OPTI-Sim: Co-simulation based virtualization of large scale DHC-networks

Wolfgang Birk[1],
Yvonne Ritter[2], Nicklas Linder[2], Ulrich Odefey[2],
Peter Lingman[3], Vikas Chandan[4]

[1]Luleå University of Technology, [2]TWT GmbH Science & Innovation,
[3]Optimation AB, [4]IBM India

The project has received funding from the European Union's Horizon 2020 Programme under grant agreement n° 649796

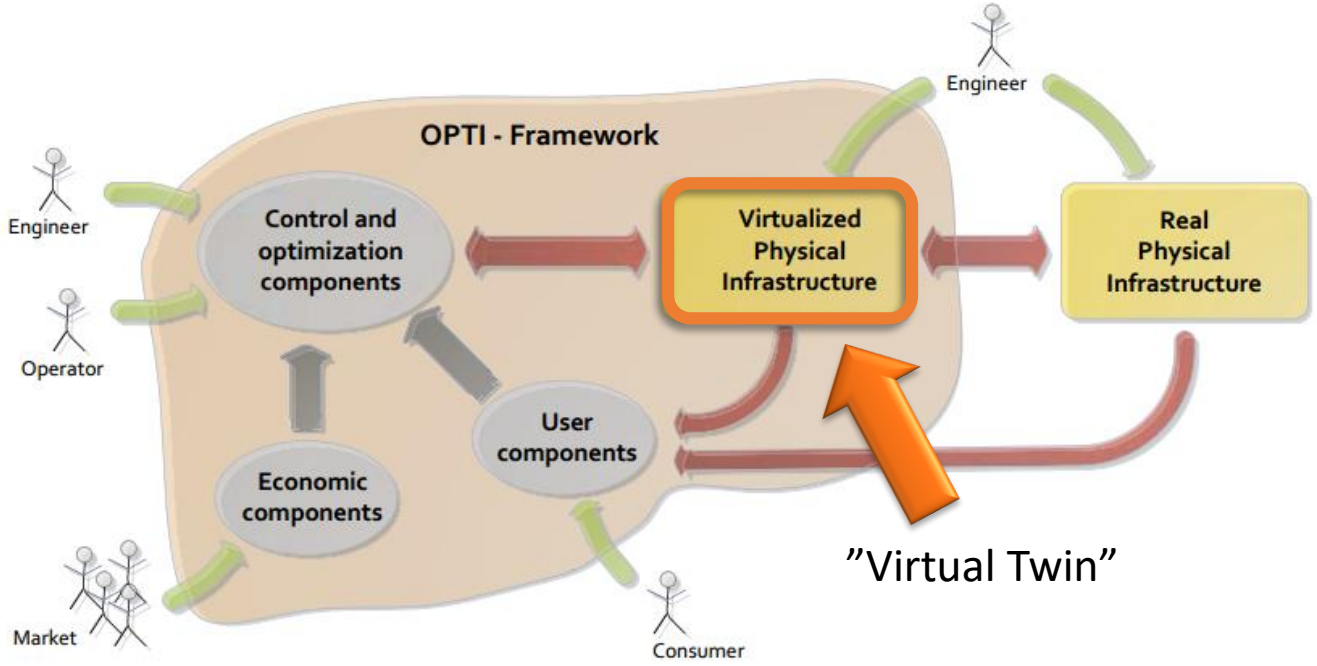
LULEÅ UNIVERSITY OF TECHNOLOGY

Outline

- Motivation and approach
- Example for a thermal grid
- Challenge
- State of the art
- Automatic model generation
- Co-simulation
- Model integration methods
- Use cases
- Conclusions & Outlook

Motivation and approach

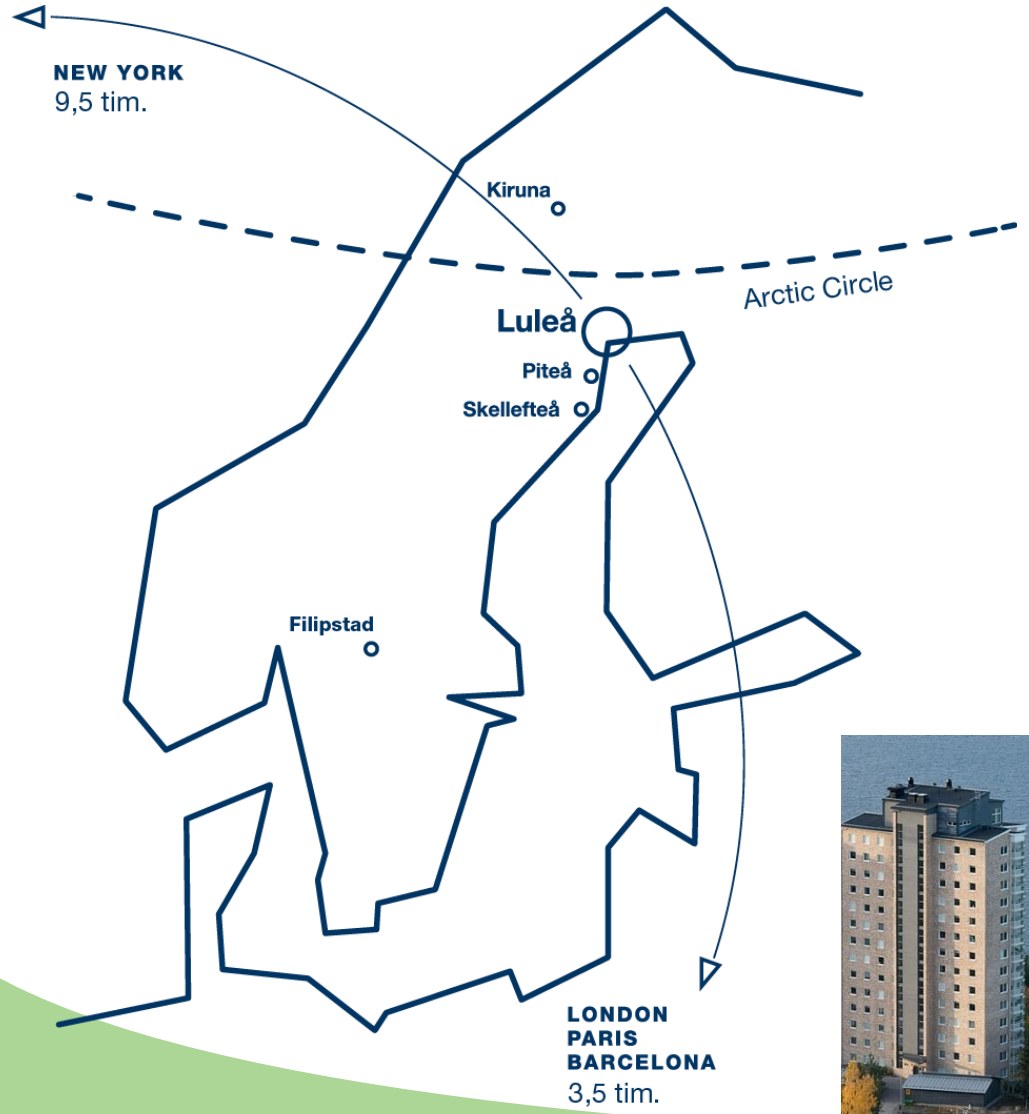
- Model-based development enables more efficient and accurate engineering solutions.
- Dynamic modeling and simulation can generate new insight.
- The OPTi project addresses the optimization of thermal grids.



Tools and methods for

- design of DHC systems
- operation of DHC systems
- increased energy efficiency

An example for a thermal grid



What is the challenge?

A glimpse on the complexity:

- approx. 23000 double pipes
- more than 400km total pipe length
- more than 9000 buildings

Modeling challenges:

- large and complex networks
- various models/granularity
- system dynamics
- simulation performance
- validation

Approach:

→automatic model generation and simplification

→co-simulation of complete DHC networks

State of the art

Scientific state of the art:

- Simplified dynamic models for DHC network simulations.
- Usually, the control system is not represented or extremely simplified

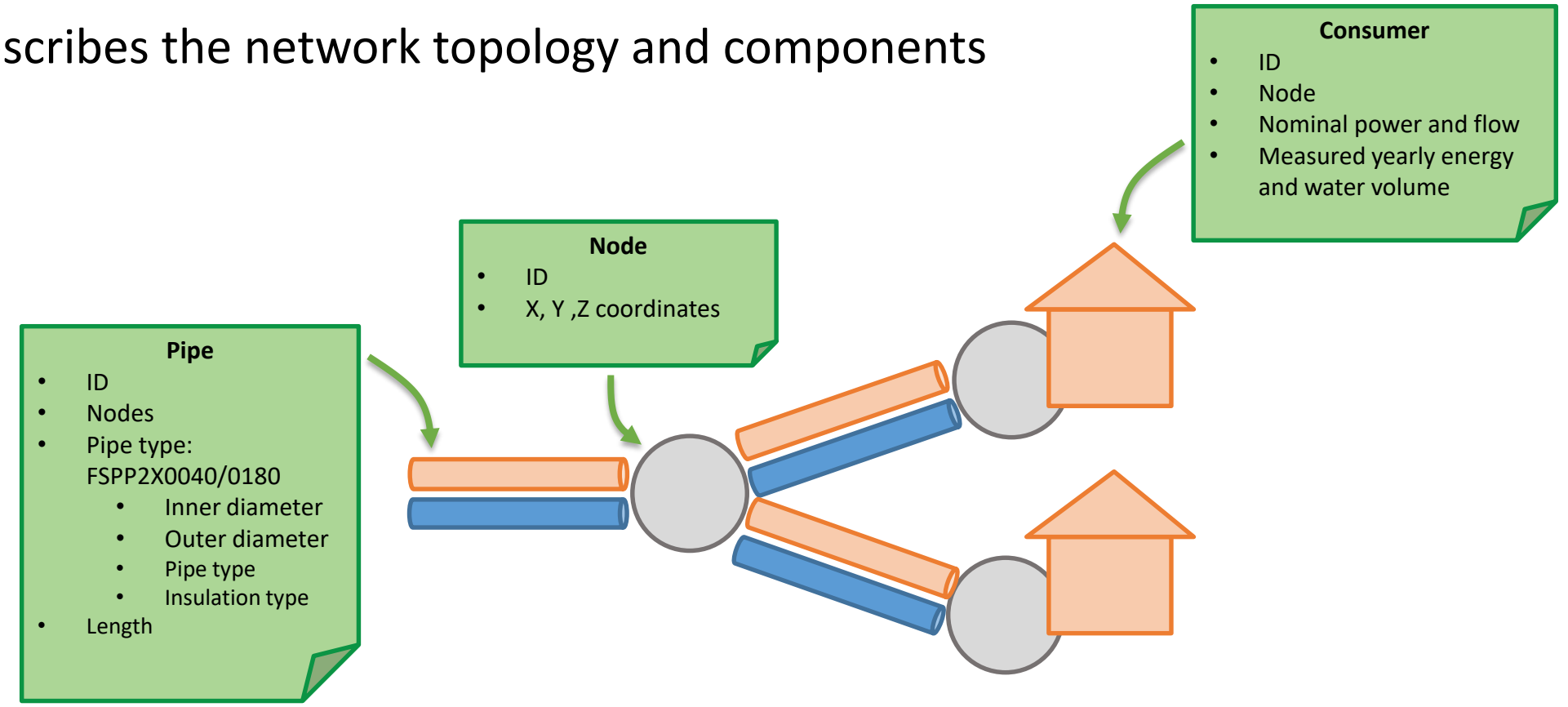
State of the art in industry:

- commercial tools based on static models: Termis , TRNSYS and Netsim not suitable to investigate short-term fluctuations in the network
- Open source simulation tool Dhemos, also uses static models
- APROS (from VTT Finland, originally used for nuclear power plants) unclear how control systems can be represented and not modular
- Dedicated and specialized simulators are available at different utilities

Automatic model generation and simplification (1/3)

The raw data

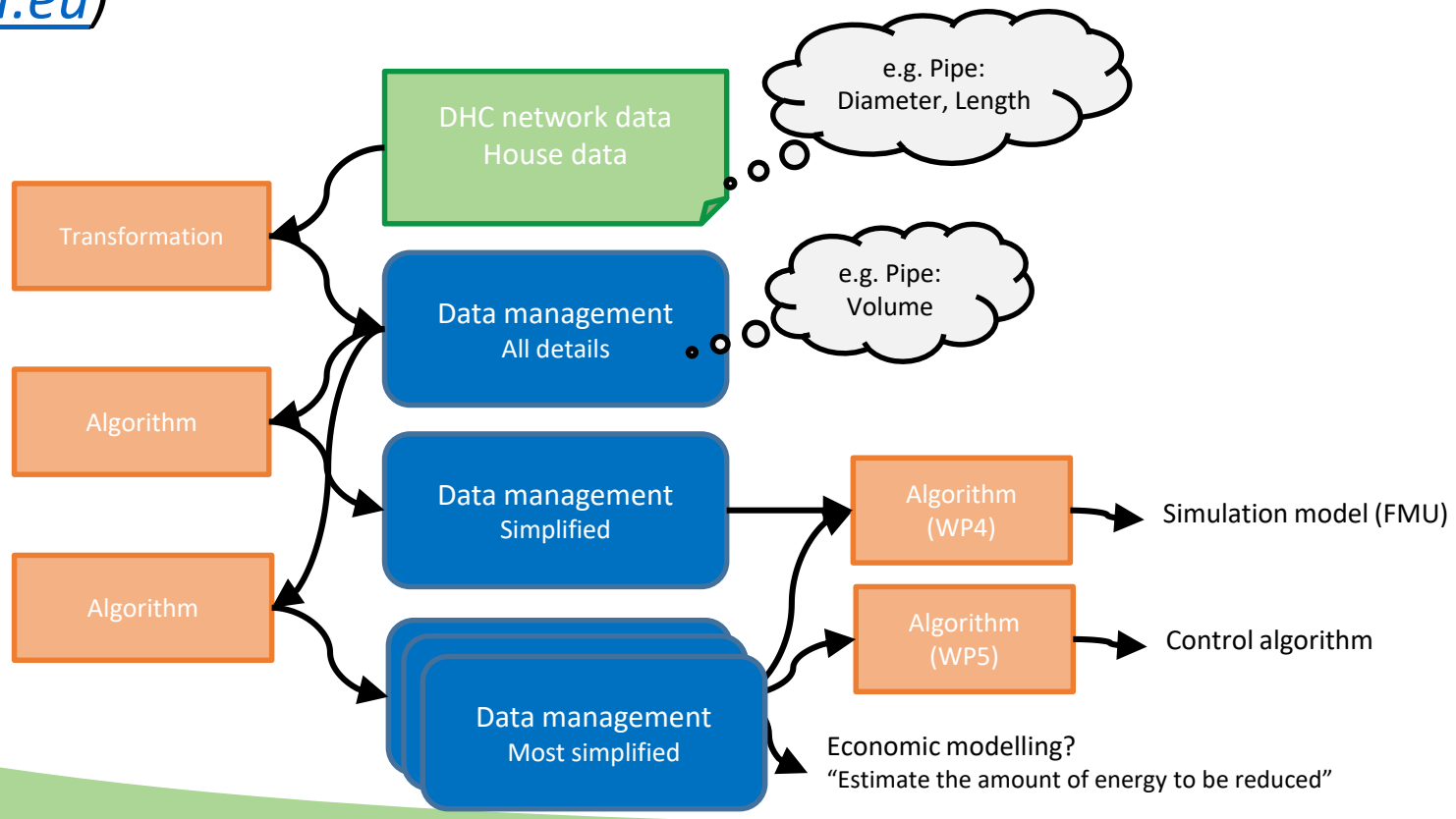
- Utilities maintain databases on all components.
- GIS data describes the network topology and components



Automatic model generation and simplification (2/3)

Remodelling the raw data

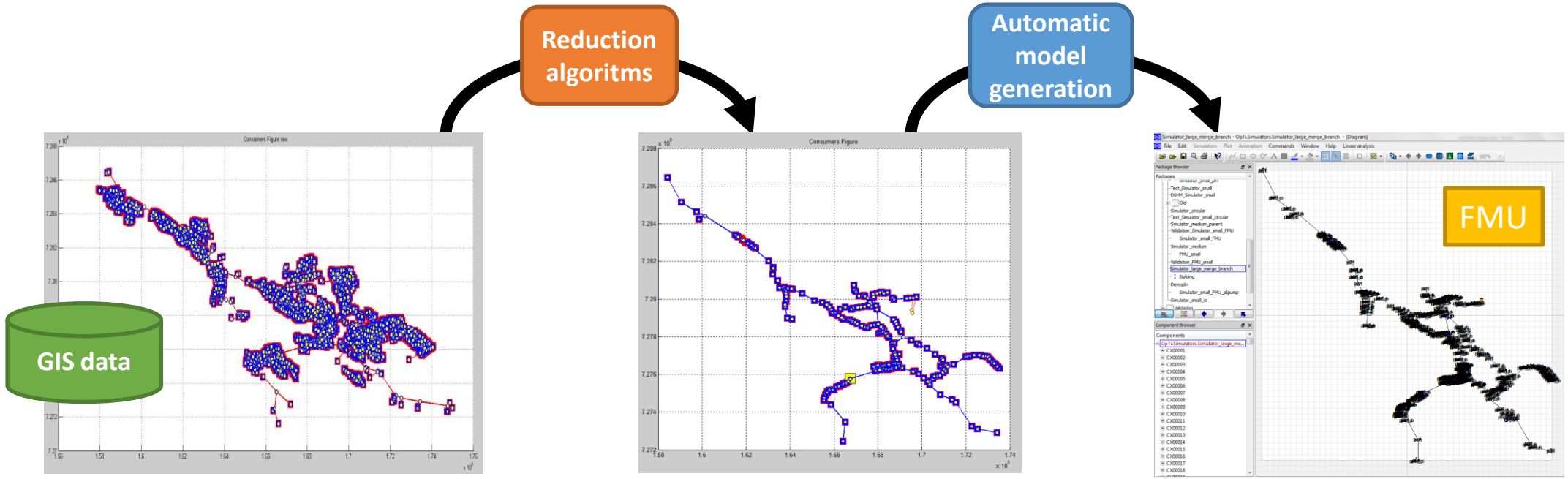
- Automatic processing of GIS data ensures up-to-date model
- Approach complies with goals of *European roadmap for industrial process automation* (*www.processIT.eu*)



Automatic model generation and simplification (3/3)

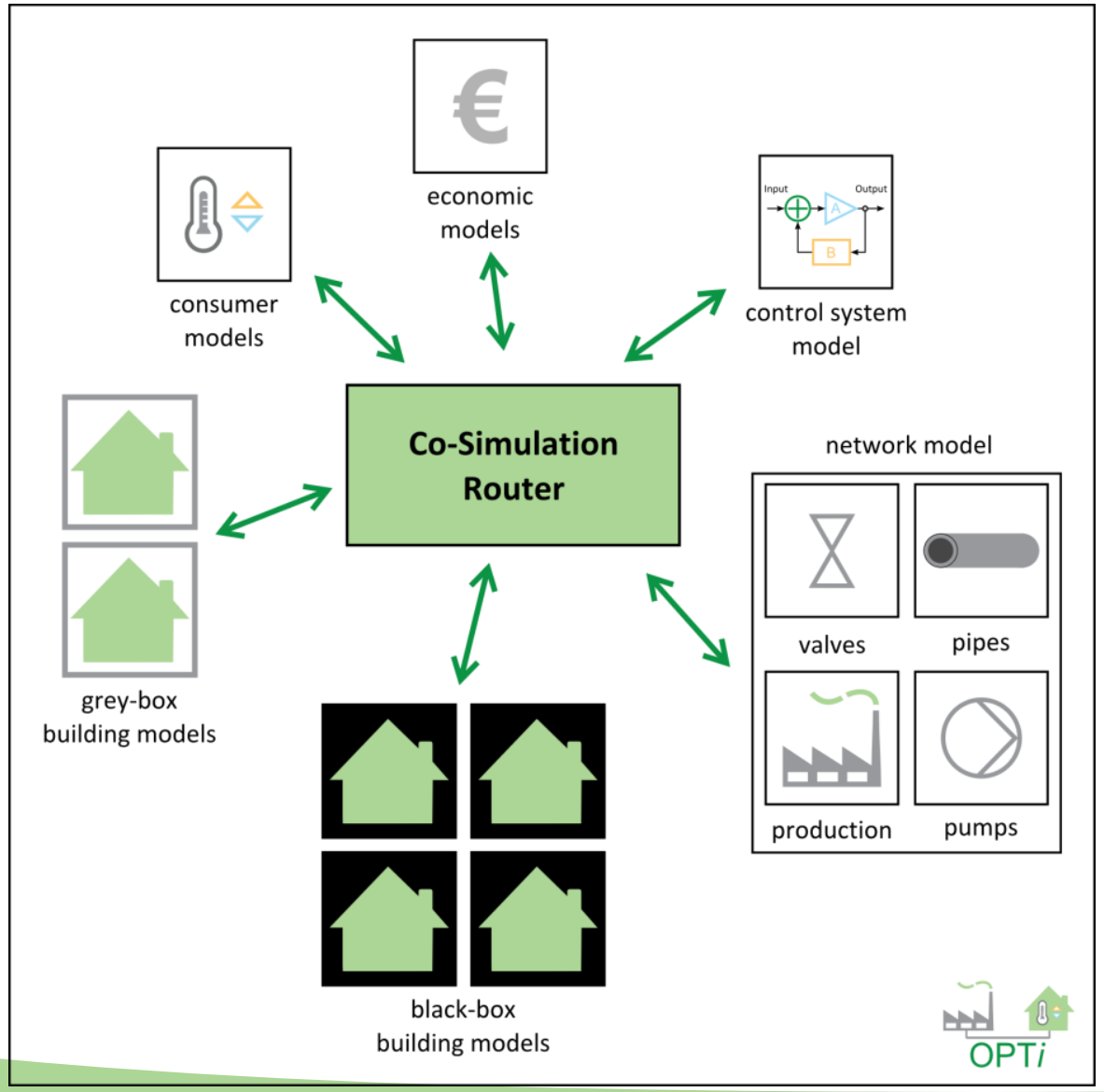
Returning to the example

- Luleå grid: > 10,000 consumers, > 45,000 pipes, 4 production units, sensors, pumps, valves
- Need for network reduction, simplification and automatic generation of dynamic models



Advantage: Can be regeneration as soon as a change occurs!

Co-simulation of complete DHC networks



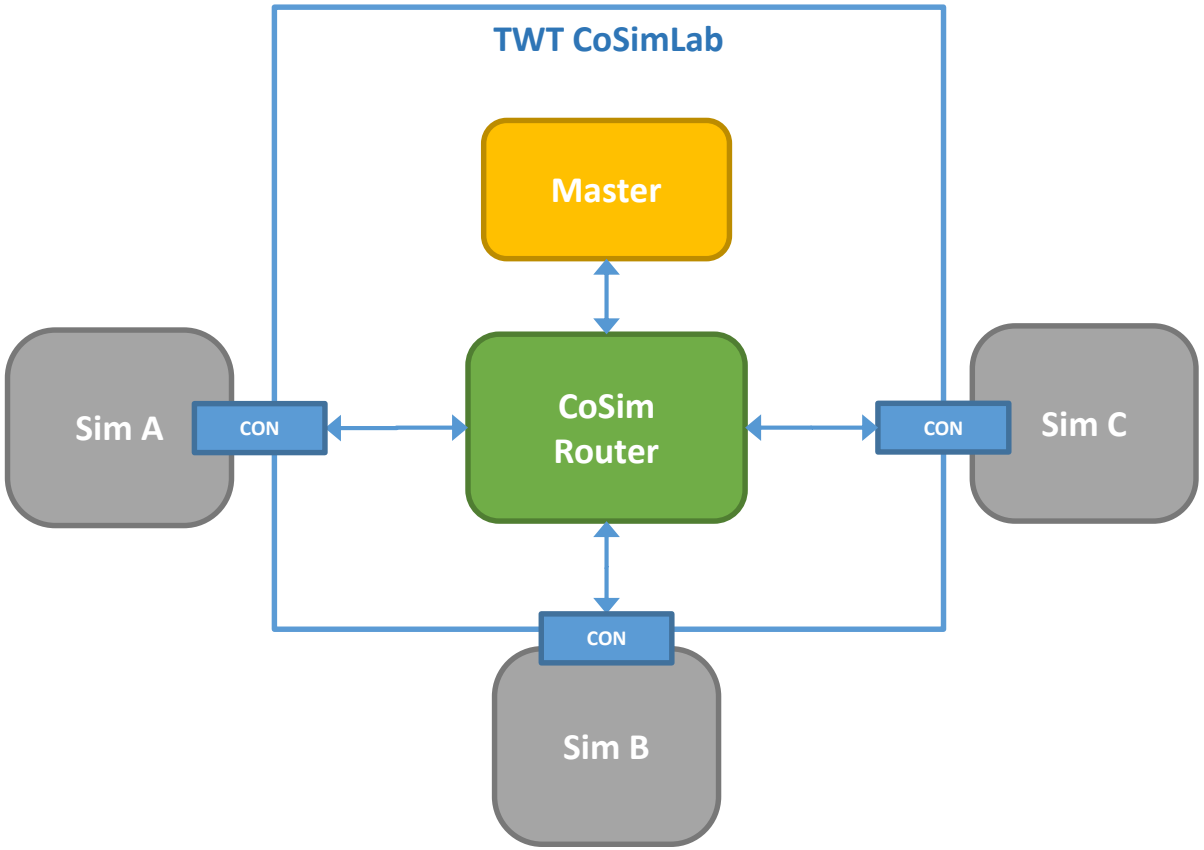
Co-Simulation Framework

TWT CoSimLab manages signal exchange between

- multiple simulations, running in
- different tools, possibly located on
- multiple hosts.

Features:

- implemented in Java
- control and monitoring GUI
- connectors for several simulation tools
- FMI compliant

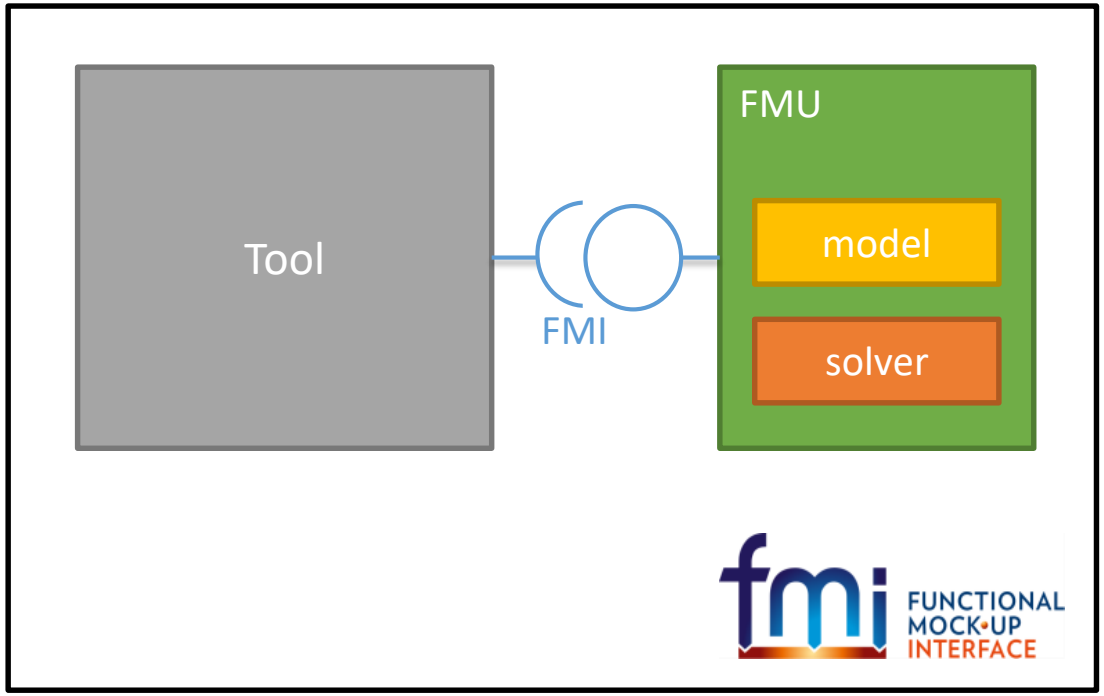


FMI: Functional Mock-up Interface

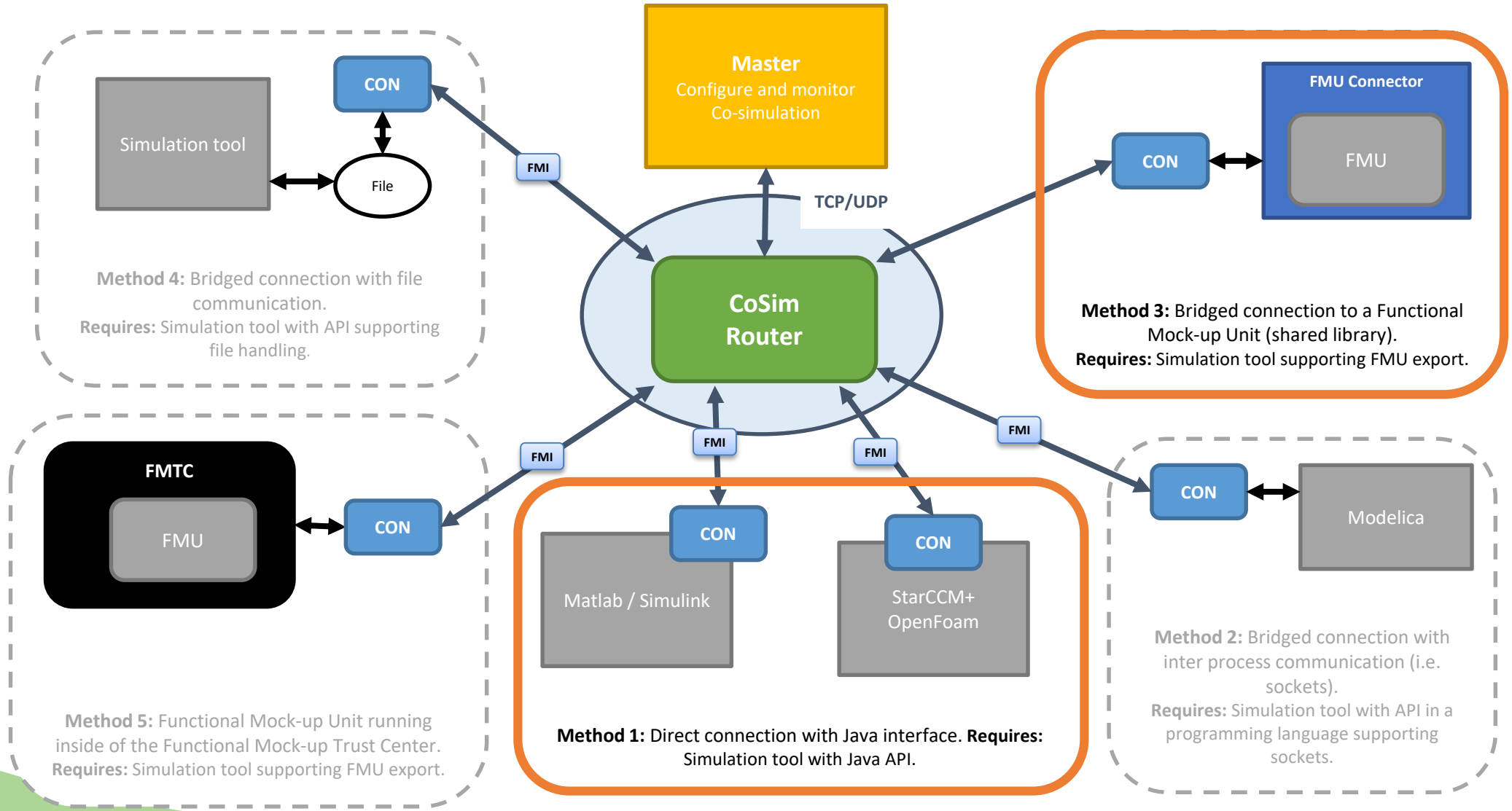
- Open interface standard for model exchange and tool coupling
  - **FMI:** .xml description of interface
  - **FMU:** .xml + model implementation (source or binary)
- Widely adopted (> 30 tools) in various disciplines

OPTi-Sim:

- FMI compliant co-simulation
- Secures flexibility and reusability



Model integration methods



Pilot use cases for OPTi-Sim

Four pilot use cases are performed by Luleå Energi AB

- 31,000 households
- base heat production: 185 MW
- peak production units: 350 MW

Use cases:

1) Peak load reduction
2) Lowered DH supply temperature
3) Limitations in the DH grid
4) Valve optimisation

Conclusion

Summary: OPTi-Sim

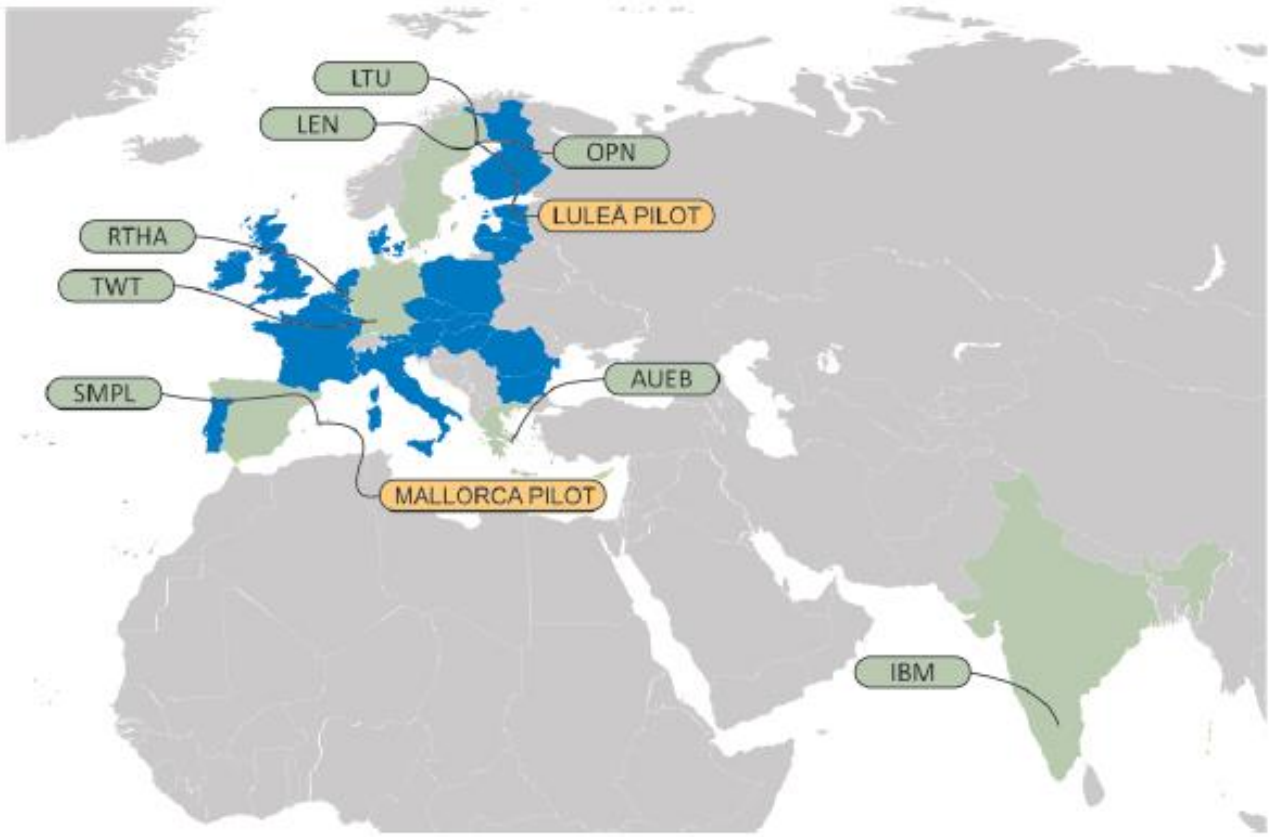
- facilitates virtual representation of the real DHC network
- features automatic model generation and simplification
- integrates different models using FMI compliant co-simulation

Future challenges

- validation of models and simulations, optimisation and control
- sensitivity analysis
- *integration of sensor data from real-life network: “tracking simulation”*
- *on-line simulation functionality*

Acknowledgements

ΟΠΑ AUEB
LULEÅ UNIVERSITY OF TECHNOLOGY
SAMPOL
TWT
IBM
SE | RWTH AACHEN UNIVERSITY
Optimation
Luleå Energi



Contacting us: www.opti2020.eu, contact@opti2020.eu, or on LinkedIn