Co-simulation using OMSimulator

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10th OpenModelica Annual Workshop, February 5, 2018

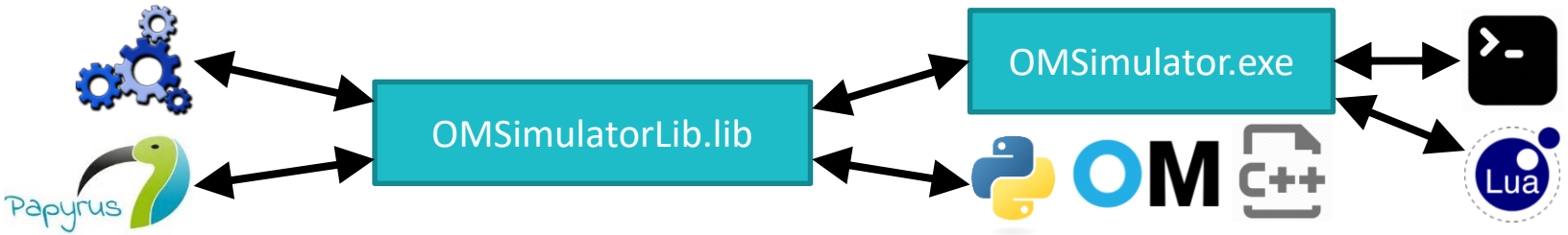
LINKÖPING UNIVERSITY

OMSimulator

- Co-simulation environment primarily based on FMUs
- Combining TLM and FMI approaches for co-simulation

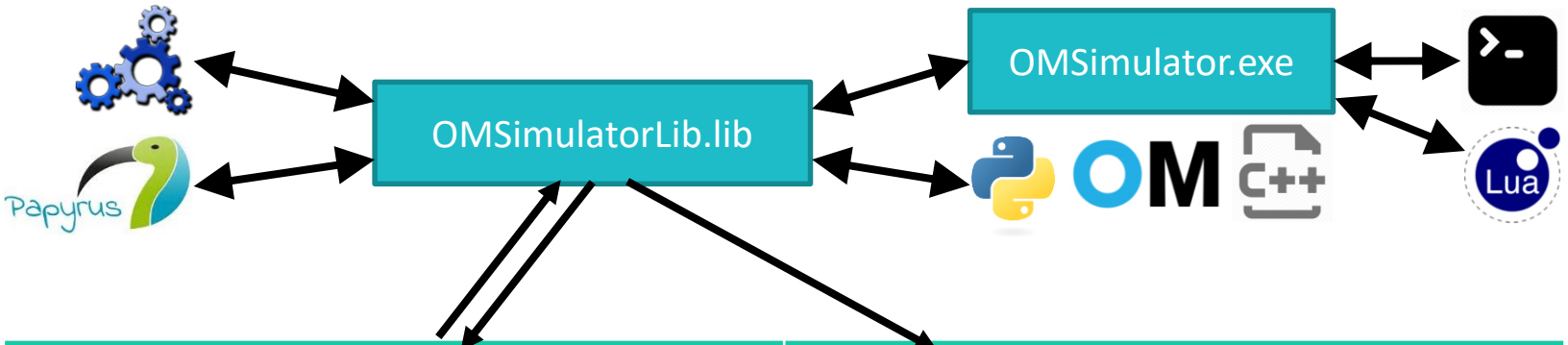
TLM	FMI
• Physical connections • Delayed connections • Distributed processes	• Signal connections • Non-delayed connections • Single process

OMSimulator



OMTLMSimulator	OMFMISimulator
• Physical connections • Delayed connections • Distributed processes	• Signal connections • Non-delayed connections • Single process

OMSimulator



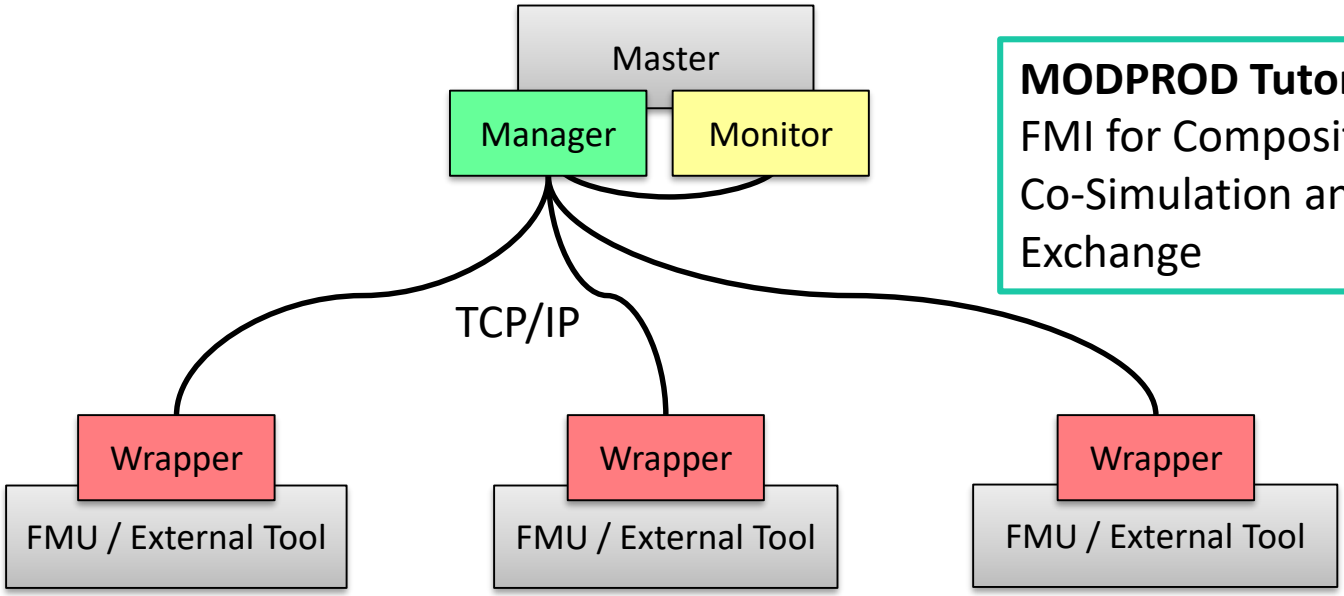
OMTLMSimulator	OMFMISimulator
• Physical connections • Delayed connections • Distributed processes	• Signal connections • Non-delayed connections • Single process

OMTLMSimulator

- Dedicated talk at MODPROD
- Bottom-up approach

MODPROD Parallel Session 2a: TLM-based co-simulation using FMI and direct tool connections

MODPROD Tutorial 2: FMI for Composite Modelling, Co-Simulation and Model Exchange



OMTLMSimulator

- Dedicated talk at MODPROD
- Bottom-up approach
- Only TLM connections
- Distributed simulation
- External tool integration (e.g. Simulink, Adams, BEAST)

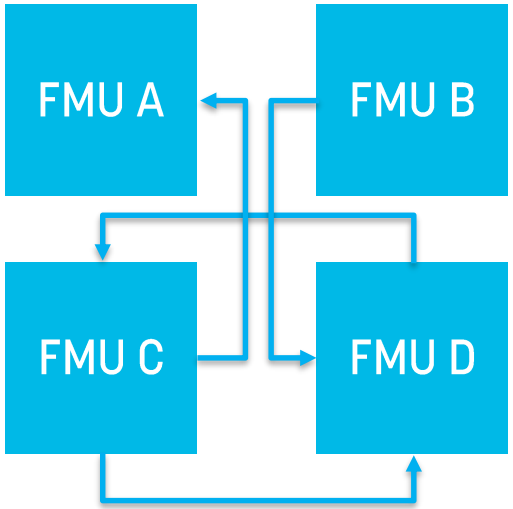
MODPROD Parallel Session 2a: TLM-based co-simulation using FMI and direct tool connections

MODPROD Tutorial 2: FMI for Composite Modelling, Co-Simulation and Model Exchange

OMFMISimulator

- Simulator for connected FMUs
- Only signal connections
- Top-down approach
- Single process
- Scripting interface

MODPROD Tutorial 2:
FMI for Composite Modelling, Co-Simulation and Model Exchange

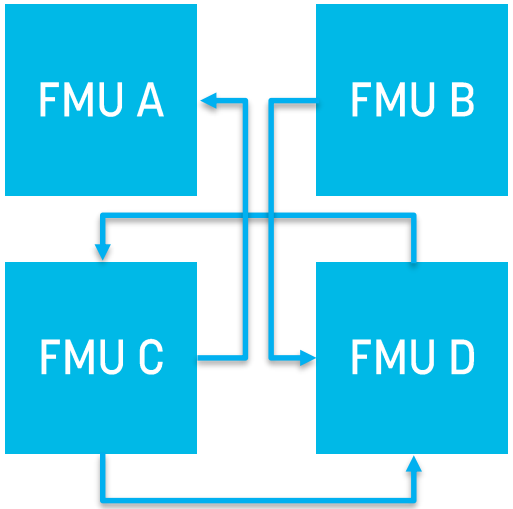


OMFMISimulator

Python interface:

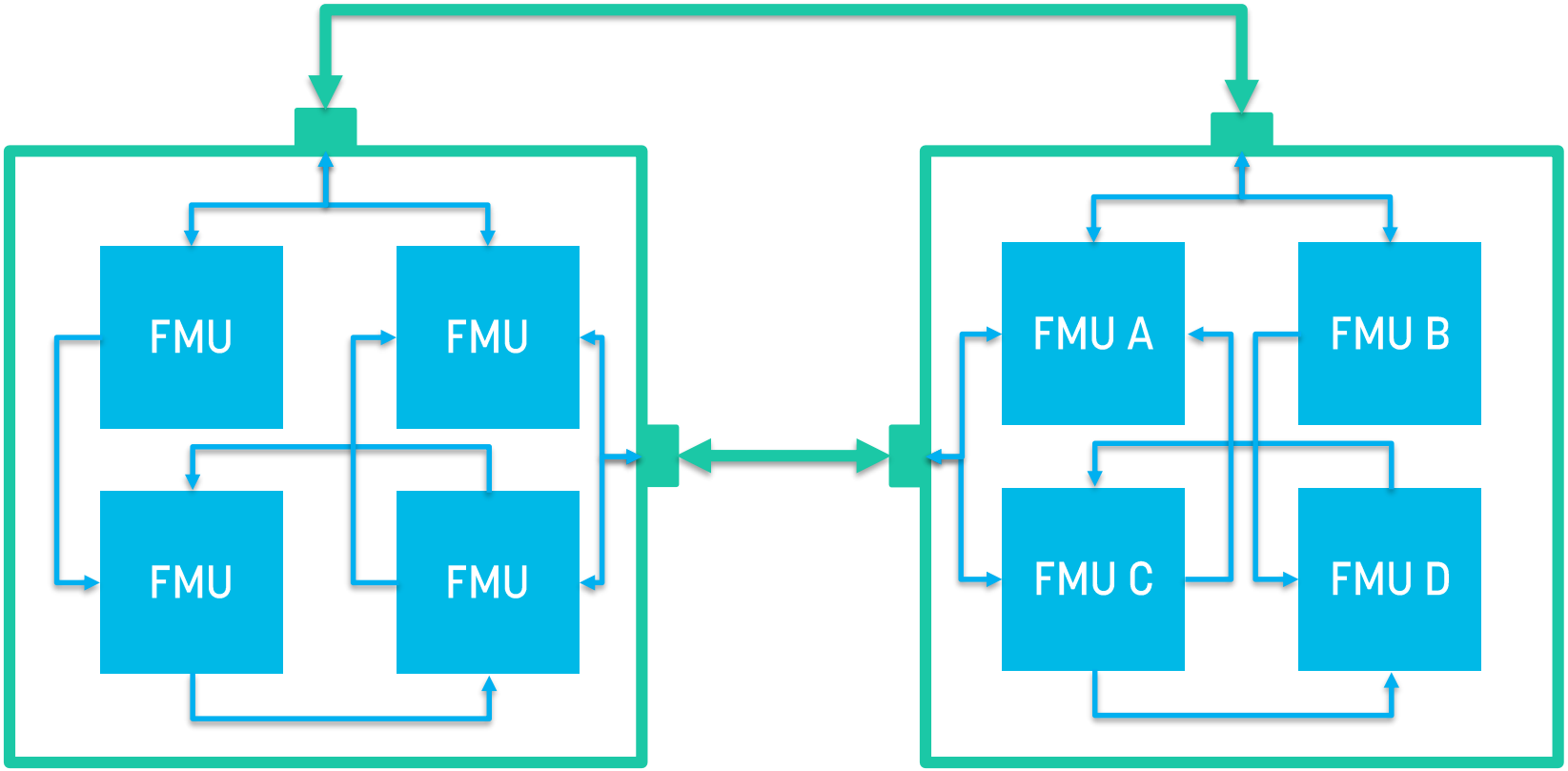
```
m = oms.newModel()
# instantiate FMUs
oms.instantiateFMU(m, "A.fmu", "A")
oms.instantiateFMU(m, "B.fmu", "B")
oms.instantiateFMU(m, "C.fmu", "C")
oms.instantiateFMU(m, "D.fmu", "D")
# add connections
oms.addConnection(m, "A.u",  "C.y1")
oms.addConnection(m, "B.y",  "D.u1")
oms.addConnection(m, "C.y2", "D.u2")
oms.addConnection(m, "C.u",  "D.y")
```

MODPROD Tutorial 2:
FMI for Composite Modelling, Co-Simulation and Model Exchange

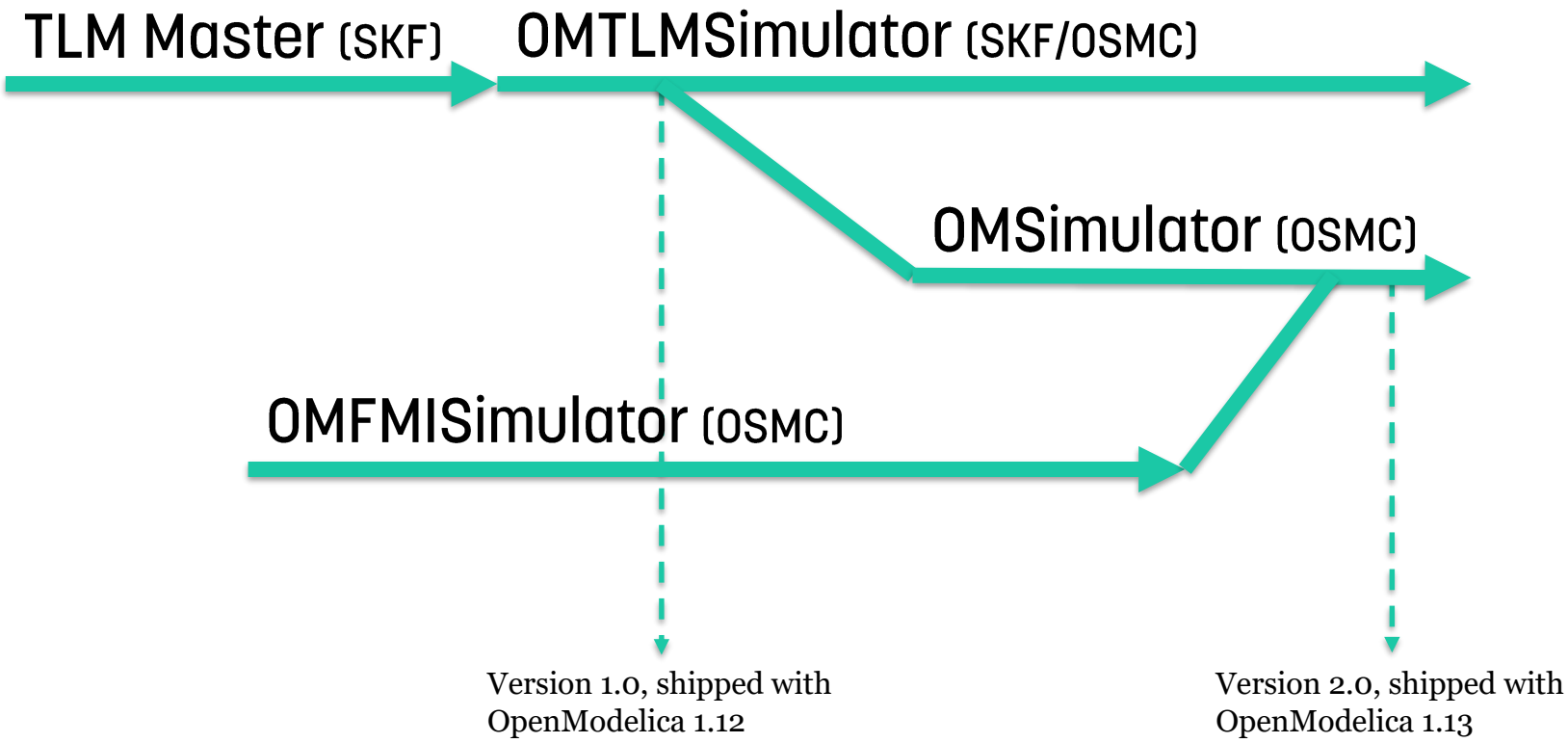


FMI
TLM

OMSimulator



OMSimulator - Roadmap



OpenModelica FMI Export

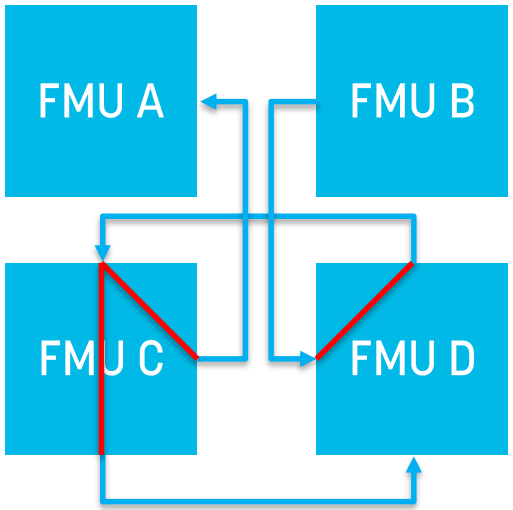
Model Structure

Required

- Outputs
- Derivatives
- InitialUnknowns

Optional

- Dependency information



Model Structure

Example: Modelica.Blocks.Continuous.Integrator

InitialUnknowns are missing completely:

```
<ModelStructure>
  <Outputs>
    <Unknown index="3" dependencies="1" dependenciesKind="dependent" />
  </Outputs>
  <Derivatives>
    <Unknown index="2" dependencies="4" dependenciesKind="dependent" />
  </Derivatives>
</ModelStructure>
```

1: y
2: der(y)
3: _D_outputStateAlias_y
4: u

OpenModelica Compiler OMCompiler v1.13.0-dev.397+g17ce08d

FMU State

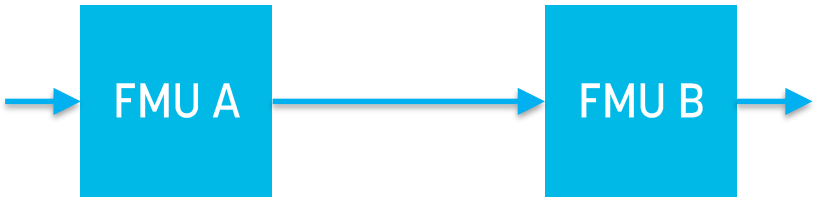
- All values that are needed to continue a simulation.
- Optional: fmi2GetFMUstate / fmi2SetFMUstate
- Needed to implement rollback mechanism

FMU State

Possible Scenario (simulating from t to $t + h$)

- Input(B) := Output(A)
- Call doStep for FMU A
  - $t \rightarrow t + h$
- Call doStep for FMU B
  - $t \rightarrow t + h$

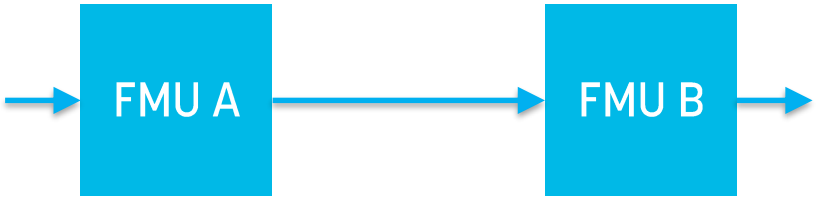
$t := t + h$



FMU State

Possible Scenario (simulating from t to $t + h$)

- Input(B) := Output(A)
- Call doStep for FMU A
  - $t \rightarrow t + h$
- Call doStep for FMU B
  - FMU B failed to compute whole step
  - $t \rightarrow t^*, \quad t \leq t^* < t + h$
- Both FMUs are out of sync



Summary & Outlook

Available features

- Simulation, basic MA, no rollback yet
- FMI 2.0 import for ME & CS
- Lookup tables (mat & csv)
- Detection of fake loops & handling of algebraic loops
- Scripting support (Python & Lua)

Work in Progress

- Integration of TLM & FMI
- Common API
- Graphical user interface (OMEdit & Papyrus)
- SSP support

Outlook

- Parallel execution
- Step size control
- Advanced MA (utilizing roll-back mechanism)

Download

- New member of the OpenModelica tool set
  - First stable version is included in OpenModelica 1.12
- Latest (possibly instable) versions:
  - OMTLMSimulator: https://github.com/OpenModelica/OMTLMSimulator/
  - OMSimulator: https://github.com/OpenModelica/OMSimulator/

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