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BUCHAREST 2018 SYMPOSIUM ON MICROGRIDS

PANEL Session: Emerging Microgrid Technologies

Microgrid Applications Using RTDS

RTDS Technologies

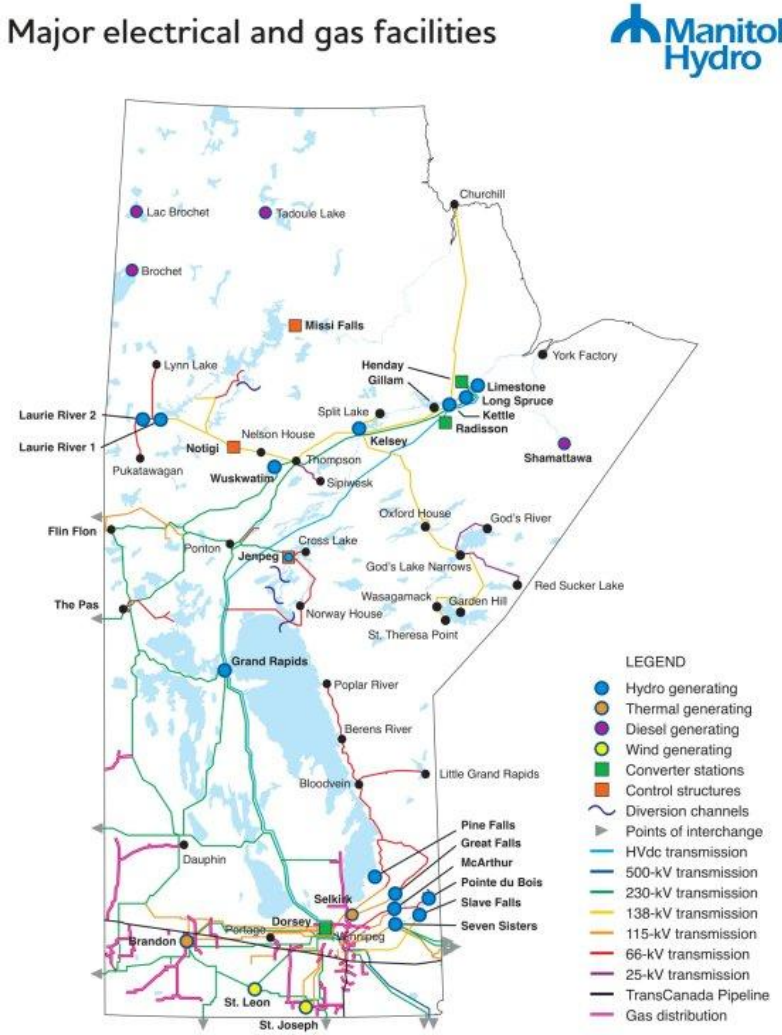
Presentation Outline

- What is a Microgrid?
- Microgrid Applications using RTDS
  - EMT Modelling
  - Available Models
  - CHIL
  - PHIL
- Questions

What is a Microgrid?

Historically, the underlying structure of power systems have been,

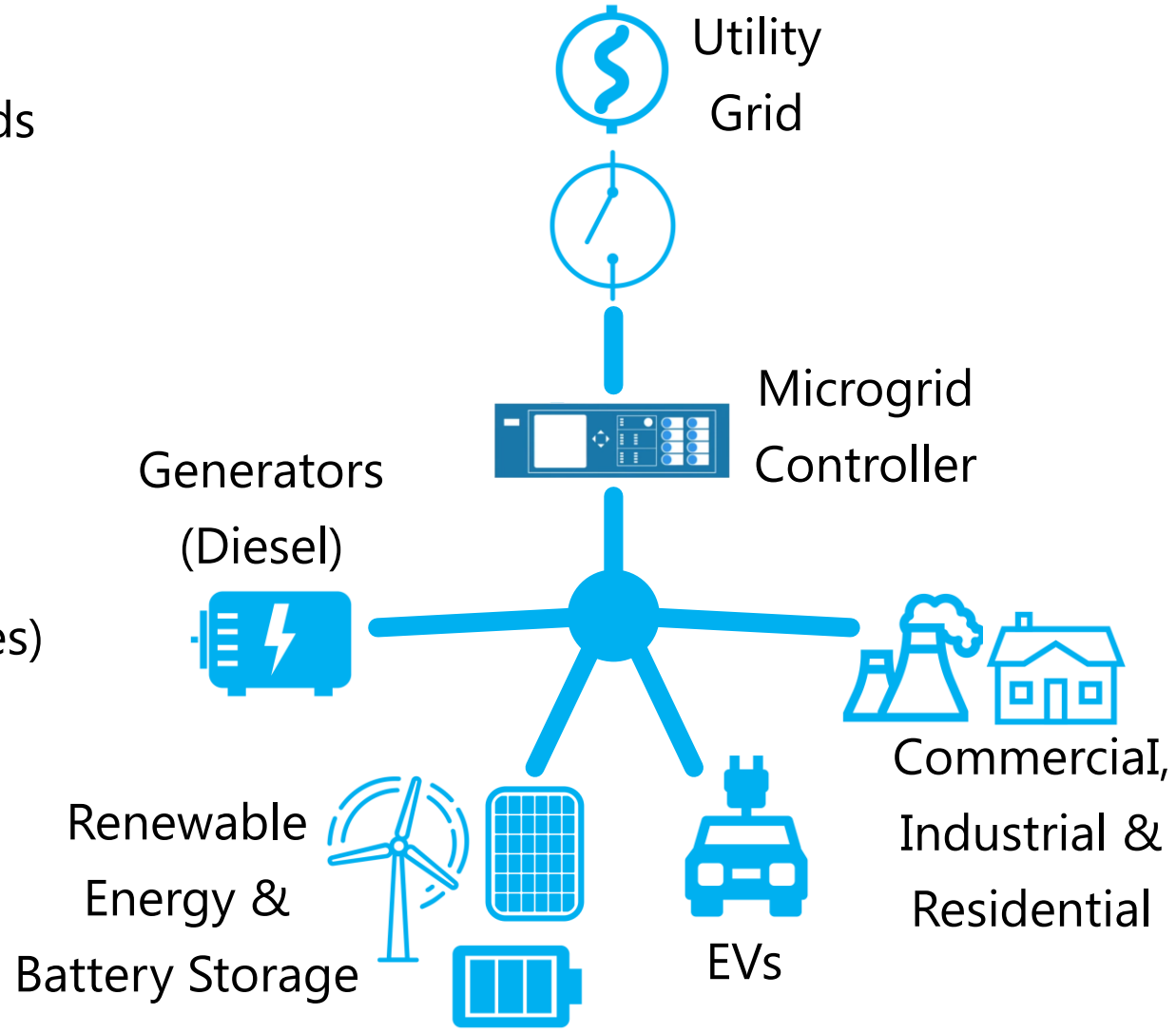
- Centralized (Both generation & load)
- Large generating facilities located close to resources and often far from populated load centers
- Bulk power is transmitted to consumers via Transmission and Distribution (T&D) networks (Unidirectional)
- Developed when the costs of transporting fuel & integrating generating technologies into populated areas far exceeded the cost of developing T&D facilities



What is a Microgrid?

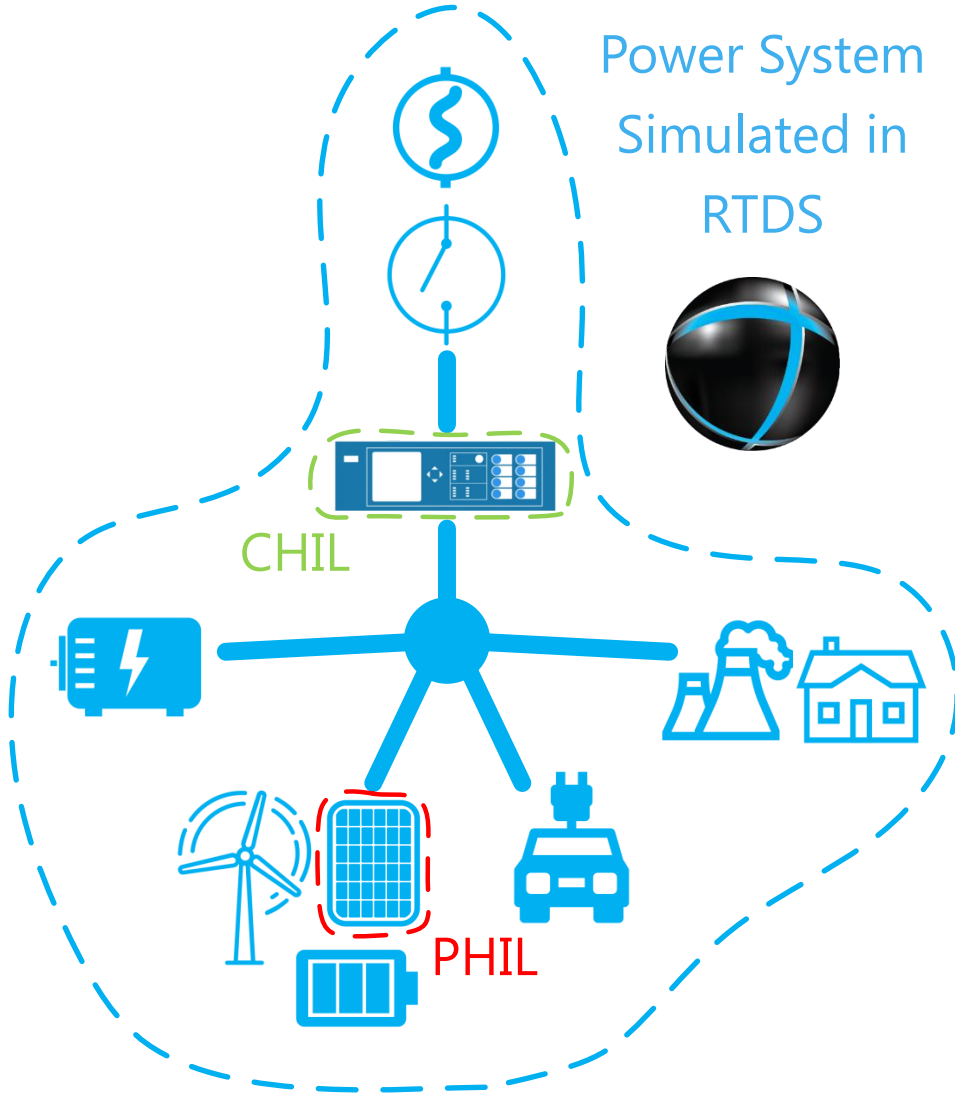
Power systems are transforming, and Microgrids are introducing a more decentralized or distributed approach.

- Localized, self contained network containing both generation and load
- Decentralized or distributed generation resources (Renewable Energy based resources)
- Ability to island or disconnect from the main grid and operate



Microgrid Applications using RTDS

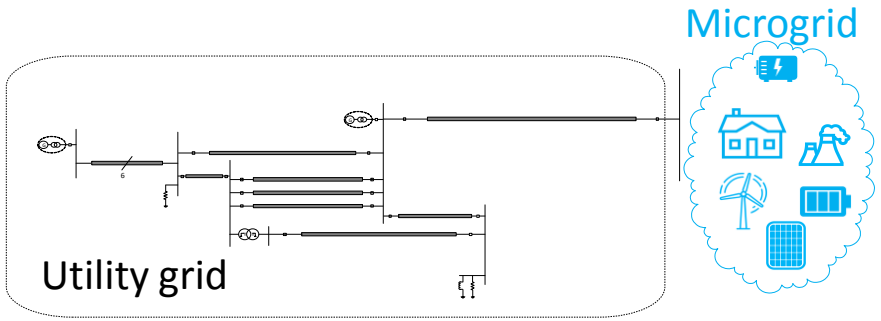
1. Utility grid and Microgrid can be modeled and simulated with the RTDS
2. Various modelling capabilities for renewable energy resources with varying levels of detail and hardware requirements
3. Ability to preform Control Hardware In the Loop (CHIL) testing for Microgrid Controllers
4. Ability to preform Power Hardware In the Loop (PHIL) testing on physical power devices such as inverters, electric vehicles, batteries etc.

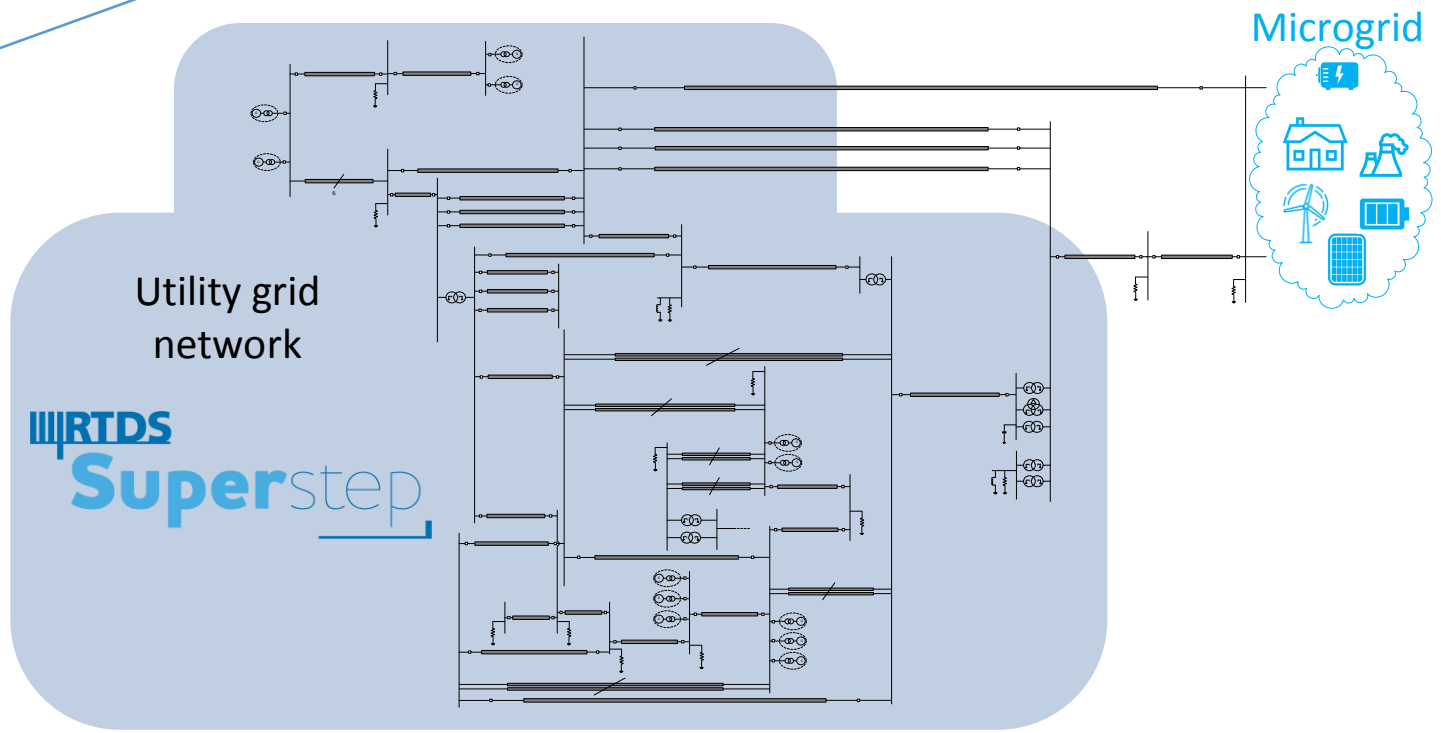


Microgrid Applications using RTDS

1. Utility grid and Microgrid can be modeled and simulated with the RTDS

- Details of the utility grid can be modelled as opposed to using a simplified equivalent.
- If required, the superstep functionality can be used to accommodate a larger, more detailed network for the grid.

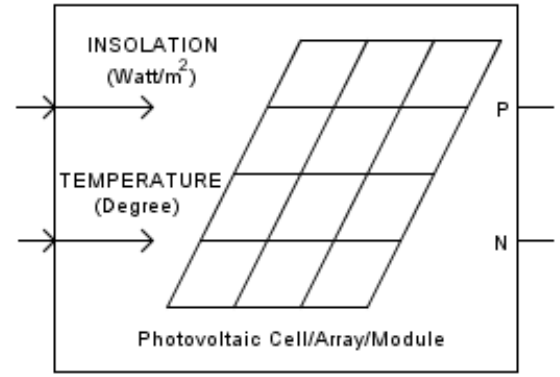


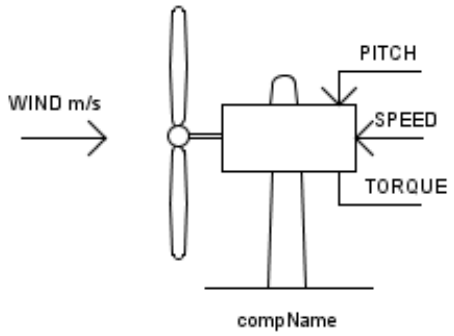


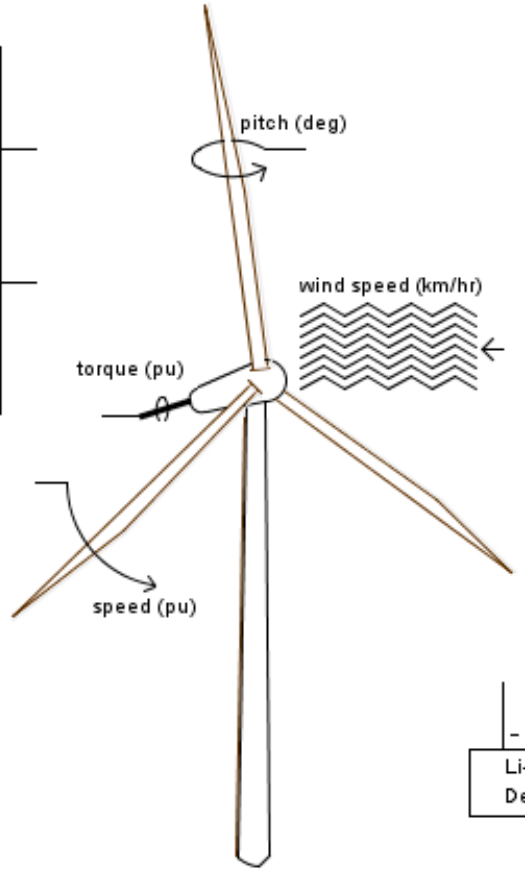
Microgrid Applications using RTDS

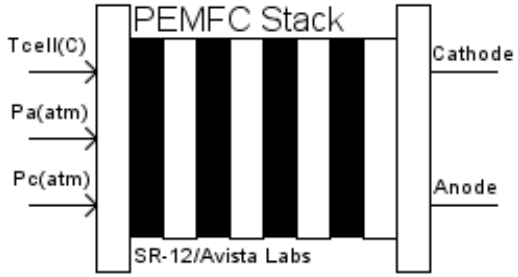
2. Various modelling capabilities for renewable energy resources with varying levels of details and hardware requirements

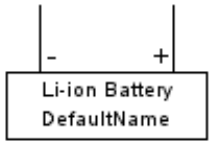
- Renewable Energy Models
  - Wind
  - PV
- Energy Storage Models
  - Batteries
  - Fuel Cells







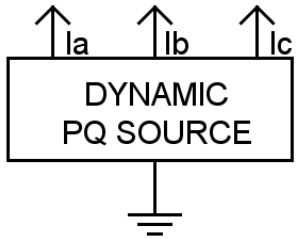


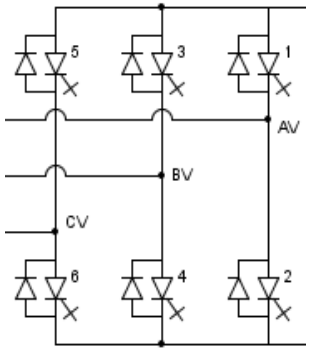


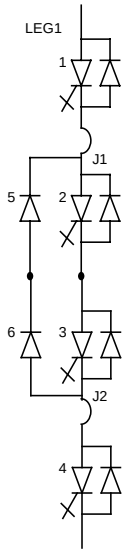
Microgrid Applications using RTDS

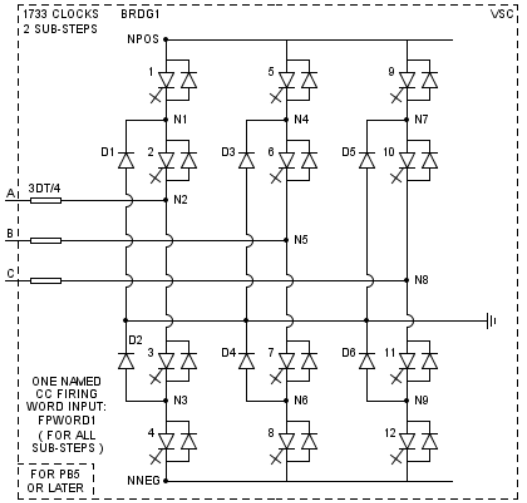
2. Various modelling capabilities for renewable energy resources with varying levels of detail and hardware requirements

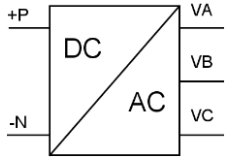
- Power Electronic Converters
  - Switching models
    - Only available in small dt environment
  - Average models
    - Available main dt & distribution modes
- Dynamic PQ Source

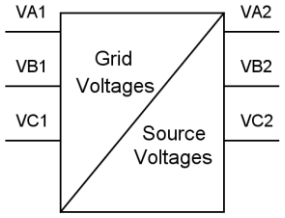


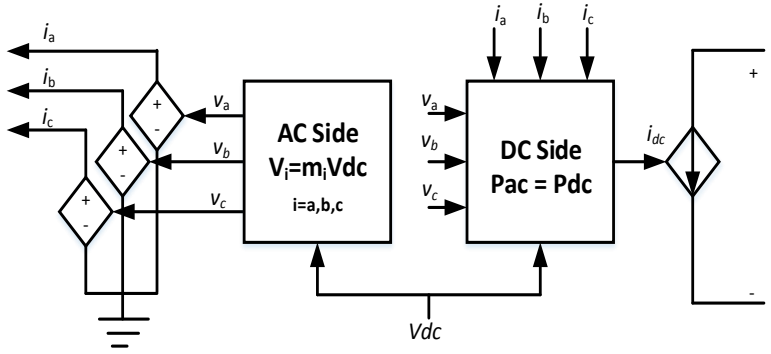








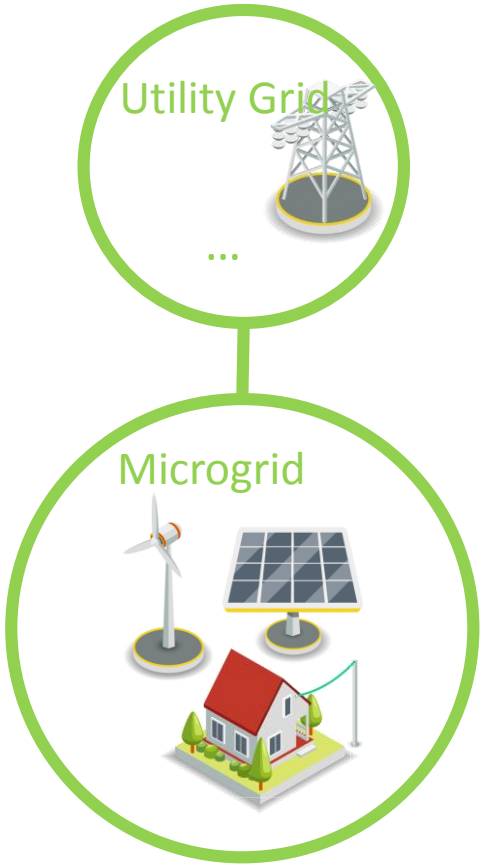


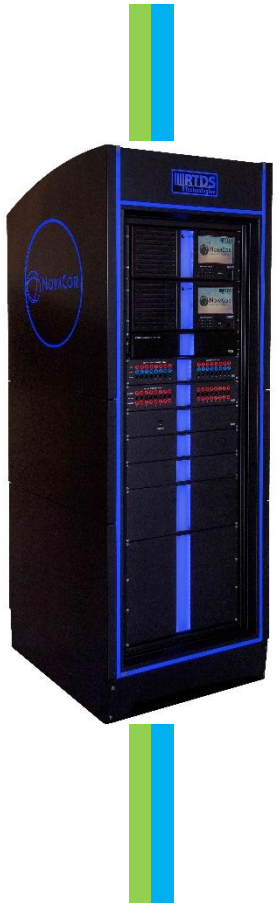


Microgrid Applications using RTDS

3. Ability to preform Control Hardware In the Loop (CHIL) testing for Microgrid Controllers

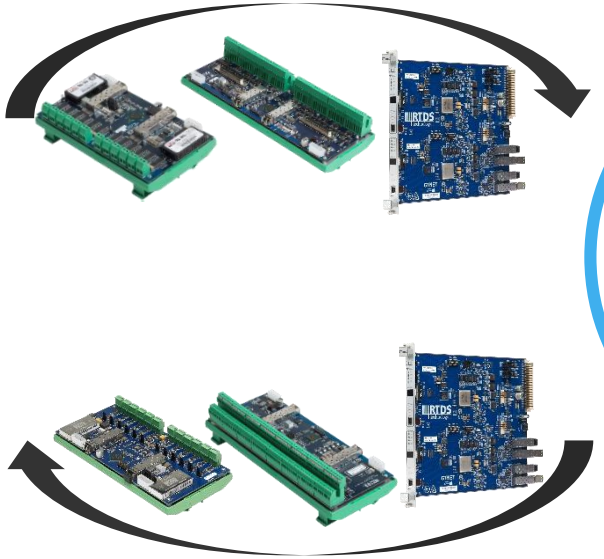
Simulated with the RTDS Simulator





Physical Hardware

- Analogue/digital output
- IEC 61850 SV/GSE, DNP3/104, MODBUS, TCP/UDP



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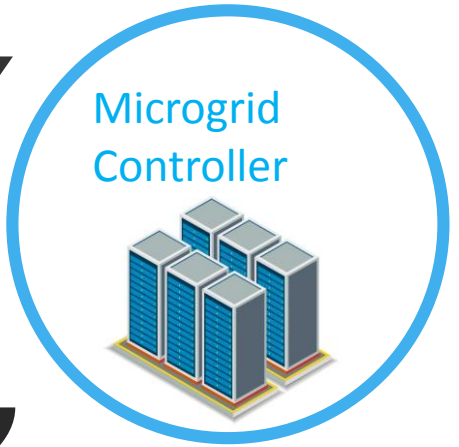

RTDS Technologies

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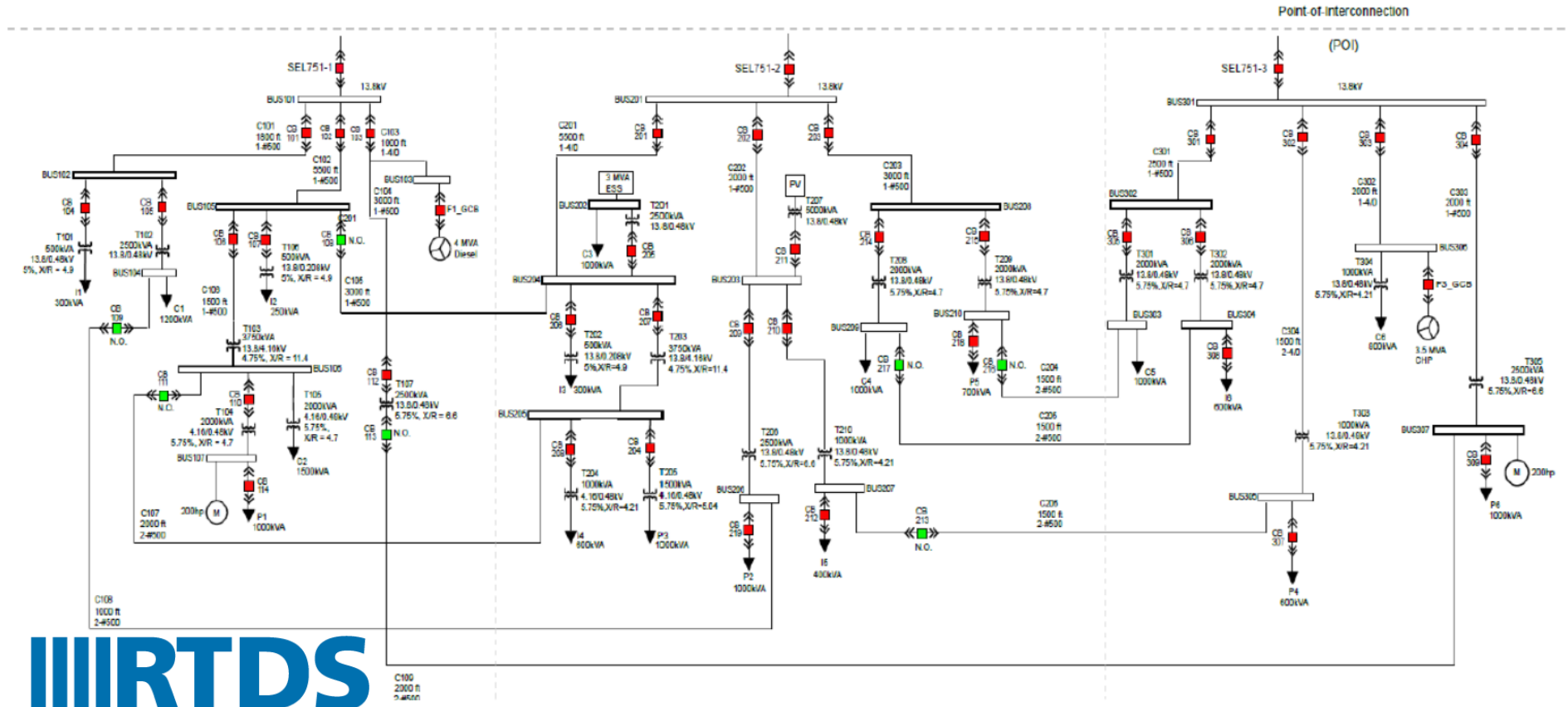
3. Ability to preform Control Hardware In the Loop (CHIL) testing for Microgrid Controllers

Example: Banshee Microgrid, Microgrid and DER Controller Symposium, MIT, February 2017



- Industrial facility with 3 utility radial feeders
- 47 Circuit breakers
- Load range 5-14 MW
- 18 Aggregated loads
- 4 MVA Diesel Gen.
- 3.5 MVA CHP
- 3 MW PV
- 2.5 MW BESS

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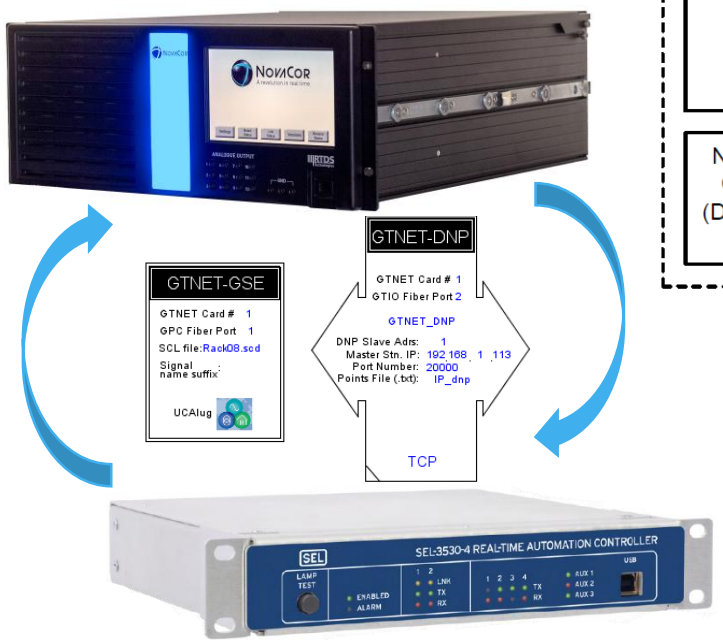
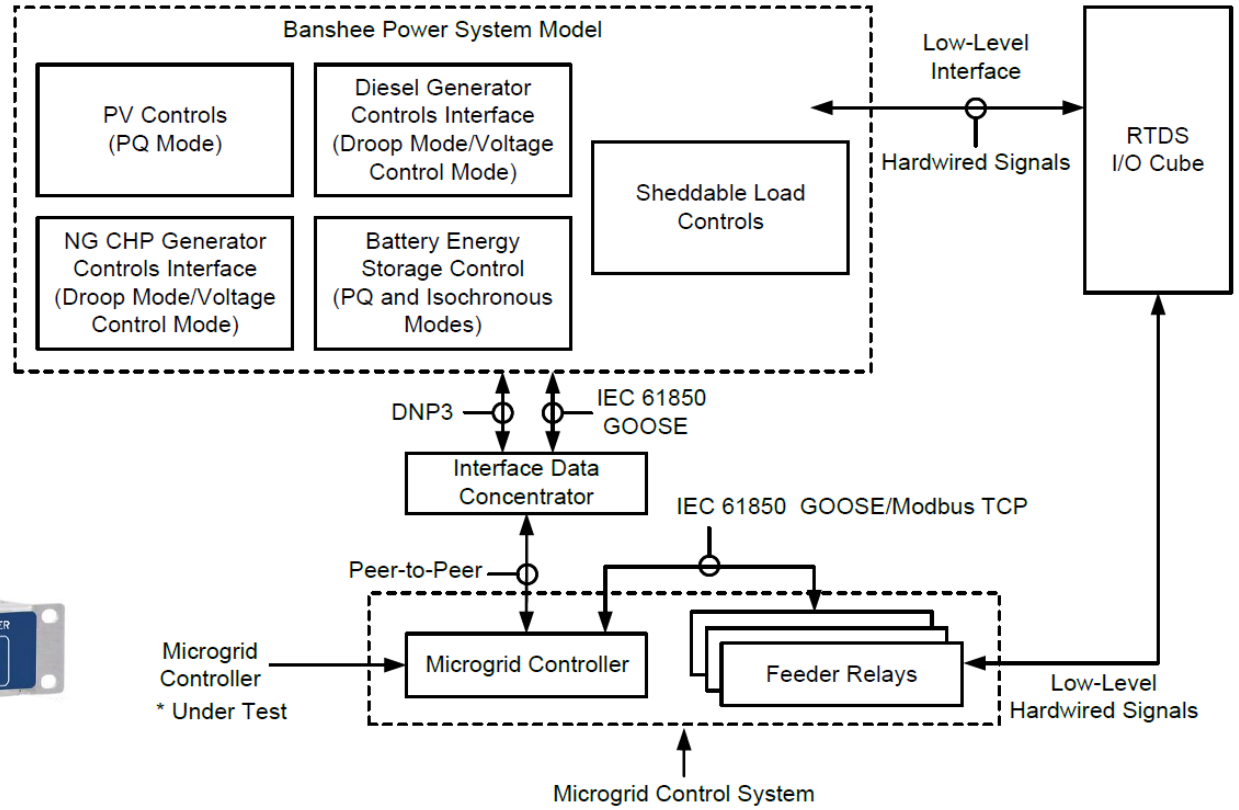




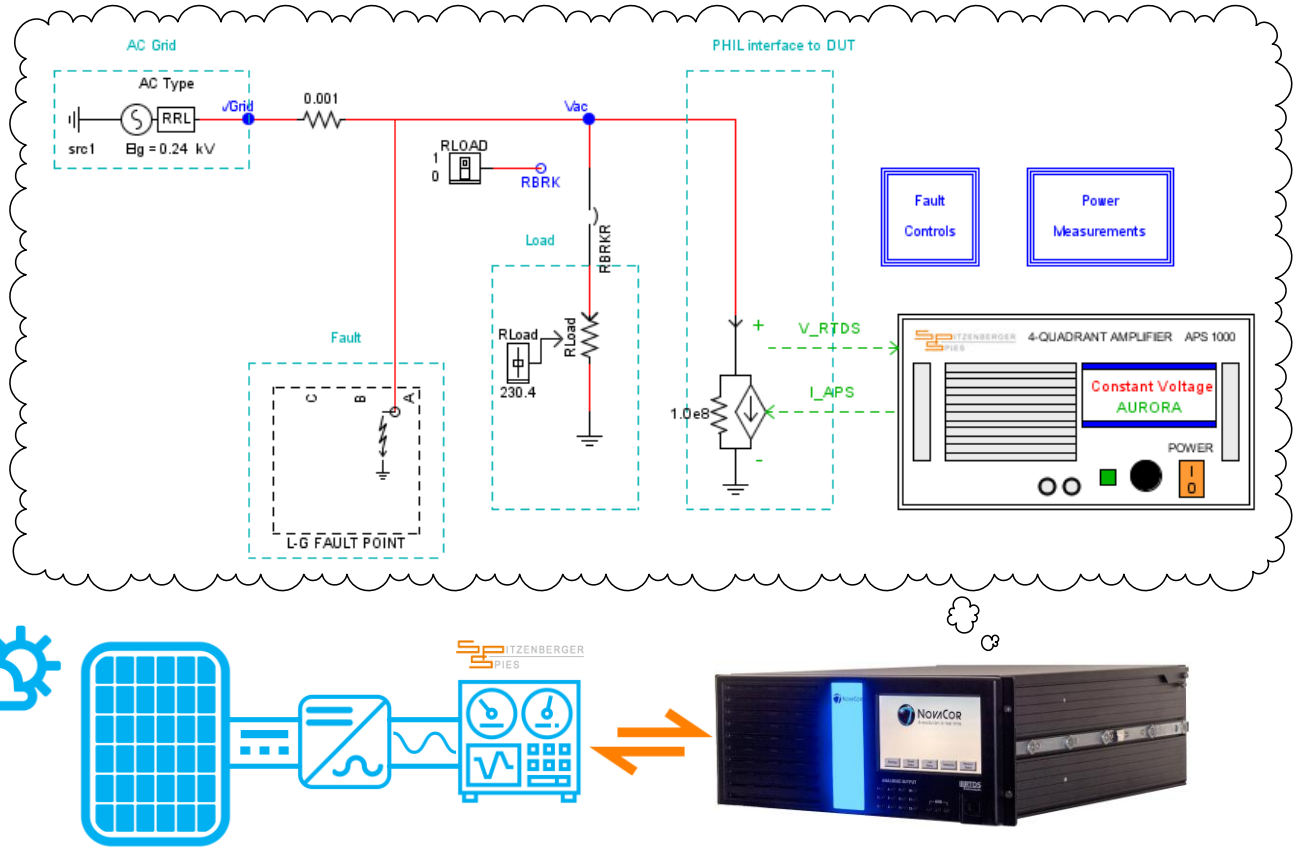
- Engineers from SEL modelled the entire Banshee system in the RTDS (1 NovaCor Chassis, with 3 cores) to run with a time-step less than 50 µs.
- Interface between RTDS and Microgrid Controler (SEL RTAC) using DNP3 & IEC 61850 GOOSE protocols.

Microgrid Applications using RTDS

4. Ability to preform Power Hardware In the Loop (PHIL) testing on physical power devices such as inverters, electric vehicles, batteries etc.

Example: PHIL with PV Panel & Microinverter

- 255W PV Panel
- 225 W Microinverter
- Aurora interface SPS Amplifier
- Characterize behavior of renewables and their inverters (black box)



Questions?