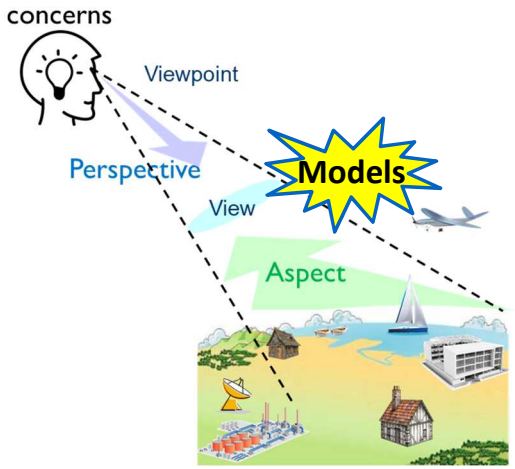
In partnership with

Models and simulation sustaining the whole life cycle of a system

From AFIS WG presented by Rémi Boutemy (Nexter Systems)

Introduction on modeling and simulation

- A model is an abstract representation of an entity.
  It allow expressing one or more stakeholder viewpoints on a subject or on an aspect of the subject.
  - Examples: Stakeholder viewpoints can be operational, system, technical, economic, legal, etc.
  - Examples: Aspects can reflect behavioral, security, safety, etc.
- Simulations are means to replace real entities for different reasons.
  - Examples: simulation of product not already existing, simulation disasters, crowd simulation, simulation of a phenomenon not implementable on earth, low cost training, etc.
- When an entity is replaced with its model(s), simulations are means to evaluate these models —and allow decision making about the real entity — according to criteria.
  - Examples: Criteria includes performance, availability, resilience, etc.
  - Note: peer reviews, prototyping and mockups are other means to evaluate models.
- Simulation can be useful to explore new concept before identification of entities. Variation of parameters allow to explore the solution space.
- Simulation can other be use to characterize the environment of a system or a component of interest.
  - Example: a processor firmware can be developed and tested before development of the chip with usage of VHDL, SystemC, RTL simulation.

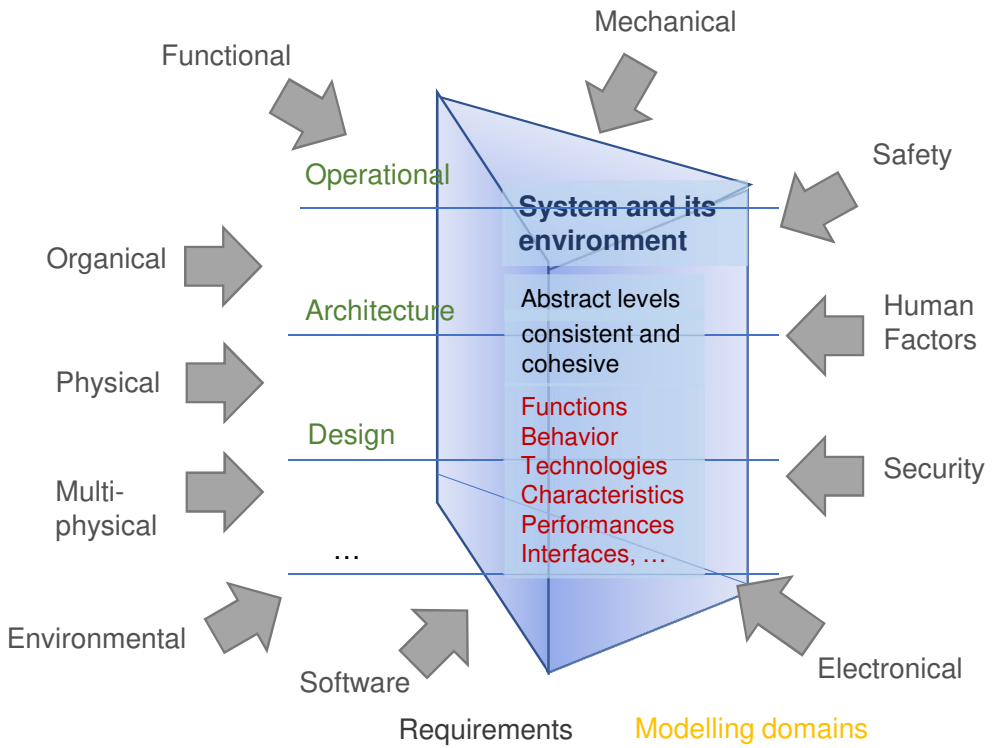


Source: Jean-Luc Garnier about the ISO/IEC/IEEE 42010 terminology

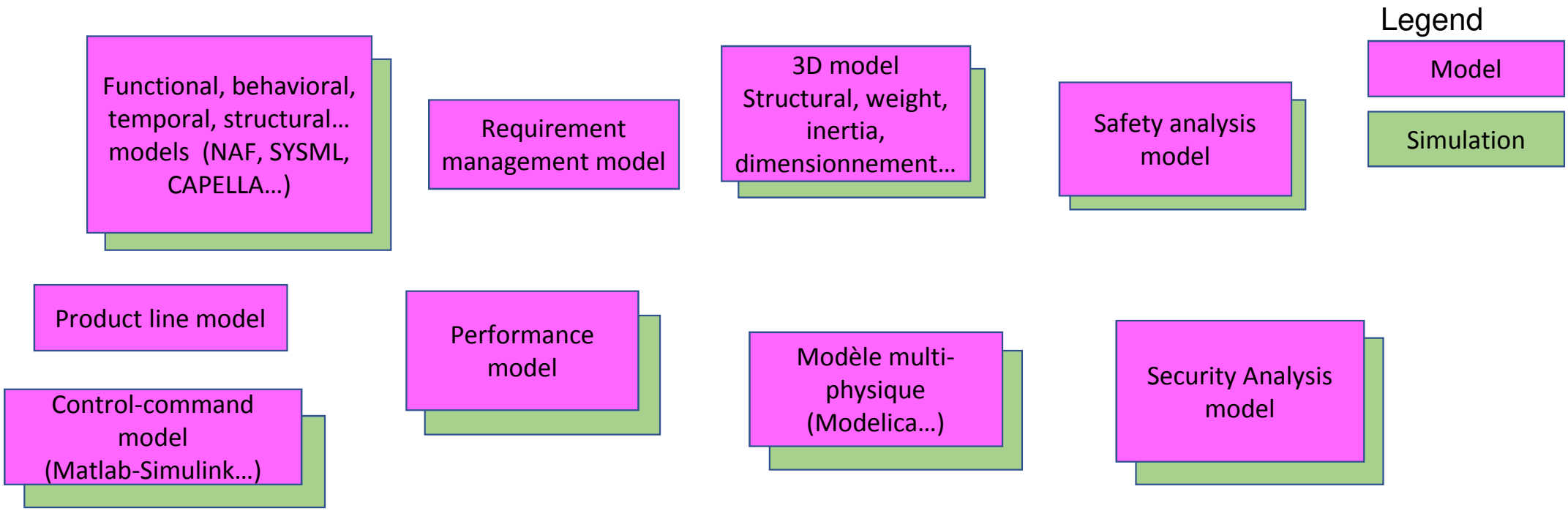
Definition: System Model
(Based on ISO 24641 MBSSE)

A system model:

- Is an abstract representation of a **system and its environment**, throught **multiple views** and with **various degrees of formalism**.
- Supports planning, requirements, **architecture, design, analysis, verification, and validation**, throughout the life cycle of the system.
- Can include a combination of geometric, quantitative, and logical models.
- Often spans several **modeling domains** such as different systems (e.g., thermal, power), **different technology domains (e.g., hardware, software), and different characteristics (e.g., physical, performance)**.
- Must be integrated to ensure a **consistent and cohesive** system representation.
- Enables the design of a system that satisfies its **requirements** and supports the allocation of the requirements to the system's components.
- Identifies the components, at a particular **abstraction level**, as black boxes and addresses their **interfaces, behavior, performances and qualities**, but not model their internal design.

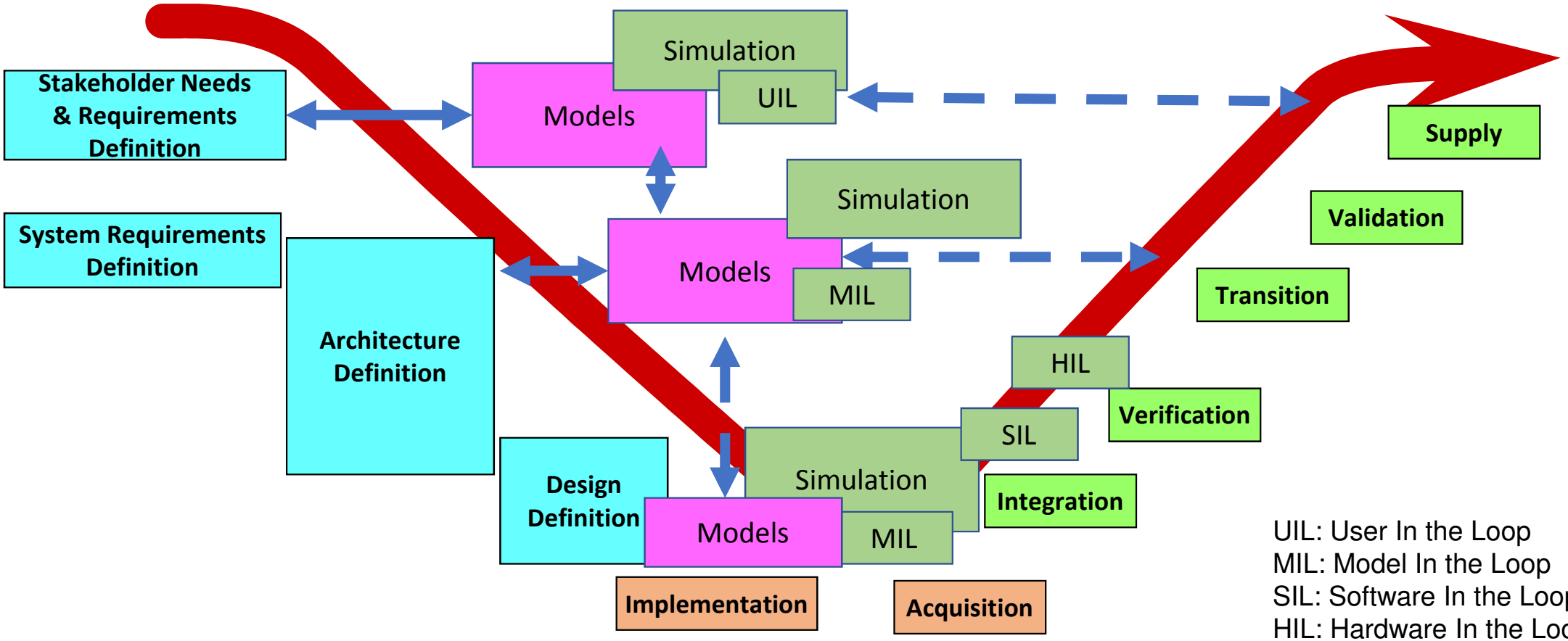


Some examples of system models & simulations
(non-exhaustive list)



Analyze, understand, identify the environment	Explore, simulate, validate the operational concepts	Formalize the problem and the needs; Elicit requirements	Build/evaluate the functional and physical architectures	Foresee, validate, demonstrate the behavior; Simulate	Assess performances, security, reliability and safety; Simulate	Capitalize, Reuse	Share knowledge; Think about the System	Train

Model-Based Systems Engineering



UIL: User In the Loop
MIL: Model In the Loop
SIL: Software In the Loop
HIL: Hardware In the Loop

ISO/IEC/IEEE 24641 (under development)
Systems and software engineering – Methods and tools for Model based systems and software engineering

Some concrete examples of system models
A lot of models are not directly executable

- Models describing facts are situations:
  - Physical Structure
  - Organization
  - Capabilities
  - Dependences
  - Configurations

  - Costs & Risks,
  - Ontologies
  - Mind maps
  - Decision Trees
  - Etc.

- Models describing expectations and fears:
  - Trends (profitability, weather forecast, people migration, etc.)
  - Programmatic views
  - Attributes and non-functional properties
    (Resilience, Reliability, Maintainability, Availability, Security, Safety)
  - Human Factors

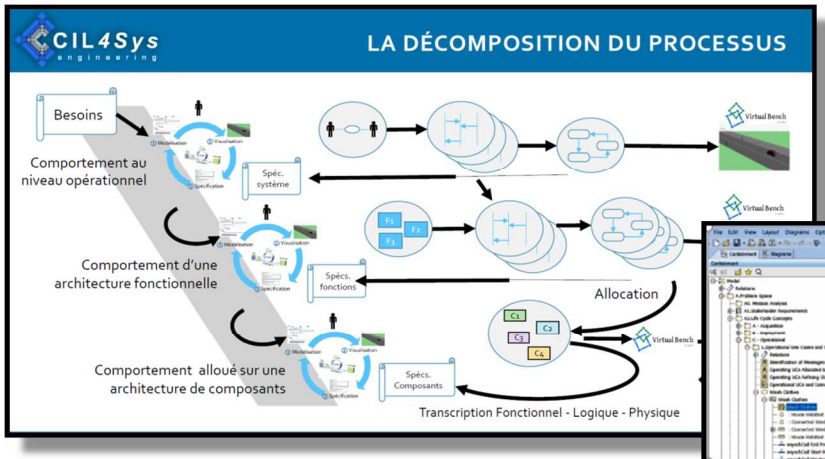
  - Value chains and networks
  - Costs and risks,
  - Decision chains
  - Etc.

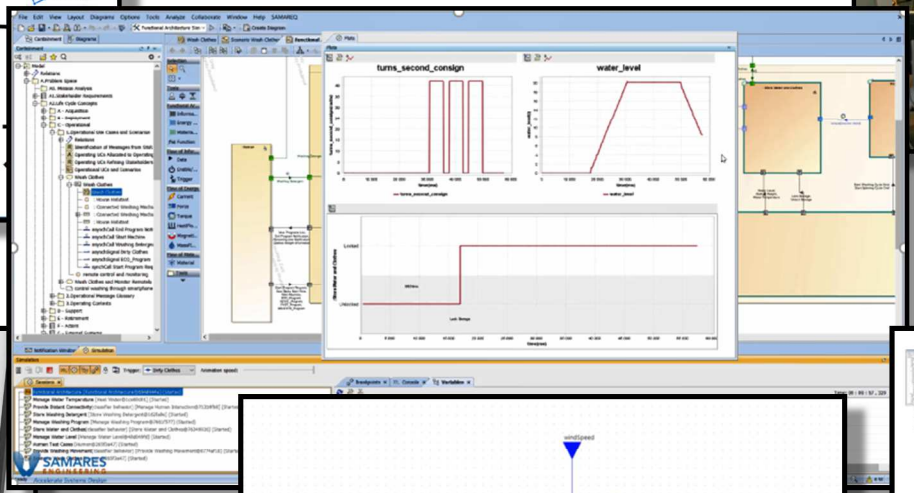
- These are analysis models essentially which can be translated or not into executable models.
  - See ISO/IEC/IEEE Architecture Evaluation for the hierarchy [Analyse, Estimation, Evaluation]
  - See multi-criteria analysis, stochastic analysis, utility curves, and methods like 80-20 or Pareto.

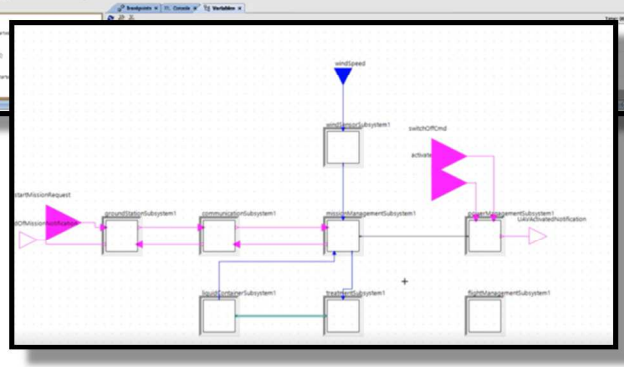
Some concrete examples of system models
Considerations of executable models

- Some models can be executed; without physics being preponderant.
  Models mainly scheduled by data-flows, deadlines, states and discrete events
  - Process diagrams
  - States and modes diagrams
  - Sequence and interaction diagrams
  - Protocol diagrams
  - Etc.
- Some models have no sense without considering their associated resources.
  - Performance models (IT, economy, etc.)
  - Operating models (IT, mechatronic, etc.)
  - Conduction models (Thermal, acoustic, optical, etc.)
  - Etc.
- Some models have no sense without considering the environment and the operational context
  - Propagation models (Electromagnetism, acoustic, etc.)
  - Interferometric models (Electromagnetism, acoustic, etc.)
  - Etc.

Some concrete examples of system models and simulations developed by members of AFIS chapter







Linked: Proposed project(s) in the ATLAS Program

- Description
  - Typology of system models, with their characteristics and utility per stage of a life cycle of a system, product or service.
  - Typology of system simulations, with their characteristics and utility per stage of a life cycle of a system, product or service.
- Challenge
  - Identification of the relevant models and simulations along the whole life cycle of an entity of interest.
- Benefits
  - Be able to define, evaluate, understand and decide at the right moment regarding entities of interest.
- Deliverables
  - Technical Report(s) stating on usage of models and simulations within des recommended pratices, with an inventory of related norms and standards, and examples.
- Relevant industry sectors
  - Any industry and operational domain, considering considering stakeholder viewpoints on an entity of interest.

Questions
&
Answers

1st and 2nd June

http://standardsdays.afnet.fr