

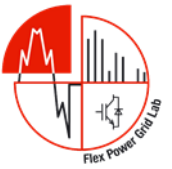
WP 16 – Testbenches CHiL – PHiL - Cosimulation

By Alejandra Fabian

August 15th, 2019



Content



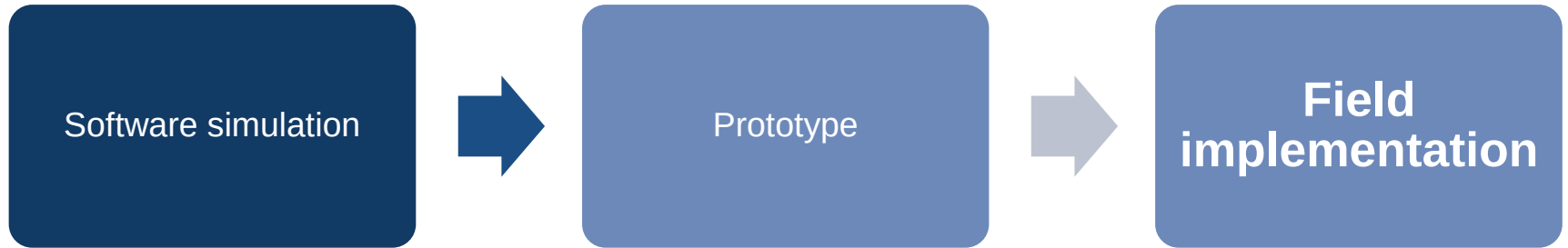
- **Power cybernetics**
 - CHiL and PHiL
 - The Playground
 - The team
- **PROMOTioN Testbenches**
- **Wind Turbine Cosimulation**



Power Cybernetics



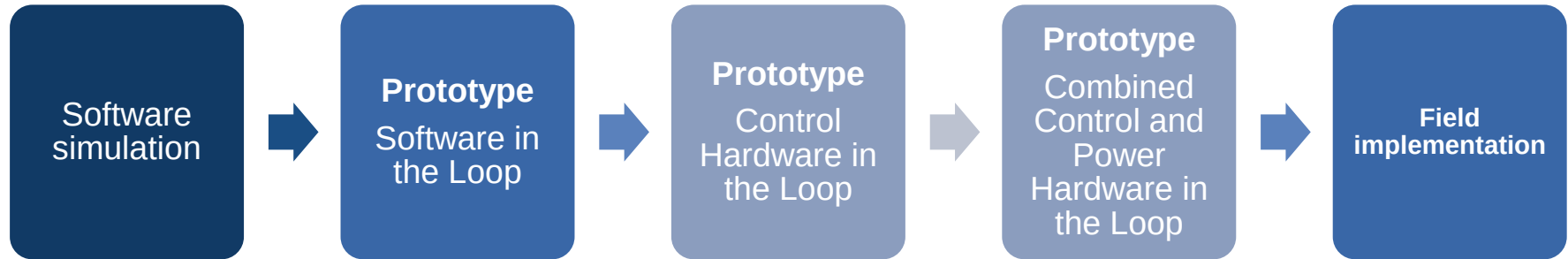
Development stages for new functions/devices



Power Cybernetics

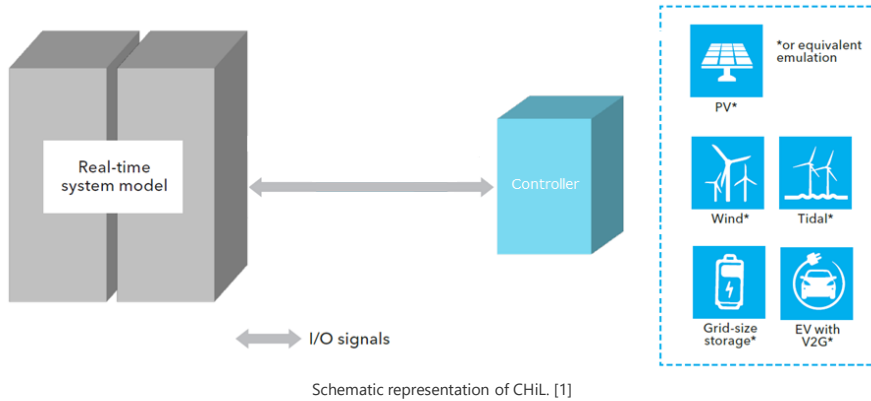


Development stages for new functions/devices



- Hardware in the Loop methodology allows a virtual representation of a dynamic system that later serves as the environment around the equipment under test.
- A cyber-physical testbed offers a flexible, cost efficient alternative for a rigorous assessment of electrical devices and its active controllers.

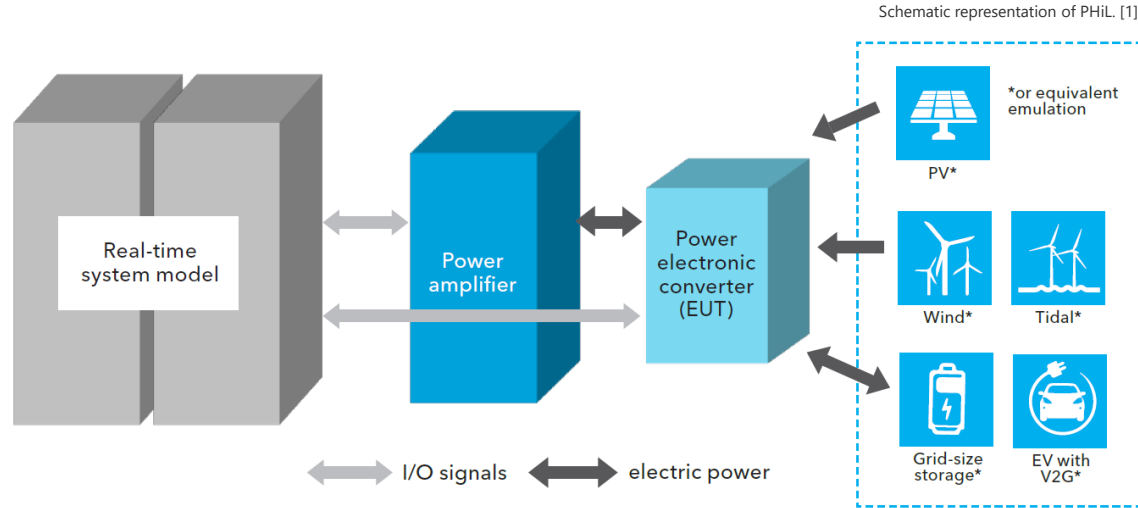
Control Hardware in the Loop



The test bench connects the physical controller to a real-time simulator. The real-time simulator contains a electrical model of a device or a grid. This allows the controller to be fully tested and validated without the need of real electrical equipment i.e. grid/inverter. This approach offers:

- Flexibility
- Cost effective certification/validation
- Testing before deployment
 - Prototyping

Power Hardware in the Loop

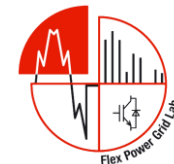


Takes the same principle and adds a power amplifier between the real-time simulator to interface with real equipment e.g. power electronics converter for different technology applications.

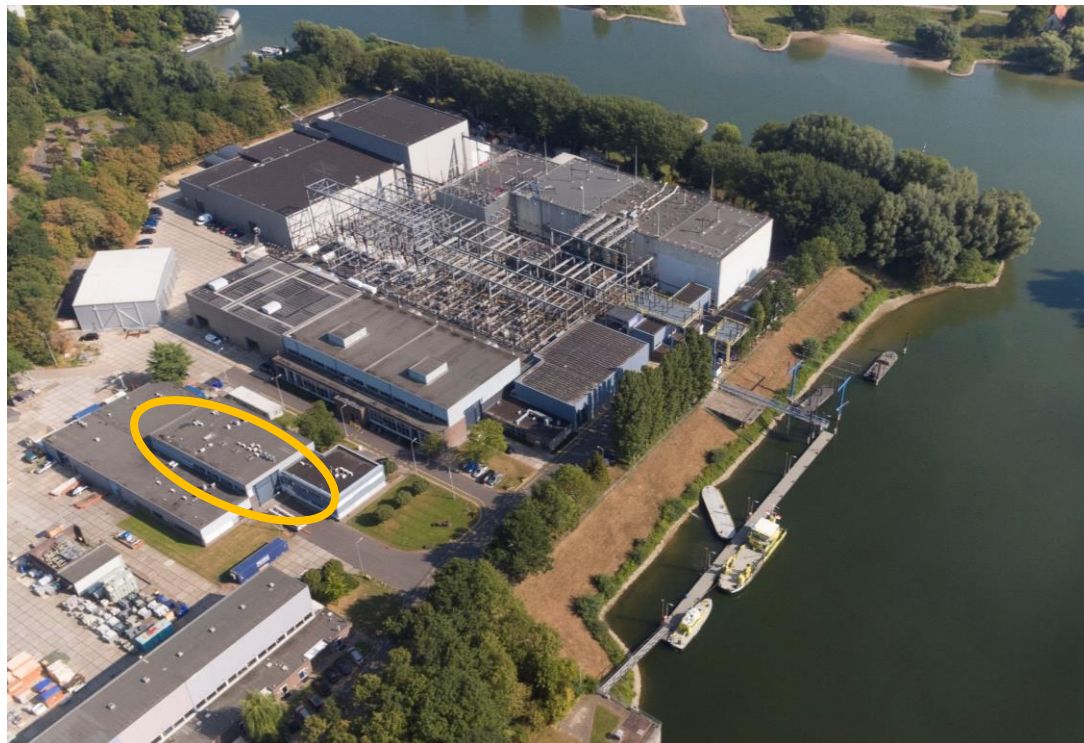
The Team



The playground – Flex Power Grid Lab



Arnhem, Netherlands





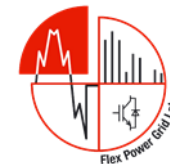
PROMOTiON Cosimulation - CHiL – PHiL Testbenches



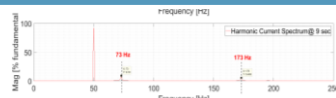
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Cyberphysical Demos



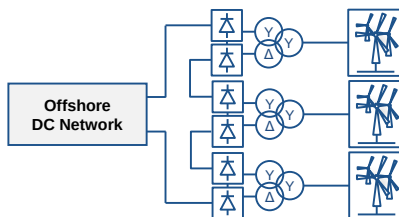
Grid-following WTG



CHiL

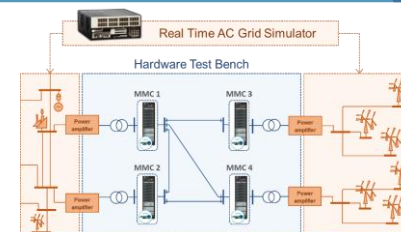
PHiL

Grid-forming WTG



CHiL PHiL Cosimulation

MMC-HVDC



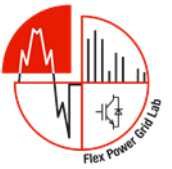
CHiL



Flexible Power Grid Lab



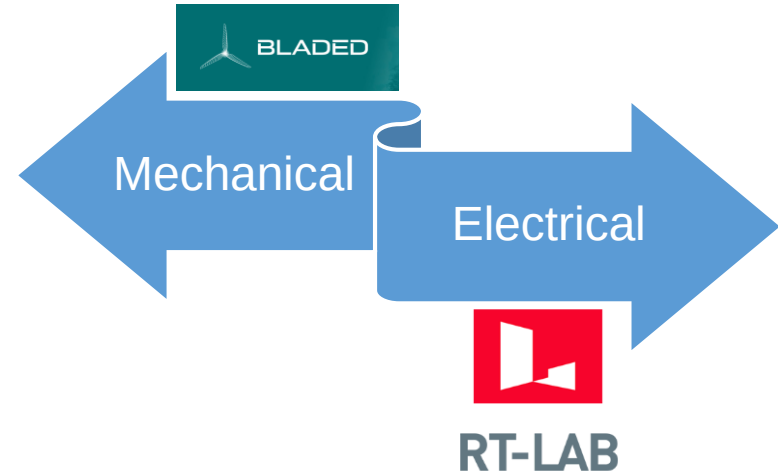
Cosimulation



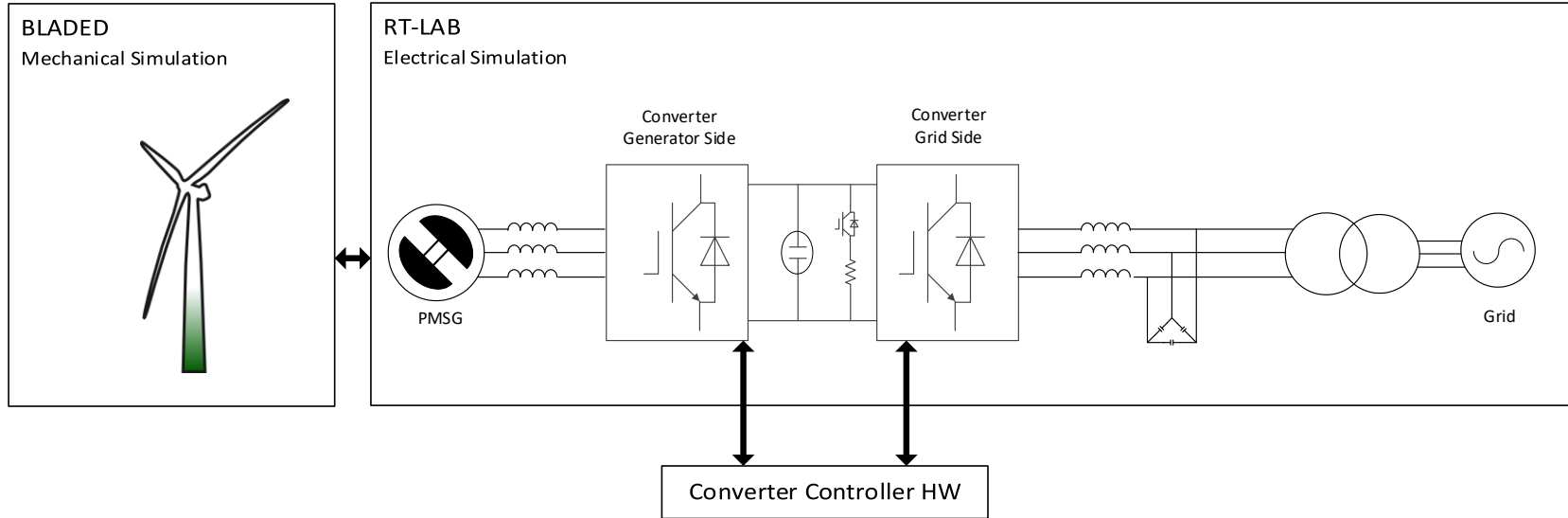
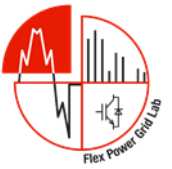
Cosimulation is when two or more simulation tools are used for dynamic modeling and solving the subsystems separately, coupling the relevant data of the points of interest.

Development stages

1. CHiL Test bench
2. CHiL for Black Start
3. PHiL for Black Start

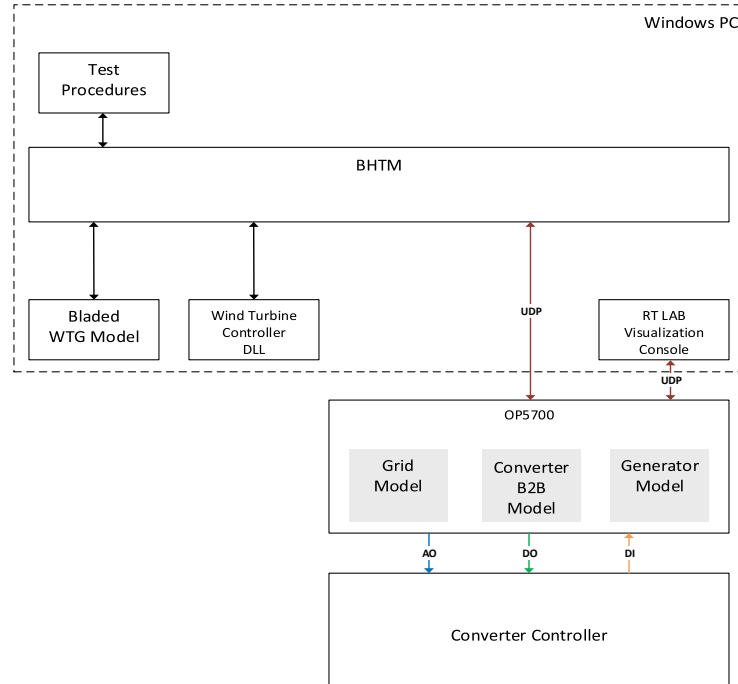


Cosimulation - CHiL Testbench Concept



Generator shaft is the point of connection between the software.
Exchanging Speed and Air-gap Torque

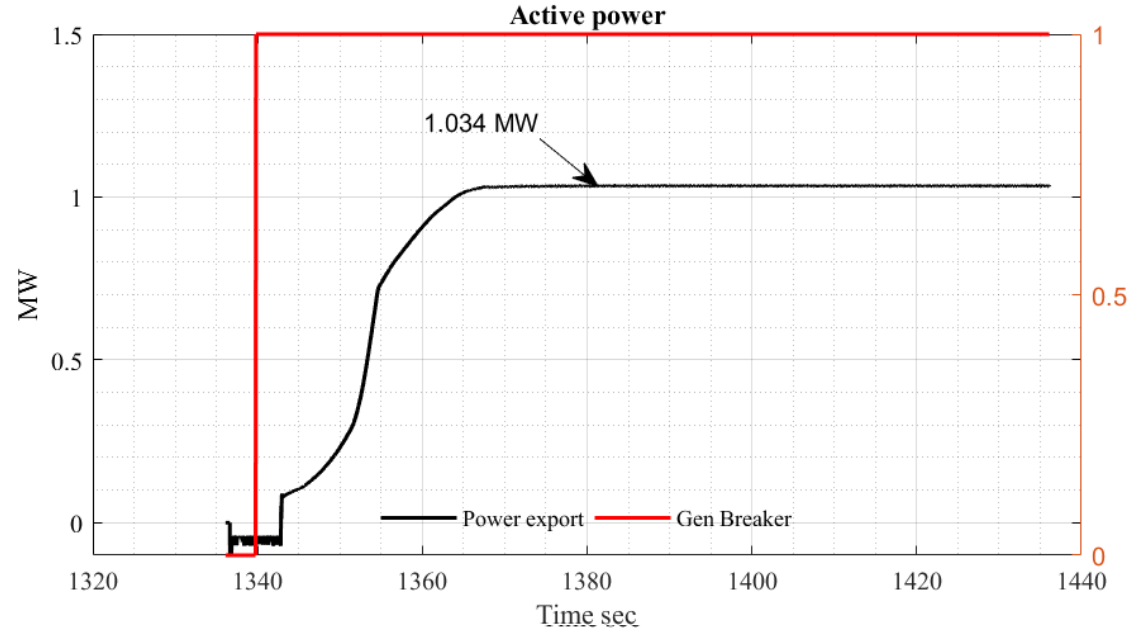
Block diagram Cosimulation CHiL



- Asynchronous Cosimulation
- Mechanical simulation (10 ms = 100 Hz)
- Electrical simulation (25 μ s = 40 kHz)
- ~132 signals are handled in the whole setup.
 - 36 to/from OP5700 and Converter Controller
 - 8 to/from OP5700 and BHTM
 - ~55 BHTM to/from WT DLL
 - ~33BHTM to/from WTG Model
 - ~132 BHTM to/from Test Procedures Script

Results – Cosimulation normal start up of a wind turbine

1. Bladed accelerates the rotor of the generator.
2. Start up command to WT when reaching synchronization speed.
3. Converter controller close grid breaker.
4. Converter controller close gen breaker
5. WT controller, increases torque reference and accelerates torque to nominal values.



Stable Cosimulation 😊

Cosimulation for wind turbine



- New Bladed Software Module - Cosimulation for Complex Electrical Studies
 - Development of new functions/services for wind turbine OEMs
 - Fast frequency response (virtual inertia)
 - Low voltage ride through
- PHiL testbench in the FPGL
 - Electrical testing without the need for mechanical drive train



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