

# Station Integration for Reduced Costs and Improved Operational Efficiency

**Power and Energy Automation Conference 2013**  
**April 10, 2013**

**Ryan McMahon and Bill Winters**  
**Con Edison (ConEd)**

**Cesar Guerriero and Farel Becker**  
**Siemens**





# Station Integration for Reduced Costs and Improved Operational Efficiency

## Introduction

**Multi-vender protection and control integration has been performed in demonstration projects to show protocol capabilities, but rarely to provide a comprehensive station protection and control system.**

**A new station, feeding power to lower Manhattan, provided an opportunity to use modern communications to reduce costs while providing advanced capabilities. This ConEd substation project applied the IEC 61850 protocol to provide a high reliability peer-to-peer network across fiber optic. Special requirements for testing and HMI features were developed to aid operators during operation, testing and maintains savings of time and expense.**



Meet the standard  
**IEC 61850**



# Station Integration for Reduced Costs and Improved Operational Efficiency

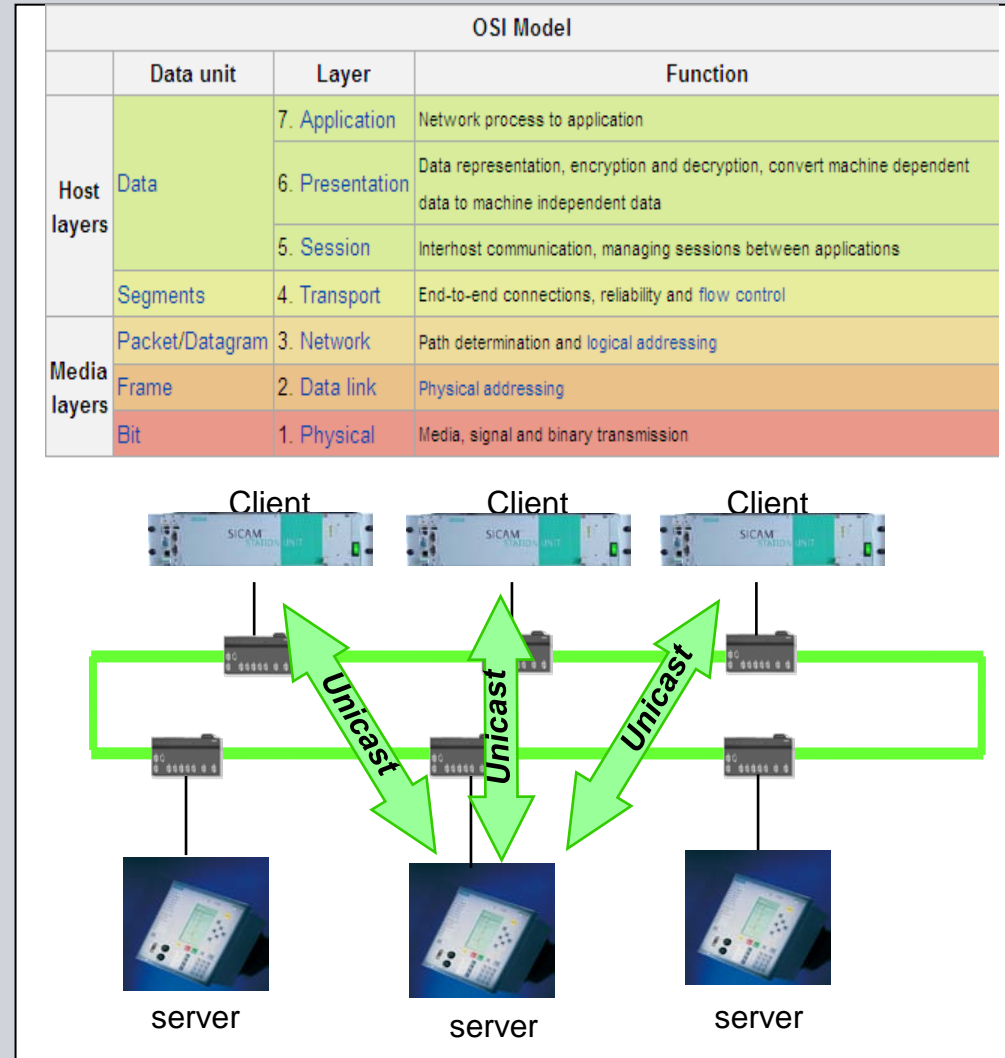
## Network Concept – Applied to IEC61850

### CONCEPTS OF THE IEC 61850 STANDARD

- OSI Data Model
- IEC 61850 Protocols
  - MMS
  - GOOSE (Generic Object oriented Substation Events)
  - SV (Sample Values)
- Multicast vs. Unicast

#### MMS Protocol

- 7 Layers ISO/OSI Model Usage)
- Reliability, every layer a confirmation
- Limited by connections Client-Server (Unicast)
- Time Non-critical.



# Station Integration for Reduced Costs and Improved Operational Efficiency

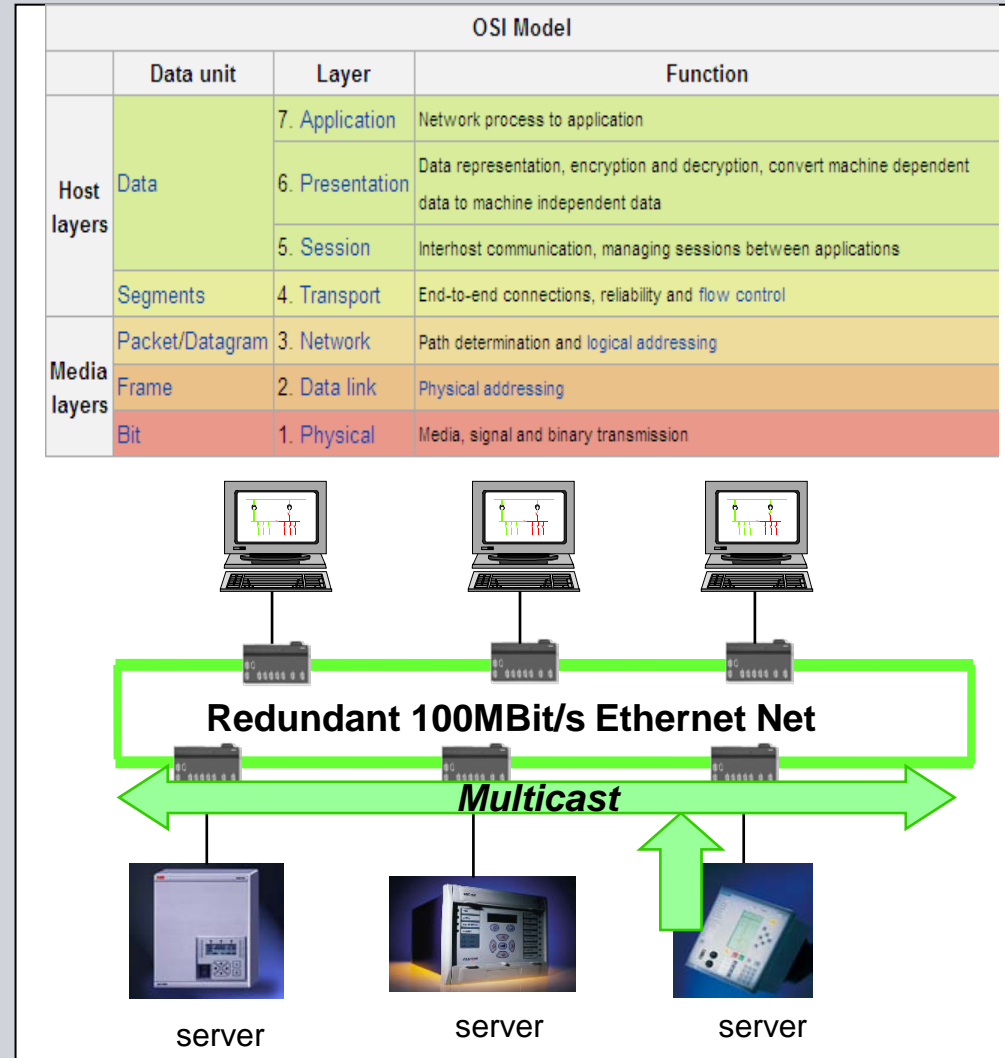
Network Concept – Applied to IEC 61850

## CONCEPTS OF THE IEC 61850 STANDARD

- IEC 61850 Protocols
  - MMS
  - GOOSE (Generic Object oriented Substation Events)
  - SV (Sample Values)
- Multicast vs Unicast

### GOOSE Protocol

- 2 Layers ISO/OSI Model Usage)
- More than one reception (Multicast)
- Fast, Time Critical (~5ms)

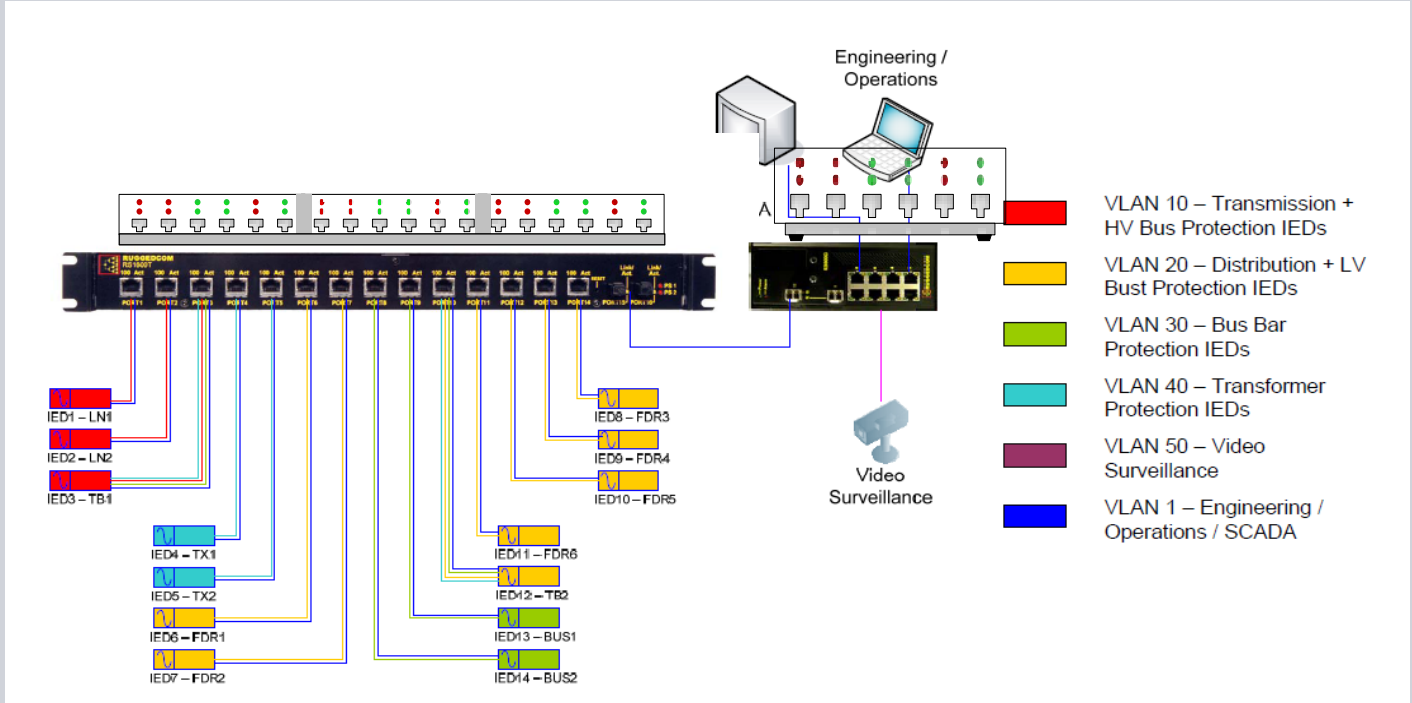


# Station Integration for Reduced Costs and Improved Operational Efficiency

## Network Concept - VLANs

### VLAN ID:

•VLAN has the same attributes as a physical LAN, but it allows for end stations to be grouped together even if they are not located on the same network switch. Network reconfiguration can be done through software instead of physically relocating devices.



### VLAN Created for the Application

#### Static VLANs

VID	VLAN Name	Forbidden Ports	IGMP	MSTI
1	MMS	None	Off	0
2	GOOSE SecA	1-5	Off	0
4	GOOSE SecB	6-10	Off	0
7	GOOSE Test Sys	1-10	Off	0

# Station Integration for Reduced Costs and Improved Operational Efficiency

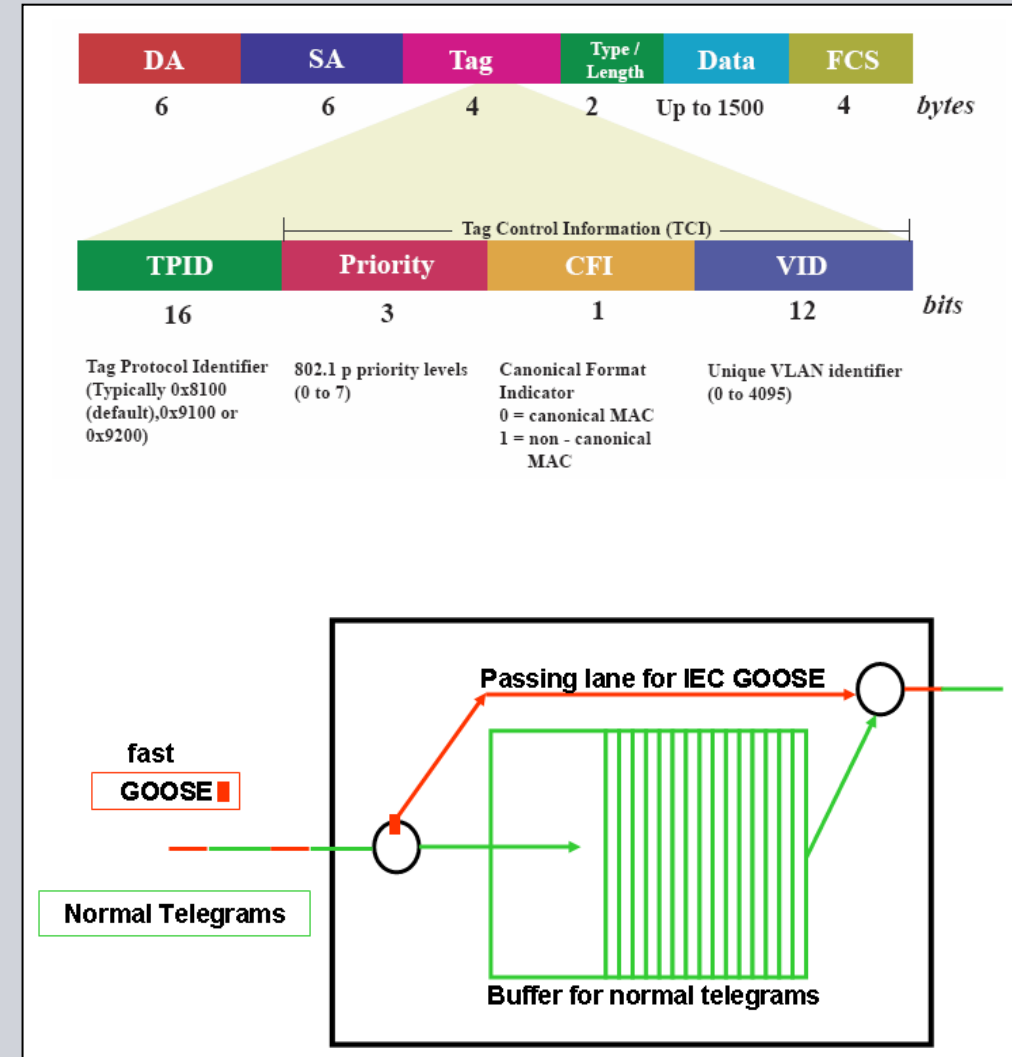
## IEC61850 - GOOSE Using the 802.1Q Frame – Layer 2

### CONCEPTS OF THE IEC 61850 STANDARD

- GOOSE Telegram structure
  - 4 Tag bytes define the tag control information
  - Up to 1500 data bytes are available per message
- GOOSE messages must be prioritized
  - 0-7 (lowest priority)

Only IEC 61850 benefits from the options of modern Ethernet.

**This feature is not** possible with DNPi or Modbus!





# Station Integration for Reduced Costs and Improved Operational Efficiency

## IEC61850 – GOOSE MECHANISM

### -Fast:

Using layer 2 frames, doesn't require any other layer's confirmation or connection. It is a multicast message without connection or confirmation.

### -Ensure delivery of message:

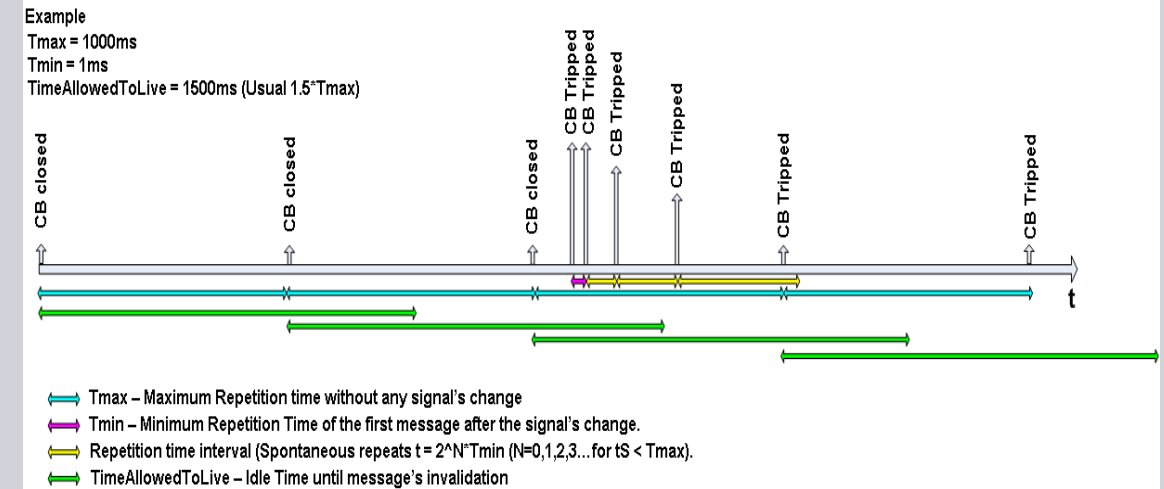
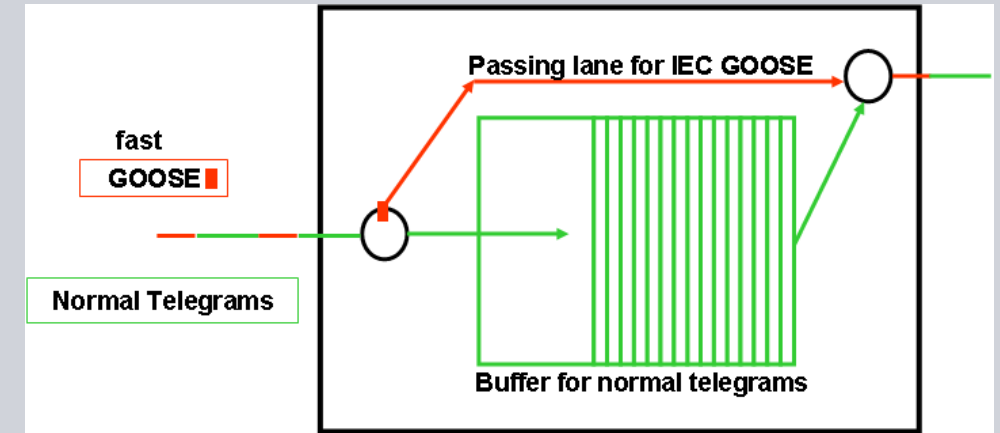
Mathematically, by repeating the same message in a short period of time, it will ensure delivery of the message. Besides, the Receptor verify the message quality and check if the Transmitter is there by usage of TimeAllowToLive.

### -Priority:

By usage of the priority tag (802.1p).

### -No message lost:

The Sequence Number and State Sequence will ensure that no message was lost. The Receptor rejects the GOOSE message if it is out of order.



# Station Integration for Reduced Costs and Improved Operational Efficiency

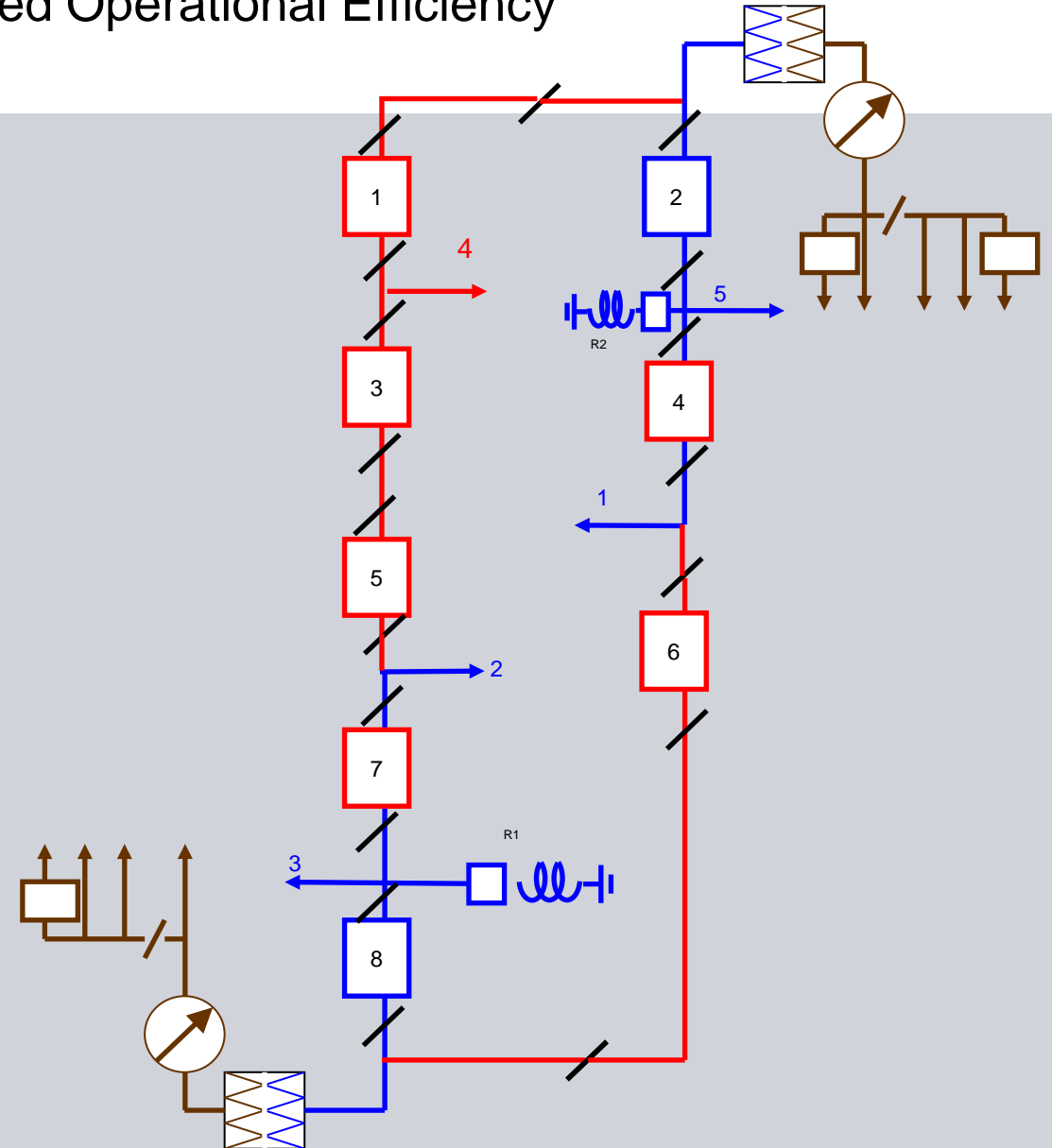
IEC61850 – Project Application

-This project is a 345 kV substation owned and operated by ConEd.

- 8 breaker ring bus
- 2 transformers
- 2 reactors
- 4 incoming lines
- 1 generator feeder

Future expansion is planned to expand to a 12 breaker ring bus.

The project included the coordination with two adjacent substations and monitoring of other site systems through the substation automation system.





# Station Integration for Reduced Costs and Improved Operational Efficiency

IEC61850 – Project Application

61850 Technology Substation.

Redundant RTU (Data Gateway) and HMI Servers with 3 Operator Consoles.

Station Data Server Access.

Communication with Control Center

2 Protection Lines:

-Conventional Protection Scheme.

- GOOSE and Bricks technology Protection Scheme.

Redundant Remote Control Center.

Secure Access from Outside

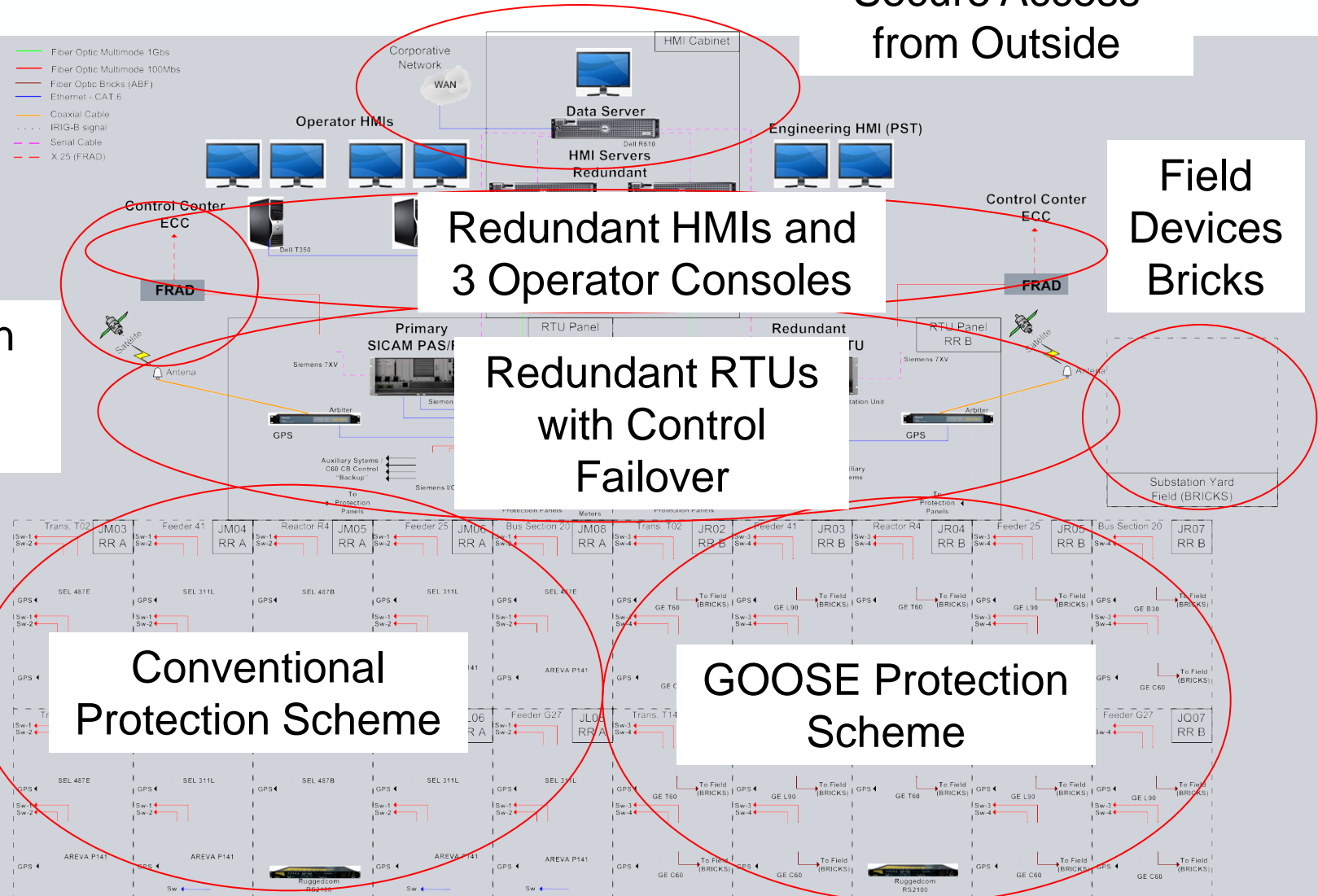
Field Devices Bricks

Redundant HMIs and 3 Operator Consoles

Redundant RTUs with Control Failover

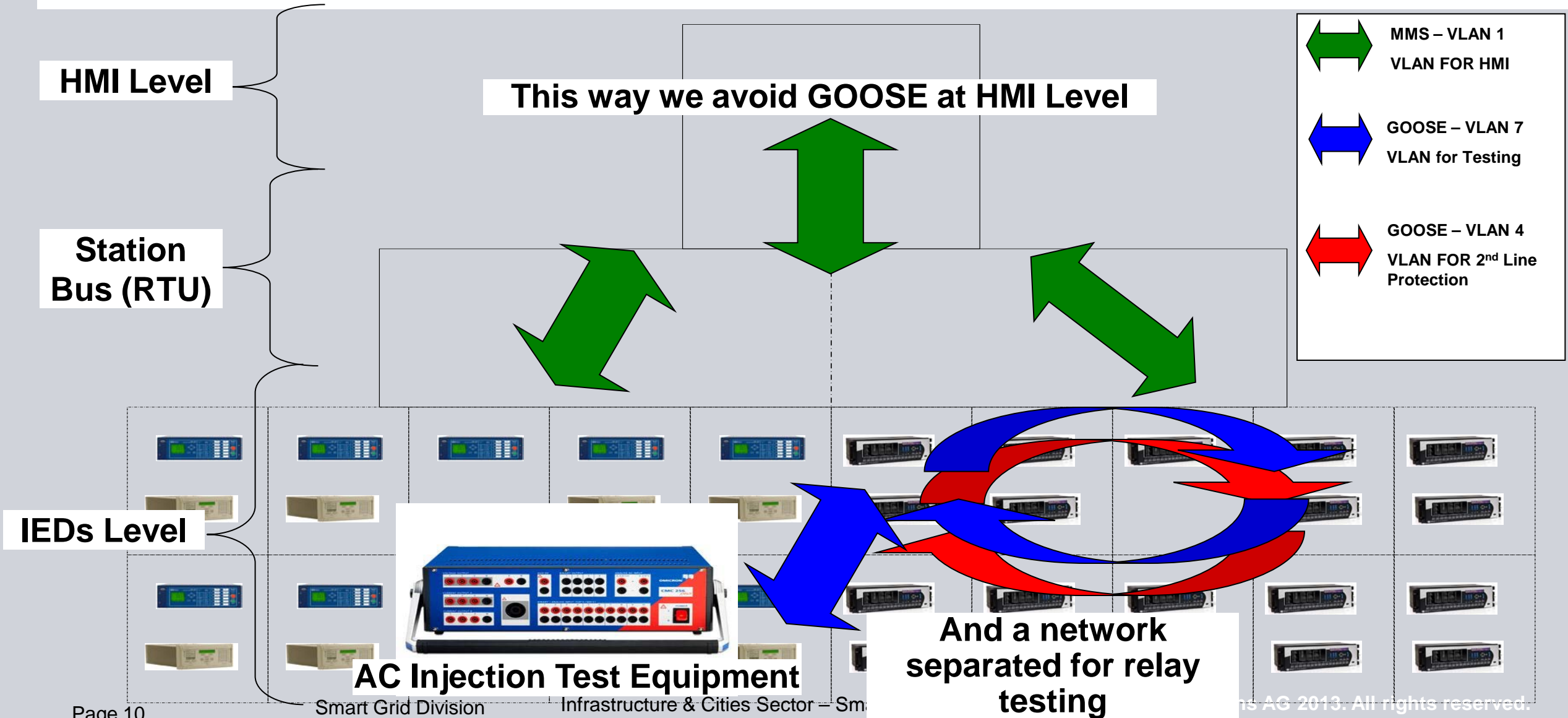
Conventional Protection Scheme

GOOSE Protection Scheme



# Station Integration for Reduced Costs and Improved Operational Efficiency

IEC61850 – Project Application

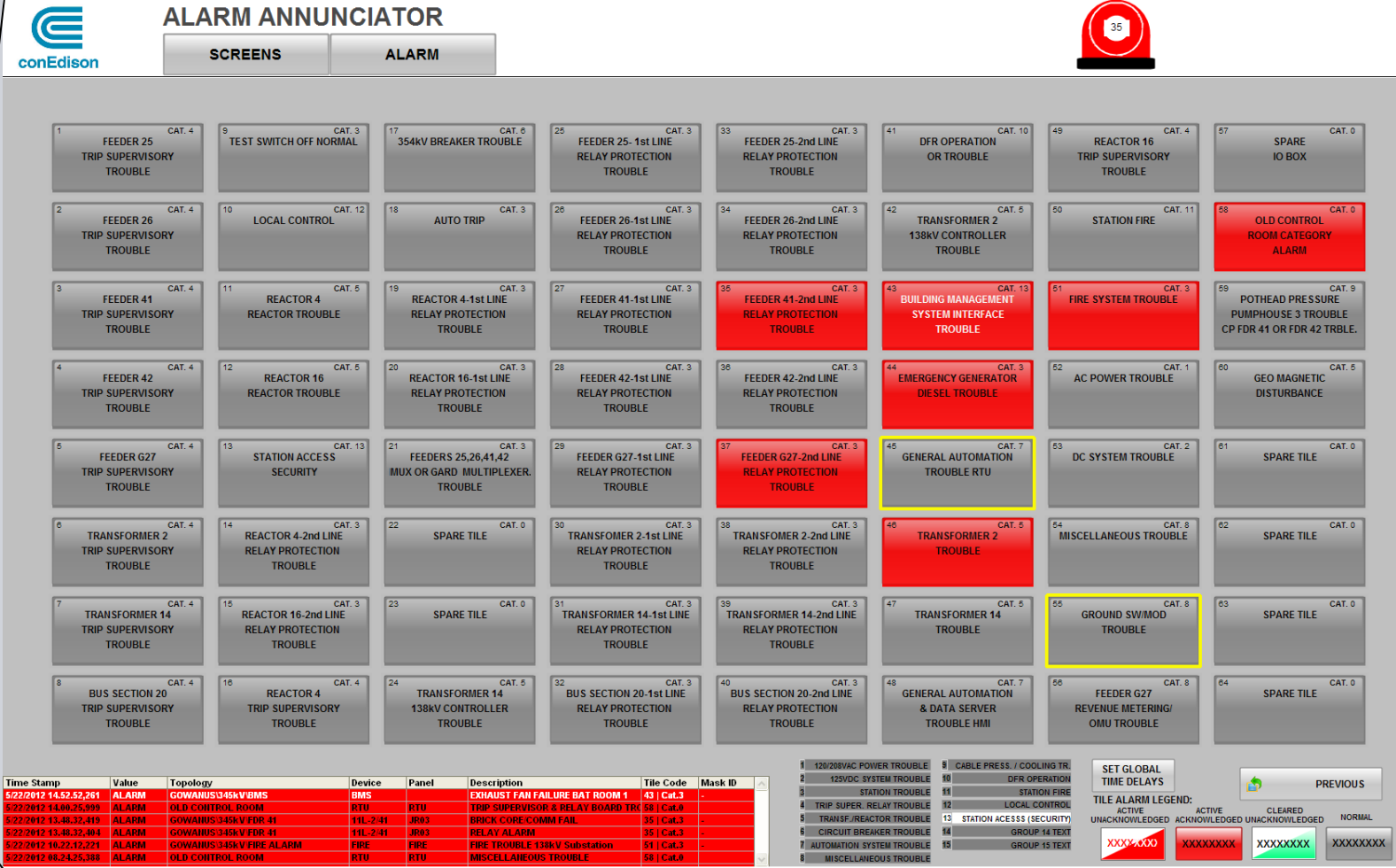


# Station Integration for Reduced Costs and Improved Operational Efficiency

## IEC61850 – Project Application

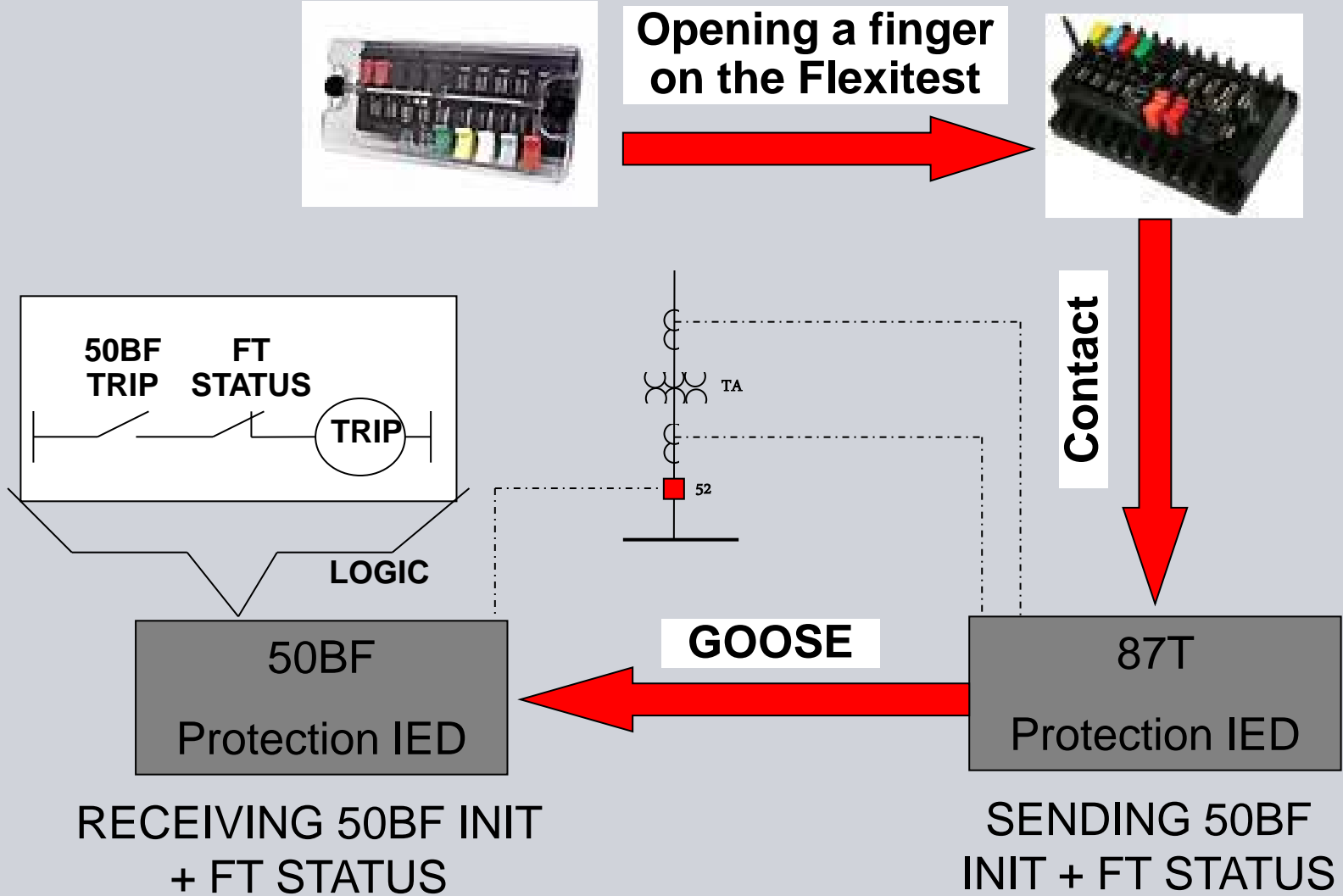
Annunciator panel that is part of local HMI screens.

Provide fast alarm trouble detection



Station Integration for Reduced Costs and Improved Operational Efficiency

IEC61850 – Project Application – Testing a protection relay (IED) in a GOOSE Protection Scheme





# Station Integration for Reduced Costs and Improved Operational Efficiency

## IEC61850 – Project Application – GOOSE Frame Testing Break Down

All individual protection elements of the relays is mapped to a published GOOSE to allow an IEC 61850 test set.

Individual Protection Elements are published in a GOOSE Frame, this way an AC Injection Test can be connected at Network and perform a IED test without disabling any function or change any settings on IEDs or Network.

JQ03	Protection Line Relay	11L-2/42	15	2	87L DIFF OP A
	<b>IP</b>	192.168.1.122	16	4	87L DIFF OP B
	<b>sub net</b>	255.255.255.0	17	6	87L DIFF OP C
	<b>gateway</b>	192.168.1.254	18	8	87L DIFF OP
	<b>61850 ID</b>	JQ03_11	64	10	87L TRIP ON
	<b>GOOSEOUT2 ID</b>	JQ03_11L_2_42_DS2	31	12	PH DIST Z1 OP AB
	<b>MAC 2</b>	01 0C CD 01 00 27	32	14	PH DIST Z1 OP BC
	<b>ETYPE 2</b>	27	33	16	PH DIST Z1 OP CA
			34	18	PH DIST Z2 OP AB
			35	20	PH DIST Z2 OP BC
			36	22	PH DIST Z2 OP CA
			37	24	GND DIST Z1 OP A
			38	26	GND DIST Z1 OP B
			39	28	GND DIST Z1 OP C
			40	30	GND DIST Z2 OP A
			41	32	GND DIST Z2 OP B
			42	34	GND DIST Z2 OP C
			65	36	21-1/21G-1 On
			66	38	21-2/21G-2 On
			25	40	PHASE IOC1 OP
			26	42	PHASE IOC1 OP A
			27	44	PHASE IOC1 OP B
			28	46	PHASE IOC1 OP C
			20	48	LINE PICKUP OP
			67	50	STUB LINE PU On (VO3)
			30	52	BF TT REC OP On (VO12)
			29	54	STUB BUS OP


GOOSE DATASET BREAK DOWN FOR  
CURRENT DIFFERENTIAL WITH  
DISTANCE BACKUP PROTECTION

# Station Integration for Reduced Costs and Improved Operational Efficiency

## IEC61850 – Project Application – GOOSE Performance

Date / Time of Last Clear: Friday, April 29, 2011 15:06:25  
 Events Since Last Clear: 20  
 Shown Number of Events: 20

### SENDER IED

Event Number	Date/Time	Cause	Data
20	Apr 29 2011 15:06:57.422102	TRIP DOff	
19	Apr 29 2011 15:06:57.422102	BF INIT Off	
18	Apr 29 2011 15:06:56.422124	87 Off	
17	Apr 29 2011 15:06:56.422124	OSC TRIGGER Off	
16	Apr 29 2011 15:06:56.422124	TRIP LED Off	
15	Apr 29 2011 15:06:56.422124	87 Off	
14	Apr 29 2011 15:06:56.422124	ANY TRIP Off	
13	Apr 29 2011 15:06:56.422124	BUS 1 BIASED DPO A	
12	Apr 29 2011 15:06:53.413859	TRIP DOn	
11	Apr 29 2011 15:06:53.403442	87 On	
10	Apr 29 2011 15:06:53.403442	OSCILLOGRAPHY TRIG'D	
9	Apr 29 2011 15:06:53.403442	OSC TRIGGER On	
8	Apr 29 2011 15:06:53.403442	TRIP LED On	
7	Apr 29 2011 15:06:53.403442	BF INIT On	
6	Apr 29 2011 15:06:53.403442	87 On	
5	Apr 29 2011 15:06:53.403442	ANY TRIP On	
4	Apr 29 2011 15:06:53.403442	BUS 1 BIASED OP A	
3	Apr 29 2011 15:06:53.403442	BUS 1 BIASED PKP A	
2	Apr 29 2011 15:06:25.793637	OSCILLOGRAPHY CLEAR	
1	Apr 29 2011 15:06:25.793637	EVENTS CLEARED	

Event Record // ConEd Gowanus: 50\_62-2\_16: Actual Values: Records

Date / Time of Last Clear: Friday, April 29, 2011 15:06:25  
 Events Since Last Clear: 45  
 Shown Number of Events: 45

### RECEIVER IED

Event Number	Date/Time	Cause	Data
15	Apr 29 2011 15:06:53.408856	RETRIP On	
14	Apr 29 2011 15:06:53.408856	PHASE A On	
13	Apr 29 2011 15:06:53.408856	RETRIP On	
12	Apr 29 2011 15:06:53.406757	BF INTIATE On	
11	Apr 29 2011 15:06:53.404670	R16_TRIP On	
10	Apr 29 2011 15:06:53.398415	Osc Trigger On	

		MSN	TimeStamp
IED SENDER	87R-2/R16	BF INIT	Apr 29 2011 15:06:53.403442
GOOSE ADD	01 0C CD 01 00 46	DA2	Apr 29 2011 20:06:53.403442
IED RECEIVER	50/62-2/16	BF INIT	Apr 29 2011 15:06:53.406757

**Total Performance: 3.315 ms**

# Station Integration for Reduced Costs and Improved Operational Efficiency

## Conclusion

### Benefits

Conventional protection and GOOSE protection follows same maintenance and testing procedures without impacting the ConEd substation standard.

Operational efficiency was enhanced by the implementation of a flexitest scheme, control failover logic, separate VLAN for testing and digital alarm annunciator.

61850 simplifies project providing engineering reusability reducing up-front and long-term costs.

### Challenges

Multi-vendor integration regarding to software tools.

Special requirement for local HMI that all the alarming processing must reside on the Data Concentrator or RTU.

Alarm Configuration in Runtime mode without restart HMI Application



**Thank you for your attention!**