RTDS Technologies

APPLICATIONS

Simulation and closed-loop testing of Wide Area Measurement, Protection, and Control

As the power network becomes more complex, involving more sophisticated protection and control devices that use high level communication protocols, simulation becomes an increasingly critical aspect of the design and operation of the network. Today's complex and dynamic grid demands the study of not only isolated areas of the network, but of the network as a whole. Phasor Measurement Units (PMUs), an increasingly prevalent technology in the modern grid, can be deployed at various locations in the power network to provide real time monitoring of the magnitude, phase, and frequency of system voltages and currents. The use of PMUs has given rise to Wide Area Measurement, Protection, and Control (WAMPAC) schemes, which have the capacity to improve grid reliability and dynamic security.

The RTDS Simulator is used worldwide for WAMPAC-related projects

Southern California Edison: This utility serves over 15 million customers on the west coast of the United States operates a total of 34 RTDS Simulator racks. WAMPAC-related projects involving the Simulator include the analysis and visualization of simulated synchrophasor data, the output of C37.118-compliant synchrophasor data and subsequent testing of phasor data concentrators (PDCs), and the development and testing of a large-scale Centralized Remedial Action Scheme (C-RAS).

Denmark Technical University: DTU's SOSPO (Secure Operation of Sustainable Power Systems) project investigates the real time assessment of power system security and stability. The RTDS Simulator is used to simulate an equivalent Nordic power network, and over 170 PMU data streams are sent from the simulation to external equipment.

Pacific Gas and Electric: This utility's state of the art Synchrophasor Proof-of-Concept facility in California features a 6 rack RTDS Simulator along with PMUs from many different manufacturers, substation-hardened PDCs, and visualization tools. The Simulator provides real-time network data to the testbed equipment to provide a closed-loop test environment, interoperability studies, and application validation.

Learn more about these and other WAMPAC projects involving the RTDS Simulator at **www.rtds.com/applications/pmu-studies.**

PMU Test Facility

The RTDS Simulator's PMU Test Facility is designed for testing the performance of physical PMUs. The IEEE Conformance Assessment Program has defined test procedures and performance limits that must be met before a PMU is compliant to the IEEE C37.118 standard. The PMU Test Utility is designed to run these test procedures.

Using the PMU Test Utility, the user can set the various parameter sliders that are embedded in the Simulator's PMU waveform control component. The resultant waveforms are then sent to an analogue output card and appropriately scaled for connection to amplifiers or low level direct connections to the PMU under test. The slider values are also used by the Test Utility to calculate the theoretical phasor values for each test.

The PMU Test Utility then gathers the measurements made by the PMU using the GTNETx2 card. The measured phasor, frequency, and ROCOF values are then compared to the theoretical values, and calculations such as frequency error, ROCOF error, and total vector error (TVE) are made.

GTNETx2 Network Interface Card

The Giga-Transceiver Network Communication Card, or GTNETx2, provides a real time communication link to and from the simulator via Ethernet. Different firmware versions are used with the GTNETx2 depending on the application. Each GTNETx2 card has two modules, meaning the card can operate two network protocols simultaneously. Each module has one Ethernet port, which may be equipped for one of three connection options: 100/1000 Copper, 100BASE-FX, or 1000BASE-SX.

IEEE C37.118-compliant synchrophasor data streaming

The PMU firmware option for the GTNETx2 provides synchrophasor output data streams according to the IEEE C37.118 standard. Two PMU streaming options are available for GTNET-PMU.

Using the first option, a single GTNET-PMU firmware can represent and provide output for up to eight (8) PMUs with symmetrical component information related to 3-phase sets of voltage and current using UDP or TCP connections. The reporting rate of each PMU can be set individually between 1 and 60 frames per second. Using this option, reporting rates as high as 240 frames per second are supported.

Using the second option, a single GTNET-PMU firmware can represent and provide output for up to twenty four (24) PMUs containing only positive sequence data. Frame rates up to the system frequency (50/60 Hz) are supported.

Both P and M class models (defined in Annex C of the IEEE C37.118 standard) for synchrophasor data output are available. CBuilder source code is provided for both the P and M class reference models should the user wish to try implementing their own algorithms. Note that M class reporting rates are limited to 10 frames per second.

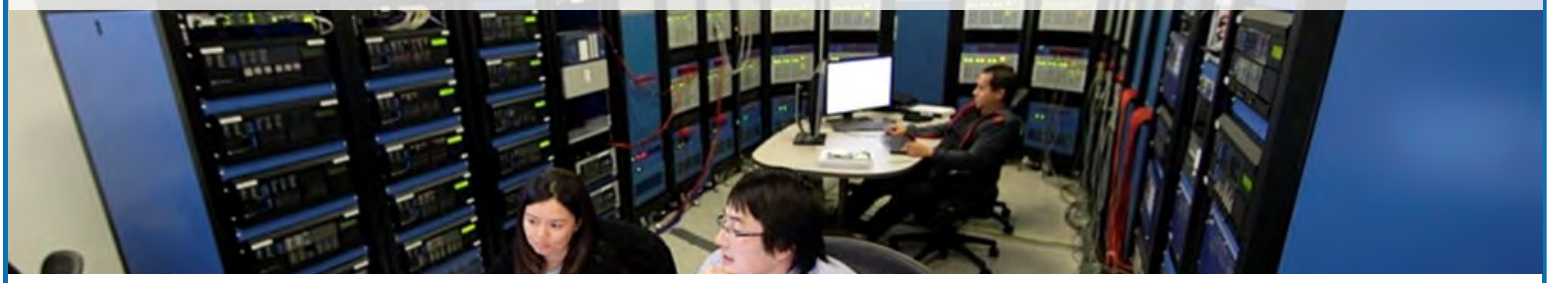
The GTNET-PMU component output is synchronized to an external 1PPS, IRIG-B or IEEE 1588 signal via the GTSYNC card.

IEC 61850 and SCADA standard-compliant data streaming

The GTNETx2 card also has firmware options for streaming IEC 61850-compliant data in and out of the RTDS Simulator. The SV and GSE firmware options support the streaming of IEC 61850-9-2 Sampled Values and GOOSE Messages, respectively, in and out of the real time environment.

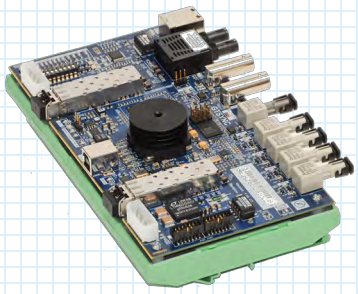
The DNP and 104 firmware options support the streaming of DNP3 and IEC 60870-5-104 compliant data in and out of the RTDS Simulator. The GTNETx2 acts as a SCADA slave device communicating with an external master.

The Centralized Remedial Action Scheme (C-RAS) project at Southern California Edison involves over 55 GTNET/GTNETx2 cards.



GTSYNC Synchronization Card

The GTSYNC is used to synchronize the simulation time step to an external time reference (e.g. GPS clock). The GTSYNC is capable of using 1 Pulse Per Second (1PPS), IEEE 1588 PTP, or IRIG -B unmodulated signals as the synchronization source. It supports 1PPS over BNC coax or ST type fiber connectors, IEEE 1588 over RJ45 or fiber, and IRIG-B over a BNC coax connection. The GTSYNC can also act as its own (internal) synchronization source in the absence of these external sources. Regardless of whether the synchronization source is internal or external, and regardless of the external signal type, the GTSYNC can provide 1PPS or IRIG-B type output.



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