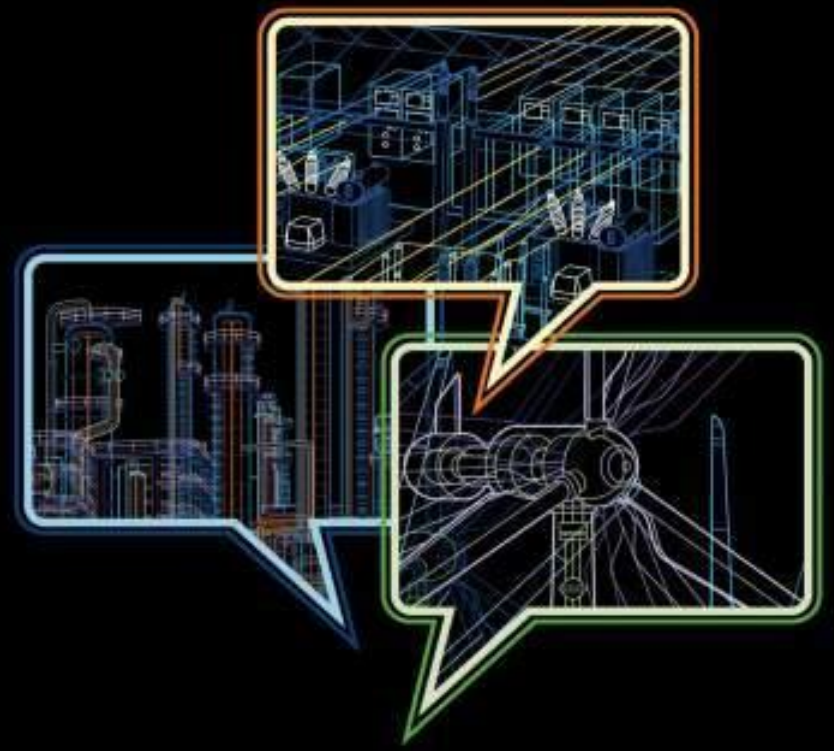


ABB Automation & Power World: April 18-21, 2011

IEC 61850 connectivity, networking and state-of-the-art Relion protection/control technologies

Overview

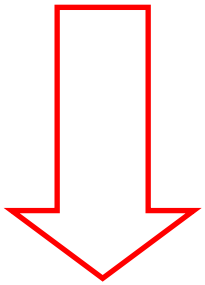
- IEC61850 Basics
- What is a GOOSE message?
- Digitizing copper in P&C applications

The Basics

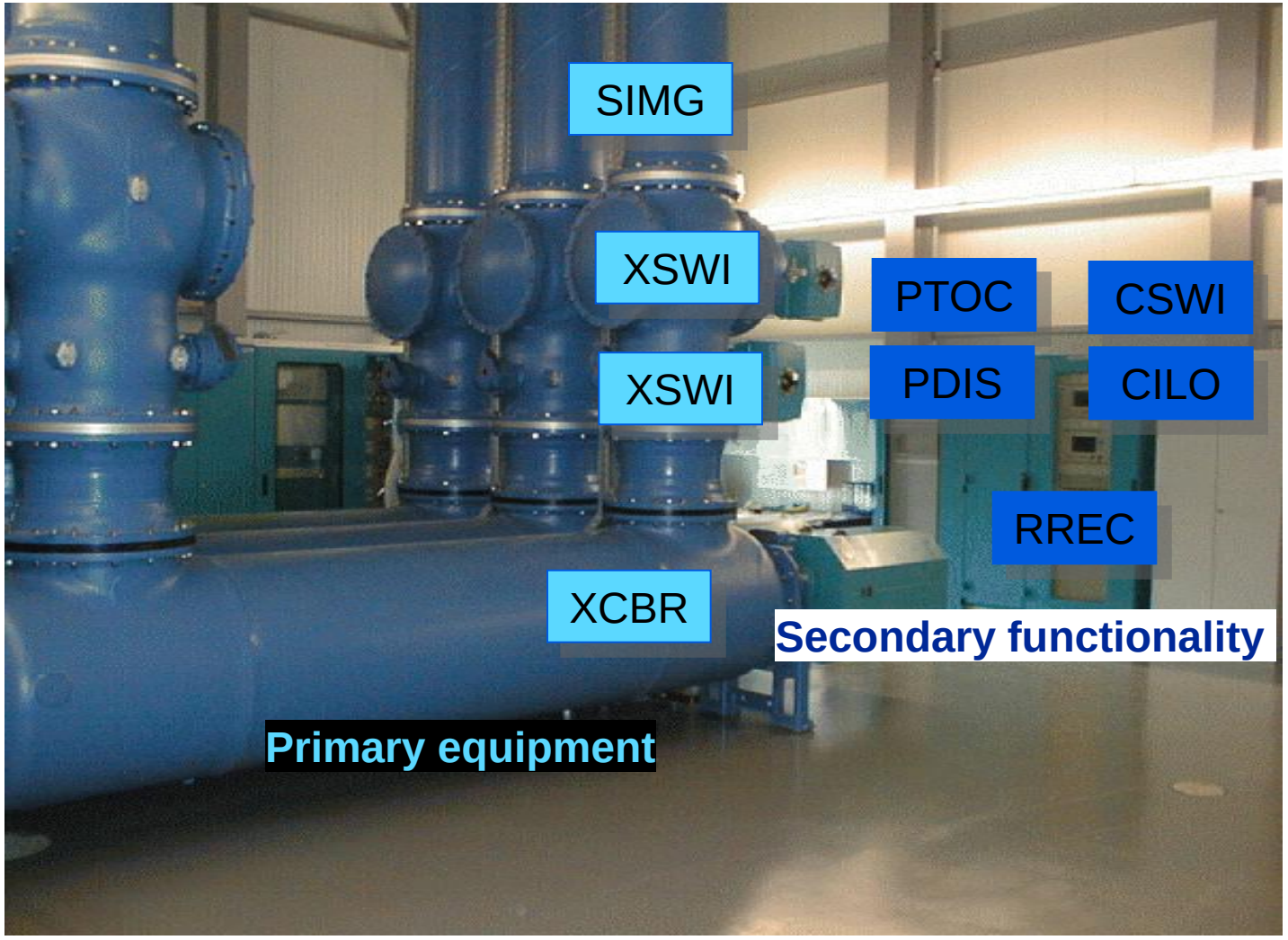
A way to model equipment/functions and document in a standard format for easy exchange

- Moving from a memory location driven data layout to one that is named and defined based on application

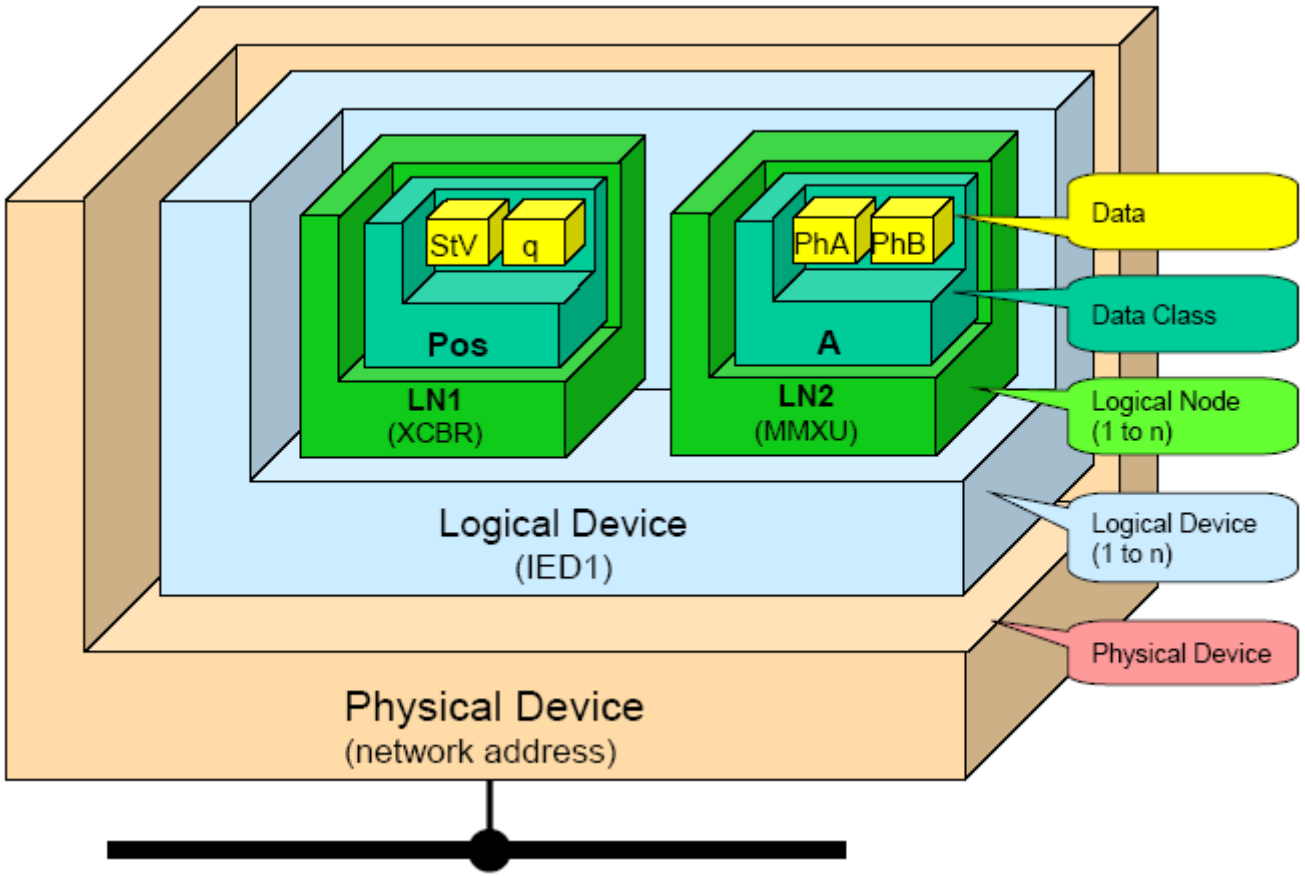
00001:	<0>	00014:	<0>	00027:	<0>	00040:	<0>	00053:	<0>	00066:	<0>	00079:	<0>	00092:	<0>
00002:	<0>	00015:	<0>	00028:	<0>	00041:	<0>	00054:	<0>	00067:	<0>	00080:	<0>	00093:	<0>
00003:	<0>	00016:	<0>	00029:	<0>	00042:	<0>	00055:	<0>	00068:	<0>	00081:	<0>	00094:	<0>
00004:	<0>	00017:	<0>	00030:	<0>	00043:	<0>	00056:	<0>	00069:	<0>	00082:	<0>	00095:	<0>
00005:	<0>	00018:	<0>	00031:	<0>	00044:	<0>	00057:	<0>	00070:	<0>	00083:	<0>	00096:	<0>
00006:	<0>	00019:	<0>	00032:	<0>	00045:	<0>	00058:	<0>	00071:	<0>	00084:	<0>	00097:	<0>
00007:	<0>	00020:	<0>	00033:	<0>	00046:	<0>	00059:	<0>	00072:	<0>	00085:	<0>	00098:	<0>
00008:	<0>	00021:	<0>	00034:	<0>	00047:	<0>	00060:	<0>	00073:	<0>	00086:	<0>	00099:	<0>
00009:	<0>	00022:	<0>	00035:	<0>	00048:	<0>	00061:	<0>	00074:	<0>	00087:	<0>	00100:	<0>
00010:	<0>	00023:	<0>	00036:	<0>	00049:	<0>	00062:	<0>	00075:	<0>	00088:	<0>		
00011:	<0>	00024:	<0>	00037:	<0>	00050:	<0>	00063:	<0>	00076:	<0>	00089:	<0>		
00012:	<0>	00025:	<0>	00038:	<0>	00051:	<0>	00064:	<0>	00077:	<0>	00090:	<0>		
00013:	<0>	00026:	<0>	00039:	<0>	00052:	<0>	00065:	<0>	00078:	<0>	00091:	<0>		



Logical nodes



What is inside a Logical Node?

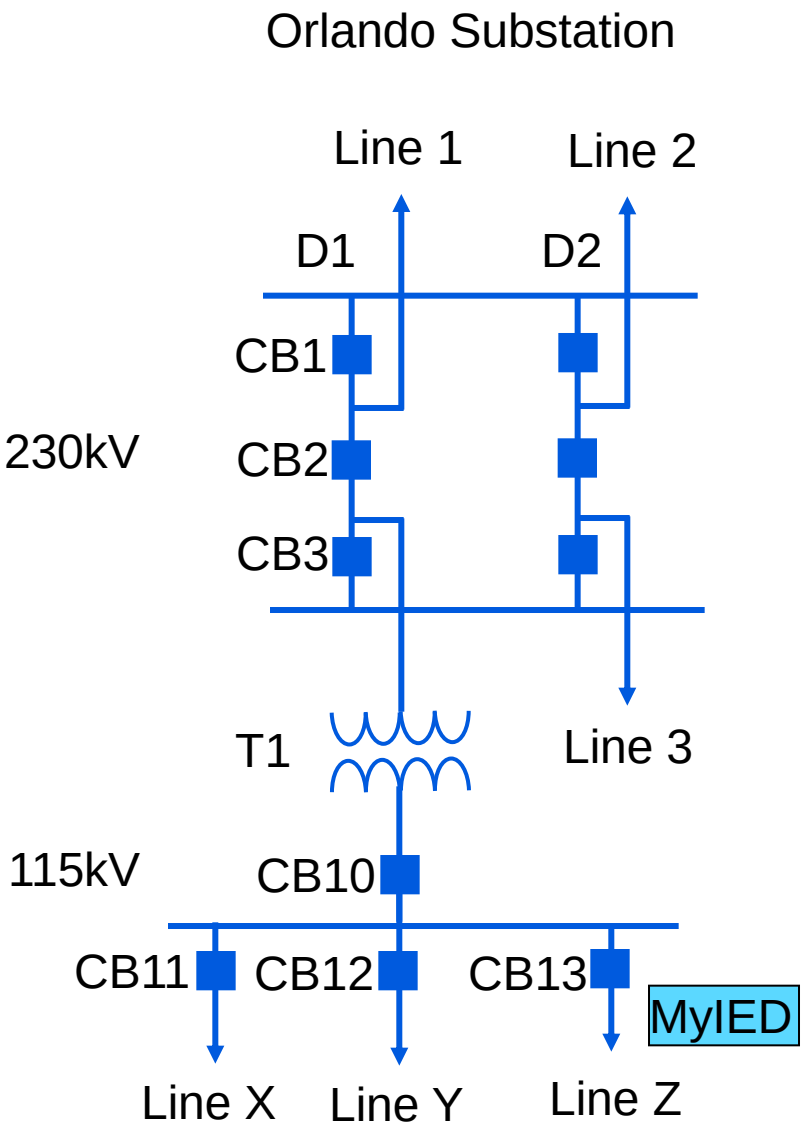


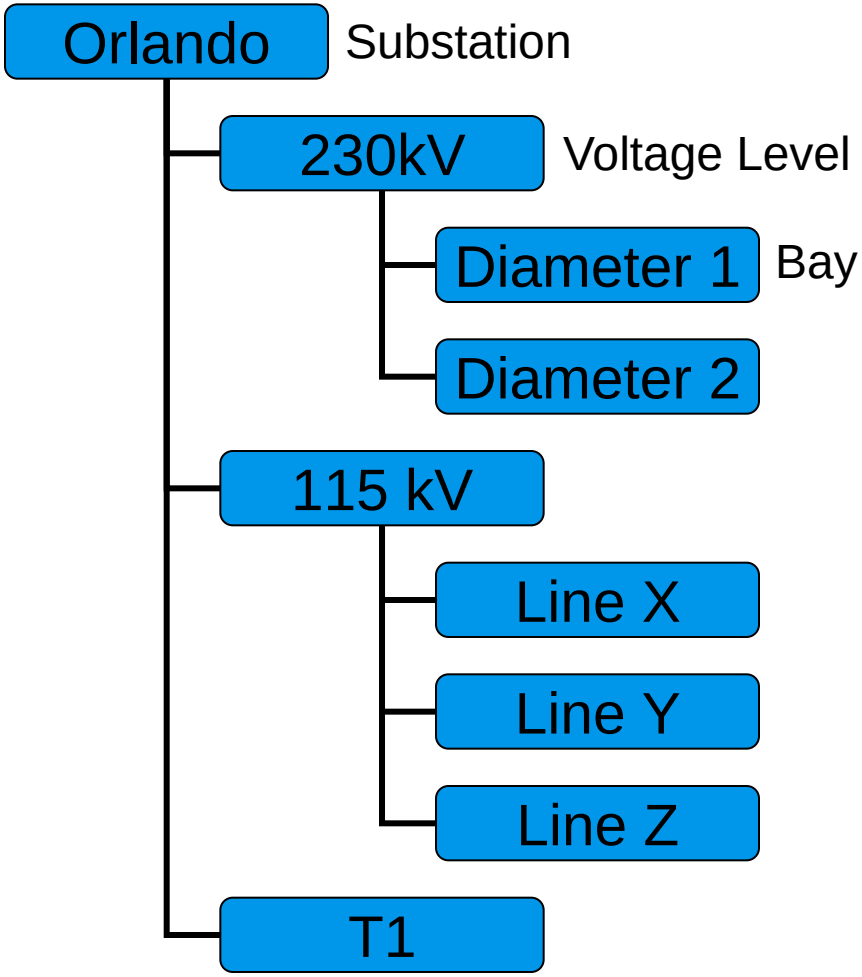
"UCA & 61850 for Dummies." – Douglas Proudfoot

Different kinds of Logical Nodes

- LLN0, LPHD: IED and function management
- Pxxx: protection (PTOC, PIOC, PDIS, PDIF,….) (28)
- Rxxx: protection related (RREC, RSYN, RDRx, ….) (10)
- Cxxx: control related (CSWI, CILO, CALH, CCGR, CPOW)
- Mxxx: measurements (MMXU, MMXN, MMTR, MHAI, MDIF, MSTA)
- Axxx: automatic functions (ATCC, ANCR, ARCO, AVCO)
- Gxxx: generic functions (GGIO, GAPC, GSAL)
- Sxxx: sensor/monitoring interface (SIMG, SIML, SARC, SPDC)
- Txxx: instrument transformer (TCTR, TVTR)
- Xxxx: switchgear process interface (XCBR, XSWI)
- Yxxx: transformer process if (YPTR, YLTC, YEFN, YPSH)
- Zxxx: further power related equipment (ZBAT, ZGEN, ZMOT,…)
- Ixxx: interfacing and archiving (IHMI, ITCI, IARC, ITMI)

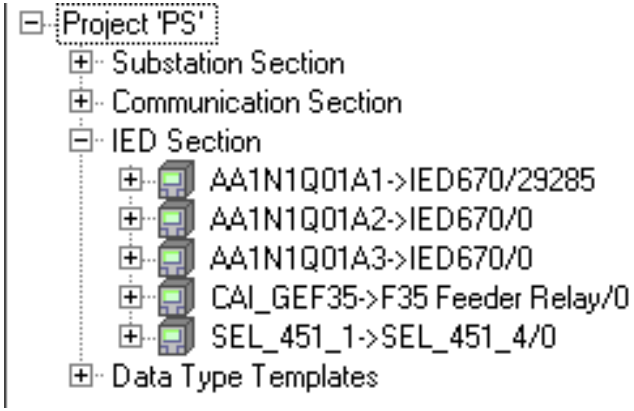
Modeling – Substation structure





SCL and Modeling in 61850

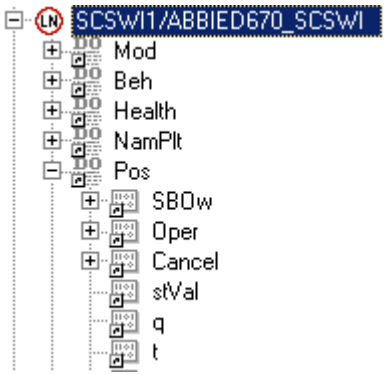
- 61850 defines a common language where all compliant manufacturers can exchange information regarding the “functions” (Logical Nodes) and related data available inside their equipment.
- Substation Configuration Language
- Offers 4 file formats (Ed. 1)
  - SSD: Substation Specification Description
  - ICD: IED Capabilities Description
  - CID: Configured IED Description
  - SCD: Substation Configuration Description



The Basics (cont.)

Client-Server interactions

- Get information from relays and meters
- Higher resolution of information
- Lower integration costs
  - Drag and drop process thanks to SCL file
  - All manufacturers with same naming convention
  - Less chances for mistakes
  - Faster integration



Point#	Refer#	Variable	Class
0	0	Ia (Load Currents)	0 3
1	2	Ib	0 3
2	4	Ic	0 3
3	6	In	0 3
4	9	KVan (Mag) (*1000)	0 3
5	11	KVbn (Mag) (*1000)	0 3

Point#	Refer#	Variable	Class
0	9	KVan (Mag) (*1000)	0 3
1	11	KVbn (Mag) (*1000)	0 3
2	13	KVcn (Mag) (*1000)	0 3
3	0	Ia (Load Currents)	0 3
4	2	Ib	0 3
5	4	Ic	0 3
6	6	In	0 3
7	15	KWan	0

SXSWI: 3.OPENPOS	CircuitSwitch, Apparatus open position
SXSWI: 3.CLOSEPOS	CircuitSwitch, Apparatus closed position
VNMMXU: 3.V_C	VoltagePhasors, V_C Amplitude, magnitude of reported value
VNMMXU: 3.V_B	VoltagePhasors, V_B Amplitude, magnitude of reported value
VNMMXU: 3.V_A	VoltagePhasors, V_A Amplitude, magnitude of reported value
CMSQI: 3.3I0	CurrentSequenceComponents, 3I0 magnitude of reported value

The Basics (cont.)

Digitize copper (GOOSE + SMV)

- Thanks to Ethernet technology and previously mentioned data model we are able to digitize copper:
  - Binary signals
  - Analog signals

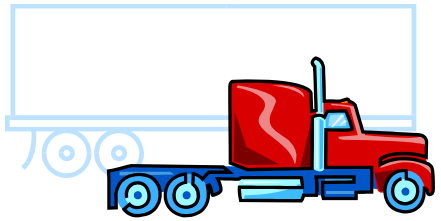
What is a GOOSE message?

- Generic Object Oriented Substation Event
- Fast and reliable distribution of information
  - Status (breaker position, trip, pickup, alarms, etc.)
  - Analog (voltage, current, counter values, etc.)
- Performance
  - Fast messages Type 1A (Class P2/P3) received within 3ms.
  - This includes transmission time into the other IEDs (similar to an output to input connection between 2 relays)
- In P&C it represents a way to exchange status points similar to inputs and outputs

What is a GOOSE message?

- GOOSE messages are based on change event
- GOOSE messages include diagnostic functions (a “heart beat” to all devices subscribed is sent periodically)
- GOOSE messages are managed by GCBs (GOOSE control block) inside IEDs
- GOOSE messages send “Data Sets” upon changes of state

Data set (information)

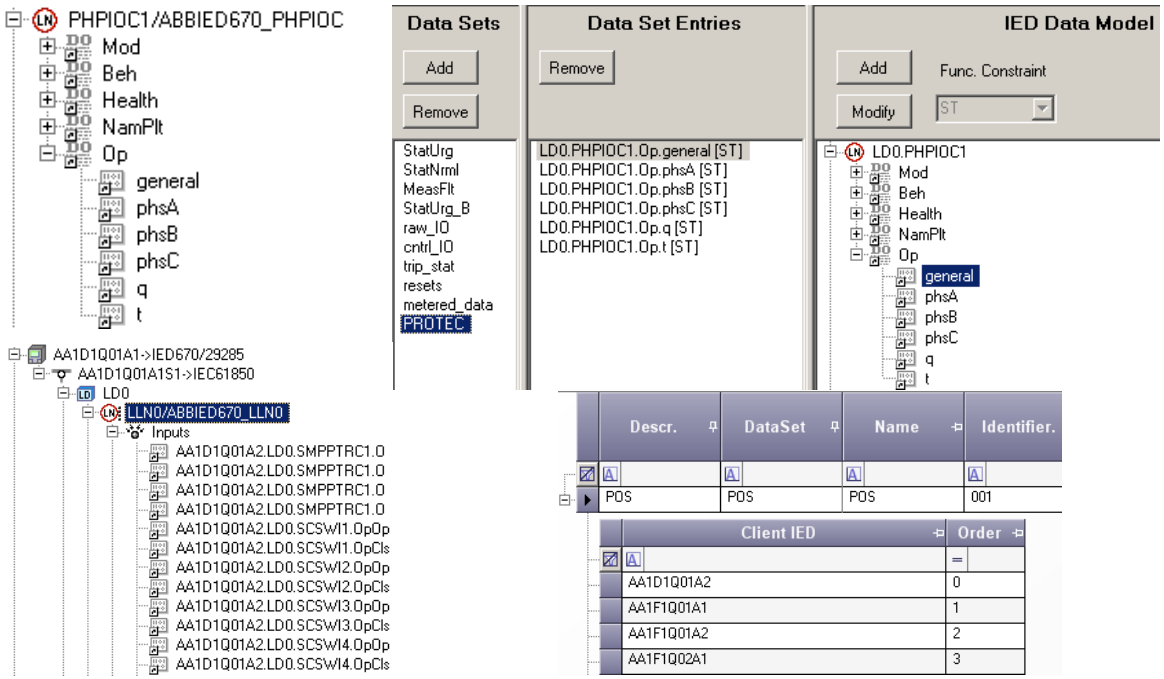


GCB

Network

What is a GOOSE message?

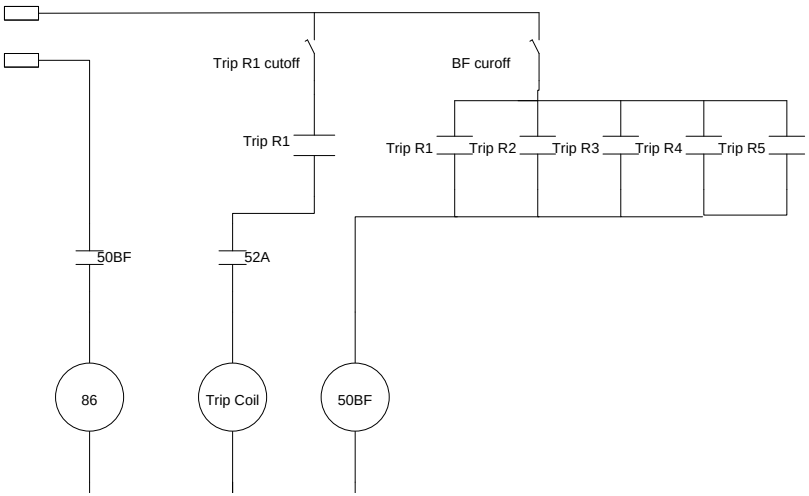
- GOOSE messages enable the connection of functions rather than inputs and outputs
- This principle results is more intuitive documentation of control diagrams
- Fast deployment and testing of changes

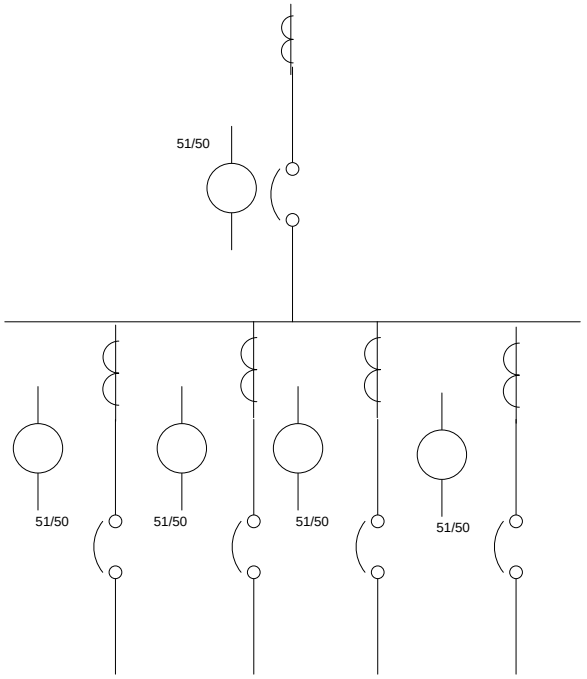


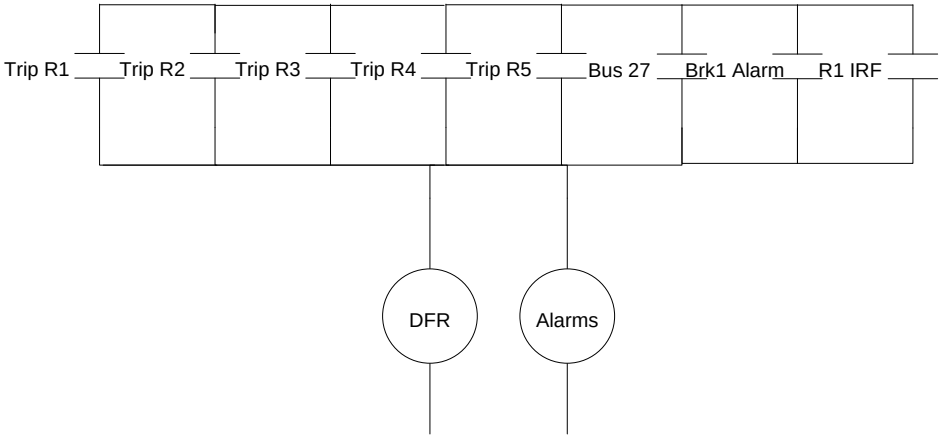
Applying GOOSE messages

Define an application

- Anything that requires the exchange of information within relays (done today via hardwired connections)
- Breaker Failure (VERIFY DROPOUT REQUIREMENTS)
- DFR
- Transfer Scheme
- Reclosing in multi breaker arrangements







Applying GOOSE messages

How about the network?

- Depending on the application of GOOSE messages the network infrastructure now becomes part of the P & C team
- Switches must comply to the same quality and performance standards as other electronic P & C equipment (Dielectric, SWC, RFI, etc).
- Redundancy (Parallel Redundancy Protocol) to ensure high availability and dependability of the system

Applying GOOSE messages

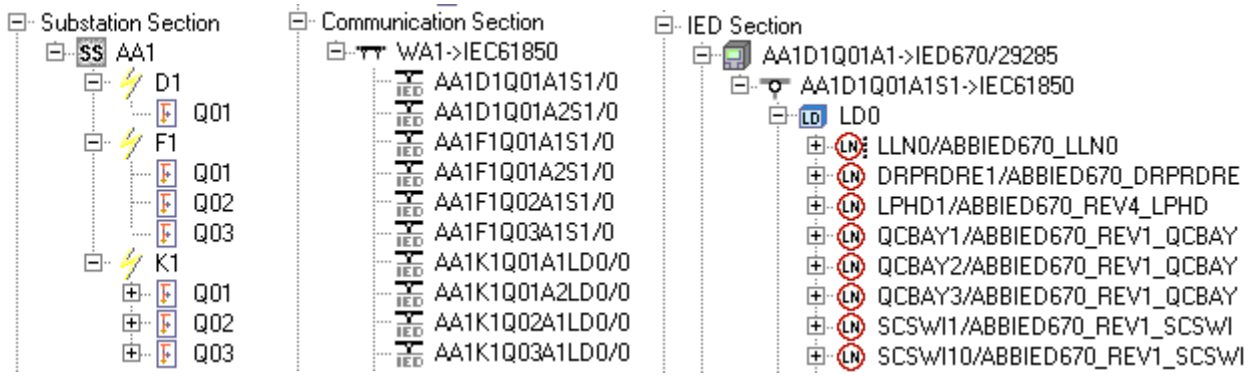
Data model of IED and how it affects integration

- As seen, the 61850 data model brings a common format for all manufacturers
- ICD files are available from manufacturers prior to ordering equipment
- Ensure selected devices have a data model that supports your application
- **Ensure selected devices can send and receive information from/to desired Logical Node (Function)**
- SAS engineering work can start with ICD files!

Applying GOOSE messages

System tool approach

- Thanks to common file format engineering of the SAS system can be performed under a single tool
- This provides a single point of interaction with the configuration files of all devices regardless of manufacturer
- End result (SCD file) must be part of the final system documentation just like DC and AC elementary are

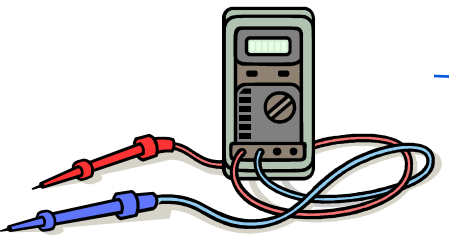


Applying GOOSE messages

Test and verification

- Digitizing copper requires new testing techniques and tools
- These tools are available now from different manufacturers
- Visualization of results are important
  - See that application works: GOOD
  - See and record network traffic: BETTER
- Network analyzers allow us to quickly diagnose and evaluate the status of the system

Applying GOOSE messages



ITT600 - Explore Ethernet

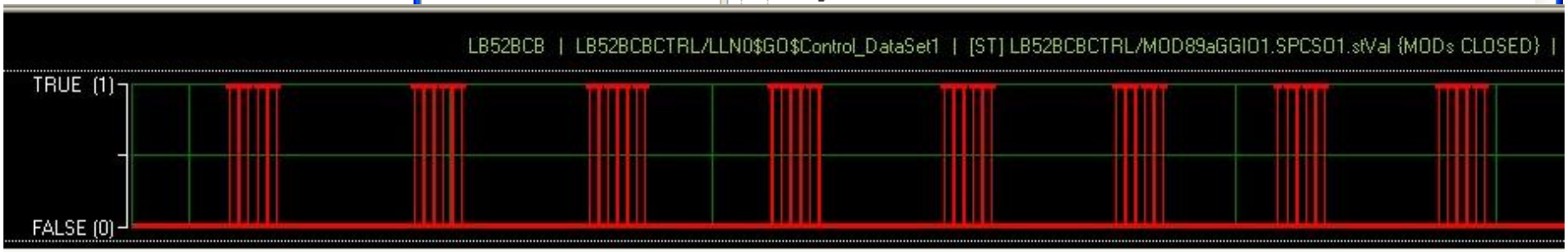
File View Tools Help

No.	SourceS	DestinationSer	RecTime	SourceIP	Destinatio	SourceM	Destination	Dat	Applicati	Details	Transport
5	Not found	Not found	20.10.2008 2	0.0.0.0	0.0.0.0	00:0A:DC:	01:80:C2:00:	60	Spanning_	Spanning T	Ethernet
6	Not found	Not found	20.10.2008 2	0.0.0.0	0.0.0.0	00:80:82:7	01:0C:CD:01	184	GOOSE	GOOSE A	Ethernet
7	Not found	Not found	20.10.2008 2	0.0.0.0	0.0.0.0	00:80:82:7	01:0C:CD:01	184	GOOSE	GOOSE A	Ethernet
8	Not found	Not found	20.10.2008 2	0.0.0.0	0.0.0.0	00:0A:DC:	01:80:C2:00:	60	Spanning_	Spanning T	Ethernet
9	Not found	Not found	20.10.2008 2	192.168.1.13	192.168.1.1	00:80:82:7	00:1C:25:18:	60	MMS	TCP Keep	TCP

General

IsComplete	True
messageCount	1
MessageDescript	GOOSE APPID: 0x0001

GOOSE Frame Header
- APPID: 0x0001
- GoCBRef: REL670LD0/LLN0GOPos
- TimeAllowedToLive: 1100
- DataSetRef: REL670LD0/LLN0$Positions
- GoID: REL670LD0/LLN0GOPos
- Timestamp: 11.10.2008 23:45:31.946
- StateChangeNumber: 32
- SequenceNumber: 35
- TestMode: False
- ConfigurationRevision: 2



Applications for Smart Substation Design

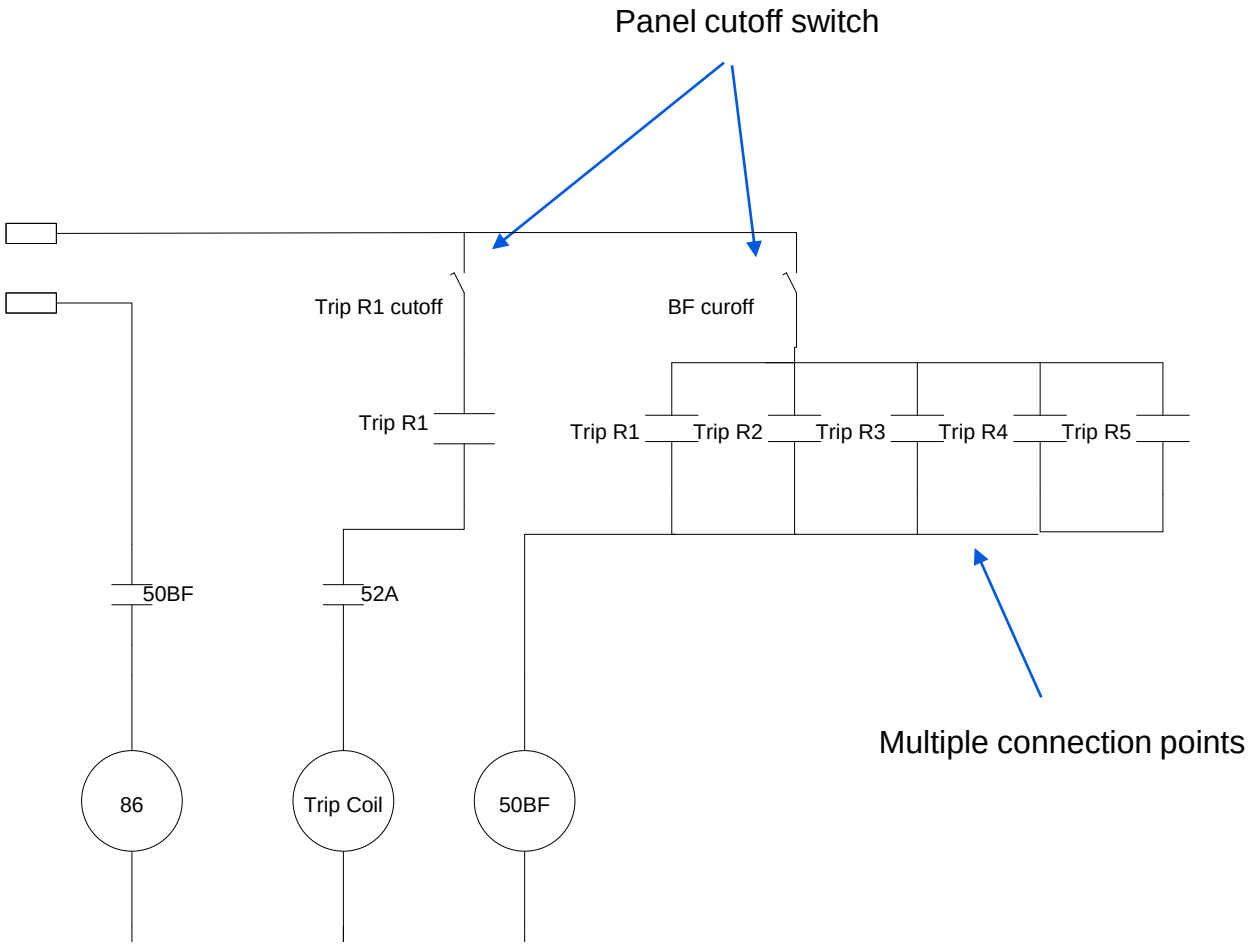
New substation design based on IEC61850 takes full advantage of microprocessor relay features saving/reducing:

- Panel Space
- Hard wired connection points
- Equipment
- Points of failure
- Testing
- Documentation

Sample applications:

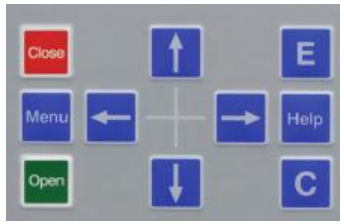
- Breaker failure
- Bus fault protection
- Alarms & Station DFR
- Transfer schemes
- Reclosing
- Sharing of status

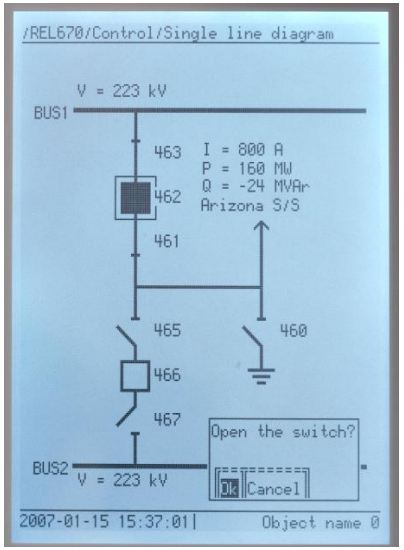
Conventional Breaker Fail Scheme



Smart Breaker Fail Scheme

Utilize Relay's HMI to enable disable protection elements instead of hard wired switches

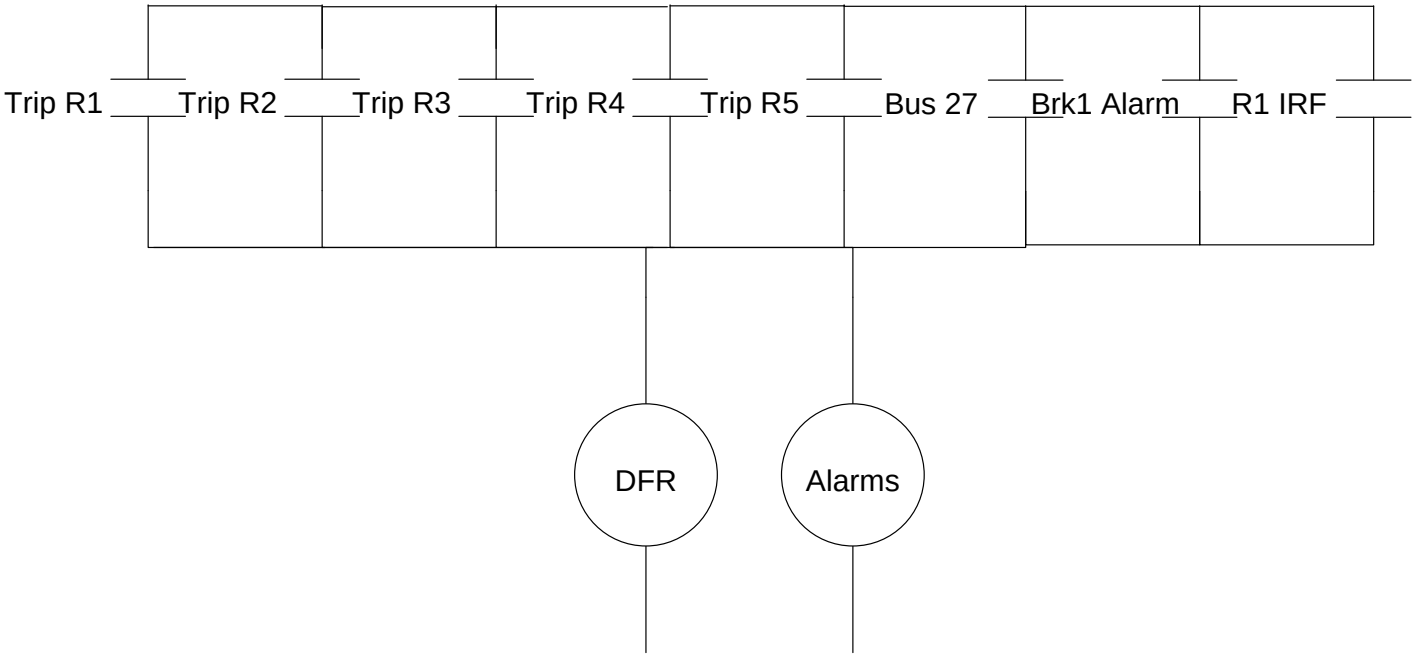




Replace multiple connection points with Peer to Peer exchange of information (GOOSE messages)

Trip signal from R2-R5 will be published as GOOSE messages. The breaker fail relay R1 subscribes to these messages and will initiate its 50BF pickup timer upon sensing a trip signal.

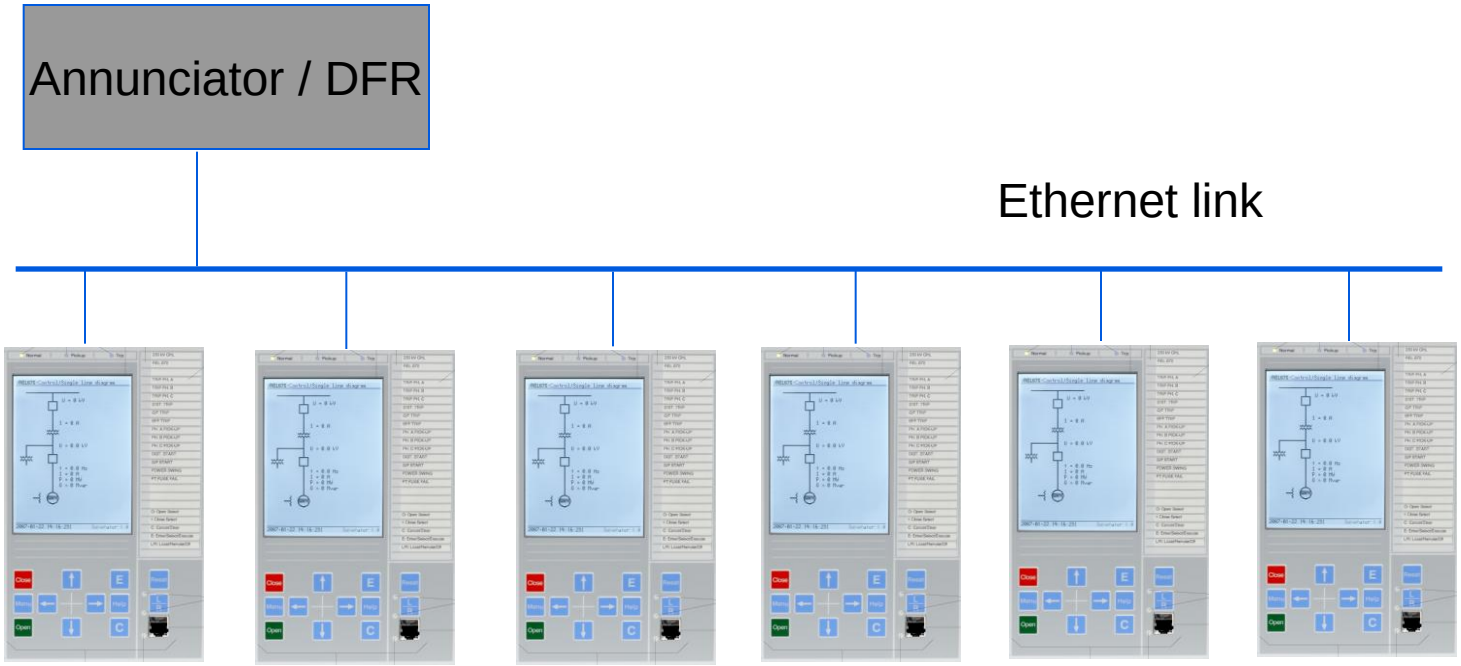
Conventional Alarms and Station DFR



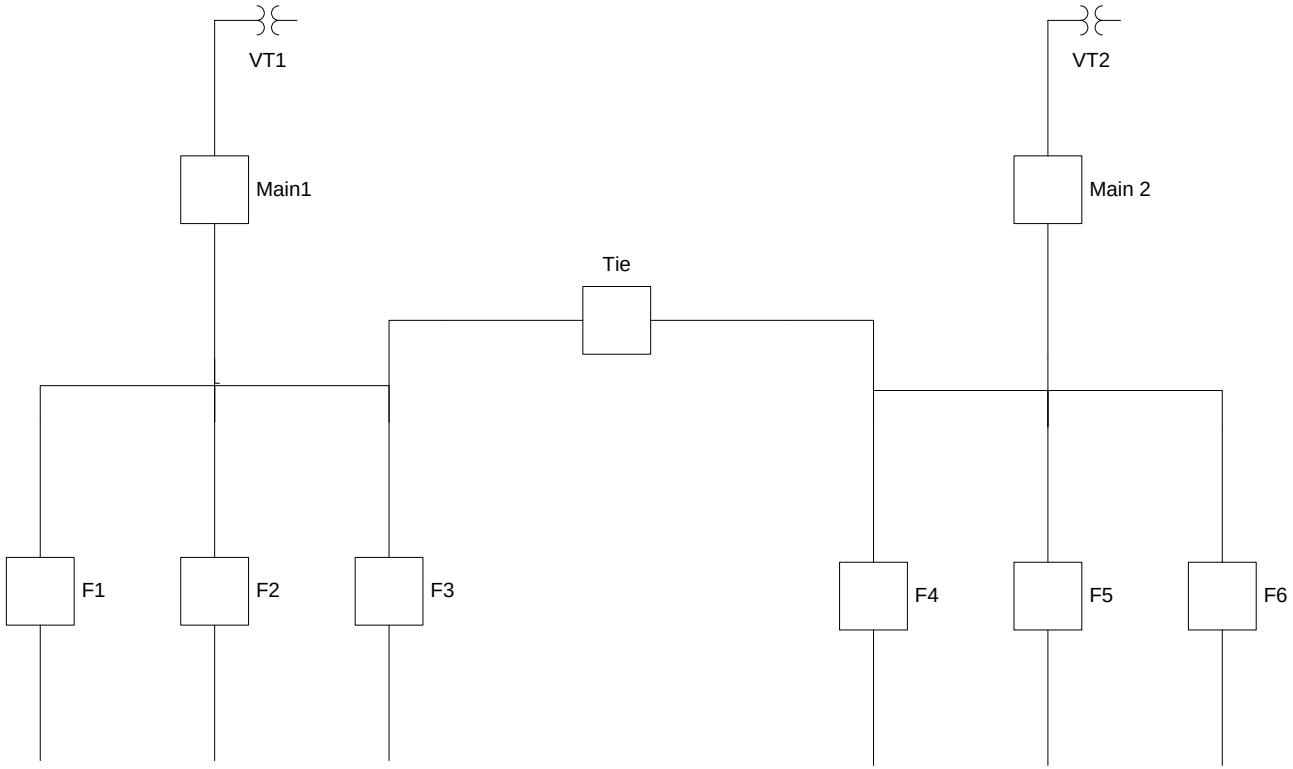
- Several connection points (costs)
- Often signals are combined to reduce amount of connections points resulting in lack of depth of information (e.g. Relay IRF)
- Rigorous documentation
- Changes require manual labor (connection points, relabeling of terminations, etc)

Smart Alarms and Station DFR

- Utilization of GOOSE messages instead of hard wired output contacts for:
  - Alarms
  - Trigger signal for DFR
  - Peer based IRF schemes

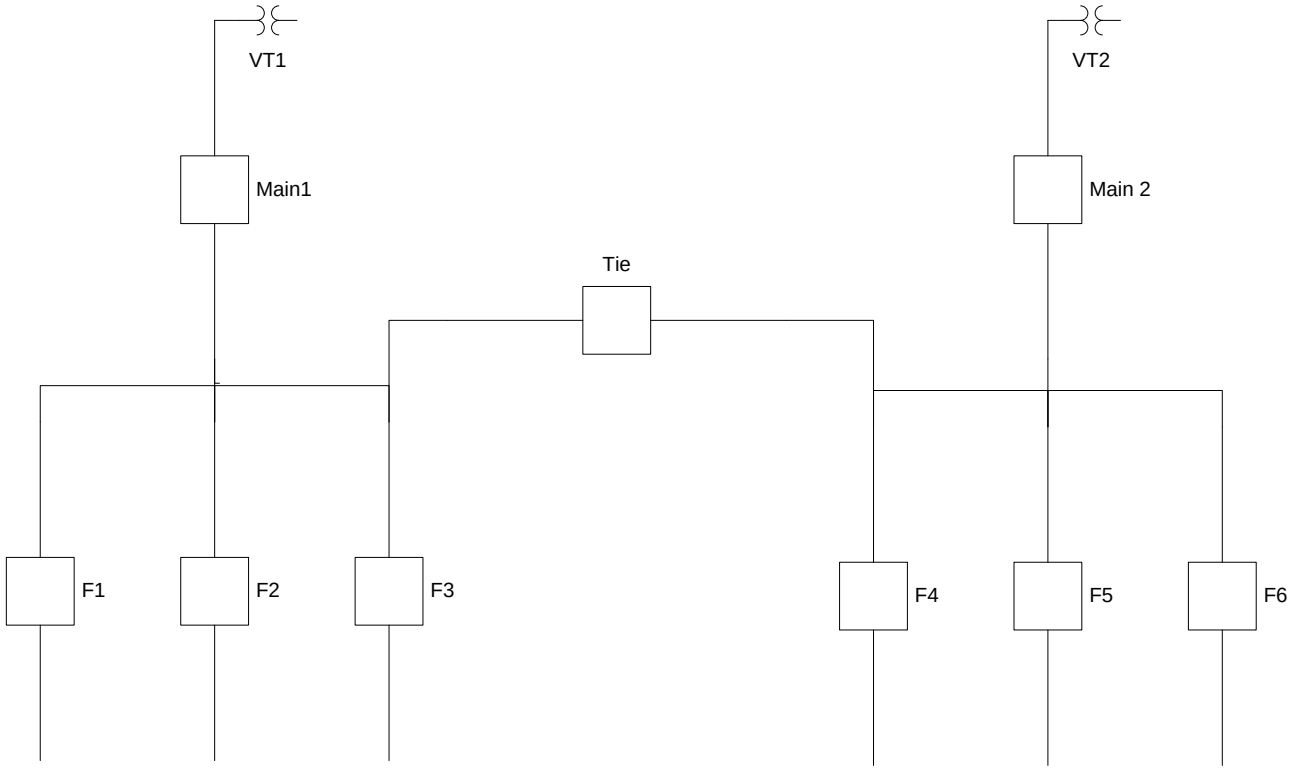


Conventional Transfer Scheme



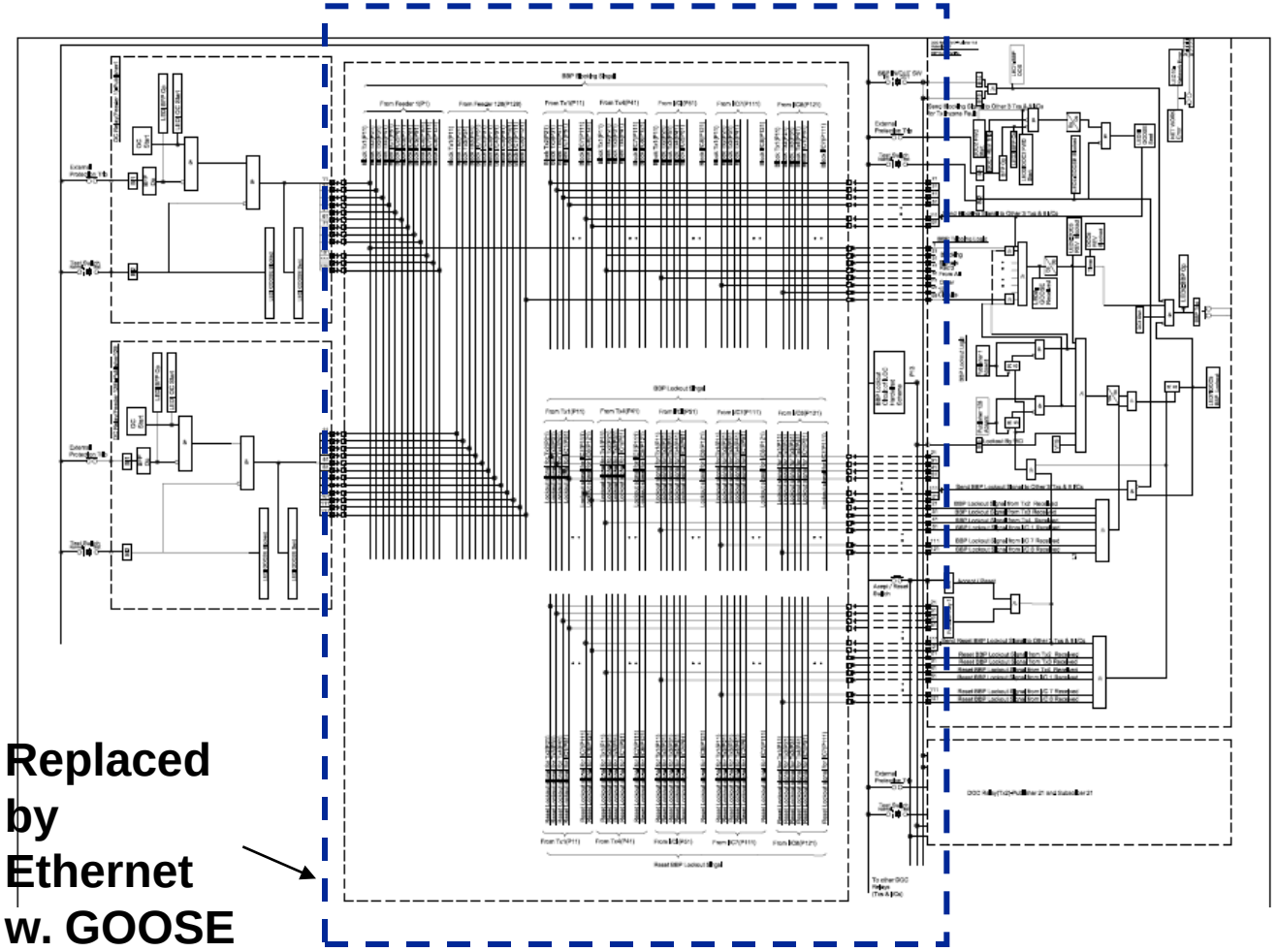
- 9 Relays needed for Feeder P&C
- 1 Transfer scheme relay
- Hardwired signals:
  - Main1 Pos
  - Main2 Pos
  - Tie Pos
  - VT1
  - VT2

Smart Transfer Scheme



- 9 Relays needed for Feeder P&C
- Tie relay executes transfer scheme logic
- Hardwired signals:
  - Tie Pos
  - VT1
  - VT2
- Signals via GOOSE:
  - Main1 Pos
  - Main2 Pos
- Advanced logic to determine load prior to transfer and determine if sources can handle combined load without equipment/apparatus failure

Logic Diagram



Utilizing GOOSE to gain simplicity – and savings

GOOSE Design

Traditional Design

IEC 61850 with GOOSE fully implemented vs. traditional version
Interpanel wirings

IEC 61850 version

- Only auxiliary supply cables and network connection for signals and interlocks

Traditional version

- **Auxiliary supply cables and several cables for each signal / interlock**

Relion® family products

- **670** - Optimized for transmission applications
- **650** - Optimized for transmission and subtransmission applications
- **620** - Optimized for High end distribution applications
- **615** - Standard series for distribution applications

Relion® family products

Family Highlights

- One common tool for all Relion® products, Protection and Control Manager PCM600
- Covers all applications, from interconnected transmission grids to secondary distribution networks
- The performance of Relion protection and control IEDs meet the comprehensive IEC 61850 communication tasks, for example, GOOSE messaging for peer-to-peer communication
- The Relion IEDs utilize ABB’s unique connectivity package concept
- The Relion product family provides configured, pre-configured or fully customized IEDs

The value of implementing 61850

- Cost reduction
  - Reduction of copper hardwires wires
  - Eliminate terminations/terminal blocks
  - Reduce testing intervals due to self monitoring
  - Reduce documentation e.g. DC elementary
  - Faster integration
  - Plasticity of design / Reusable Engineering
- Improved performance:
  - Faster than conventional binary inputs and outputs
  - Increased reliability due to repetitive messages
- Flexible architecture allowing easy migration
  - Future technologies
  - Simplify retrofits/upgrades

QUESTIONS?