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mosaik

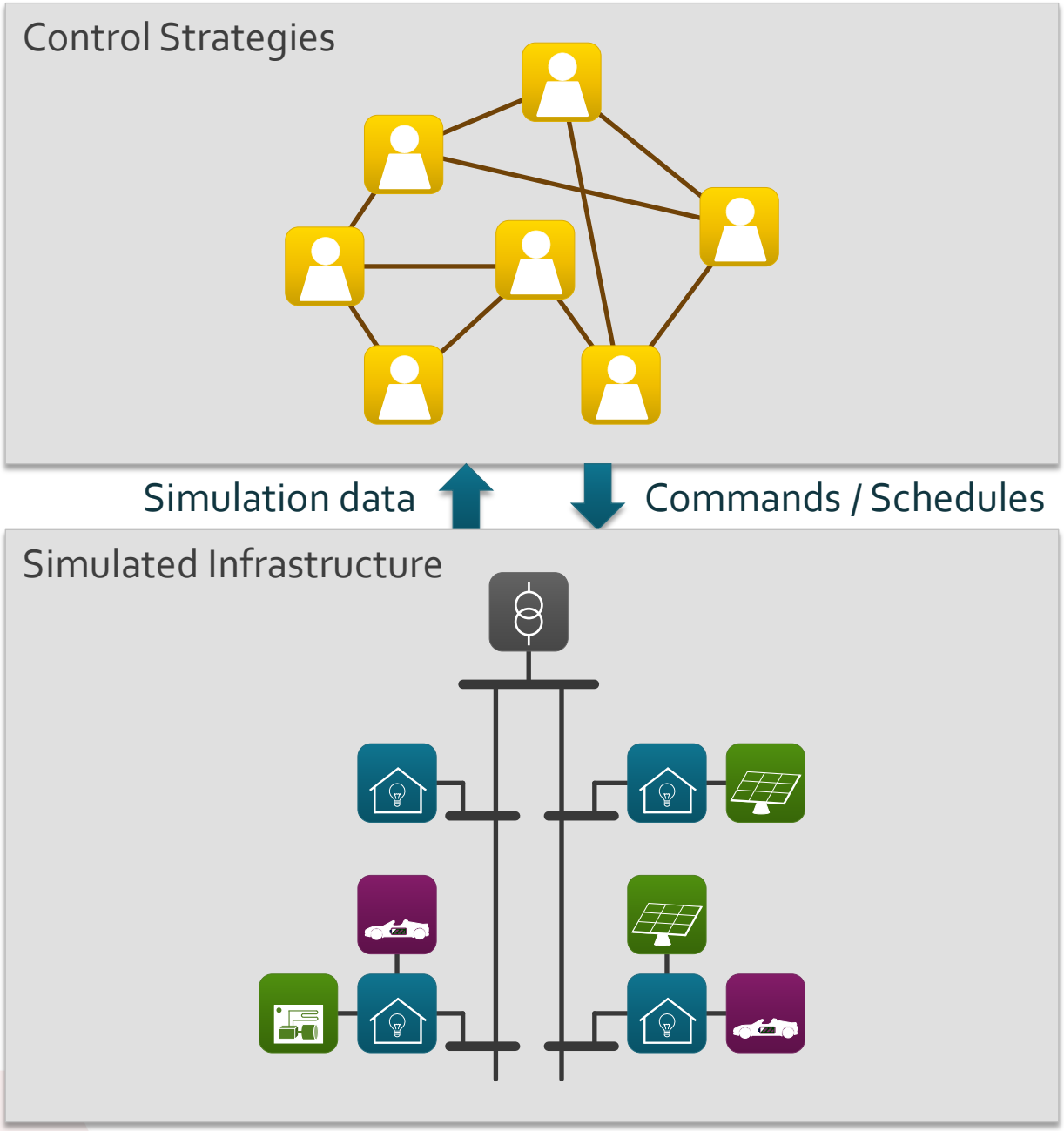
The flexible smart-grid co-simulation framework

Florian Schlögl, Okko Nannen, Cornelius Steinbrink
Bilbao, September 2016

Agenda

- Why mosaik?
- Architecture / functionalities
- Connections to FMI
- Advanced topics / examples

Why mosaik?


Control Strategies
Simulation data
Commands / Schedules
Simulated Infrastructure

Modular design

mosaik

Eco-system

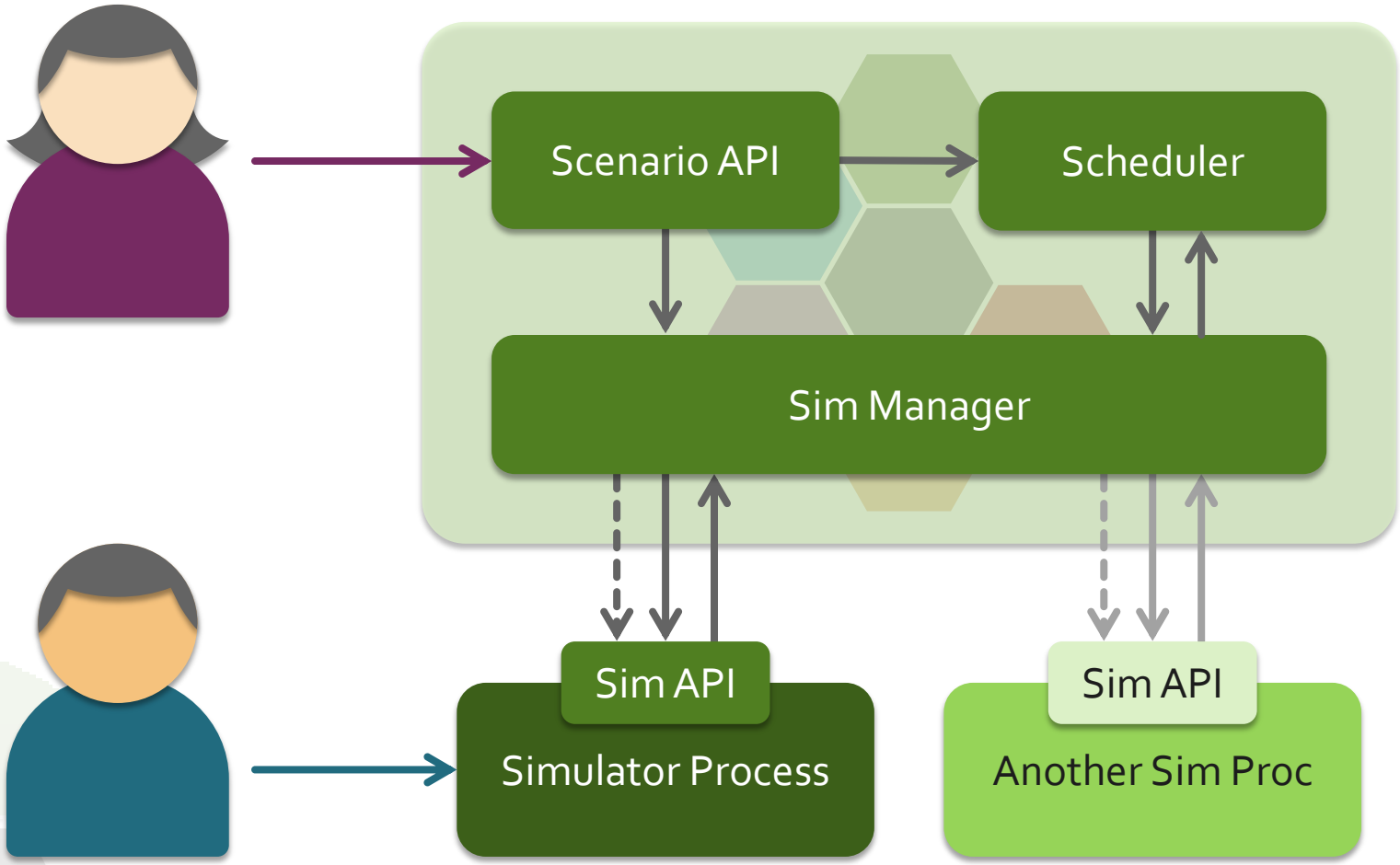
Model/Simulator

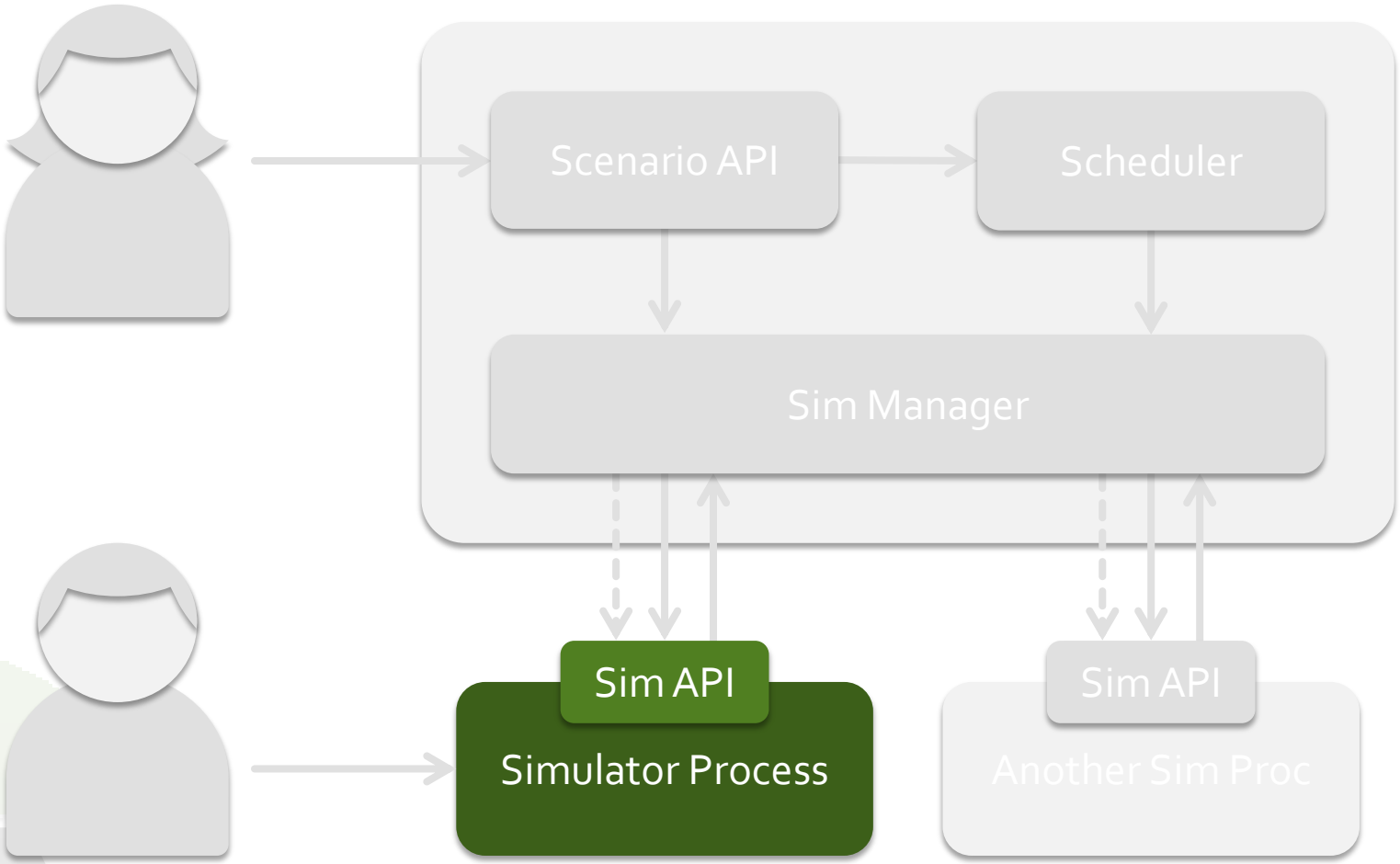
- Model:
  - Simplified representation of a real world system/object or process
  - Reproduces relevant system aspects for analysis; purpose specific
- Simulator:
  - Implementation of a model
  - Includes functionalities to run the model

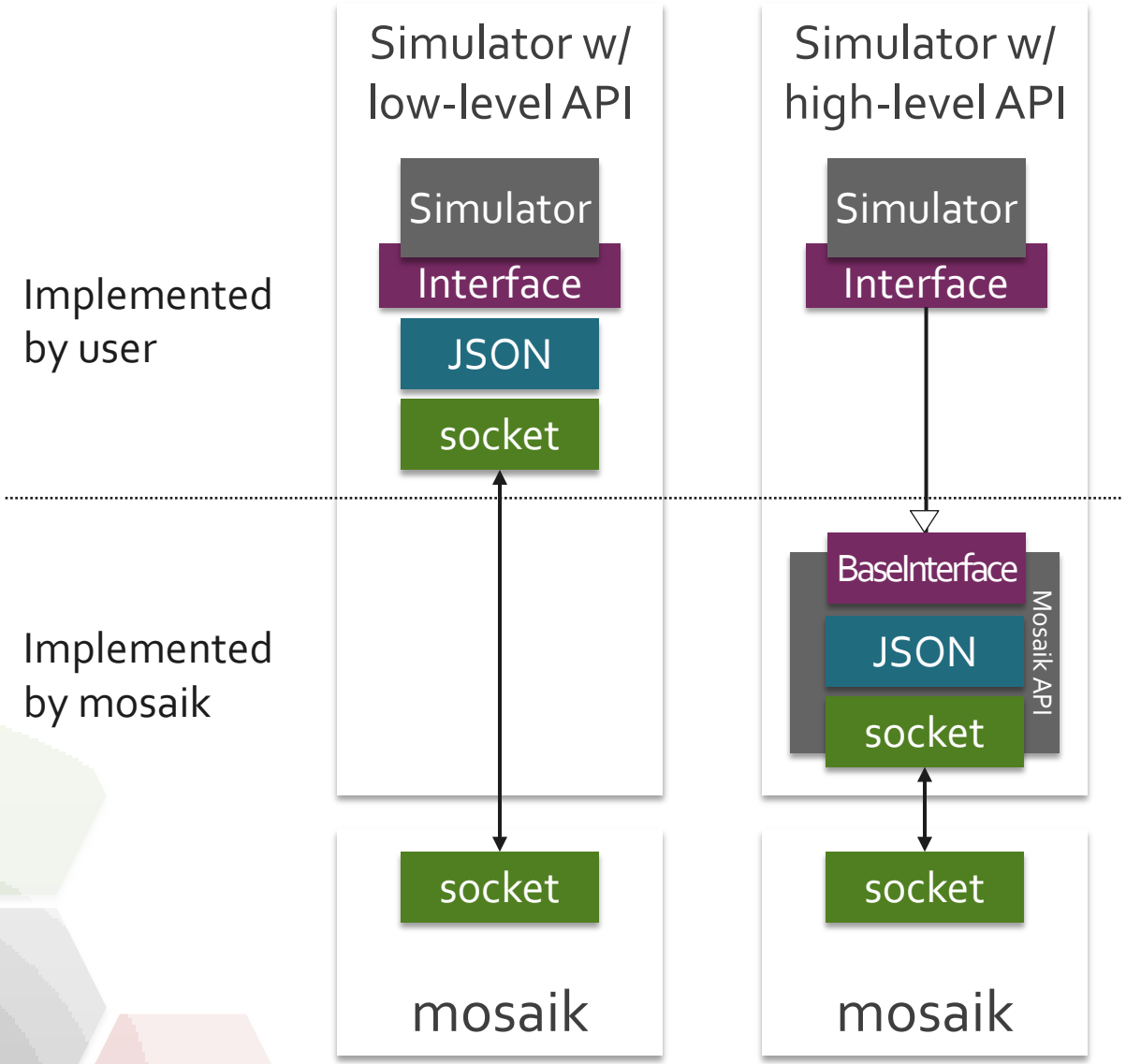
Co-Simulation/Scenario

- Co-Simulation:
  - Synchronized data exchange
  - Every simulator provides its “solver”
- Simulation scenario:
  - Numbers and connections of system entities
  - Parameter values, input, runtime given
  - Described in executable file

Architecture




Scenario API
Scheduler
Sim Manager
Sim API
Simulator Process
Sim API
Another Sim Proc


Simulator w/
low-level API
Simulator w/
high-level API
Implemented
by user
Implemented
by mosaik
Simulator
Interface
JSON
socket
Simulator
Interface
BaseInterface
JSON
socket
Mosaik API
socket
socket
mosaik
mosaik

API Overview

- API to integrate simulators (and other components: database, visualization, etc.)

- Meta description:
  - Object models provided
  - Parameters
  - Connection attributes

Example: "HouseSim"

Model: Household

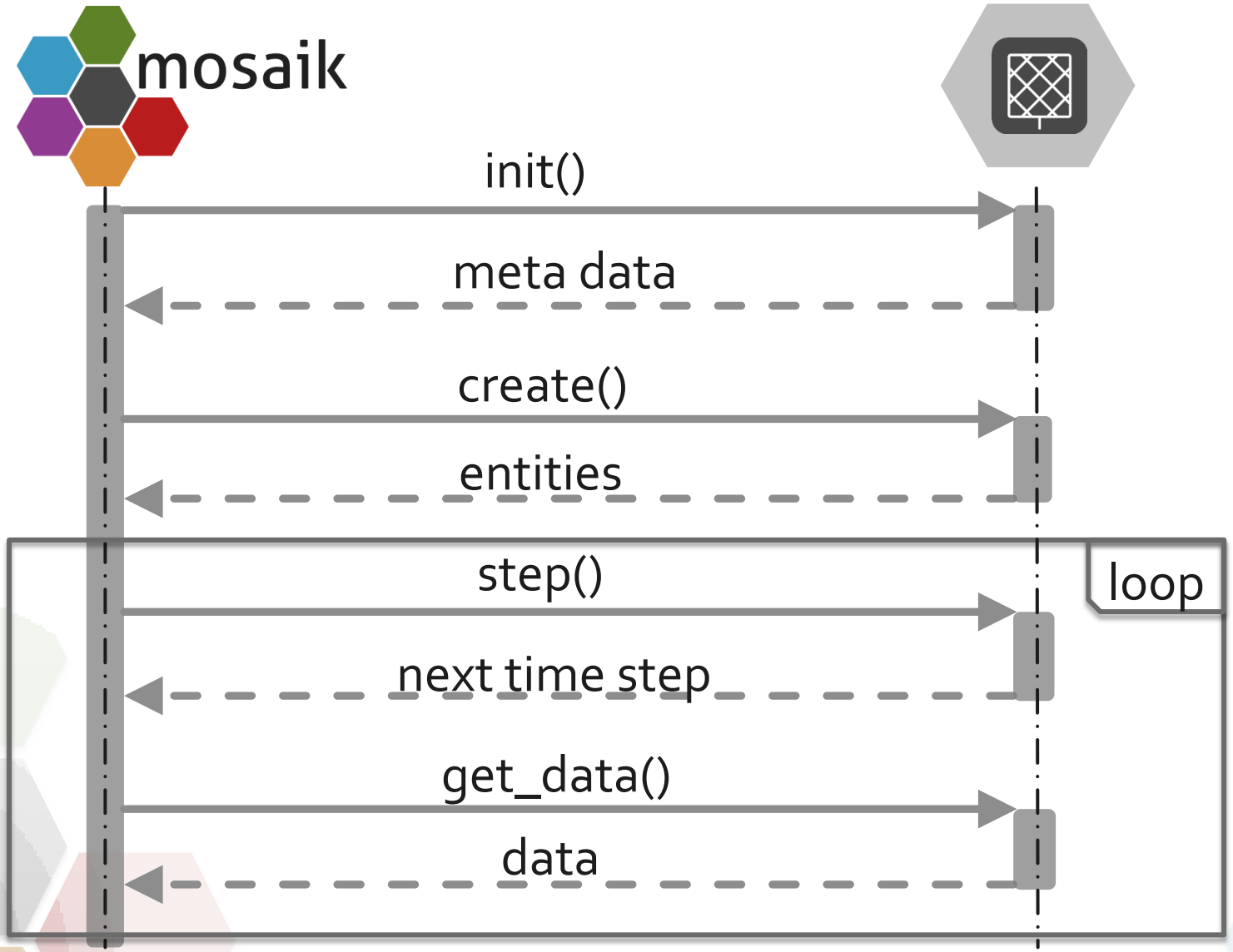
Param: Inhabitant number

Attr: Active Power (sending)

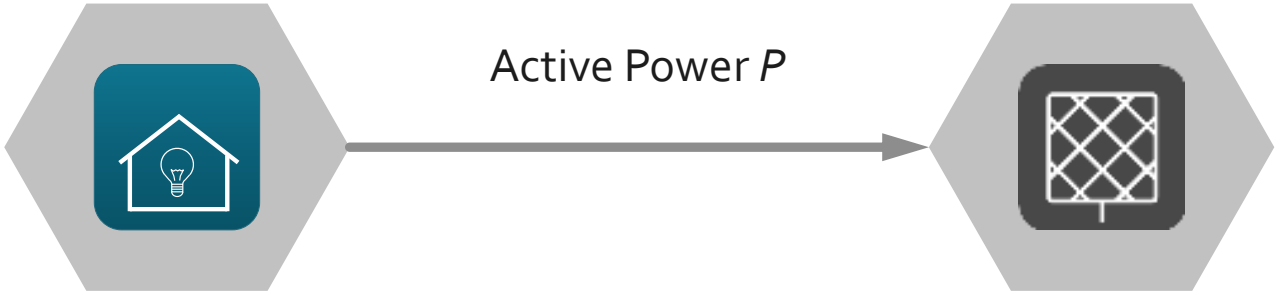
API Overview

- Four API methods for control:
  - *init*() → start simulator process
  - *create*() → instantiate model entities
  - *step*() → provide input data and advance simulator in time
  - *get_data*() → obtain output data

mosaik-API

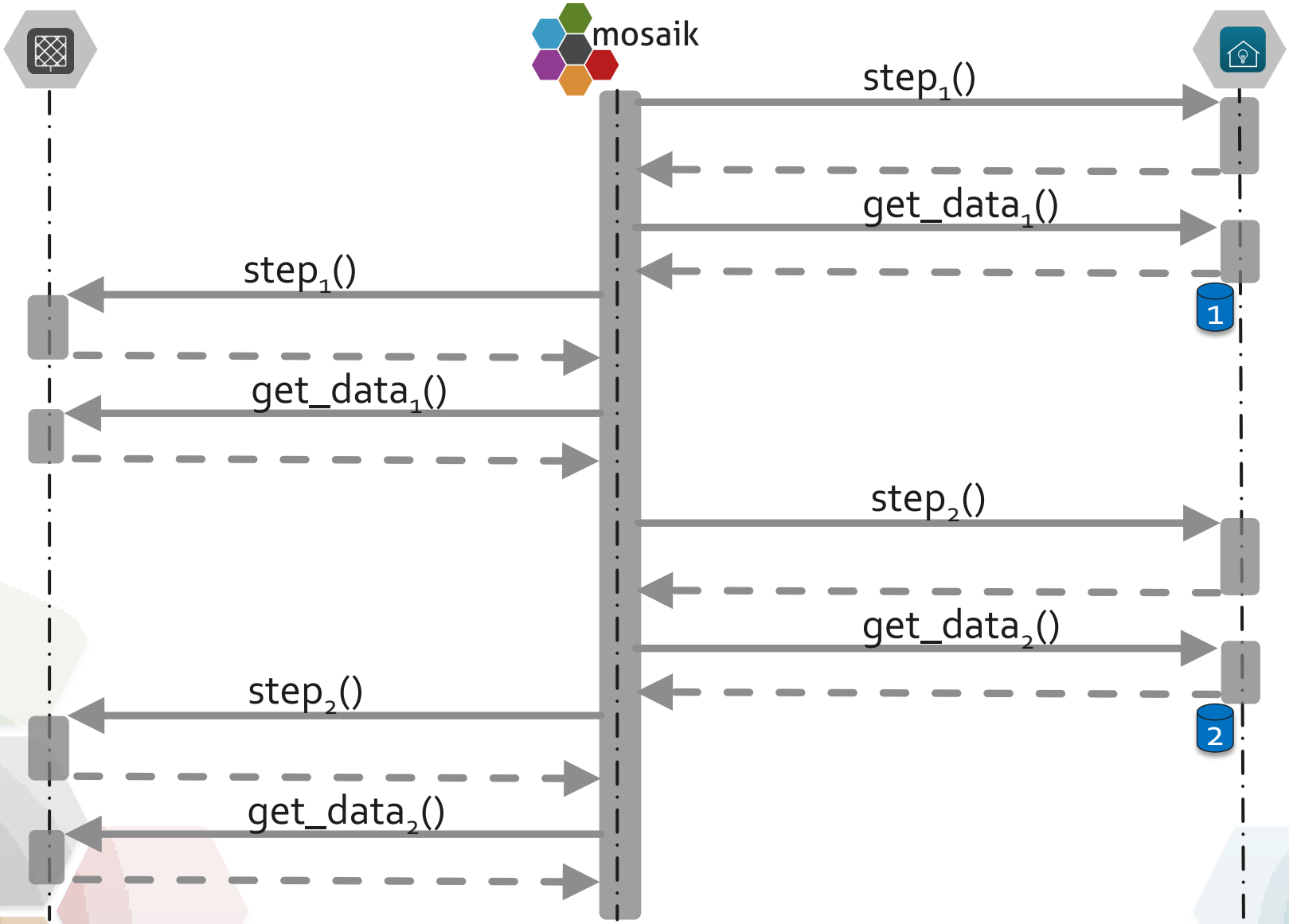

mosaik
init()
meta data
create()
entities
loop
step()
next time step
get_data()
data

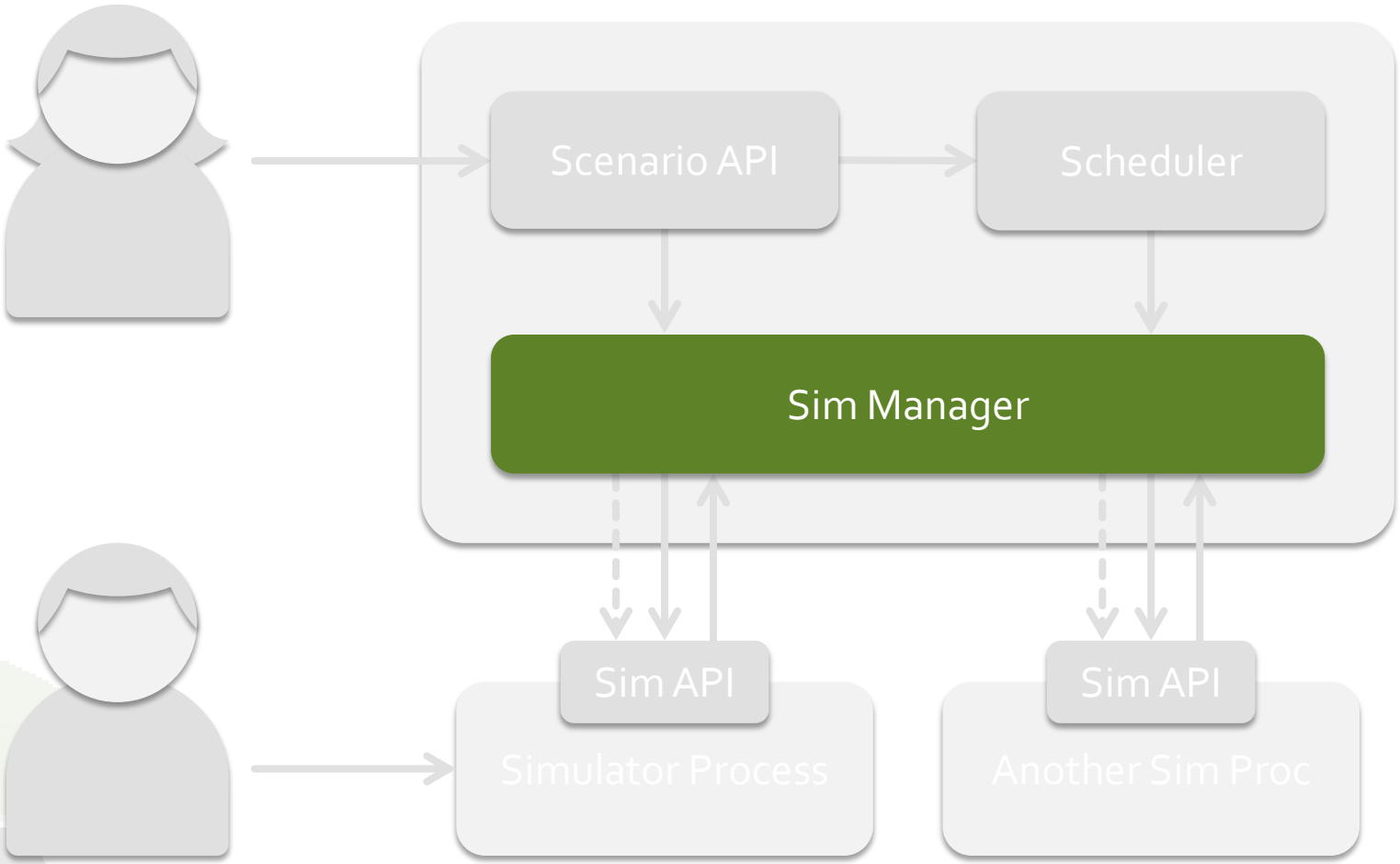
Simulator Interaction



Simple example, two simulators

Example


mosaik
step$_1$()
get_data$_1$()
step$_1$()
get_data$_1$()
1
step$_2$()
get_data$_2$()
step$_2$()
get_data$_2$()
2


Scenario API
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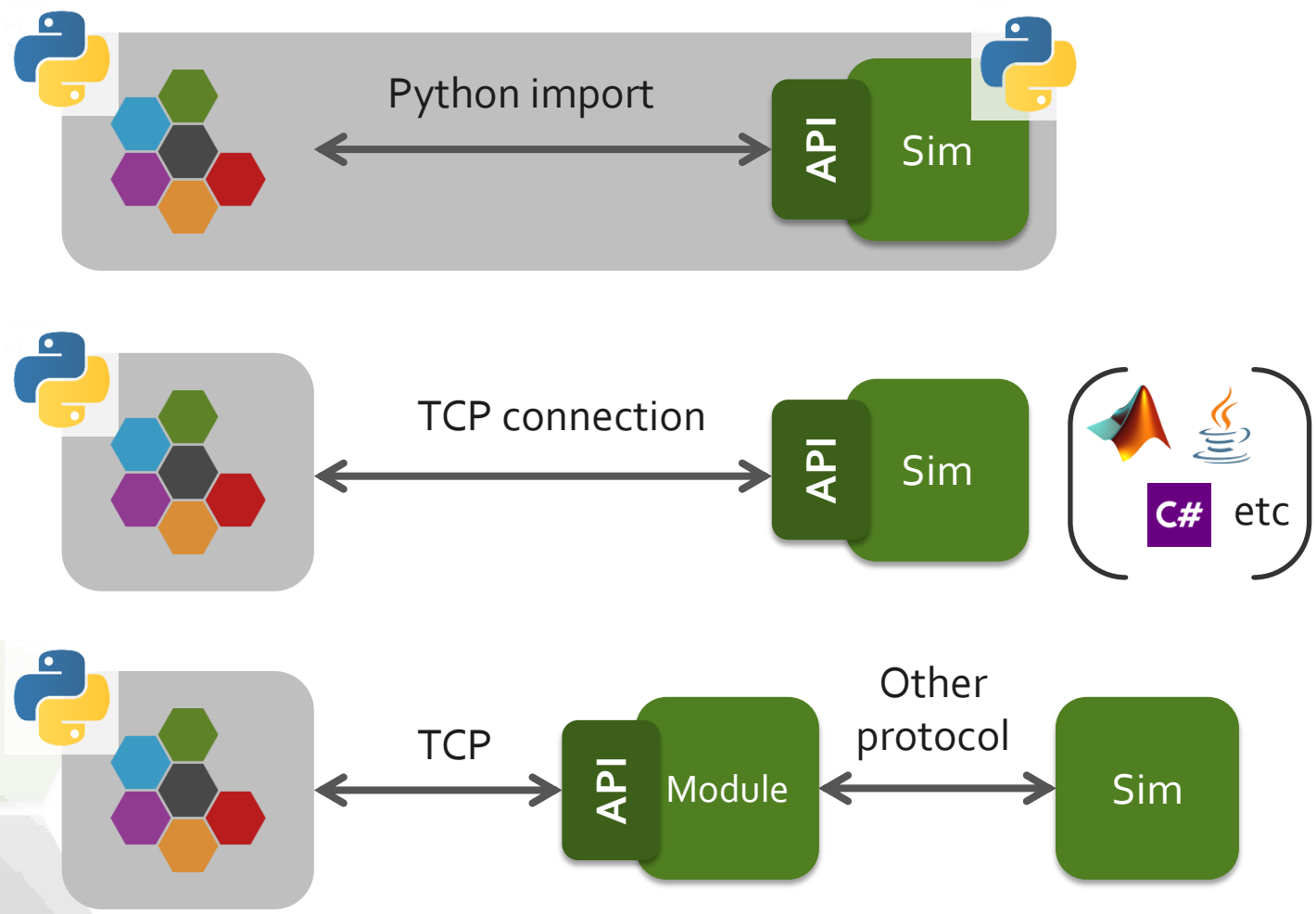
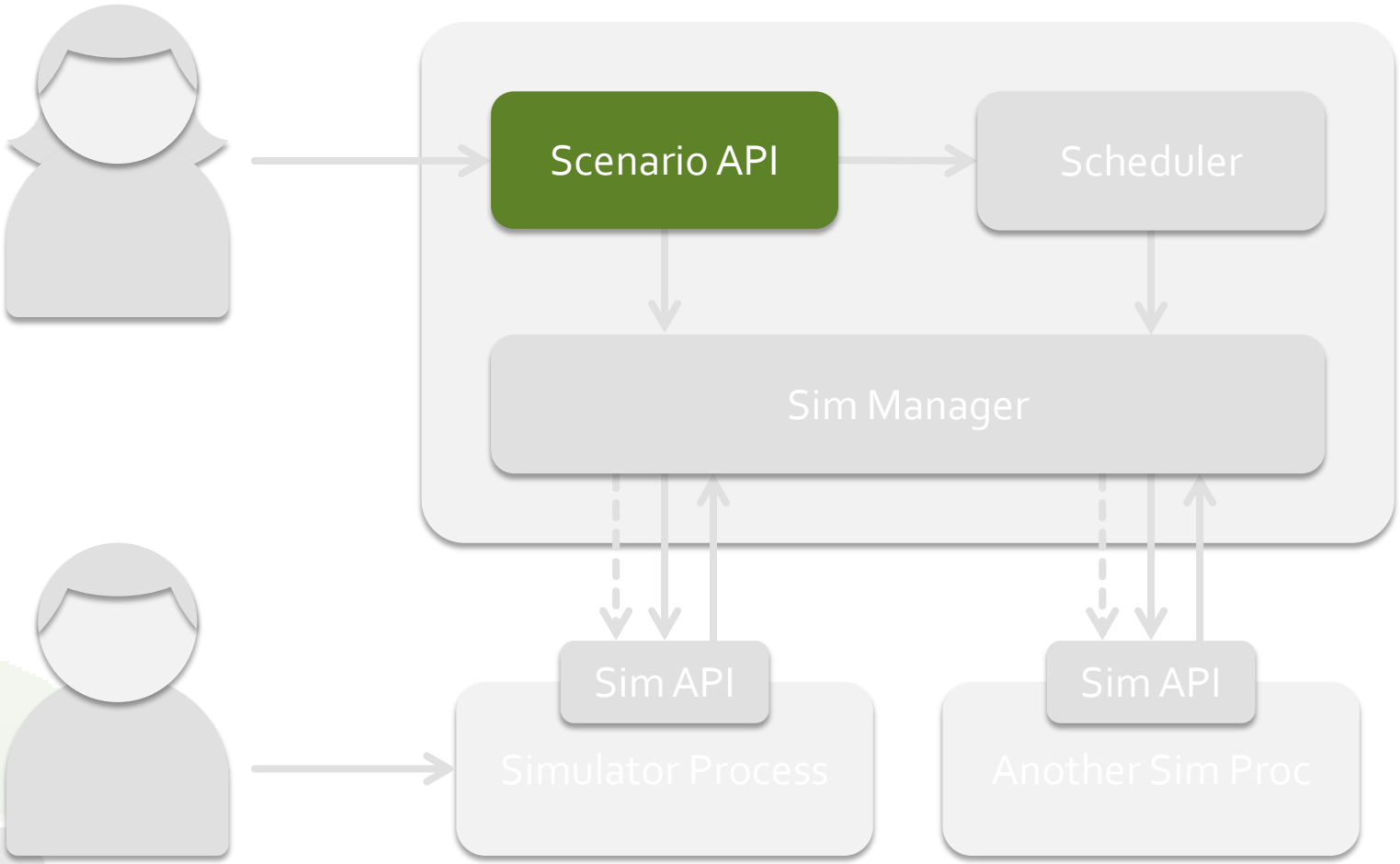
Simulator Process
Sim API
Another Sim Proc

Management Possibilities

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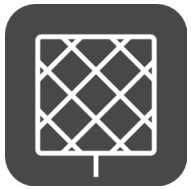
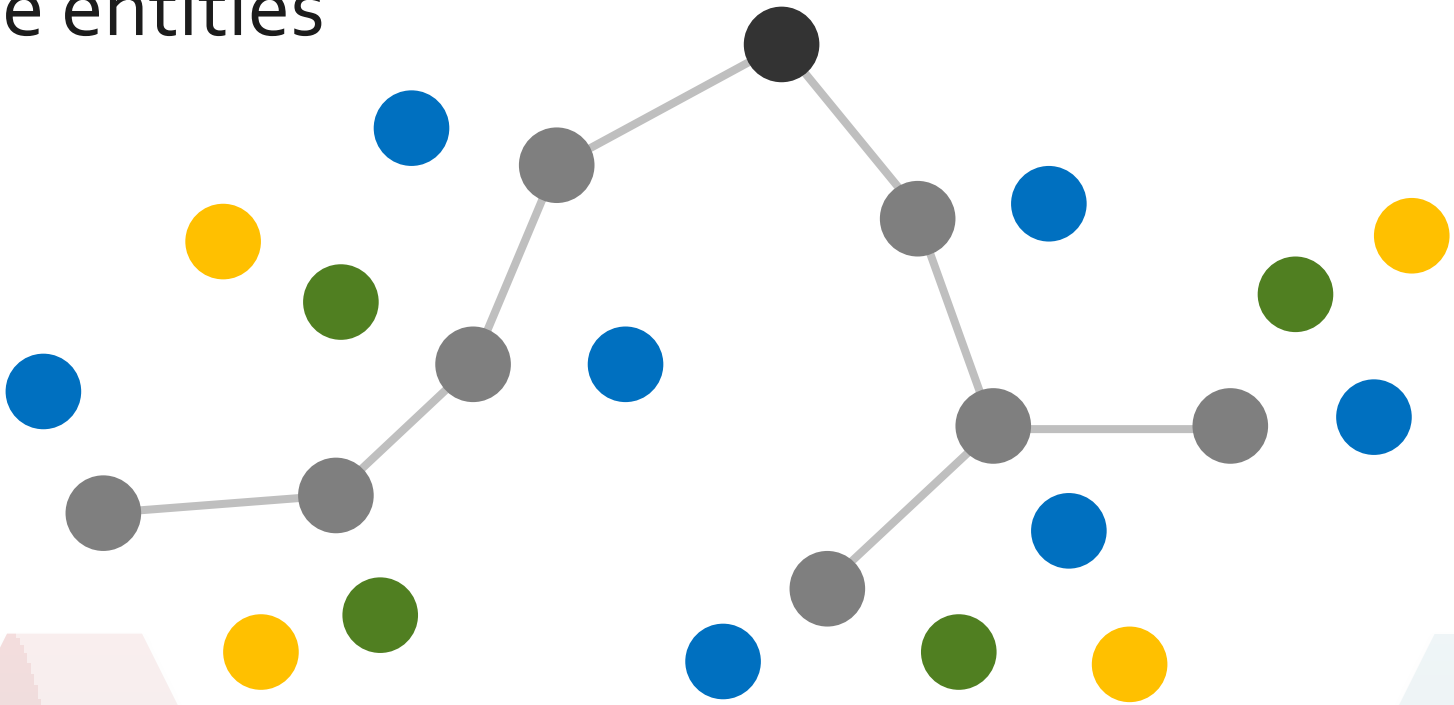
Scenario Creation




List and initialize simulators

Scenario Creation

Create entities

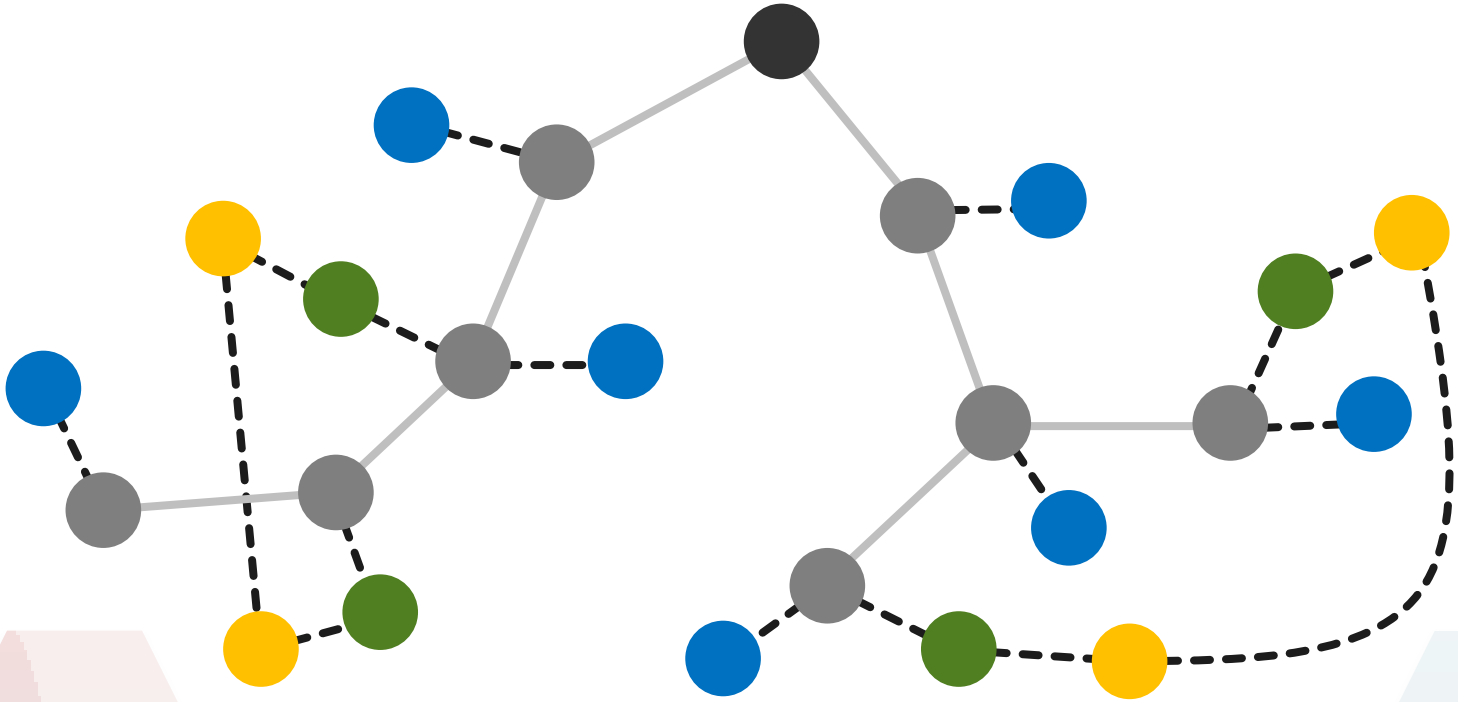


Scenario Creation

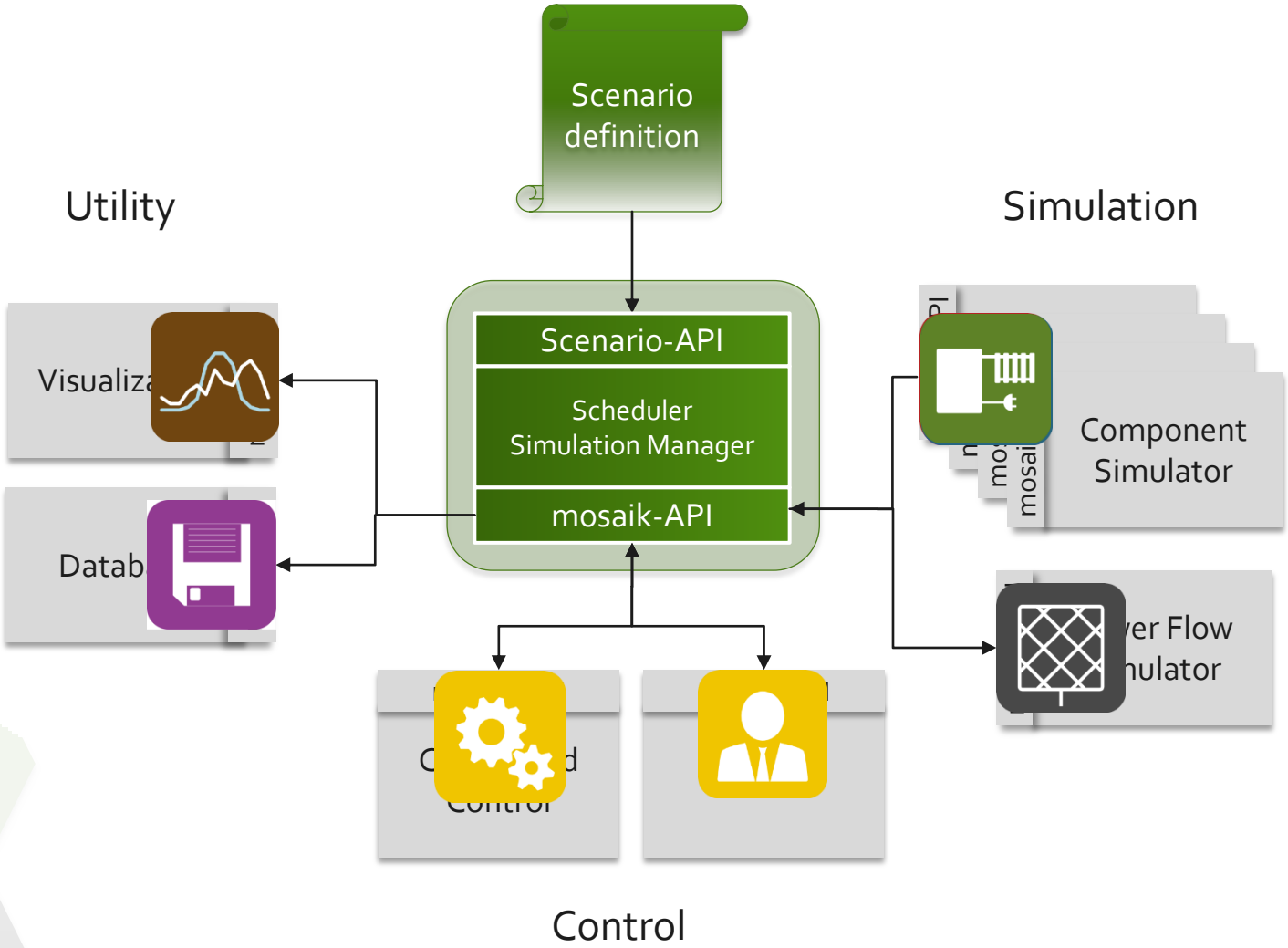
Connections are:

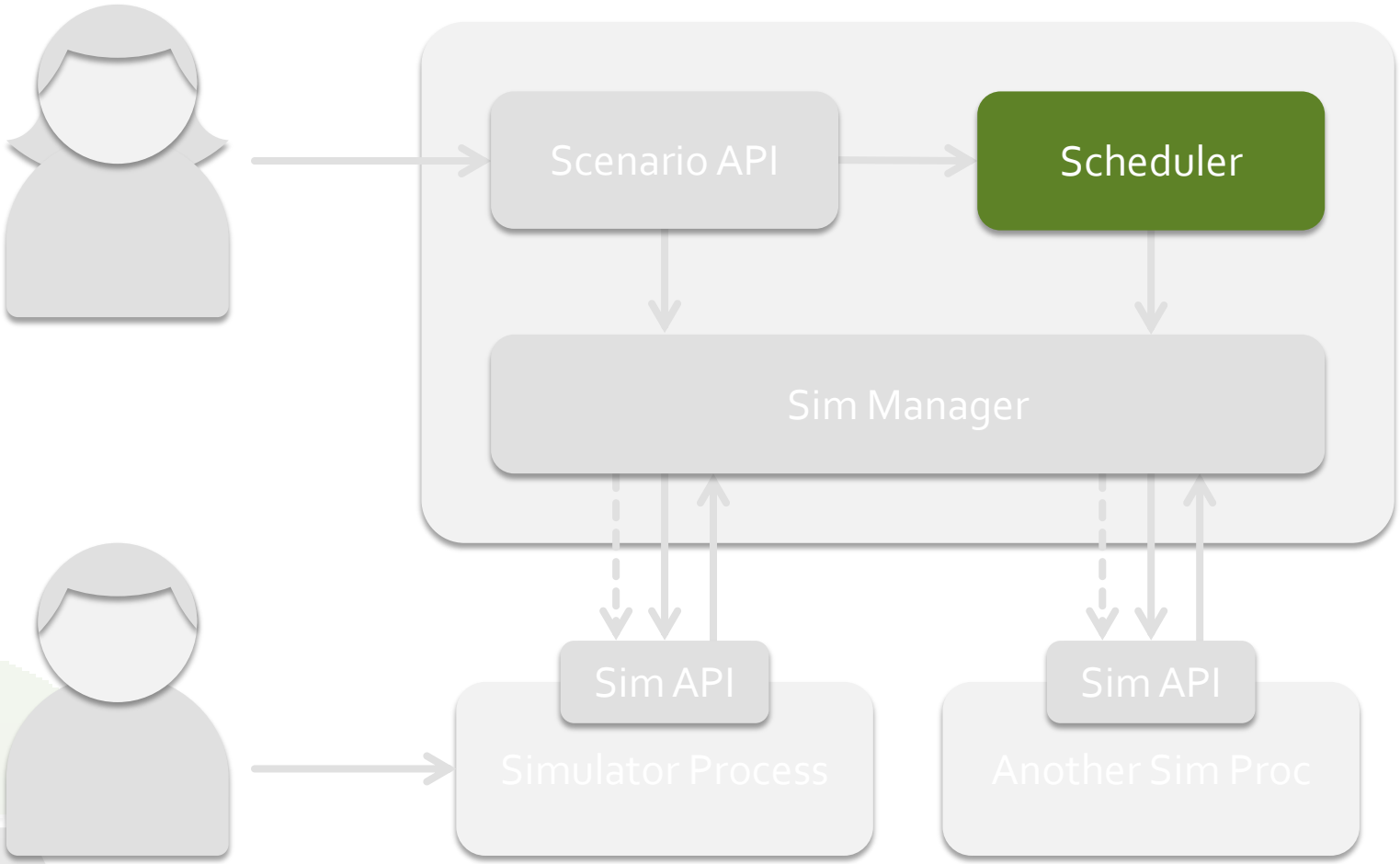
- Rule-based
- Established for complete sets

Connect entities



Overview


Scenario definition
Utility
Simulation
Scenario-API
Scheduler
Simulation Manager
mosaik-API
Component Simulator
Control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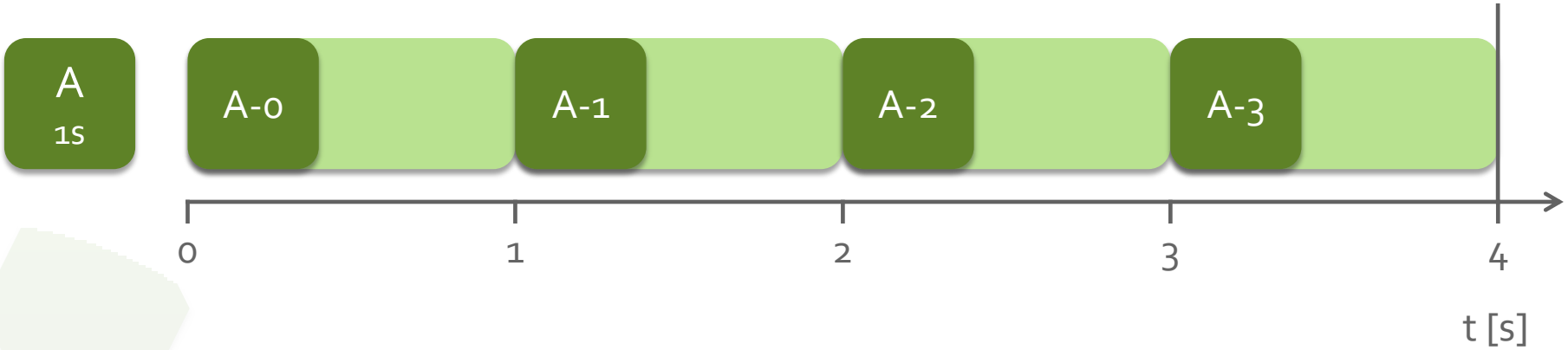
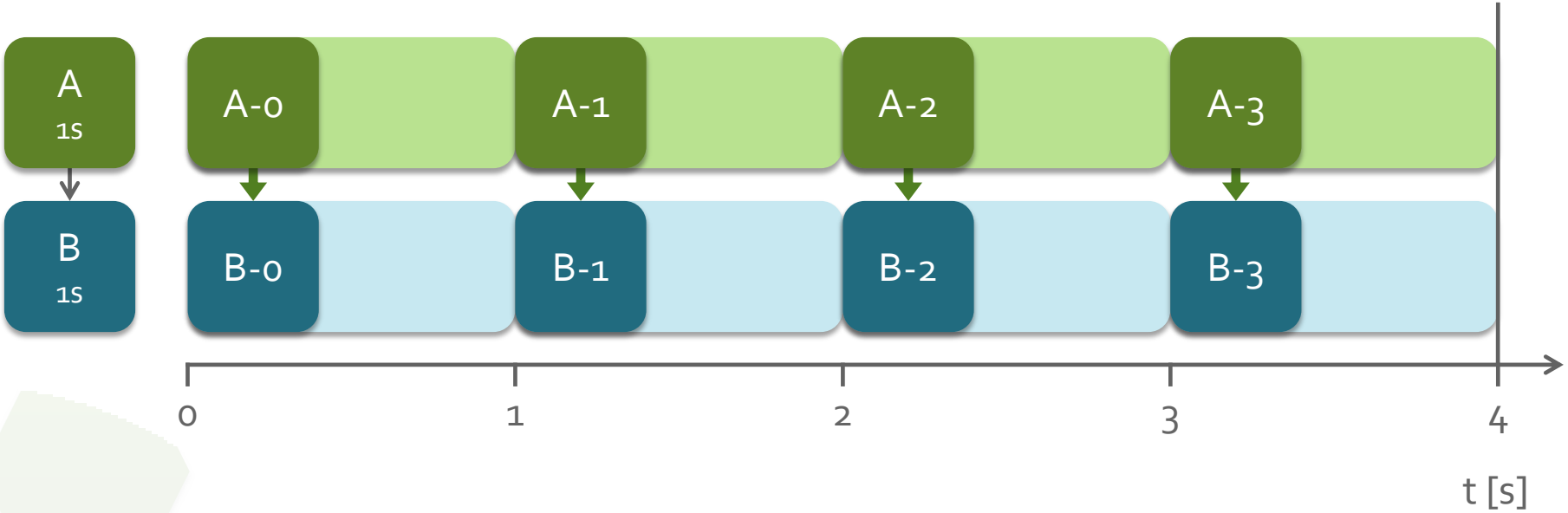
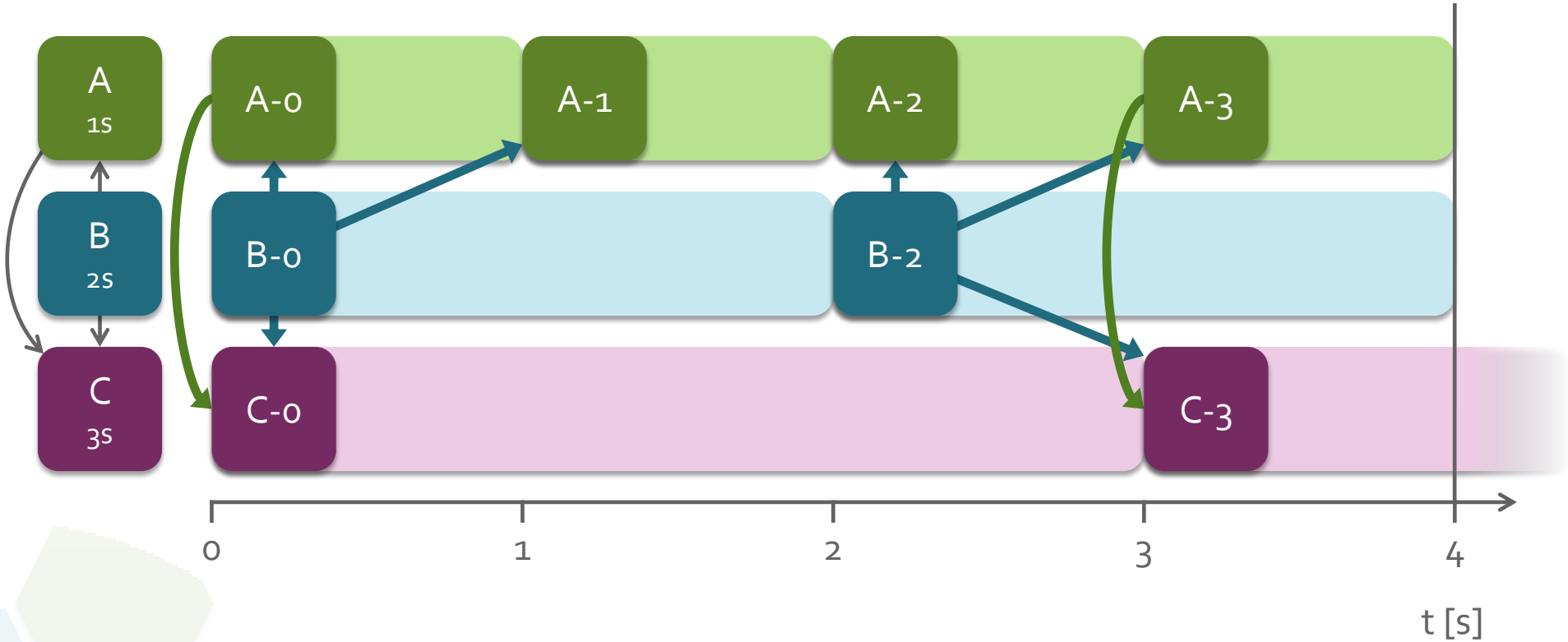


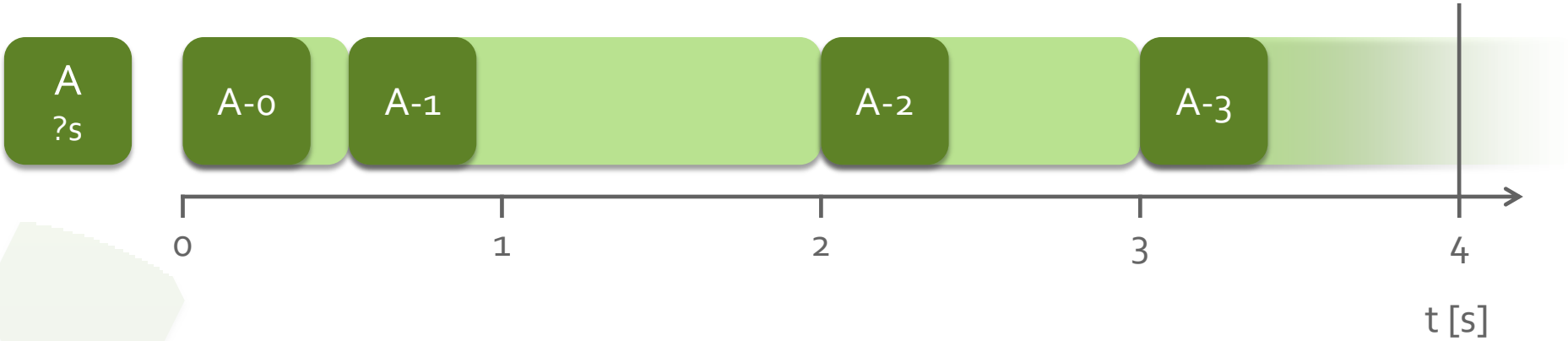
A.step(1) ⟶ 2



B.step(1) ⟶ 2



A.step C.step(3) → 6 2) → 4



A.step(0.5) → 2

Summary of mosaik

- Mosaik is a co-simulation tool
- Main functionalities:
  - Organize data exchange
  - Synchronization
- Main use cases:
  - Create scenario
  - Connect simulators

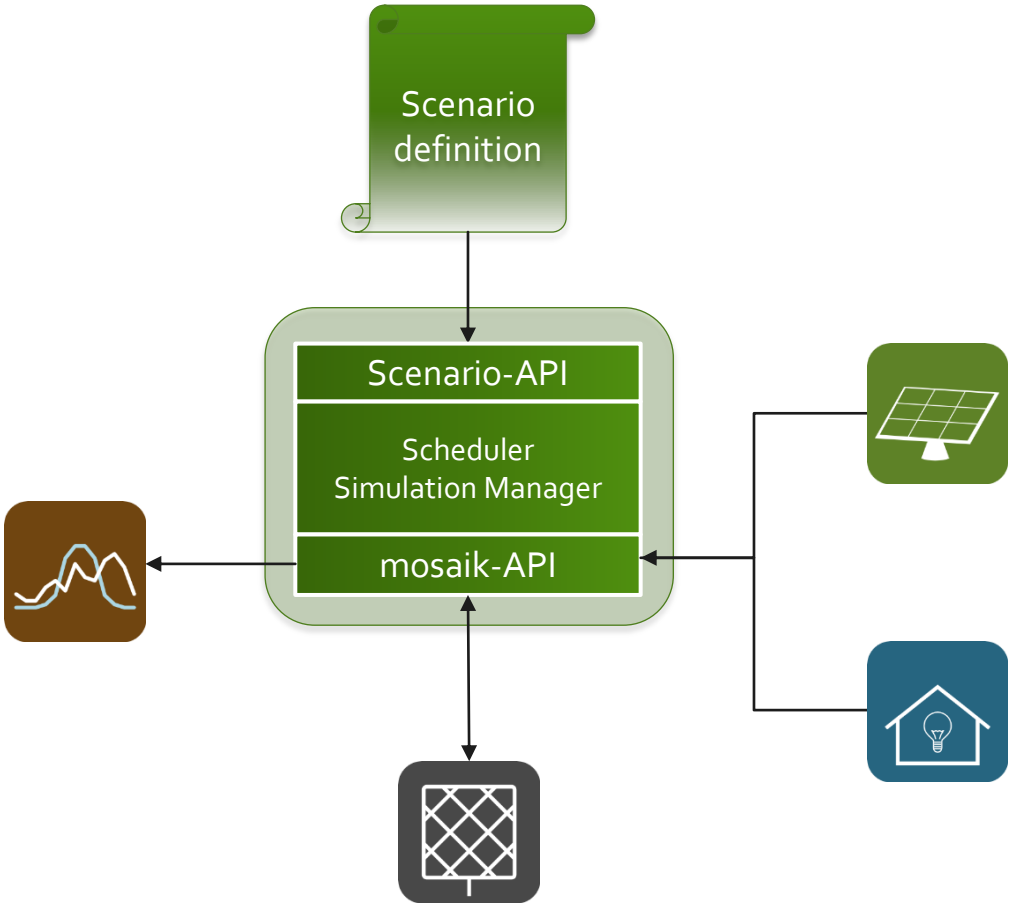
Mosaik and FMI

Functional Mock-Up Interface	Mosaik
FMI for Co-Simulation	Mosaik-API for simulators
Slave / FMU	Simulator
Master (no part of FMI)	Scheduler
Advantages: • More complete model description • Extensive interface for nuanced control	Advantages: • Interface more easily implemented • Scheduling included • Flexible scenario creation

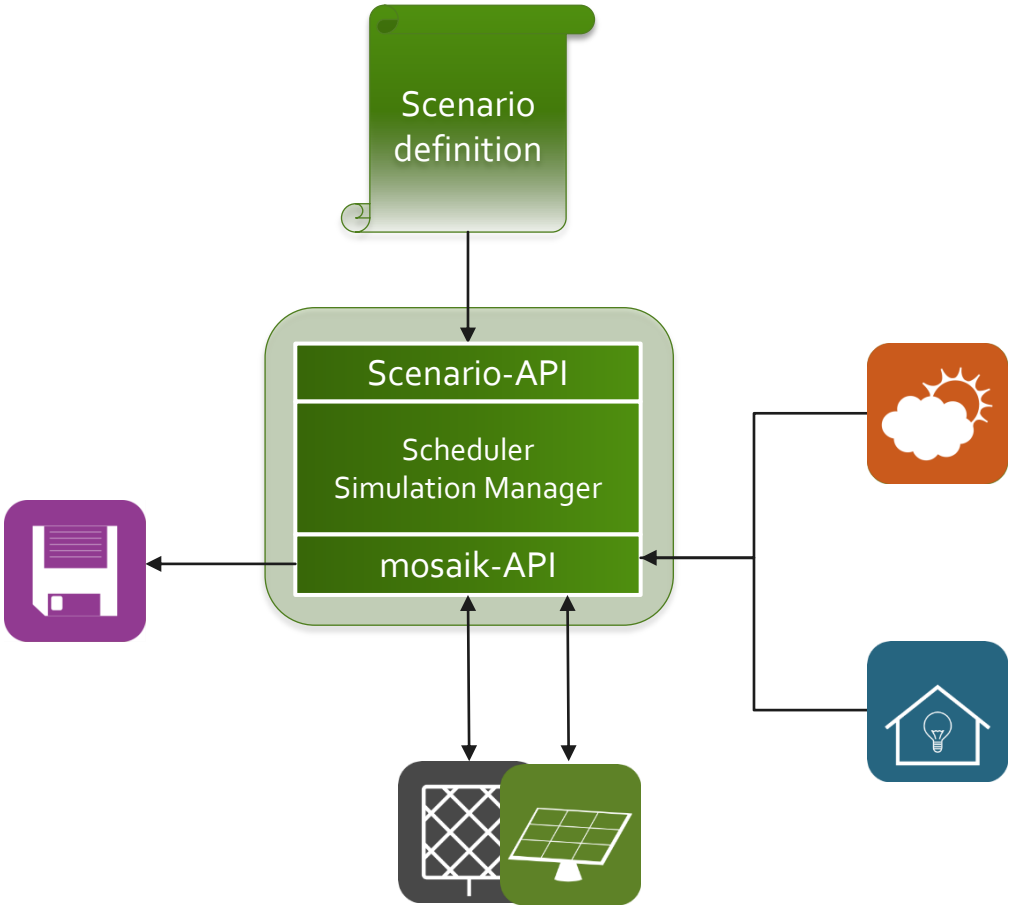
Conclusion:

- No "either/or"
- Mosaik as possible master for FMI (mapping between mosaik-API and FMI)

Simple Demo Scenario

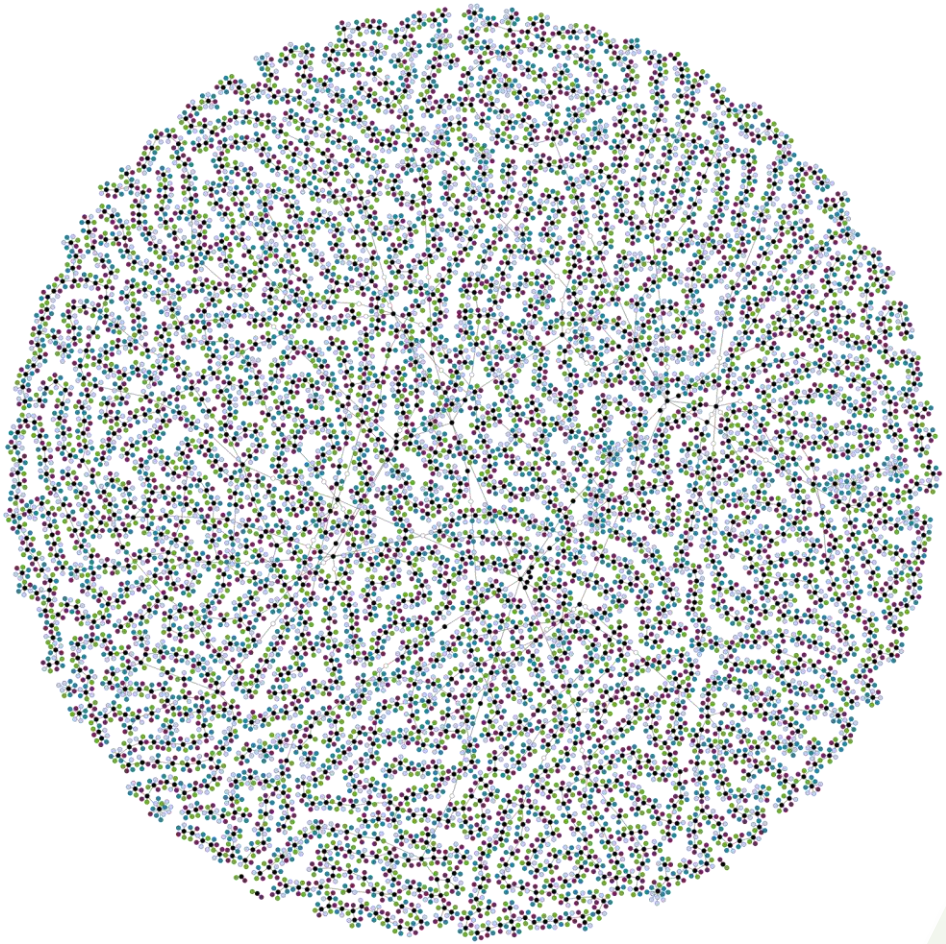


Simple Demo Scenario (II)



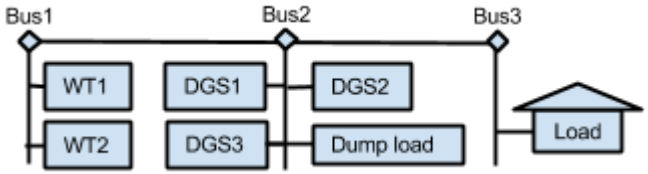
Application Cases

- One MV grid with sub-ordinate LV grids
  - About 8k nodes in total
- Decentral producers, consumers and storage
  - About 55k units in total
- Discrete step size:
  - 1 minute

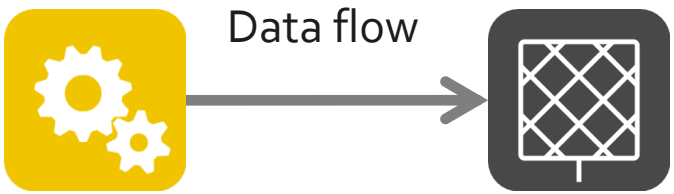


Application Cases (II)

- Mosaik-IPSYS
- First external use of mosaik (by *DTU*)
- Couple a Java simulation *(IPSYS)* and a Java MAS *(MasSim* and *JadeSim)*
- Relatively small scenario



Cyclic Data Dependencies

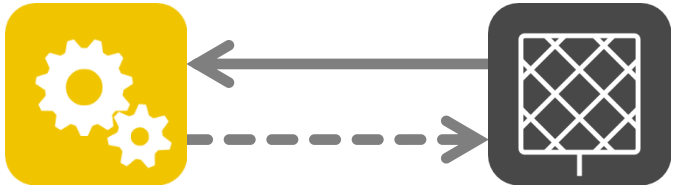


No problem

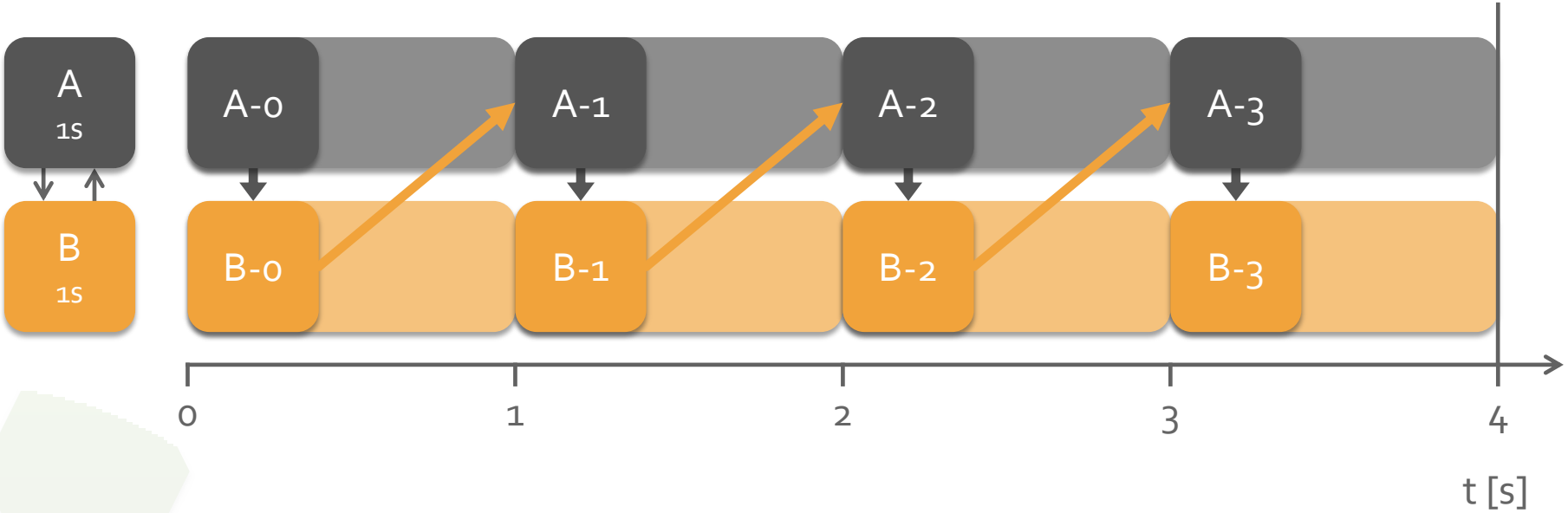
Problem
(Who comes first?)

Mosaik solution: *Asynchronous Requests*

Cyclic Data Dependencies

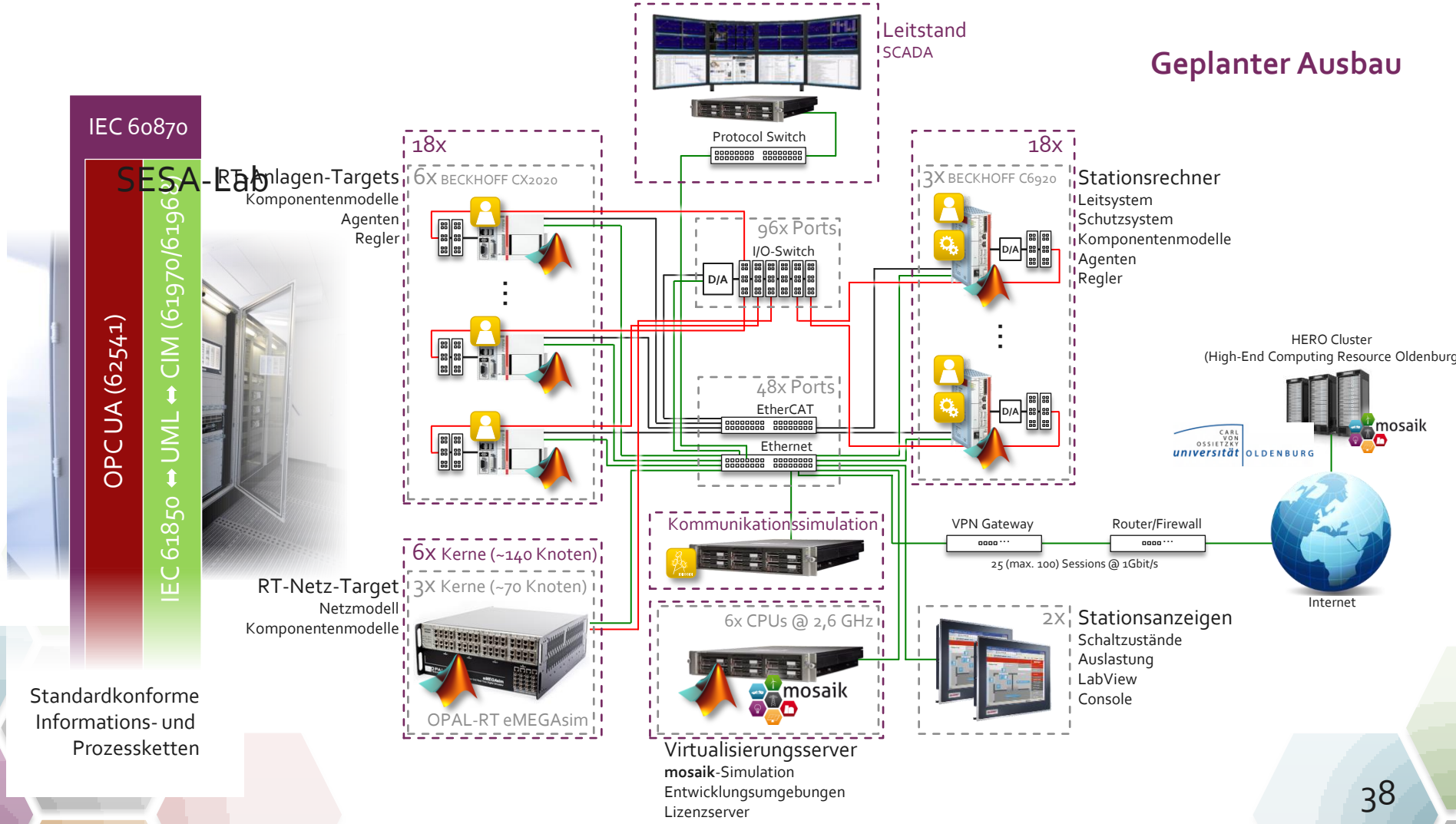


- Establish data connection in one direction
- Include asynchronous request
- Cycle is resolved via a shift in time



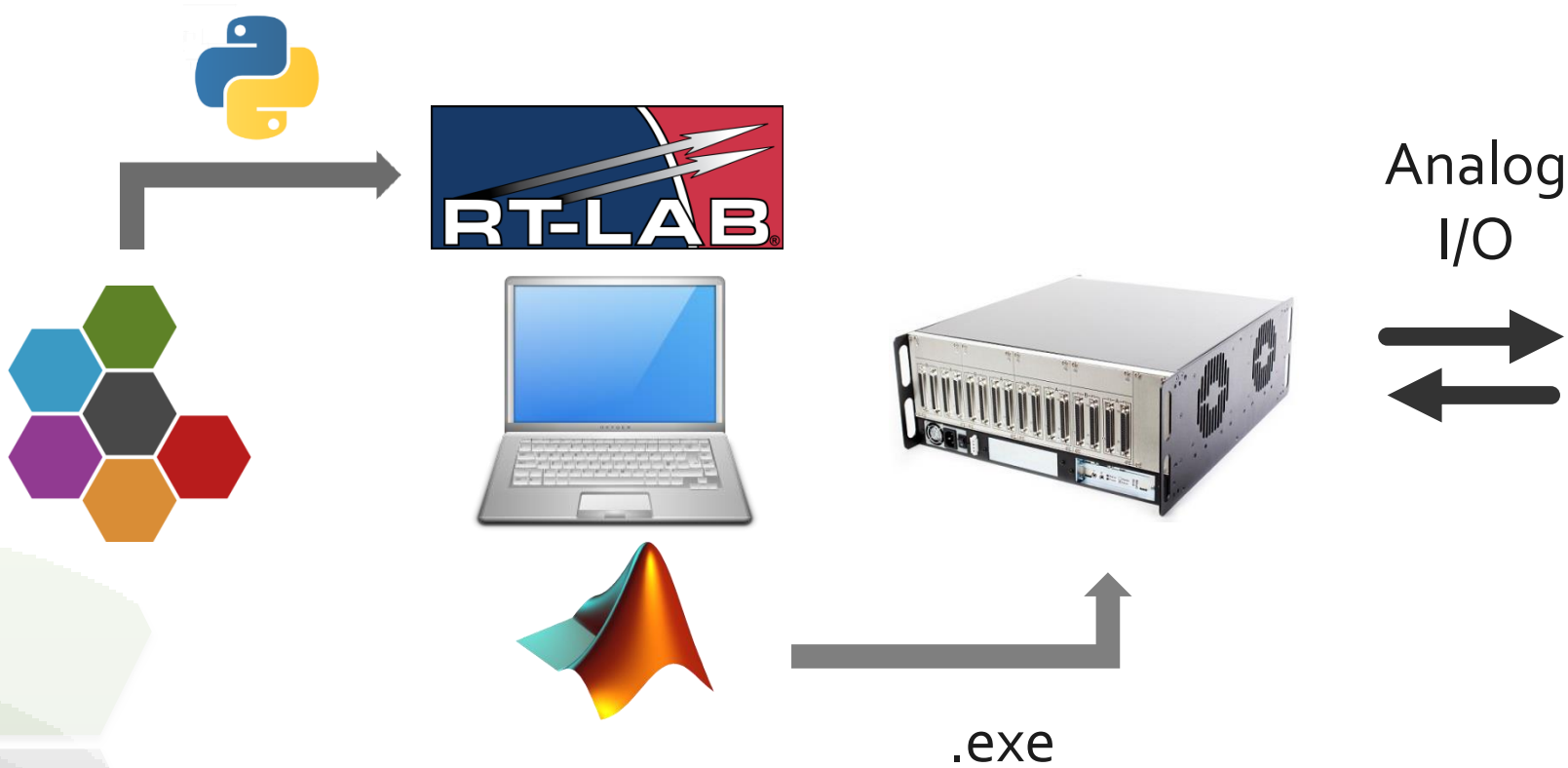
B.step(1) ⟶ 2

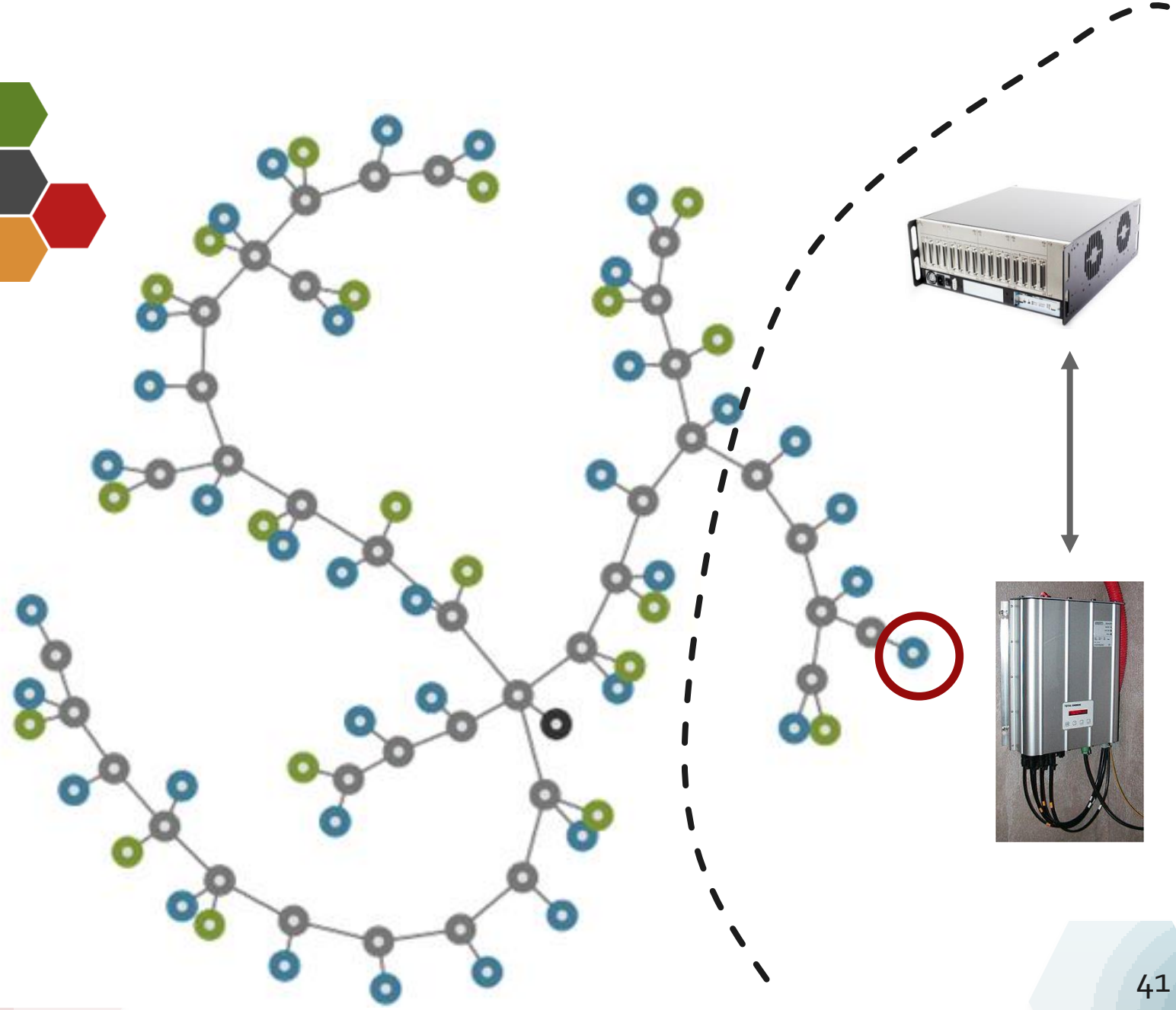
With mosaik toward HiL



With mosaik toward HiL

With mosaik toward HiL





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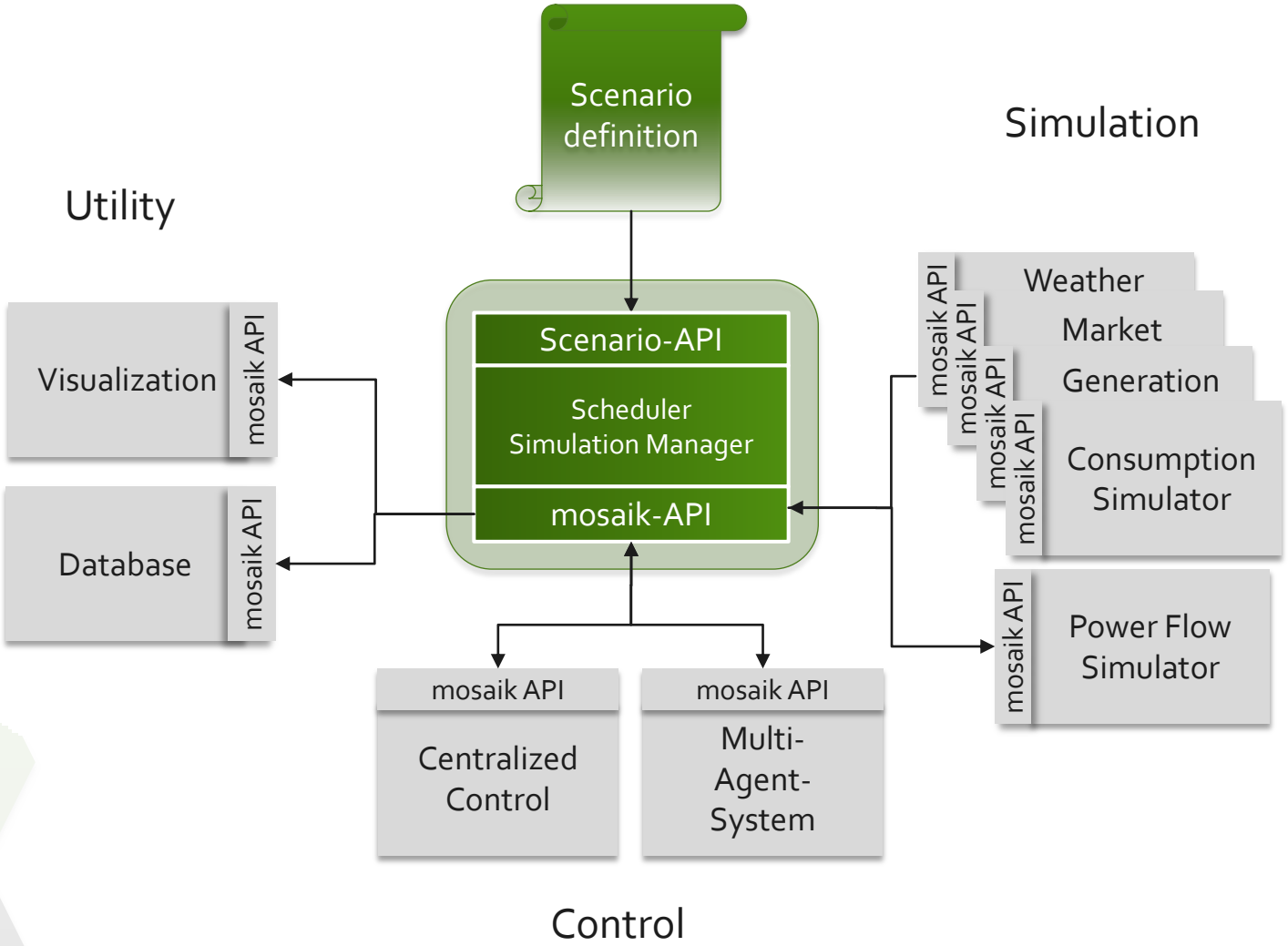
mosaik

mosaik.offis.de

Help: mosaik-users@lists.offis.de
Docs: mosaik.readthedocs.org
Code: bitbucket.org/mosaik


Scenario definition
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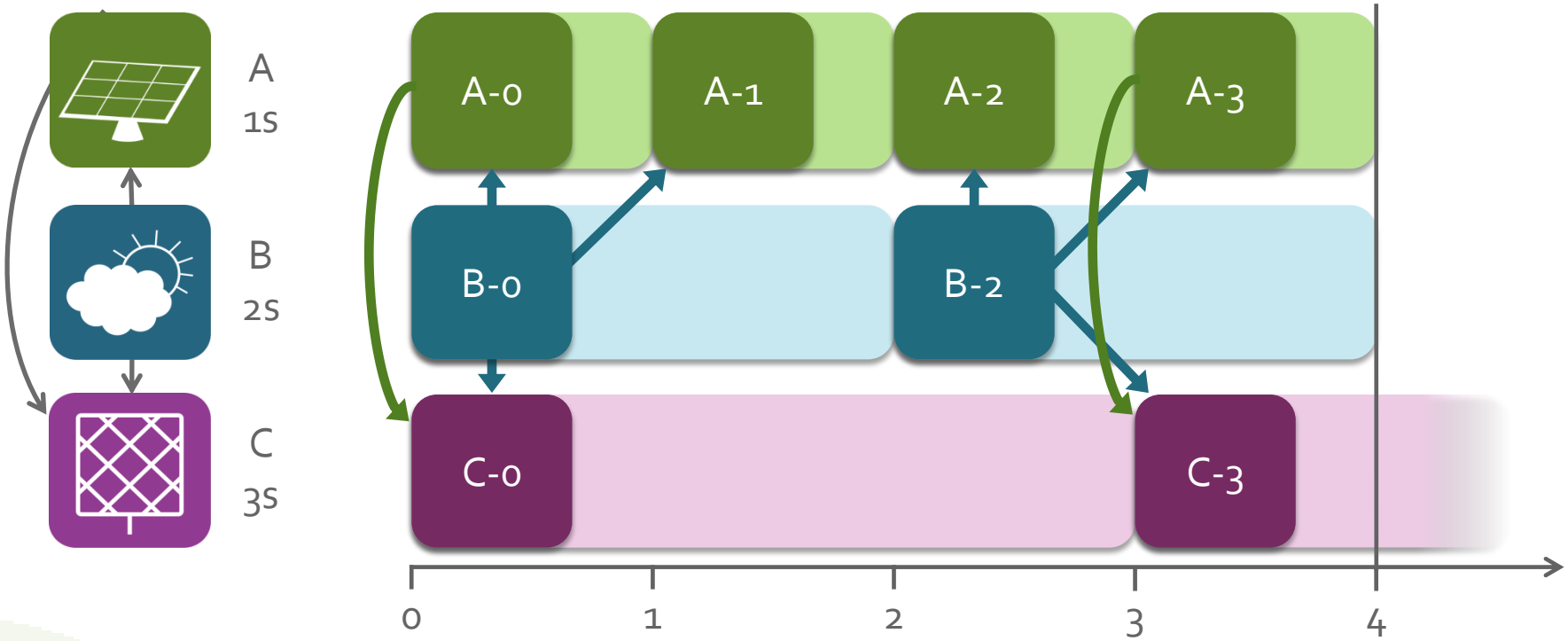
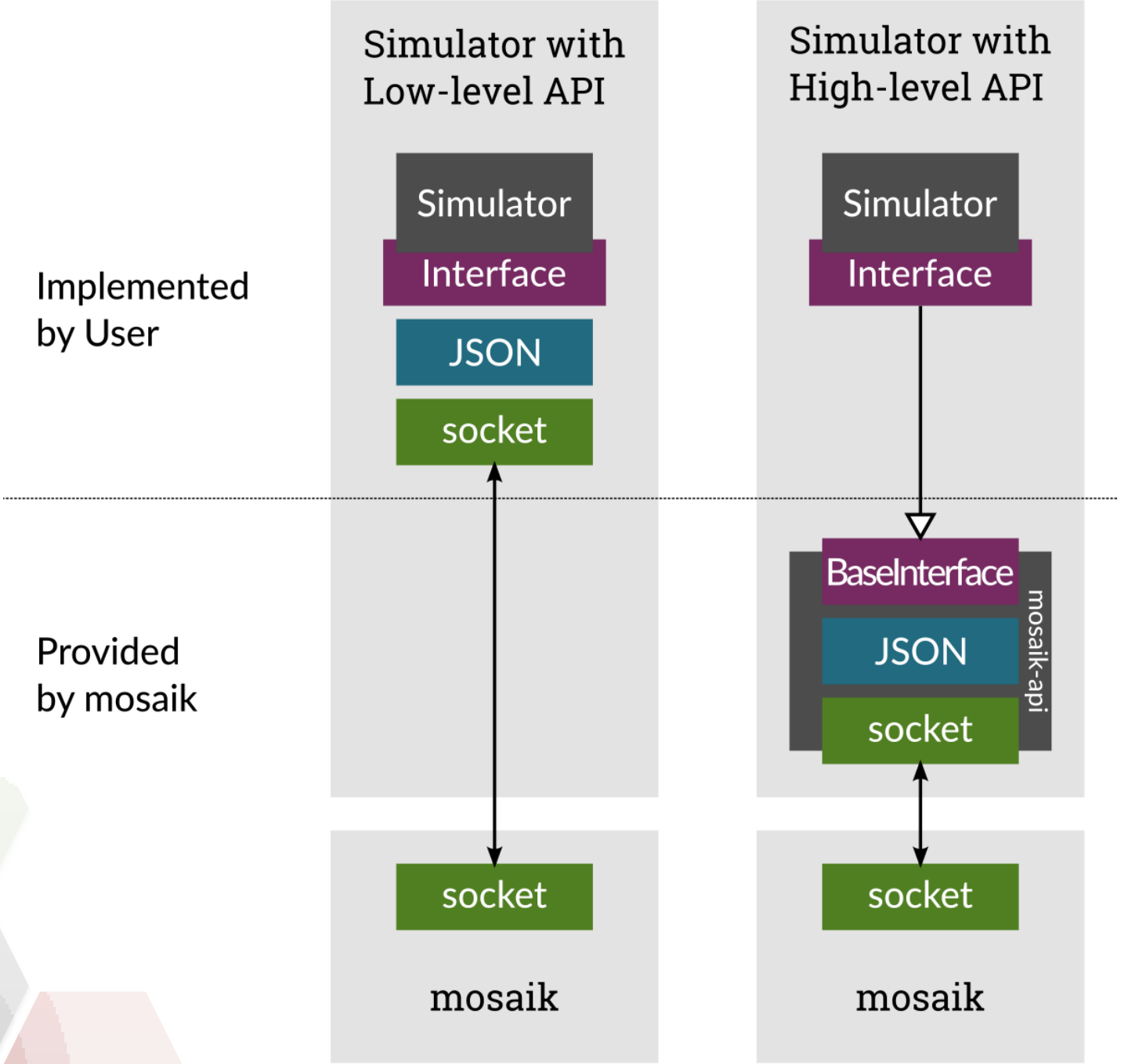
mosaik-API
Visualization
mosaik API
Database
mosaik API
mosaik API
Weather
mosaik API
Market
mosaik API
Generation
mosaik API
Consumption Simulator
mosaik API
Power Flow Simulator
mosaik API
Centralized Control
mosaik API
Multi-Agent-System
Control


A
1s
B
2s
C
3s
A-0
A-1
A-2
A-3
B-0
B-2
C-0
C-3
0
1
2
3
4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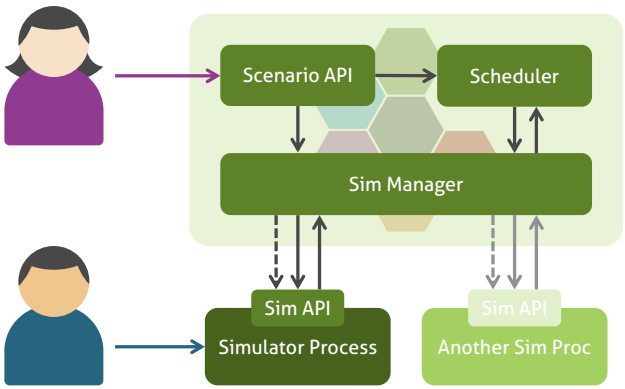
mosaik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