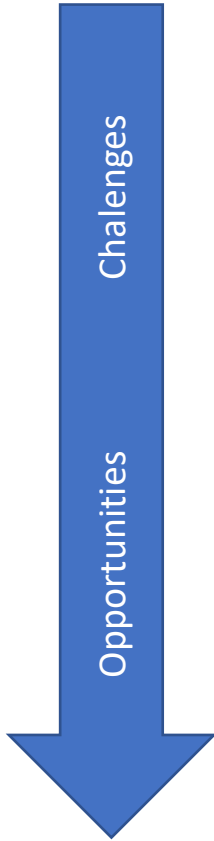
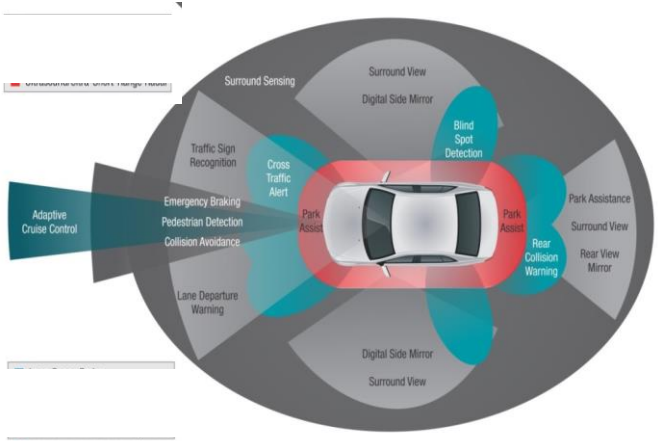
NEW STAKES FOR NUMERICAL MODELING AND SIMULATION OF CYBER-PHYSICAL SYSTEMS

Agenda

- From mechanical products to Cyberphysical systems
- Increase of complexity : systems, organization
- Evolution of validation/certification context
- New needs for Hi Fidelity modelling
- Bridge to file the gap between MBSE and numerical modeling
  - New actors
  - New process
  - New tools
  - New communication : MIC



Automotive industry : autonomous driving

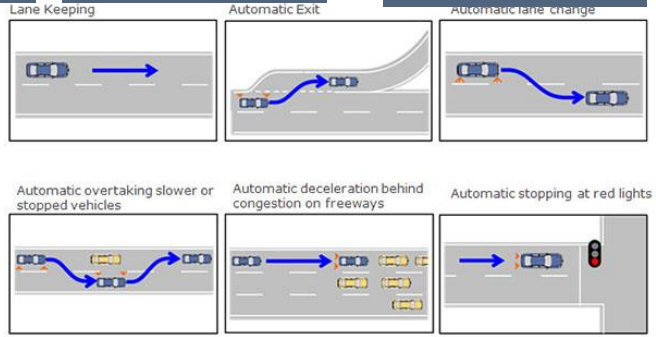


1-Sensing

2- Cognition

3 - Decision

4- Actuation

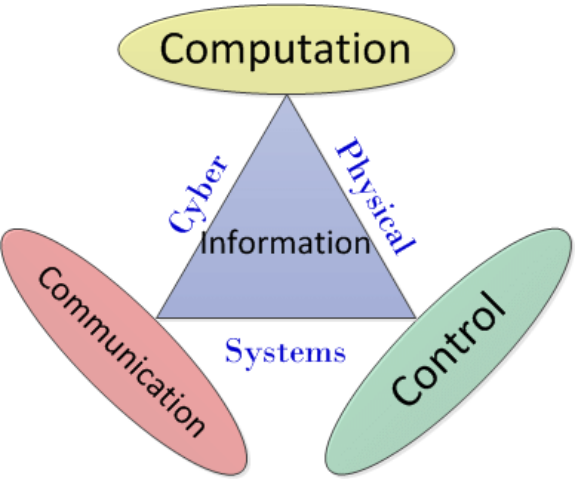


Validation

"They shouldn't allow humans to drive!"

Cyberphysical systems

A **Cyberphysical system** (**CPS**) is a Computer system in which a mechanism is controlled or monitored by computer-based algorithms.



Cyber : Computation, communication, and control that are discrete, logical, and switched.

Physical : Natural and human-made systems governed by the laws of physics and operating in continuous time.

Cyber-Physical Systems (CPS) : Systems in which the cyber and physical systems are tightly integrated at all scales and levels

Connections between parts increase :

- Physical phenomena
- Control (sensor/ECU/actuators)
- Communication (between control units)

Complexity !

Certification (ex : Automotive industry)

- Robustness of critical performances as safety, fuel consumption,…
- Validation and certification of vehicle tend to be extended to numerous situations

Evaluation of the customer car for its personal usage

Worst case — rare — common — All cases

Cycle — artificial — realistic — Real use

Normative physical test
=>reproductible

Random evaluation
=>direct rating

In laboratory

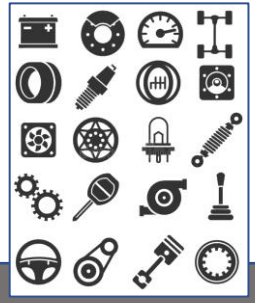
On open road

Automotive industry : personal usage

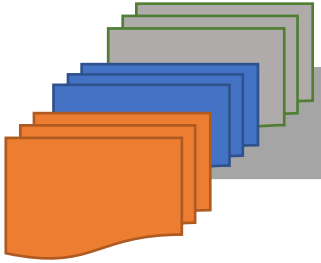


Personal usage


Context of usage =Scenario

Specific vehicle configuration = Diversity

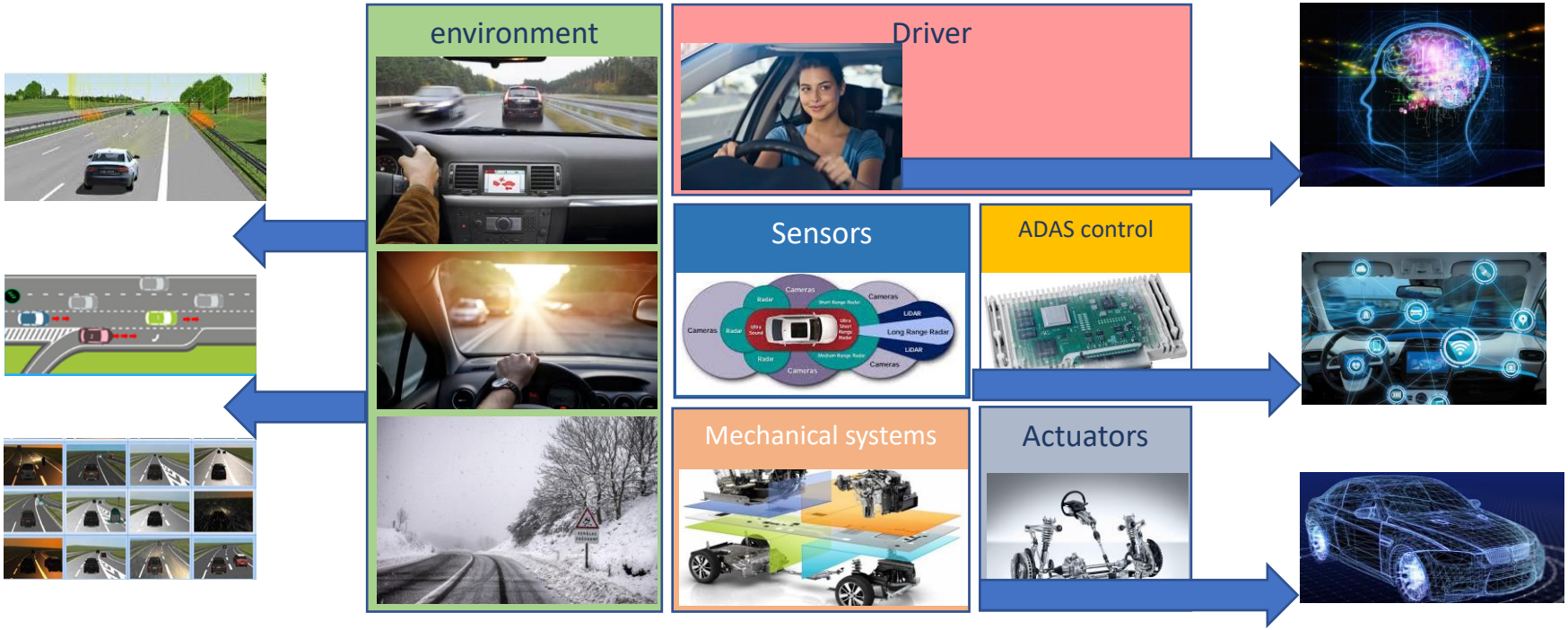


Validation Plan €

numerical simulation €

Simulation platform for Autonomous vehicle

A complex assembly of models



⇒ Need to assemble high fidelity model

⇒ Accuracy must be equal to physical tests

General view of process and simulation activities

ISO 15288-2015
Technical process

Business or Mission Analysis process

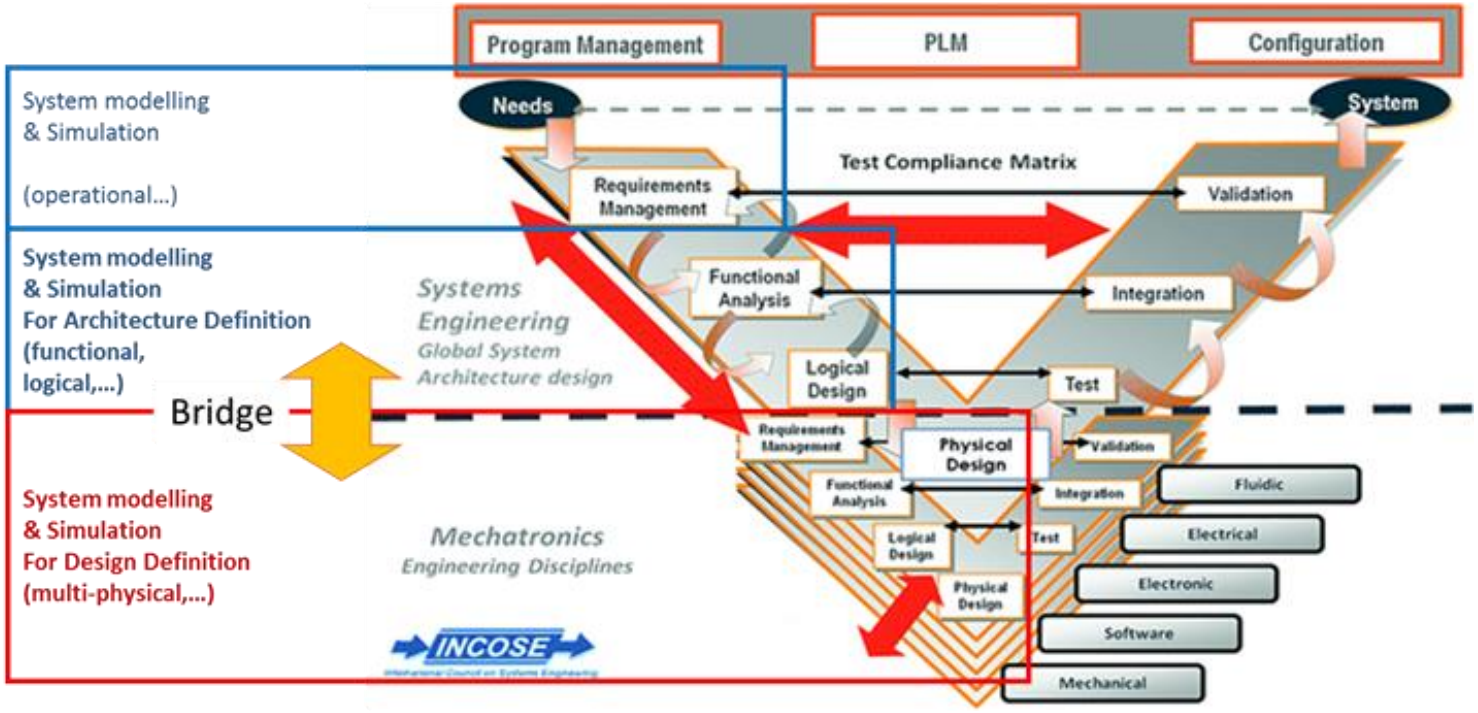
Stakeholder needs and requirements definition process

System requirements definition process

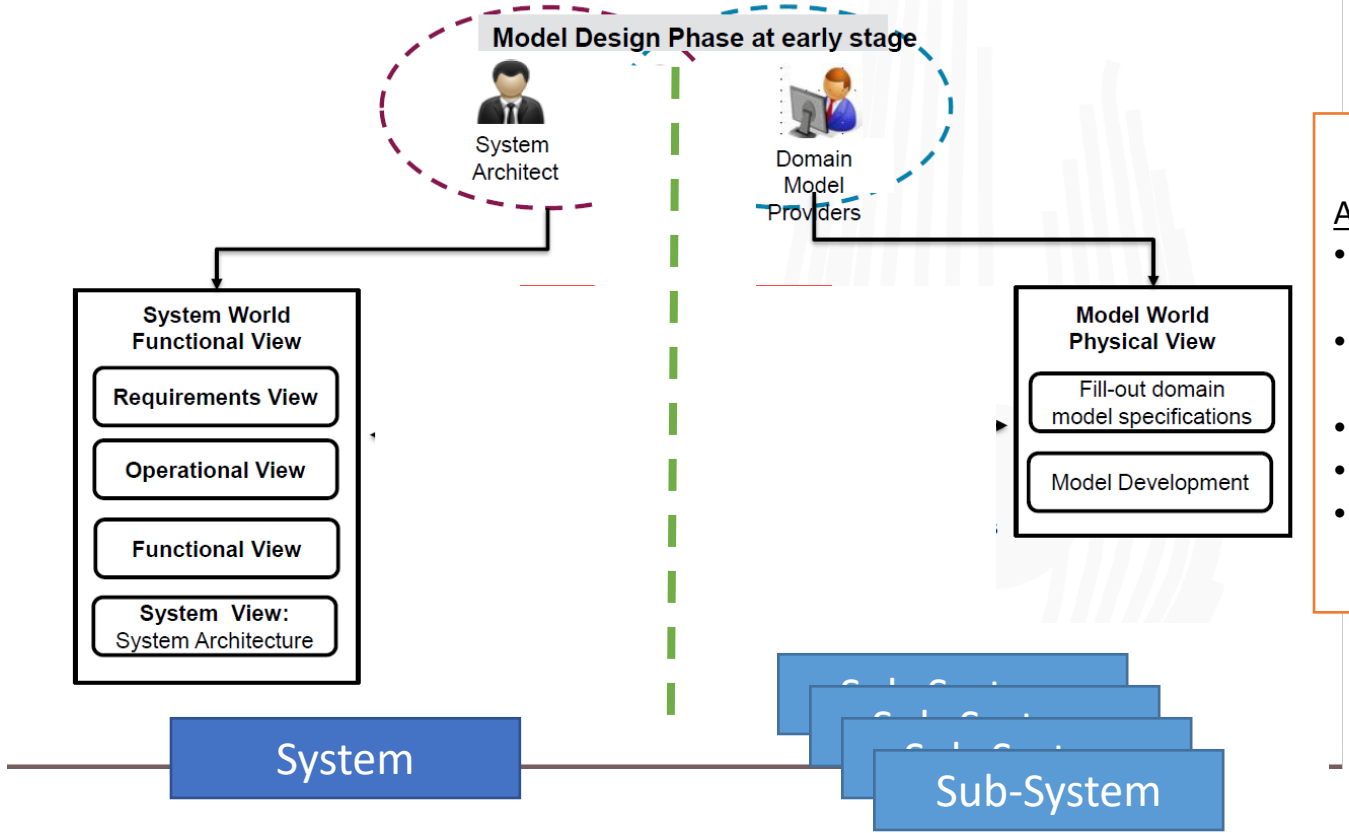
Architecture Definition process

Design Definition process

Implementation process



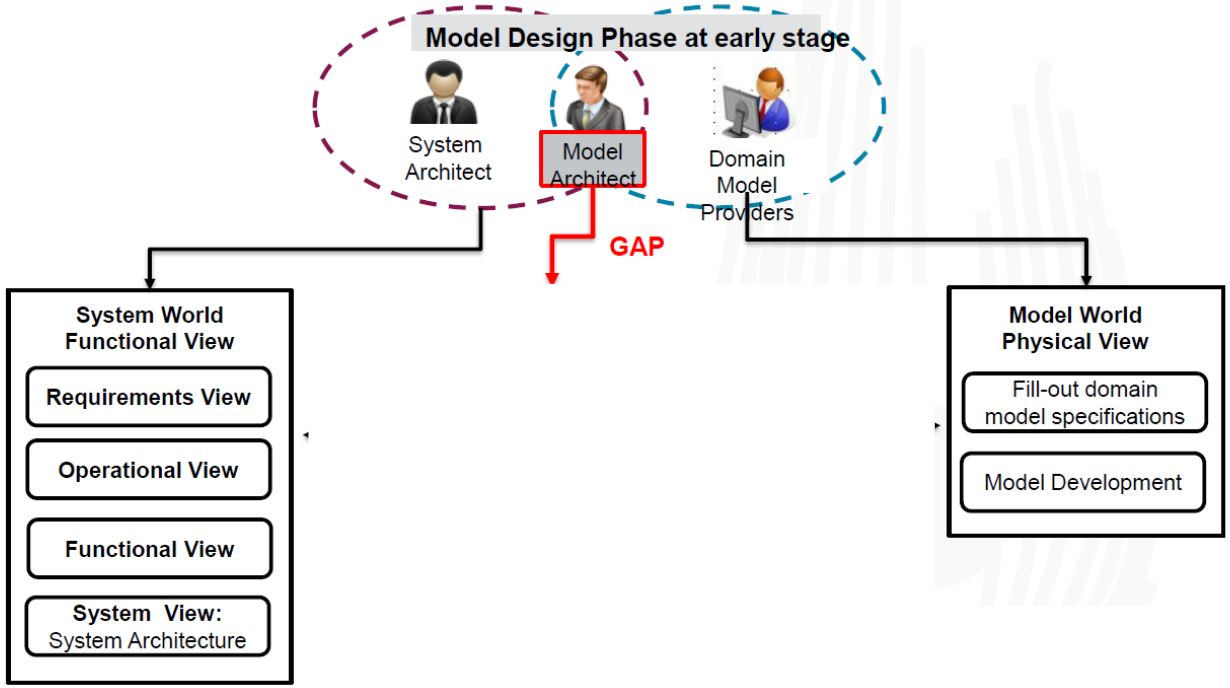
Relationship between actors



Actors are:

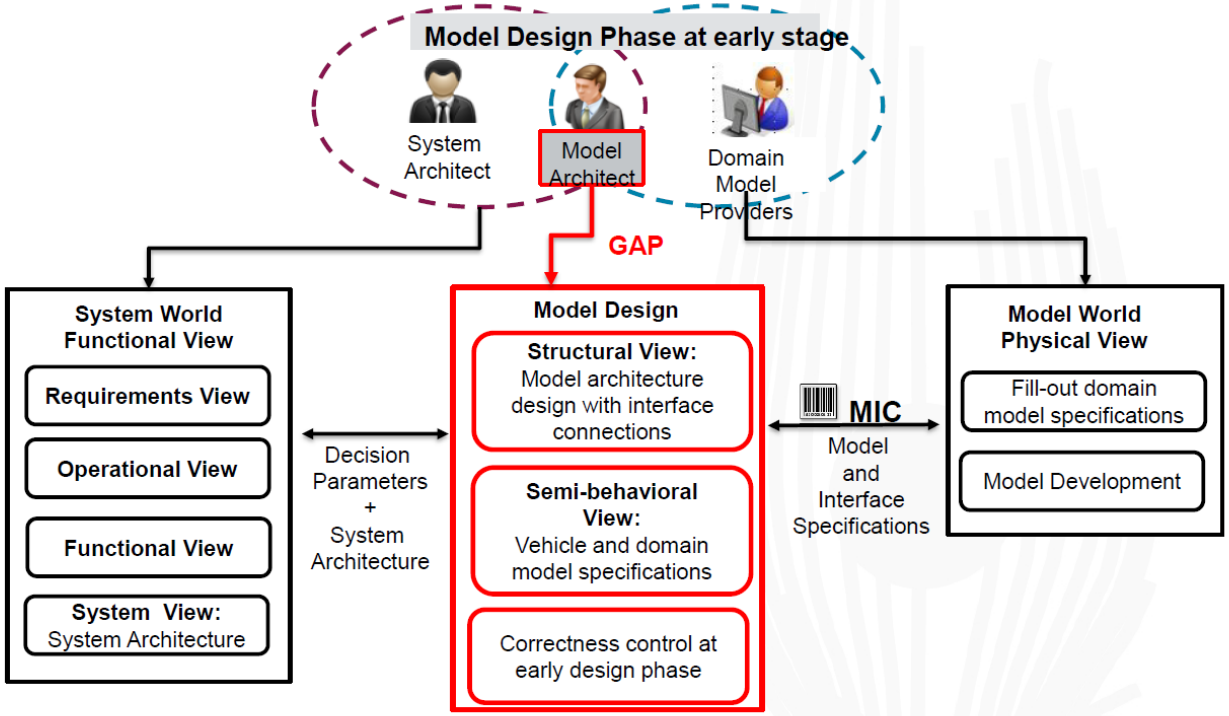
- Belonging to different teams or organization
- Developing models of different kinds
- Working with different process
- Using different methods and tools
- Using different references

Relationship between actors



New role : model architect for managing the model of the vehicle and the assembly of models

Relationship between actors



New role : model architect for managing the model of the vehicle and the assembly of models

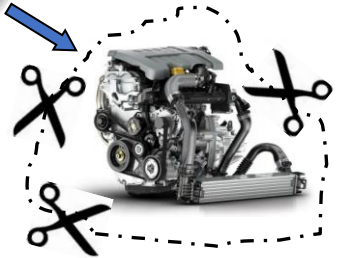
New processes for organizing the cooperation between actors

New methods and tools for transferring, exchanging and transforming models

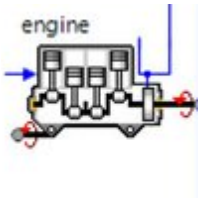
Metamodel (Model Identify card) for facilizing the communication between actors without ambiguities

MIC = Model Identity Card : 5 sets of items

Real object

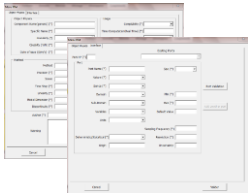


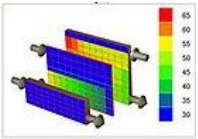
Model

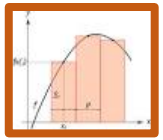


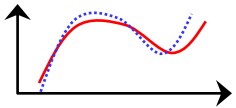
Meta- model

- interface
- object / physic
- methods
- ressources
- validation





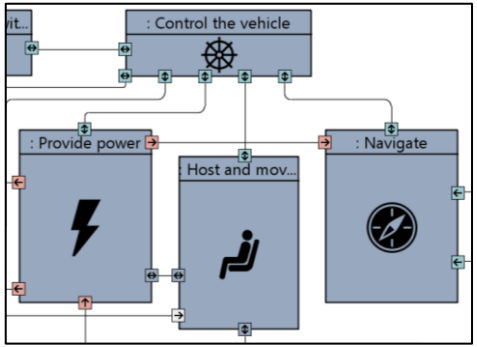




Agility in simulation based desing :Numerical continuity

SYSTEM ARCHITECT

System architecture



Part of the system to simulate ?

Environment scenarios?

Observables, parameters ?

?

Correct representation of the system?

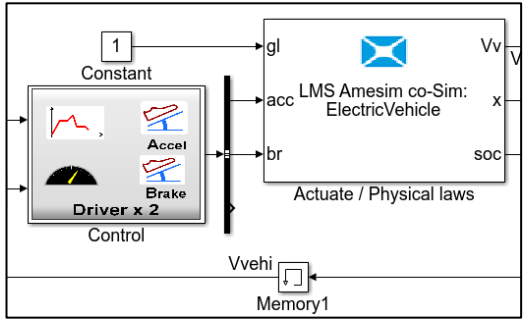
?

How to choose simulation models, re-use ?

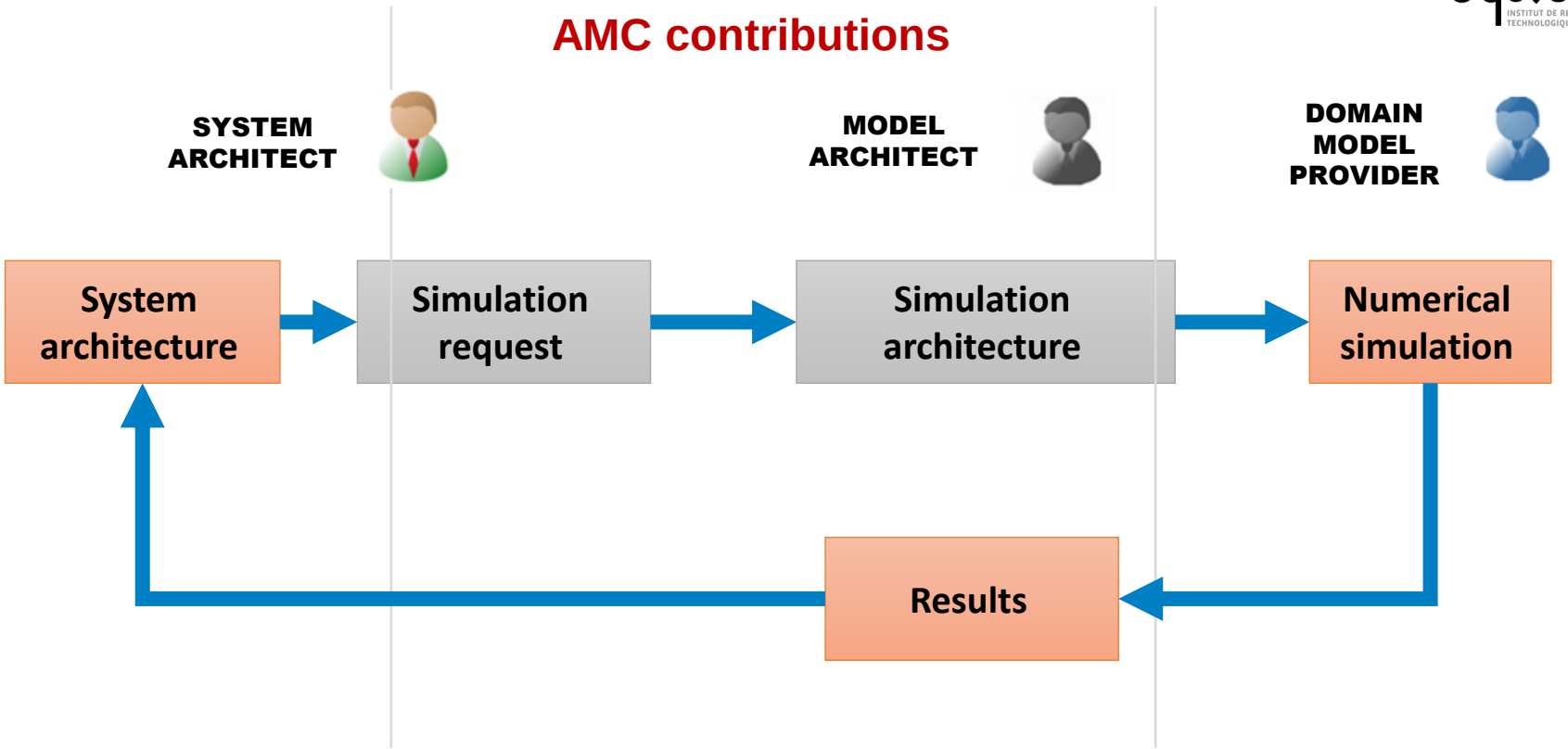
?

DOMAIN MODEL PROVIDER

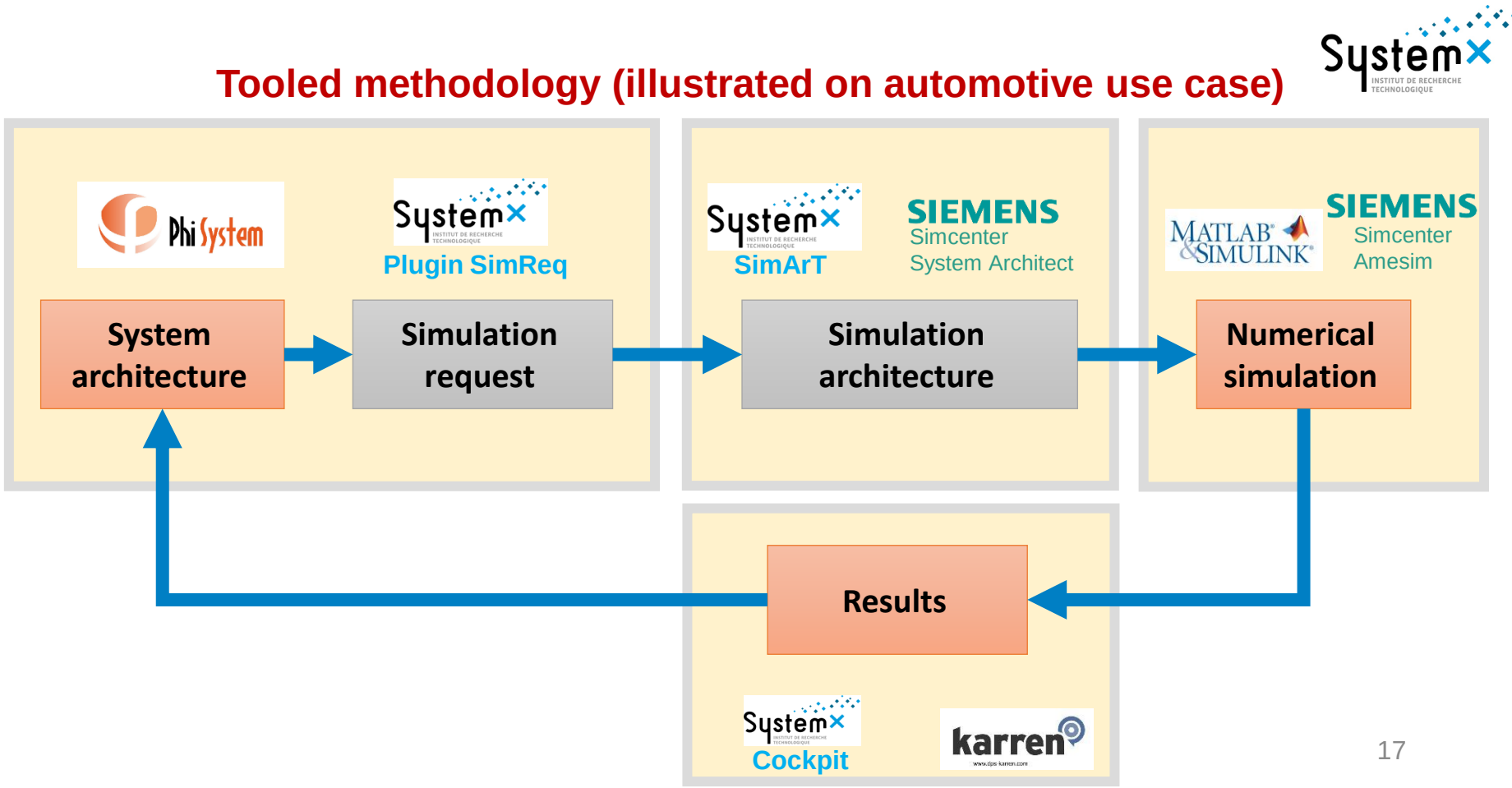
Numerical simulation



Agility in simulation based desing :Numerical continuity

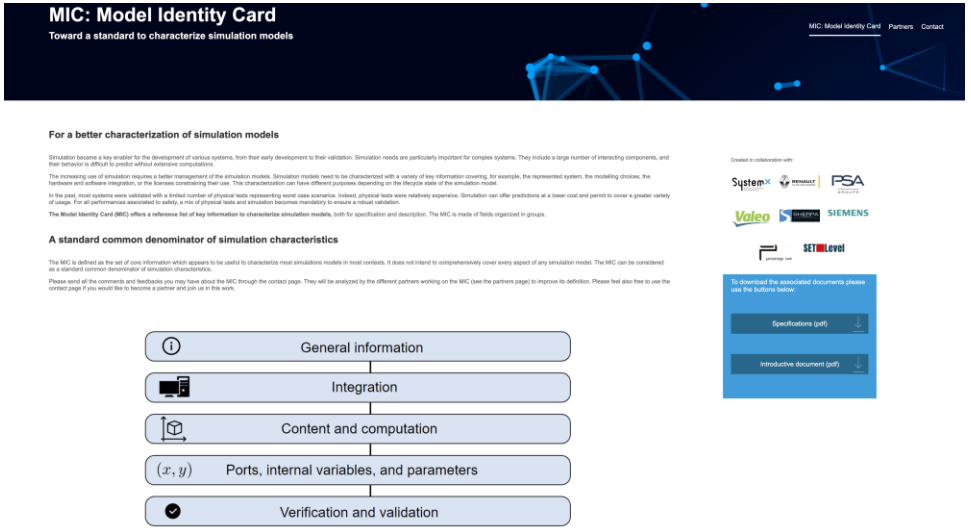


Agility in simulation based desing :Numerical continuity



Publication of a white paper

- MIC specification document available at :
  - https://mic.irt-systemx.fr/#/mic



Summary

1. Cyberphysical systems are more and more complex due (especially) to communication between sub-systems
2. Validation and certification of Cyberphysical systems request extended testing plan to cover scenario and diversity

=> Hi-fidelity numerical modeling is needed to ensure the extended validation plan in support of the physical testing

1. Numerical model must be initiated from the model-based design system by using a bridge (which is under development).
2. New role of actors are defined and their relationship must be supported by new methods : Metamodel (Model Identity Card for example)

MELISSA

MICRO-ECOLOGICAL
LIFE SUPPORT SYSTEM
ALTERNATIVE

THANK YOU.

Landel Eric
Elandel.elc@gmail.com

www.**melissafoundation**.org

Follow us on social networks