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Model Management at the Renault Virtual Simulation Team: State of Practice, Challenges, and Research Directions

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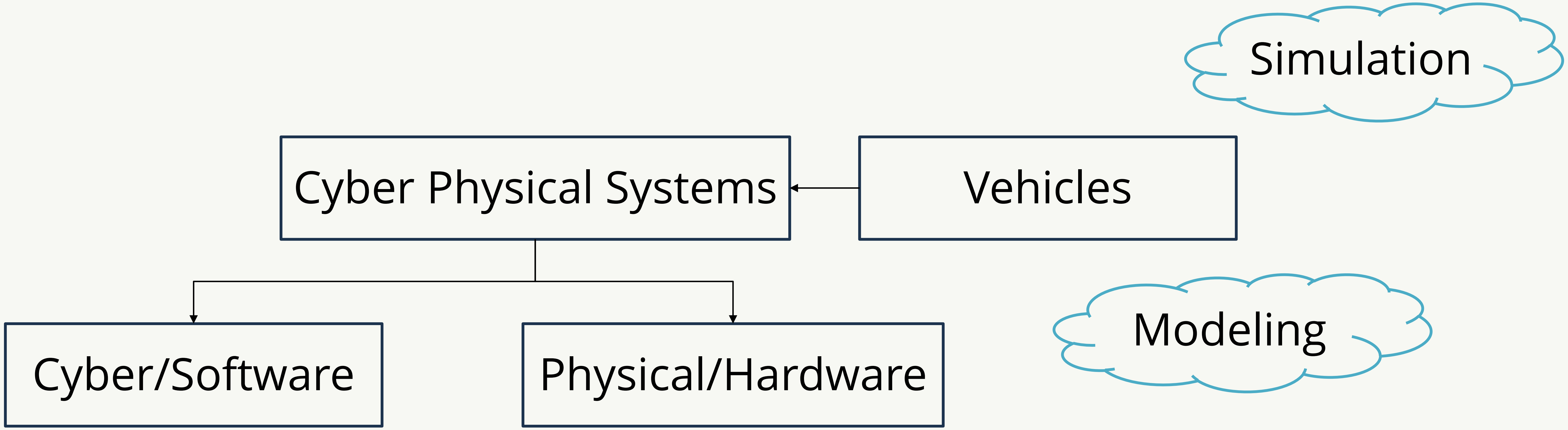
MoM Workshop - MODELS Conference

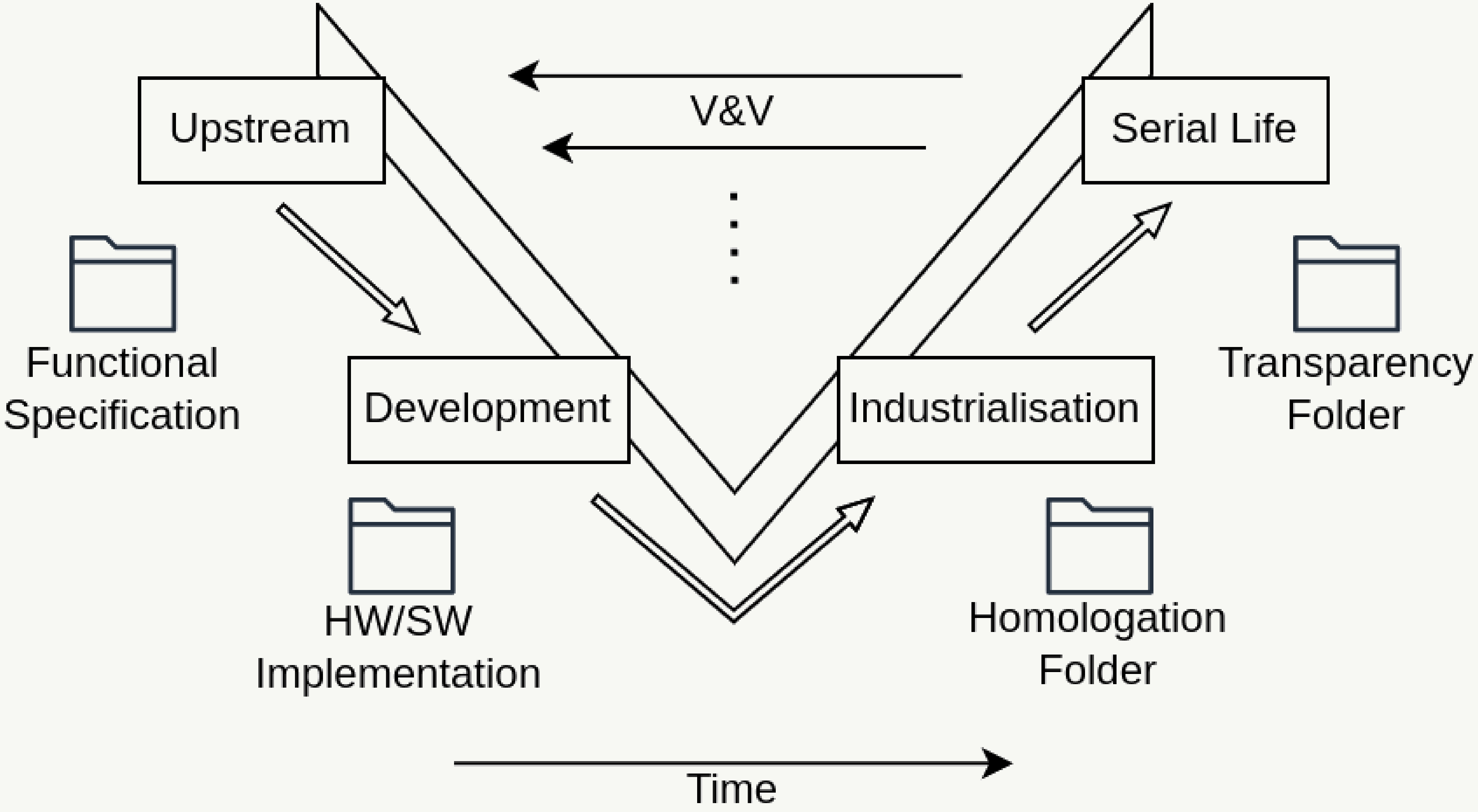
Introduction



Introduction

- Experimentation and analysis on only physical prototypes is infeasible (cost, time, resources).
- Simulation-Based approaches are essentiel for **developing** and **testing** systems before using physical prototypes.
- Complex system → Sub-systems → Being modeled → Many heterogeneous models
- These models must be well managed.

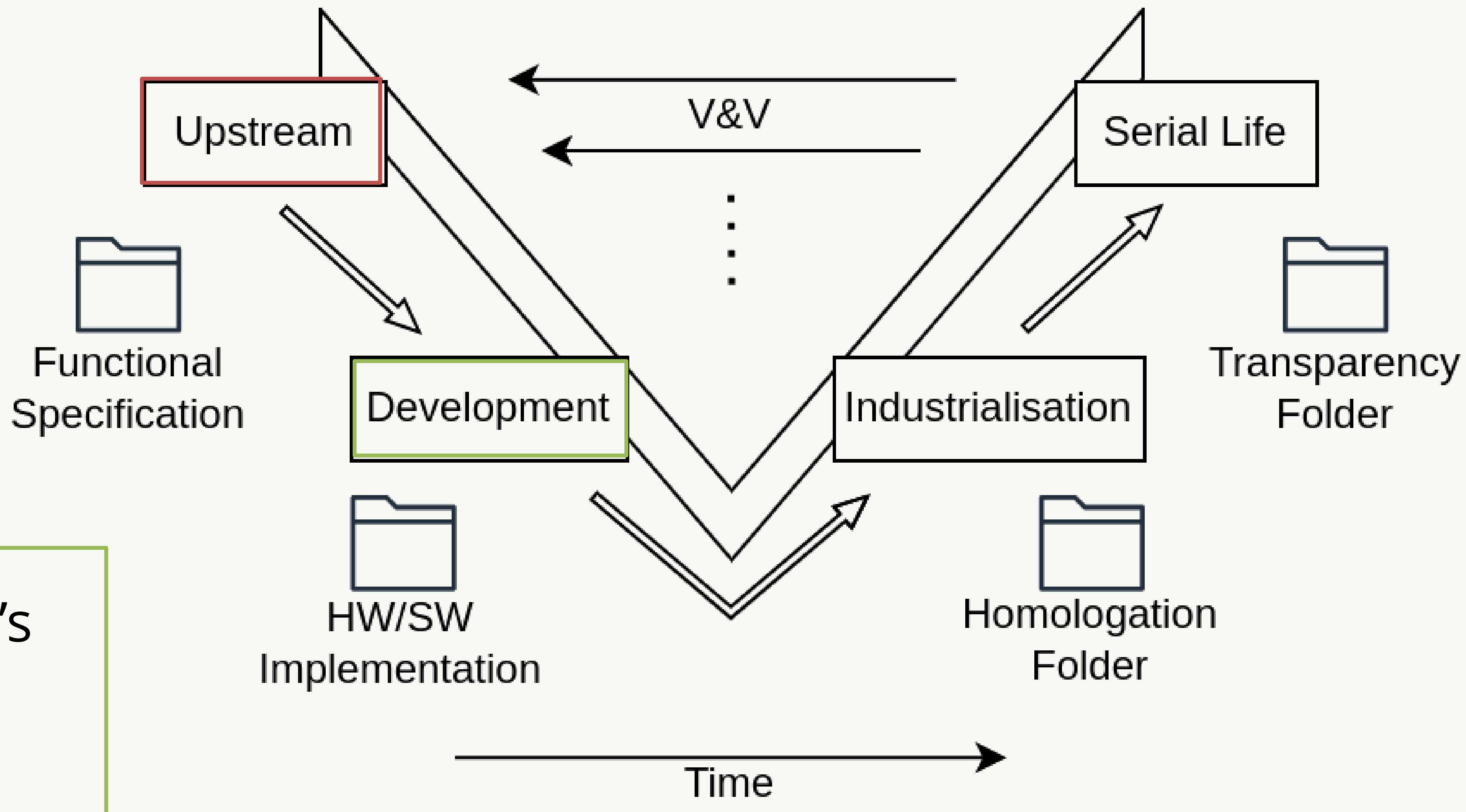
Project life cycles



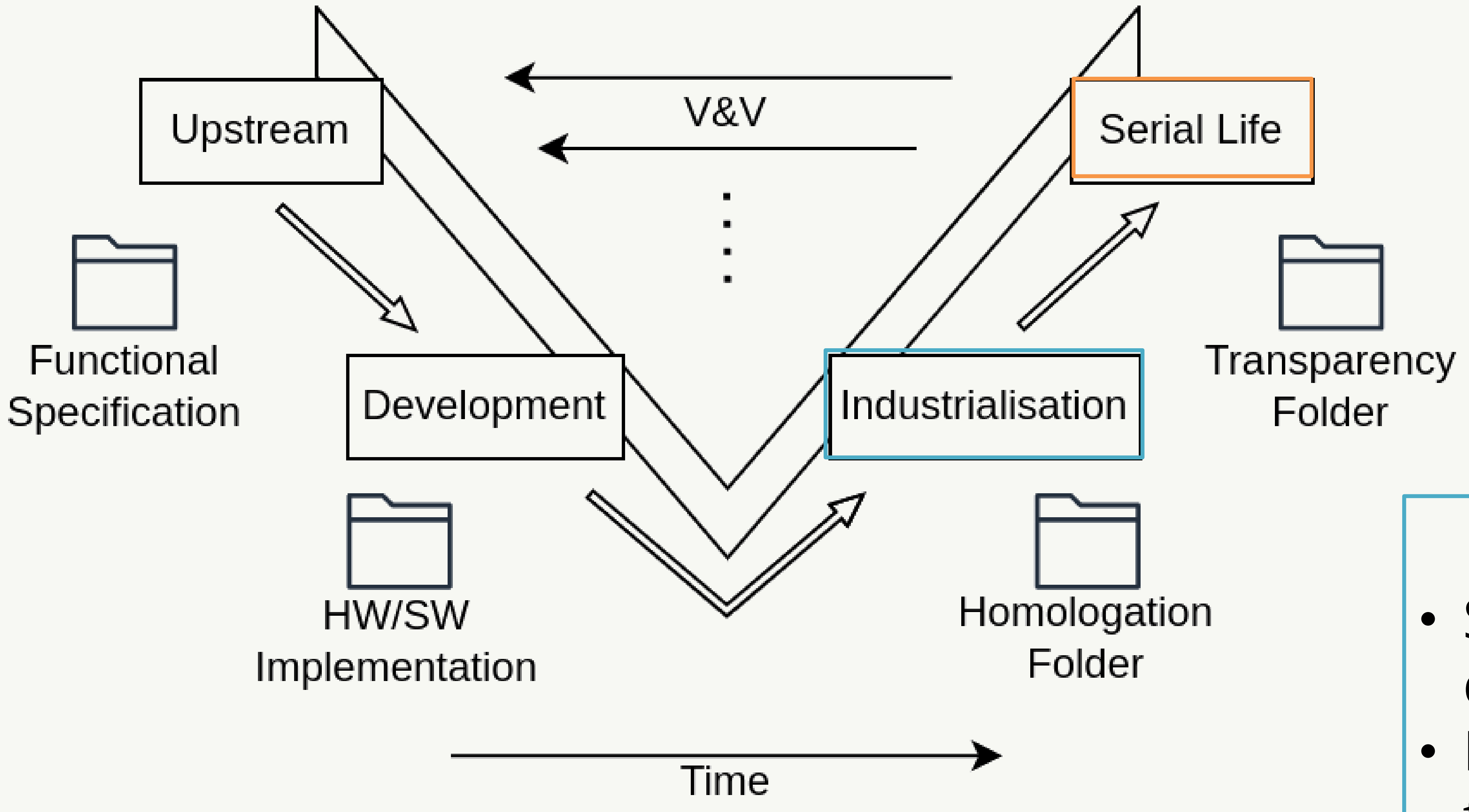
Project life cycles

- Defining customer's requirements.
- Creating functional specification.
- Supporting early design of the system.

- Implementing system's functions (HW/SW).
- Rough tuning and calibration.
- Ensuring robustness.
- Varying contexts.



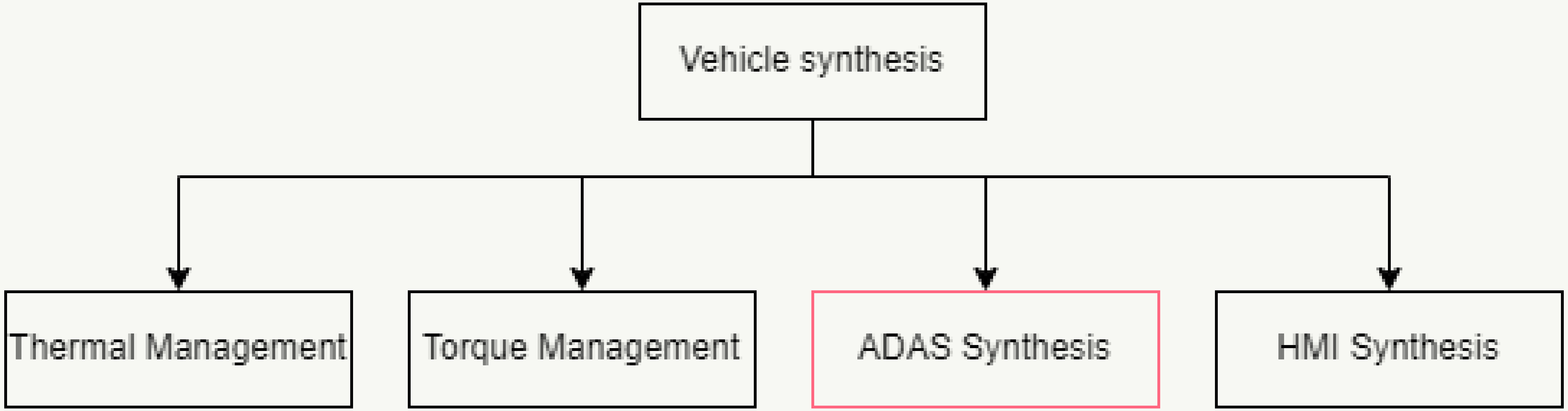
Project life cycles



- Monitoring the system after its production.
- Integrating updates
- Maintain a transparency folder

- System's transition from development to production.
- Providing the homologation folder.
- Evaluating the customer side performance.

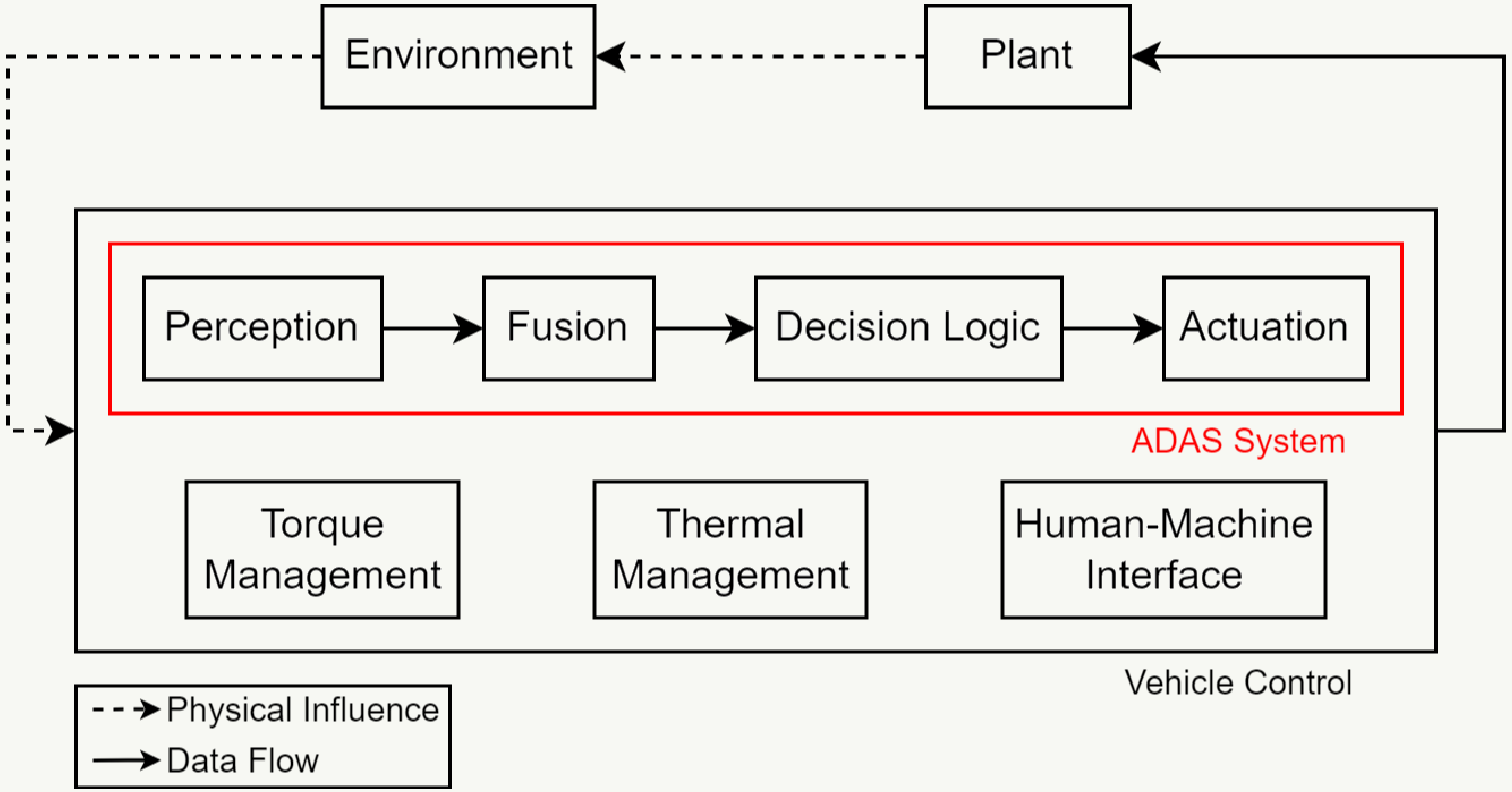
Control Simulation Overview



Example

ADAS

Advanced driver assistance systems



A single sub system like the ADAS can consist of multiple heterogeneous models

Each sub system has its models, each phase has its models

For each context, the simulation models change

For each simulation, different models will be used, either new models or existing ones

→ Dealing with thousands of models…need effective model management approaches

MBSE
(Model based systems engineering)

MBSE is the use of models to support systems engineering activities throughout all systems life cycle phases.

At Renault, SysML is used for MBSE

At Renault, MBSE is used to design vehicles, which are composed of several multidisciplinary components.

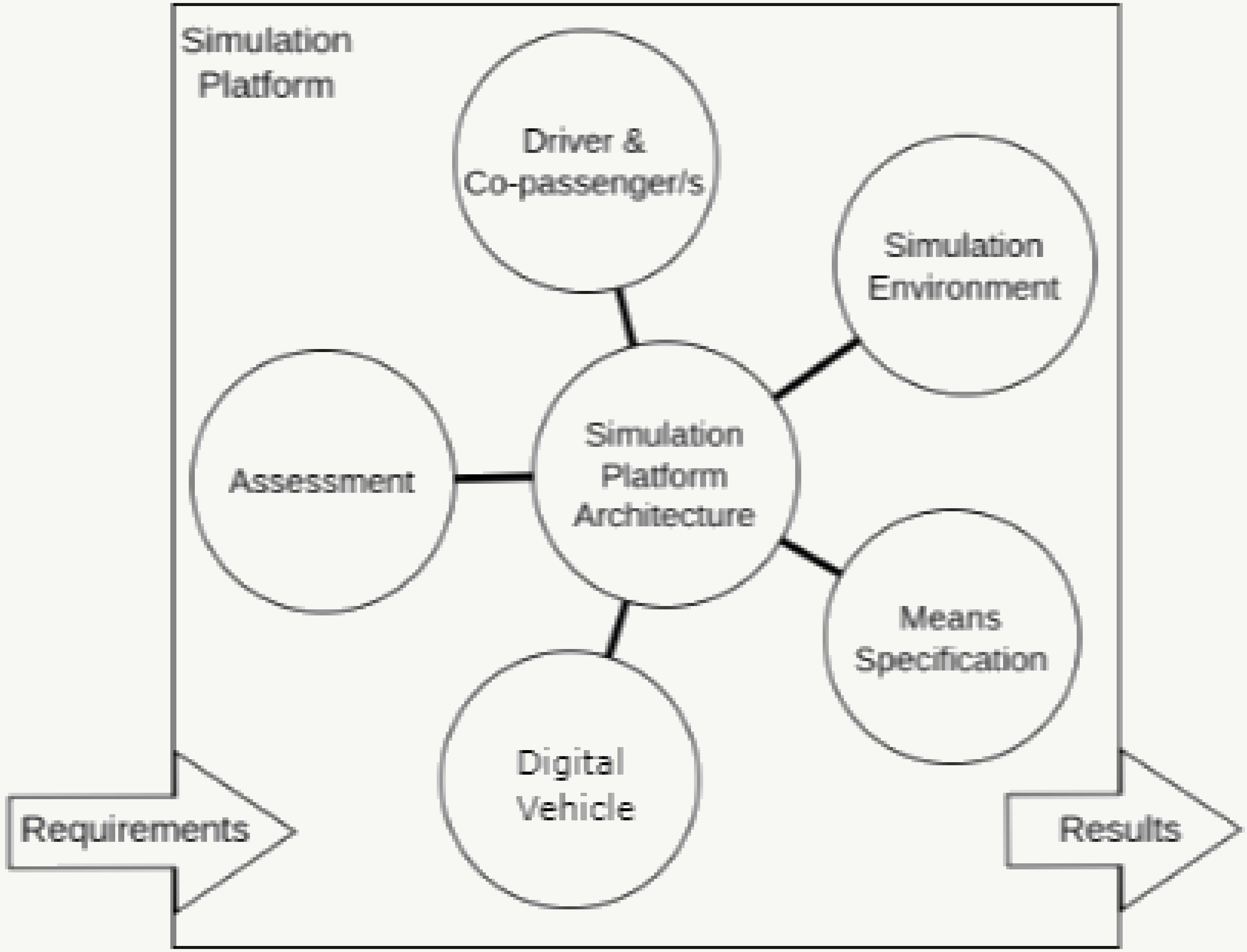
A dedicated team for each (kind of) system is responsible to develop the simulation models used in each phase of the project life-cycle to perform the analysis and run the simulations.

MBSi
(Model Based Simulation)

MBSi is a general **methodological**, **collaborative**, and **interdisciplinary** approach including all appropriate methods and workflows to initiate, define, and maintain **simulation architectures** with traceability links to MBSE requirements and functions.

In MBSi, simulations are composed of many simulation models (that are derived from MBSE), in a simulation platform that is unique w.r.t its simulation platform architecture.

Simulation Platform



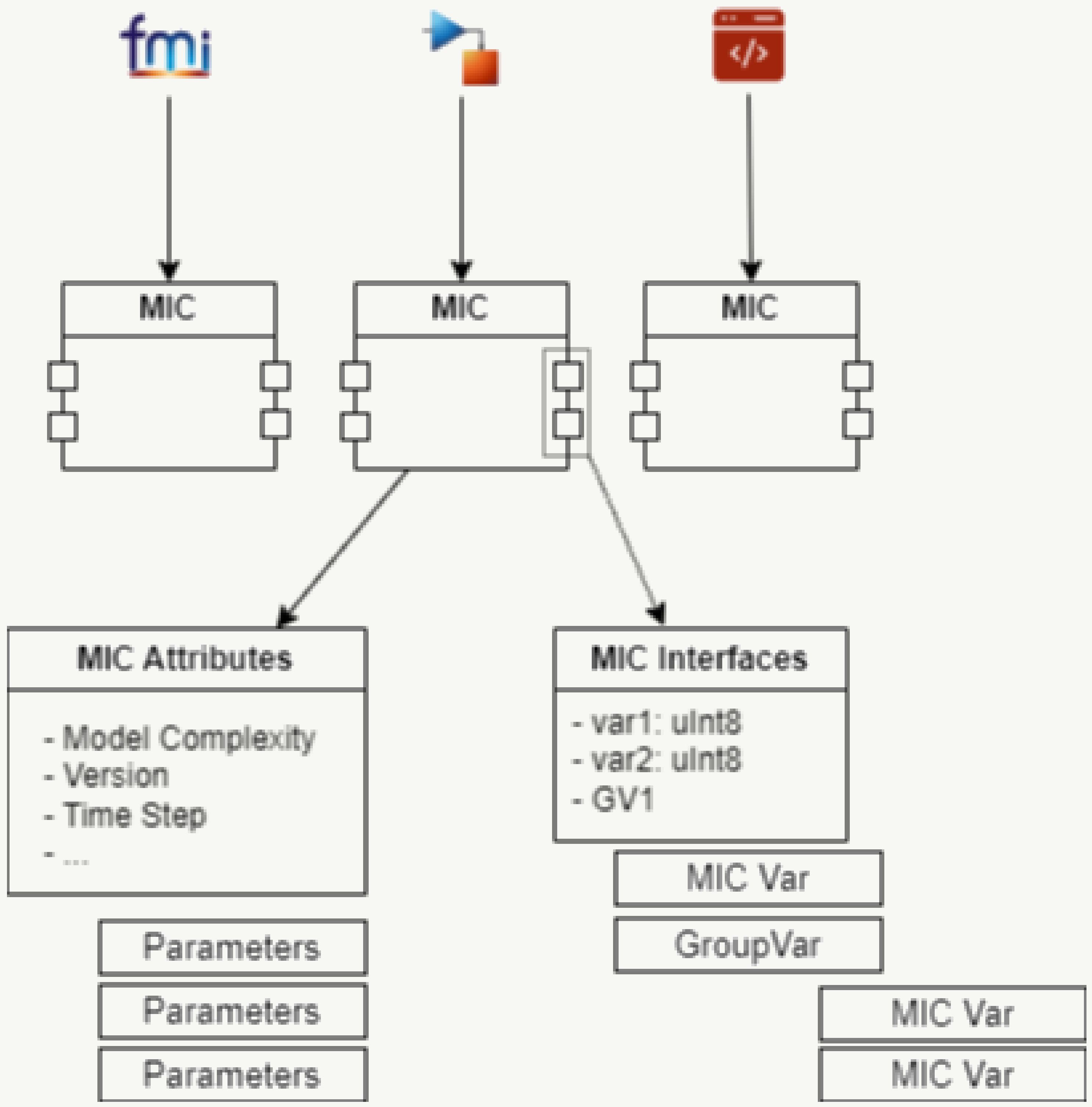
What is a MIC ?

(Model Identity Card)

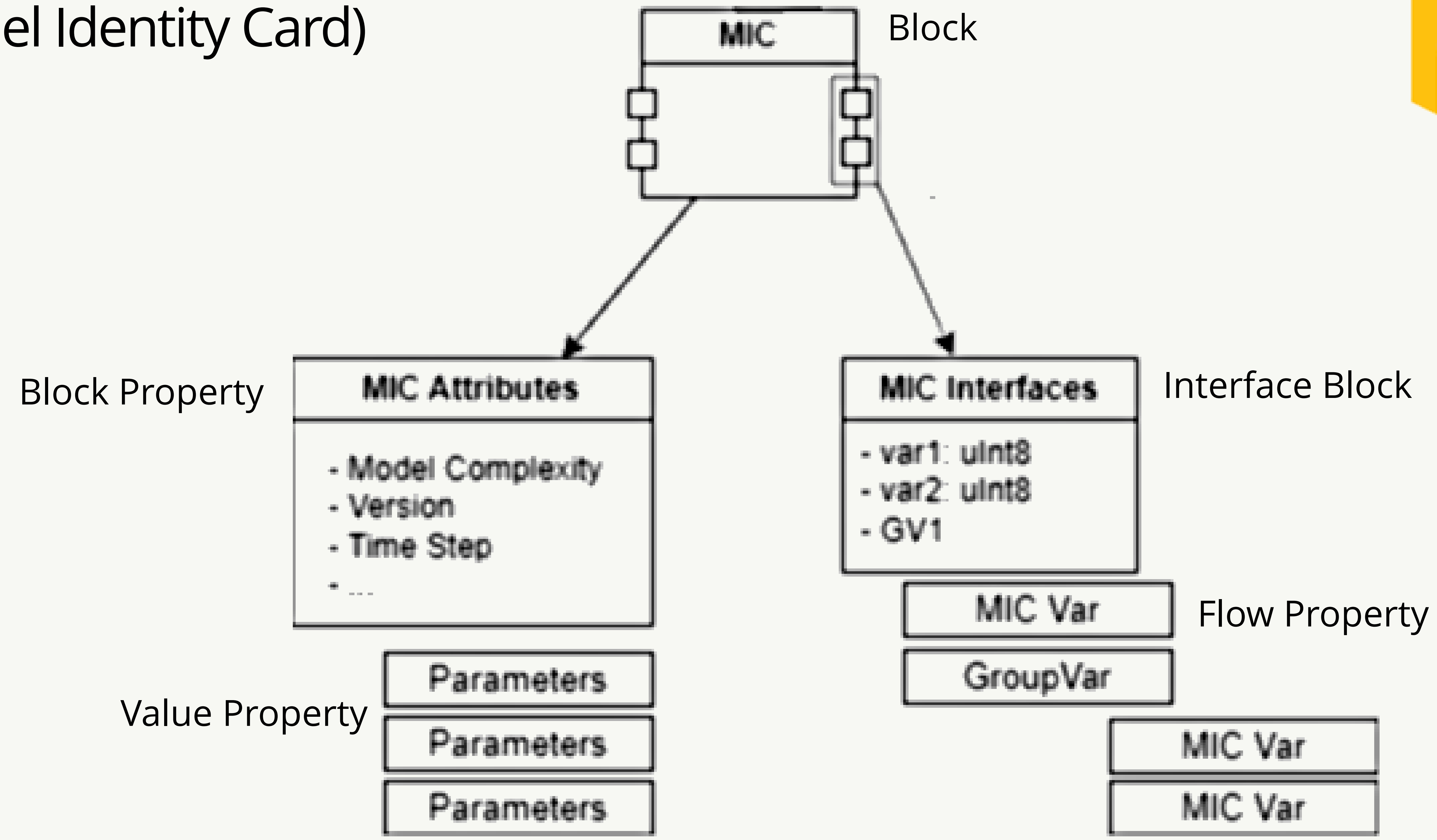
- MIC is an abstract object representing a simulation model, which standardizes and clarifies the identity and the characteristics of that model.
- It is a contract or a template representing and describing a simulation model.
- Form the link between MBSE and MBSi by providing continuity between the design produced with MBSE and its analysis and verification with MBSi.
- Was developed by a consortium of French industrial partners

MIC
(Model Identity Card)

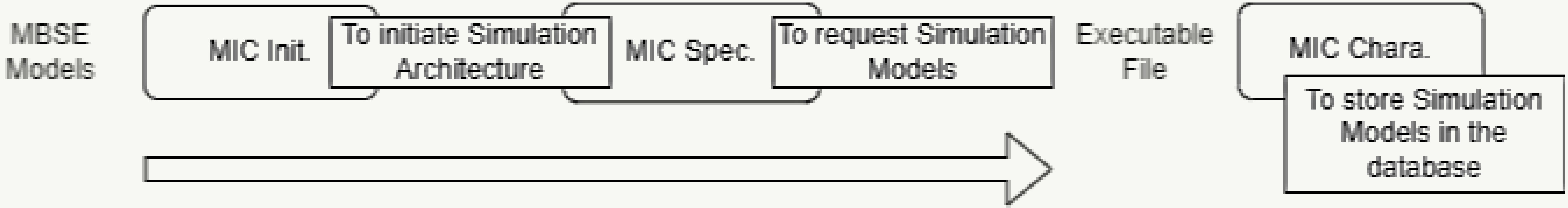
- Supports identification of simulation models expressed in all languages and platforms.
- Specified in various formats such as Excel, XML, HTML, and CATIA Magic.



MIC Parts
(Model Identity Card)



MIC Life Cycle



MIC States:

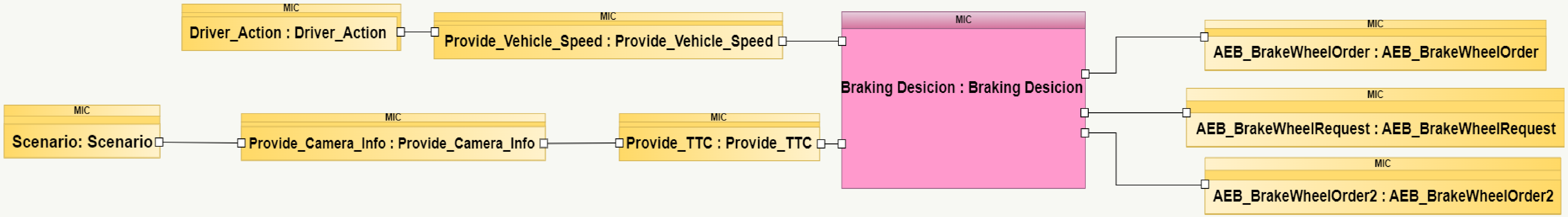
- The Initialisation state (a.k.a MIC Init)
- The Specification state (a.k.a MIC Spec)
- The Characterization state (a.k.a MIC Chara)

MIC Based Simulation Architectures

Functional Architecture

It a logical representation of:

- Functions covered by the system
- Dependencies, inputs and outputs of each of them
- Data flow to ensure synchronization in the execution of the functions

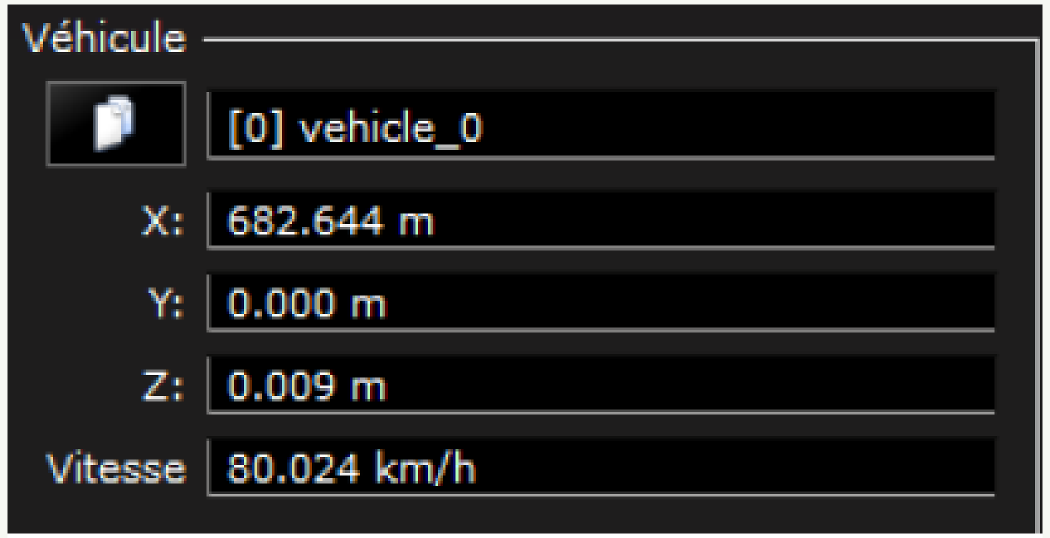


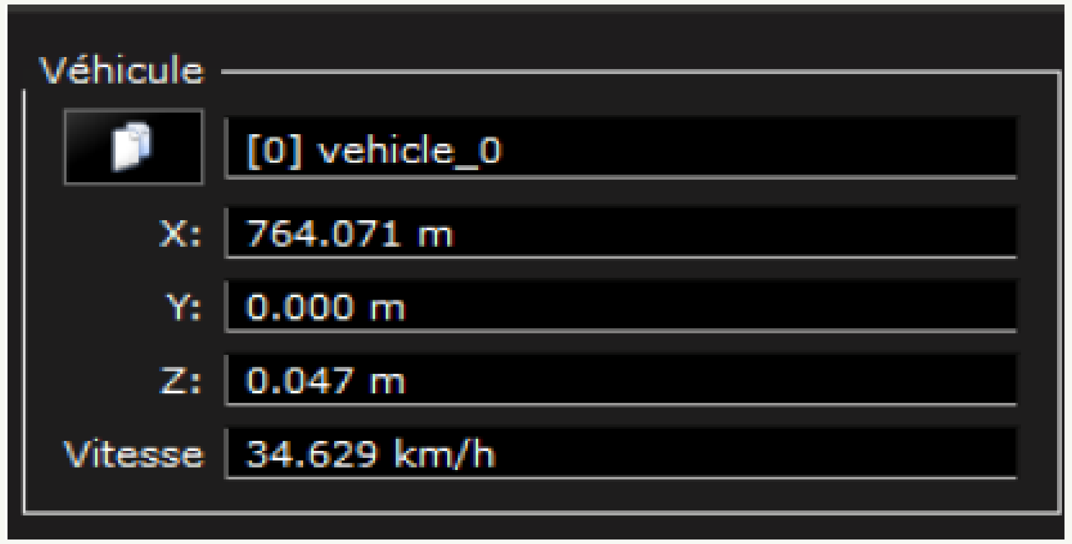
MIC Based Simulation Architectures

Technical Architectures

- Defines precisely the interfaces and connections between the tools and simulators.
- It is the concrete implementation of the reference architecture.
- It is a complete, concrete realization of the functions specified in the functional architecture.
- It represents the allocation of the models to their individual simulation tools e.g. SCANeR, CATIA, ControlBuild.

MIC Based Simulation Architectures





Challenges

Defining Simulation Needs
Simulation models contain a large amount of information.
The simulation needs must be well defined, clear, and precise.
Defining these needs in a clear and direct way is one of the challenges faced at Renault.

Assets Assembling
Assembling multiple assets (e.g. models, calibration files, configuration files), coming from multiple sources to constitute an adequate simulation platform

Challenges

Choosing the Appropriate Model

Models chosen on Trial error method by experts
These platforms are found sometimes over-dimensioned:
- Models take too much time to simulate
- Unsuitable representativeness levels not adapted to needs

Research Directions

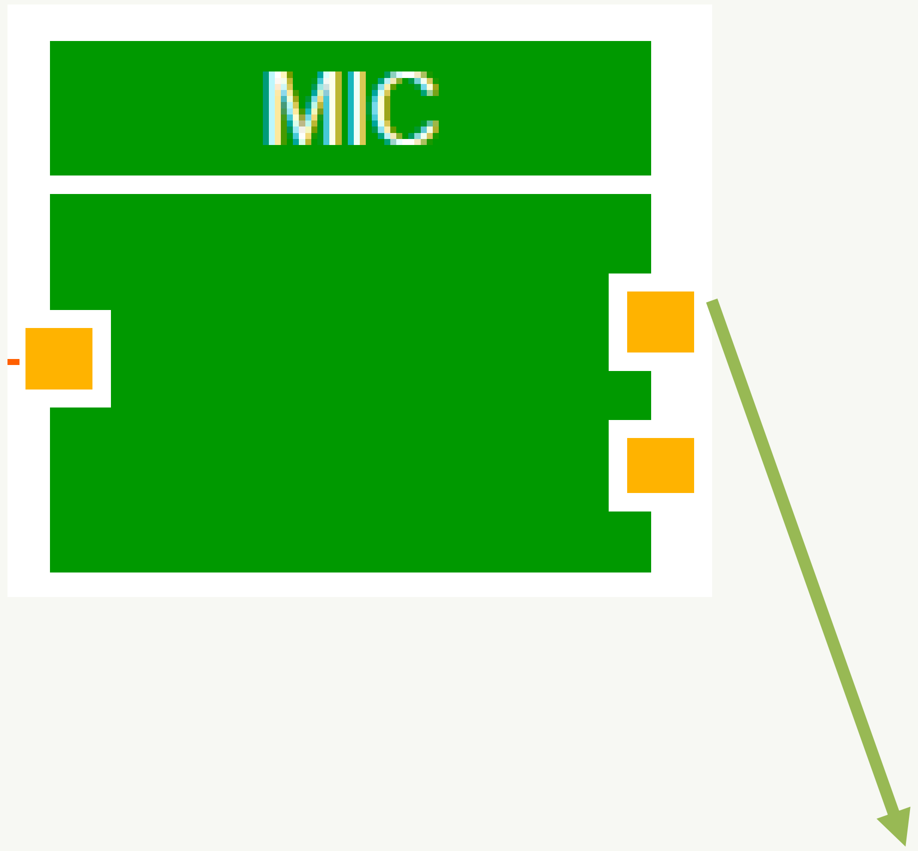
Establish a standardized vocabulary of concepts related to validity: representativity, accuracy, fidelity, validity, verifiablity.

Optimize the simulation architectures and allow automatic selection of the right models depending on the simulation needs and requirements in a specific context..

→ By extending the MIC and associating new metrics to each model.

Research Directions

- Description of the model (Name, ID, mic state, granuality level)
- Model Quality description (robustness, complexity, uncertainity)
- Model Usage (source code , tool name)
- Model Method (model dimension, behavior)



Representativity
Validity
Accuracy
Fidelity

Conclusion

- Described the current approaches and practices at Renault.

- Introduced some of the challenges

- Develop solutions and find new approaches and techniques to address these problems and challenges.

- Extend the MIC and add new metrics.

Thank you

References

- Saïna Herssand, Eric Landel, Jean-Marc Gilles, and Joe Matta. 2016. Model Identity Card (MIC) for Simulation Models. In Complex Systems Design & Management, Gérard Auvray, Jean-Claude Bocquet, Eric Bonjour, and Daniel Krob (Eds.). Springer International Publishing, Cham, 317–317
- Goknur Sirin, Christiaan J. J. Paredis, Bernard Yannou, Eric Coatanea, and Eric Landel. 2015. A Model Identity Card to Support Simulation Model Development Process in a Collaborative Multidisciplinary Design Environment. IEEE Systems Journal 9, 4 (2015), 1151–1162. https://doi.org/10.1109/JSYST.2014.2371541
- Cláudio Gomes, Joachim Denil, and Hans Vangheluwe. 2020. Causal-Block Diagrams: A Family of Languages for Causal Modelling of Cyber-Physical Systems. Springer International Publishing, Cham, 97–125. https://doi.org/10.1007/978-3- 030-43946-0_4
- Rakshit Mittal, Raheleh Eslampanah, Lucas Lima, Hans Vangheluwe, and Dominique Blouin. 2023. Towards an Ontological Framework for Validity Frames. In 2023 ACM/IEEE International Conference on Model Driven Engineering Languages and Systems Companion (MODELS-C). 801–805 https://doi.org/10.1109/MODELSC59198.2023.00128