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Co-Simulation scenarios in industrial production plants

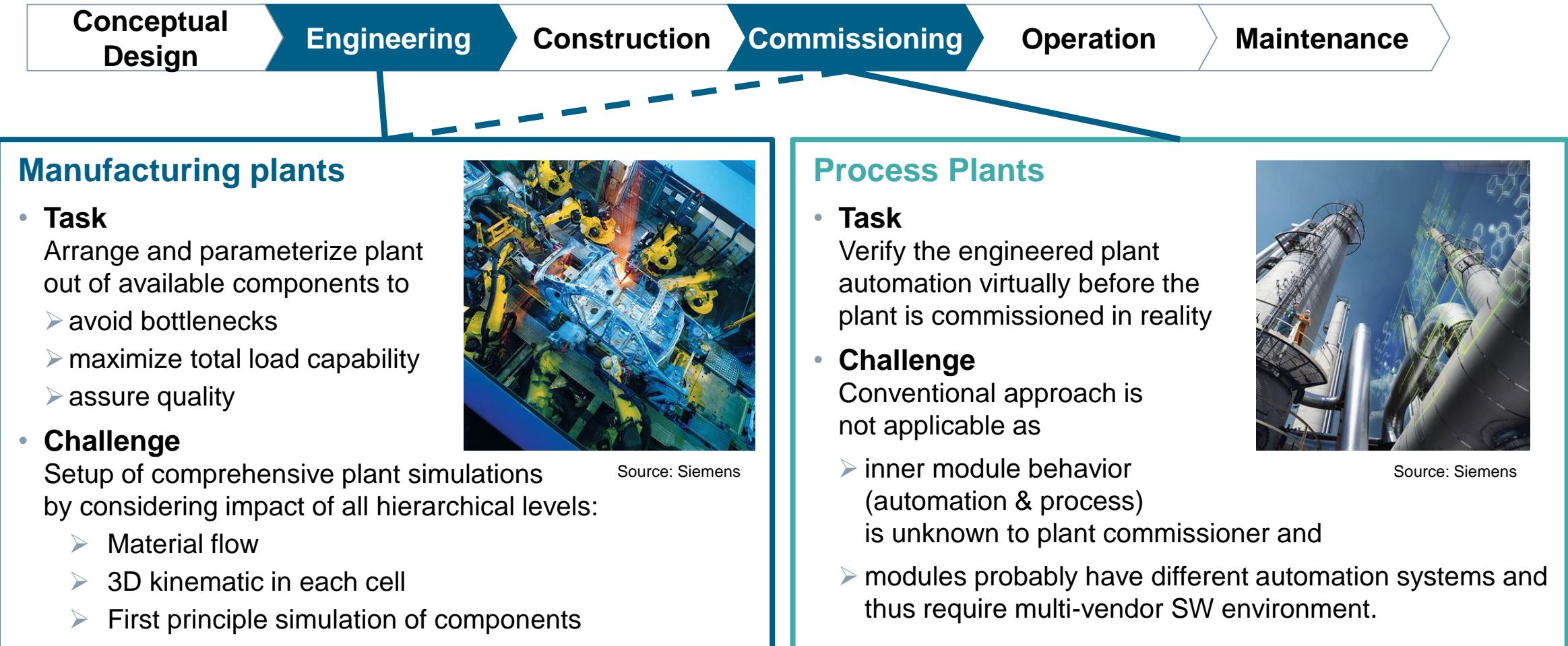
Two use cases from the manufacturing domain and the process industry

Andrés Botero, Tim Schenk, Jan C. Wehrstedt

Some challenges for modular production plants during the lifecycle

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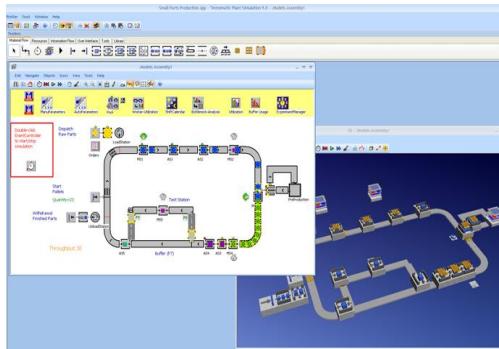
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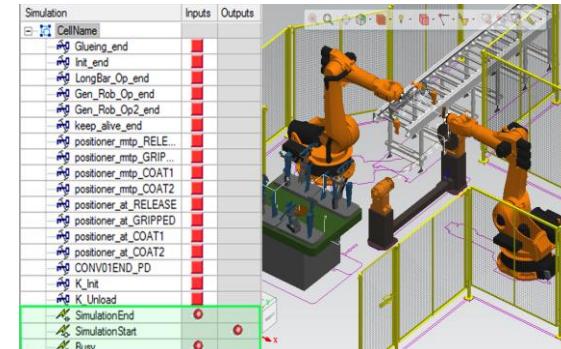
- **Engineering of Manufacturing plants**
- Virtual commissioning of process plants

Comprehensive simulation of modular manufacturing plants has to be executed by using different tools

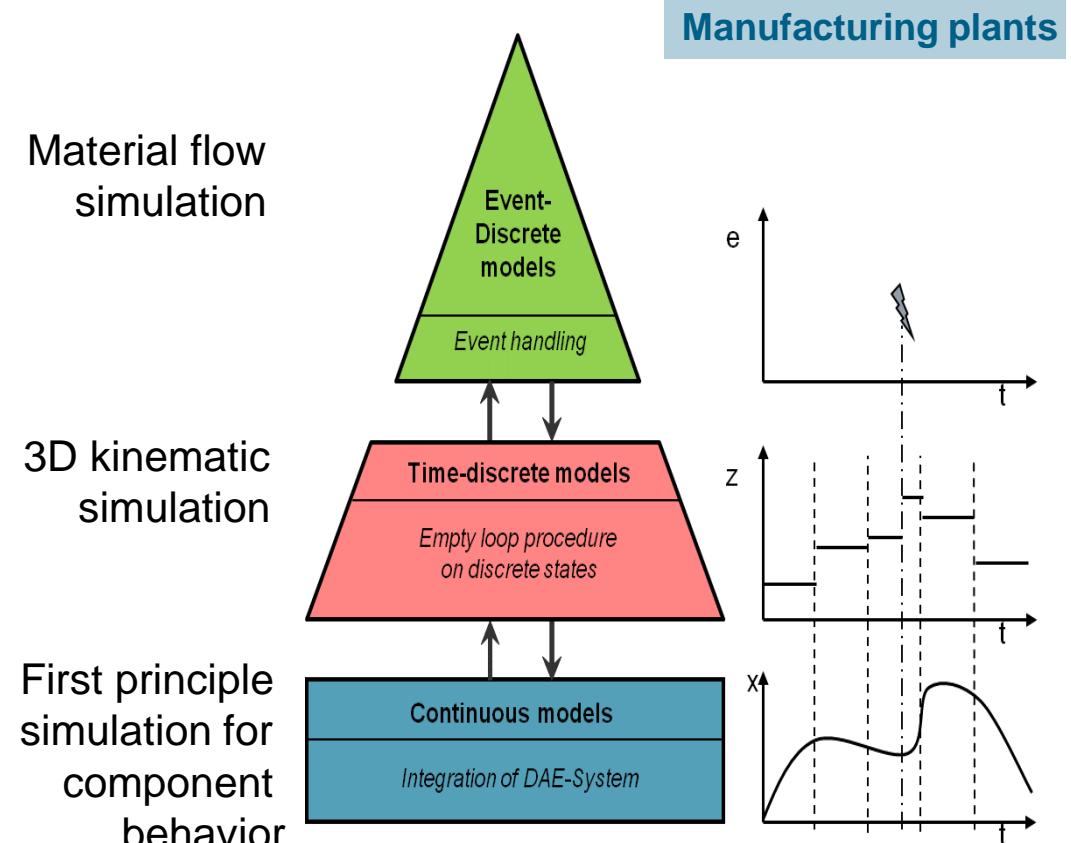
	Plant Simulation	Process Simulate
Type	Material flow	3D kinematic
Timing	Event-based	Time discrete
Scope	Logistics, material flow, dimensioning,...	Interaction between machines, humans and product
Purpose	Calculation of plant KPIs	Evaluation of dynamic behavior
Modeling aspects	Cells are modelled as time-delay blocks	Physical behavior is simplified



Source: Siemens



Source: Siemens



A Co-Simulation approach accounting for different time evaluation strategies of the clients is required

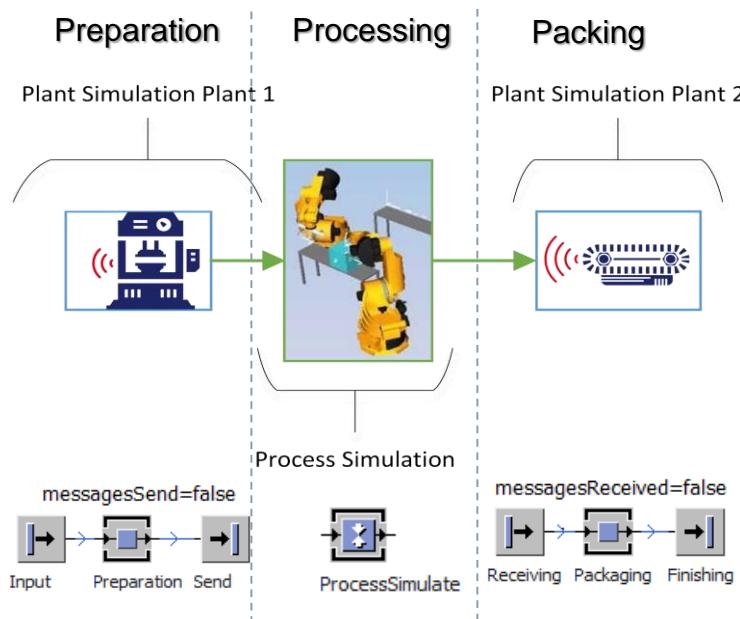
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Use Cases for such a coupling

- Validation of detailed cell behavior in the whole plant context (different cell configs, different component vendors)
- Accurate plant simulation by detailed cell behavior

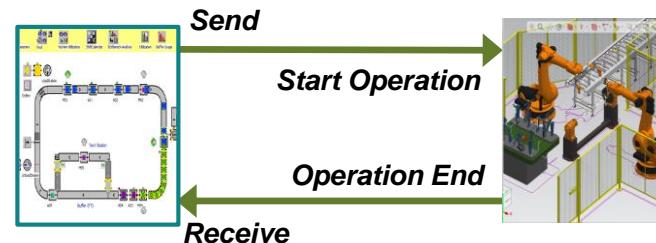
Manufacturing plants

Example Setup

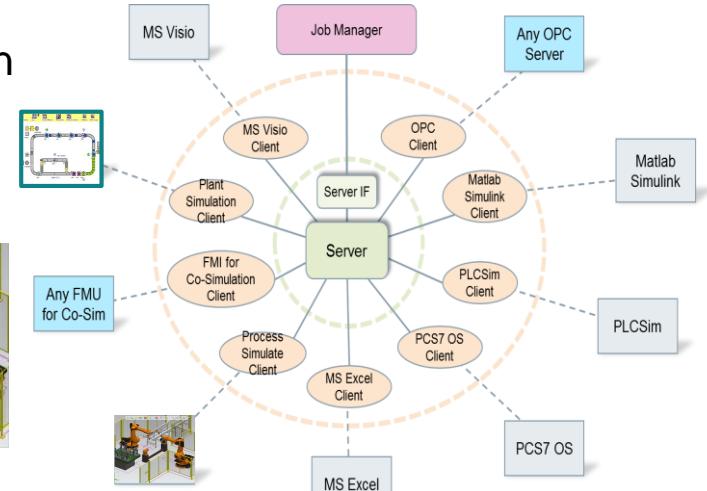


Realization by a master-slave co-simulation environment

- Establish communication between *Plant Simulation* and *Process Simulate*



- Co-Sim Master coordinates event-based, time-discrete and continuous simulators



Demo of interplay between Plant Simulation and Process Simulate

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- Engineering of Manufacturing plants
- Virtual commissioning of process plants

Modular process plants are a new approach to reduce engineering effort, reduce downtimes and be much more flexible

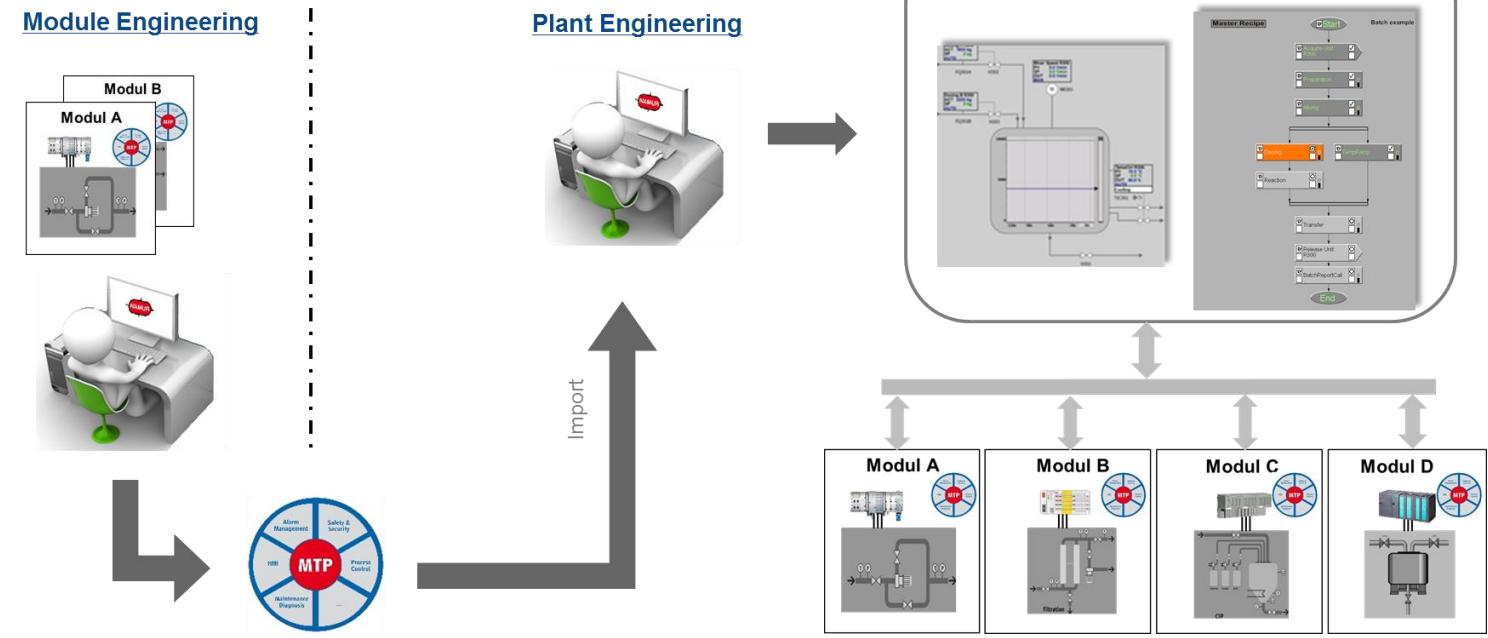
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- **Process Equipment Assembly (PEA)**
Module with integrated control (e.g. automation)

- **Module Type Package (MTP)**
Description used for integration into higher level plant automation

- Module services (utilized in state-based process control)
- Communication variables
- Communication technology
- HMI description
- Open to further aspects

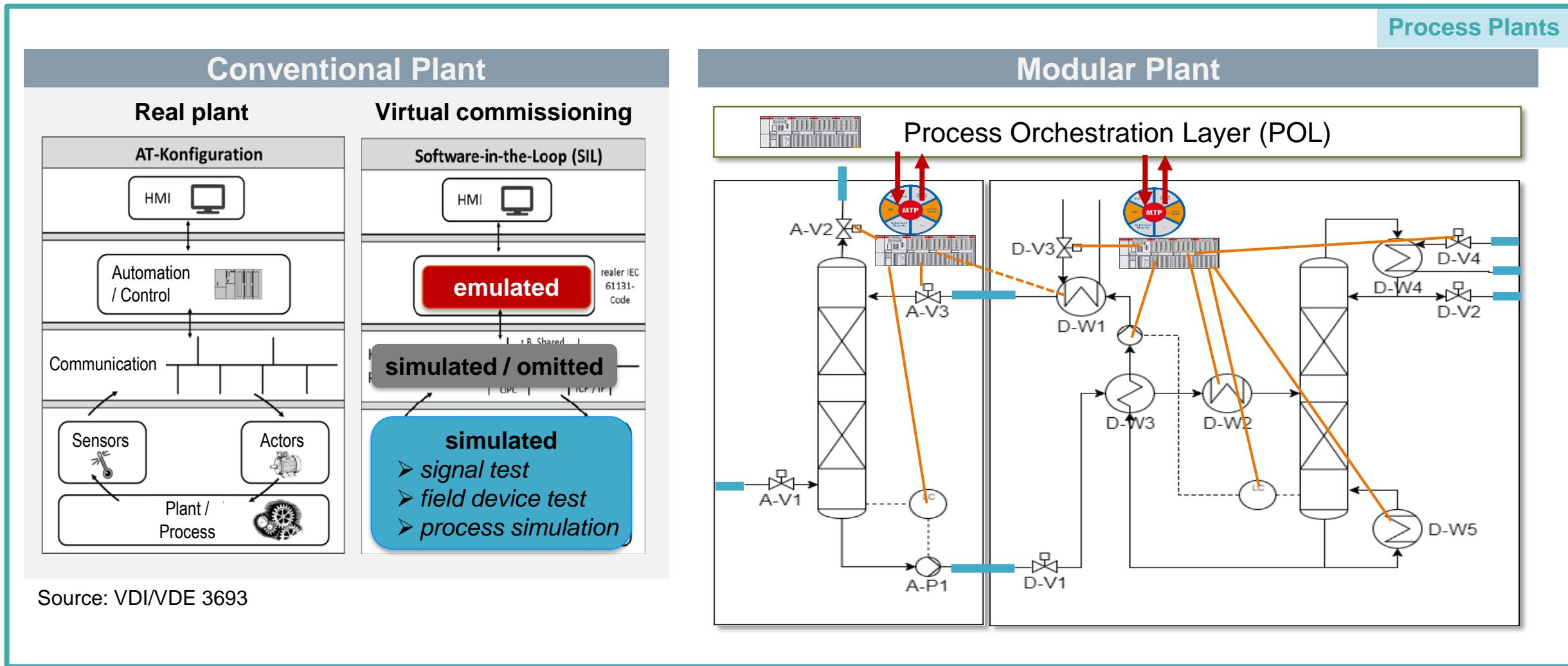
- Connection of PEAs results in process
 1. Import of MTPs
 2. Orchestration of the services



Source: J. Bernshausen & A. Haller, Namur HS 2017

Virtual commissioning of a process plant has to test the engineered **SIEMENS** automation against different virtual realizations of the plant

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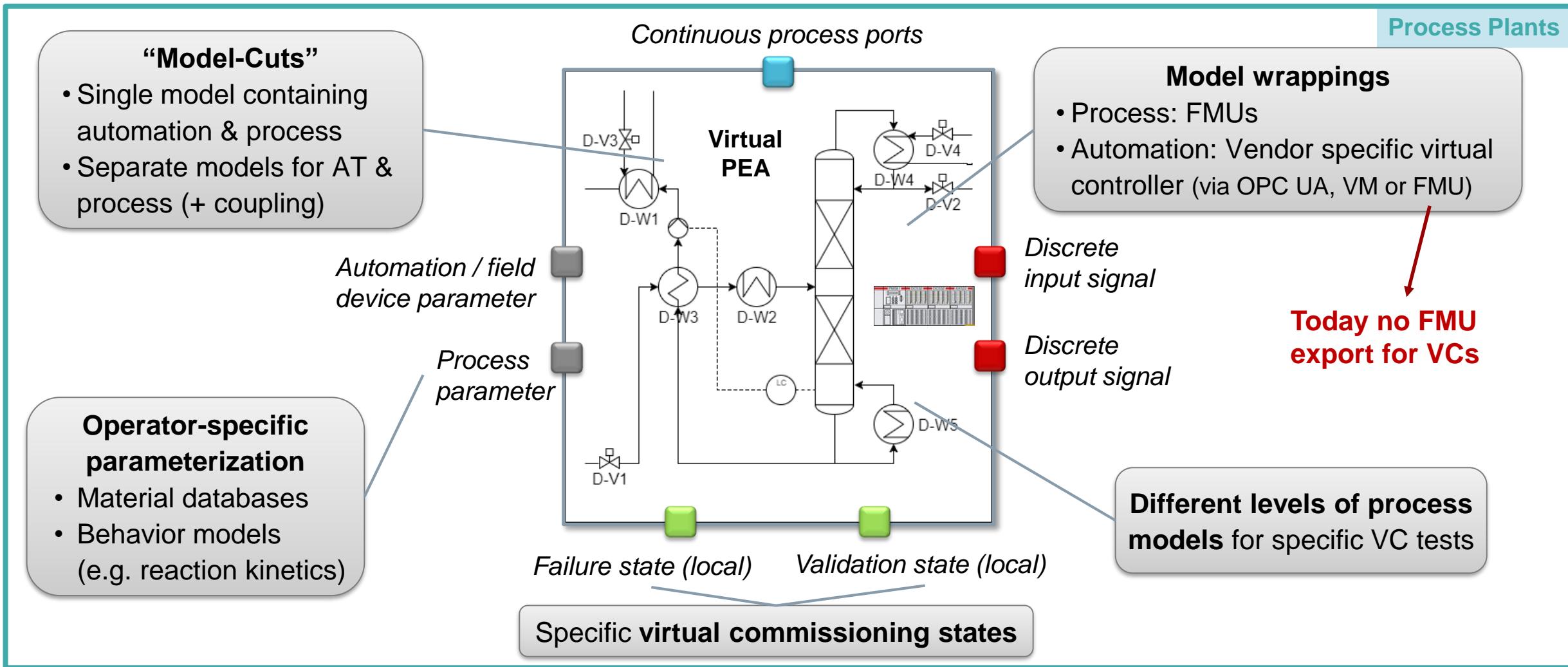
Demo of proprietary modular VIBN with Siemens tool SIMIT

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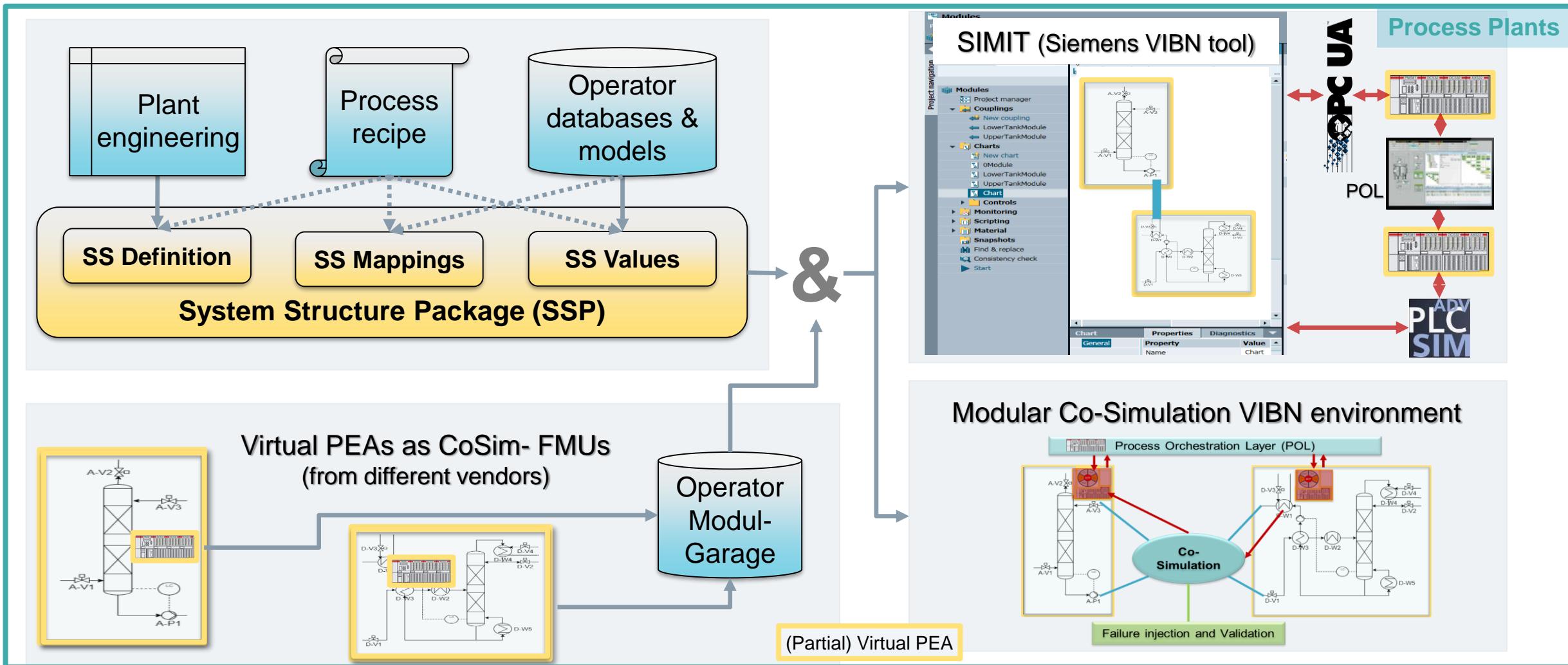
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Virtual PEAs (modules) can solve the problem of setting up a comprehensive simulation model of the whole plant



Co-Simulation realizations can be set up by either vendor specific tools or a generic co-simulation environment

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Co-Simulation together with utilization of standards like FMI and the new SSP speed up different use cases in the production industry

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Summary & Outlook

- As production plants get more modular and thus **multi-vendor plants**, simulations cannot be set up with a single simulation environment anymore.
- The modularity enables a new flexibility of the plants, which allow **fast plant changes**. To not lose this advantage by conservative (long-lasting) verifications of the new setup, the (simulation-based) validations have to be as flexible.
- **Co-Simulation is actually the appropriate choice** of exchange as most of the commercial simulation tools in the production industry support only one specific solver type.
- The engineering of production plants results already in a **topology model**. Export into a standard like SSP enables an easy setup of system simulations independent of the specific simulation environment.
- **Virtual commissioning tools** should be able to **import Co-Simulation FMUs** (Siemens SIMIT plans to release this feature in next version). **Virtual controller** should be able to **export FMUs**.



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