

# SIMULATION AND CLOSED-LOOP TESTING WITH IEC 61850

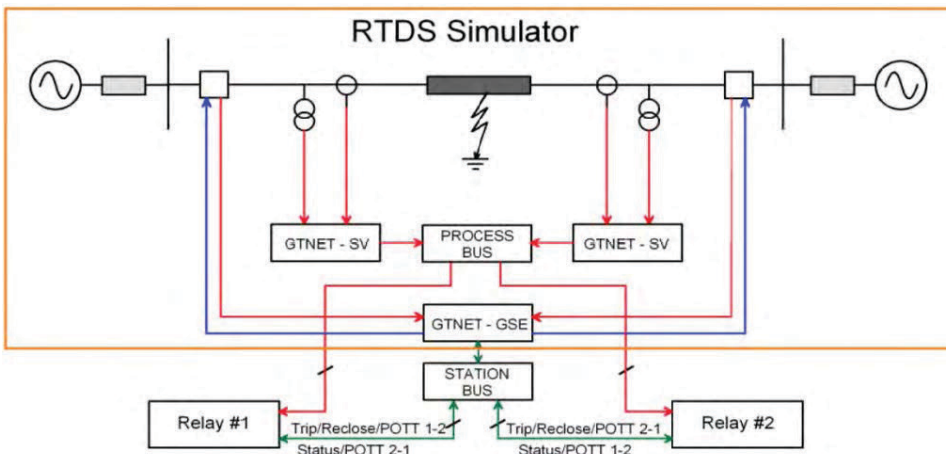
The RTDS® Simulator offers the most advanced and effective means available for testing protection systems. Since the simulation runs in real time, the physical protection equipment can be connected in closed-loop with the power system model.

The RTDS Simulator features hardware and software facilities that allow the user to interface the real time simulation with IEC 61850-compliant protection equipment. The closed-loop interaction of the protection system with the network model provides insight on both the performance of the relay scheme as well as its effect on the power system.



## CLOSED-LOOP INTERFACING WITH IEC 61850-COMPLIANT DEVICES

A model of the power system is implemented on the RTDS Simulator that includes the high voltage components (e.g. lines, breakers, instrument transformers, power transformers, generators, etc.), plus the required protection and control functions not included in the equipment under test.



The RTDS Simulator's IEC 61850 communication capability is provided by the GTNETx2 card with the Sampled Values (GTNET-SV) and/or GOOSE (GTNET-GSE) firmwares installed, or by the GTFPGA Unit running the GTFPGA-SV firmware.

When testing IEC 61850-compliant devices, the secondary voltage and current signals can be provided to the protection equipment via a GTNETx2 card or GTFPGA Unit running the GTNET-SV protocol. The breaker commands can be imported into the simulation using the GTNET-GSE protocol.

## COMBINING PHYSICAL AND SIMULATED PROTECTION DEVICES

RSCAD includes predefined models for generator, differential, distance, and overcurrent relays. This allows the user to run protection system testing involving simulated protection devices, physical protection devices, or a combination of both.

## IEC 61850 INTEROPERABILITY

The GTNET-GSE and GTNET-SV options have been successfully tested with products from a number of different vendors. RTDS Technologies has also demonstrated closed-loop testing that included IEC 61850 GOOSE messaging and sampled values with multiple vendor products interoperating. RTDS Technologies has also participated in IEC 61850 interoperation events along with major protective relay manufacturers where the RTDS Simulator and GTNET card were an integral part of the testing.

## GTNETX2 NETWORK INTERFACING CARD: IEC 61850 CAPABILITIES

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.

### IEC 61850 GOOSE MESSAGING

The GTNET-GSE firmware option supports up to 4 TX/RX modules, which can be arranged to simulate 1-4 IEDs (i.e. 1 IED with 4 modules, 4 IEDs with 1 module each, etc.). Each module is capable of sending and receiving up to 64 points (or 32 points with associated quality bitmap). For each GSE firmware installed, GOOSE messages can be received from a total of 16 unique external IEDs. The GTNET GOOSE configuration is done via an SCD file. RSCAD contains a built in SCD editor that helps the user to easily and conveniently configure the publication and subscription of GOOSE messages.

IEC GOOSE fields such as the Test mode, Needs Commissioning, and individual Quality bitmaps can be dynamically changed and monitored for both transmit and receive messages during a simulation to allow many scenarios to be thoroughly tested and verified.

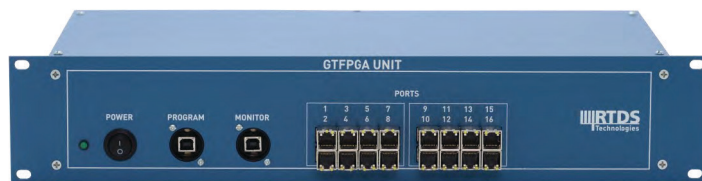
### IEC 61850-9-2 SAMPLED VALUES

The SV firmware option provides IEC 61850-9-2 sampled value messaging for power system voltages and currents. In order to timestamp the sampled values, the GTSYNC synchronization card must be used in conjunction with the GTNETx2.

The new GTNET\_SV9\_v5 component is able to transmit up to two data streams for up to 4 current and 4 voltage channels at a rate of 80 samples per cycle, or one stream at 256 samples per cycle. The new component can also be configured to receive sampled data from one Merging Unit (4 x V and 4 x I) at either 80 or 256 samples per cycle. There must be a GTSYNC card present to synchronize the simulation timestep to an external time source to make use of the GTNET\_SV9\_v5 component.

In non-9.2LE mode, based on IEC 61869-9 and the Chinese National Standard for SV merging units, one GTNET-SV can publish 1 data stream for up to 24 voltages or currents at a rate of 80 samples per cycle, with < 10  $\mu$ s jitter between samples.

### STREAMING IEC 61850 SAMPLED VALUES VIA GTFPGA UNIT



The GTFPGA-SV component provides IEC 61850-9-2LE and IEC 61869-9 Sampled Values (SV) communications using the GTFPGA Unit hardware. The use of dedicated FPGA-based hardware significantly increases the number of SV data streams that can be output from the RTDS Simulator.

The GTFPGA Unit supports connection to up to 16 external IEDs simultaneously, over both copper and fibre Ethernet. When using IEC 61850-9-2LE configuration, the GTFPGA Unit is able to simultaneously transmit up to 16 data streams for up to 4 current and 4 voltage channels, at a rate of 80 samples/cycle (1 ASDU) or 256 samples/cycle (8 ASDU).

When using IEC 61869-9 configuration, based on the Chinese National Standard for SV merging units, the GTFPGA is able to simultaneously transmit up to 16 data streams for up to 24 quantities, at a rate of 80 samples/cycle (1 ASDU), 96 samples/cycle (1 ASDU), or 4,800 Hz (2 ASDU). It can also stream 16 data streams for up to 9 quantities, at a rate of 256 samples/cycle (8 ASDU) or 14,400 Hz (6 ADSU).

