



REAL TIME SIMULATION:
DELIVERING IEC 61850
INTEROPERABLE TESTING TOOLS

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AGENDA

- Introduction
- Configurable 61850 Hardware
- Panel Q&A after presentations



INTRODUCTION

Creating an IEC 61850 Interoperable Test Tool

- Why do we need a configurable test tool?
- Can the real-time simulation data be bound to the 61850 data model?
- Can the real-time simulation 61850 data model be vendor agnostic?
- Can the 61850 data model keep up with the real-time simulation environment?
- Can multiple 61850 data models operate independently in a real-time simulation environment?
- Can the test tool support any edition of the standard?
- Can the test tool support Ratable-GOOSE?

CONFIGURABLE 61850 HARDWARE

User Configurable GOOSE and MMS

- Real-time simulator with an interface to the user's 61850 data model
- Need to support multiple IEDs with their own IP address
- Need a high performance database for the 61850 data model
- Need a method to bind the 61850 data model to the simulation environment
- Need for an ICT to manage the SCL file
- Need for additional support of state machine code not part of vendor's stack



CONFIGURABLE 61850 HARDWARE

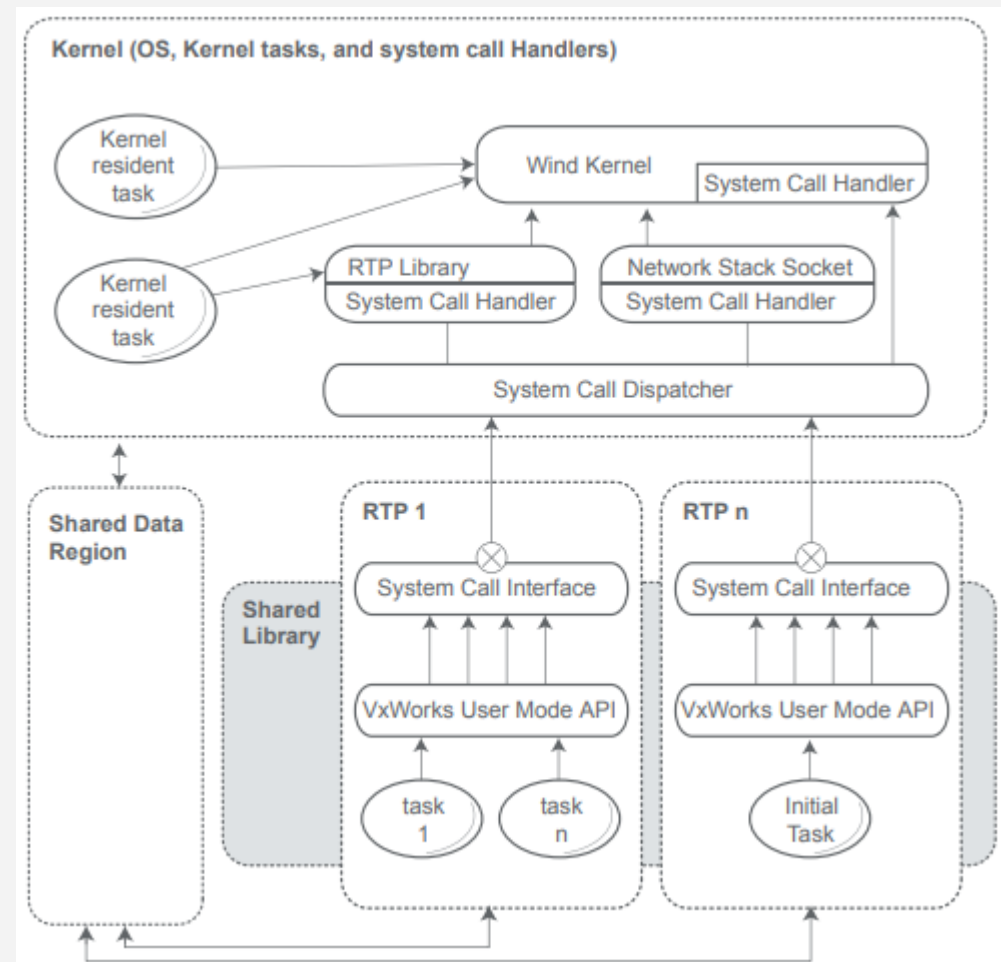
Interfacing a real-time simulator to a 61850 data model

- The firmware was re-engineered to consume the configuration in the SCL
- As long as the SCL file is valid the 61850 stack will auto-configure itself based on the content of the SCL
- Support for Edition 1.0, 2.0, 2.1
- Some changes were made to the 61850 stack to make it more event driven and improve real time performances (i.e. for Event reporting and GOOSE publishing)

CONFIGURABLE 61850 HARDWARE

Supporting Multiple IEDs with their own IP

- The hardware uses a RTOS (VxWorks) from Wind River
- IP alias support was added to the RTOS
- Supporting multiple IEDs instances with the stack required that their tasks be isolated while running in the RTOS
- To support isolation of tasks associated with each IED the real-time process (RTP) model needed to be integrated into the RTOS
- RTPs always load applications in their entirety (never non-deterministic)
- RTPs are not scheduled (the system remains deterministic)
- RTPs preserve the VxWorks architectural model (low latency design remains in tact)



CONFIGURABLE 61850 HARDWARE

A High Performance Database for the Input / Output

- A database is used to interface simulation data to the 61850 data model
- Database is comprised of a pool of memory in an FPGA. The data pool is a container that maps RTDS case variables to 61850 data attributes of an IED
- A proprietary solution was developed to exchange data from/to the simulator to/from the GTNET via the GT link (thus enabling the simulation data to be part of the data model)
- The data pool is kept synchronized with the GTNET during the simulation

CONFIGURABLE 61850 HARDWARE

Binding the Data Model to the Simulation Environment

- The hardware needs to be configured with a SCL file
- sAddr and intAddr attributes are used to bind the data model to the simulation data (no private sections are used)
- Additional information not available in the SCL like the re-transmit curve is stored in an additional XML file
- There is also an override for the physical Source MAC address and initial stNum

CONFIGURABLE 61850 HARDWARE

An ICT to Manage the SCL

A new ICT was designed to:

- Manage the data model
- Configure Subscriptions
- Configure Publications
- Re-transmit curve
- Data Binding (input and output)
- Datasets

The screenshot displays the RSCAD IEC 61850 IED Configuration Tool interface. The main window is titled "RSCAD IEC 61850 IED Configuration Tool" and features a menu bar with "File", "Project", and "Library".

The interface is divided into several panels:

- Left Panel:** A tree view under "Draft Components" showing a hierarchy: "GTNET_GTNET64booleans.dft conversi" > "[CMPNT] GTNET1" > "[IED] GTNET1" > "DataModel". Below this is a "DataModel" section with "Desc" and "Type" buttons.
- Center Panel:** A table titled "Binding Address Configuration" with columns: "DA Name", "Direction*", "IO Name", and "Bit Mapping". The table lists various DA names like "DO - Health", "DO - NamPlt", "DO - Ind1", and "LN - IN_GGIO2 [Inputs]" through "LN - IN_GGIO14 [Inputs]". The row for "ExtRef - GTNET2CTRL1/OUT_GGIO1.Ind1.stVal" is highlighted in blue, and a dropdown menu is open over the "Direction*" column, showing options "input" and "bit_mapped_input".
- Right Panel:** A "Component Properties" panel showing "Select Control Block" with a tree view: "COMPONENT (GTNET1)" > "IED (GTNET1)" > "GSEControl (Gcb01)" > "GSEControl (Gcb05)". Below this is a table with "Description" and "Value" columns, containing entries like "Initial message State Number" with value "1", "Needs Commissioning Draft variable" with value "COIED1ONC", and "Simulation flag Draft variable" with value "COIED1OGT".
- Bottom Panel:** A "Console" panel showing log output: "STATUS: Loading project 'C:\RTDS_USER\fileman\version5\CANADA\Deans\Devel\GINET_GSE\GSEv7\v6tov7\GINET-GINET\GINET_GTN ET64booleansconverted.ipf'...", "STATUS: successful.", and "IEED Publishers".

At the bottom right of the main window, there is a status bar indicating "GTNET I/O Capacity: 0 of 0 bytes".

CONFIGURABLE 61850 HARDWARE

Support State Machines/Logics not in Vendor Stack

The C code to support state machines and additional logics for certain LNs is executed on the RTDS processor and information is exchanged every time-step

- Support for LN LLN0
- Support for LN LPHD
- Support for LN LGOS
- Support for LN CSWI
- Support for LN XCBR
- Support for LN XSWI
- Support for LN CILO
- Support for LN RSYN

CONFIGURABLE 61850 HARDWARE

Conclusions

The real-time simulation environment can be designed and engineered in such way as to provide an interoperable user configurable test tool.

Creating and running multiple IEDs on a single piece of hardware required:

- Implementation of new features within the RTOS
- Design of a database based within a FPGA
- Using attributes of SCL for the data binding
- An additional XML file to extra information
- Support for state machines and additional logic



THANK YOU!



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