Transforming the world of energy using open standards

SISCO IEC 61850 Products Overview

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About SISCO

- Founded in 1983
- Standards:
  - » IEC 61850
  - » ICCP-TASE.2 (IEC 60870-6)
  - » CIM (IEC 61970/61968)
  - » COMTRADE (IEEE C37.111)

- Focus:
  - » Helping users extract value from open interoperable standards by providing solutions based on knowledge, experience and innovation.

SISCO Committed to Standards

- IEC Technical Committee 57 (TC57)
  - WG07/19 – IEC60870-6 TASE.2 (ICCP)
  - WG10 – IEC 61850 (power system automation communications)
  - WG13 – IEC 61970 for EMS (CIM modeling and model exchange)
  - WG14 – IEC 61968 for DMS (CIM modeling and messaging)
  - WG15 – IEC 62351 Communications Security
  - WG17 – IEC 61850-420 and 8-2 Distributed Energy Resources
  - WG19 – Interoperability and Harmonization with TC57
- IEEE
  - Power System Relaying Committee (PSRC)
  - CIM Task Force
- UCA International Users Group
  - Founding Member
  - CIM Users Group
  - IEC 61850 Users Group
- ISO
  - TC 184 - ISO 9506 (MMS)
- Smart Electric Power Association (SEPA)
  - Founding Member of SGIP 2.0
  - OpenFMB

SISCO Technology

- Communication Protocol Software and Tools for:
  - Control Center-Control Center and Control Center-Power Plant communications
    - Intercontrol Center Communications Protocol (ICCP) IEC 60870-6 TASE.2
  - Power System Automation Communications
    - IEC 61850
- Common Information Model
  - CIM based messaging for model-driven application integration
  - Adapter and tools to apply CIM to data and tag name management for operational systems.
- COMTRADE Utility for PI
  - Enterprise level power system disturbance file management system for PI
- Unified Analytic Platform
  - A high-speed analytic platform for processing real-time data streams such as GOOSE and IEC TR 61850-90-5 (Routable GOOSE) for wide area protection, measurement and control.
- Training, adapter/application development, consulting, and systems integration services to assist our customers in the exploiting benefits of model-driven integration based on these open international standards.

IEC 61850 Products

- AX-S4 61850: Complete IEC 61850 Interface for Windows Applications
  - IEC 61850 Client
  - IEC 61850 GOOSE publisher and subscriber
  - IEC 61850 Server
- GOOSE Blaster
  - » Testing tool to simulate GOOSE and R-GOOSE messaging
- R-GOOSE Gateway
  - » Transforms GOOSE ←→ R-GOOSE
- MMS-EASE Lite: Portable IEC 61850 Source code
  - » Commonly used for IEDs of many different types and functions
- Unified Analytic Platform (UAP)
  - » Real-time processing of high-speed field data for wide area protection and centralized remedial action systems (C-RAS)

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AX-S4 61850

ACCESS FOR...

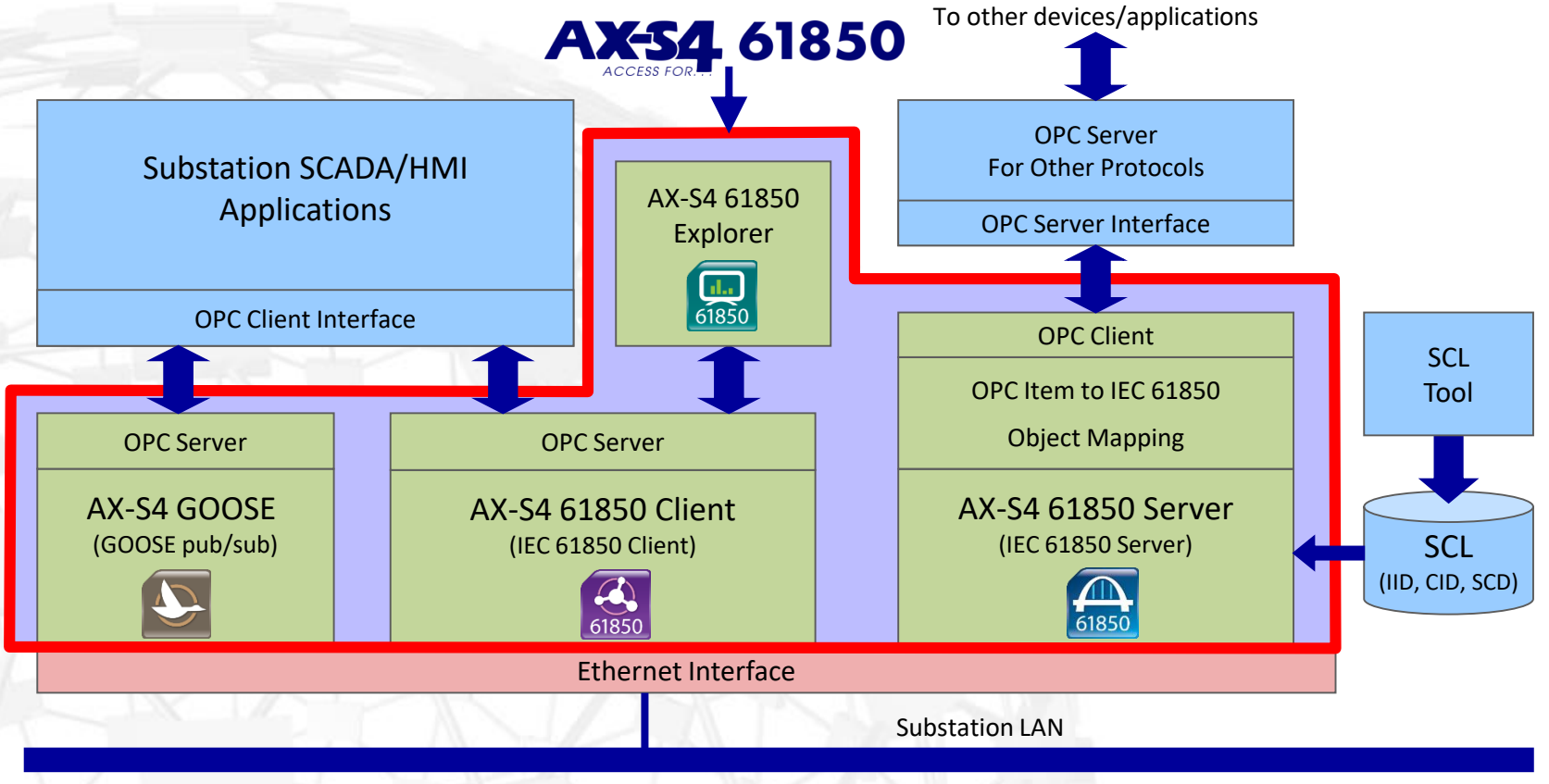
Features, Architecture, and Applications

AX-S4 61850 Description

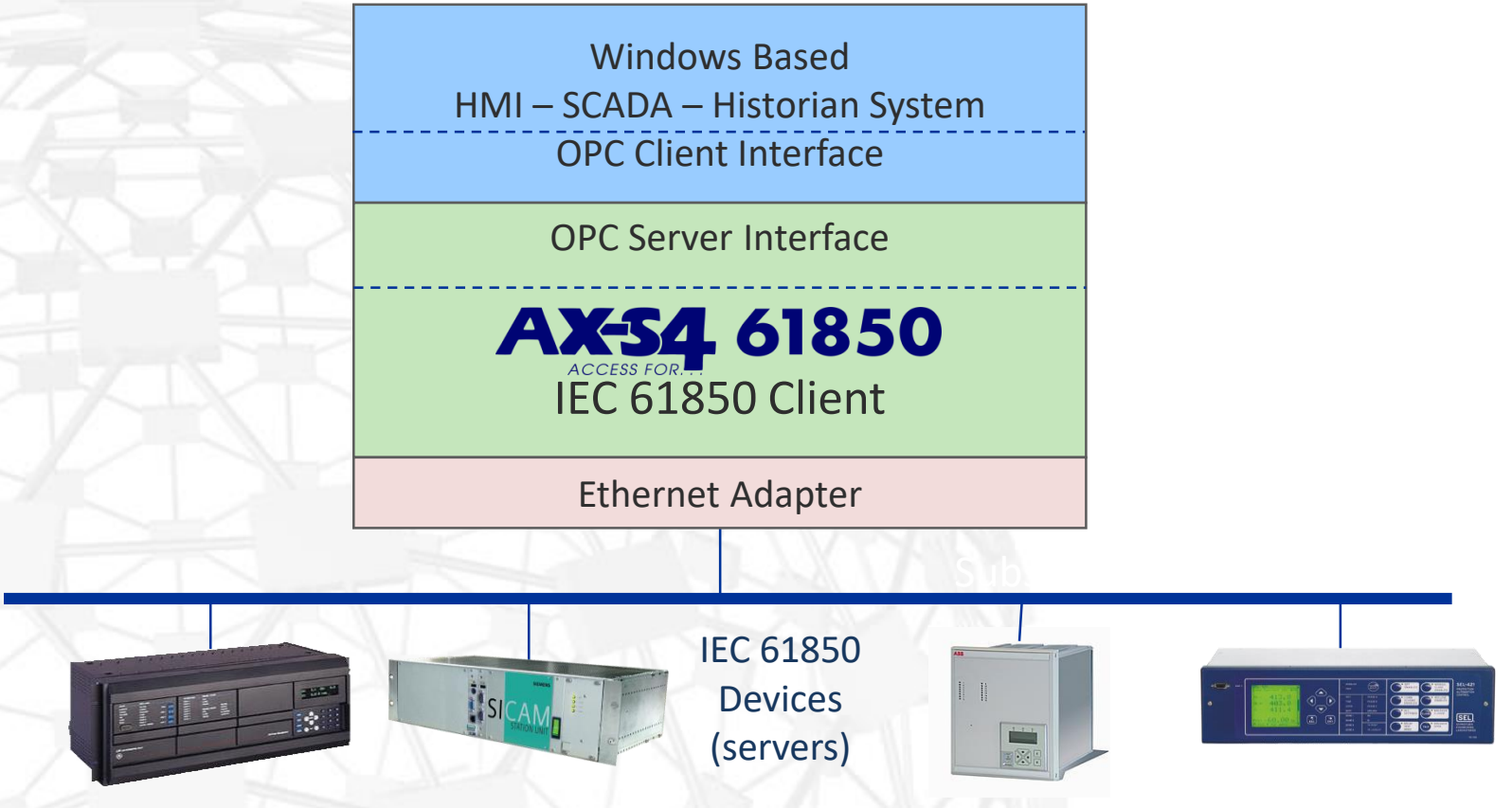
- Complete "*Access For IEC 61850*" interface for Windows applications
  - » IEC 61850 Client to access data in IEC 61850 devices
  - » IEC 61850 Server for gateways, concentrators, and proxies.
  - » IEC 61850 GOOSE publisher and subscriber

- Standardized interface to applications:
  - » OPC Data Access (DA) V3.0 (see http://www.opcfoundation.org)
  - » Backward Compatible to OPC DA V2.05

AX-S4 61850 Complete Architecture



AX-S4 61850 Basic Application



AX-S4 61850 Client Features

- IEC 61850 Ed.1 and Ed.2 Client functions supported (OPC Server):
  - Object discovery and automatic configuration of data using ACSI services
  - SCL (IEC 61850-6-1) import to configure client for remote devices
    - Can import individual devices via ICD, IID and CID Files
    - Can import an entire substations in a single operation via SCD files
  - Transparent and Automatic Handling of Buffered and Unbuffered Reporting
  - Read/Write of any IEC 61850 Object
  - Automated Controls (with Normal or Enhanced Security)
  - Logs
  - File Transfer client
  - OPC DA V3.0 Server
  - IEC 62351 secure communications supported:
    - TLS 1.2 for server level authentication and encryption
    - X.509 Digital certificates for strong application level authentication
- Includes interactive object explorer for device object visualization, debug, testing, configuration, and control

AX-S4 61850 Explorer – Interactive Access

ACCESS FOR...

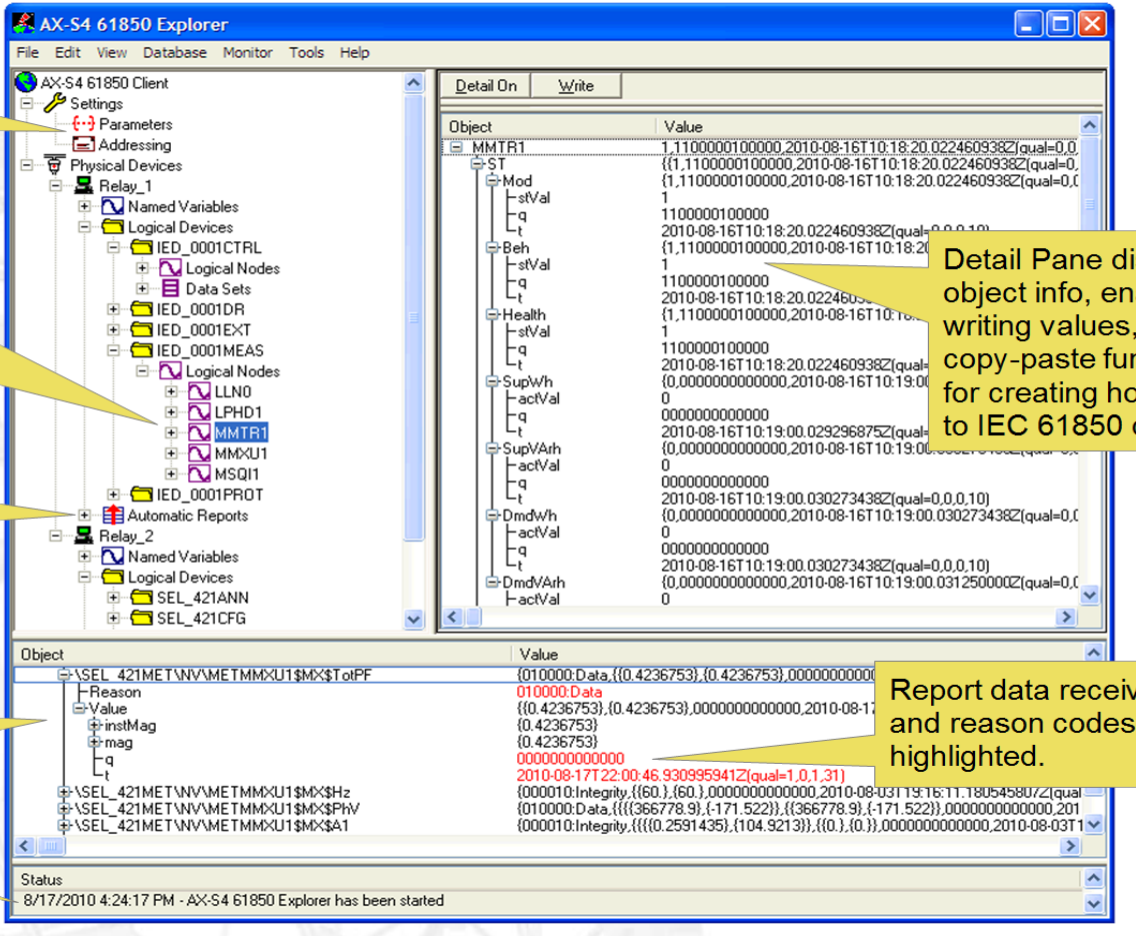
Configuration functions available via integrated explorer interface.

Object pane shows available devices. Click on the device to access or expand the data. Right-click to bring up supported functions.

Automatic reporting is configurable interactively or via XML file import.

Monitor pane displays reports and data from multiple devices

Status line displays activity messages.



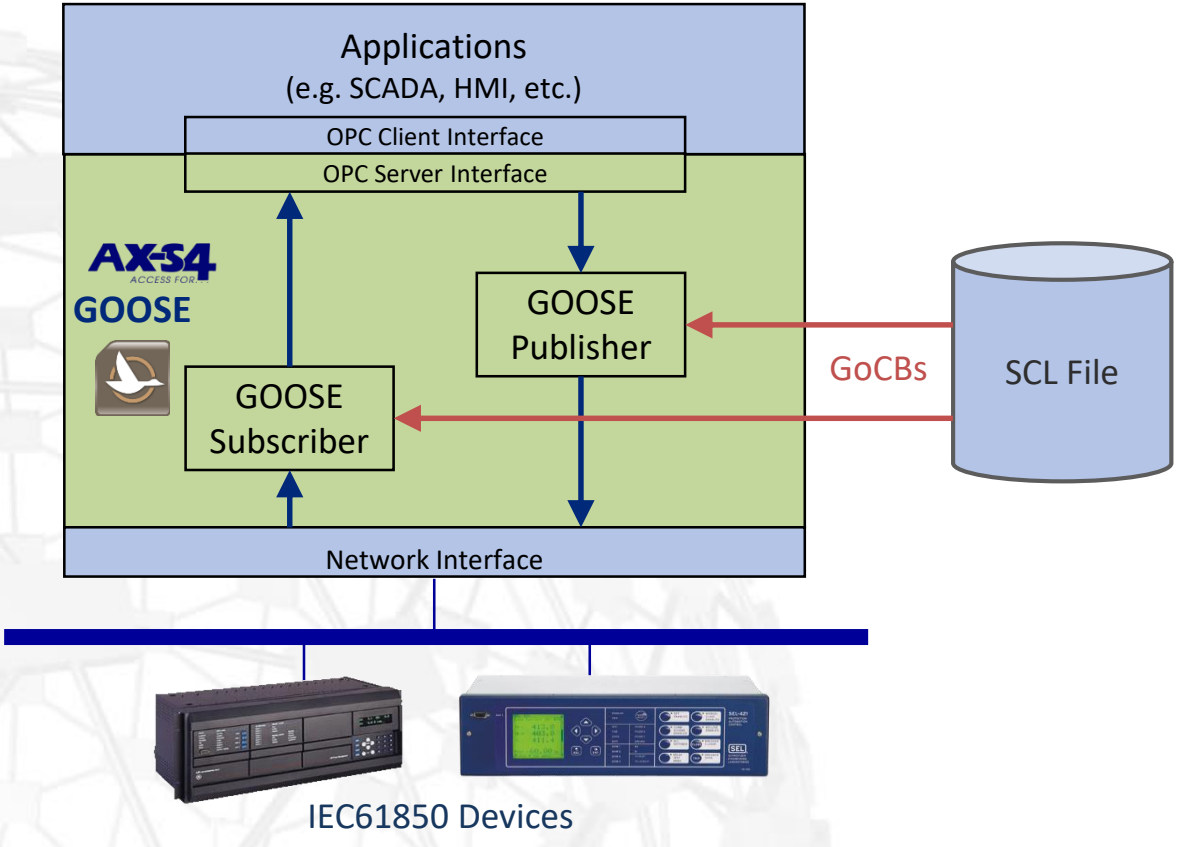
Detail Pane displays object info, enables writing values, and copy-paste function for creating hot-links to IEC 61850 data.

Report data received and reason codes are highlighted.

AX-S4 GOOSE Features

- IEC 61850 Publisher and Subscriber (OPC Server DA V3.0 interface):
  - Configuration of GOOSE control blocks via SCL (IEC 61850-6-1)
    - Can represent single or several IEDs and GoCBs from SCL file
  - Enable and disable GOOSE control blocks via OPC interactions
  - Configurable retransmission curves
  - Automated timestamp, quality, state, sequence number and time allowed to live processing
  - Writing changed data to AX-S4 GOOSE triggers outgoing GOOSE and increments state number
  - OPC items updated as GOOSE messages arrived
  - High performance architecture provides reliable processing
  - OPC DA V3.0 Server

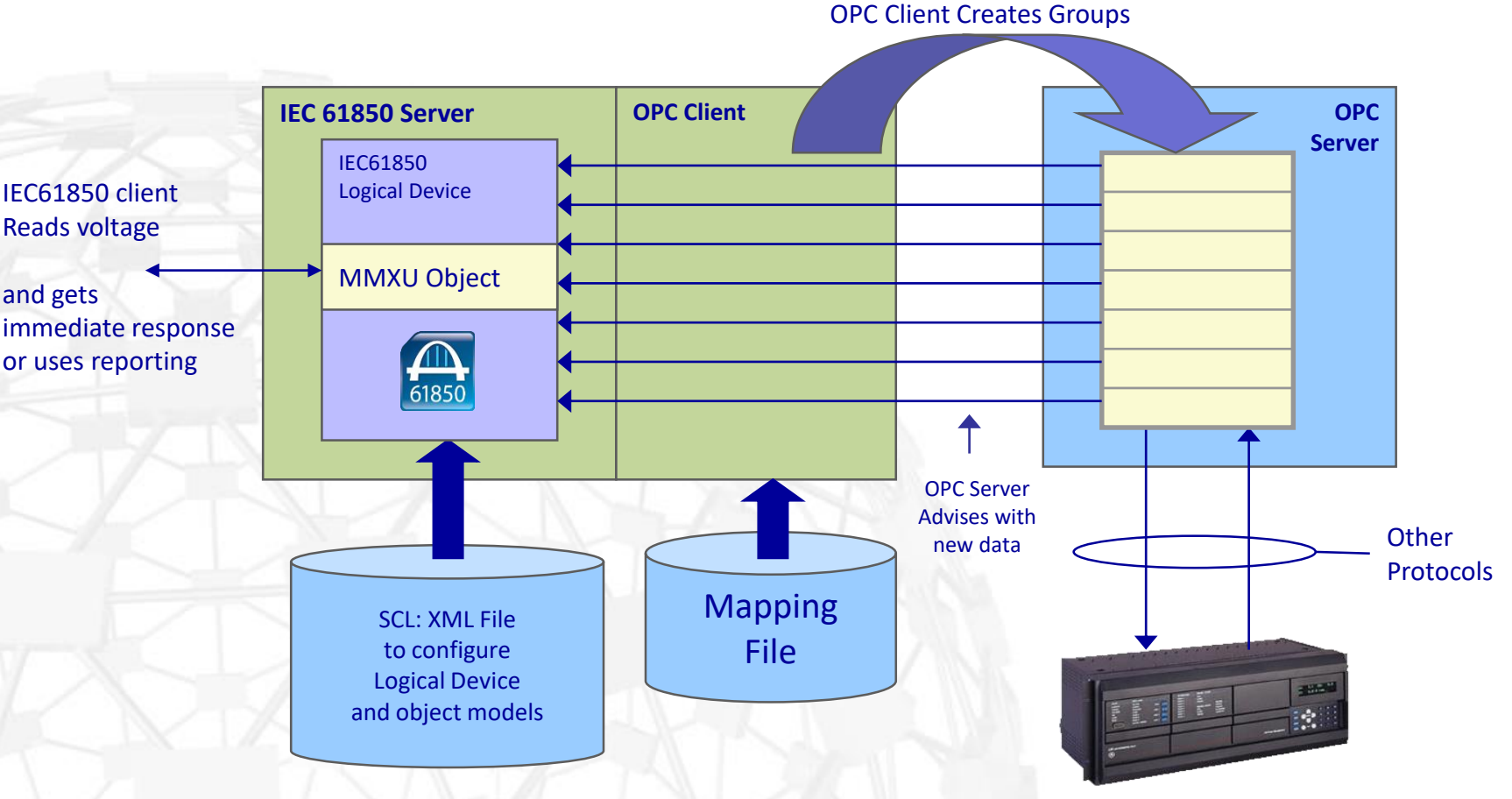
GOOSE Application



AX-S4 61850 Server Features

- IEC 61850 Server functions:
  - Configuration of IEC 61850 server via SCL (IEC 61850-6)
  - Mapping of IEC 61850 objects to external OPC server for dynamic data
  - Fixed value initialization via SCL or mapping file for static data.
  - Read/Write of any IEC 61850 Object
  - Buffered and Unbuffered Reporting
  - Controls (Direct and SBO via Normal Security)
  - Full support for object discovery using ACSI services
  - IEC 61850 file server functions
  - OPC DA V3.0 Client
  - IEC 62351 secure communications supported:
    - TLS 1.2 for server level authentication and encryption
    - X.509 Digital certificates for strong application level authentication

AXS4 61850 Server



Example Mapping File: IEC 61850 gateway to Modbus Device

CTRL	AlmGGIO1STBeh$stVal	KEPware.KEPServerEx.V4	Simulated.User.beh_stVal	ReadOnlyDyn	
CTRL	AlmGGIO1STHealth$stVal	KEPware.KEPServerEx.V4	Simulated.User.Health_stVal	ReadOnlyDyn	
CTRL	AlmGGIO1STSPCSO1$stVal	SISCO.AXS4GOOSE.1	Local.SISCO_IED1CTRL/SPSCO1$stVal	ReadWriteDyn	
CTRL	AlmGGIO1CFMod$ctlModel	KEPware.KEPServerEx.V4	Simulated.User.ctlModel	ReadOnlyStatic	
CTRL	AlmGGIO1CFSPCSO1$ctlModel	KEPware.KEPServerEx.V4	Simulated.User.ctlModel	ReadOnlyStatic	
CTRL	AlmGGIO1DCNamPlt$vendor	KEPware.KEPServerEx.V4	Simulated.User.vendorSISCO	ReadOnlyStatic	
CTRL	AlmGGIO1DCNamPlt$swRev	KEPware.KEPServerEx.V4	Simulated.User.swRev	ReadOnlyStatic	
CTRL	AlmGGIO1DCNamPlt$d	KEPware.KEPServerEx.V4	Simulated.User.namPltSISCO	ReadOnlyStatic	
CTRL	AlmGGIO1DCNamPlt$configRev	KEPware.KEPServerEx.V4	Simulated.User.configRev	ReadOnlyStatic	
CTRL	AlmGGIO1EXNamPlt$lnNs	dummy_opcserver	dummy_opcitem	ReadOnlyStatic	IEC 61850-7-4:2003
CTRL	MMXU1MXHzmagf	KEPware.KEPServerEx.V4	MODBUS.GEUR.HzMagf	ReadOnlyDyn	
CTRL	MMXU1MXPhV$phsA$cValmagf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsA_V_Mag	ReadOnlyDyn	
CTRL	MMXU1MXPhV$phsA$cValangf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsA_V_Ang	ReadOnlyDyn	
CTRL	MMXU1MXPhV$phsB$cValmagf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsB_V_Mag	ReadOnlyDyn	
CTRL	MMXU1MXPhV$phsB$cValangf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsB_V_Ang	ReadOnlyDyn	
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CTRL	MMXU1MXA$phsA$cValmagf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsA_A_Mag	ReadOnlyDyn	
CTRL	MMXU1MXA$phsA$cValangf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsA_A_Ang	ReadOnlyDyn	
CTRL	MMXU1MXA$phsB$cValmagf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsB_A_Mag	ReadOnlyDyn	
CTRL	MMXU1MXA$phsB$cValangf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsB_A_Ang	ReadOnlyDyn	
CTRL	MMXU1MXA$phsC$cValmagf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsC_A_Mag	ReadOnlyDyn	
CTRL	MMXU1MXA$phsC$cValangf	KEPware.KEPServerEx.V4	MODBUS.GEUR.PhsC_A_Ang	ReadOnlyDyn	

Mapped to AX-S4 61850 GOOSE publisher

Unmapped item with initial value

Mapped to Modbus OPC Server for device data (for example)

Logical Device

IEC 61850 Item

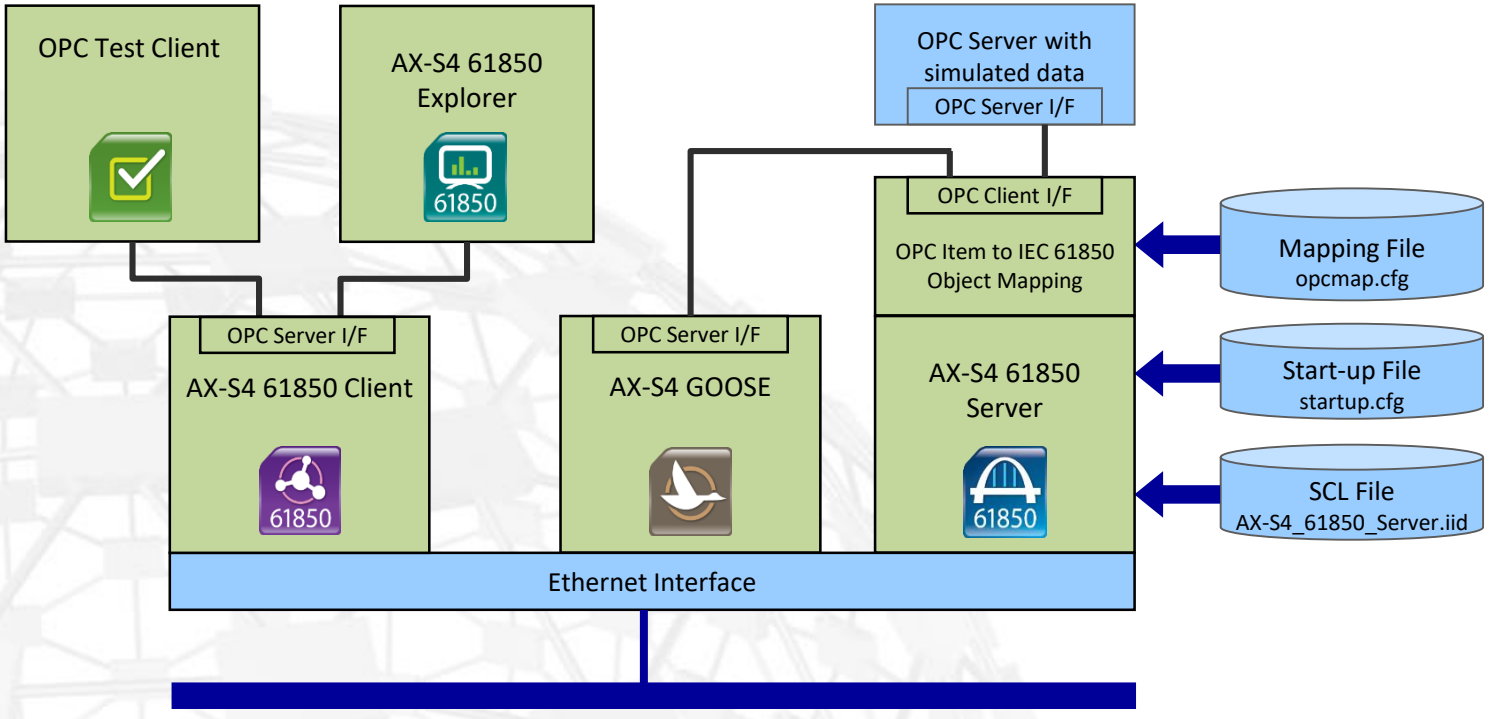
OPC Server from which to read/write data

OPC Item

OPC Group defined in IOCLASS.CFG

Initial Value

AX-S4 61850 "Out-of-the-Box" and Ready to Run System

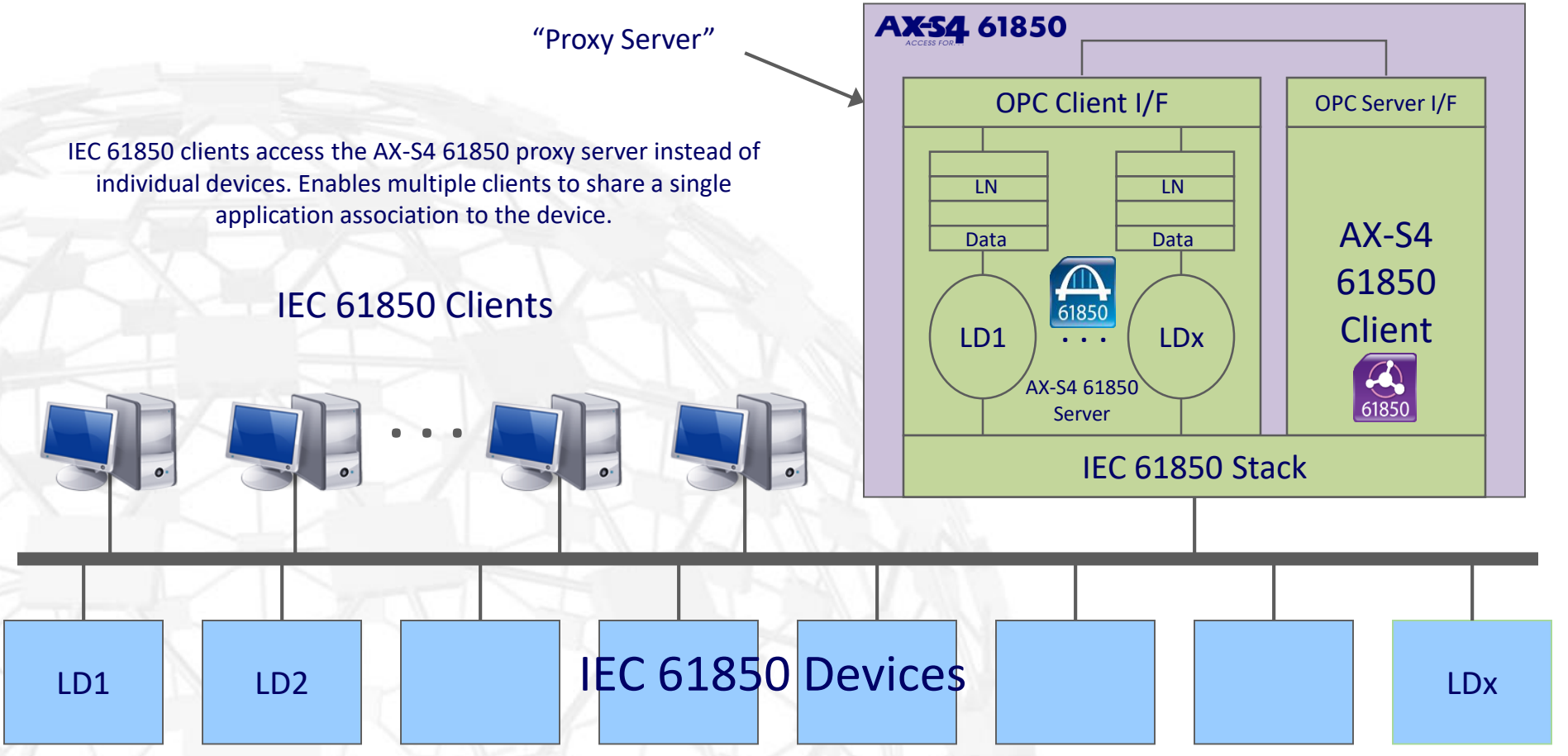


After installation there is a pre-configured IEC 61850 server (based on the AX-S4 61850 Server) supporting ACSI and GOOSE with simulated data that can be accessed via the AX-S4 61850 client or other networked ACSI clients and GOOSE devices.
Useful for application testing or illustrating configuration and setup concepts.

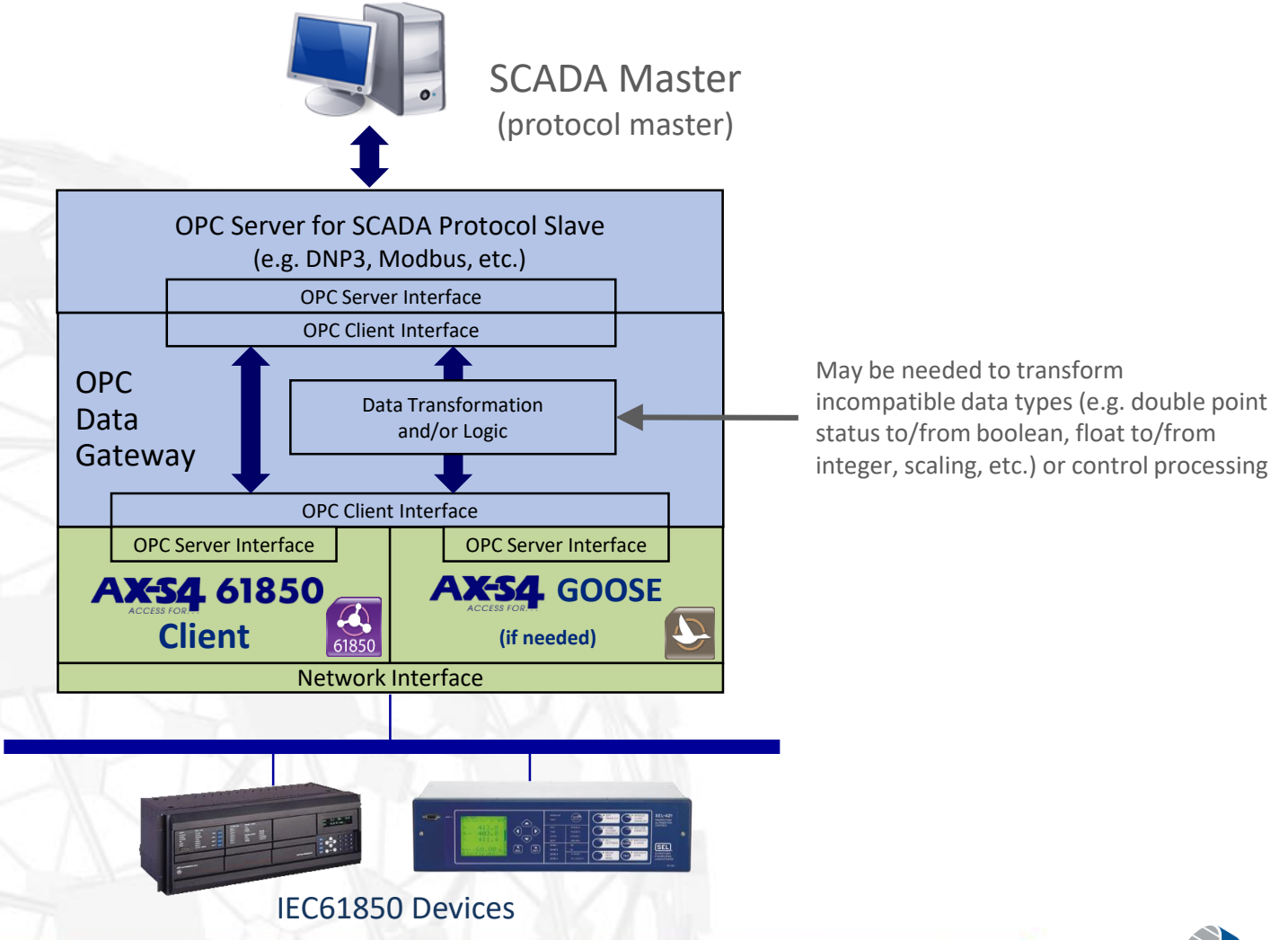
AX-S4 61850 as an IEC 61850 Proxy

"Proxy Server"

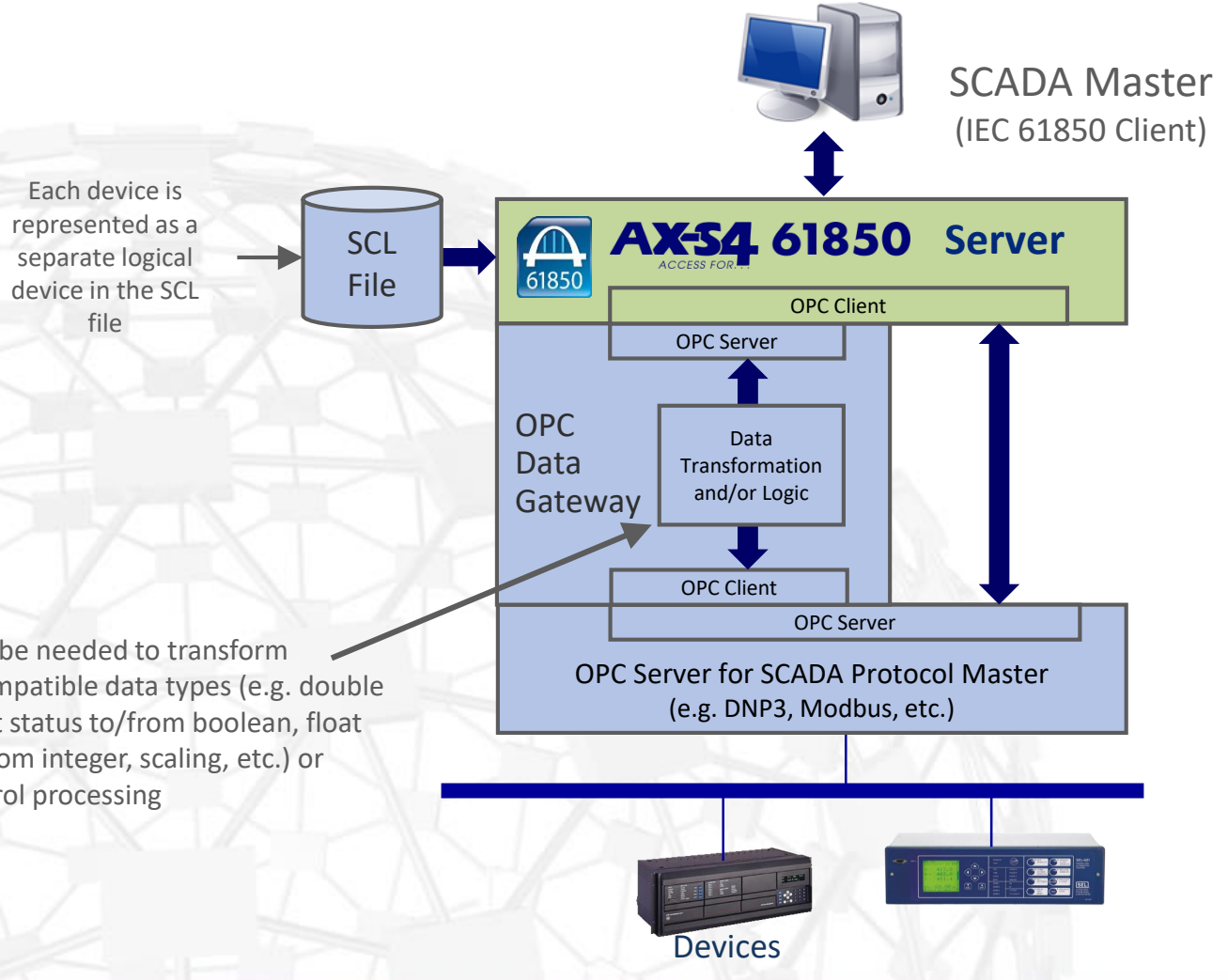
IEC 61850 clients access the AX-S4 61850 proxy server instead of individual devices. Enables multiple clients to share a single application association to the device.



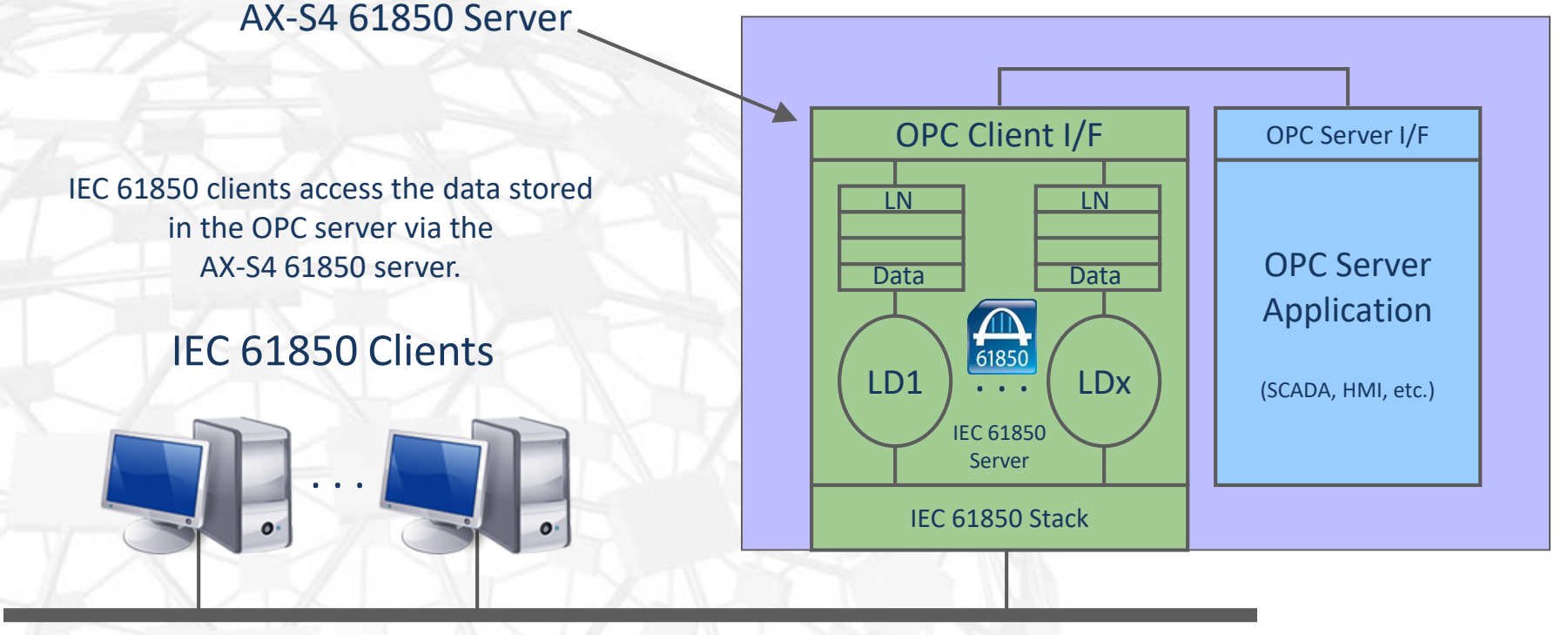
AX-S4 61850 SCADA Protocol Gateway



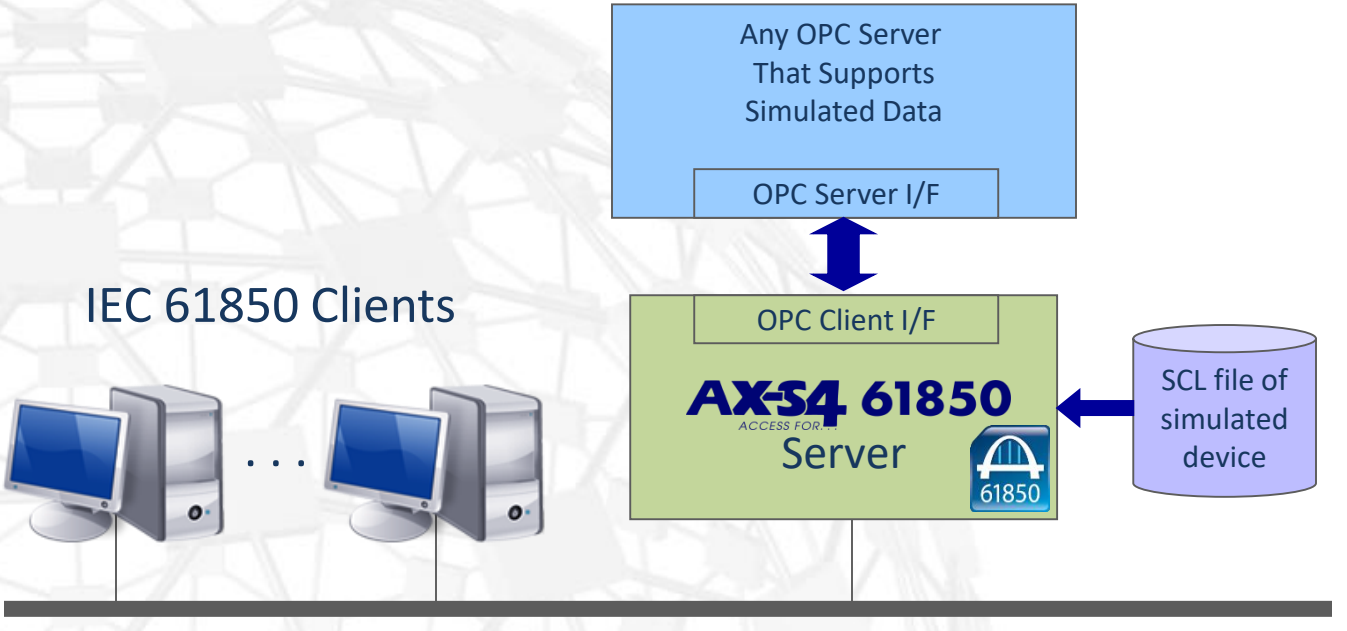
AX-S4 61850 Data Concentrator



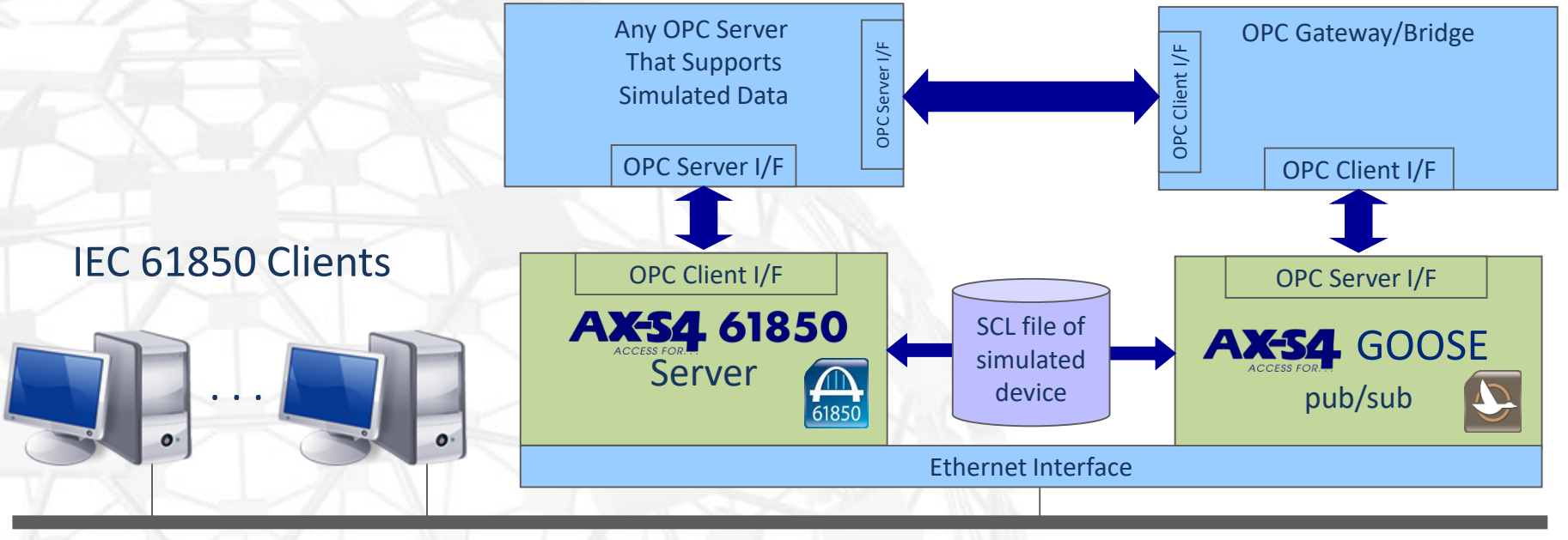
AX-S4 61850 to Expose OPC server data to IEC 61850 clients



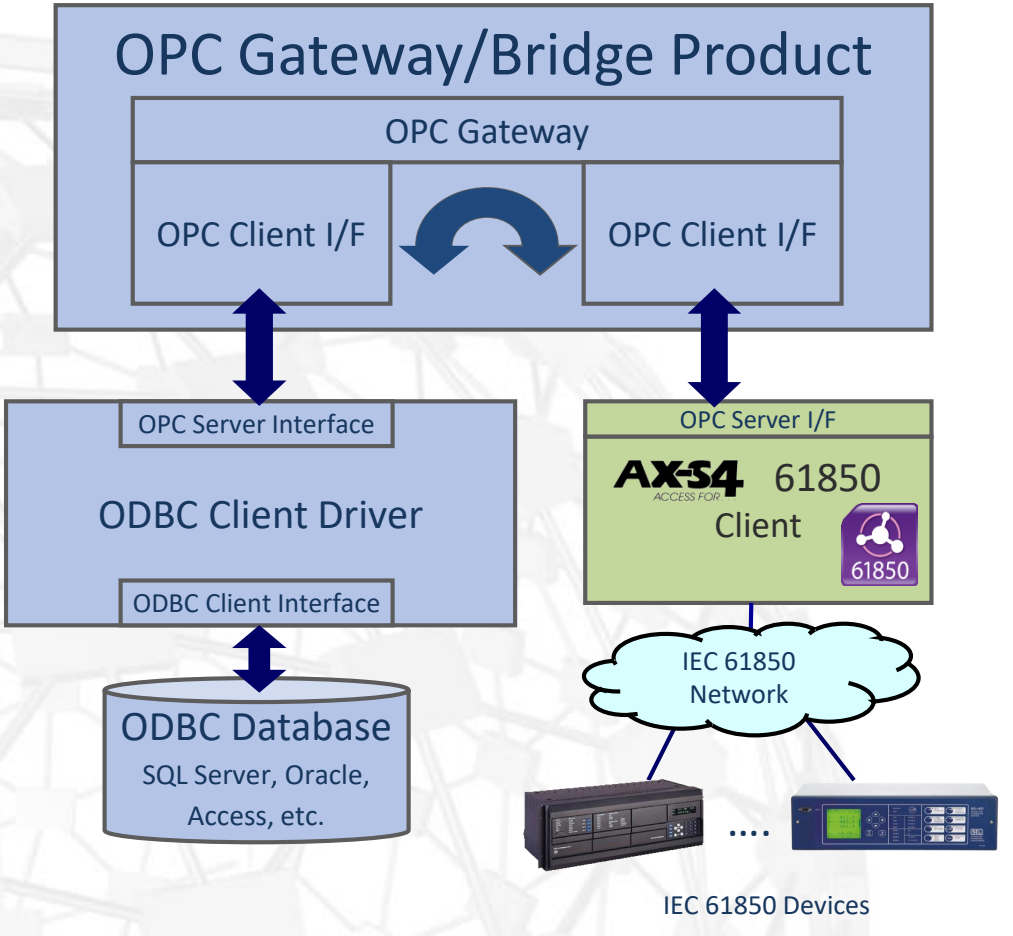
AX-S4 61850 as an IEC 61850 Device Simulator



AX-S4 61850 IEC 61850 Device Simulator with GOOSE



AX-S4 61850 Interface to ODBC



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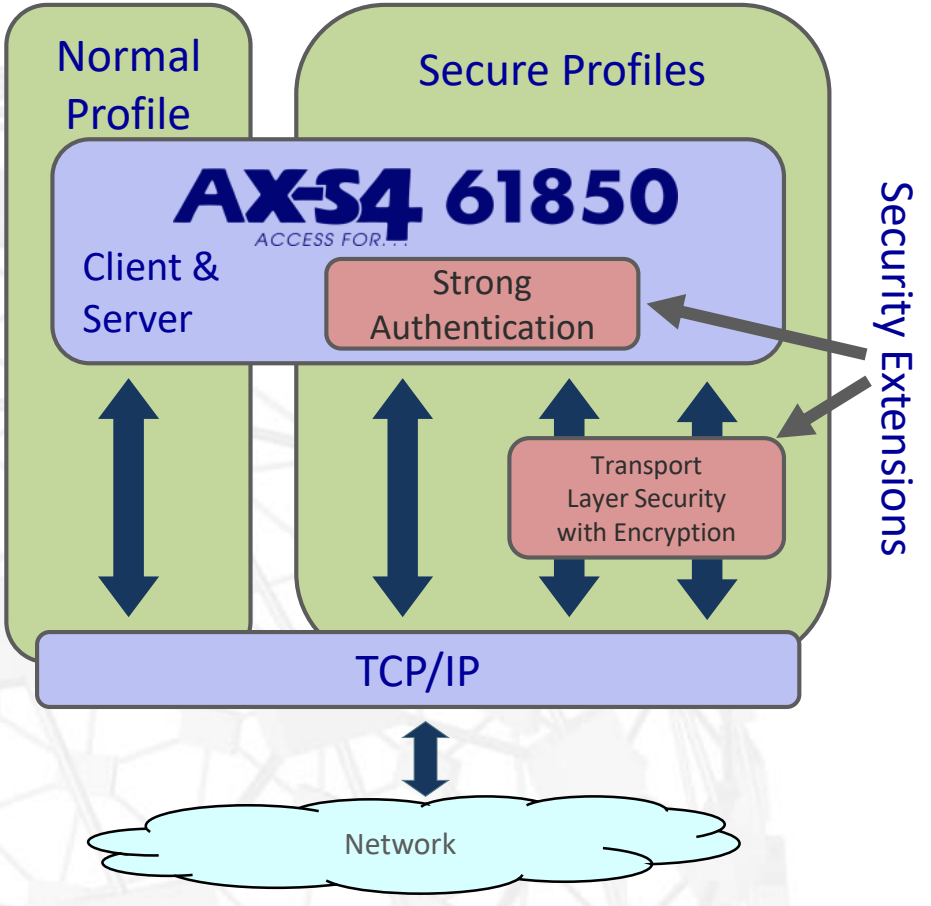
IEC 62351-4 Security Extensions for AX-S4 61850

AX-S4 61850 Security Extensions

- Incorporates Support for IEC 62351-4 to provide
  - Application level authentication using digital certificates
  - Transport Layer Security (TLS) for encryption
- 1024/2048 bit asymmetrical keys for authentication and connection establishment and 256-bit symmetrical keys for encryption
- Encryption is periodically rekeyed to eliminate brute force breaking of encryption
- Connect requests are time stamped and signed to avoid playback and spoofing
- Supports simultaneous use with or without security functions on a link by link basis
- Security extensions are included with AX-S4 61850 at no additional cost
- Supports both AX-S4 61850 Client and AX-S4 61850 Server
- AX-S4 61850 Security Extensions are subject to governmental export restrictions

AX-S4 61850 Security Extensions



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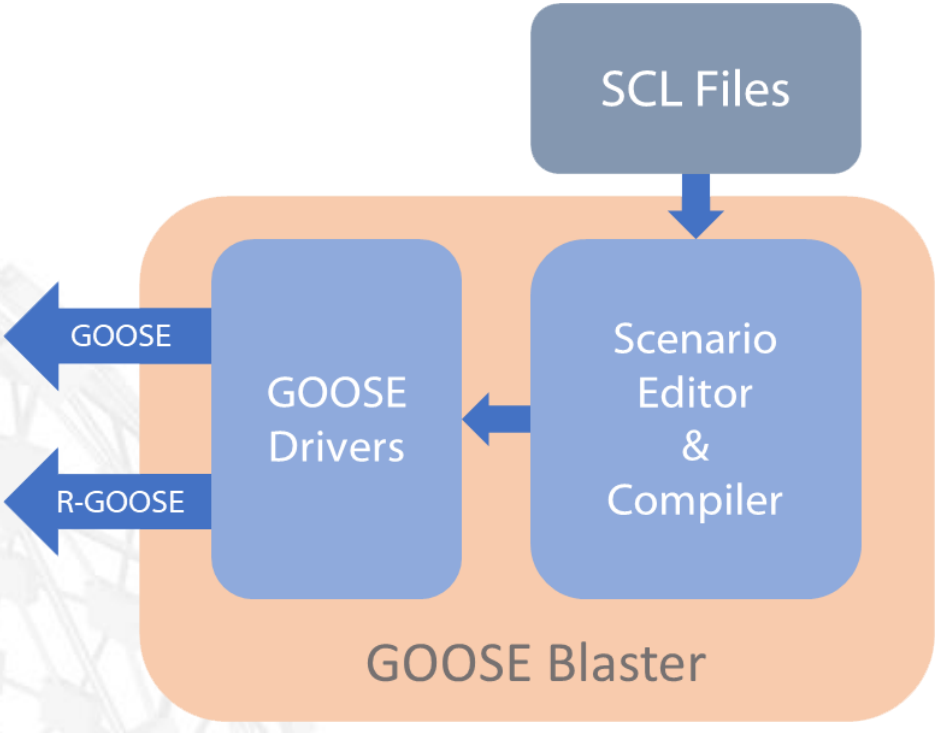
GOOSE Blaster

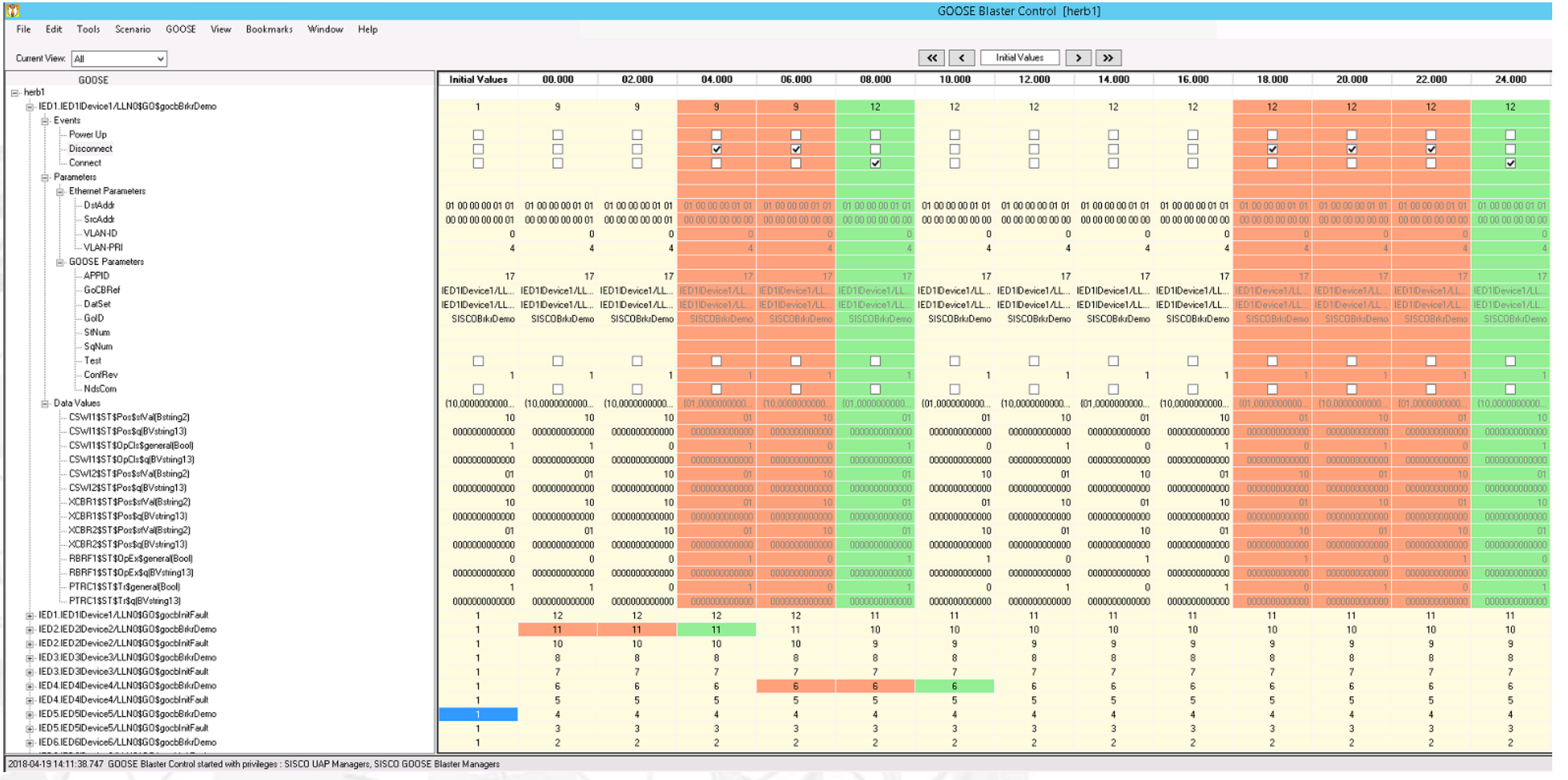
Simulate GOOSE and R-GOOSE Messaging for Testing

GOOSE Blaster

- Simulates GOOSE and R-GOOSE messaging
- Capable of supporting large scale simulations of many devices including
  - » Critical state changes
  - » Out of sequence and missing message scenarios
  - » Good/bad quality/timestamps
  - » Many realistic and anomalous conditions can be simulated
- Supports execution of multiple scenarios simultaneously



GOOSE Blaster Scenario



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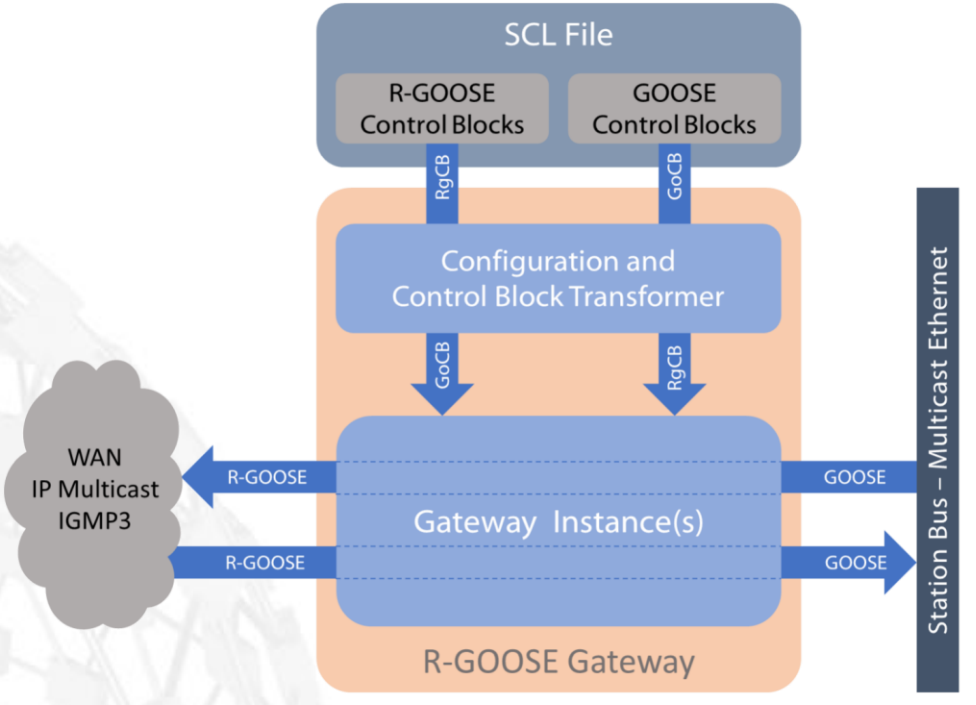
R-GOOSE Gateway

Interconnect GOOSE and R-GOOSE Systems

R-GOOSE Gateway

- Translates Ethernet Multicast GOOSE messaging to/from IP Multicast GOOSE (R-GOOSE) with minimal latency
- Configures with SCL and autogenerates the necessary GoCB and RgCBs needed on either end of the gateway
- Supports execution of multiple gateway instances and multiple network interfaces



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MMS *Lite*

IEC 61850 Portable Source Code for Embedded Systems and Other Applications

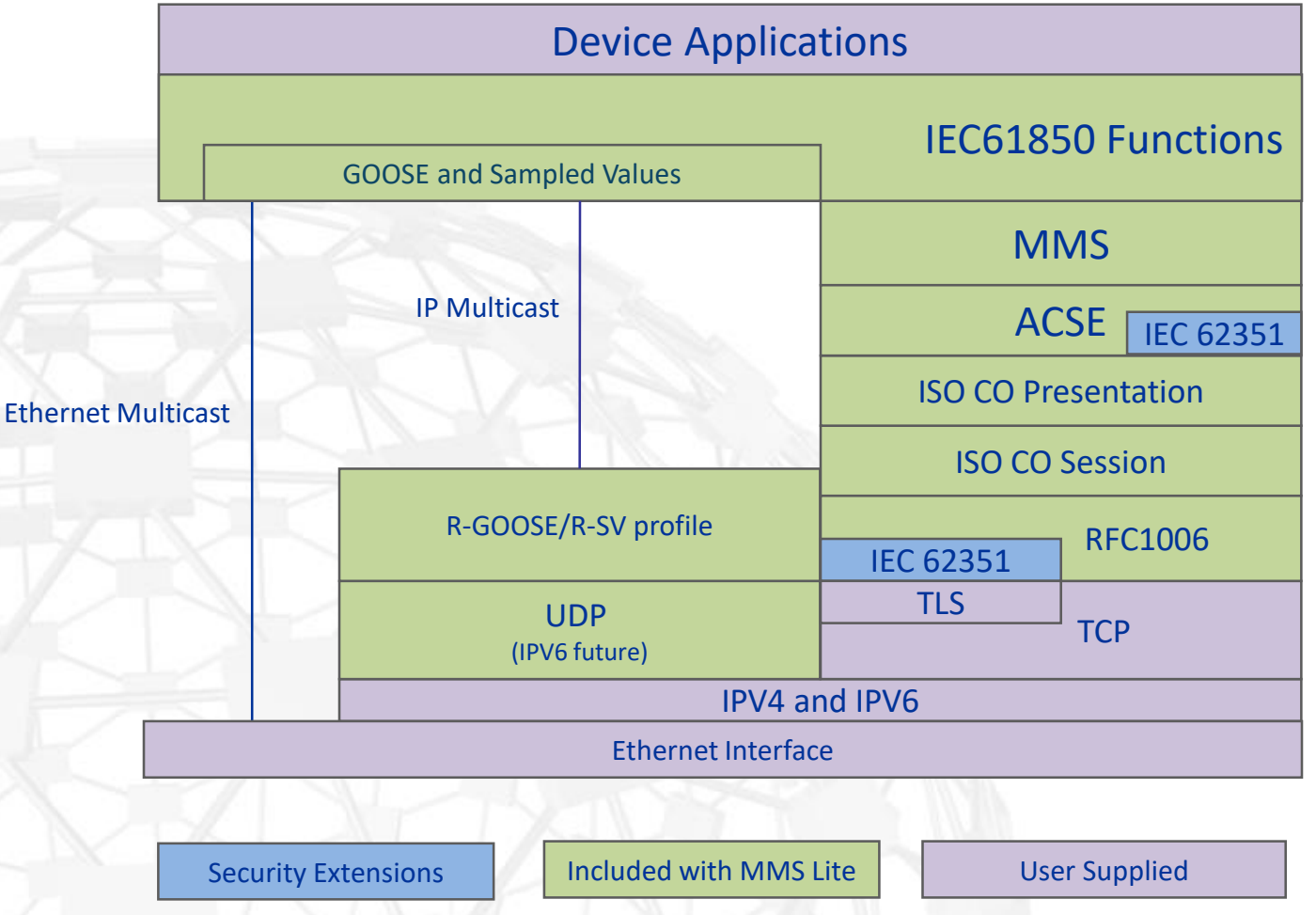
MMS *Lite*

- Source code implementation helps you get IEC 61850 products to the market fast using robust field-proven technology
- Designed specifically for resource constrained embedded systems yet suitable for host system development
- Portable to any computing platform
- Used in protection relays, RTUs, PQ meters, wind turbine controllers, transformer monitoring, host applications, etc.
  - » Over 450 device manufacturers using MMS *Lite* world-wide
  - » Hundreds of devices using MMS *Lite* have passed UCAIug certified conformance testing
  - » Millions of devices installed and operational world-wide using MMS *Lite*
- Flexible licensing options minimize initial cost while providing upgrade path as needs grow
- ICCP-TASE.2 Extensions Available (Optional)
- IEC 62351-4 Security Extensions Available (Optional)

MMS *Lite* Features

- Resource Efficient in both RAM and ROM
- Portable to any O/S supporting ANSI C
- Flexible memory management:
  - User managed memory pool; or
  - Dynamic memory allocation
- Uses well defined interfaces to:
  - Ethernet
  - TCP/IP
  - Memory management
  - Activity logging for debug
  - O/S calls

MMS *Lite* Profiles



Current IEC 61850 Support

- IEC61850 Edition 1 and Edition 2 Client and Server in one implementation
- Supports All ACSI Services and Objects parts 6, 7-2, 7-3, 7-4, 7-410, 7-420, 8-1, 61400-25-2 and more.
  - » Buffered and Unbuffered Reporting
  - » Controls (all options)
  - » Settings
  - » Logs
  - » GOOSE Ethernet Multicast
  - » 9-2 Process Bus
  - » Routable GOOSE and SV per IEC TR 61850-90-5* for IP Multicast (excluding GDOI)
  - » IEC 62351 security extensions available as an option
- Supports both IPV4 and IPV6 for client/server communications
- Run Time Definition of Objects via SCL per IEC 61850-6

* - IEC TR 61850-90-5 will become part of Ed 2.1 in 2018.

MMS *Lite* Portability

- Portable to any OS and CPU supporting ANSI C compiler
- Customers have also ported to:
  - pSOS
  - VxWorks
  - RTXc
  - LynxOS
  - ThreadX
  - Home-Grown
  - Many many others
- Portation services are available if needed.
- Most customers port MMS Lite to their platform with minimal (if any) assistance from SISCO and typically without informing SISCO. **MMS *Lite* is truly platform independent.**

MMS *Lite* Porting

- Sample application provided to assist in testing the ported software
- Ready to compile “out of the box” on:
  - RedHat Linux
  - Win32
- Portable to **any** platform supporting ANSI C.
- Accommodates any byte alignment or ordering (big/little endian) system
- Lower layer provider code isolates interfaces to TCP and Ethernet to minimize impact for non-Linux/Win32 systems
- O/S specific functions controlled via #define and isolated into specific modules to improve portability

MMS *Lite* Licensing Options

- Source Code is licensed to a single location
  - » Temporary access allowed for outside contractors
- Flexible licensing enables low cost entry and preserves investment as needs and volumes increase.
  - » All source code license fees paid can be credited towards purchase of an upgraded license
- Per Copy Based Licenses
  - » Lower source code fees to get started
  - » License fee per unit of end product
- Paid-Up License
  - » Higher source code fees
  - » No per unit license fees for high-volume devices
- License Options
  - » Corporate Licensing
  - » Product Restricted
  - » Academic Research

MMS *Lite* Security Extensions

- Incorporates Support for the IEC 62351-4 subset of IEC 62351-6 to provide
  - Application level authentication using digital certificates
  - Transport Layer Security (TLS) for encryption
- 1024/2048 bit asymmetrical keys for authentication and connection establishment and 256-bit symmetrical keys for encryption
- Encryption is periodically rekeyed to eliminate brute force breaking of encryption
- Connect requests are time stamped and signed to avoid playback and spoofing
- Supports simultaneous use with or without security functions on a link by link basis
- Internal data structure support for holding role/privilege information in support of IEC 6235-8 Role Based Access Control (RBAC)
- Security extensions are available separately as a one-time purchase for any existing MMS *Lite* license

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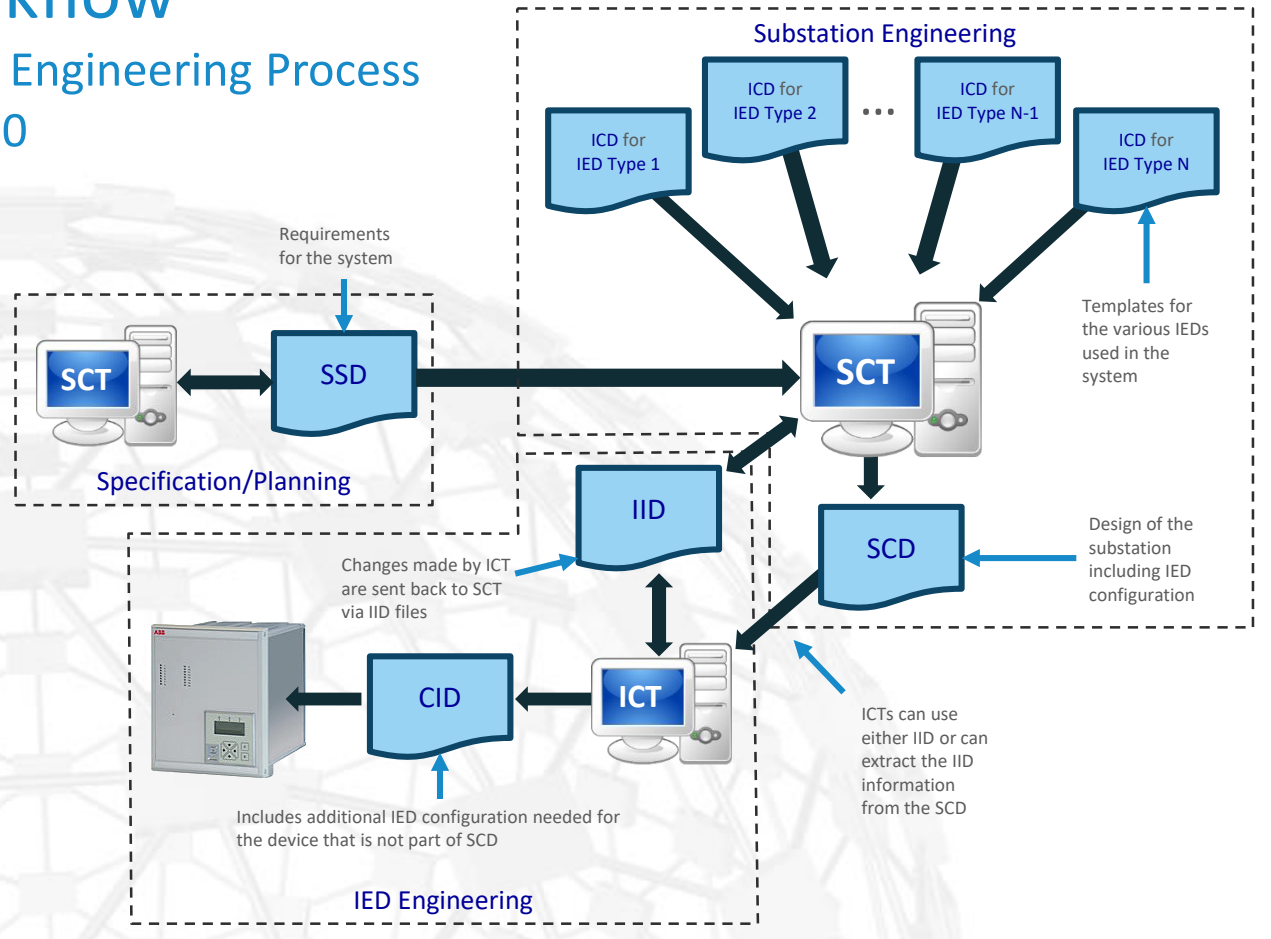
Future IEC 61850 Products

SCL Toolkit

GOOSE Monitor

SCL Workflow

"Top-Down" Engineering Process per IEC 61850



SCL File Types

- **SSD**: System Specification Description

  XML description of a system. A specification for what is needed without specific IEDs assigned to power system functions.

- **SCD**: Substation Config. Description

  XML description of a single substation. A description of the substation and IEDs in it that is generated by a Substation Configuration Tool (SCT).

- **IID**: Instantiated IED Description

  XML description of a device that is used in the substation design of an SCD but may not be completely configured.

- **CID**: Configured IED Description

  XML configuration for a specific IED that has been completely configured. An IED Configuration Tool (ICT) uses an IID or SCD as input and generates the CID.

- **SED**: System Exchange Description

  Subset of a SCD file that specifies responsibilities between entities implementing different parts of a project

- **ICD**: IED Capability Description

  XML description of what is supported by an IED. A template for a given type of product that is provided by the IED supplier. Used by a SCT to select devices for the design of the substation.

SISCO

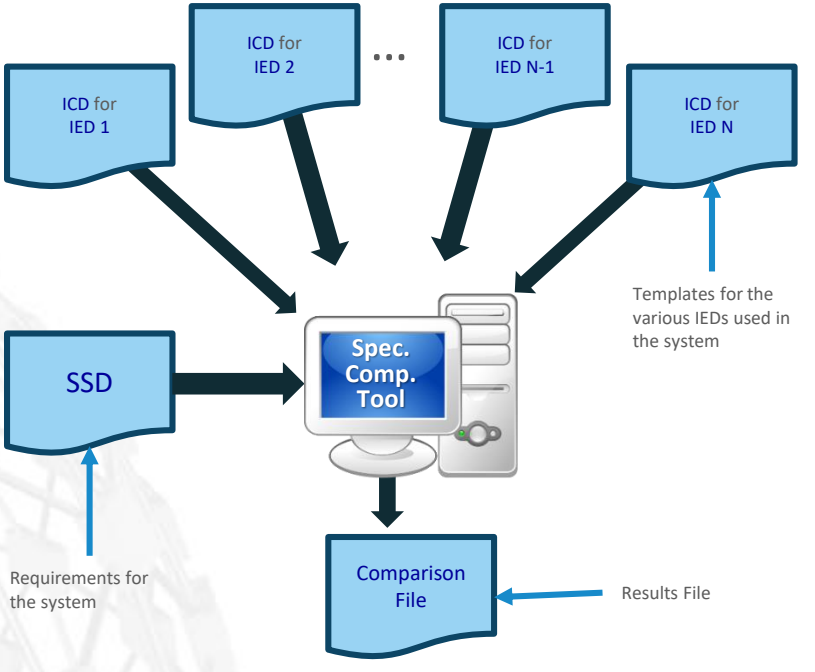
SCL Toolkit

- A set of utilities to assist users in implementing the IEC 61850 “Top-Down” engineering process
  - Specification Comparison Tool – IED selection utility
  - Workflow Comparison Tool – Evaluates changes in SCL files
  - LN Definition Browser – Provides access to IEC 61850 object definitions
  - SCD to CID Extractor – Extracts CID/IID information from an SCD
  - SCL to CIM Converter – Converts IEC 61850 SCL to IEC 61970 CIM
  - DNP3 ICD Creator and Mapping – Enables use of DNP3 devices with the IEC 61850 engineering process
  - IEC 61850 UML – UML for Enterprise Architect for use in Enterprise Semantic Modeling (ESM) and Application Integration activities

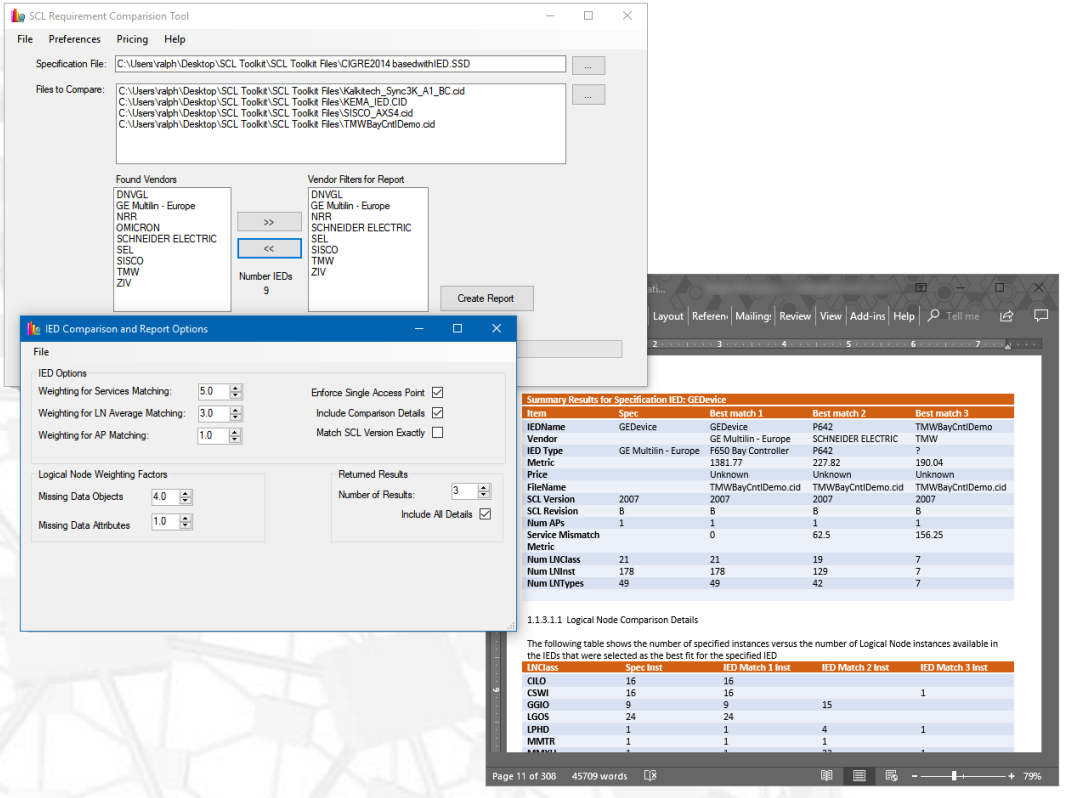
SISCO

Specification Comparison Tool

- Compares the requirements of a System Specification Description (SSD) file to determine which IEDs are the best functional fit for that project
- Inputs:
  - SSD file for the project (or SCD)
  - IED Capability Description (ICD) (or CID/IID) files for all the devices being considered
- Output:
  - Microsoft Word File with tables illustrating the comparison results

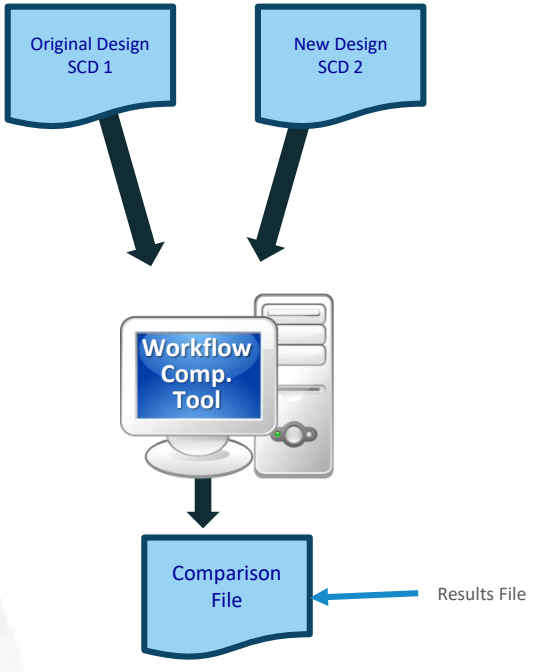


Specification Comparison Tool Demo

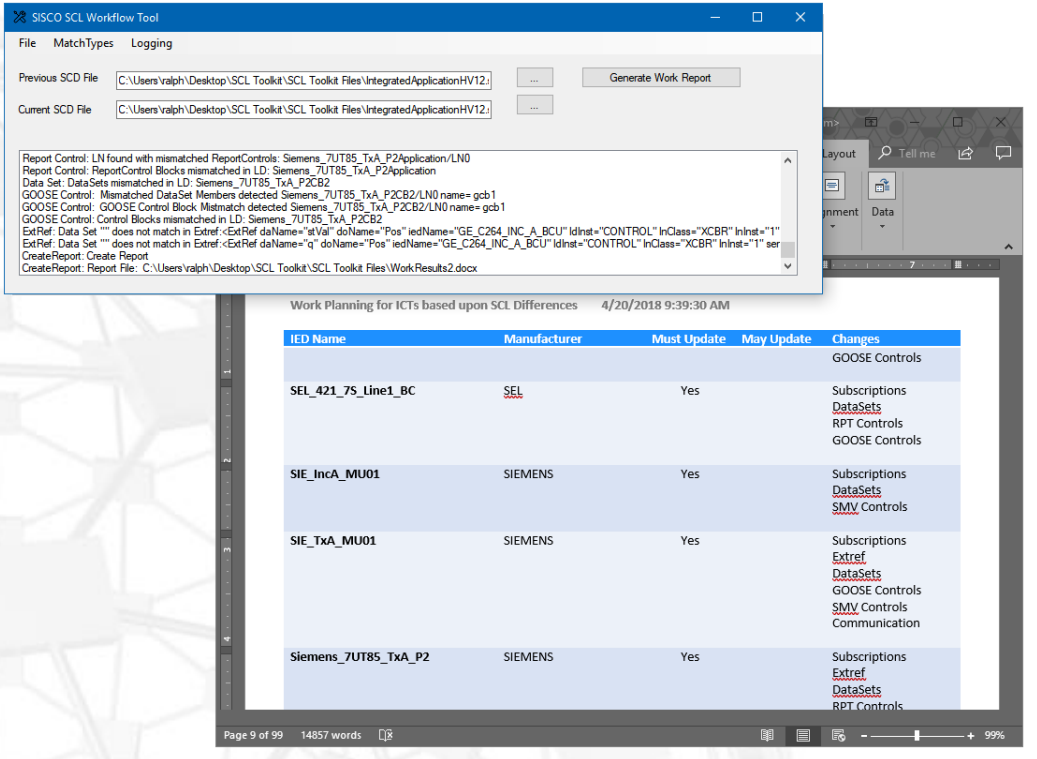


Workflow Analysis Tool

- Used to determine the work required to migrate a substation from one design to another
- Compares the contents of 2 SCD files and identifies the changes that need to be implemented to an existing system in order to accommodate the new substation design
- Input:
  - Original SCD file
  - New SCD file
- Output:
  - Word document identifying the changes required

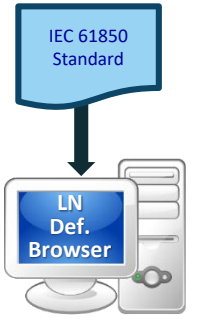


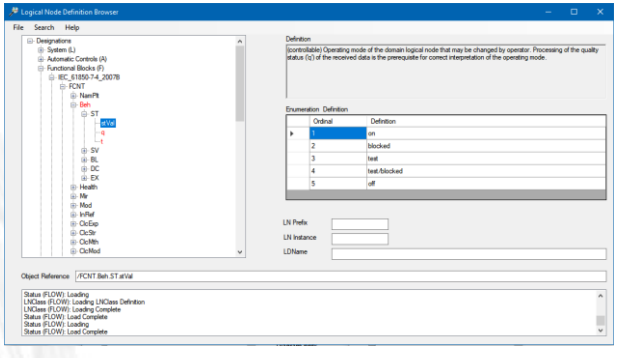
Workflow Analysis Tool Demo



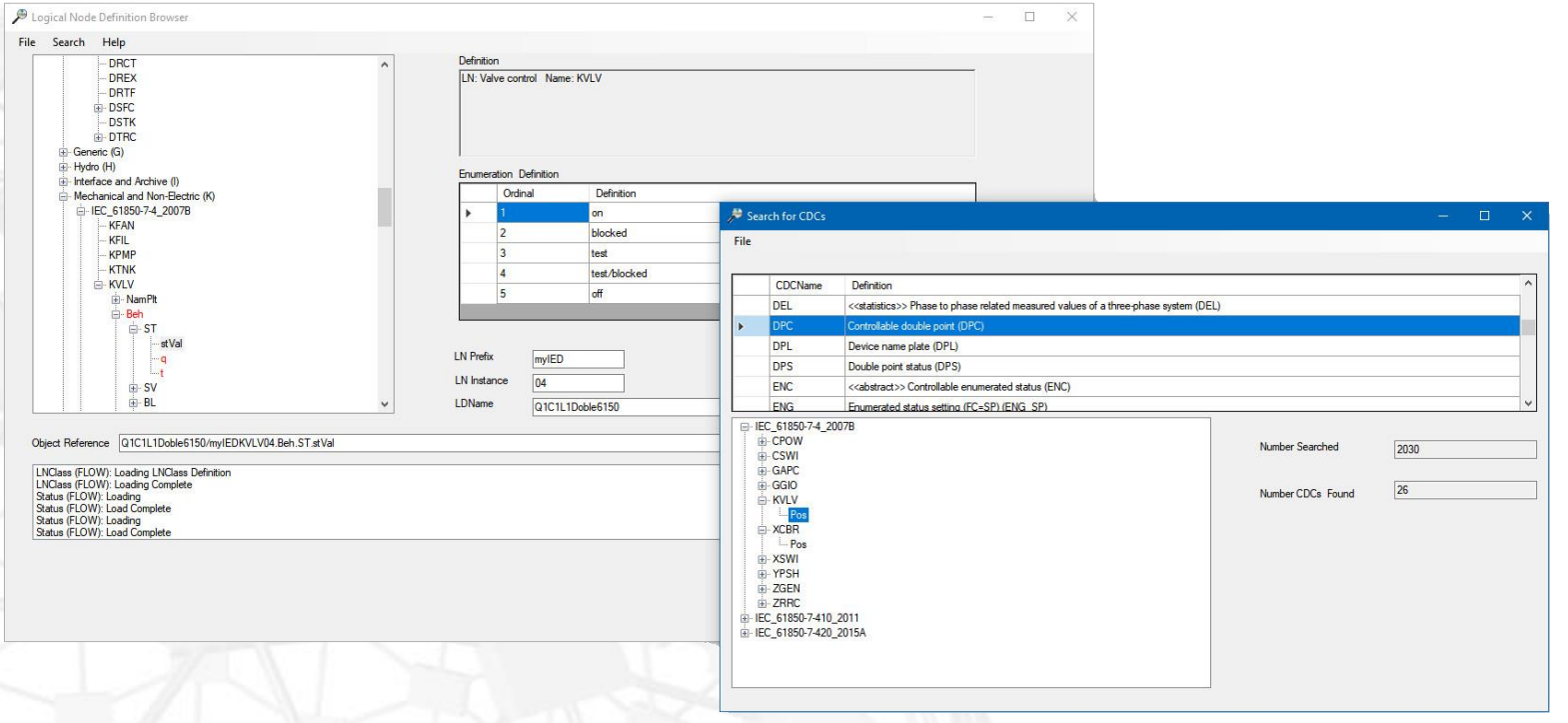
Logical Node (LN)Definition Browser

- Provide the user with easy electronic access to the standardized IEC 61850 object models
- Displays detailed definitions of IEC 61850 Logical Nodes
- Users can browse the LN definitions in supported IEC 61850 standards:
  - » IEC 61850-7-4
  - » IEC 61850-7-410 (Hydro Power)
  - » IEC 61850-7-420 (Distributed Energy Resources)
- Search for references to specific CDCs
- Display mandatory/optional objects
- Create object references and copy to clipboard



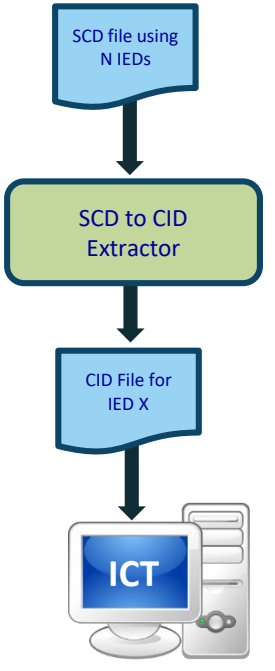


Logical Node (LN)Definition Browser Demo



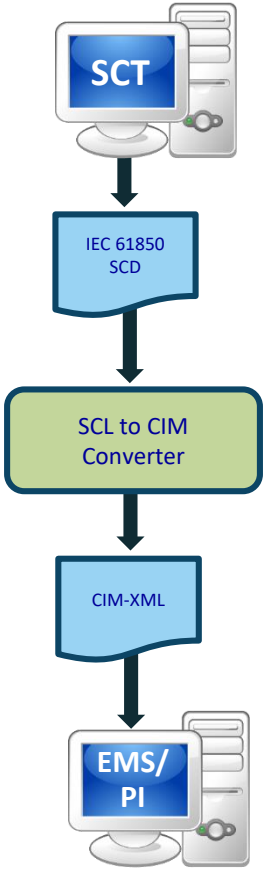
SCD – CID Extractor

- Extracts individual CID files from an IEC 61850 SCD file.
- Useful for situations where the device vendor does not have an IED Configuration Tool (ICT) that supports IEC 61850



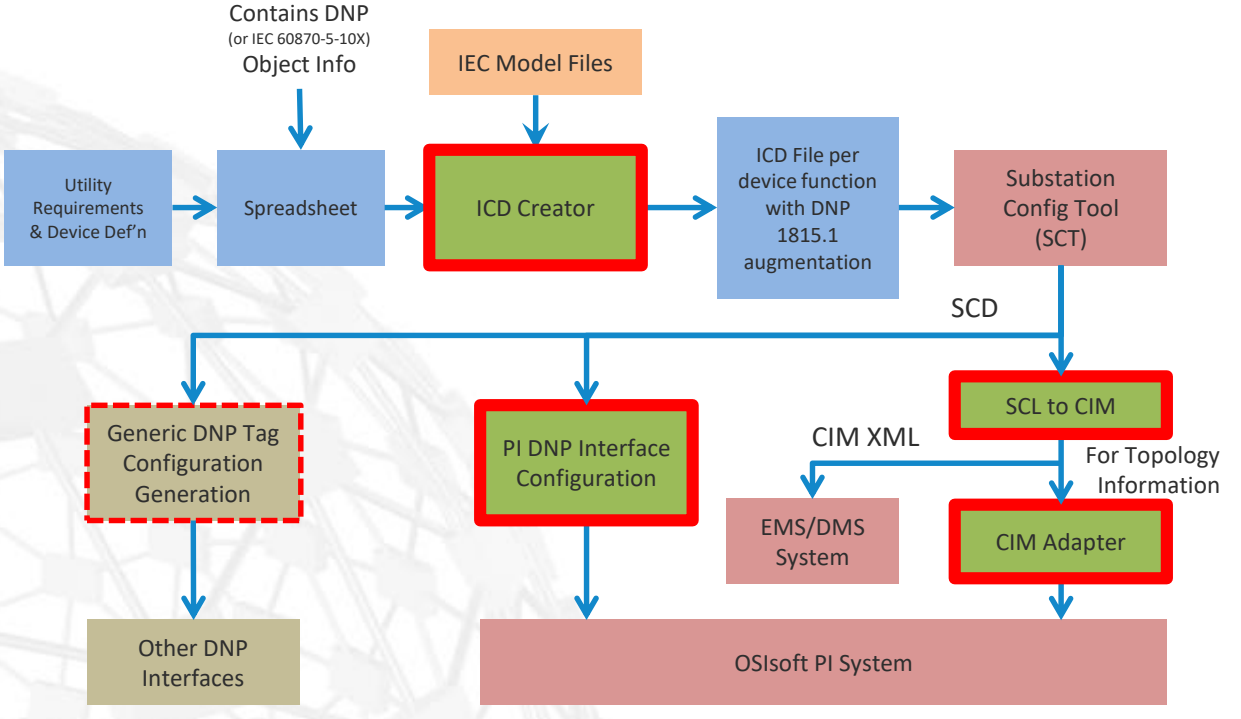
SCL – CIM Converter

- Converts IEC 61850 SCD file into IEC 61970 Common Information Model (CIM) files for import into EMS, DMS, PI, etc.
- Enables the substation semantic information created during the substation design process to be used for configuration of other systems including:
  - » Substation power system topology and connectivity
  - » Attribute/tag naming
  - » Settings
  - » Subscriptions for SCADA clients



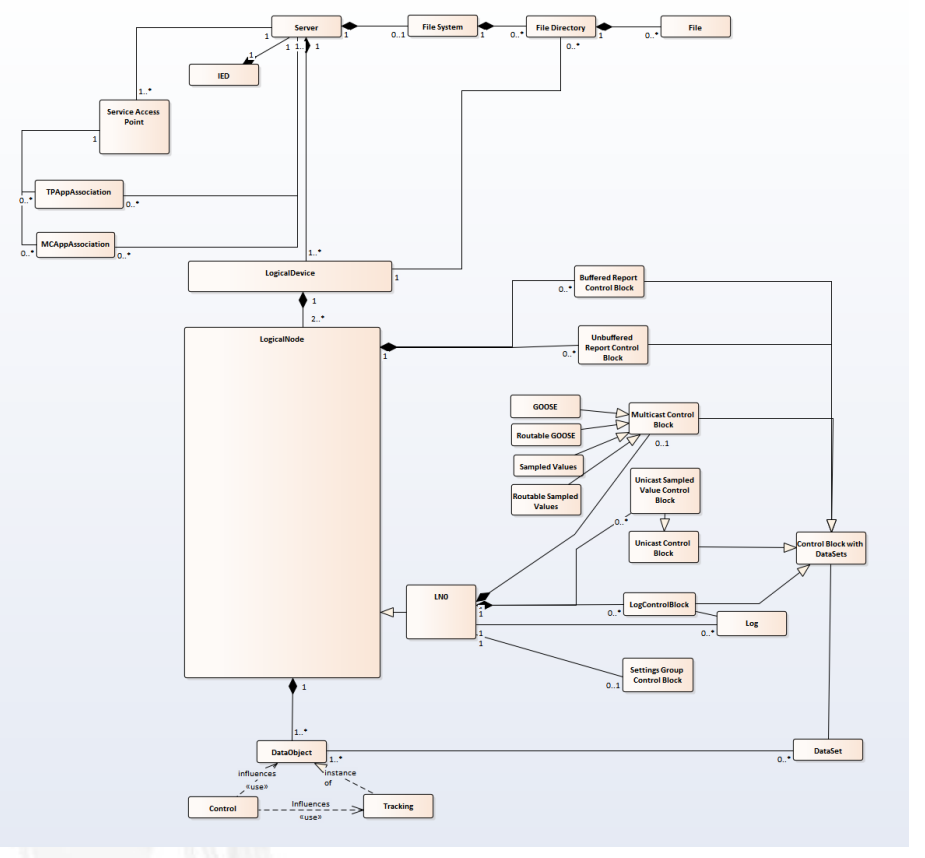
DNP3 ICD Creator and Mapping Tool

- Enables application of the IEC 61850 engineering process to DNP3 based systems
- Simplifies configuration via automated tag name generation and mapping



IEC 61850 UML

- Conversion of IEC 61850 Code Components to Unified Modeling Language (UML) in Enterprise Architect (EA)
- UML can be used for Enterprise Semantic Modeling (ESM) for analytic management and model-driven integration
- UML enables harmonization with CIM power system models to create combined CIM-IEC 61850 Models
- Currently available under Apache OSS license. Will be included in SCL Toolkit under commercial internal use license.



SCL Toolkit Packaging

- All SCL Toolkit components will be packaged together in a bundle
- A “Launcher” will provide a central app from which any of the individual tools can be invoked
- As new tools are released they can be added to an existing system under maintenance.

Transforming the world of energy using open standards

SISCO GOOSE Monitor

The Challenge of GOOSE

- IEC 61850 GOOSE Messaging uses multicast technology for station level time-critical protection and automation messaging
- Each device is typically publishing multiple GOOSE control blocks and subscribing to multiple GOOSE control blocks from other devices in the substation
- In large substations there are many hundreds of publish-subscribe relationships between devices
- With messages being transmitted as fast as 5-10 ms per message it can be very difficult for the substation engineer to debug these systems using traditional network monitoring or by monitoring a single device

The GOOSE Monitor Solution

- The GOOSE Monitor is designed to provide an intuitive visualization of the real-time GOOSE messaging occurring on station bus that enables the engineer to quickly identify what is working and what is not working

- Allows the engineer to cut through the complexity and focus their attention on where the problems are

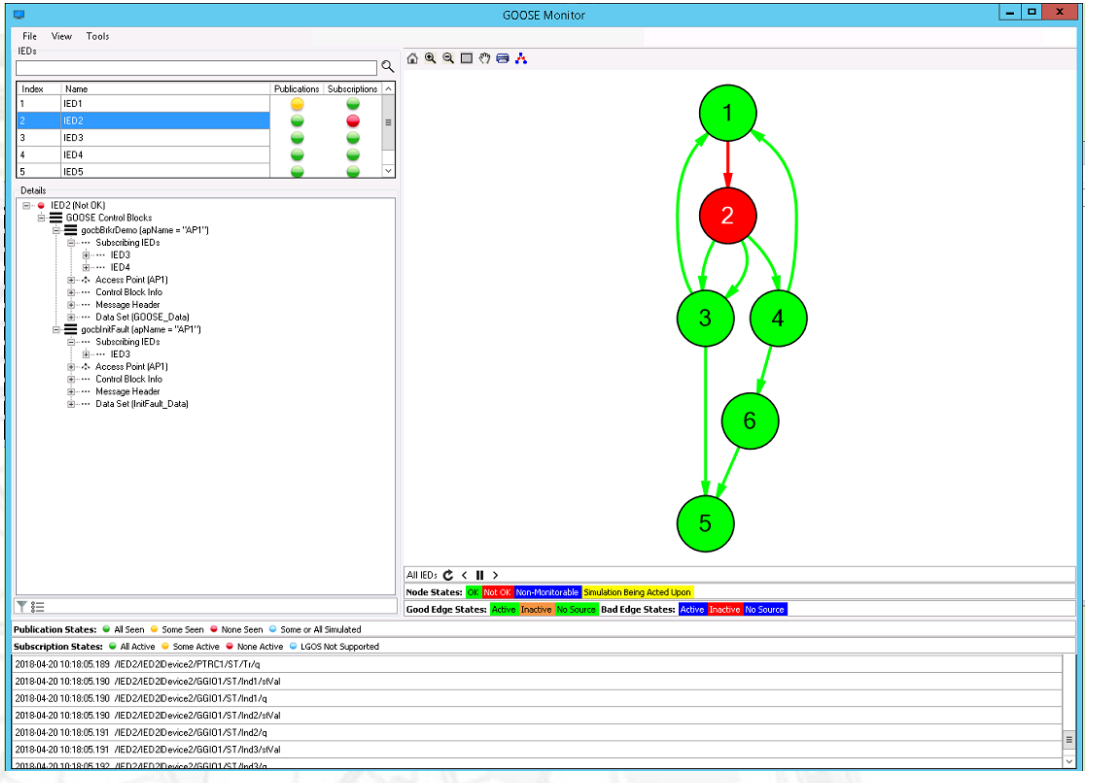
GOOSE Monitor Provides Answers

- Are GOOSE messages being published as expected?
- Are GOOSE messages being received by the IEDs as expected?
- Are their unexpected GOOSE messages on the network?
- What data is being published in each GOOSE message?
- Is the flow of GOOSE messages as expected?
- Are their simulated GOOSE messages on the network?

GOOSE Monitor Features

- Provides an intuitive and simplified view of network relationships and GOOSE traffic status to help the engineer focus on what is important
- GOOSE configuration is automatically generated from SCD file:
  - Graph diagram
    - Nodes represent state of GOOSE subscriptions via LGOS
    - Connections between nodes represent GOOSE messaging
  - Addressing
  - LGOS monitoring
- Beep Mode allows the engineer to follow the publisher and subscriber relationships through the system to track down root causes of problems

GOOSE Monitor Demo



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