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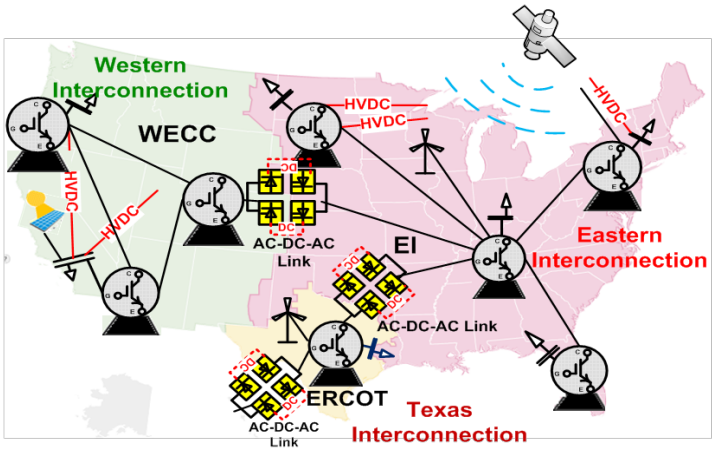
RESEARCH

Hardware Test-bed

Overview

Transmission network emulator, also called Hardware Test-Bed (HTB), is conceptualized to emulate the large scale power system by interconnected converters which emulate power generators and loads. With modular and reconfigurable converters, the HTB can have flexible network and perform various scenario emulations. The HTB will allow testing, integration and demonstration of various key technologies on monitoring, control, actuation, and visualization. With HTB, it is also convenient to test different system architectures, such as HVDC vs. HVAC by reconfiguring the system structure. The impact of renewable energy sources, responsive loads, and energy storage to the power grid can also be evaluated.



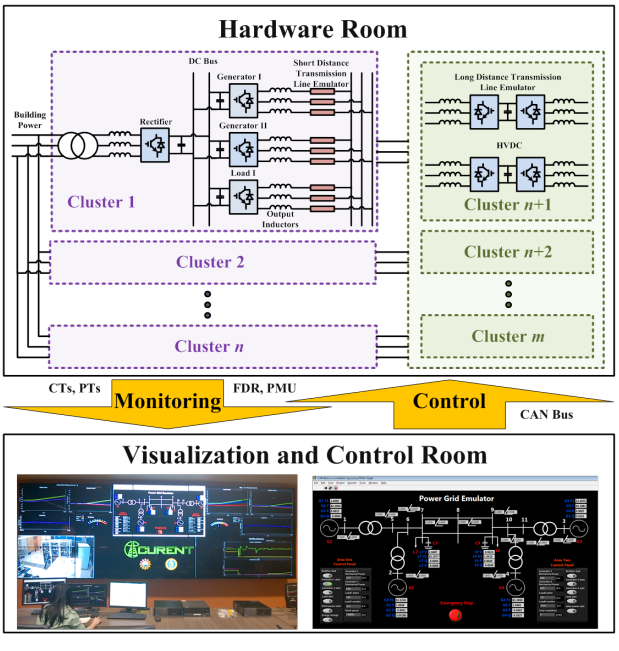
HTB Advantages

- Broad time scales in one system - microseconds for power electronics to miliseconds and seconds for power system event.
- Integrate real-time communication, protection, control, and power (and cyber security).
- Multiple power electronic converters (for wind and solar and energy storage) with separate controls.
- Capable of testing actual communication and measurements.
- Capable of performing prolonged real-time experiments and providing detailed system information simultaneously.
- Less dependency on numerical calculation while allowing more flexibility of the whole system.

HTB Structure

A regenerative topology is adopted: converters are connected at both the AC and DC side with a rectifier at DC side. Because the power flows back and forth between AC and DC side, the total power consumed in steady state is only the converter loss.

LabVIEW is used to emulate control centers in power systems.



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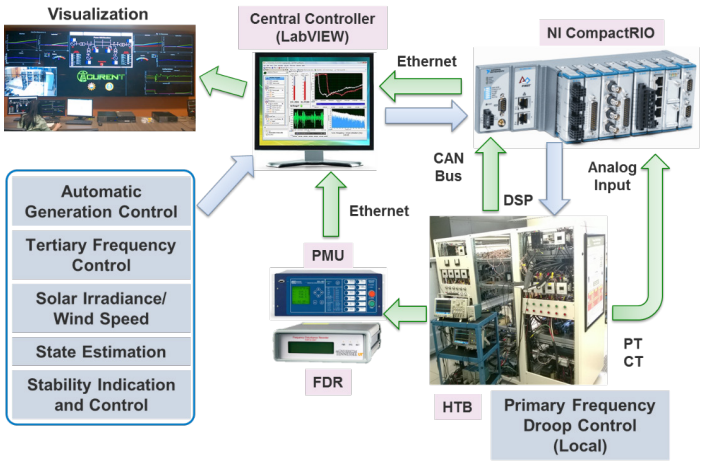
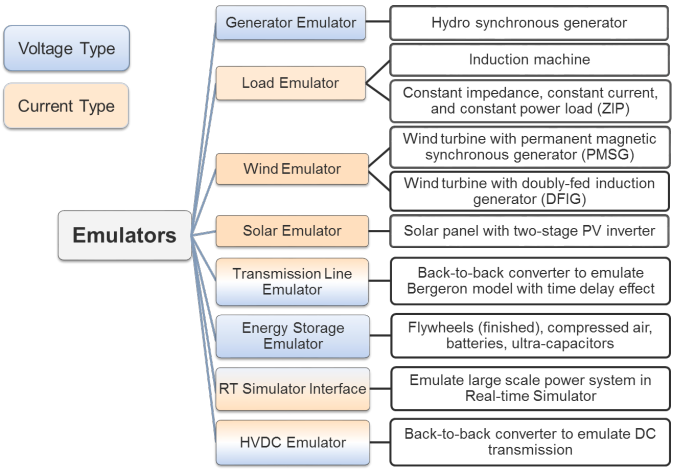
It gathers data from monitoring devices such as a power measurement unit (PMU) or frequency disturbance recorder (FDR), and sends supervisory control commands, such as power dispatch, wind speed, and irradiance level to emulators. With NI CompactRIO, the HTB can

be controlled remotely by LabVIEW from the visualization and control room. Time delay effects in communication can also be emulated to make the system more realistic.

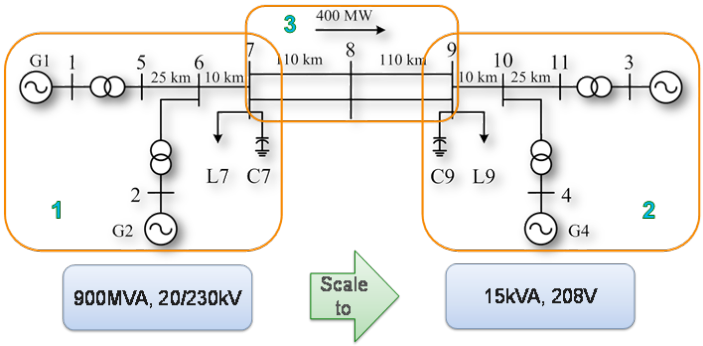


Power System Component Emulators

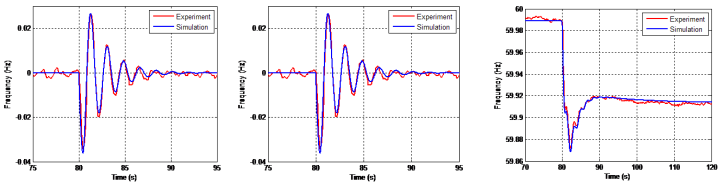


Example Scenarios for Emulation

Two Area System:

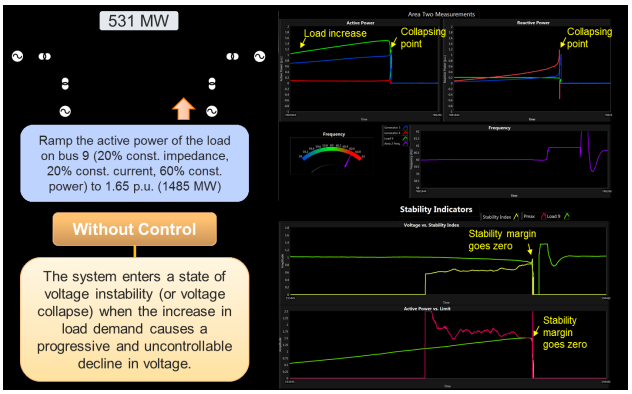


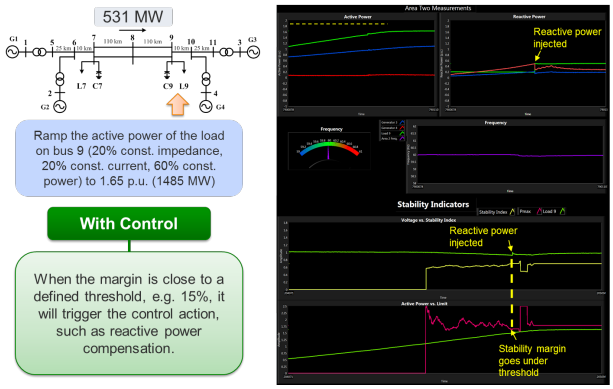
Verification through comparison between experiment and simulation (Load 7 disturbance):



a) Current output of each emulator
b) Inter-area mode
c) GI frequency response duing disturbance

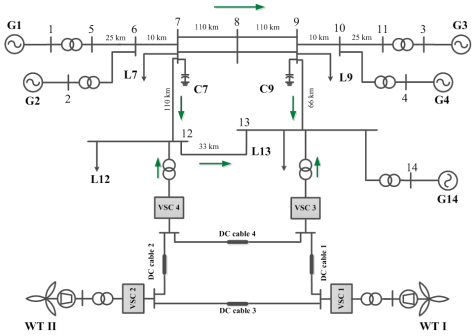
Voltage Collapse Scenario:





Overview

This system is based on the reduced model of the NPCC testbed. A remote load center including including L12 and L13 is fed by a local generator, two inter-connected systems, and offshore wind through multi-terminal HVDC (MTDC). This system will allow testing and verification of power system control algorithms considering renewable energy sources and the investigation of the impact from the MTDC system to the power grid.



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