



34th Annual **INCOSY**
international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024



Panel Building the digital bridge between MBSE and Engineering Simulation

Alexander Busch, PhD., CSEP (NAFEMS INCOSY SMSWG, Ansys)

Challenges and trends for connecting System Architecture Modeling and Behavioral Simulation

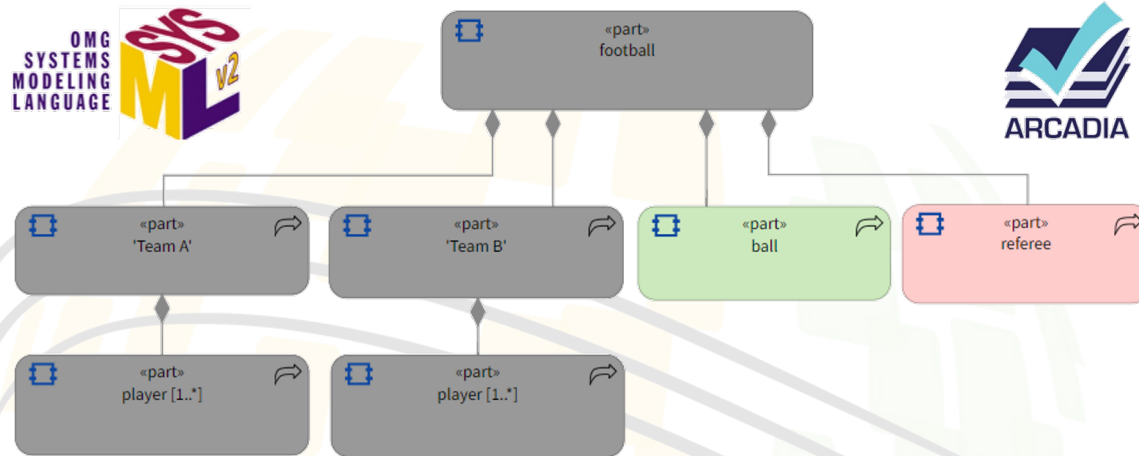
What do you mean?



Architecture Modeling



Defining the architecture of the System of Interest, system context, requirements, use cases, intended behavior ..., RFLP.



De-/Prescriptive → Specification
« What I want »

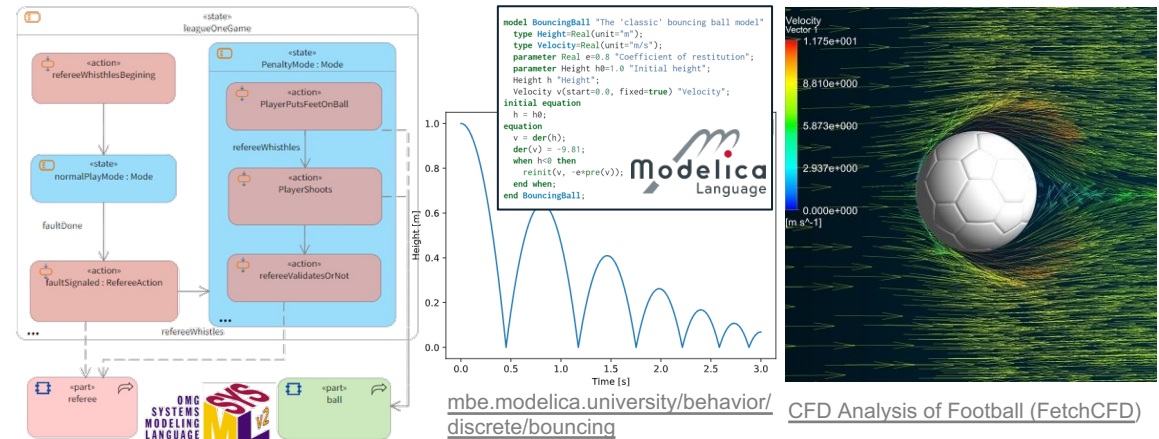


Behavioral Simulation



Simulating the behavior of the System of Interest

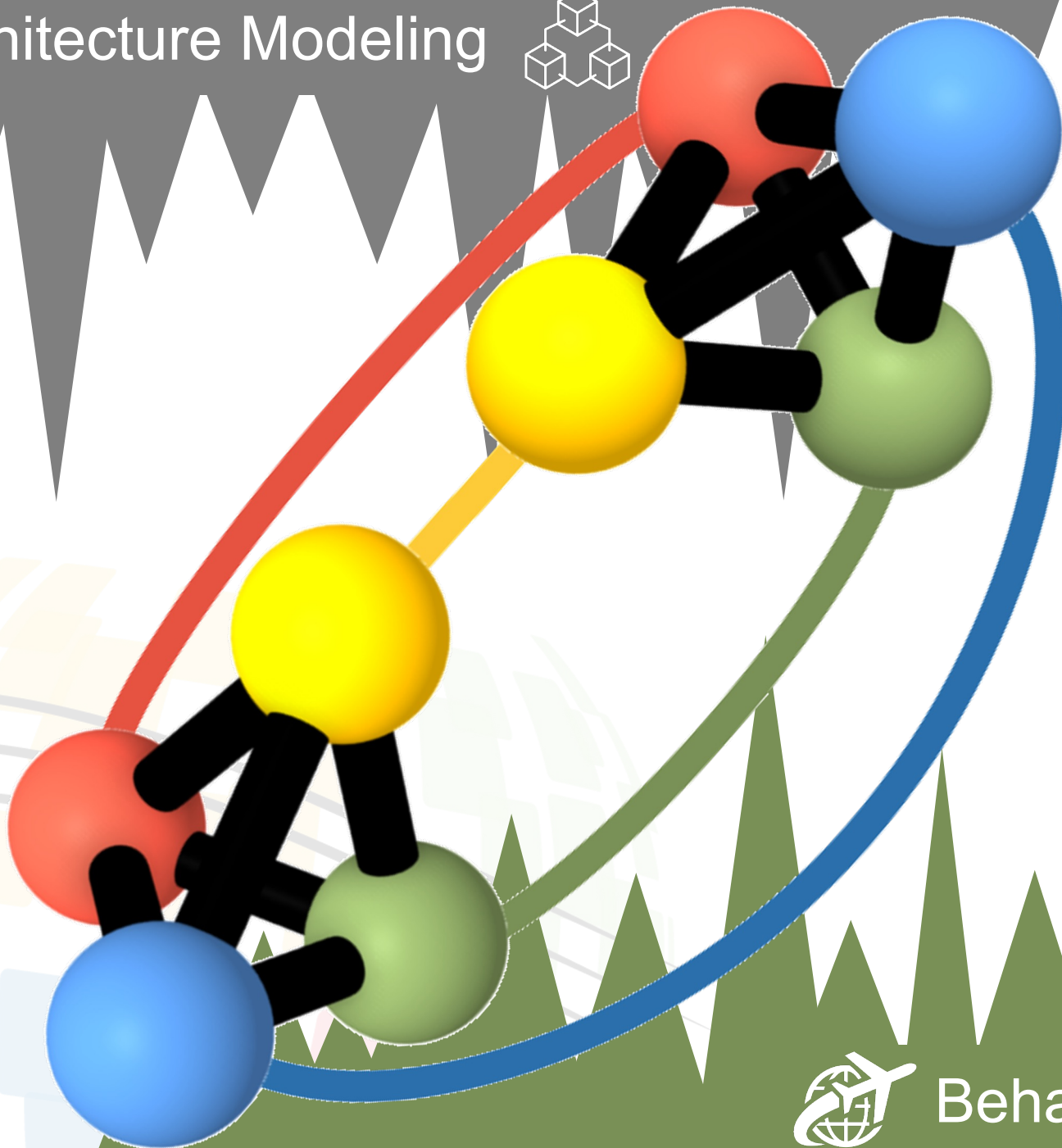
- Logical (e.g., fUML, State Machines, ...)
- Physical (Modelica, 0D...3D simulations)



Observative → Analysis
« What I likely get »



Architecture Modeling



5 July 2024

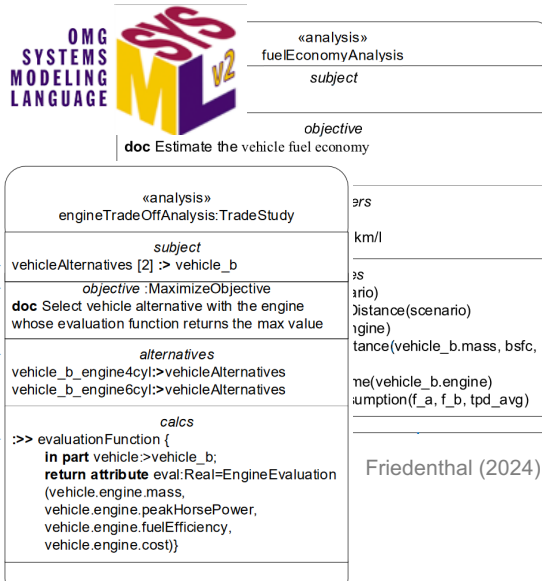


Behavioral Simulation



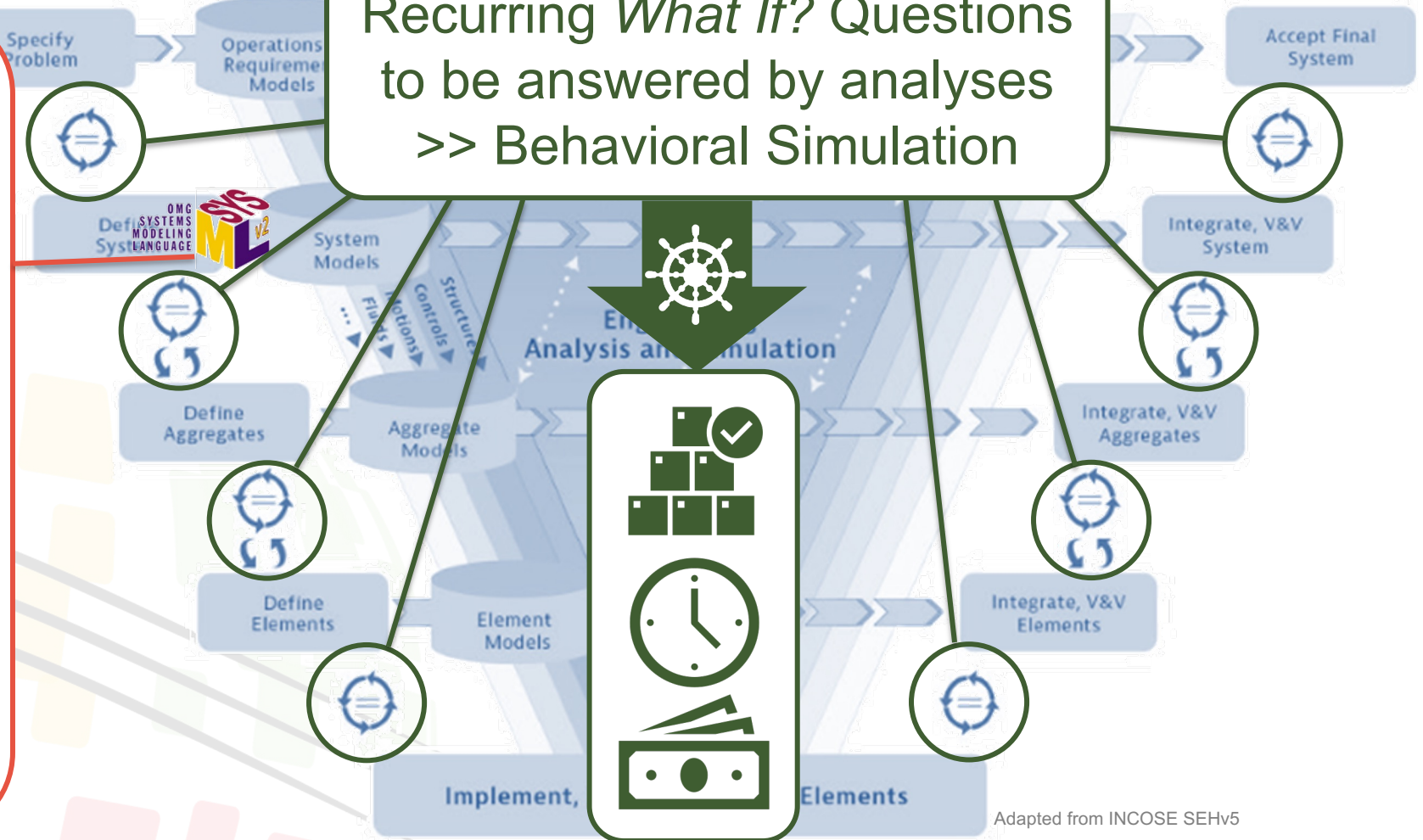
Why should I bother?

SysML v2



Verification Case
Analysis Case
Trade Study

Recurring *What If?* Questions
to be answered by analyses
>> Behavioral Simulation



Adapted from INCOSE SEHv5

HOW STANDARDS PROLIFERATE: (SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)

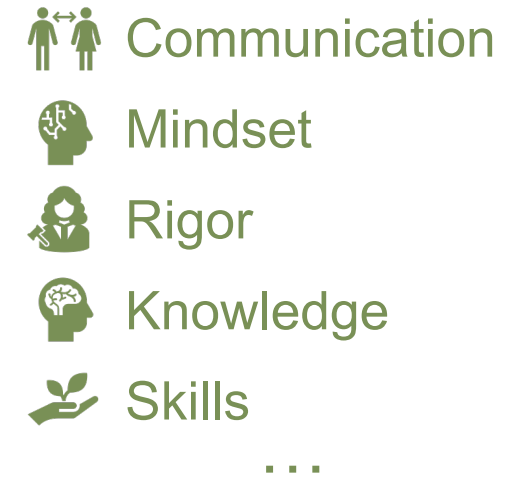
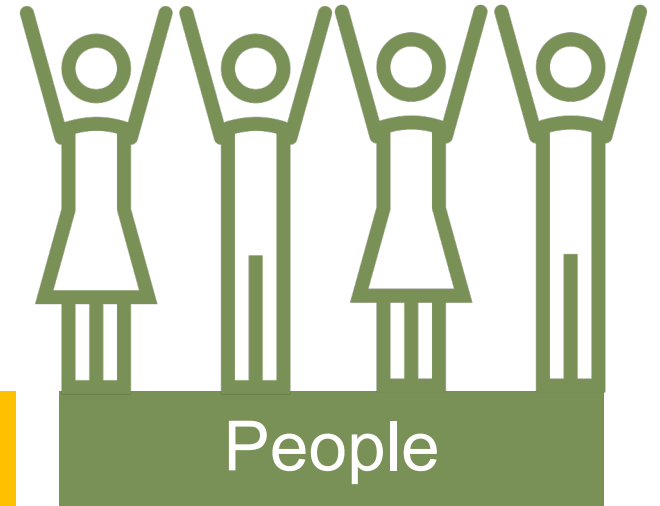
14?! RIDICULOUS!
WE NEED TO DEVELOP
ONE UNIVERSAL STANDARD

SOON:

Many good examples though



MBSE & Engineering Analysis Fundaments



A better model

Languages

Tools

Methodologies

People

-  Communication
-  Mindset
-  Rigor
-  Knowledge
-  Skills



2-6 July 2024

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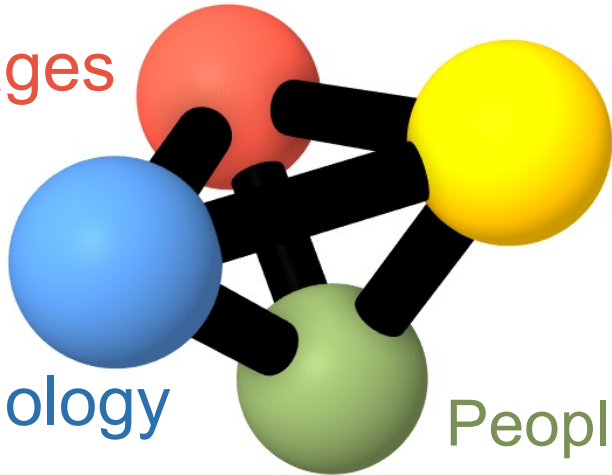
An even better model



Architecture Modeling



Languages



Tools

Methodology

People

Systems Engineer

needs are an early validation of the modeled architecture and the optimization of system properties by varying design variables in a design space.



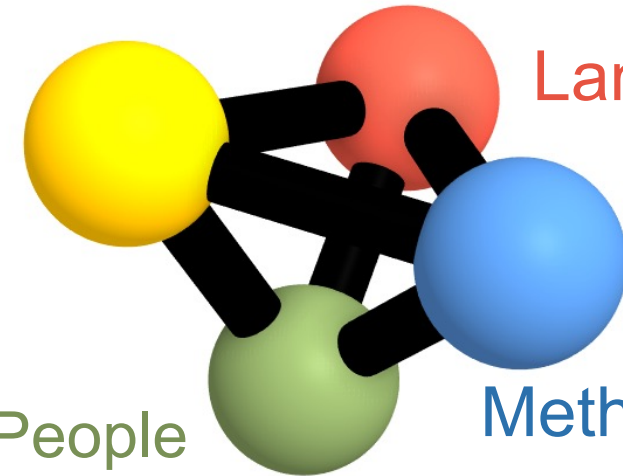
Customer \leftrightarrow Supplier
Relationship



Behavioral Simulation



Tools



Languages

People

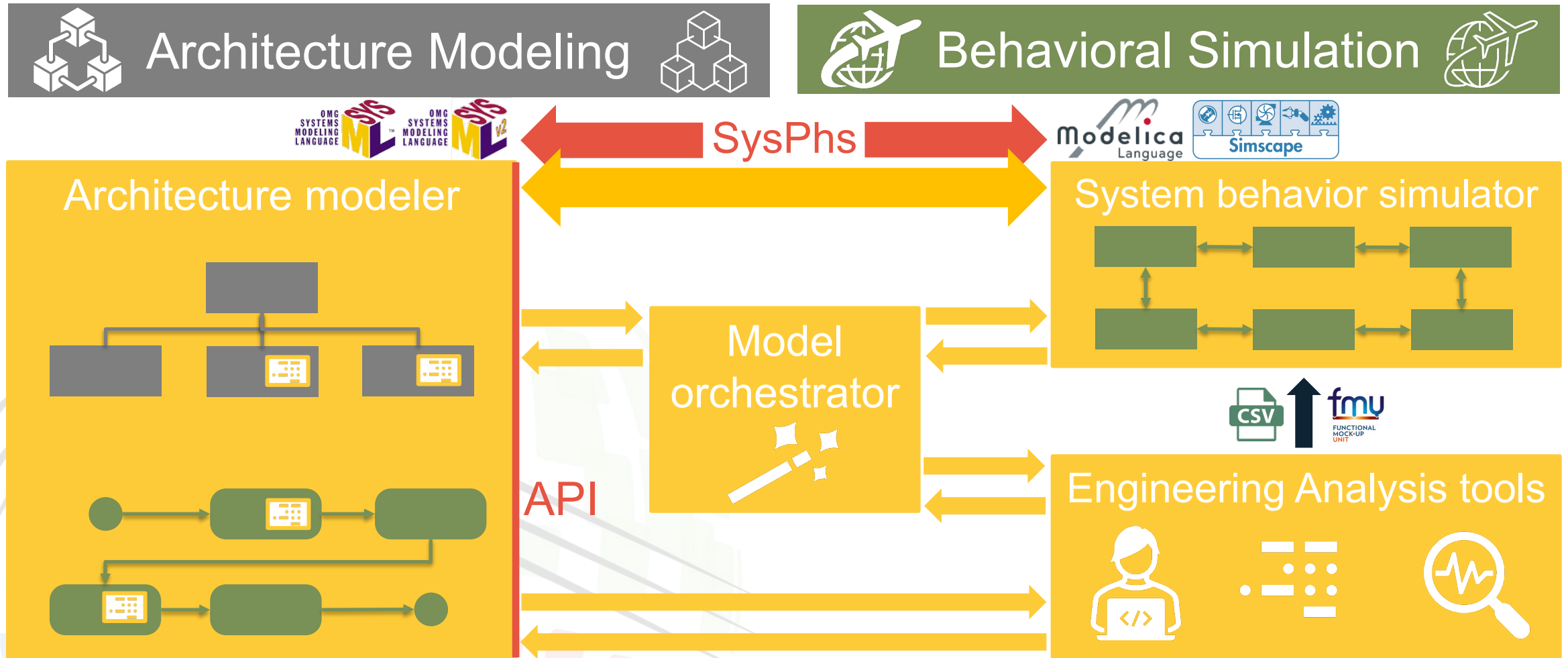
Methodology

Systems Analyst

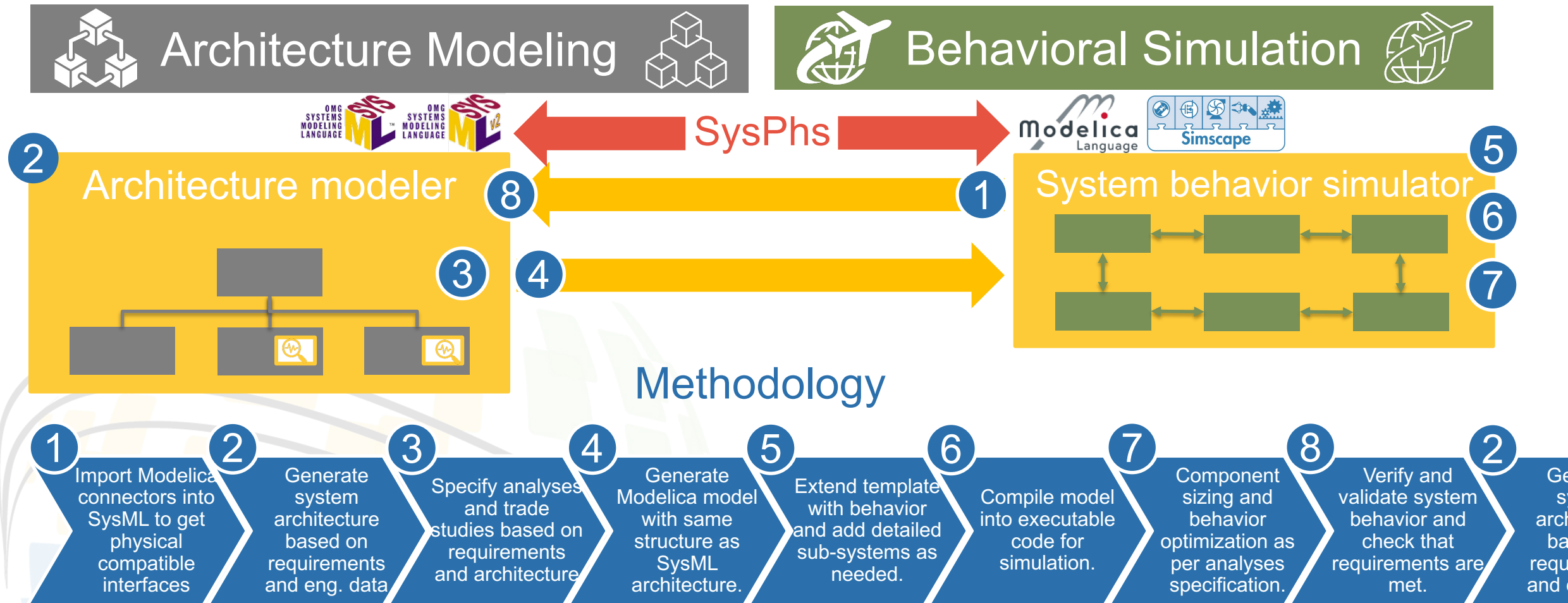
to satisfy the system analysis needs by simulation, but also to provide feedback on missing information in the SysML model to fulfill the required simulation.



Implement languages in tools...

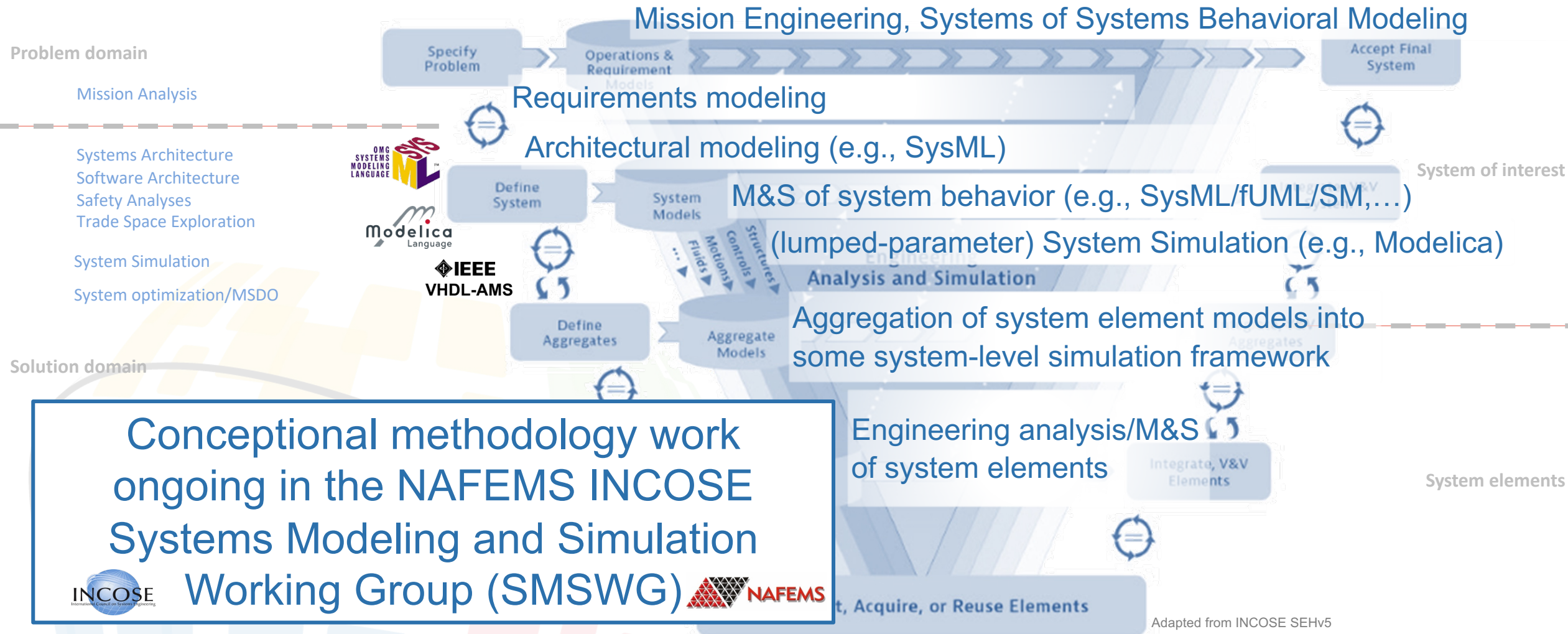


...and add methodology

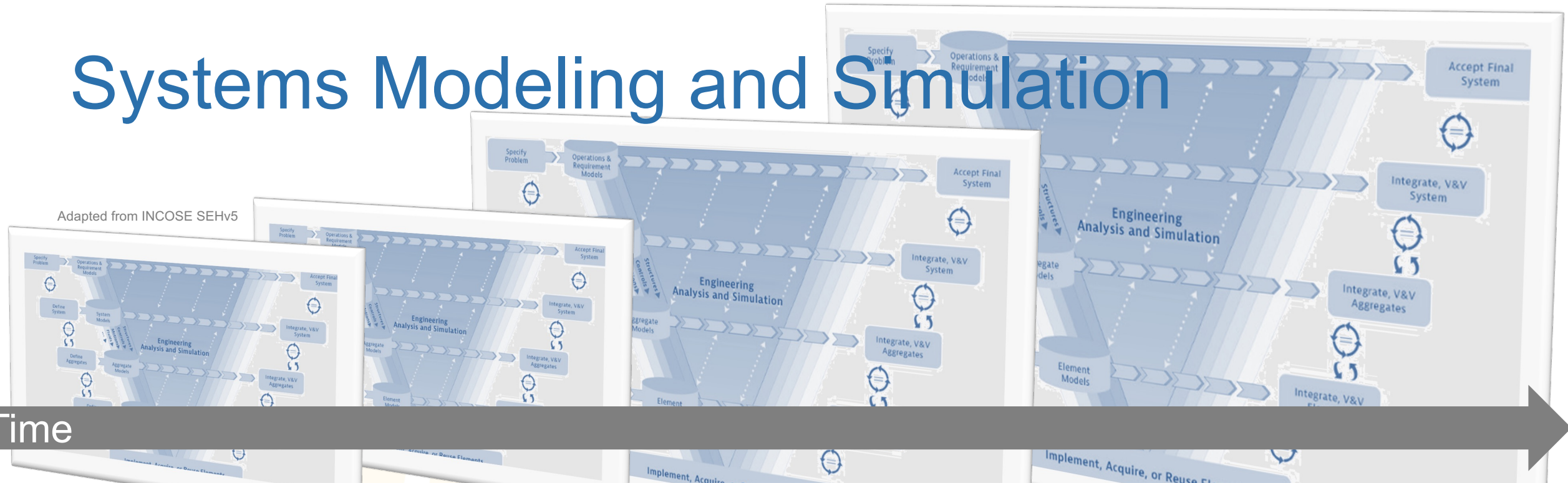


Adopted from "Open Standards SysML and Modelica Integration Strategy". Jyothi Matam and Saulius Pavalkis. Presented at the INCOSE Western States Regional Conference (WSRC) 2023.

Systems Modeling and Simulation



Systems Modeling and Simulation



Time

Mission Engineering, Systems of Systems Behavioral Modeling

Requirements modeling

Architectural modeling (e.g., SysML)

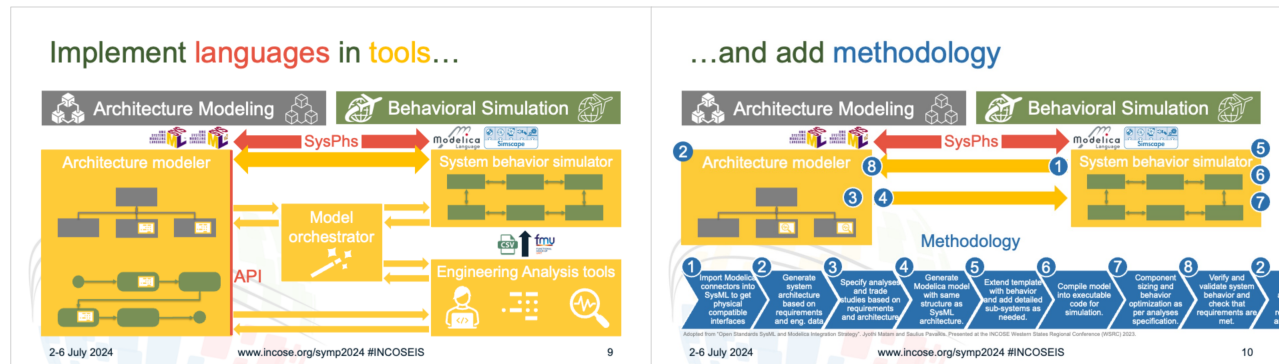
M&S of system behavior (e.g., SysML/fUML/SM,...)

(lumped-parameter) System Simulation (e.g., Modelica)

Engineering analysis/M&S of system elements

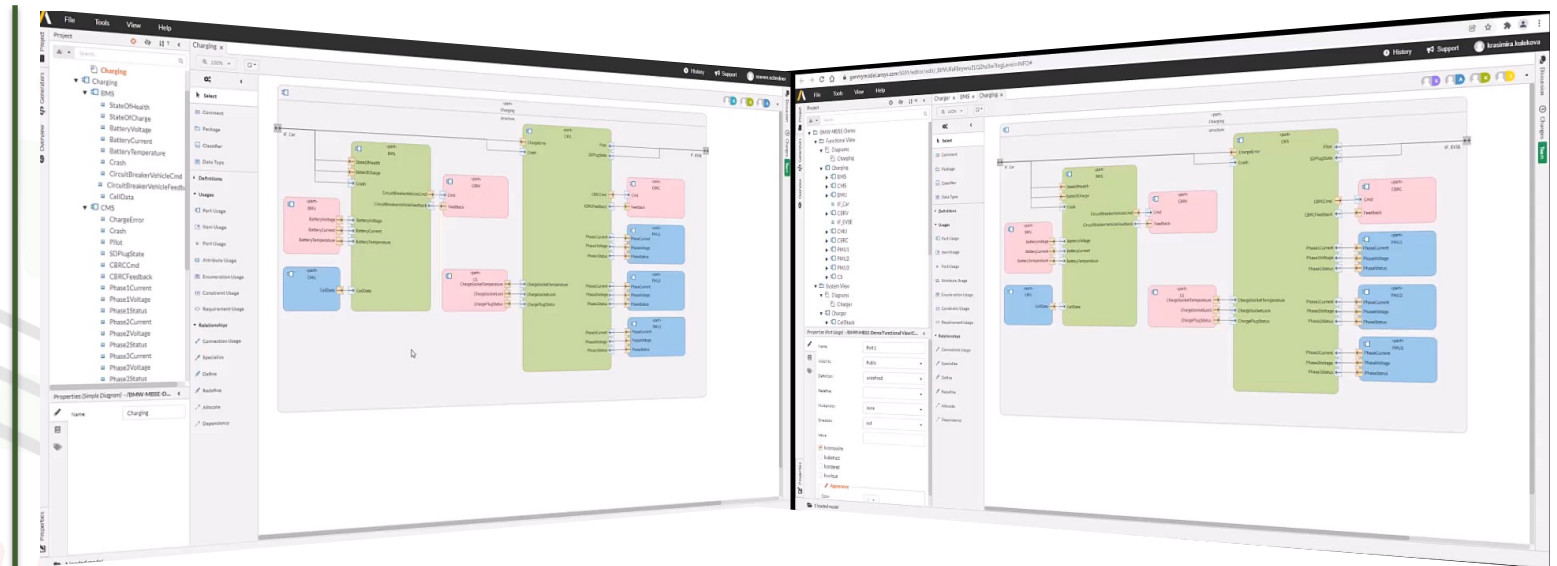
Aggregation of system element models into some system-level simulation framework

Real-time collaboration



We are not there yet for classical MBSE and M&S, which is often disconnected and sequential.

Real-time collaboration capabilities of modern **tools** will require more tool connectivity and automation as well as new **methodologies**.



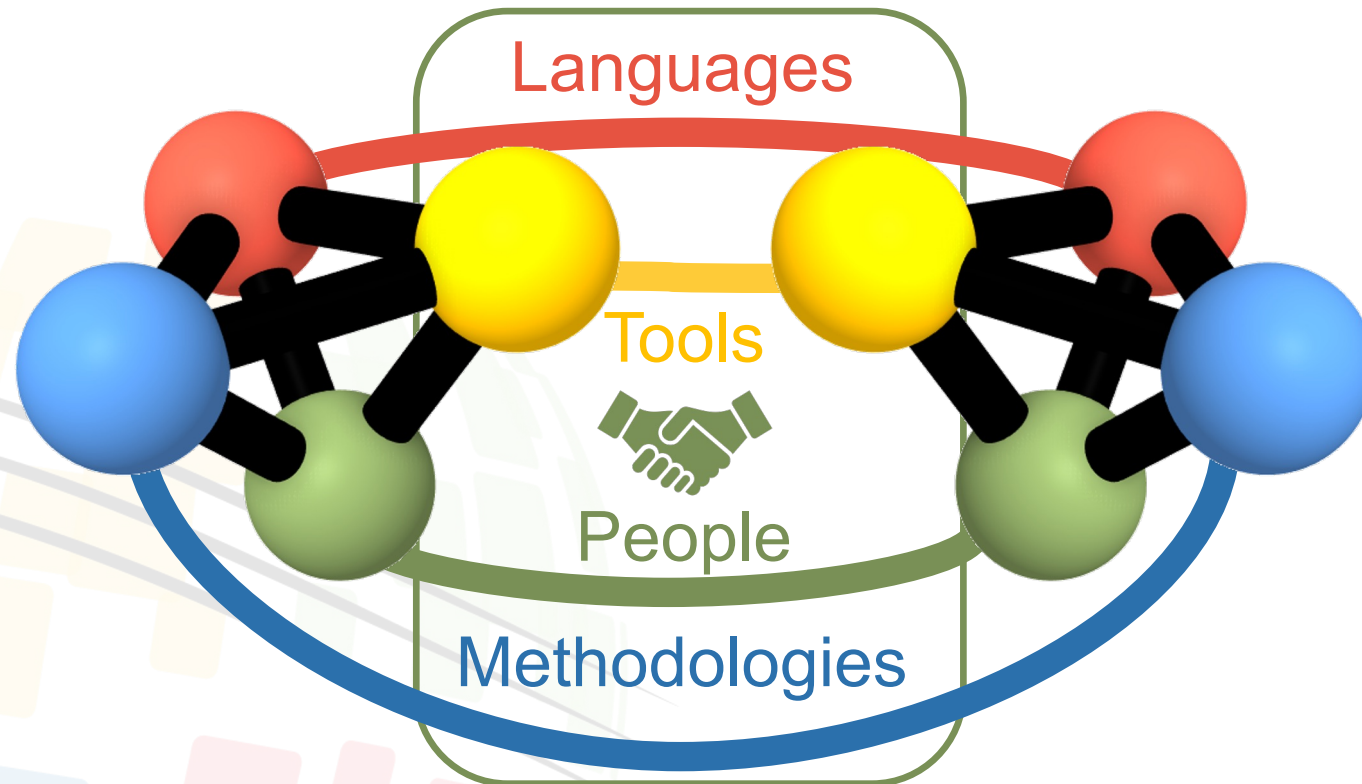
Take aways



Architecture Modeling

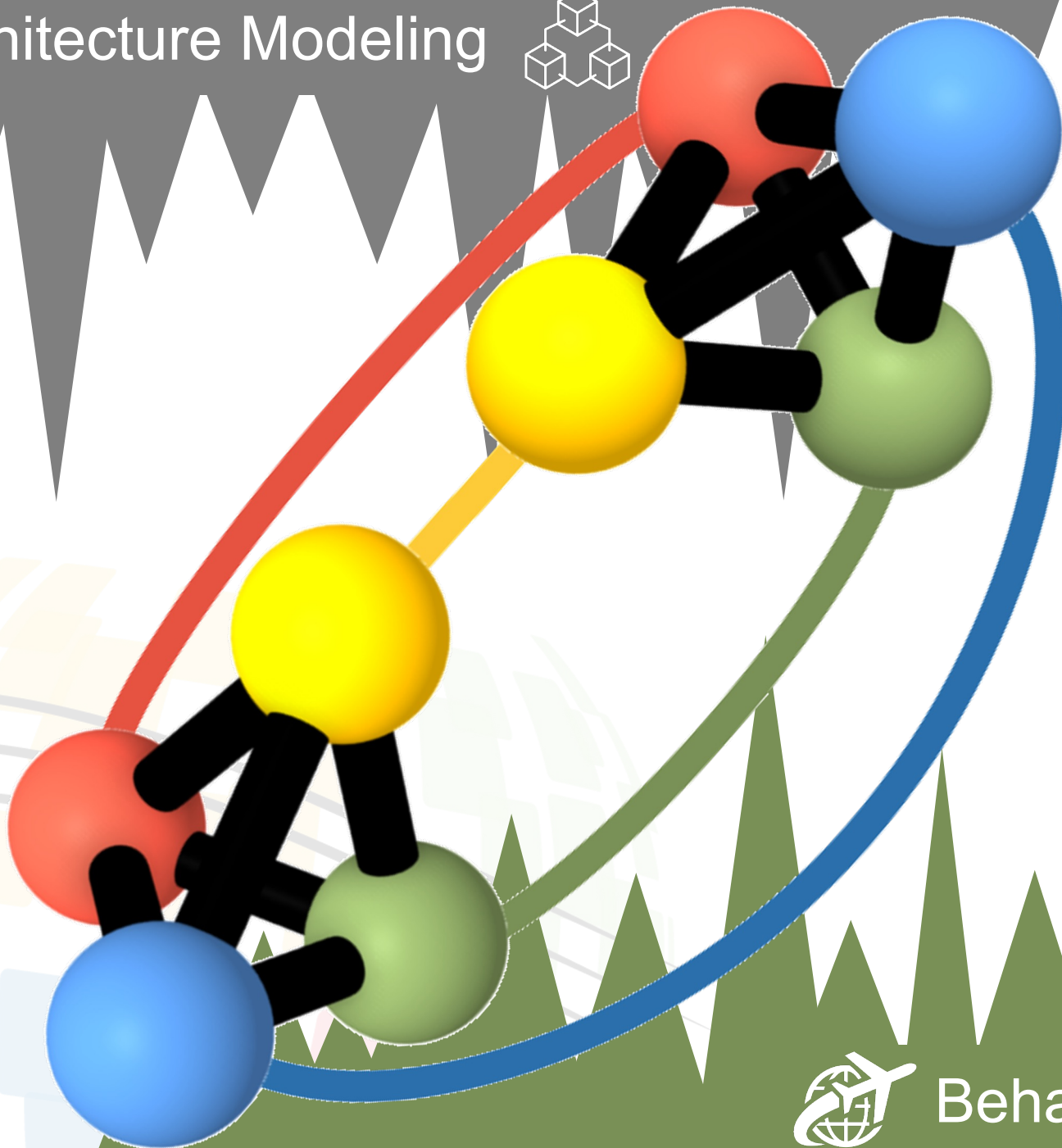


Behavioral Simulation





Architecture Modeling



Languages

Tools

People

Methodologies

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Behavioral Simulation





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