JFMS 2020

Couplage de FMI et HLA pour l'Ingénierie de Systèmes

Simon GORECKI
Jalal Possik
Yves Ducq
Gregory ZACHAREWICZ
Nicolas PERRY

Modeling & Simulation

- Modeling & Simulation (M&S) is required to design complex systems
  - Study behaviors / interactions

- Modeling describe process → allow development of a Simulation
- Simulation virtually designs the subject → studies and anticipates

- Technologies growing → complexity also
  - More difficult to simulate
  - More difficult to validate
  - Increase risks

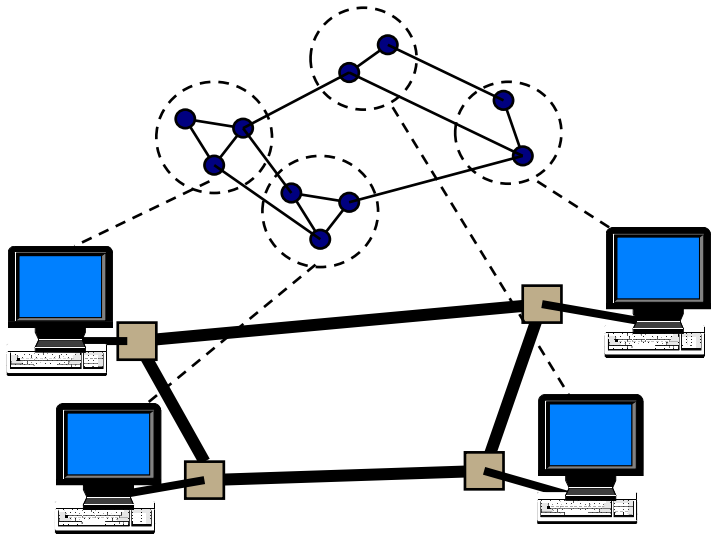
- Objectives
  - Outsourcing risk modeling
  - Distribute complexity → Co-Simulation & Distributed Simulation

Co-Simulation

- Several stand-alone simulations
- One main execution
- Sub-components can be relocated to a different computer

- Allows :
  - loads balancing
  - time saving
  - interoperability problems management

- High Level Architecture (HLA)
- Functional Mock-up Interface (FMI)



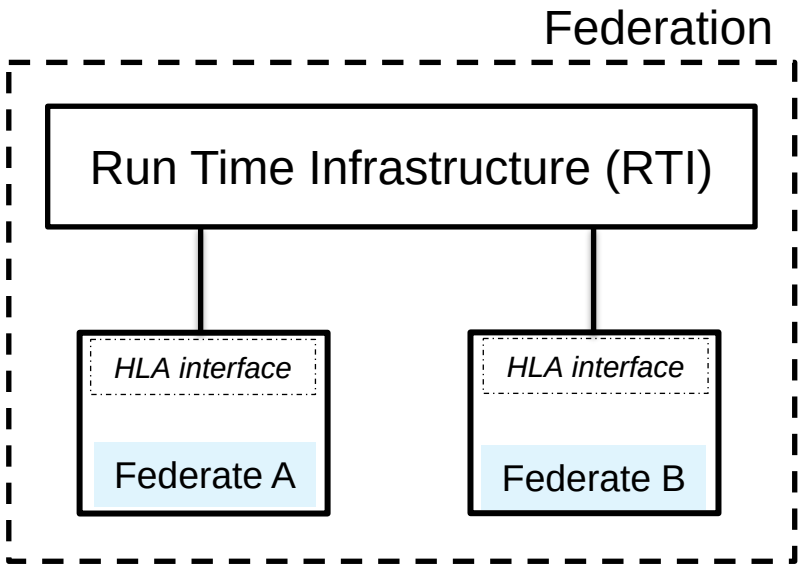
Richard M. Fujimoto

High Level Architecture (HLA)

- Specification of software architecture
- Created by US Department of Defense
- Designed for reusability

- main execution : Federation
- sub simulation : Federate

- The RTI can
  - Starts federation
  - Joins federates
  - Closes federation
  - Communication management
    - Publish (write)
    - Subscribe (listen)
  - Time management

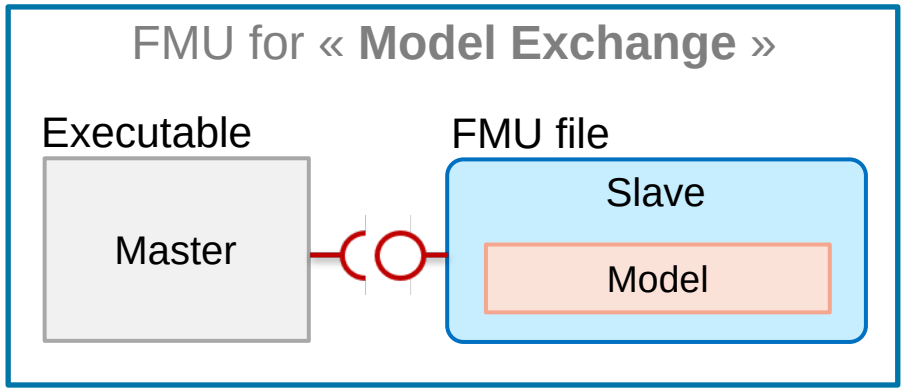


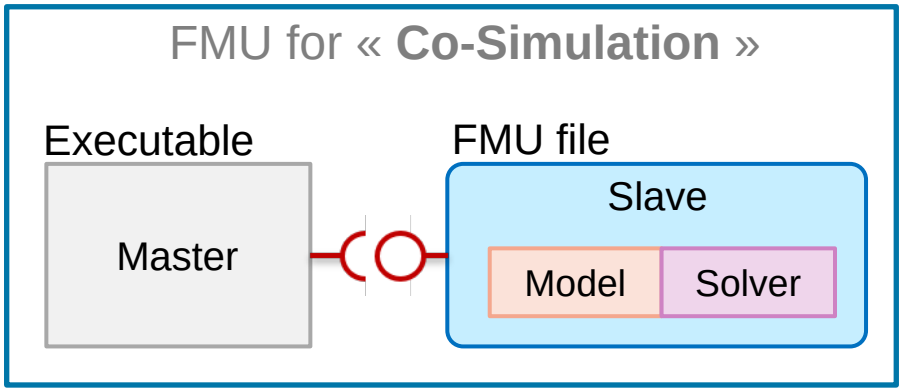
Co-Simulation

- Standard of Co-Simulation
- European project : 2010

- BlackBox mechanism
  - XML Description file
  - Compiled C-code
  - Wrapped in 1 file

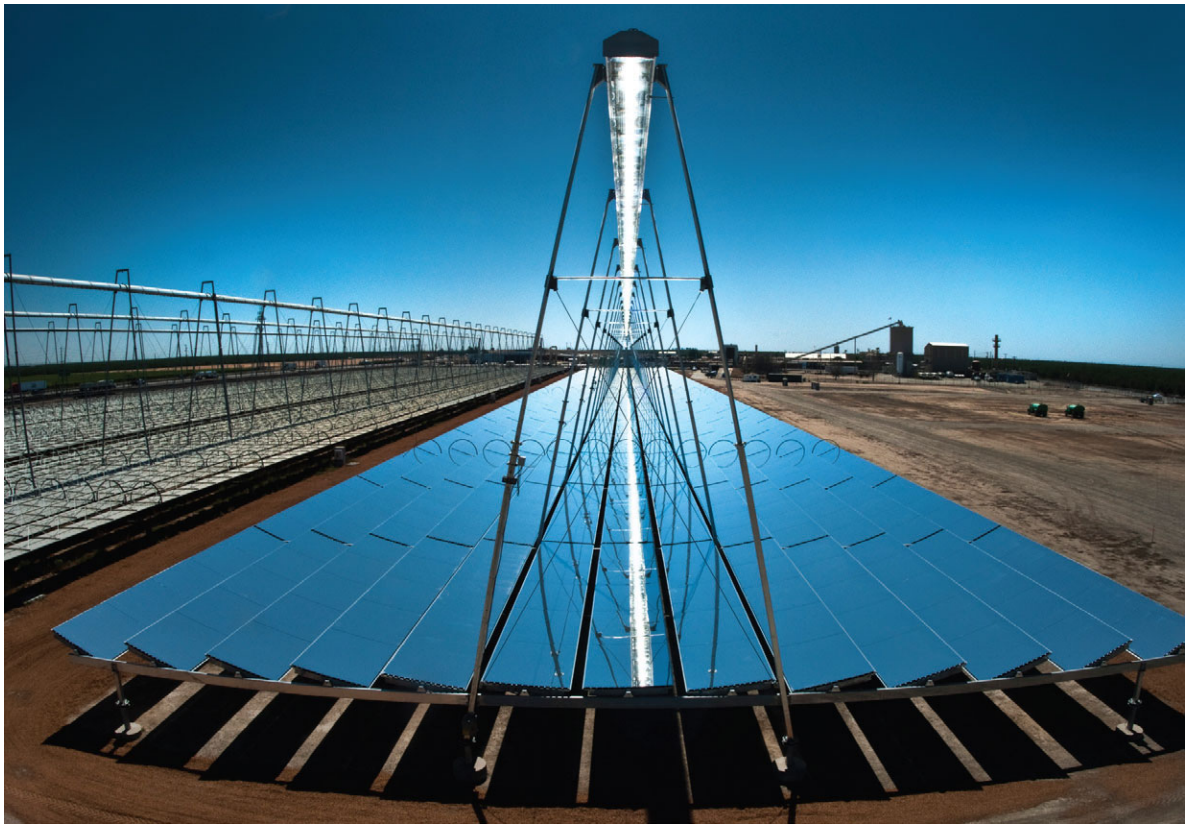
- Master
  - Load and Initiate FMU
  - Execution and time management
  - Data flow management





Overview – Industrial context

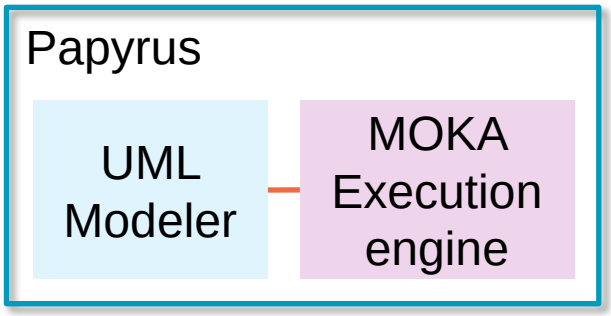
- Produces electricity from the sun without photovoltaic panels
- Fresnel mirrors
- 1 MW / 20 000m²



- Stores energy as heat
- Uses renewable energy
- Multi-function system
  - Ice production
  - Heat production
  - Water desalination

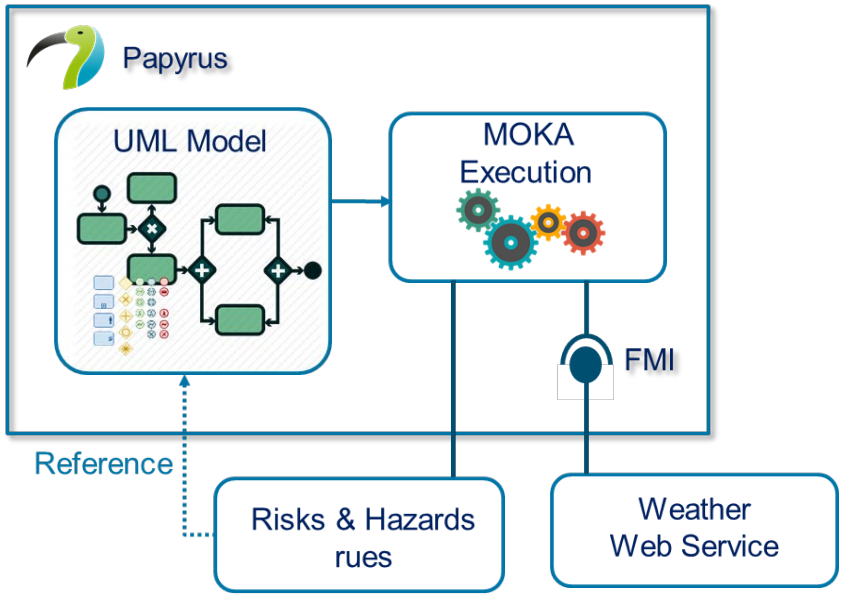
Modeling tool - Papyrus

- UML and SysML modeler
- Supported by *CEA tech & Eclipse foundation*
- Open source project
- Support UML profiles → define other graphic languages (BPMN)
- MOKA engine can execute UML models
- Papyrus allow Modeling and Simulation



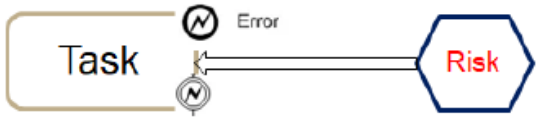
Contributions – Risk management

➔ Outsource risk rules from Papyrus model designer

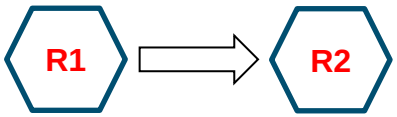


➔ Several rules impact, on process

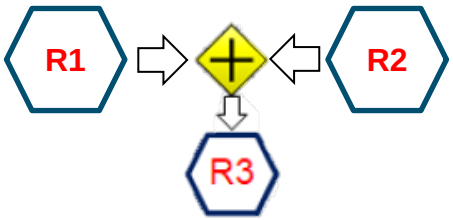
› Risk impact on task



› Risk generate risk



› Several risks generate new risk



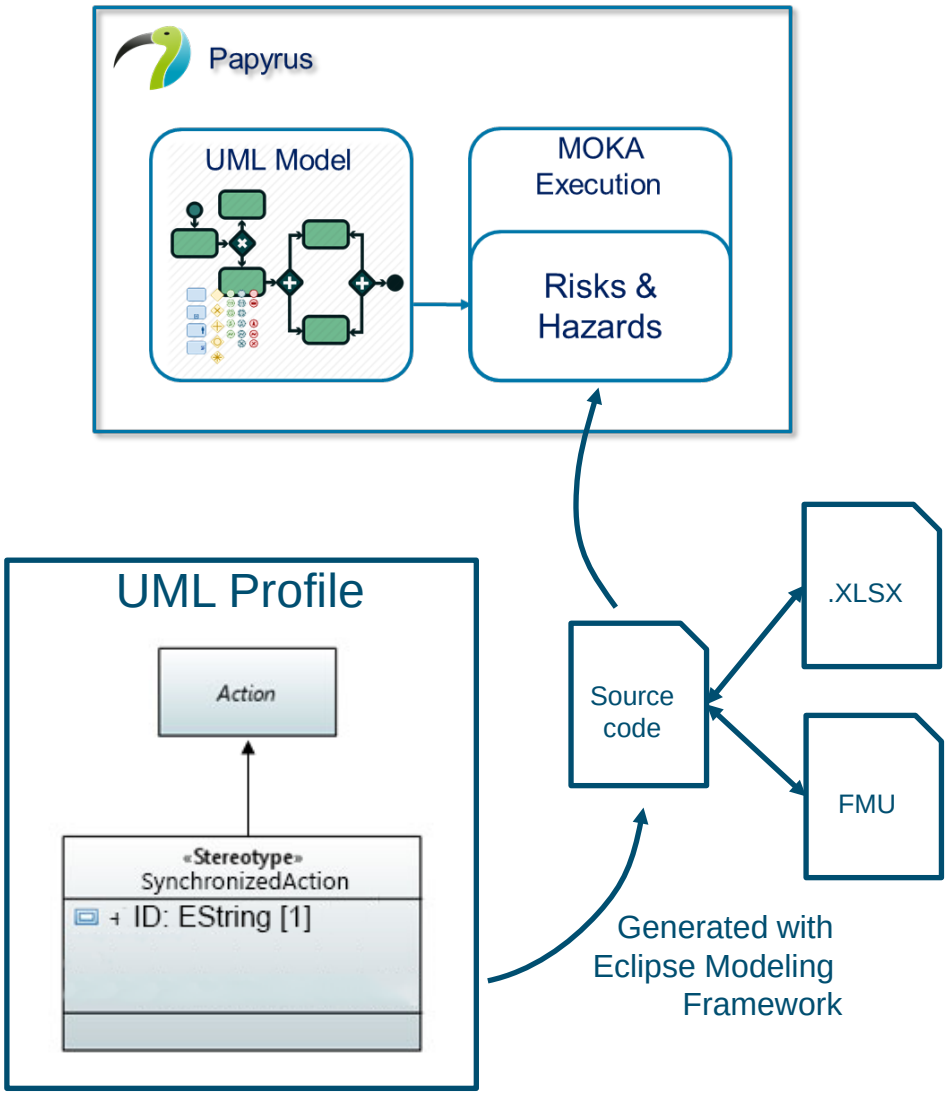
➔ Use Moka extension

➔ Use Functional Mock-up Interface

› Co-Simulation

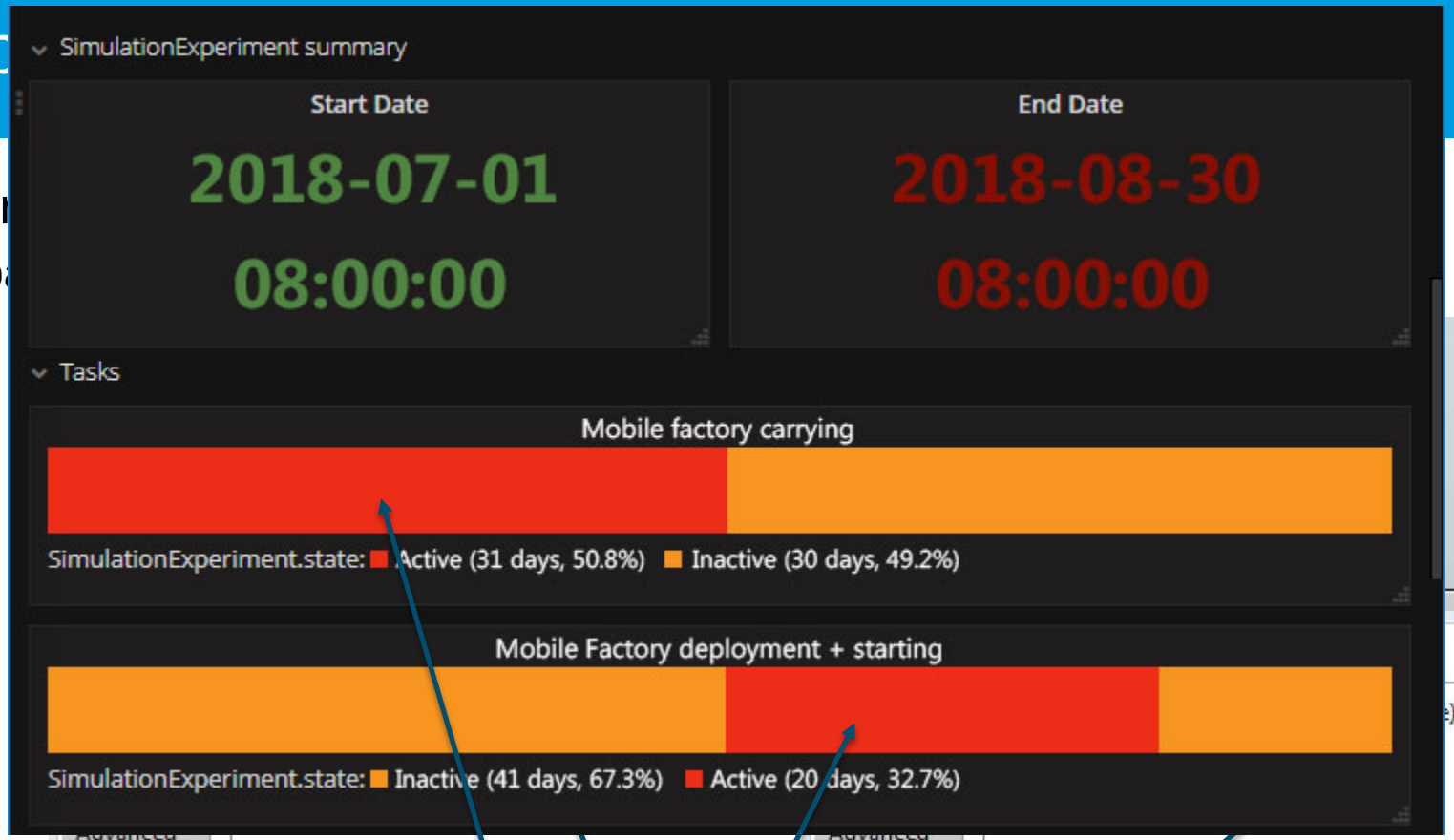
Contributions – Risk management

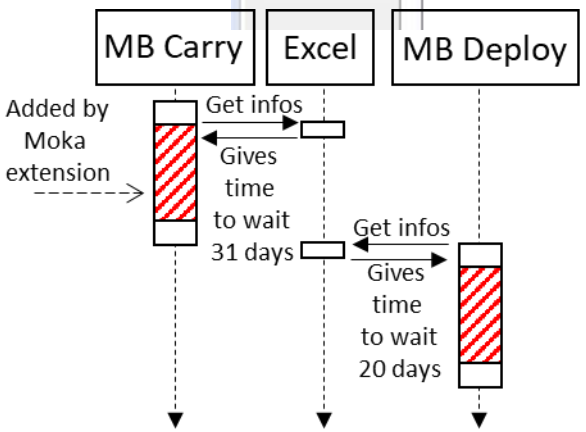
- Define new UML profile
  - New stereotypes will be linked to UML Class or UML Action
  - Stereotype can have attributes
    - Mean Time Between Failure
    - Mean Time To Repair
- Generate source code of the new profile → behavior description
- Customize MOKA execution engine to add implementation generated



Contrib

- UML pr
  - Imp

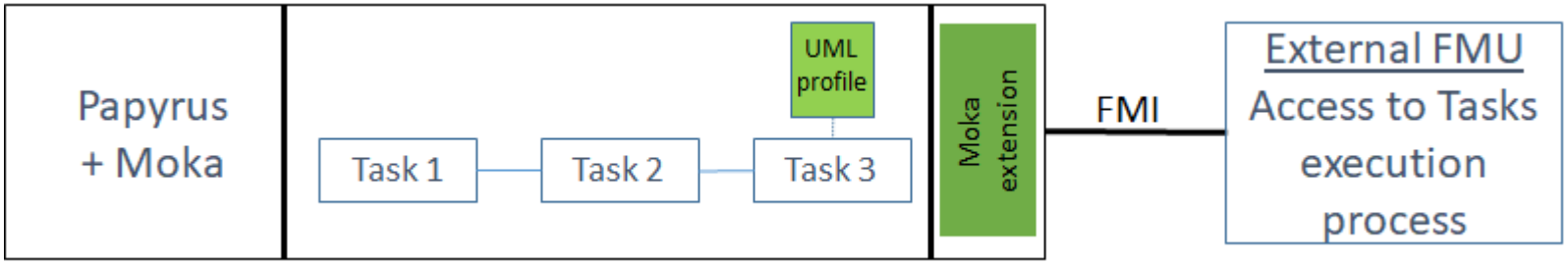




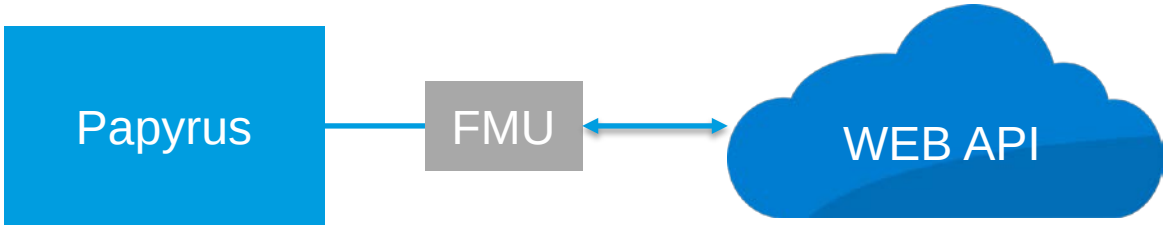
Data		
Task length	ID	Execution date
20d	MB Deploy	01/08/2018 08:00:00
31d	MB Carry	01/07/2018 08:00:00

Contribution – Complexity management

› Papyrus instance connected to a FMU

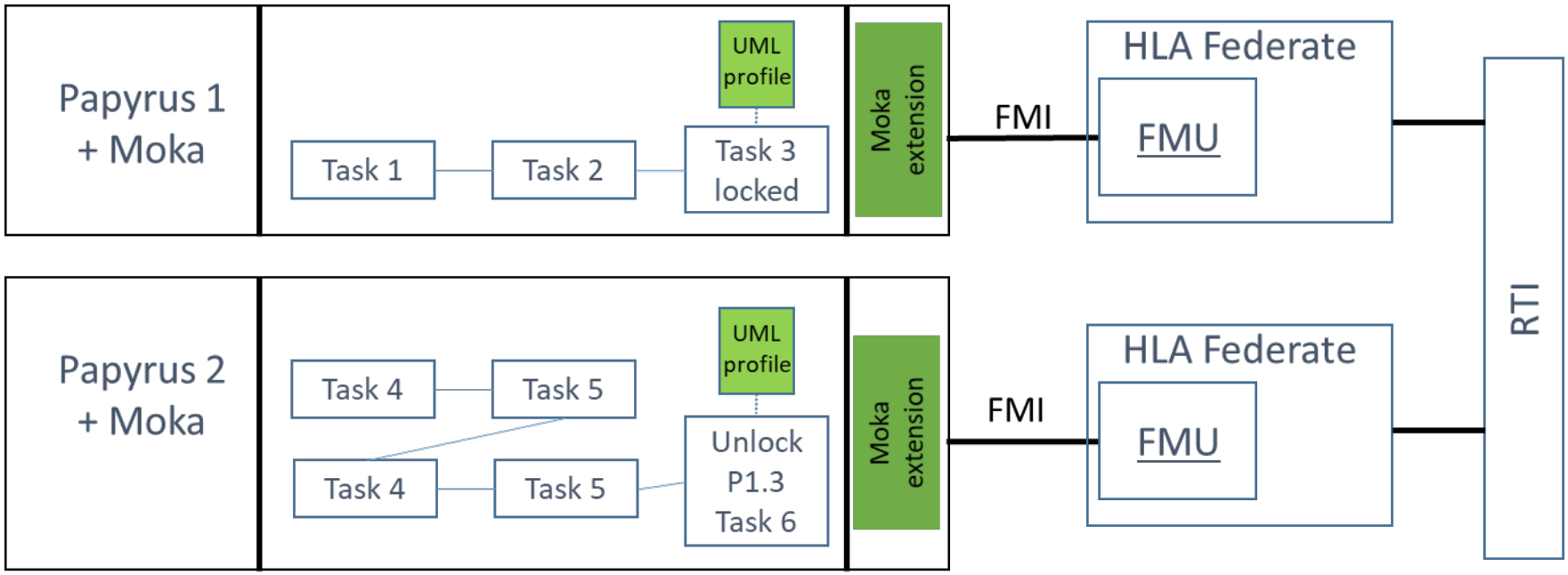


› Weather WebAPI requests

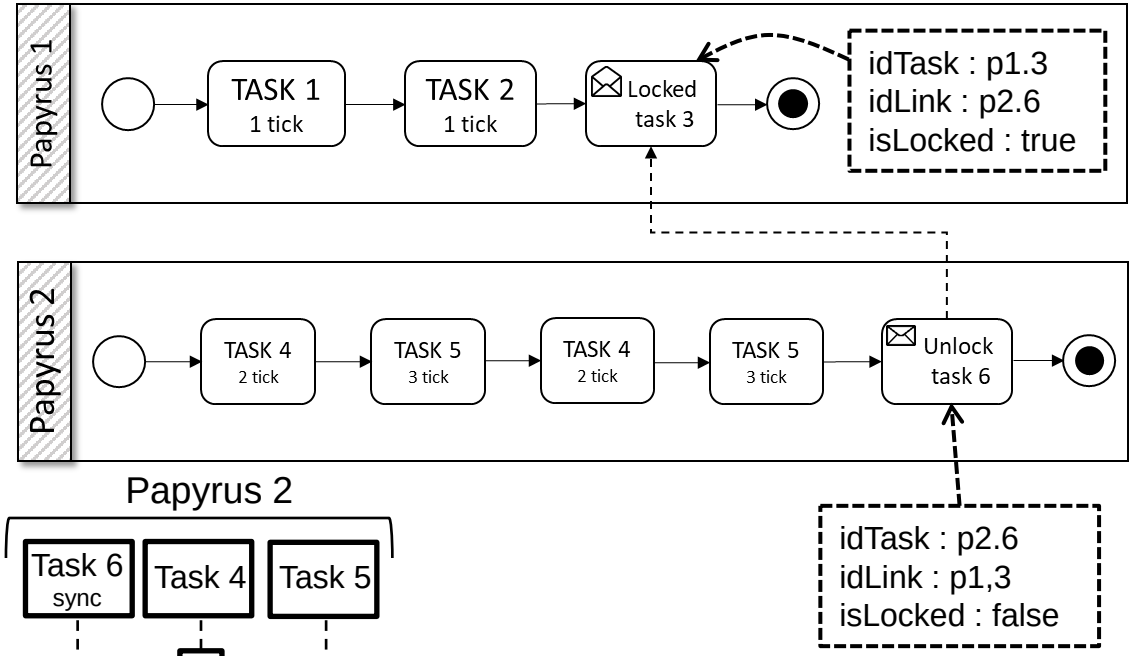


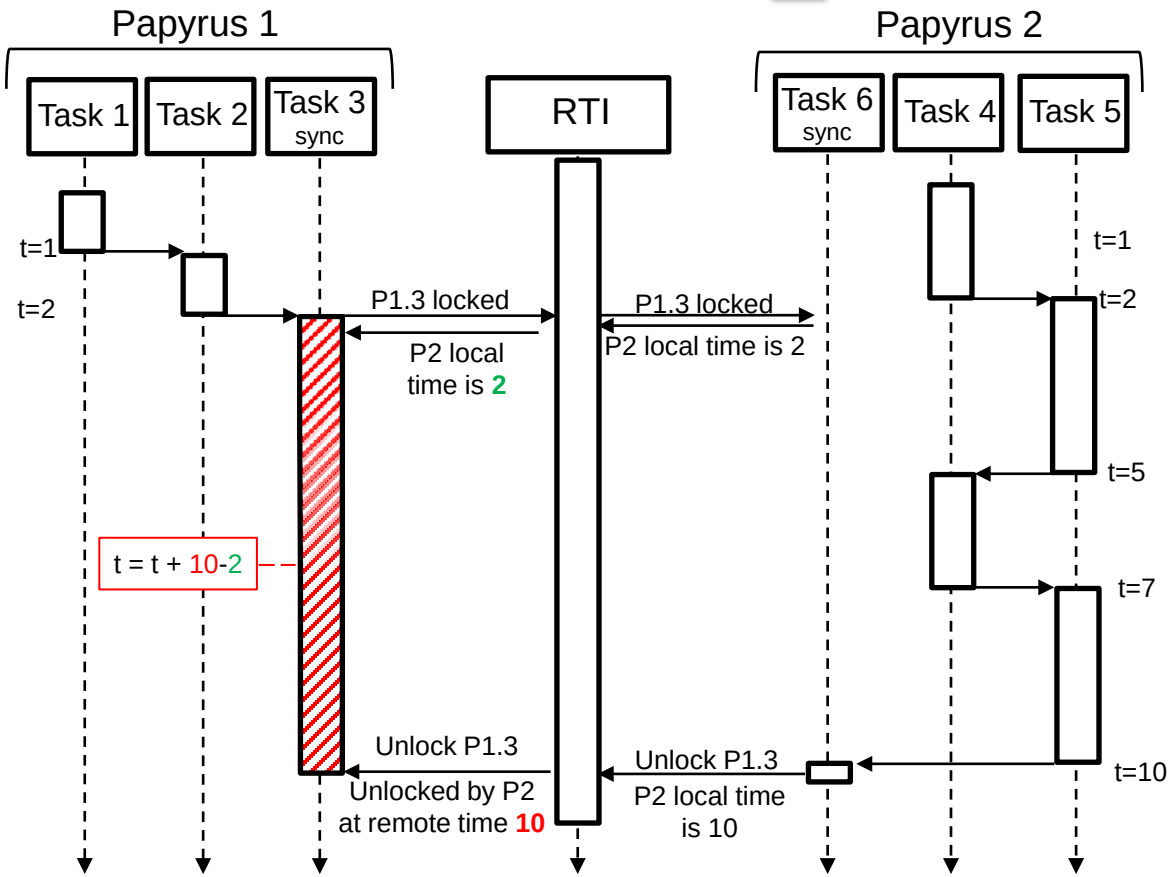
Contribution – FMI - HLA

- Distributed Papyrus environment
  - HLA RTI
  - Communication



➔ Exemple of sync points





Conclusion & Perspectives

- Papyrus is a powerful that allow to develop UML and MOKA extension to customize it according to the needs
- It tend to open the software to FMI for Model exchange
  - We proposed a begin to Co-Simulation
  - Using HLA RTI as master
- Distributed simulation is currently at the early stage of implementation
  - It can only share tokens as resources
- Much remain to be done
  - Performance evaluation
  - More complex shared resources
  - Experimental framework

Thank you for your attention

simon.gorecki@u-bordeaux.fr