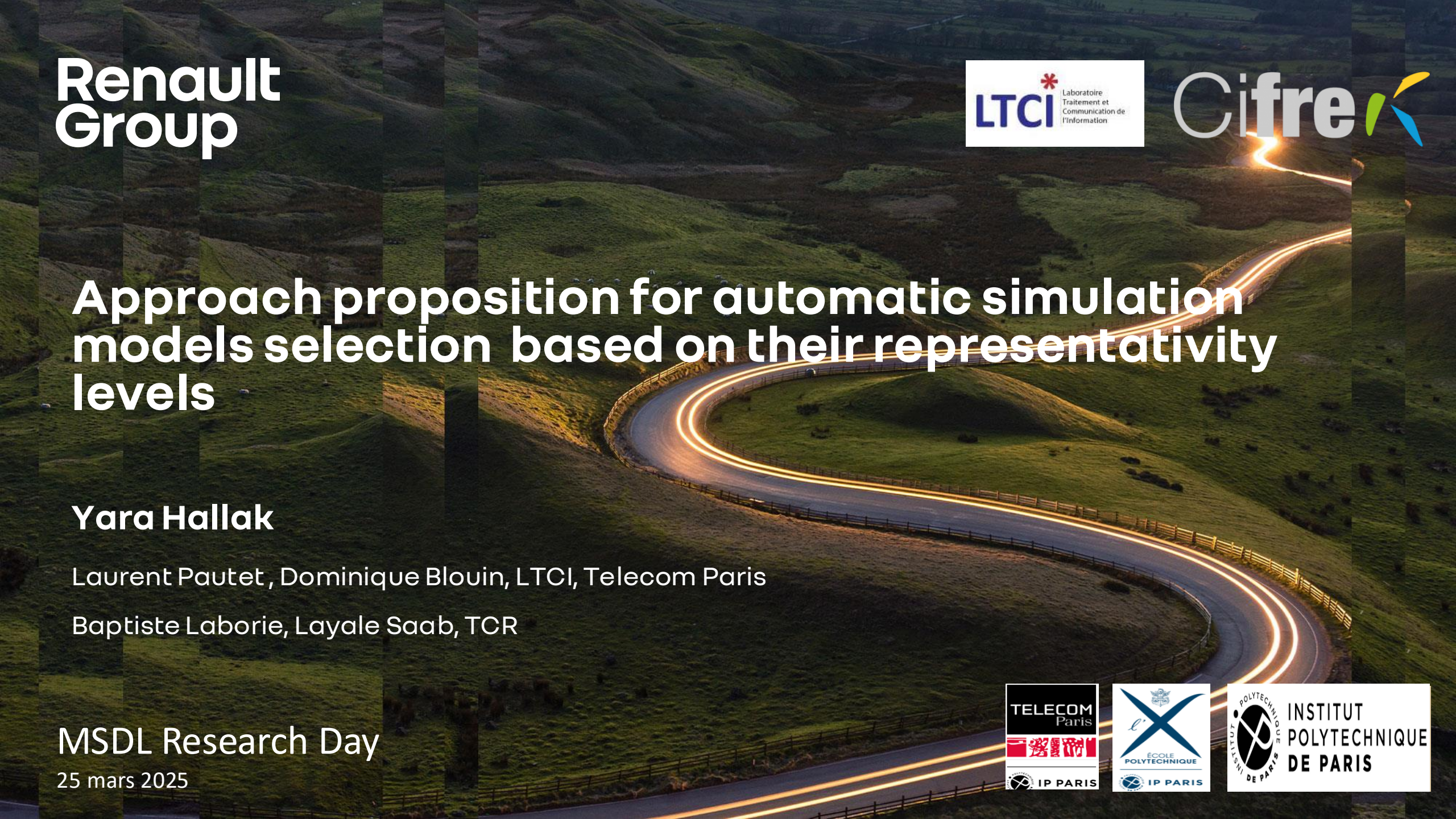

Renault Group

LTCI Laboratoire Traitement et Communication de l'Information

Cifre

Approach proposition for automatic simulation models selection based on their representativity levels

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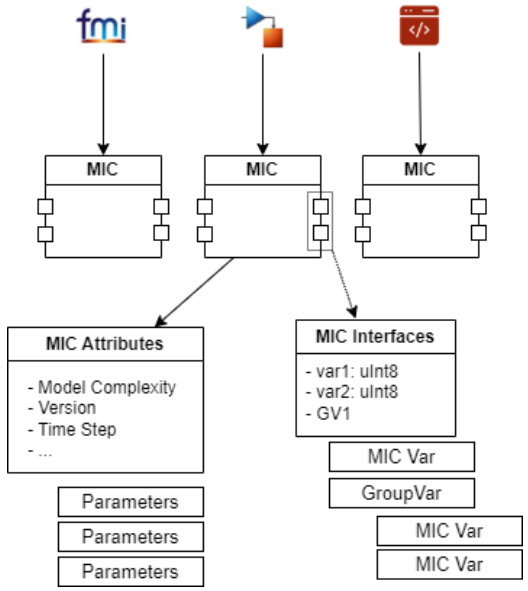
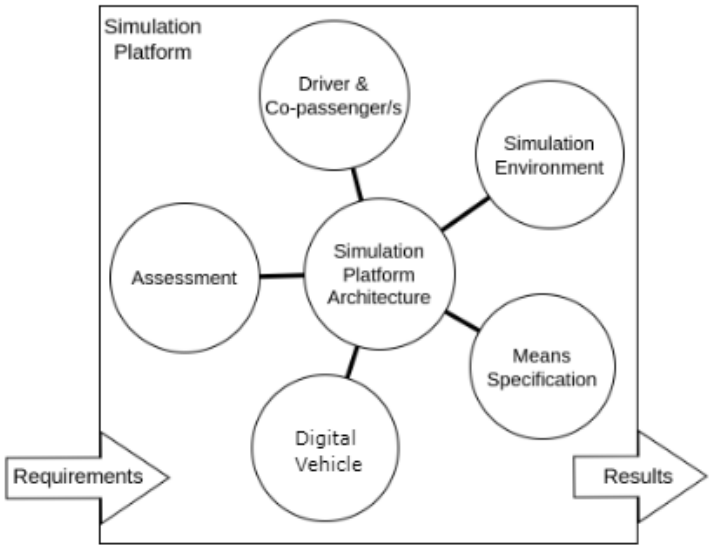
MSDL Research Day

25 mars 2025

Introduction





- CYBER PHYSICAL SYSTEMS (VEHICLES) ARE INCREASINGLY COMPLEX TO BUILD AND MAINTAIN ON BOTH CYBER/SOFTWARE AND PHYSICAL/HARDWARE LEVELS.
- EXPERIMENTING AND ANALYSING ONLY PHYSICAL PROTOTYPES IS UNFEASIBLE (COST, TIME, RESOURCES).
- SIMULATION-BASED APPROACHES ARE ESSENTIEL FOR DEVELOPING AND TESTING SYSTEMS BEFORE USING PHYSICAL PROTOTYPES.
- A COMPLEX SYSTEM IS DIVIDED INTO SUB-SYSTEMS THAT ARE MODELED.

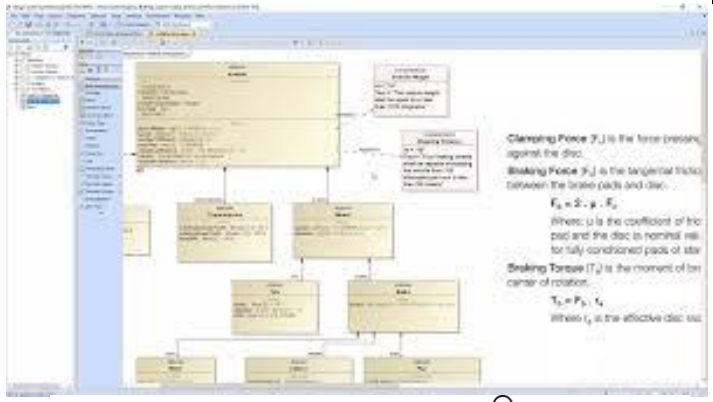
Problematic

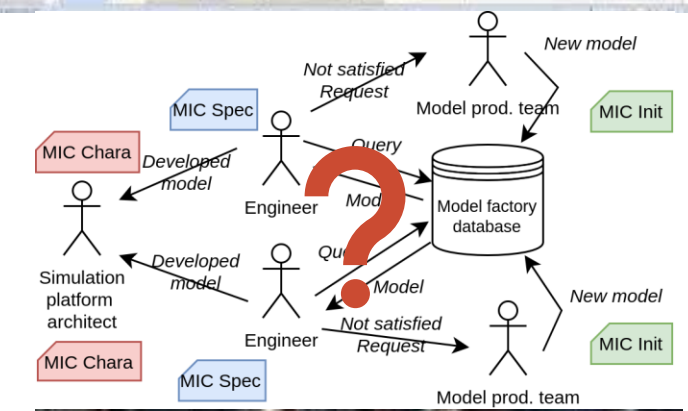
For a simulation experiment:

- DEFINE THE SIMULATION NEED/REQUEST
- BUILD THE SIMULATION PLATFORM : SIMULATION ARCHITECTURE FROM MBSE (MODEL BASED SYSTEM ENGINEERING)
- CONDUCT THE SIMULATION AND EVALUATE IT

OUR QUESTION

HOW TO CHOOSE THE RIGHT MODELS? TO ANSWER THIS SIMULATION NEED





Maturity vs Validity vs Representativity

MATURITY:

IS THE DIGITAL/NUMERICAL METHODOLOGY FOLLOWED READY TO A CERTAIN POINT THAT IT CAN BE USED ENTIRELY WITHOUT HAVING PHYSICAL TRIES?

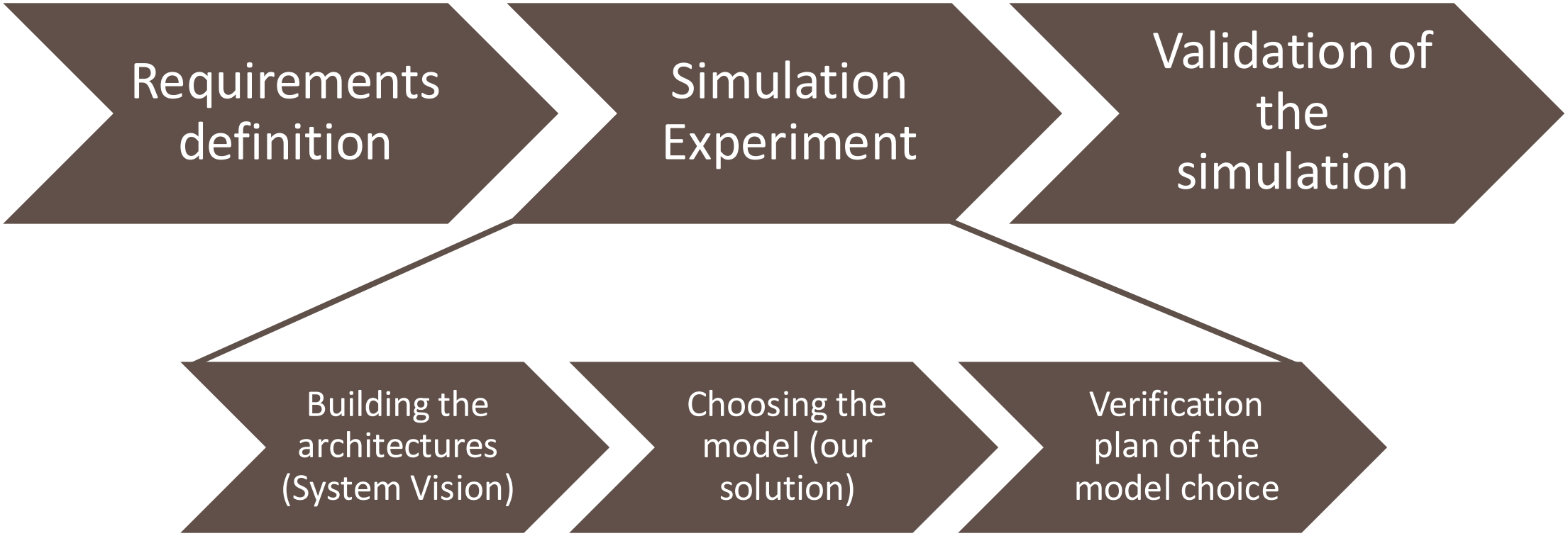
VALIDITY:

ARE THE SIMULATION RESULTS WELL CORRELATED WITH THE REAL-WORLD SYSTEM RESULTS ACCORDING TO A PROPERTY OF INTEREST?

REPRESENTATIVITY:

DOES THE MODEL CAPTURE ALL THE REAL-WORLD SYSTEM PROPERTIES. AND CAN HAVE THE REAL SYSTEM BEHAVIOR?

Process Model



Representativity Assessment Scale (RAS)

INSPIRED BY NASA CREDIBILITY ASSESSMENT SCALE (CAS)

EXAMPLE:

Category	Behavior Simulation	Climate Representation	Food preferences
Level 3	The penguin model waddles and slides on its belly, as in real life	The model places the penguin in cold, sub-zero temperatures	The penguin model only eats fish, as expected in reality
Level 2	The penguin model waddles, but sometimes flies	The model places the penguin in cool, but not freezing conditions	The penguin model eats both fish and berries
Level 1	The penguin model barks like a dog	The model places the penguin in tropical temperatures	The penguin model prefers cat food

Levels

Categories

Representativity Assessment Scale (RAS)

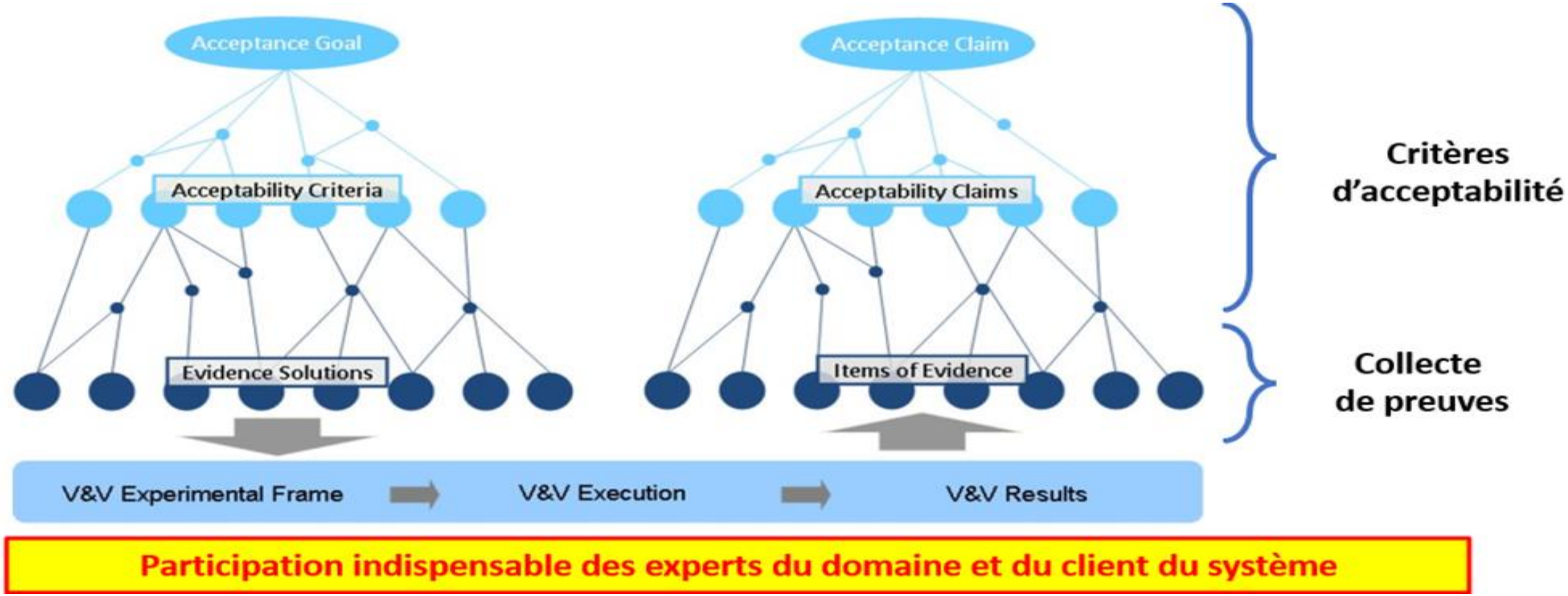
Factor Level	Functions coverage	Code Verification	Interfaces existence	Completeness Complexity level	Experts Review	Developer confidence	Use History
Level 3	All required functions are covered in the model with all parameters in consideration	No numerical error to small errors	The exact number of interfaces exist and are typed correctly	Model is predictive	Extensive experience in this M&S domain	Advanced	Model used with successful simulation results multiple times
Level 2	All required functions are covered in the model	Formal numerical errors estimation	Extra interfaces exist and are typed correctly	Model is comparative	Formal experience in this M&S domain	Intermediate	Model used with successful simulation results one time
Level 1	Some required functions are missing from the model	Model passes some tests with modification need	Not all interfaces exist	Model in development	Expert in another M&S domain	Beginner	Model used with unsuccessful simulation results
Level 0	Insufficient Evidence	Insufficient Evidence	Insufficient Evidence	Insufficient Evidence	No review	Not Confident	Model was never used

1 Development Evidence

2 Supporting Evidence

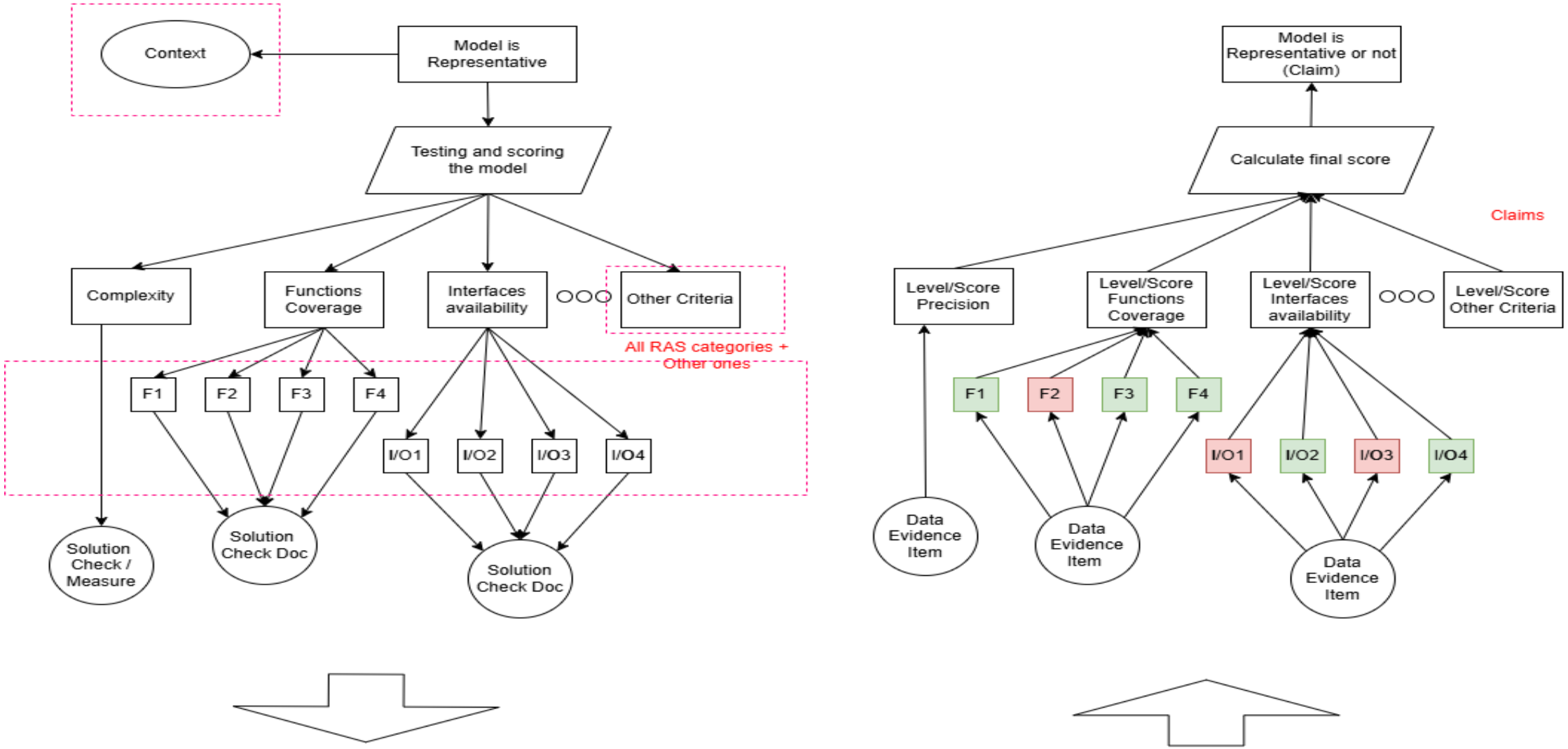
3 Performance Evidence : Resources, time

Goal-Claim network



Participation indispensable des experts du domaine et du client du système

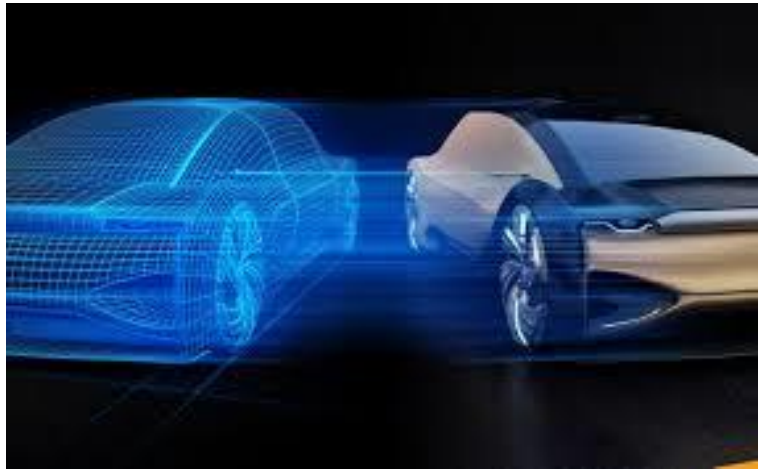
RAS + Goal Claim network



Conclusion & Future Steps

- TEST & EVALUATE THE APPROACH ON AN EXAMPLE USING AADL (ARCHITECTURE ANALYSIS AND DESIGN LANGUAGE) AND ALISA (ARCHITECTURE LED INCREMENTAL SYSTEM ASSURANCE)

- IMPROVE THE SIMULATION ARCHITECTURES
- BUILD PRECISE SIMULATION PLATFORMS THAT ARE NOT OVER-DIMENSIONED OR UNDER-DIMENSIONED
- GIVE MORE ACCURATE RESULTS CLOSER TO REAL WORLD RESULTS
- PREVENT TIME LOSS.



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Thank you