LIVE LABORATORY DEMONSTRATIONS

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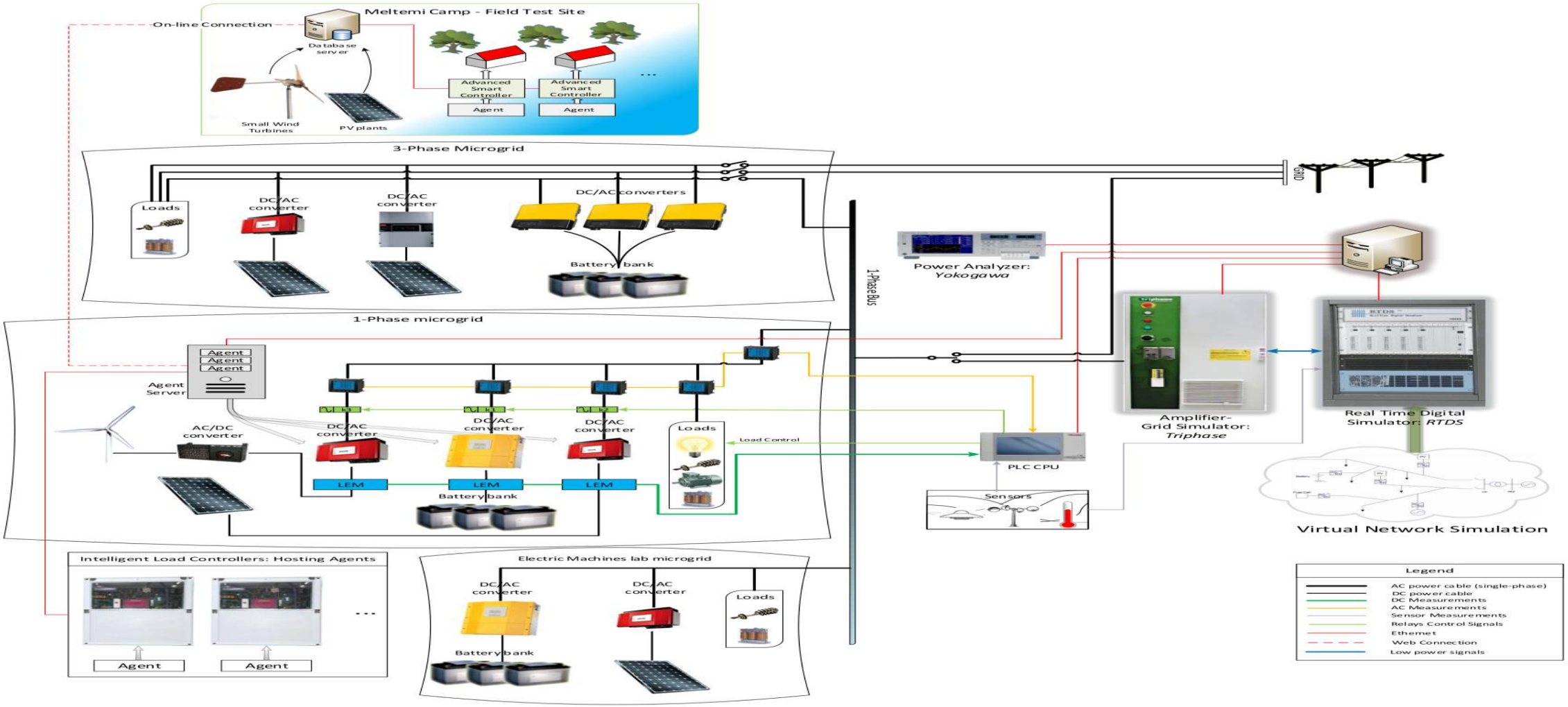
ERIGrid workshop: Advanced power system testing using Hardware in the Loop simulation

NTUA, Athens, 23 November 2018

Overview

1. CHIL testing of DER inverter controls
2. PHIL testing of DER inverter anti-islanding protection
3. Combined Control-HIL and Power-HIL testing of coordinated voltage controller
4. CHIL testing of adaptive protection system for distribution grids
5. Virtual Power Plant laboratory platform using Multi Agent Systems

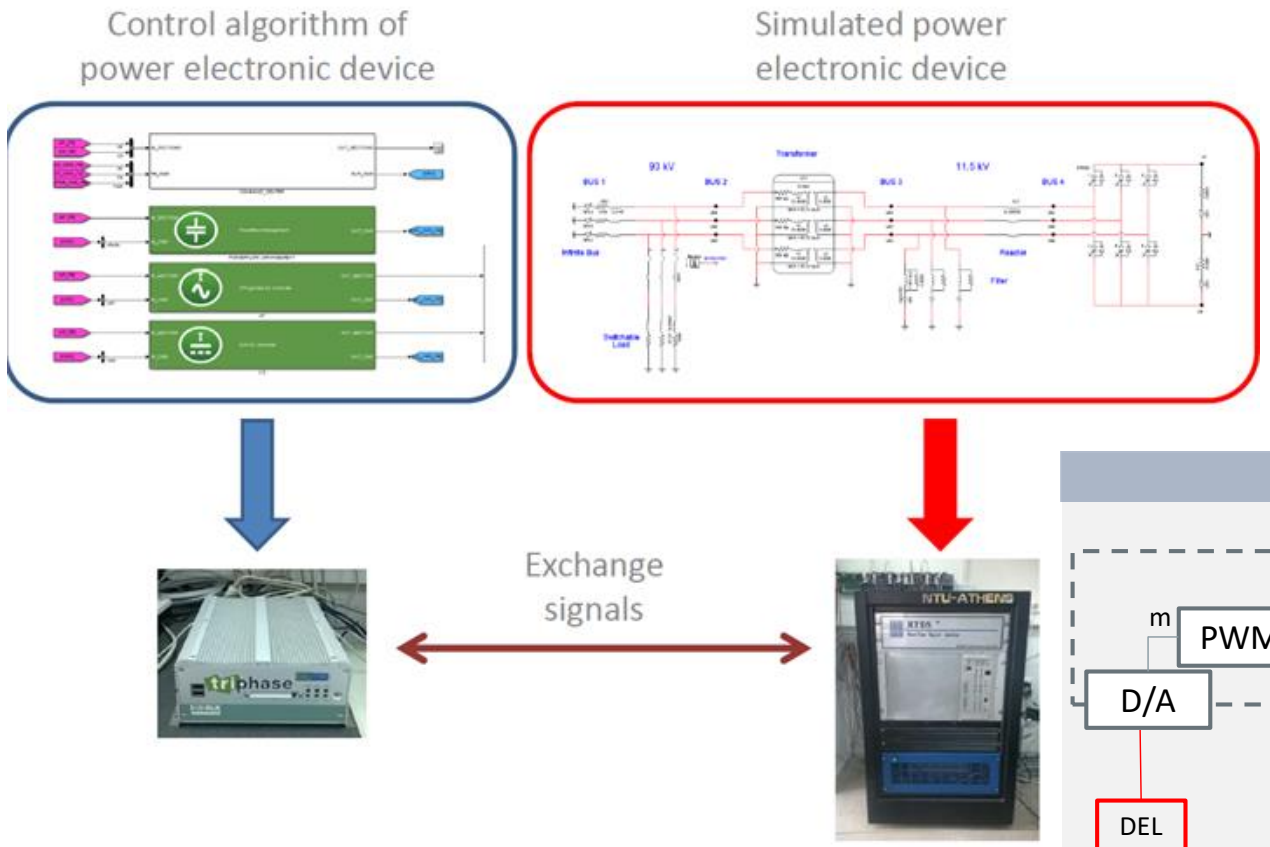
The NTUA Laboratory

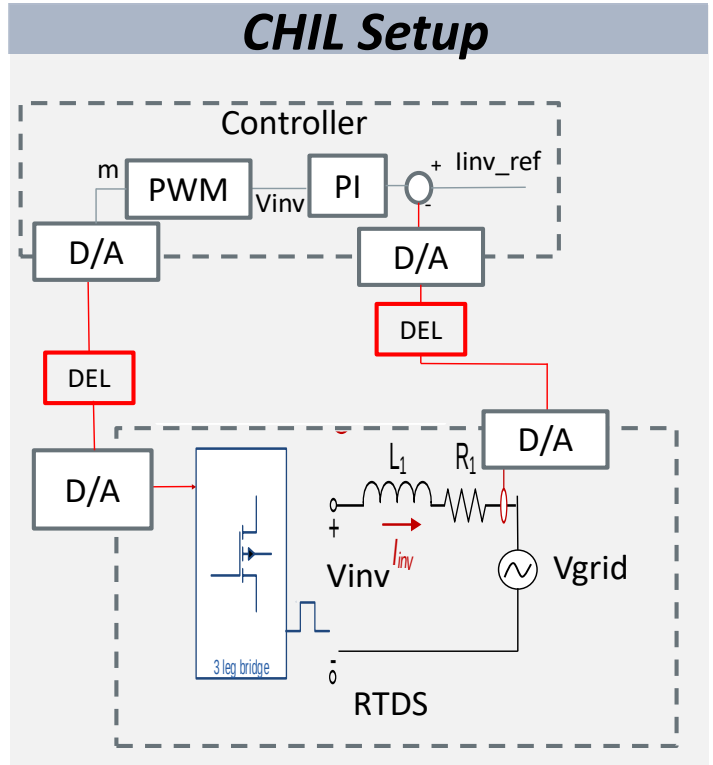


1) CHIL testing of DER inverter controls

- Pure Simulation can't always model exact real conditions (time delays, noise)
- Stable control in simulation could be unstable in CHIL and hardware setup
- Example:

1) Inverter's control designed with specific bandwidth in simulation
2) Instability might occur in CHIL for that bandwidth due to time delays
3) Recalculation of bandwidth and performance of CHIL test for stability and performance assessment



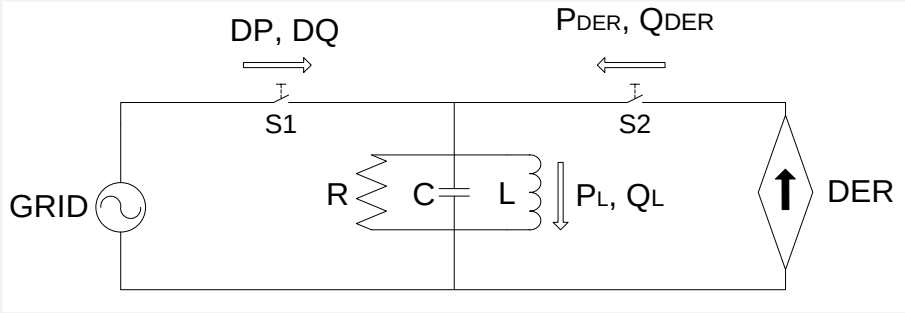


2) PHIL testing of DER inverter anti-islanding protection

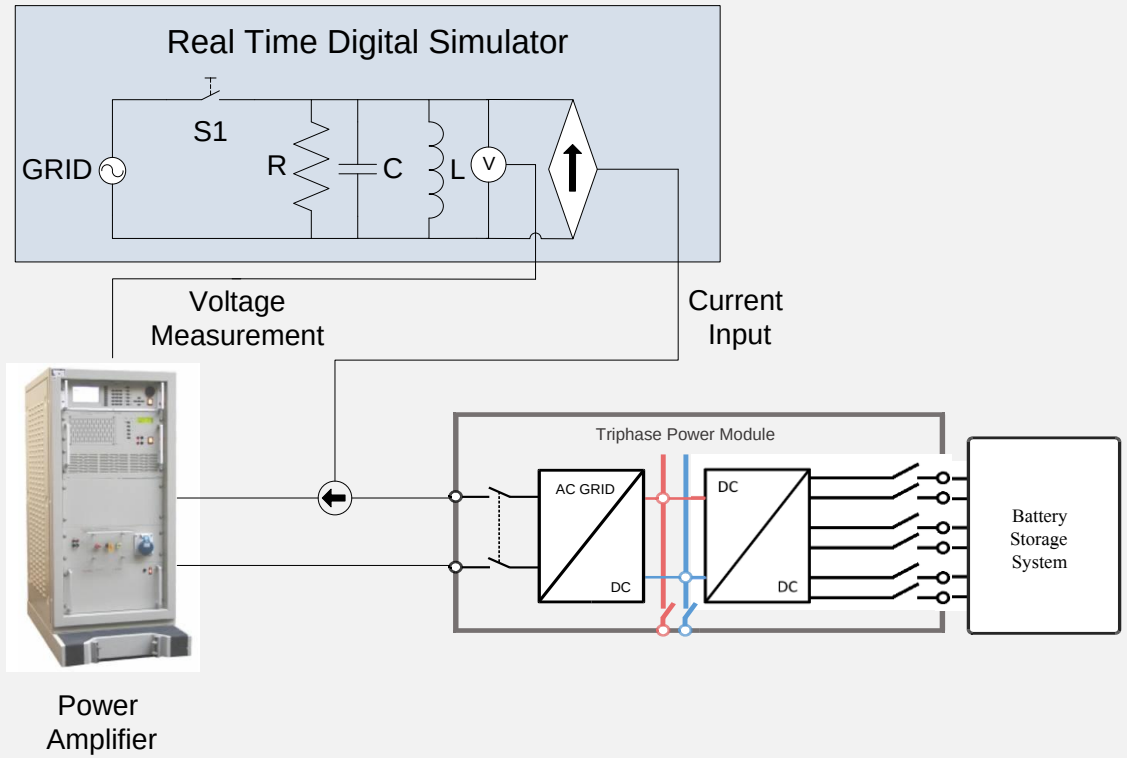
Islanding Detection Algorithms testing with PHIL setup

- Same setup as the IEEE 1547.1 standard
- Easy modification of the load bank to the different RLC values required by the standard in the PHIL setup
- Check if the islanded is detected in adequate time
- **More flexible than conventional hardware test**

IEEE 1547.1 setup for Islanding detection tests



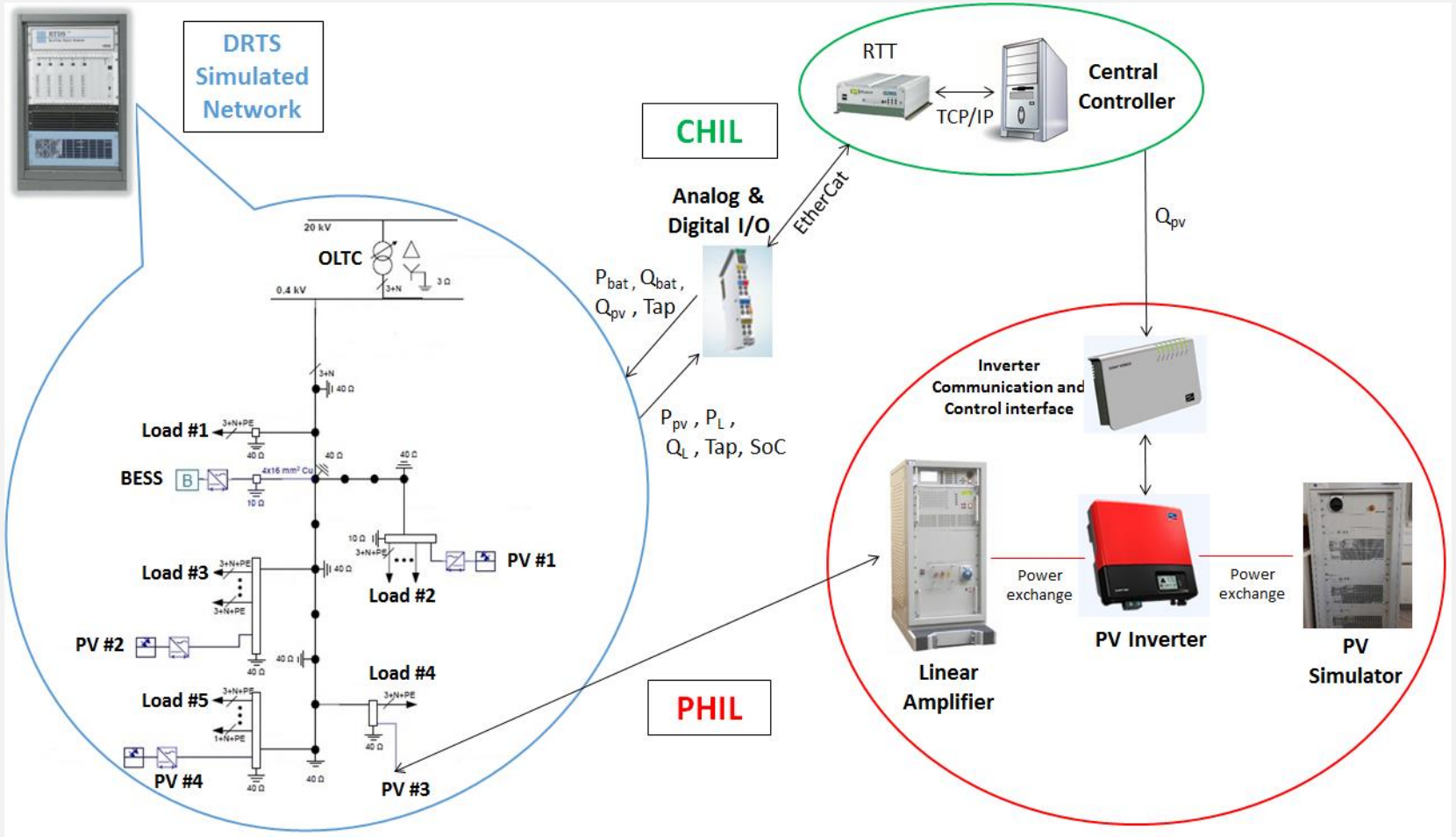
PHIL setup for Islanding detection tests



3) Combined Control-HIL and Power-HIL testing of Coordinated Voltage Controller (CVC)

- An Optimization problem is implemented in the central controller
- LV benchmark grid in RTDS
- CHIL testing of the controller
- PHIL testing of real hardware inverter as part of the CVC controlled devices (insight on the communication and dynamics of the hardware inverter)

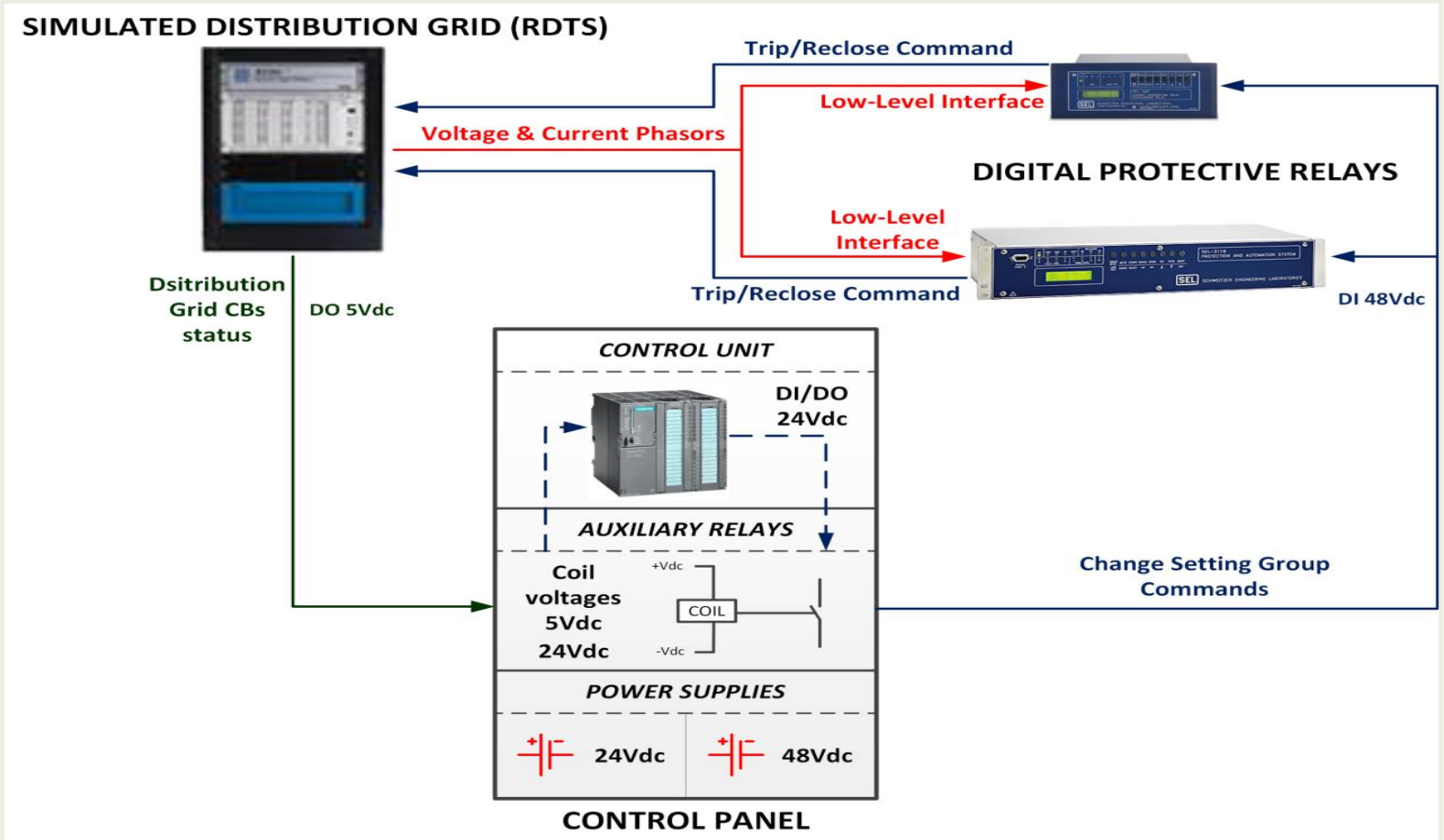
Combined Control-HIL and Power-HIL Setup



4) CHIL testing of adaptive protection system for distribution grids

- The hardware controller (PLC) changes the setting-groups of the relays, according to the status of the simulated network.

CHIL Setup for adaptive protection testing



5) Virtual Power Plant laboratory platform using Multi-Agent Systems

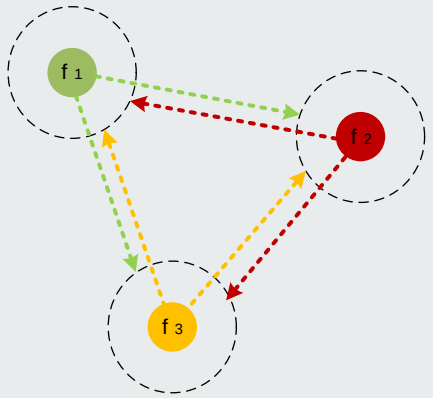
VPP setup

GUROBI OPTIMIZATION

MATLAB

JADE Hosting Computer/ ICCS lab

Distributed optimization



User Interface

VPP MAS implementation framework

JADE | TCP SOCKETS

JAVA

OS

Hardware PV inverter

Hardware Loads

RTDS-Simulated LV Grid