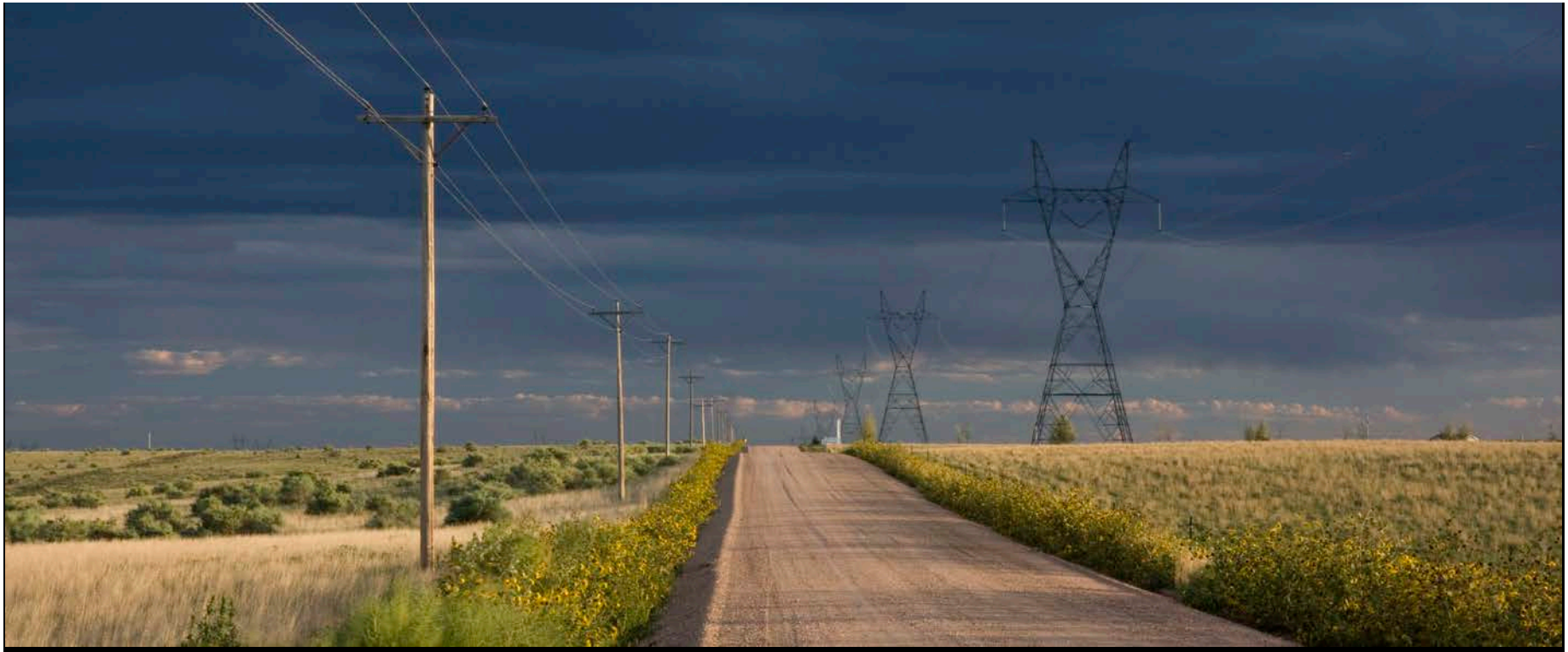


ABB Protective Relay School Webinar Series

Using IEC61850 for Advanced, Reliable Feeder Automation

Bryan Shannon

August 20, 2013

Presenter

Bryan Shannon

Bryan received a Bachelor of Science degree in Electrical Engineering from the University of Missouri-Rolla. He started with ABB in 2008 as a Proposal Engineer in our relay division in Coral Springs, FL. He also handled relay proposals through our switchgear division.

He recently relocated to Houston, TX and is the Regional Technical Manager for Distribution Automation, focusing on distribution protection relays and supporting products.

In his free time Bryan enjoys traveling, playing basketball and golf, and is taking flying lessons.

This webinar brought to you by the Relion® product family

Advanced protection and control IEDs from ABB

Relion. Thinking beyond the box.

Designed to seamlessly consolidate functions, Relion relays are smarter, more flexible and more adaptable. Easy to integrate and with an extensive function library, the Relion family of protection and control delivers advanced functionality and improved performance.

Learning objectives

- Brief History and Overview of IEC 61850
- GOOSE Messaging
- Bus Blocking Scheme
- Bus Transfer Scheme

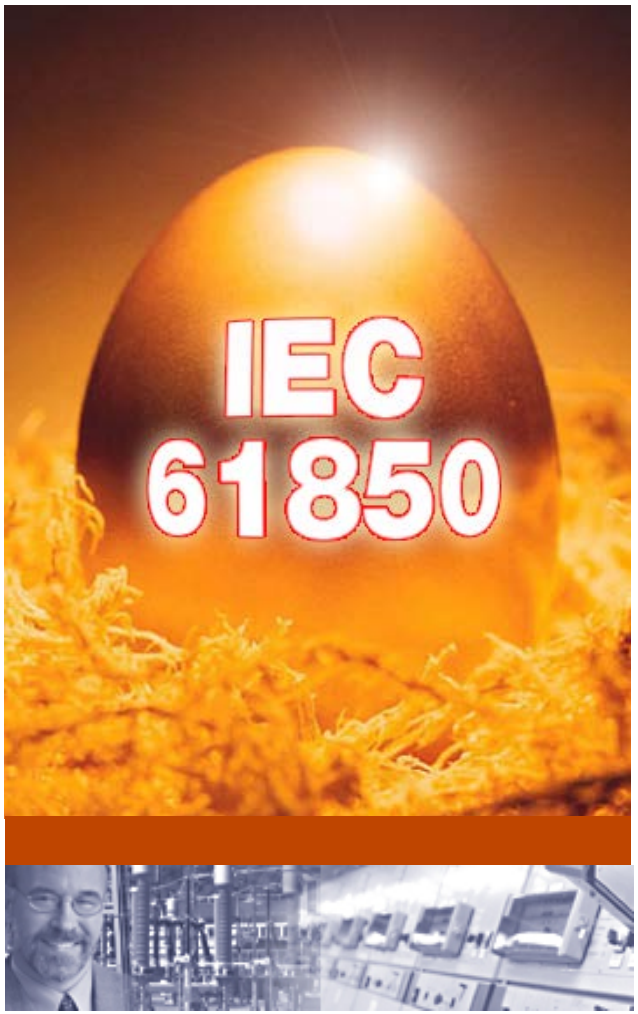
A Global Standard for IEC and ANSI

- Today UCA International Users Group heavily involved in technical issue resolution and device level conformance testing
- IEC TC57

IEC61850 - goal of the standard

- **Interoperability**
  - Exchange information between IED's (Intelligent Electronic Device) from several manufacturers
  - IEDs use this information for their own function
- **Free Configuration**
  - Free allocation of functions to devices
  - Support any philosophy of customer – centralized or decentralized systems
- **Long Term Stability**
  - Future proof
  - Follow progress in mainstream communication technology
  - Follow evolving system requirements needed by customers

IEC61850 based SA Systems



"Combining the best properties in a new way..."

Basics:

- Fast Ethernet (100 MBps to 1 GBps)
- Station Bus 61850 8-1
- Process Bus 61850 9-2
- Data Model
- Substation Configuration Language

Much more than a protocol:

- Modularization and structuring of data
- On-line meaningful information
- Free allocation of functions in IEDs
- Complete description of configuration
- Structured engineering & services
- Testing, validation, and certification

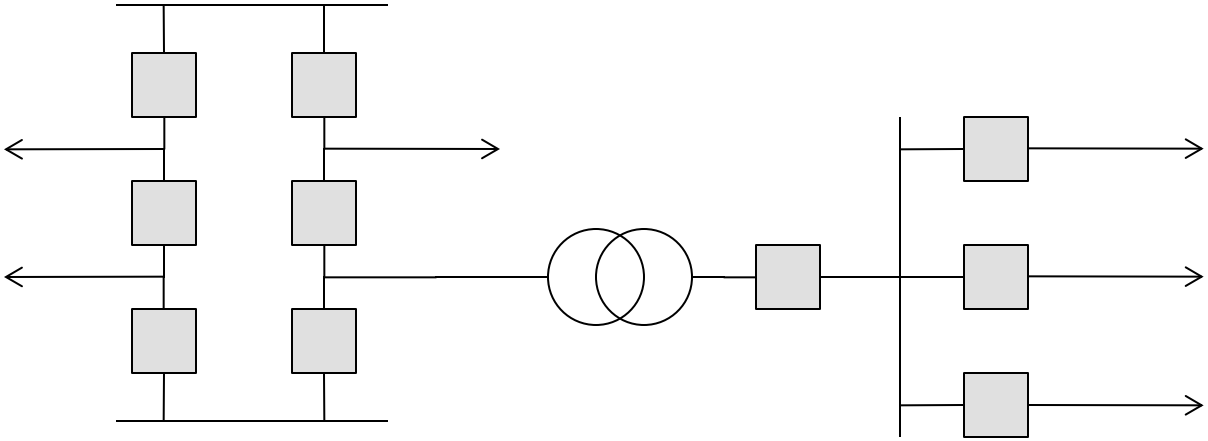
IEC61850 10 parts and growing…

61850 - Communication networks and systems in substations

- 61850-1 Introduction and overview
- 61850-2 Glossary
- 61850-3 General requirements
- 61850-4 System and project management
- 61850-5 Communication requirements for functions and device models
- 61850-6 Substation configuration language
- 61850-7-1 Basic Communication Structure
- 61850-7-2 Abstract communication service interface
- 61850-7-3 Common data classes
- 61850-7-4 Compatible LN classes and DO classes
- 61850-8-1 Specific communication service mapping (SCSM)
- 61850-9-1 Sampled values over serial point to point link
- 61850-9-2 Sampled values over ISO/IEC 8802-3
- 61850-10 Conformance testing

Data model

The core of 61850 is the standard representation of functions and equipment, its attributes, and its location within a system

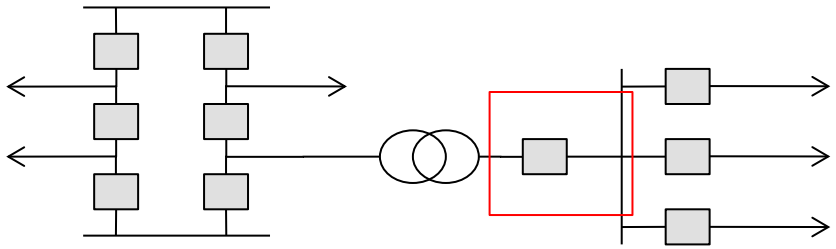


WHY IS THIS IMPORTANT???

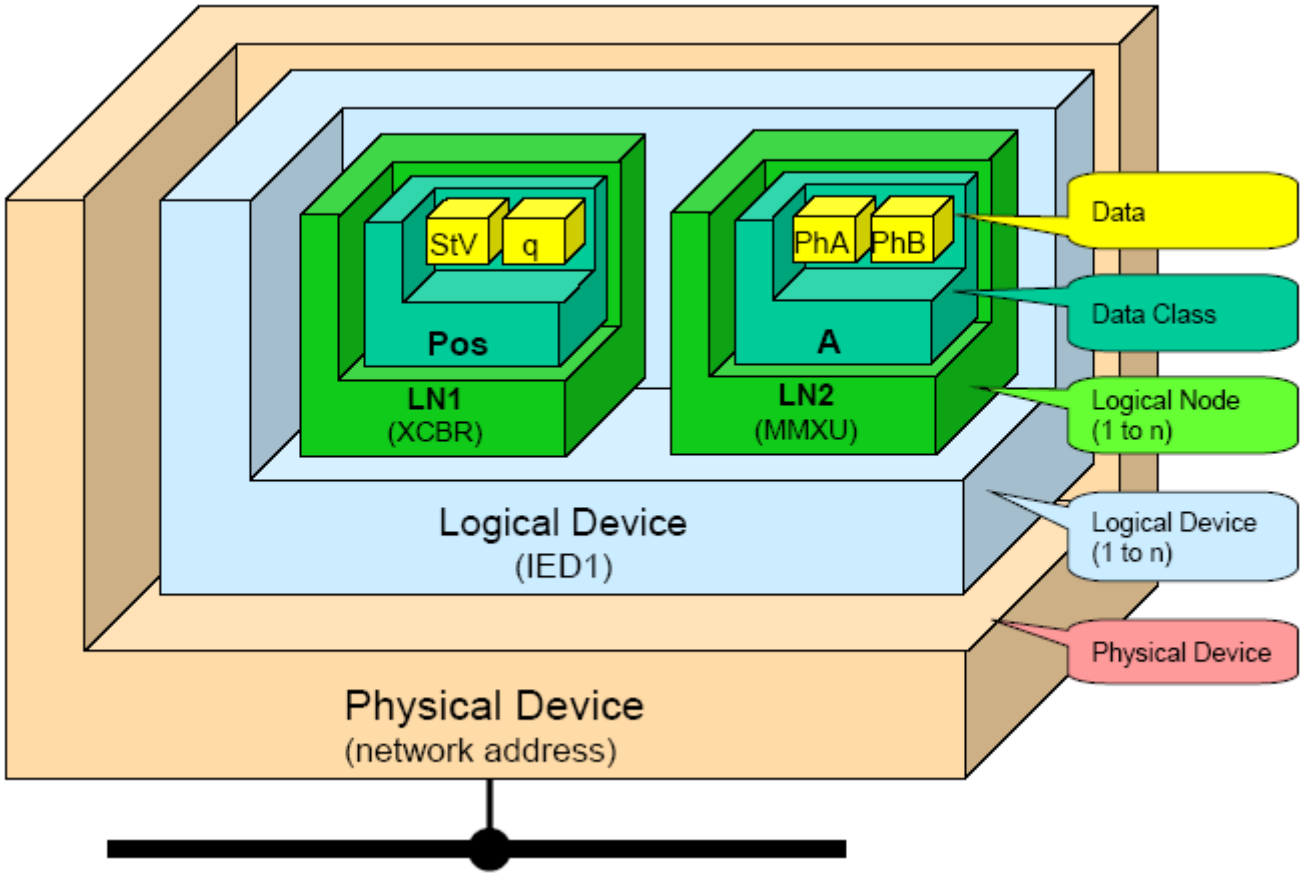
Data model

- 61850 helps by standardizing the representation of function/equipment, their data attributes, and location within the system

Function / Equipment	LOGICAL NODE
Position of Breaker1	Breaker = XCBR
52A = Device 5, BI #4	Position = XCBR.Pos.stVal
52B = Device 5, BI #5	Measurements = MMXU
Breaker1 Current	Current PhA = MMXU.A.phsA
PhA = Device 5, AI #10	Current PhB = MMXU.A.phsB
PhB = Device 5, AI #11	Current PhC = MMXU.A.phsC
PhC = Device 5, AI 12	51P Target
Breaker 1 51P and 50P targets	51P = PTOC.Op.general
51P = Device 5, BI #6	50P = PIOC.Op.general
50P = Device 5, BI #7	



Data model – Logical Node



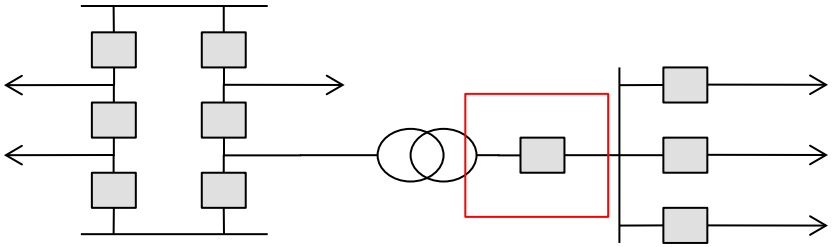
"UCA & 61850 for Dummies." – Douglas Proudfoot

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)

Data model

- Thanks to such representation, functions can then be allocated to objects within the substation
- Addressing scheme takes this into consideration tying the data with the application, object, and location within the substation



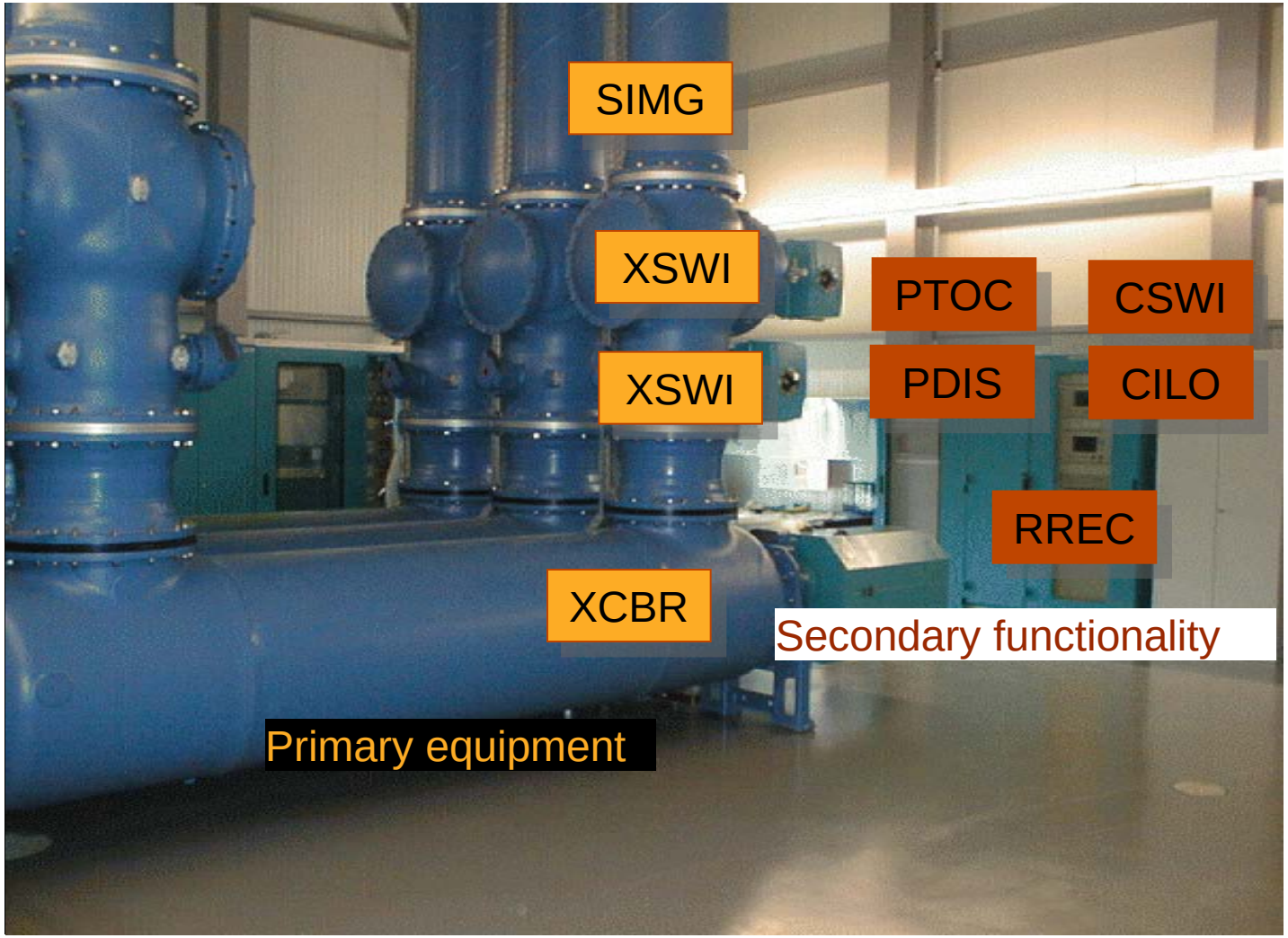
Bradley.J1.Q08.A01.LD0.MMXU1.A.phsA

Bradley.J1.Q08.A01.LD0.MMXU1.A.phsB

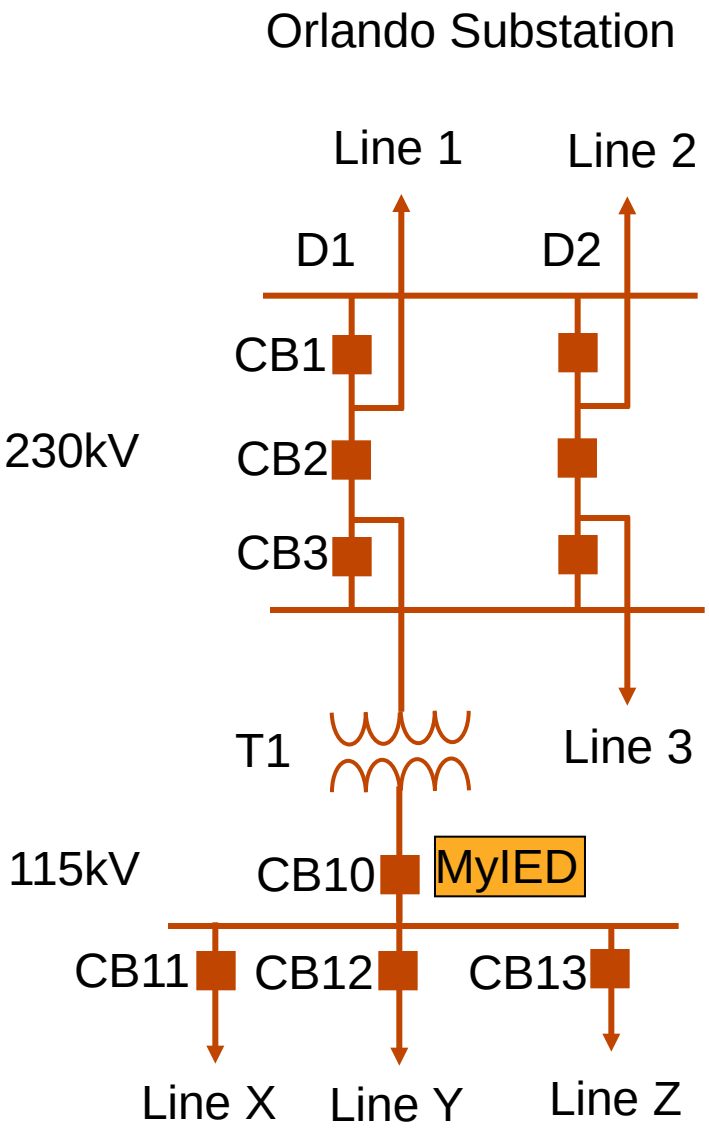
Bradley.J1.Q08.A01.LD0.PTOC.Op.general

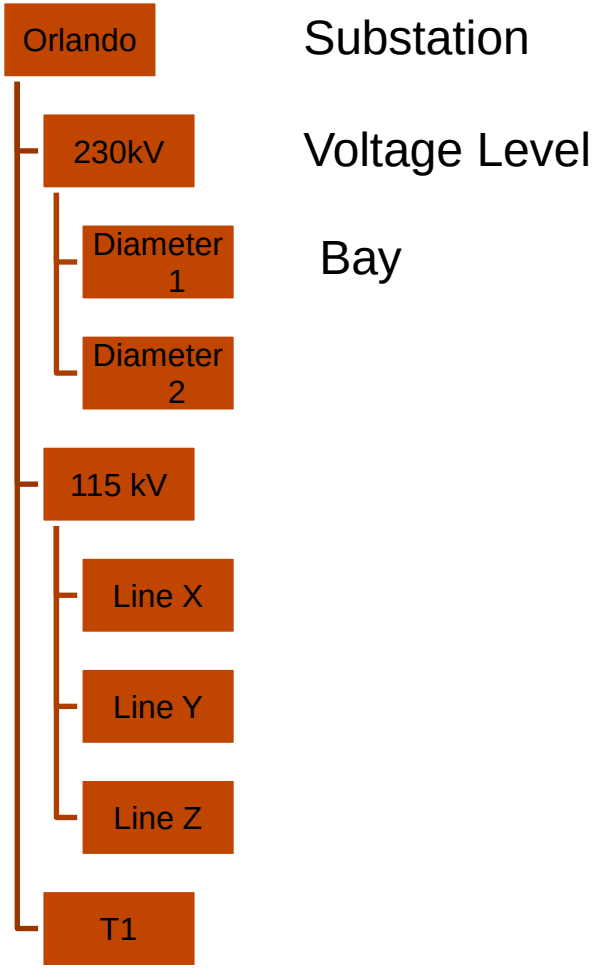
Bradley.J1.Q08.A01.LD0.XCBR1.Pos.stVal

Logical nodes

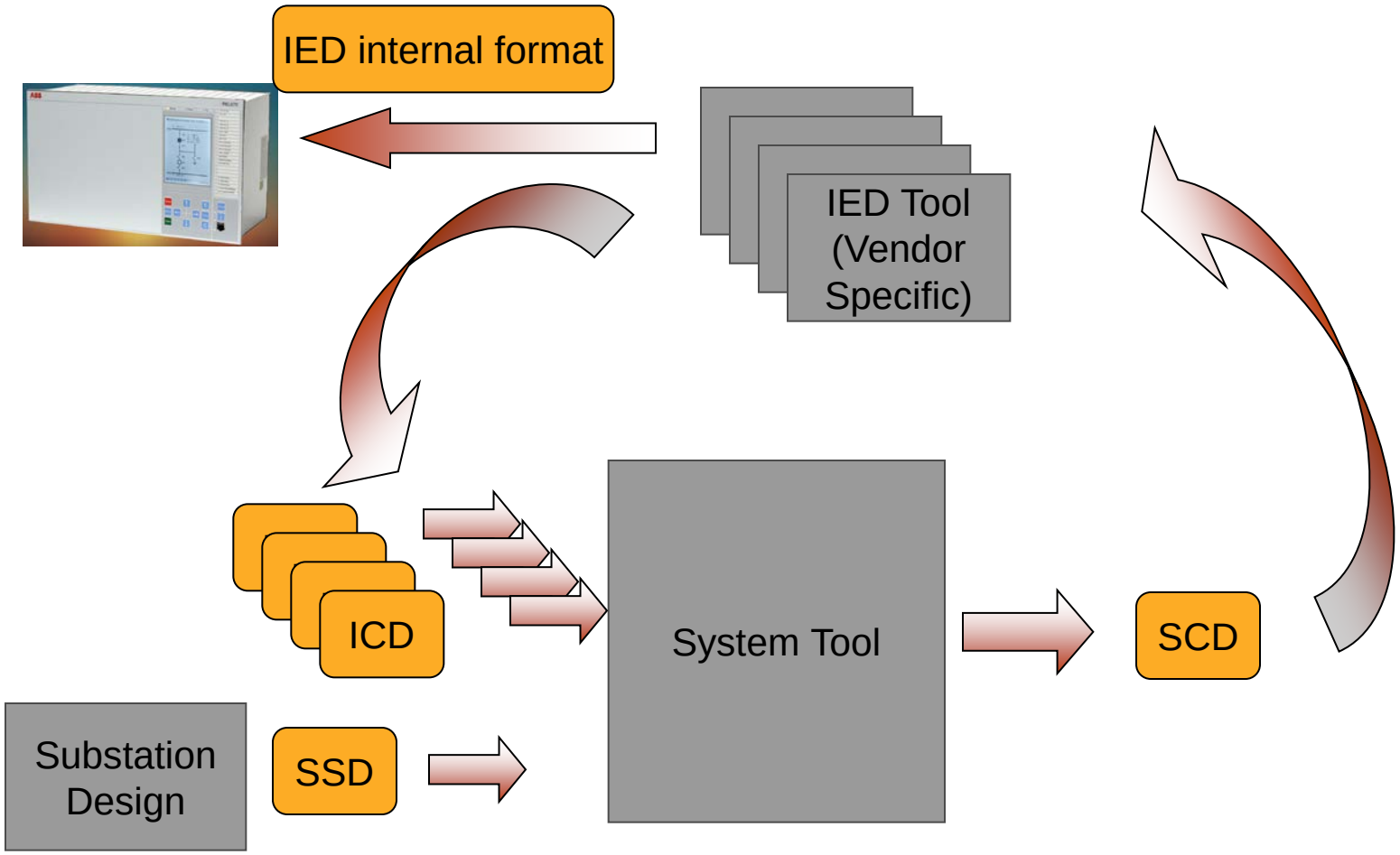


Modeling – substation structure





Engineering with SCL



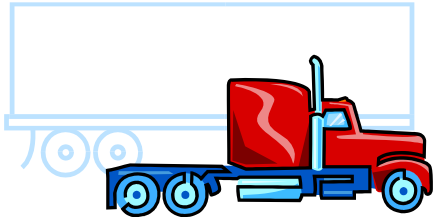
What is a GOOSE message?

- Generic Object Oriented Substation Event
- Fast and reliable distribution of information
  - Status (breaker position, trip, pickup, alarms, etc.)
  - Analog (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)

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)

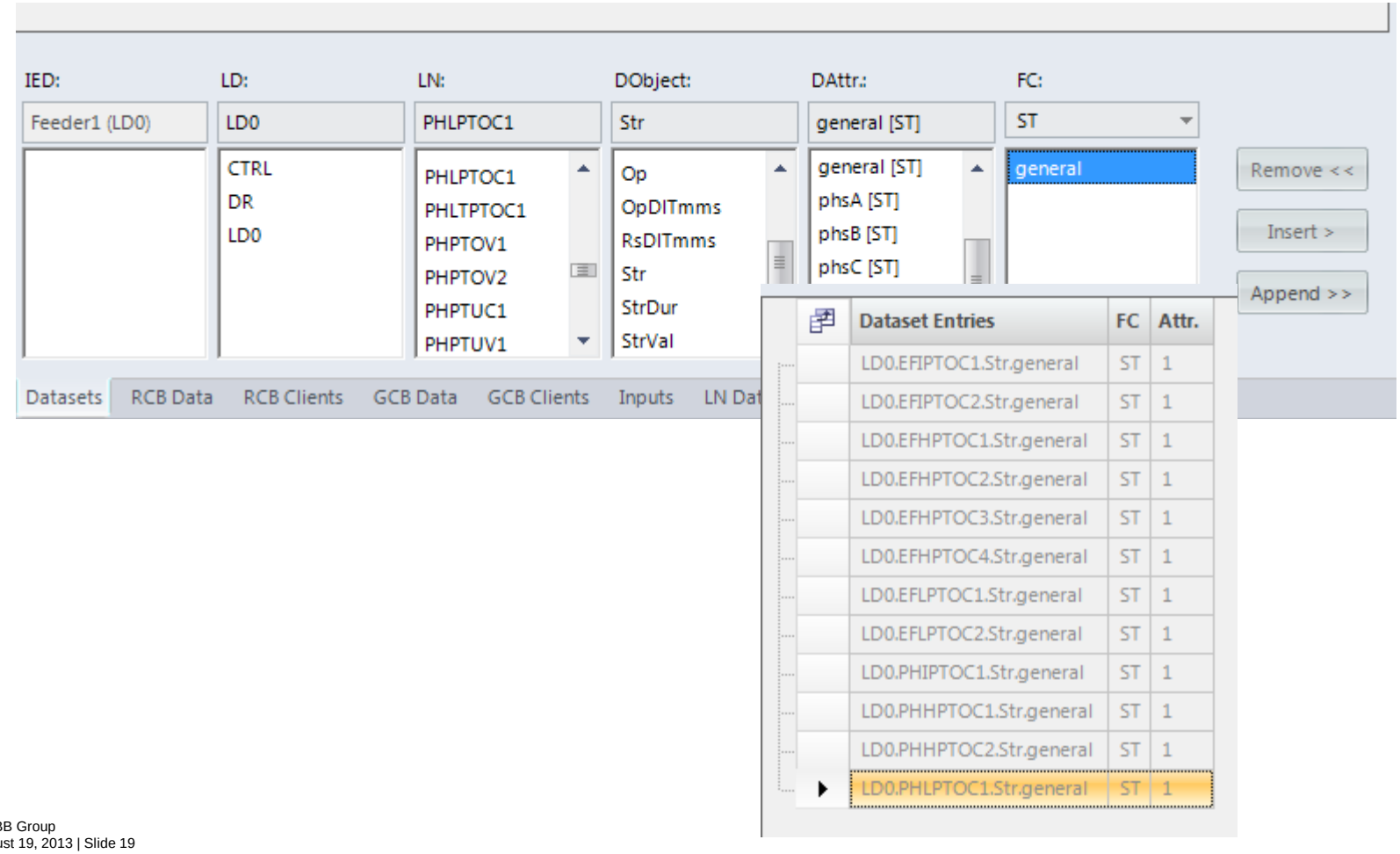


GCB

Network

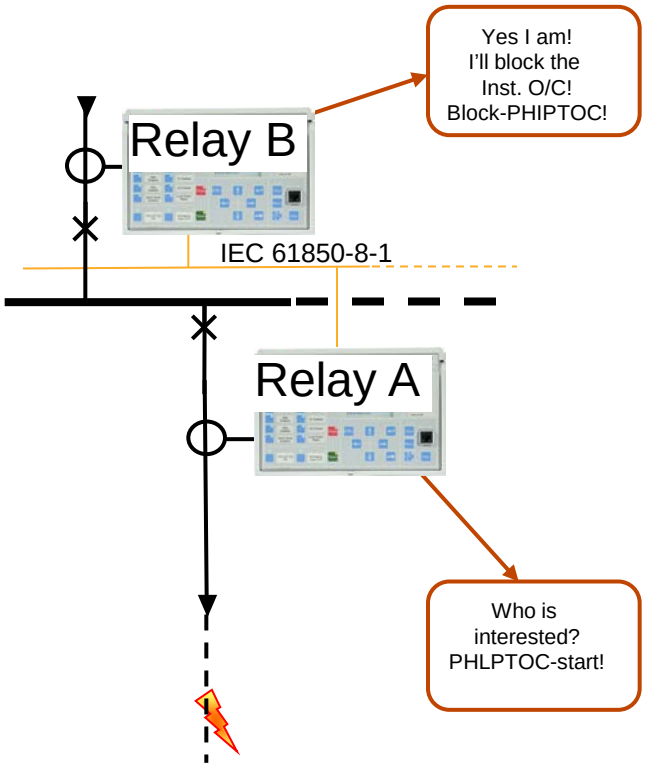
What is a GOOSE message?

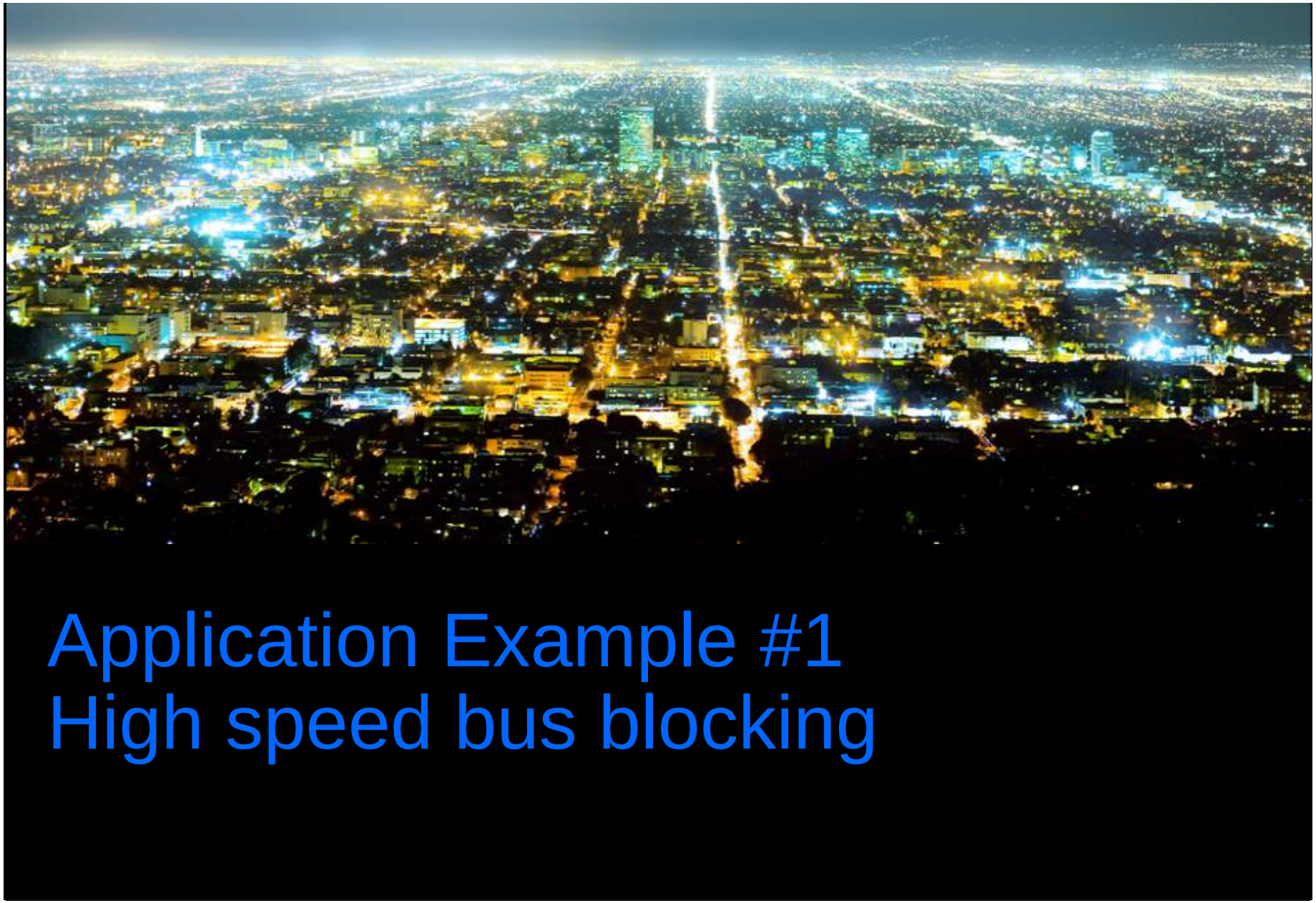
Can send 1 or several data attributes from 1 or several functions



What is a GOOSE message?

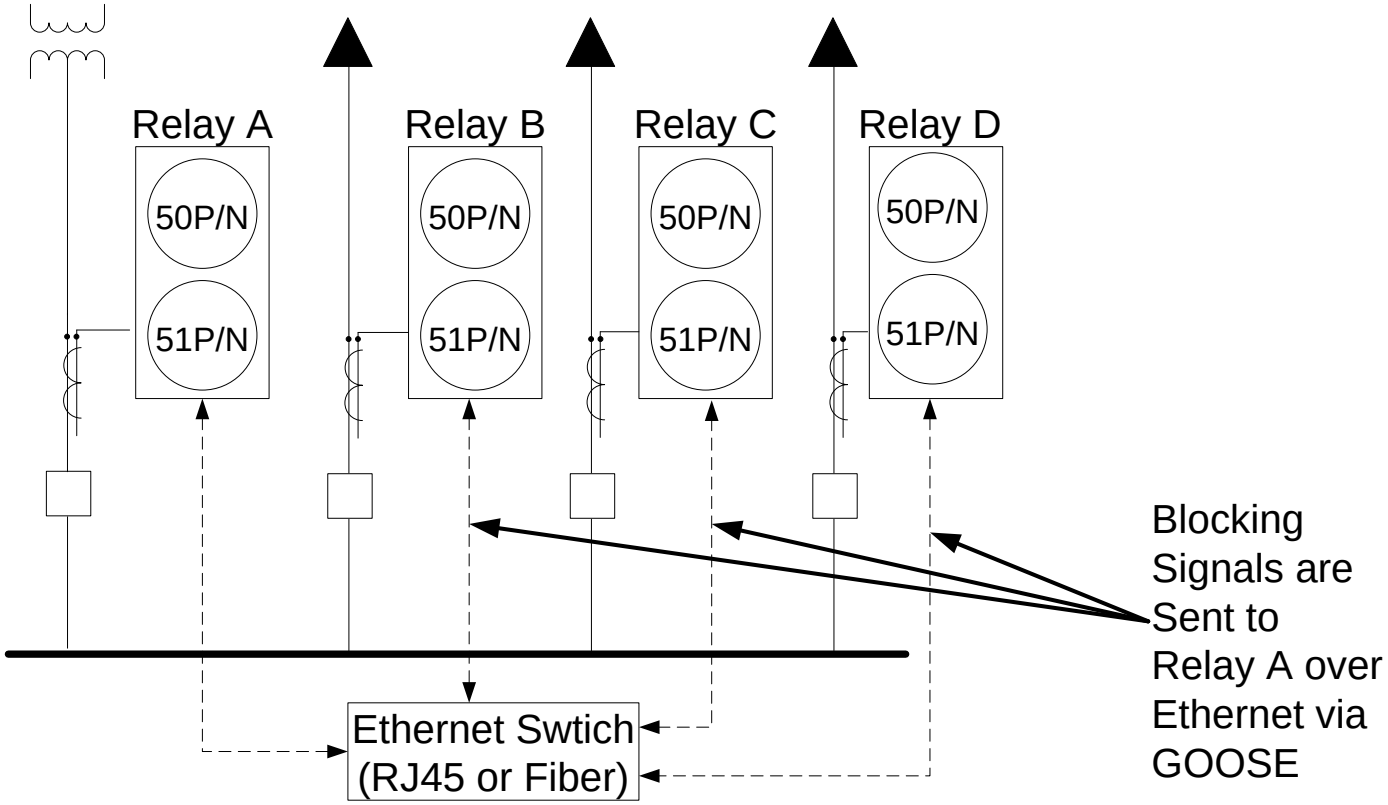
- Instead of just sending a binary 1 or 0, we can now share a data stream of information between two IEDs
- In other words, I am a 51P element from relay A and I am in pickup
- Only relays that are subscribed to this message will hear it, and can then take appropriate actions to respond to a given event
- In this case relay B is interested and can take action





Application Example #1
High speed bus blocking

Bus blocking
GOOSE driven



Bus blocking
Allocation of functions

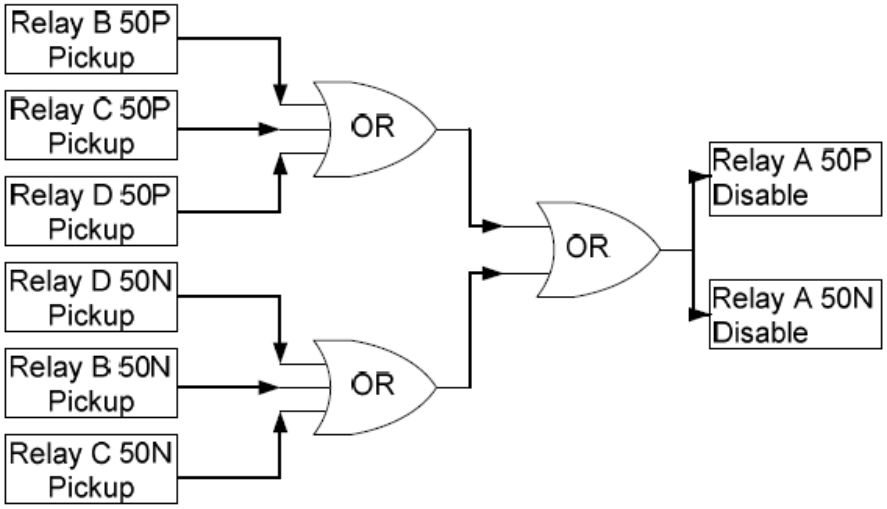


Figure 5 – Zone Interlocking Scheme Blocking Logic.

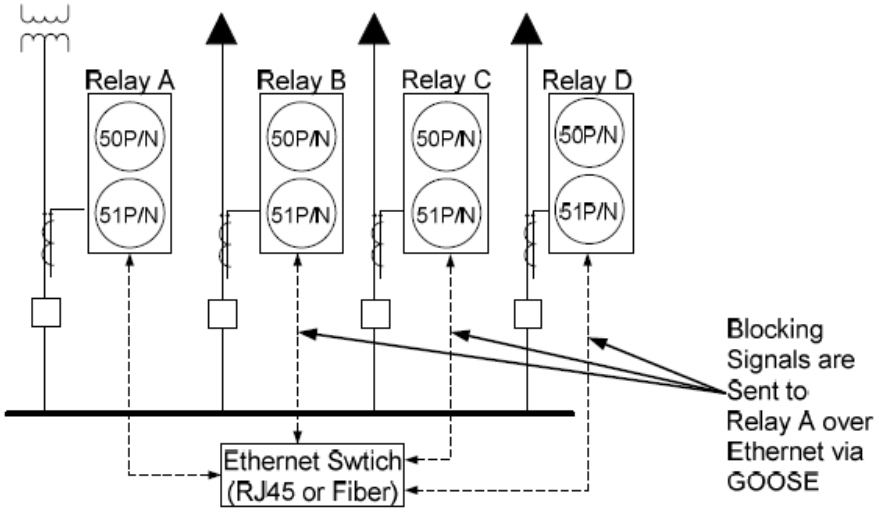


Figure 6 – GOOSE Based Zone Interlocking Scheme.

Bus blocking
Fault examples

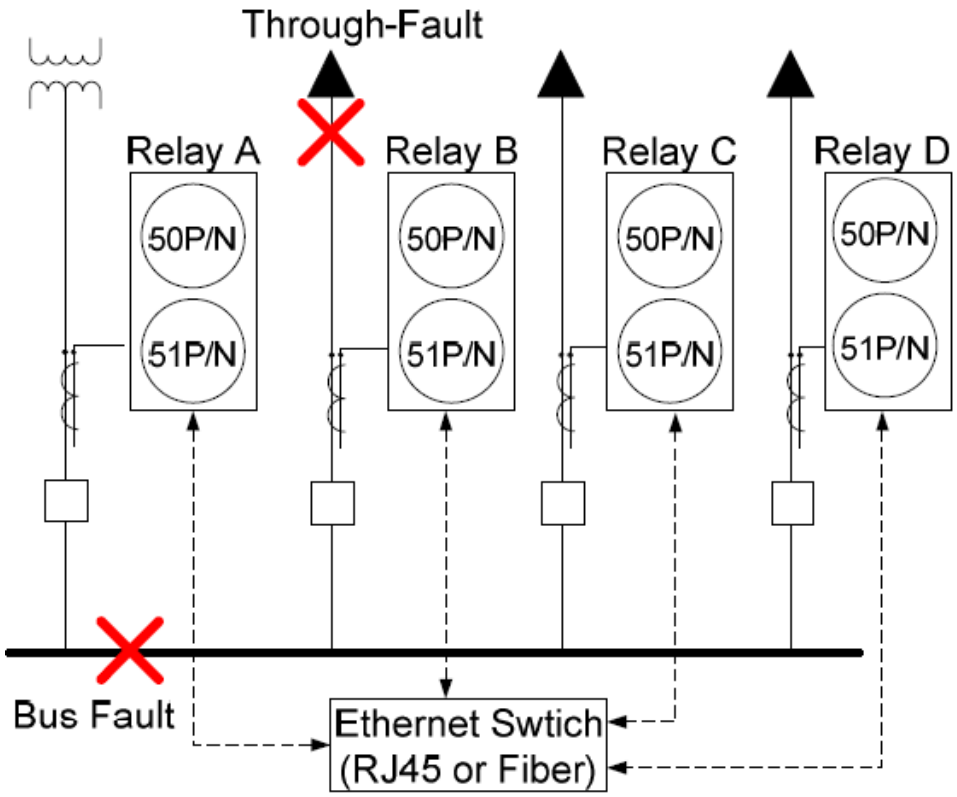
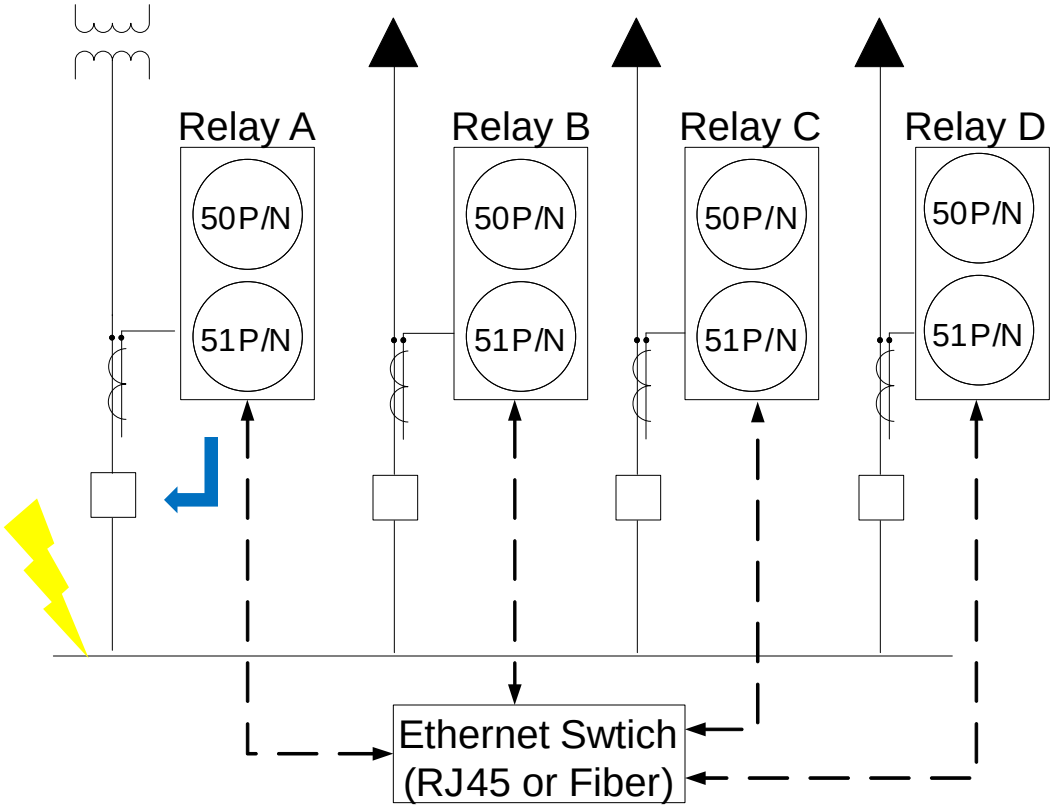


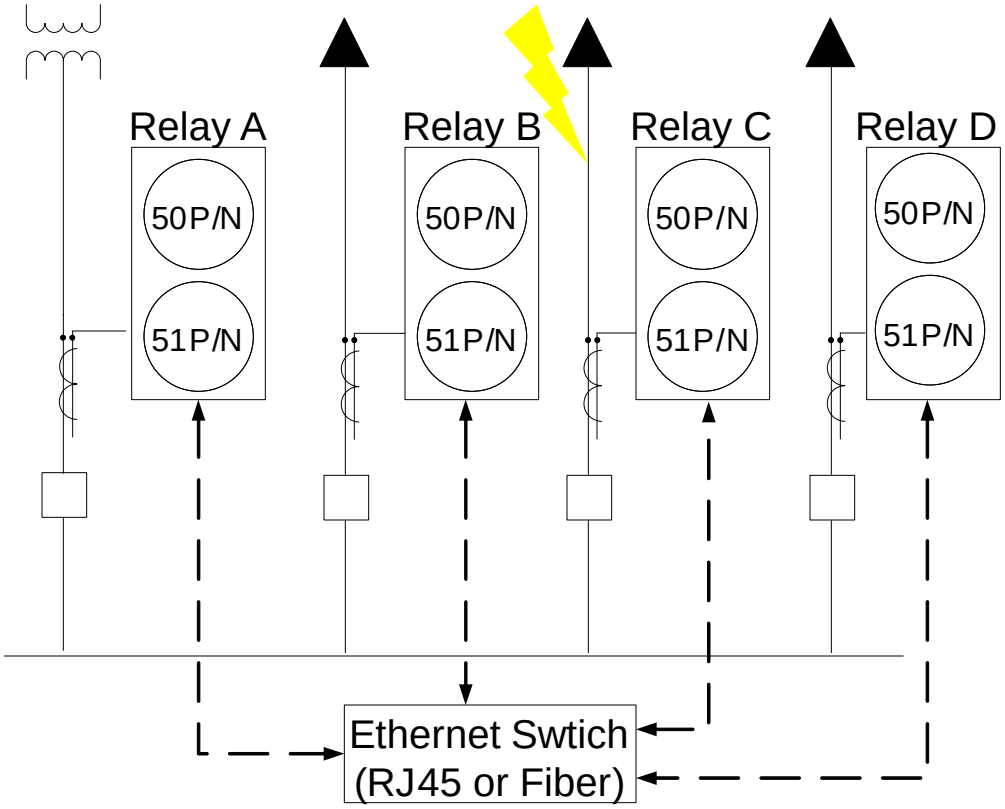
Figure 7: Bus Fault and Through-Fault Locations.

Bus blocking
Fault examples – Bus Fault



1. Relay A sees this fault as it is the main incomer to the bus
2. Normal overcurrent protection operates to clear the bus

Bus blocking
Fault examples – Through/Feeder Fault



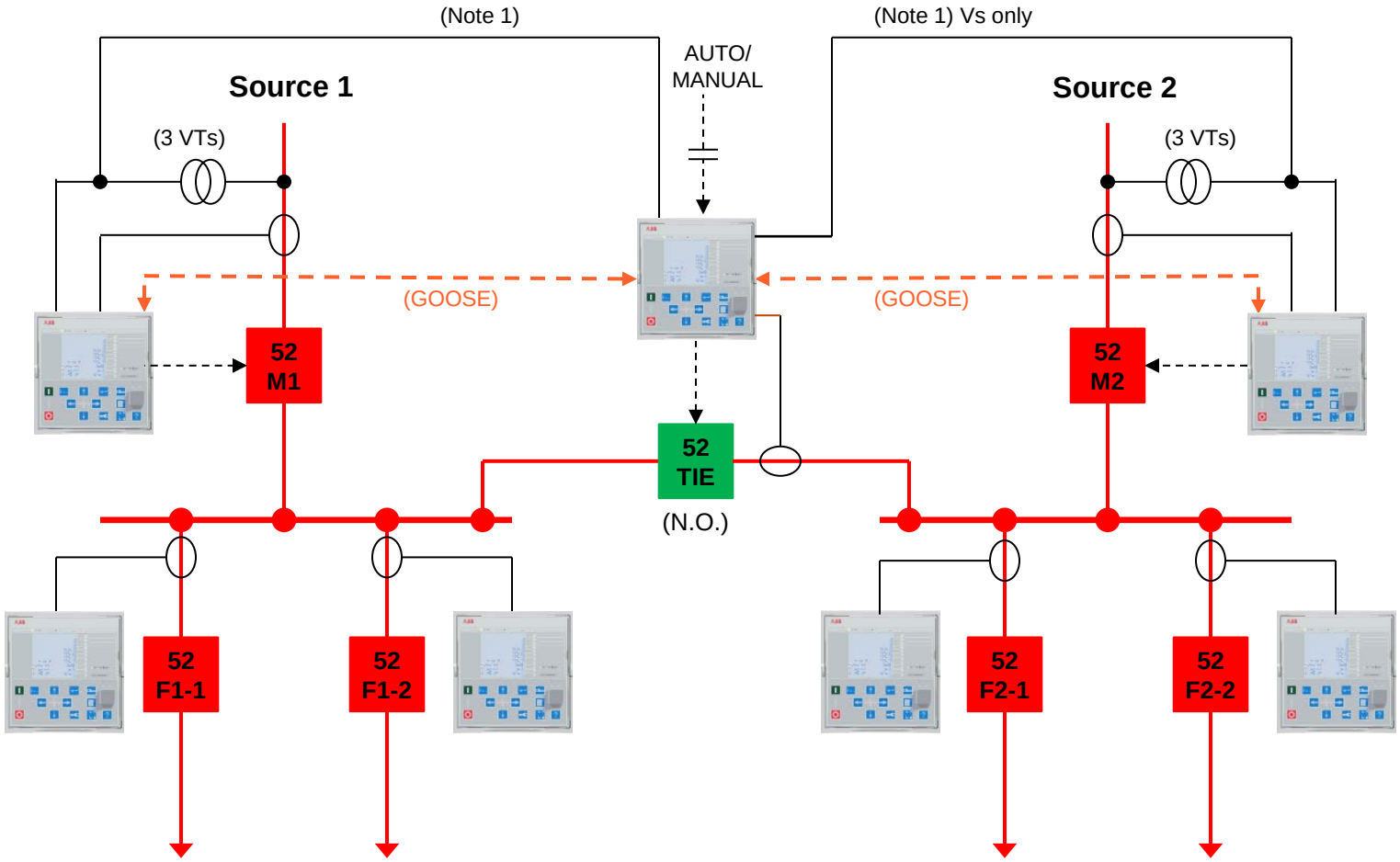
1. Relay C see this fault as it is downstream on its feeder
2. Instantaneous or time overcurrent signals go to pickup as they see the fault
3. Relay C shares this information with relay A via GOOSE messaging
4. All instantaneous elements in relay A are blocked as relay C clears the fault

Bus blocking
Advantages of GOOSE based scheme

- Mis-operations due to CT saturation are not a concern
- Fast operation: 21-30 mS typical
- Additional feeder positions are easy to accommodate
- Open CT circuit detection can be included via logic
- Minimal wiring required as all information is shared between IEDs over Ethernet
- Typical relay coordination is simplified and optimized
- Other features can be easily added on top of bus protection, for example high speed breaker failure

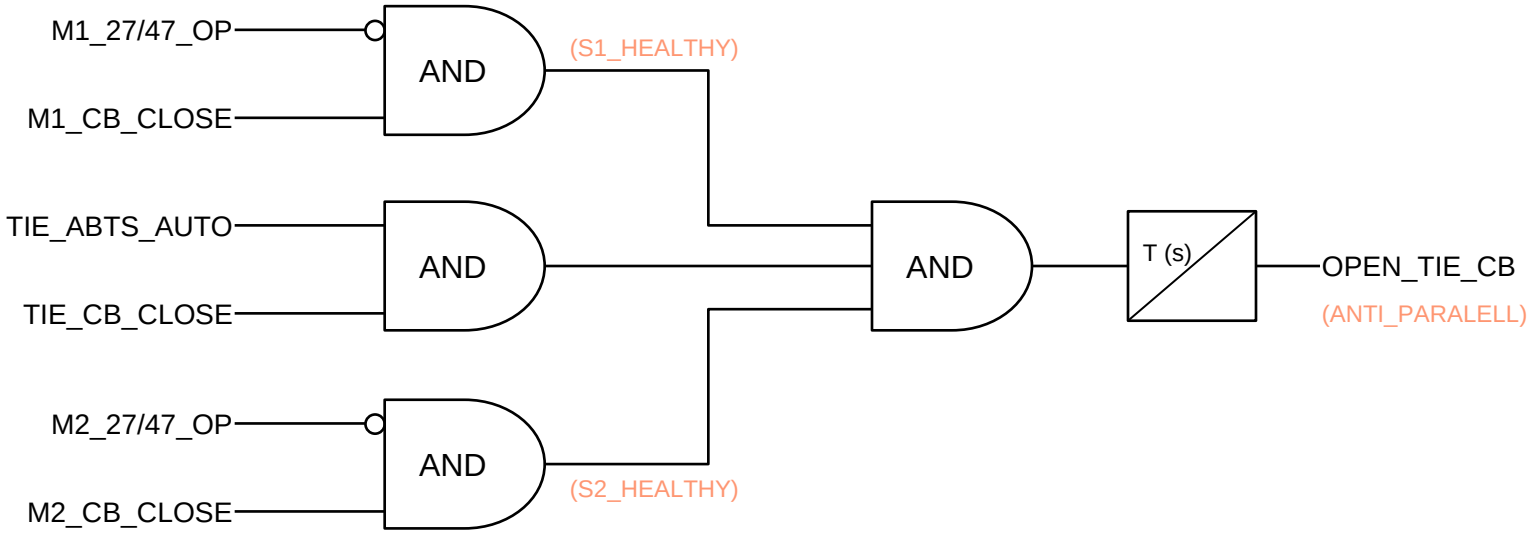
Application Example #2
Automatic Bus Transfer

Automatic Bus Transfer Scheme
Normal Operation Condition

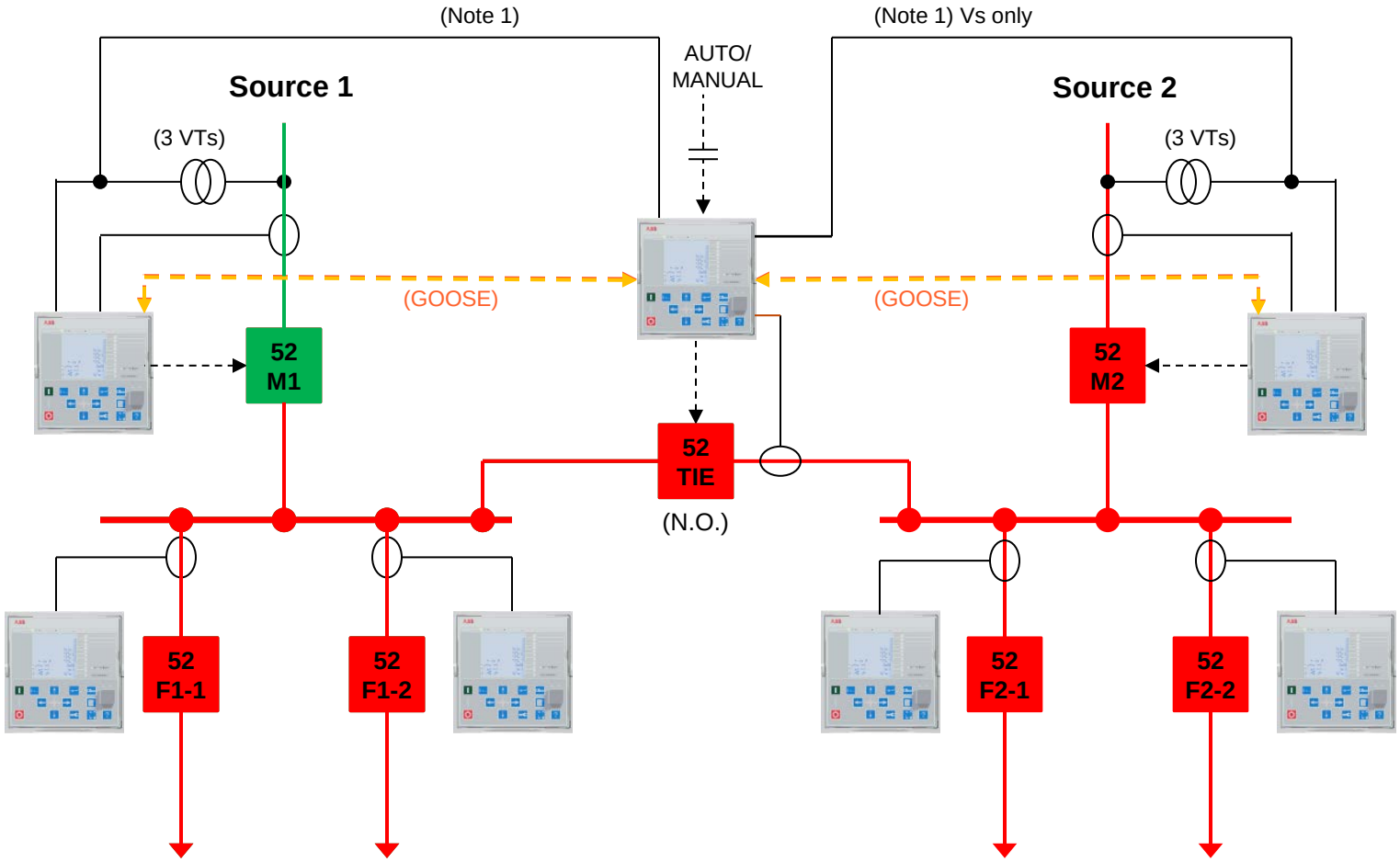


Note 1: Used for sync check only to close the tie breaker, if:
- The tie relay is on MANUAL TRANSFER mode
- Both 52-M1 and 52-M2 breakers are closed and energized

Automatic Bus Transfer Scheme
Normal Operation Condition



Automatic Bus Transfer Scheme
Loss of Source 1



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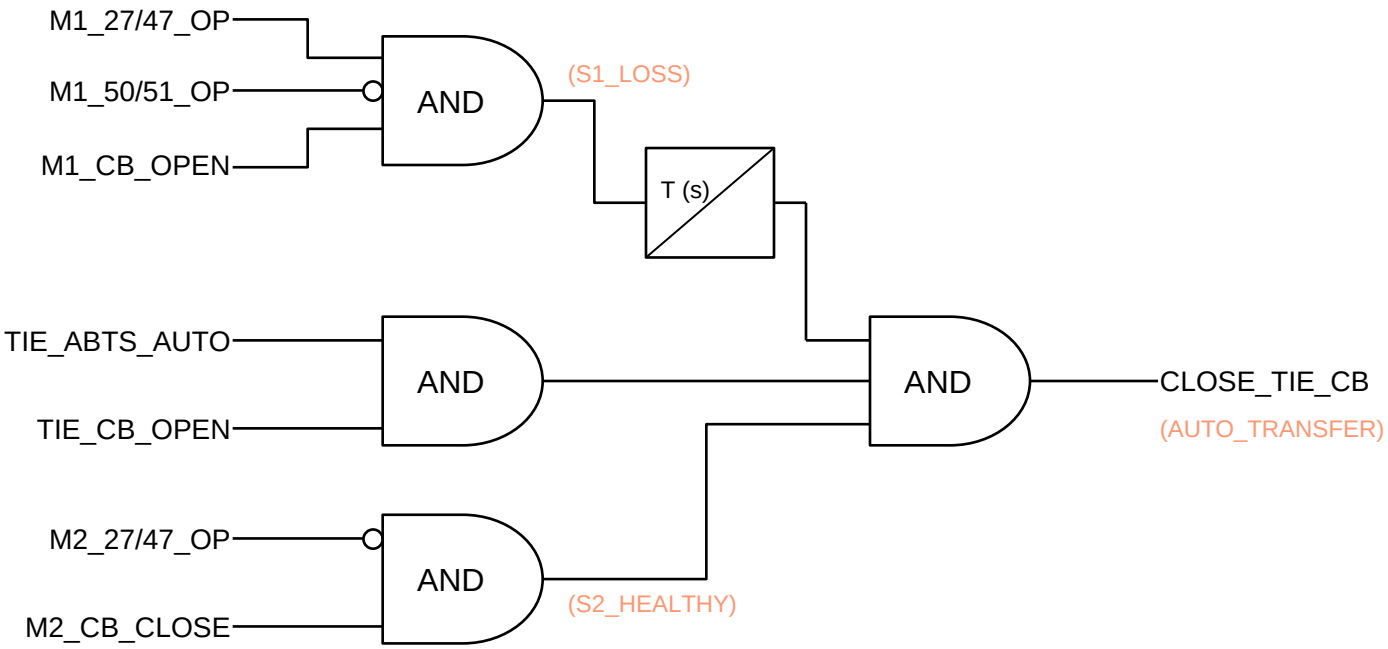
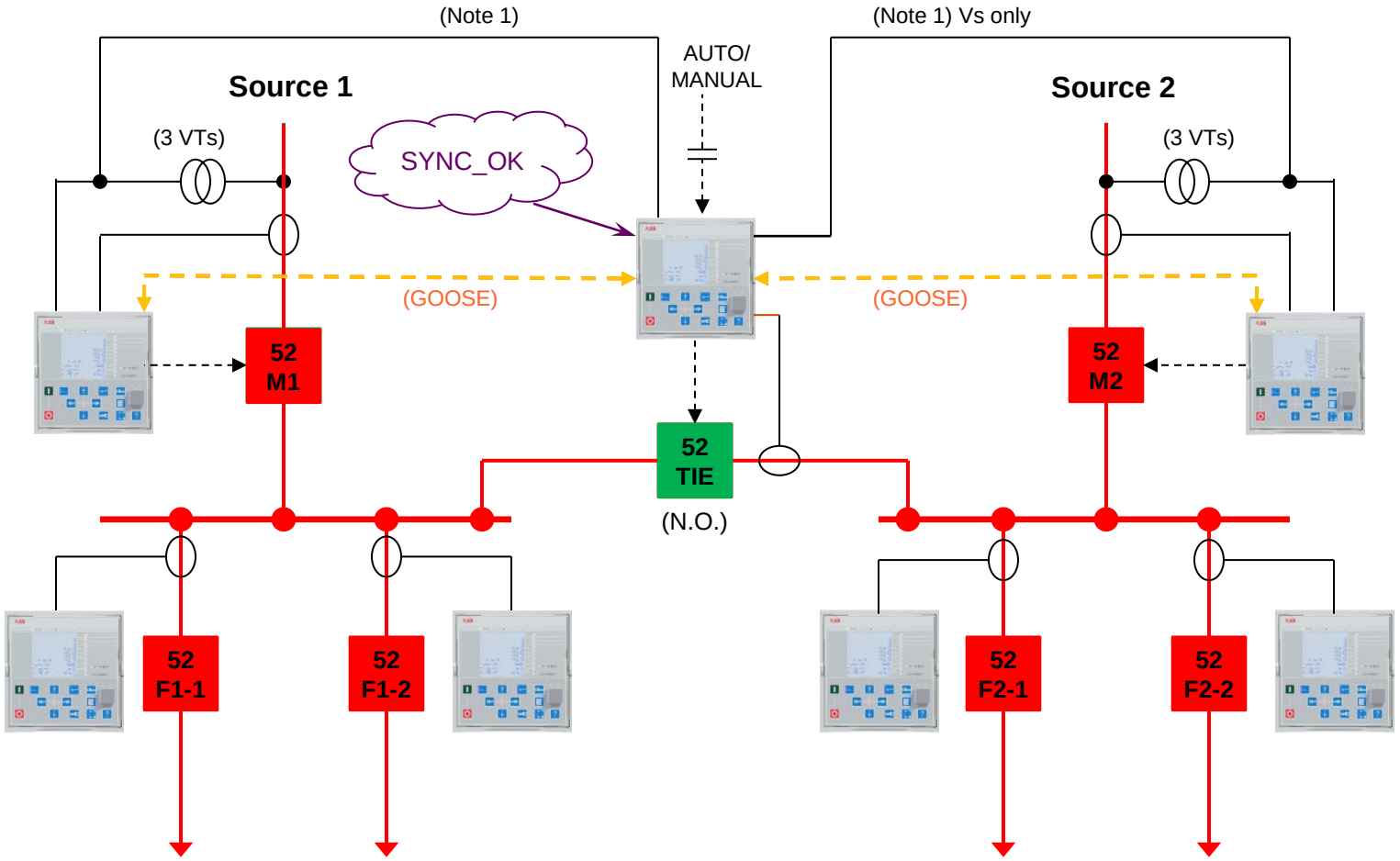
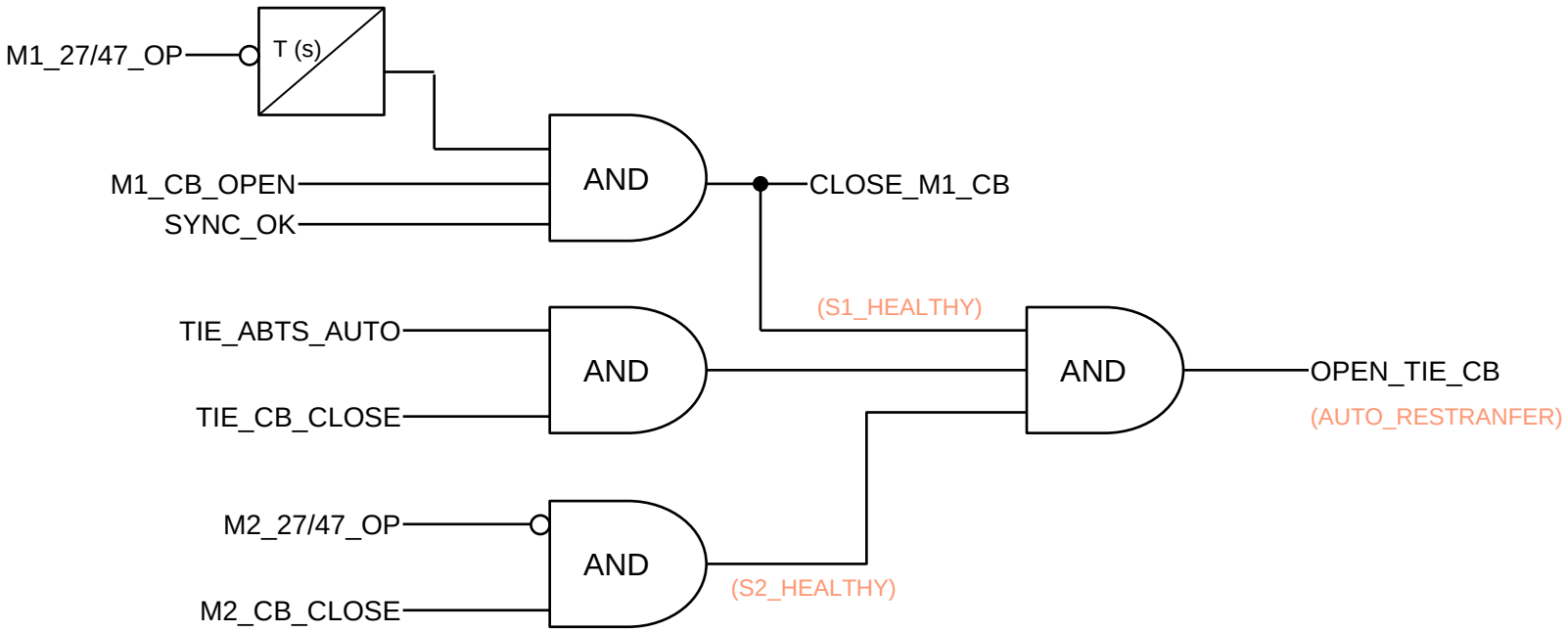
Automatic Bus Transfer Scheme
Loss of Source 1



Automatic Bus Transfer Scheme
Return of Source 1



Automatic Bus Transfer Scheme
Return of Source 1



Summary

- GOOSE messaging allows complex feeder automation schemes to be preformed quickly and easily with minimal programming by the end user
- Relays regardless of manufacturer can work together seamlessly for advanced automation schemes
- GOOSE messages are high speed in nature and faster than using binary I/O wired between substation IEDs, thus minimizing wiring between IEDs
- Easily expandable in the future

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Thank you for your participation

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