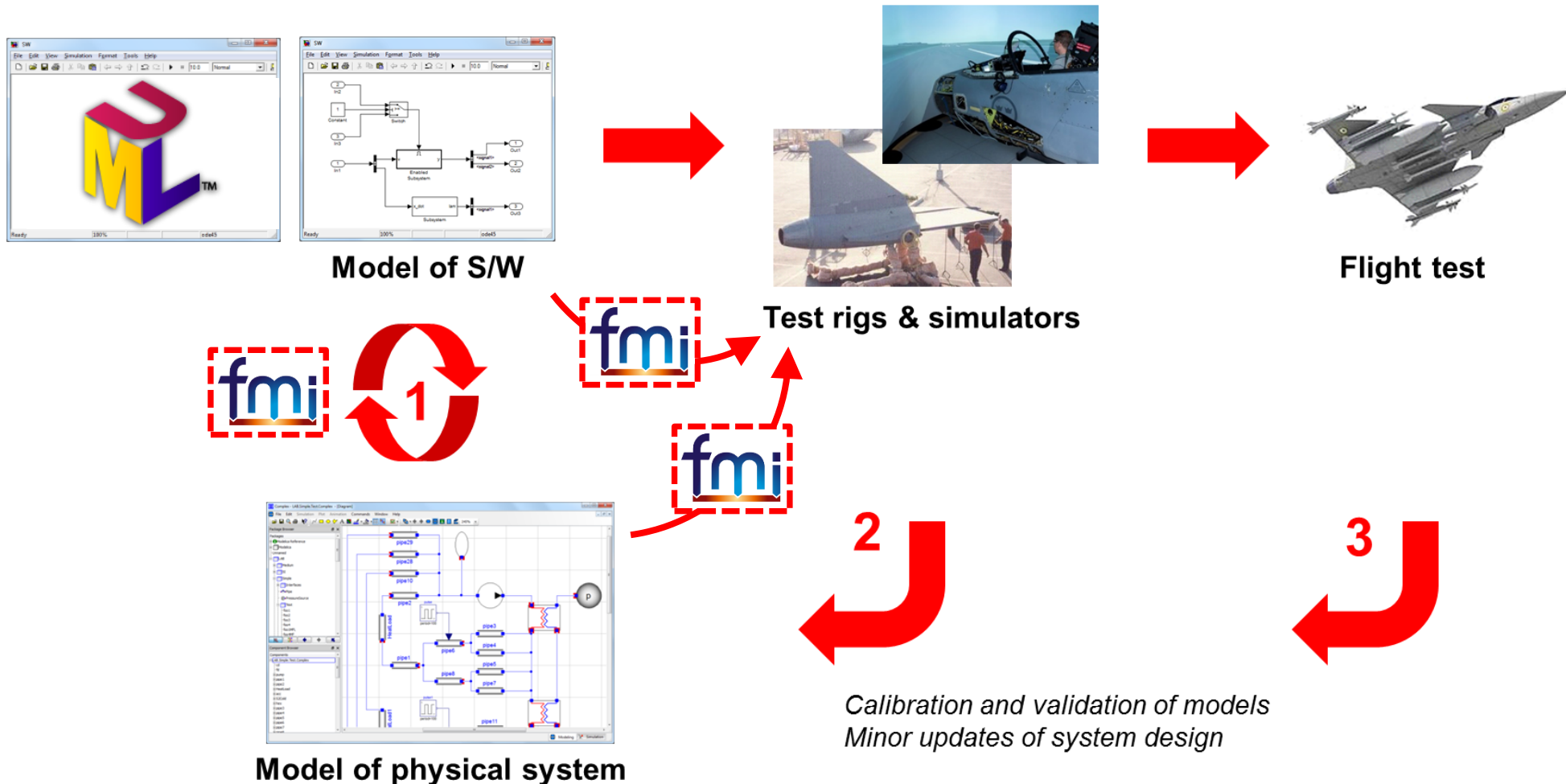
OPEN CYBER-PHYSICAL SYSTEM MODEL-DRIVEN CERTIFIED DEVELOPMENT

- EUREKA/ITEA3 project coordinated by Saab Aeronautics:
 - Duration 3 years, ending December 2018
 - Sweden, France, Finland, Hungary
 - 46.5 person-years, 6.5 M€, 18 partners
- General aim:
 - Interoperability of **Modelica** and **UML** via the Functional Mock-up Interface (**FMI**) standard
 - **Open source** development environment, significantly enhanced w.r.t. debugging, V&V, code generation, and simulation efficiency
 - Industry grade **FMI Master Simulation Tool**
- Saab aim:
 - Increased knowledge and influence on development of open tools and standards
 - More **efficient model integration** supporting **continuous model improvement and V&V**

OpenModelica



MODEL-BASED DEVELOPMENT OF GRIPEN'S VEHICLE SYSTEMS



QUESTIONS?

