IEC 61850

Overview and Application

imagination at work

Who am I?

Rich Hunt

Market Development Leader – GE Grid Solutions

- Over 25 years in the power systems industry
- At GE for 10 years (almost)
- Member of IEEE PSRC, U.S. Representative to CIGRE B5 (protection and control), Member of IEC TC57 WG10 (the 61850 WG)

What we'll talk about

- Overview of IEC 61850 concepts
  - Definition of terms – maybe
- Using IEC 61850 in specific applications
  - What can be done, and why
  - Main-Tie-Main Autotransfer scheme

IEC 61850 Concepts

IEC 61850 – 2 concepts

- We can "know" a piece of information
  - What it represents
  - Where it comes from
  - We can trust it
- We can "share" this information with other devices
  - Publish/subscribe
  - MMS

What 61850 is

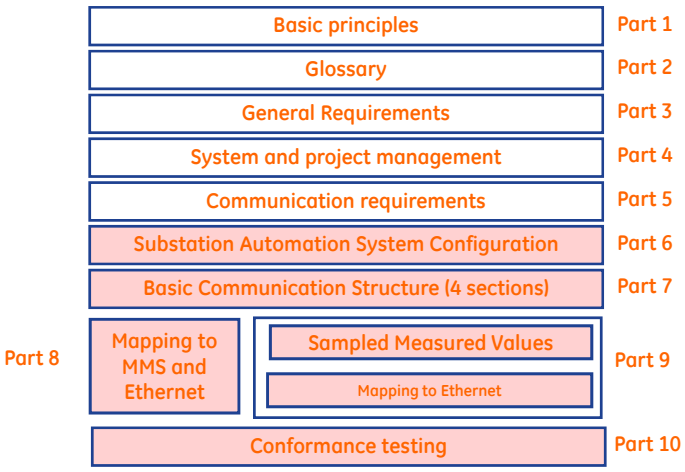
- All 61850 defines
  - How we "know" information
  - How we "share" information
- What 61850 does not define
  - What to do!!!
  - Applications
  - Devices
  - Architectures

61850 is all nouns and no verbs

IEC 61850

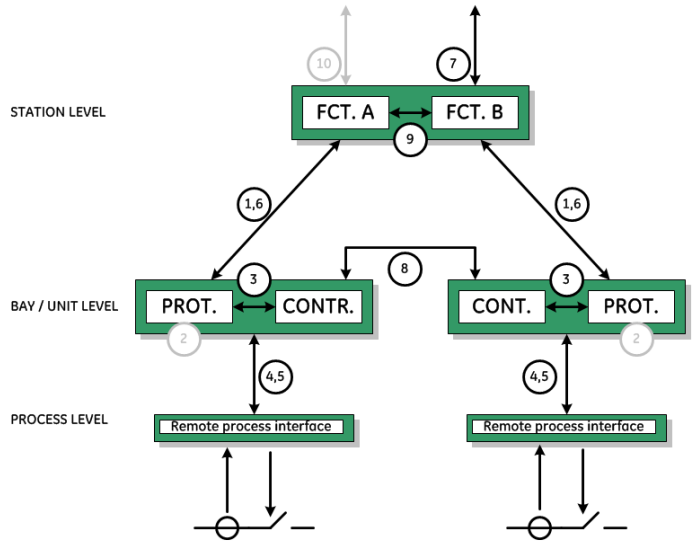
- Standard is 1200 pages over 10 parts (!!)
  - Referenced by other standards
  - Dependent on other standards
- The goal of the Standard is to define digital communications within a substation
  - Protocols, data types, message formats
  - Not applications
- Long term vision is interoperable devices
  - Communications only
  - Interoperable <> interchangeable

Parts of the IEC 61850 Standard

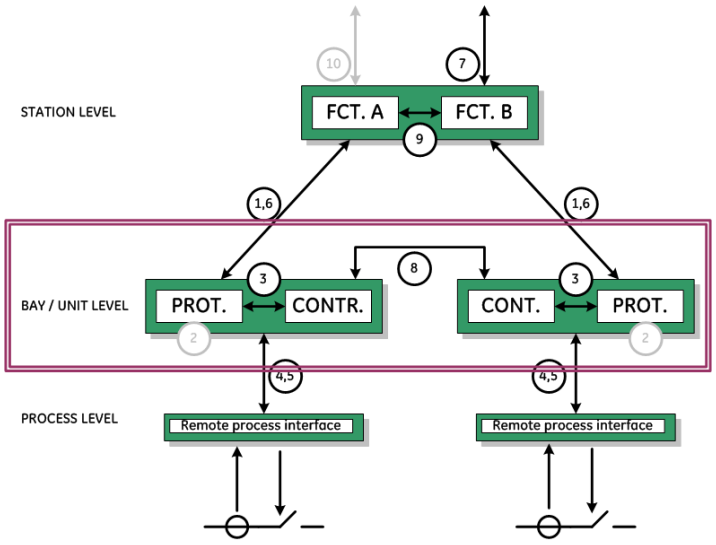


Structured Using Extensive Past Experience

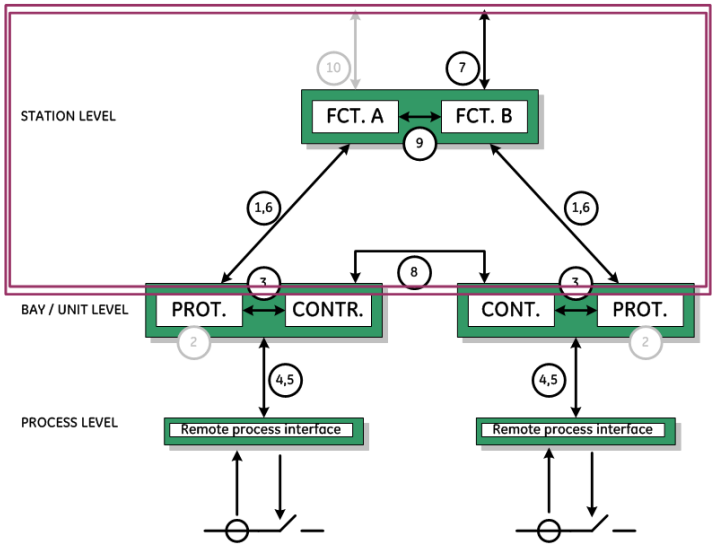
Communications interfaces



Bay level



Station level



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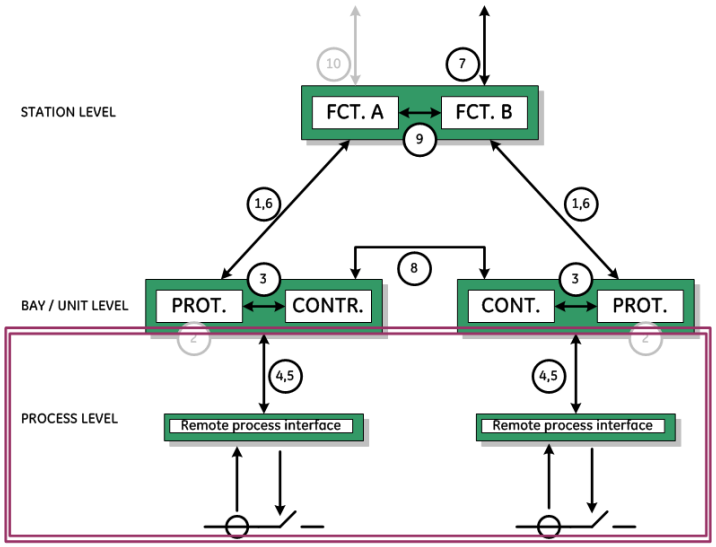
February 23, 2016

Process level



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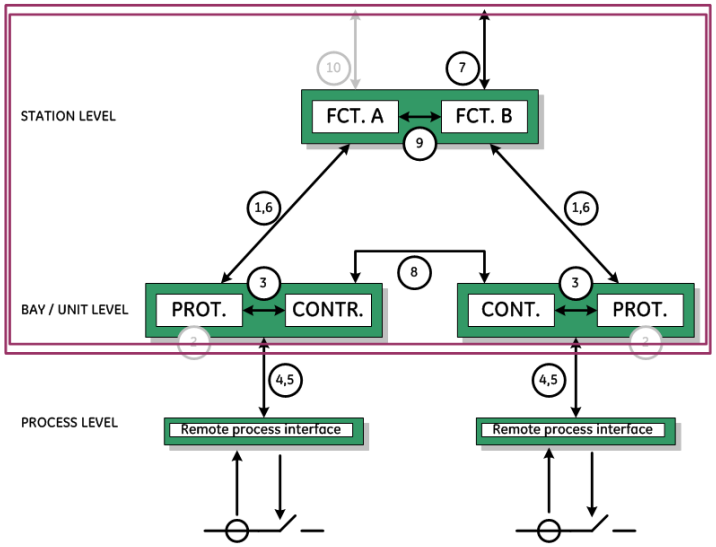
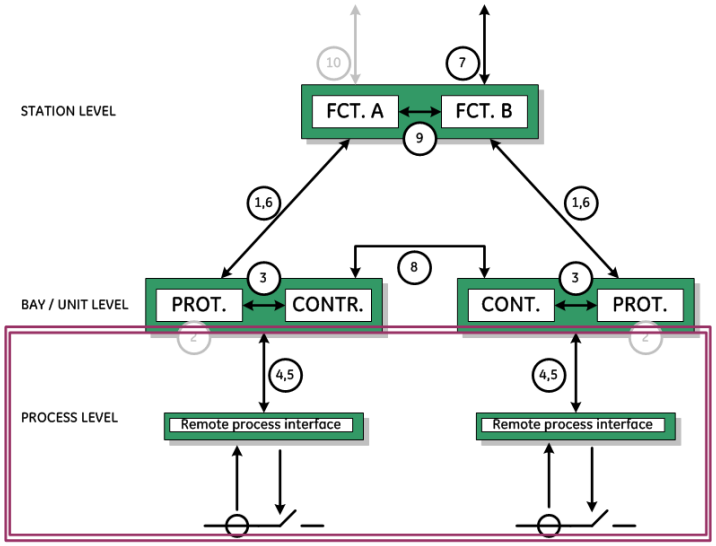
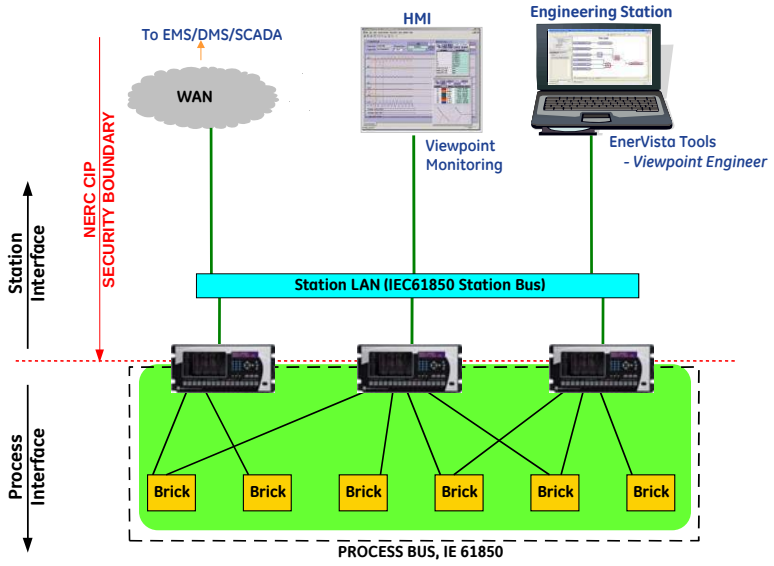
"Station bus"



"Process bus"



IEC61850 System Architecture



IEC61850 Basics

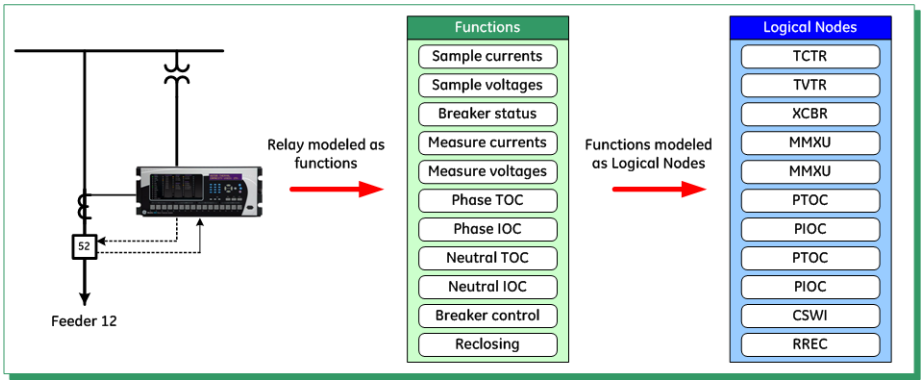
- How 61850 works:
  - Functional modeling of the power system
  - Self-description of information
  - Application-based transmission
    - Publish-subscribe for “right now” data
    - Client-server for “must trust” data
  - XML for configuration, documentation

IEC 61850 Definitions

Terms you hear:

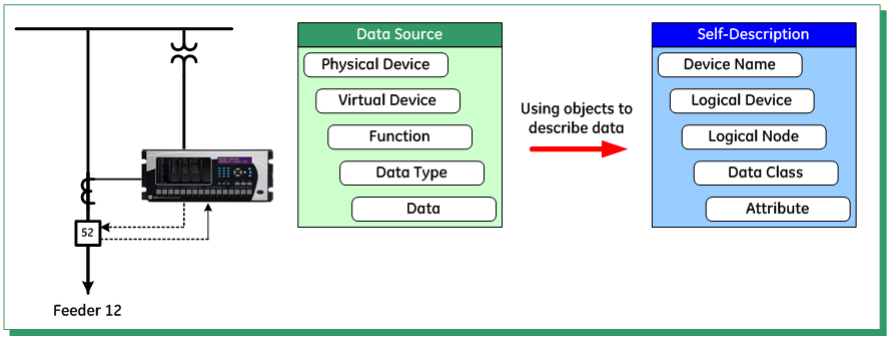
- Station Bus & Process Bus
- Self description & Logical nodes
- Ethernet, VLANs, 7 Layer Stack
- GOOSE
- MMS and Client/Server
- SCL / XML

Functional Modeling of Data
Logical Nodes

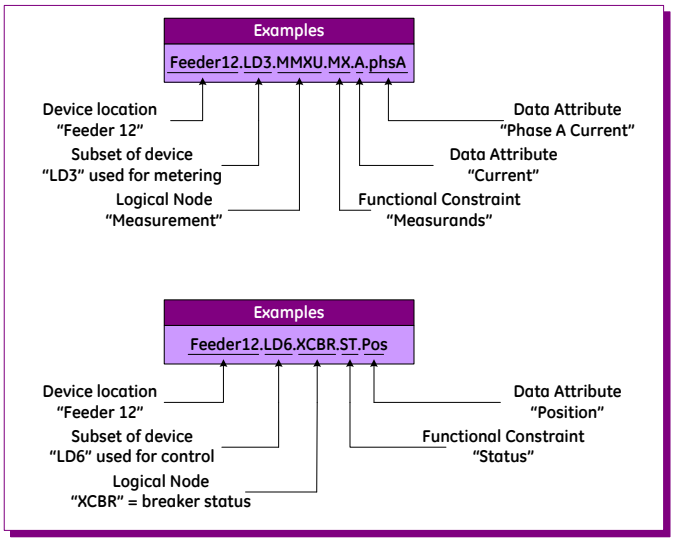


Nothing more than object-oriented programming

Self-Description of Data



Self-Description Example

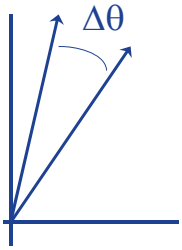


IEC 61850 Concepts
Data Structures

Logical Node Concept

Definition: A Logical Node is an abstract model of a real device or function

XCBR
Circuit Breaker

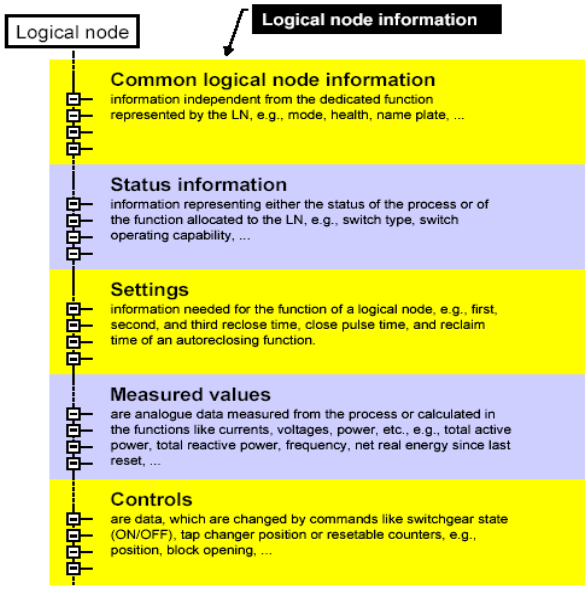


RSYN
Protection Related

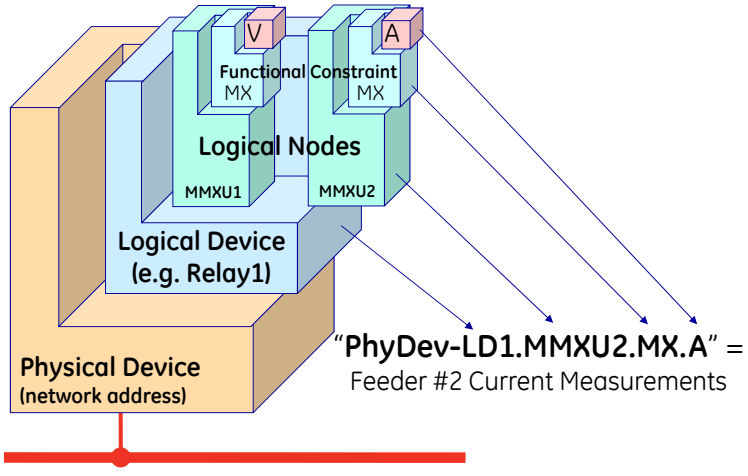
YPTR
Transformer

The Model includes Data, Data Attributes, and *Behavior*

Logical Node Information Categories



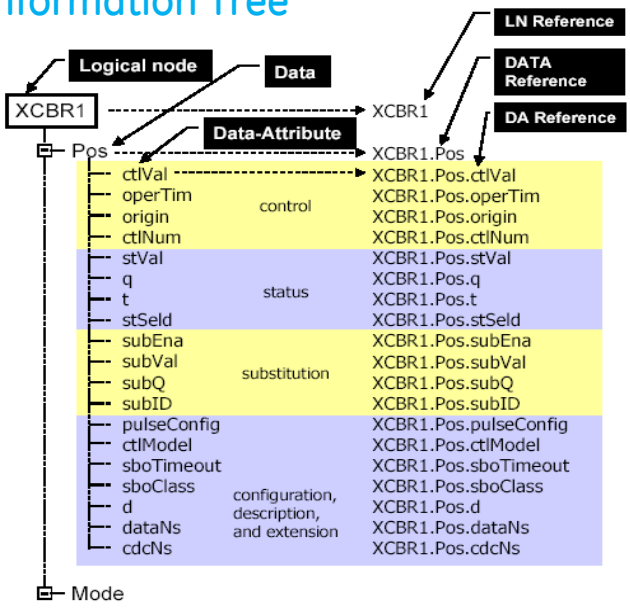
Anatomy of an IEC61850 Object Names



...Intuitive, Standardized Object Naming

Circuit breaker model

XCBR Information Tree



Logical Node Groups

L System LN (2 → 9)

P Protection (28 → 30)

R Protection related (10 → 11)

C Control (5 → 6)

G Generic (3 → 4)

I Interfacing and archiving (4 → 6)

A Automatic control (4 → 5)

M Metering and measurement (8 → 13)

S Sensor and monitoring (4 → 11)

X Switchgear (2)

T Instrument transformers (2 → 20)

Y Power transformers (4)

Z Further power system equipment (15 → 18)

→ F Functional Blocks (0 → 9)

→ K Mechanical (0 → 5)

→ Q Power Quality (0 → 6)

- ***Examples:***
- ***PDIF: Differential protection***
- ***RSYN: Synchrocheck***
- ***XCBR: Circuit breaker***

- ***Edition 2:***
- ***Adds 3 new LN Groups***
- ***Goes from 91 to 159 LNs***
- ***Other LNs defined in TRs***

Logical Node Objects

- IEC 61850 7-4 defines Logical Nodes
- IEC 61850 7-3 defines common data classes
- IEC 61850 7-2 defines functional constraints

PDIF example

PDIF class				
Data object name	Common data class	Explanation	T	M/O/C
LNName		The name, Instance, the class name, the LN-Prefix and LN-850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		O
Op	ACT	Operate	T	M
TmASt	CSD	Active curve characteristic		O
Measured and metered values				
DifACIc	WYE	Differential current		O
RstA	WYE	Restraint current		O
Controls				
OpCntRs	ING	Resettable operation counter		O
Settings				
LinCapac		Capacitance (for load currents)		O
LoSet	ASG	Low operate value, percentage of the nominal current		C
HiSet	ASG	High operate value, percentage of the nominal current		C
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
RstMod	ENG	Restraint mode		O
RsDlTmms	ING	Reset delay time		O
TmACrv	CURVE	Operating curve type		O
TmAChr33	CSG	Multiline curve characteristic definition		O
Condition C: These data objects are conditional, and if used only one data object should be applied.				
NOTE TmAChr33 refers to the attribute TmACrv.setCharact = 33 etc.				

Data class defines possible data attritubtes

Data Object Name

Mandatory or Optional data

LN descriptions in 7-4 define data objects by:

- Name
- Data Class
- Required

PDIF → Op → ACT

7.3.6 Protection activation information (ACT)

Table 23 defines the common data class "protection activation information".

Table 23 – Protection activation information common data class specification

ACT class					
Data attribute name	Type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from IEC 61850-7 GenSu				
DataAttribute					
status					
general	BOOLEAN	ST	dchg		M
phsA	BOOLEAN	ST	dchg		O
phsB	BOOLEAN	ST	dchg		O
phsC	BOOLEAN	ST	dchg		O
neut	BOOLEAN	ST	dchg		O
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
originSrc	Originato				O
operTmPhsA	TimeStar				O
operTmPhsB	TimeStamp	ST			O
operTmPhsC	TimeStamp	ST			O
configuration, description and extensio					
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			NDA_M
cdcName	VISIBLE STRING255	EX			NDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table 18.					

Data attribute

When does this trigger

Functional Constraint

Type

Mandatory or Optional data

CDC descriptions in 7-3 define data attributes:

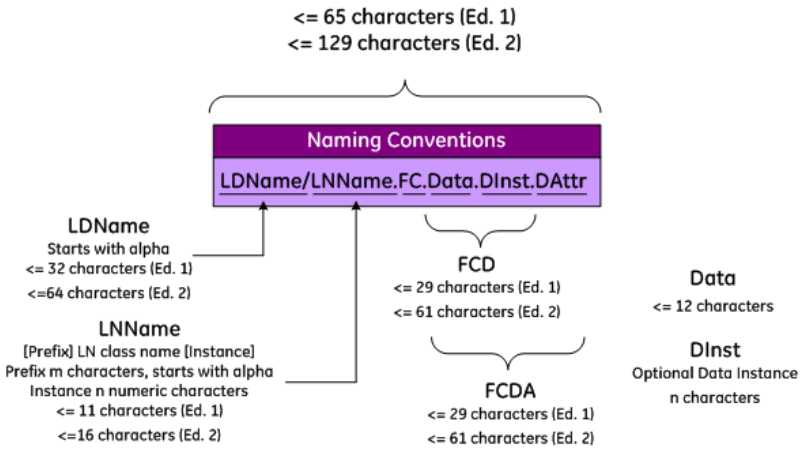
- Type
- Functional Constraint
- Trigger Operation
- Required

PDIF → Op → ACT → ST

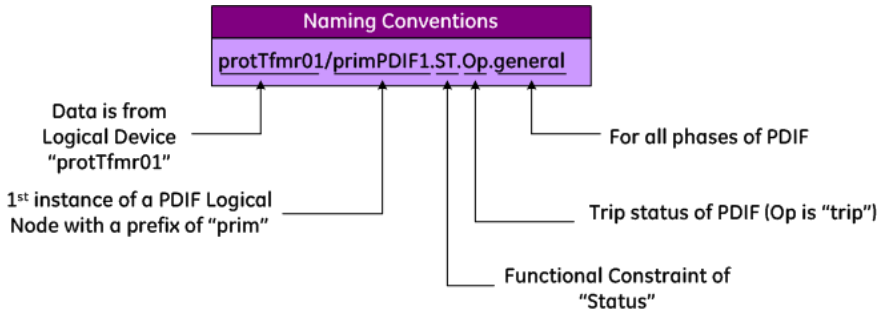
Table 20 – Functional constraint values

FunctionalConstraint values			
FC	Semantic	Services allowed	Initial values/storage/ explanation
ST	Status information	**DataAttribute** shall represent status information whose value may be read, substituted, reported, and logged but shall not be writeable.	Initial value of the **DataAttribute** shall be taken from the process.
MX	Measurands (analogue values)	**DataAttribute** shall represent measurand information whose value may be read, substituted, reported, and logged but shall not be writeable.	Initial value of the **DataAttribute** shall be taken from the process.
SP	Setting (outside setting group)	**DataAttribute** shall represent setting parameter information whose value is read and may be written. Changes of values shall become effective immediately, and may be reported.	Initial value of the **DataAttribute** shall be as configured; value shall be non-volatile.
SV	Substitution	**DataAttribute** shall represent substitution information whose value may be written to substitute the value attribute and read.	If the value of the **DataAttribute** is volatile then the initial value shall be FALSE, else the value should be as set or configured.
CF	Configuration	**DataAttribute** shall represent configuration information whose value may be written and read. Values written may become effective immediately or deferred by reasons outside the scope of this standard. Value changes may be reported.	Initial value of the **DataAttribute** shall be as configured; value shall be non-volatile.
DC	Description	**DataAttribute** shall represent description information whose value may be written and read.	Initial value of the **DataAttribute** shall be as configured; value shall be non-volatile.
SG	Setting group	Logical devices that implement the **SGCB** class maintain multiple grouped values of all instances of **DataAttributes** with functional constraint SG. Each group contains one value for each **DataAttribute**. **DataAttributes** with functional constraint SG shall be the current active value (for details see Clause 16). **DataAttributes** with FC=**SG** shall not be writeable.	Initial value of the **DataAttribute** shall be as configured; value shall be non-volatile.
SE	Setting group	**DataAttribute** that can be edited by **SGCB** services.	Value of the **DataAttribute** shall

So let's define this:



To finish



Trust

- "protTfmr01/primPDIF1.ST.Op.general" defines some information:
  - Where it comes from
  - What it represents
- But what about "we can trust it"?

Back to ACT

7.3.6 Protection activation information (ACT)

Table 23 defines the common data class "protection activation information".

Table 23 – Protection activation information common data class specification

ACT class					
Data attribute name	Type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from GenDataObject Class or from GenSubDataObject Class (see IEC 61850-7-2)				
DataAttribute					
			status		
general	BOOLEAN	ST	dchg		M
phsA	BOOLEAN	ST	dchg		O
phsB	BOOLEAN	ST	dchg		O
phsC	BOOLEAN	ST	dchg		O
neut	BOOLEAN	ST	dchg		O
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
originSrc	Originator	ST			O
operTmPhsA	TimeStamp	ST			O
operTmPhsB	TimeStamp	ST			O
operTmPhsC	TimeStamp	ST			O
d	VISIBLE ST				O
dU	UNICODE STRING255				O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table 18.					

Quality and TimeStamp are always Mandatory

All CDCs include:
- Quality
- TimeStamp

TimeStamp is time when data changed

Quality is "what we know about this data"

Quality

Quality type definition			
Attribute name	Attribute type	Value/Value range	M/O/C
	PACKED LIST		
validity	CODED ENUM	good | invalid | reserved | questionable	M
detailQual	PACKED LIST		M
overflow	BOOLEAN	DEFAULT FALSE	M
outOfRange	BOOLEAN	DEFAULT FALSE	M
badReference	BOOLEAN	DEFAULT FALSE	M
oscillatory	BOOLEAN	DEFAULT FALSE	M
failure	BOOLEAN	DEFAULT FALSE	M
oldData	BOOLEAN	DEFAULT FALSE	M
inconsistent	BOOLEAN	DEFAULT FALSE	M
inaccurate	BOOLEAN	DEFAULT FALSE	M
source	CODED ENUM	process | substituted DEFAULT process	M
test	BOOLEAN	DEFAULT FALSE	M
operatorBlocked	BOOLEAN	DEFAULT FALSE	M

XCBR Logical Node Description

XCBR class				
Attribute Name	Attr. Type	Explanation	T	M/O
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment name plate		O
OpCnt	INS	Operation counter		M
Controls				
Pos	DPC	Switch position		M
BlkOpn	SPC	Block opening		M
BlkCls	SPC	Block closing		M
ChaMotEna	SPC	Charger motor enabled		O
Metered Values				
SumSwARs	BCR	Sum of Switched Amperes, resetable		O
Status Information				
CBOpCap	INS	Circuit breaker operating capability		M
POWCap	INS	Point On Wave switching capability		O
MaxOpCap	INS	Circuit breaker operating capability when fully charged		O

Data Name
Common Data Class
Description
Mandatory/Optional

Single Point Status (SPS)

Common Data Class (CDC)

SPS class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
status					
stVal	BOOLEAN	ST	dchg	TRUE | FALSE	M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
substitution					
subEna	BOOLEAN	SV			PICS_SUBST
subVal	BOOLEAN	SV		TRUE | FALSE	PICS_SUBST
subQ	Quality	SV			PICS_SUBST
subID	VISIBLE STRING64	SV			PICS_SUBST
configuration, description and extension					
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M

Attribute Name | Type | Functional Constraint | Range of Values | Mandatory/ Optional/ Conditional

Why functional modeling matters

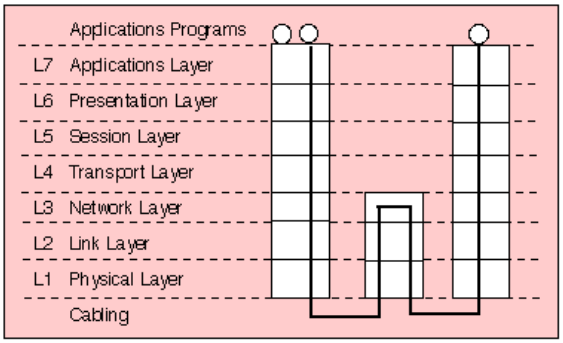
- Reuse of information
  - Once information is modeled in 1 device, it can be shared with other devices
- Configuration / mapping
  - Once information is described in one location, it is known / mapped to all locations
- Described in Standard Parts 7-1, 7-2, 7-3, 7-4

Why we care

- Need to know LNs and data attributes to take share data
  - "Sharing" can be used for information, for status, for control
  - Need to know how other devices accept this data
- Example: XCBR, Pos, and DPS…
  - XCBR.Pos.stVal is a DPS
  - Can end device accept DPS?

IEC 61850 Concepts
Ethernet

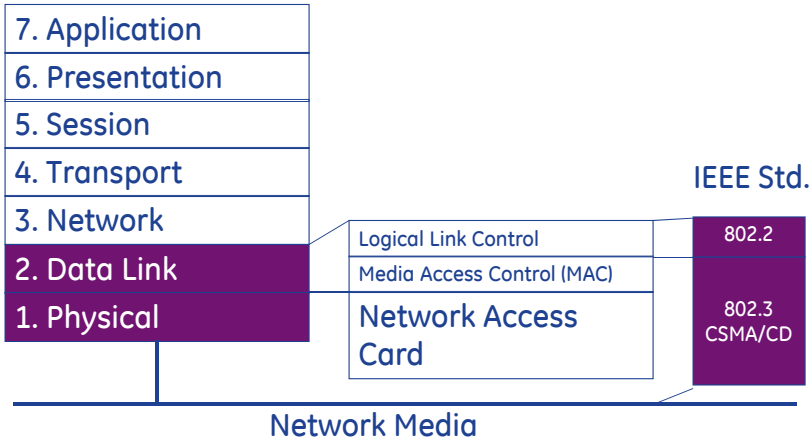
Ethernet Interface Layers



Gateway

Router
Bridge / Switched Hub
Repeater / Shared Hub

Ethernet and the 7 Layer OSI Model



Why we care

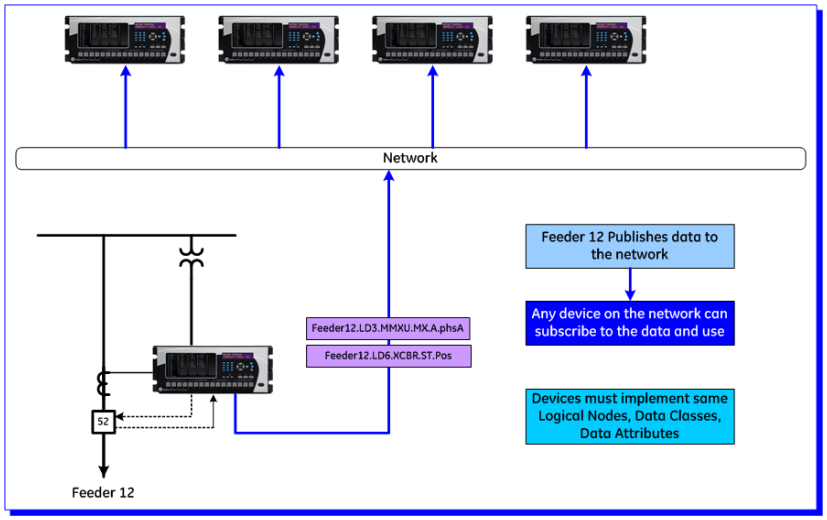
- GOOSE, SV traffic are MAC address only
  - Layer 2 traffic only
  - Works with switches, does not pass routers
- MMS are Network traffic
  - Layer 3 (uses IP address)
  - Can theoretically pass routers

IEC 61850 Concepts
GOOSE

Publish - Subscribe

- Data types
  - Peer-to-peer messaging ("GOOSE")
  - Instantaneous sampled values ("SV")
  - Client-server messaging (HMI)
  - Reporting (metering data for SCADA)

Publish – Subscribe (Multicast)



Why we care

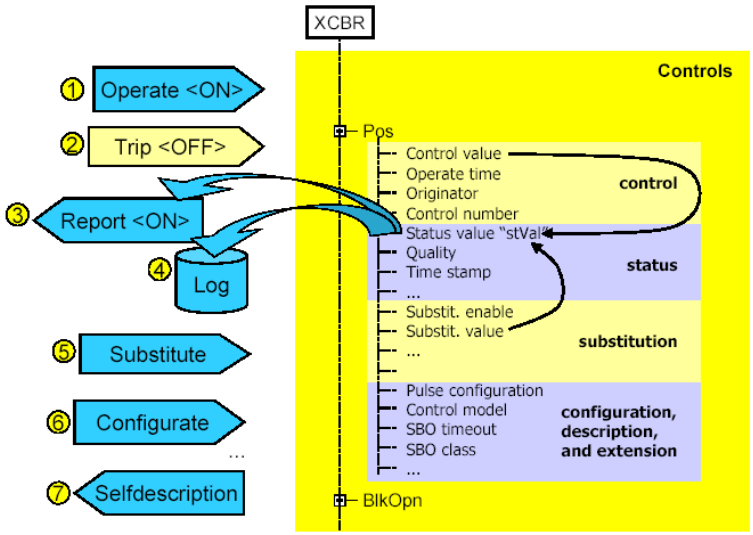
- GOOSE can replace field wiring
  - One GOOSE can carry multiple pieces of information
- GOOSE goes everywhere on network segment
  - Requires traffic shaping on large networks
- GOOSE uses retransmit for reliability
  - Message sent multiple times to ensure receipt

IEC 61850 Concepts
MMS

MMS
Machine Messaging Service

- Uses a "two party association" model
  - Essentially a point-to-point connection through the network
- Used for services, reporting
  - "Services" means control, data access, file access, etc.

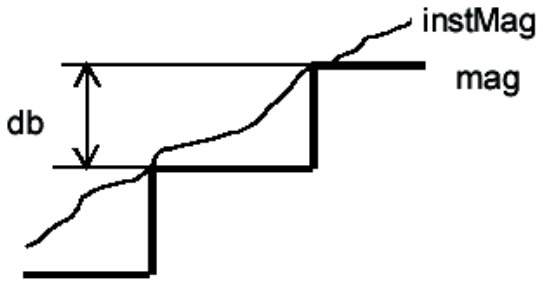
"Services" Concept
Client-Server Functionality Summary



Reporting

- Automatic Transmission of Information based on *Change Detection*
- Unbuffered Reporting is typically used to feed an HMI
- Buffered reporting enables the server to retain data if associations are lost enabling the client to retrieve ALL data

Analog Data Change Detect



- The Deadband (db) is calculated as a % of the total RANGE of the value being measured (the % is a user-setting)
- In a Report, ONLY the "mag" value from the last Deadband detection is reported
- In a poll, the instMag value is read

Some architecture thoughts

- HMI client
  - Unbuffered reporting for metering, status
  - Local control commands
- Gateway
  - Buffered reporting for metering, status, historical data
  - Remote control commands
  - Interlocking (maybe)
- Relays / meters as data servers
- Relays / distributed I/O as control points

Why we care

- If DCS / SCADA master is 61850 compliant
  - Configuration is simpler (no point mapping!)
  - Reporting is better than polling
  - Trust but verify controls (SBO)

IEC 61850 Concepts
Configuration

SCL – Substation Configuration Language

- Common description language configuring IEC 61850 communications in all IEDs
- XML based language that allows a formal description of
  - Substation automation system and the switchyard and the relation between them
  - IED configuration
- Standard Part 6

SCL File Types

SSD: System Specification Description
XML description of the entire system

SCD: Substation Configuration Description
XML description of a single substation

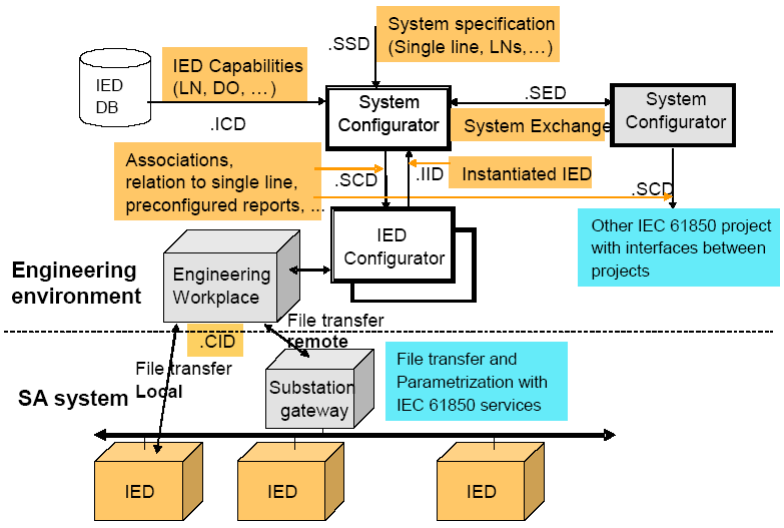
SED: System Exchange Description
XML description of a project

ICD: IED Capability Description
XML description of items supported by an IED

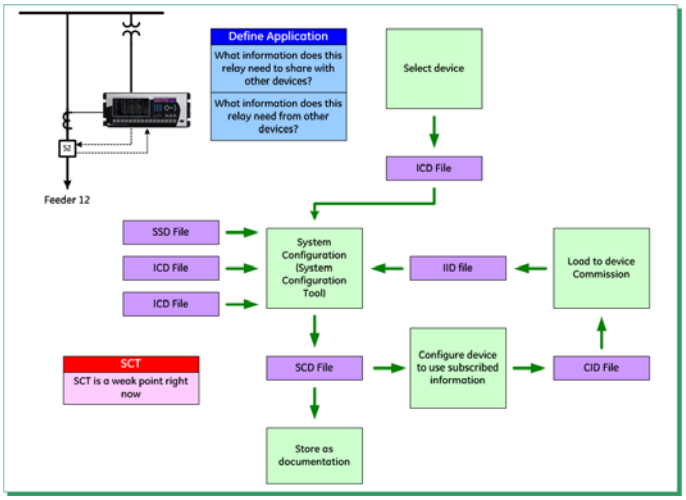
CID: Configured IED Description
XML configuration for a specific IED

IID: Instantiated IED Description
XML description of commissioned device

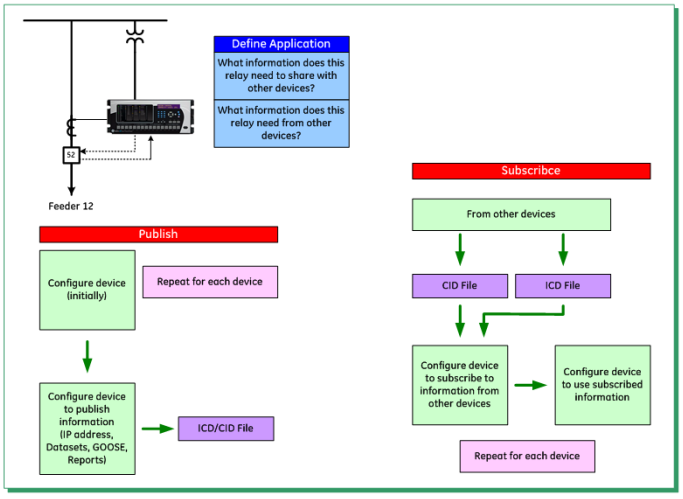
IEC 61850 configuration process



"Top Down" Configuration



"Bottoms Up" Configuration



Takeaways

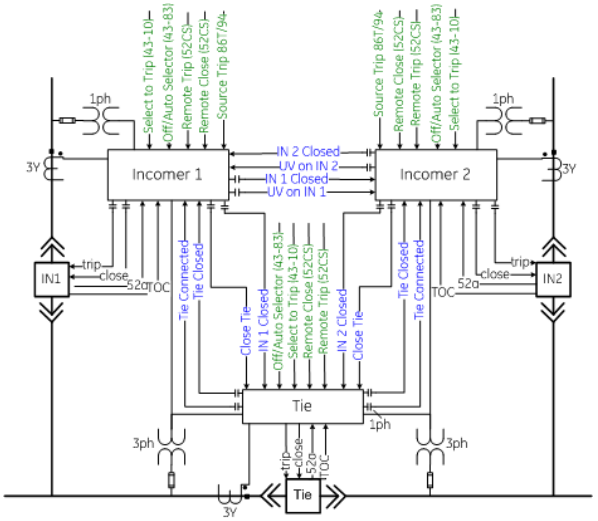
- Need to have some understanding of basic Logical Nodes
- Need to know how GOOSE works
- Need to know which files to use
- Need to understand your application first!

An Example

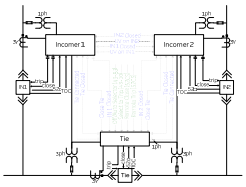
Example:
Main-Tie-Main Autotransfer

- Example M-T-M scheme:
  - Open residual voltage transfer
  - Close transfer to restore
  - Auto-restore possible
- GOOSE messaging makes this simpler, faster, repeatable
- Use “Bottoms Up” configuration approach

M-T-M Hardwired

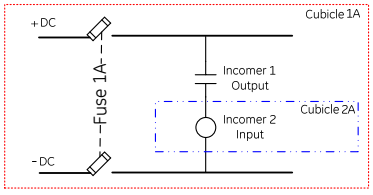


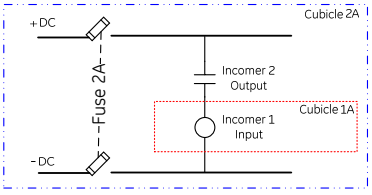
Wiring count



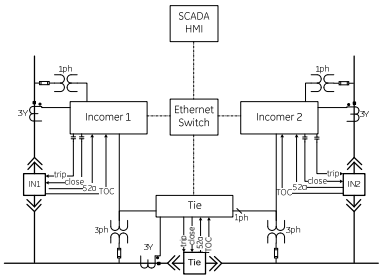
	Incomer 1	# of Relay Terminations	Contact Inputs Used	Outputs Used
Mandatory Hardwiring	VT #1	6		
	VT #2	2		
	Phase CT's	6		
	Trip Incomer 1	2		1
	Close Incomer 1	2		1
	Incomer 1 Status	1	1	
	Incomer 1 Racked In/Out	1	1	
Inter-Relay Hardwiring	Incomer 1 Status to IN 2	2		1
	Incomer 1 Status to Tie	2		1
	Incomer 1 Undervoltage to IN2	2		1
	Close Tie	2		1
	Incomer 2 Status	1	1	
	Incomer 2 Undervoltage	1	1	
	Tie Connected	1	1	
	Tie Closed	1	1	
Controls Hardwiring	Source Trip (94 or 87T)	1	1	
	Remote Close (52CS)	1	1	
	Remote Trip (52CS)	1	1	
	Selected to Trip (43-10)	1	1	
	Off/Auto Selector (43-83)	1	1	
	TOTAL (Fully Hardwired):	37	11	6
	TOTAL (Inter-Relay Digitization):	25	7	2
	TOTAL (Inter-Relay & Control Digitization):	20	2	2

Control Voltage Isolation



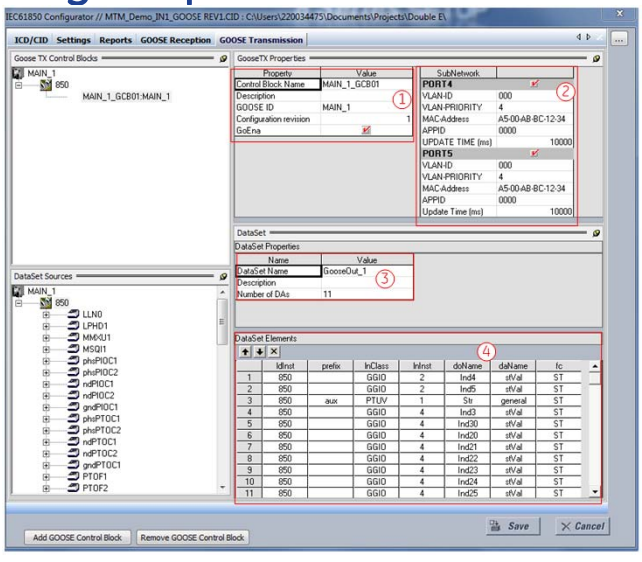


Digitizing I/O

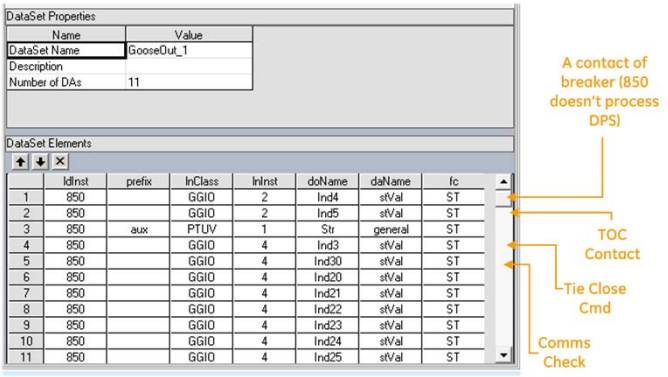


Publisher	Message	Subscriber(s)
Incomer 1	Incomer 1 52a Status	Incomer 2
		Tie
Incomer 1	Incomer 1 TOC Status	Incomer 2
		Tie
Incomer 1	Close Tie Command	Tie
Incomer 1	Source 1 Voltage Unhealthy	Incomer 2
Incomer 2	Incomer 2 52a Status	Incomer 1
		Tie
Incomer 2	Incomer 2 TOC Status	Incomer 1
		Tie
Incomer 2	Close Tie Command	Tie
Incomer 2	Source 2 Voltage Unhealthy	Incomer 1
Tie	Tie 52a Status	Incomer 1
		Incomer 2
Tie	Tie TOC Status	Incomer 1
		Incomer 2
Tie	Phase IOC1 Status (Block for ZSI)	Incomer 1
		Incomer 2

Digitizing outputs with GOOSE



Main 1 Dataset



DataSet Properties

Name	Value
DataSet Name	GooseOut_1
Description	
Number of DAs	11

DataSet Elements

	IdInst	prefix	InClass	InInst	doName	daName	fc
1	850		GGIO	2	Ind4	stVal	ST
2	850		GGIO	2	Ind5	stVal	ST
3	850	aux	PTUV	1	Str	general	ST
4	850		GGIO	4	Ind3	stVal	ST
5	850		GGIO	4	Ind30	stVal	ST
6	850		GGIO	4	Ind20	stVal	ST
7	850		GGIO	4	Ind21	stVal	ST
8	850		GGIO	4	Ind22	stVal	ST
9	850		GGIO	4	Ind23	stVal	ST
10	850		GGIO	4	Ind24	stVal	ST
11	850		GGIO	4	Ind25	stVal	ST

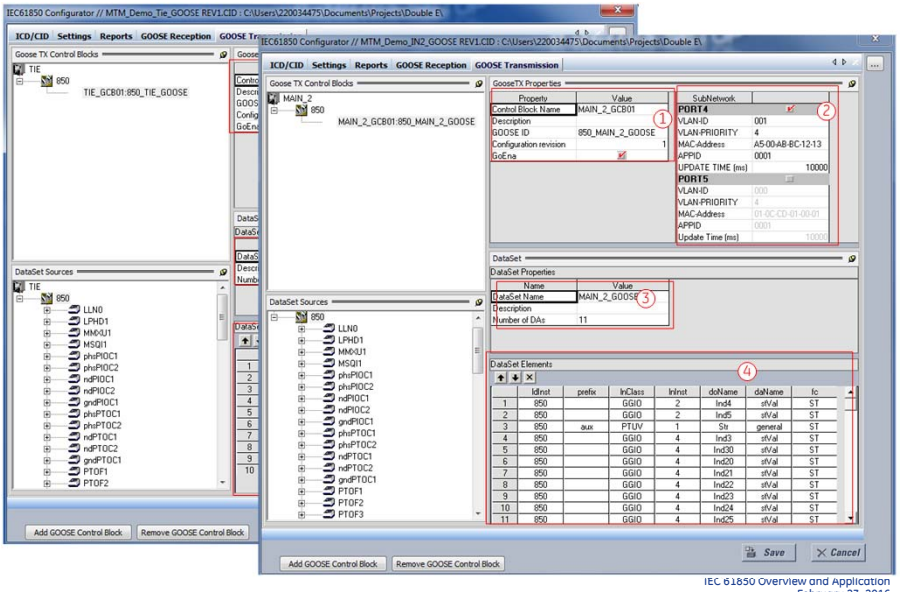
A contact of breaker (850 doesn't process DPS)

TOC Contact

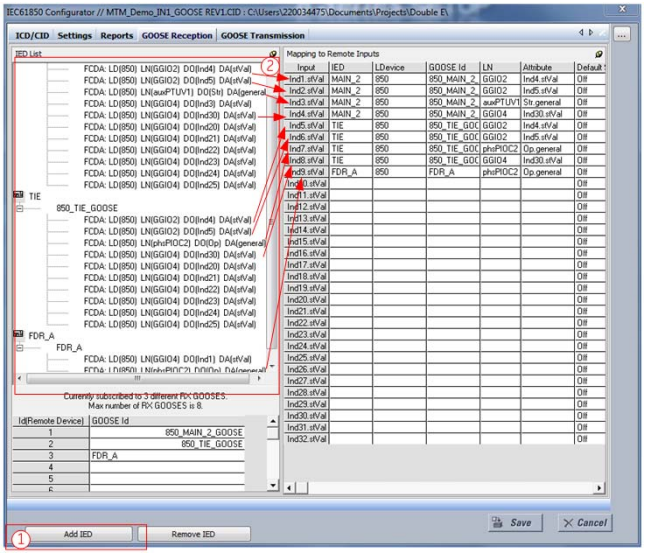
Tie Close Cmd

Comms Check

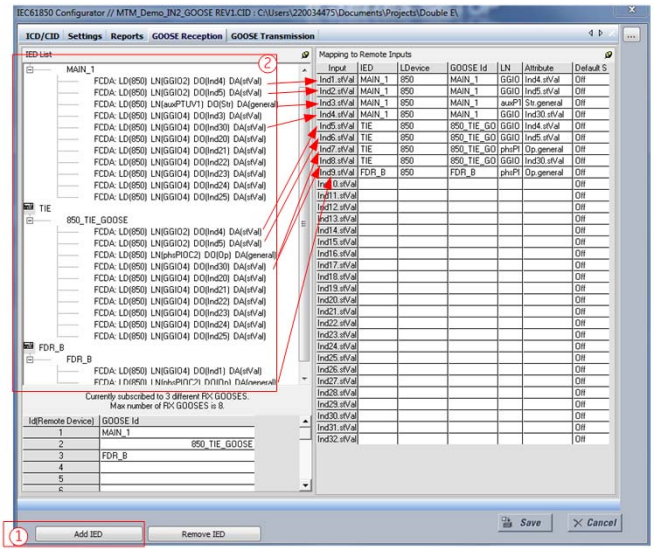
Tie, Main 2 Config



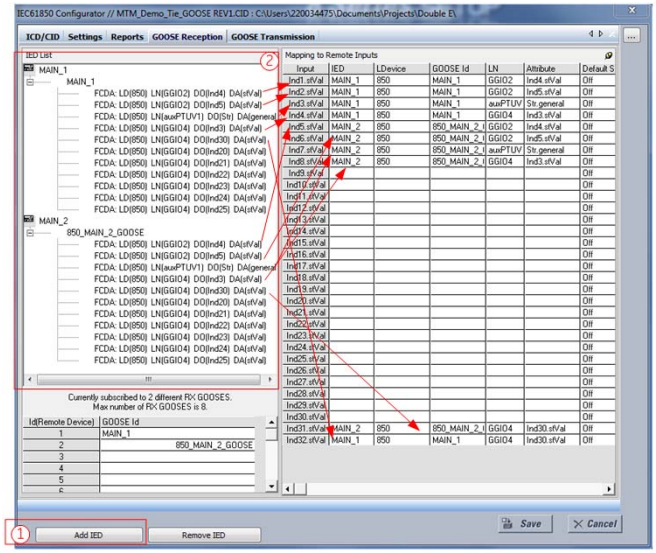
Main 1 RX GOOSE



Main 2 RX GOOSE



Tie RX GOOSE

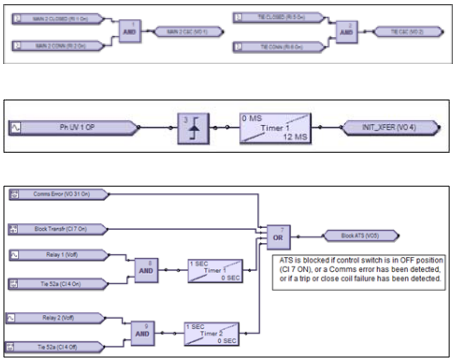


Digitizing Inputs with GOOSE

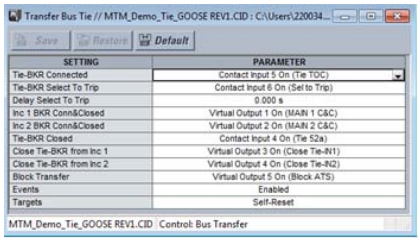
Relay	Message	Remote Input
Incomer 1	Incomer 2 52a Status	Remote Input 1
	Incomer 2 TOC Status	Remote Input 2
	Incomer 2 Undervoltage	Remote Input 3
	Incomer 2 Communications OK	Remote Input 4
	Tie 52a Status	Remote Input 5
	Tie TOC Status	Remote Input 6
	Tie PIOC2 Operated	Remote Input 7
	Tie Communications OK	Remote Input 8
	FDR_A PIOC2 Operated	Remote Input 9
Incomer 2	Incomer 1 52a Status	Remote Input 1
	Incomer 1 TOC Status	Remote Input 2
	Incomer 1 Undervoltage	Remote Input 3
	Incomer 1 Communications OK	Remote Input 4
	Tie 52a Status	Remote Input 5
	Tie TOC Status	Remote Input 6
	Tie PIOC2 Operated	Remote Input 7
	Tie Communications OK	Remote Input 8
	FDR_B PIOC2 Operated	Remote Input 9
Incomer 2	Incomer 1 52a Status	Remote Input 1
	Incomer 1 TOC Status	Remote Input 2
	Incomer 1 Undervoltage	Remote Input 3
	CLOSE Tie from IN 1	Remote Input 4
	Tie 52a Status	Remote Input 5
	Tie TOC Status	Remote Input 6
	Tie PIOC2 Operated	Remote Input 7
	CLOSE Tie from IN 2	Remote Input 8
	IN 2 Communications OK	Remote Input 30
	IN 1 Communications OK	Remote Input 31

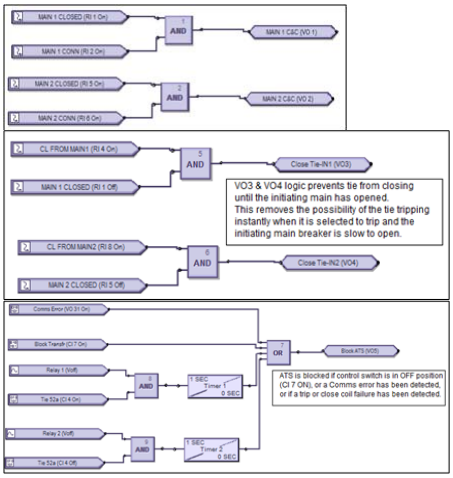
Configuring Inputs: Main 1

SETTING	PARAMETER
Transfer Incomer 1	
Inc 1 BKR Connected	Contact Input 5 On (IN1 TOC)
Inc 1 BKR Select To Trip	Contact Input 6 On (Sel to Trip)
Delay Select To Trip	3.000 s
Inc 2 BKR Conn&Closed	Virtual Output 1 On (MAIN 2 C&C)
Tie-BKR Conn&Closed	Virtual Output 2 On (TIE C&C)
Tie-BKR Connected	Remote Input 8 On (TIE CONN)
Inc 1 Transformer Lockout	Off
Inc 1 Source Trip	Off
Timed UV On This Source	Virtual Output 4 On (INIT_XFER)
Block Trip On Double Loss	Disabled
Inc 1 BKR Closed	Contact Input 4 On (IN1 52a)
UV On Other Source	Remote Input 3 On (SOURCE 2 UV)
Delay Other Source	3.000 s
Inst UV On This Source	Ph UV 1 PKP
Delay This Source	1.000 s
Fault Current Pickup In 1	Off
Fault Current Pickup In 2	Off
Fault Current Pickup In 3	Off
Fault Current Pickup In 4	Off
Fault Current Pickup In 5	Off
Fault Current Pickup In 6	Off
Block Transfer	Virtual Output 5 On (BLOCK ATS)
Events	Enabled
Targets	Self-Reset

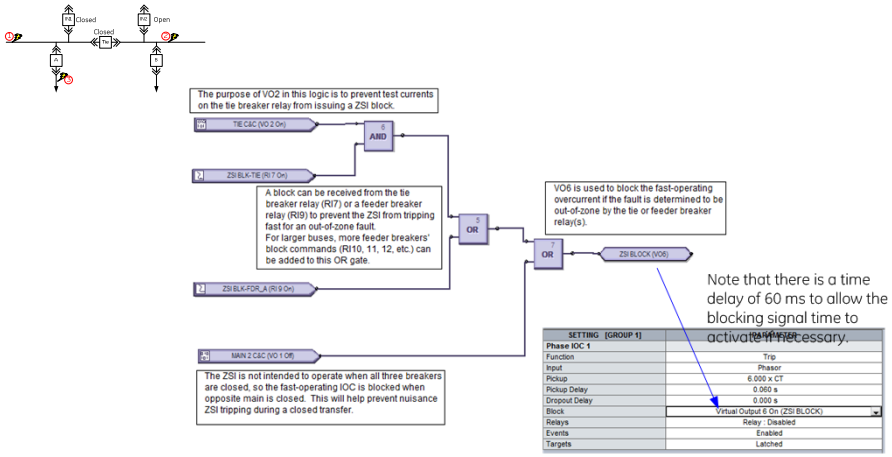


Configuring Tie





Extending: ZSI

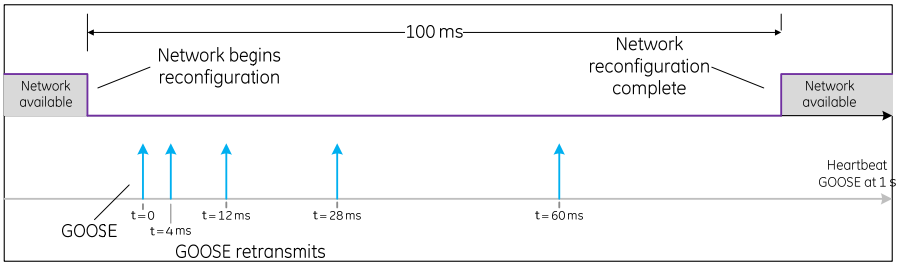


Some Ethernet network thoughts

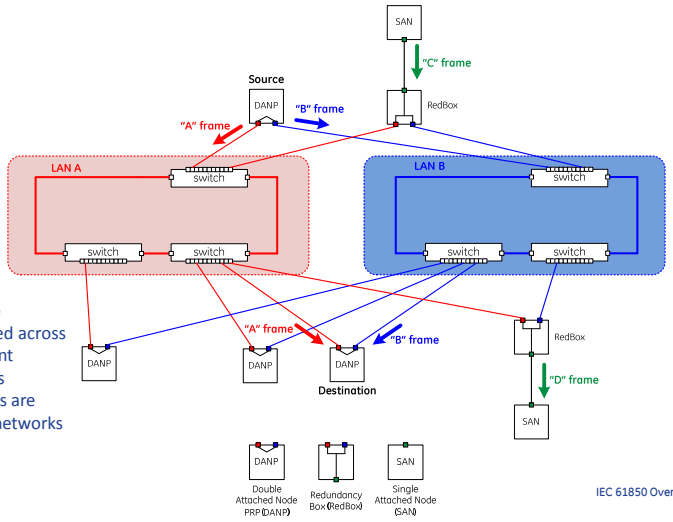
Network

- Using 61850 requires an Ethernet network
- For a small sub, or switchgear lineup:
  - 2 switches, with RSTP, is probably OK
  - 5-10ms reconfig time means GOOSE gets through on retransmit
- Large sub, large network: not OK

GOOSE retransmit

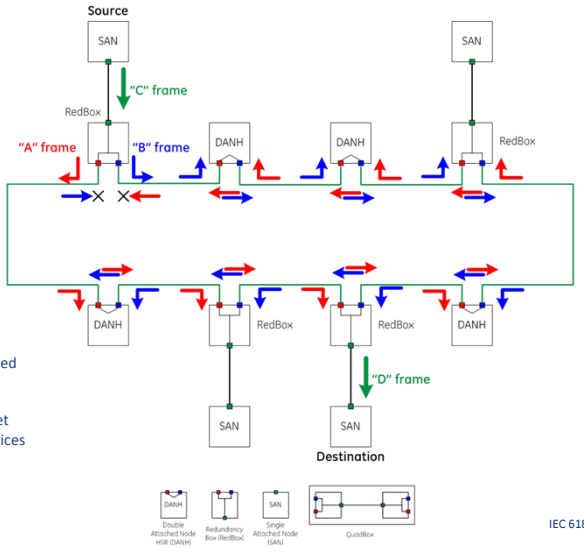


PRP
Parallel Redundancy Protocol



- Message duplicated across redundant networks
- Networks are normal networks

HSR
High-availability Seamless Recovery



- Message duplicated both directions around ring
- Uses non-Ethernet frames, so all devices must be HSR

The Big Finish

Ethernet Networks

- RSTP network (1-2 switches) good enough for most applications
- PRP / HSR make sense on larger applications
  - PRP is simpler: standard networks, testing is clear
  - HSR can make sense: if HSR devices are available

Final Thoughts

- IEC 61850 is not an abstract thing: it has value for some applications
- M-T-M Scheme: GOOSE eliminates field wiring
  - Allows standard, repeatable design
  - Field changes are simple configuration (that can be lab tested!)
- Don't need to know the Standard inside and out
- Everything documented in XML
  - Instantly, and consistently, understood by others