Technological challenges for Autonomous driving systems validation in heterogeneous environments

OPAL-RT TECHNOLOGIES

SUMMARY

Context and issues

From Simulation to Real hardware testing

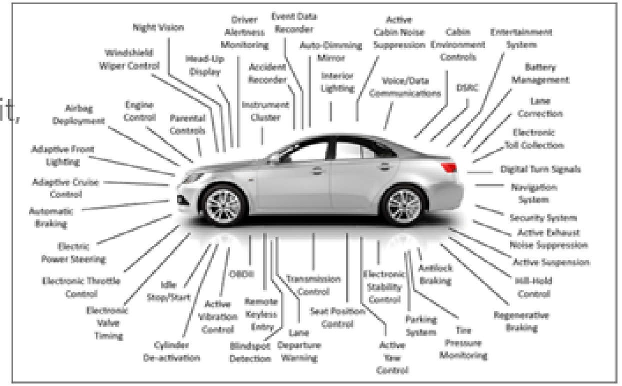
- Simulations : why ? how? To what extent ?
- Hardware and software based co-simulation.

Opal-RT added value.

- Multiple hardware platforms support,
- RT-LAB / Orchestra : A common and unique software that handles all your testing phases and requests,
- Hosting the simulation environment and Opal-RT software and hardware solution on the same physical machine.

What is to come

CONTEXT AND ISSUES (1/2)



Vehicles complexity

- Multitude of sensors/actuators, Heterogeneous communication interfaces, Variety of processing unit,
- Reliability concerns -> redundancy, increases complexity,
- High value components and new concepts / trends.

Reducing cost VS accelerating validation

- Automotive market is volume driven,
- ECUs cost including testing and validation: 35% (2020) - 50% (2030) of the total vehicle cost, billion of miles of testing,
- Need to optimize the validation processes and leverage new testing methods.

Heterogeneous architectures

- Multiple busses: CAN, FlexRay, Automotive Ethernet, V2X, etc.
- Multiple subsystems: not all made to communicate or interact, running at different rates and different hardware architectures,
- Data sources, sinks and flows: two or more systems can share the same sensor on different interfaces,
- Different timing constraints: a video stream for entertainment VS video stream for an AEB system, Systems response time

CONTEXT AND ISSUES (2/2)

Communication and cybersecurity

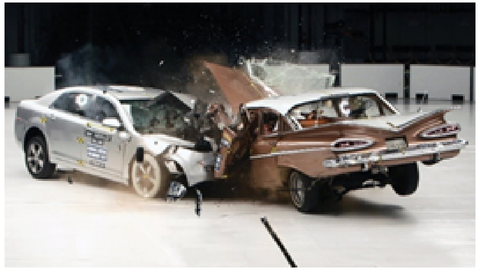
- Wireless communication technologies: Enhance vehicles interaction with their environment, Constitute an additional source of information, Can create an entry point for a cybersecurity threat,
- Shared mediums / backbone: Ensure sensors/ subsystems interactions, Can propagate the risk to safety critical systems.

Artificial intelligence and data fusion

- Constitute the senses and the brain of the intelligent and autonomous vehicle,
- A must for richer information construction and environment awareness,
- Not an easy task but can be of a high value,
- No clear approach to how to test and validate such systems.

Regulatory constraints

- Real world testing,
- Responsibility and liability.



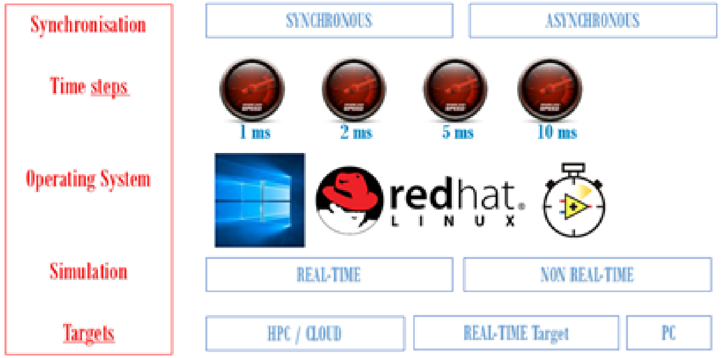
SOLUTIONS: FROM SIMULATION TO REAL HARDWARE TESTING (1/2)

Simulation : Why ?

- Easy to fit, lower cost, faster validation,
- Validation at earlier stages, easier debugging, corrections and design changes,
- Interoperability, Hardware abstraction / virtualization,
- Easy upgrade of the simulation environment compared to the real-world testing,

Simulation: How?

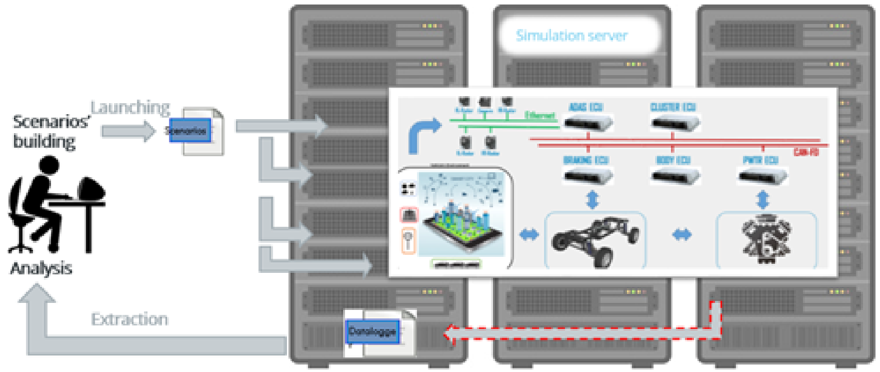
- A complete simulation based testing solution does not exist
- Interoperability between simulation environments to achieve a common goal,
- Tests repeatability and optimization,
- Time constraints
  - off-line (as a first step)
  - real-time (for safety critical systems)
  - faster than real-time (accelerated),



SOLUTIONS: FROM SIMULATION TO REAL HARDWARE TESTING (2/2)

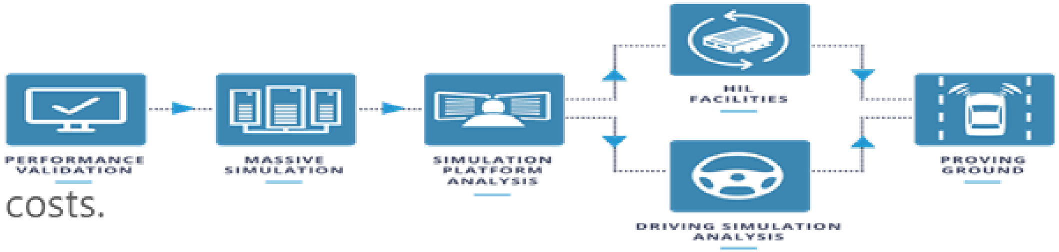
Simulation: To what extent? Massive!!!

- Billions of miles driven to validate the entire vehicle,
- Simulations and scenarios optimization: can be AI based,
- Divide and rule: from the subsystems to the entire architecture,
- Reduce the duration of the physical testing,
- Needs of AI simulation based procedures for AI systems testing,



Hardware and software based co-simulation

- Simulate the environment while testing real ECUs,
- Lower risks and testing systems versatility,
- Explore multiple processing architecture with lower costs.



SOLUTIONS: OPAL-RT ADDED VALUE (1/4)

RT-LAB :

- A Real-Time architecture for distributed simulations,
- Ensures models execution over a variety of processing cores (X86, ARM, FPGA, etc.),
- Supports a multitude of Interfaces on Real-Time Targets for enhanced versatility.

ORCHESTRA :

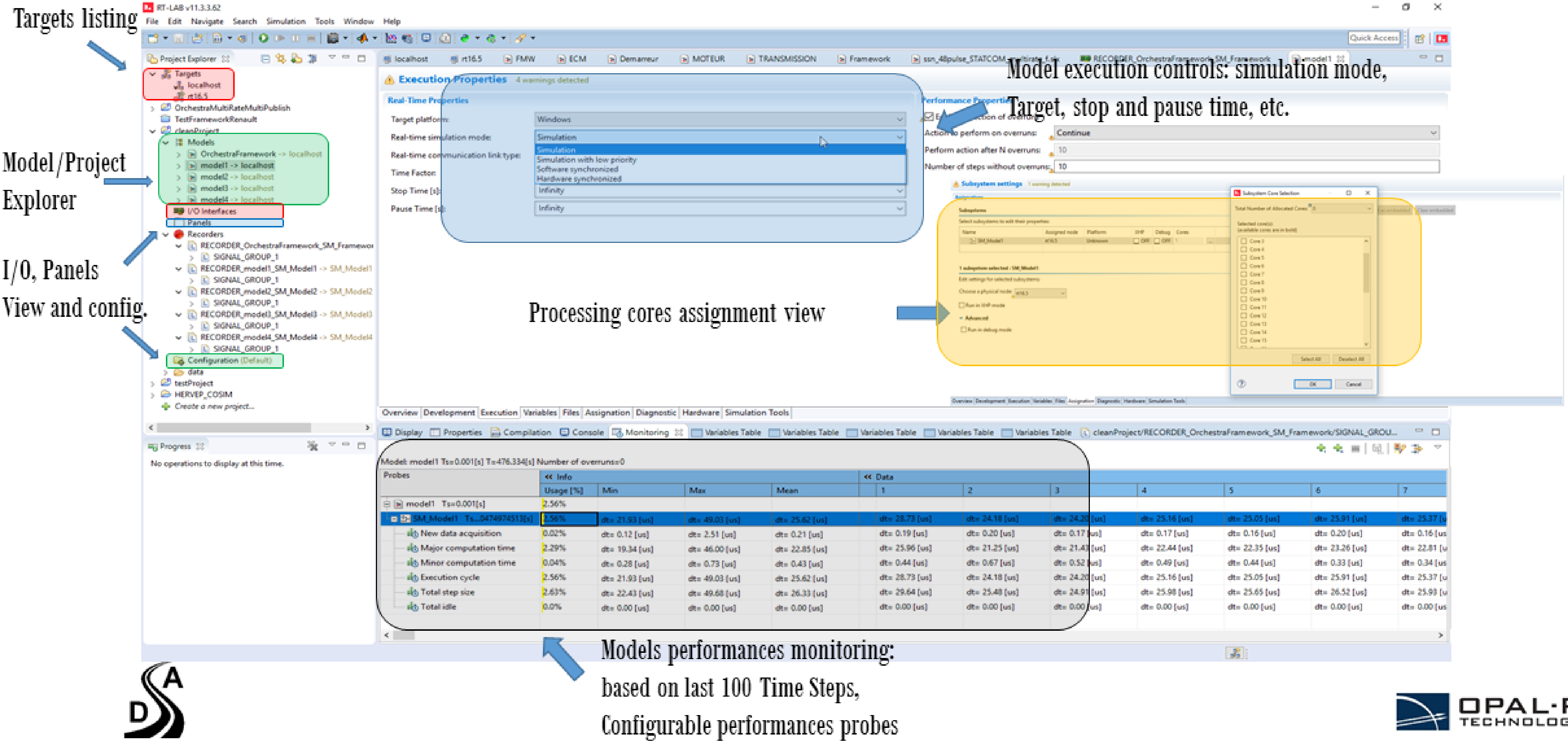
- An Application-level data communication layer that leverages RT-LAB Framework,
- A plug and play tool for data mapping and synchronization between Co-Simulation environments,
- Data-centric for ease of integration and interoperability,
- Easily configurable through an XML-based DDF and GUI,
- Does not interfere with the simulation performances (high performances, scalability, etc.),

RT-LAB Orchestra is a high-performance Co-Simulation framework optimized for laboratory-scaled real-time HIL simulation and High-Performance Supercomputer using private and public servers

RT-LAB

eMEGASIM eFPGASIM ePHASORSIM

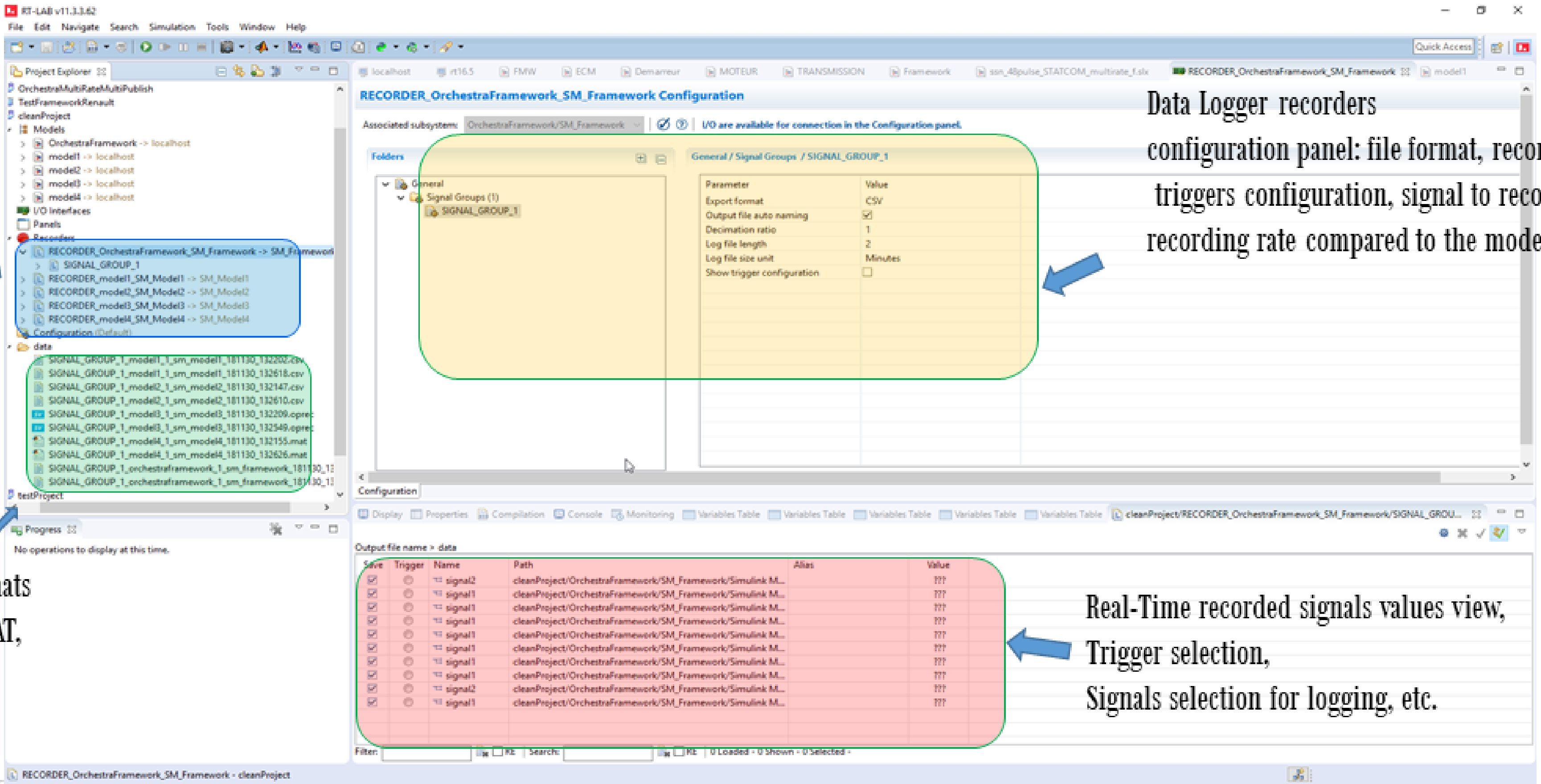
SOLUTIONS: OPAL-RT ADDED VALUE (2/4)



SOLUTIONS: OPAL-RT ADDED VALUE (3/4)

Recorders listing for Data logging

3 Output files formats Supported: CSV, MAT, OPREC



Data Logger recorders configuration panel: file format, recording duration, triggers configuration, signal to recorder assignment, recording rate compared to the model execution rate, etc.

Real-Time recorded signals values view, Trigger selection, Signals selection for logging, etc.

SOLUTIONS: OPAL-RT ADDED VALUE (4/4)

Hosting RT-LAB and the simulation environment on the same physical machine: all is simulated

- Reduced latency and optimized data flows,
- Accommodate massive deployment on cloud data center,
- Optimizing simulation environment execution,

Hosting RT-LAB and the simulation environment on the same physical machine: combination of simulation and real hardware / interfaces

- In addition to the previous advantages,
- Access to highly efficient I/O such as FPGA-based ones,
- Optimizing simulation environment execution if not ensuring its execution in real time,
- Possibility to handle hardware based co-simulation: GPU for sensors simulation, FPGA for I/O handling, and CPU for controllers testing and validation,
- Supports a multitude of Interfaces on Real-Time Targets for enhanced versatility.

WHAT IS TO COME

Standard interface for co-simulation platforms: ACOSAR, SYSML,

GPU support for AI and Data Fusion processes,

Multi-instance multi-project support optimization for massive simulation deployment,

Optimized testing scenarios selection based on AI,

Cybersecurity testing and protection.