Campus Wide 61850 Microgrid

for a Tri-Generational Critical Care Campus at UMass Medical School

CampusEnergy2019

February 26 - March 1, 2019 | New Orleans, LA | Hilton New Orleans Riverside

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

WM Wunderlich-Malec

UMASS University of Massachusetts Medical School

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AGENDA

- History/Overview
- Campus Needs
- Plant Expansions
- Problem Statement
- The Microgrid model
- 61850 Necessity
- Challenges
- Summary

CAMPUS HISTORY/OVERVIEW

- New England Campus
  - 60 acres
  - 3.5MSF of facilities
- Medical School
  - Full and Part-Time Faculty
  - 1,000 students (Medical Education, Graduate School of Biomedical Sciences and Grad School or Nursing)
  - Over $220M in annual research funding
- Healthcare System
  - Full service healthcare system in central Mass
  - Campus has 400 Registered Beds, Lifeflight, 20 surgery suites, Emergency Department, Radiology, Oncology, Cardio Vascular, Ortho, etc.

CAMPUS NEEDS

- Reliable Sources of Energy
  - Electrical
  - Steam
  - Chilled Water

- Critical Loads
  - Two Independent Sources of Electrical Power
    - Onsite Generation
    - Utility

2000 and 2010 Plant Expansions

Major Additions to Generation and Campus Loads

- **2000 G3 Project**
  - Added the 1100psi high pressure plant
  - 5.5MW Backpressure STG (1100/250psi)
  - 5000 Ton Chiller

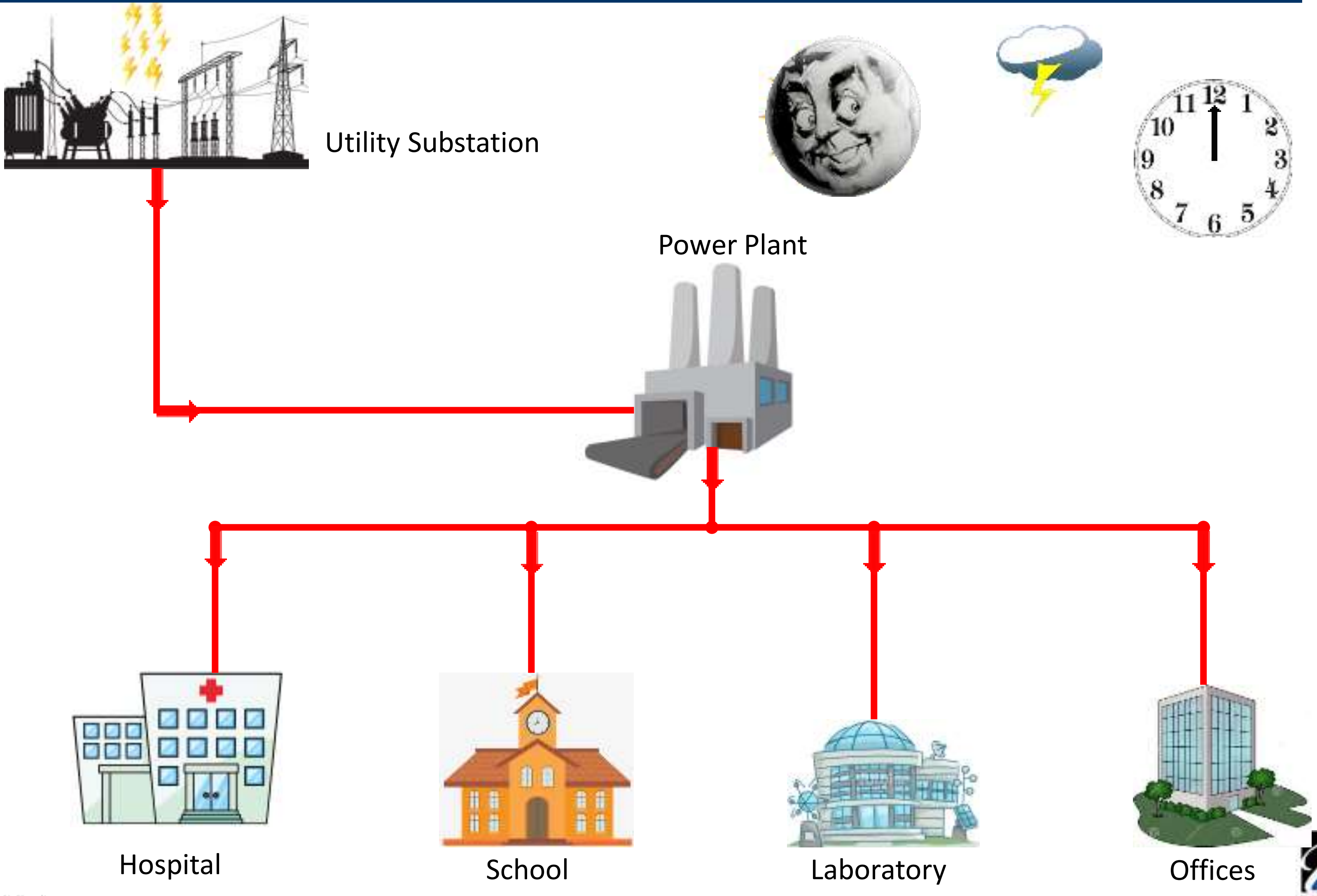
- **2010 G4 Project**
  - Added 7.5MW CTG / 1100psi HRSG
  - 4000 Ton Electric Chiller

Problem Statement

- For many years the Plant has provided reliable steam, chilled water and electricity to the UMMS Campus.
- During a utility (NGrid) outage, the Plant maintains the electricity for the Campus critical loads (via the Plant's Emergency Bus).
- As a result of the recent Cogeneration Expansion (2010) the onsite electrical generation capacity has nearly doubled;
- The Plant now has the electrical capacity to supply the majority of the Campus electrical loads (critical and non-critical).

- ***How do we expand the existing Micro-grid model to the entire campus with such a complex plant combined with serving critical loads?***

Existing Micro-Grid



2015 and Future Plant Expansion

Expanding the Microgrid Model

Relocating the PCC provides enhanced Campus Reliability and Resiliency

- **Increase *Campus* Reliability and Resiliency to external events**
  - Natural Disasters no longer jeopardize all the Campus loads
  - Adding more of the campus onto the ILS system
  - Maximizing campus on-line reliability

- **Match Campus load to the onsite generation**
  - Maintain NFPA 99 requirement for the Campus Critical Loads

2015 and Future Plant Expansion

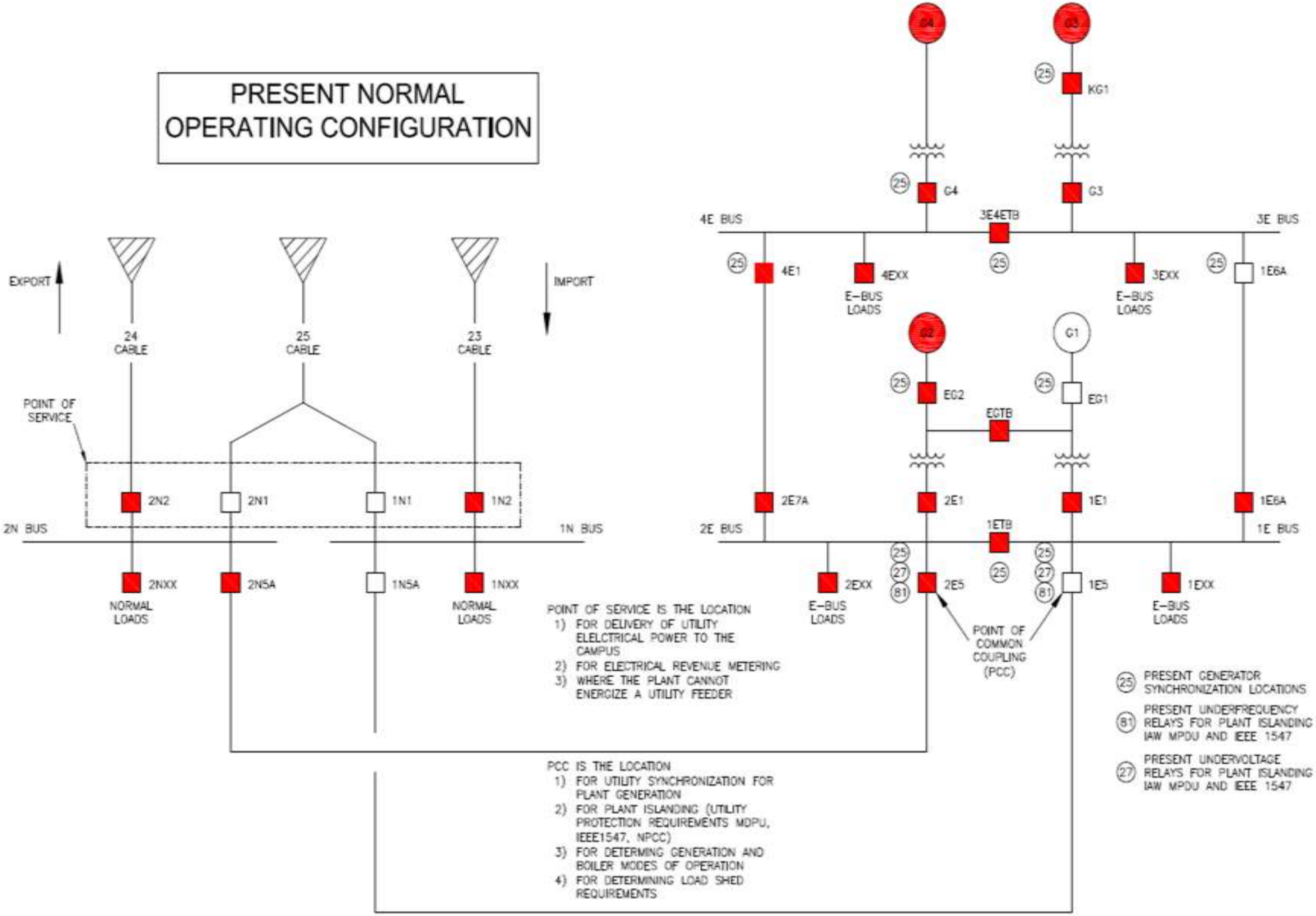
Point of Common Coupling

Point of Common Coupling (PCC) in a plant's electrical system can be defined as a location point for:

- Utility Synchronization for Plant Generation
- Plant Islanding
- Determining Generating Modes of Operation
- Determining Load Shed Requirements

This location can be different than the Electrical Utility's Point of Service

PRESENT NORMAL OPERATING CONFIGURATION



2015 and Future Plant Expansion

Point of Common Coupling - Present Location

PCC is presently at the interconnection between the Emergency (Critical Loads) and Normal (non-Critical) Buses

- Plant Islanding does not supply power to the Normal Bus
- Plant Spinning reserve is significant and not available Normal Bus

An electrical load survey has shown:

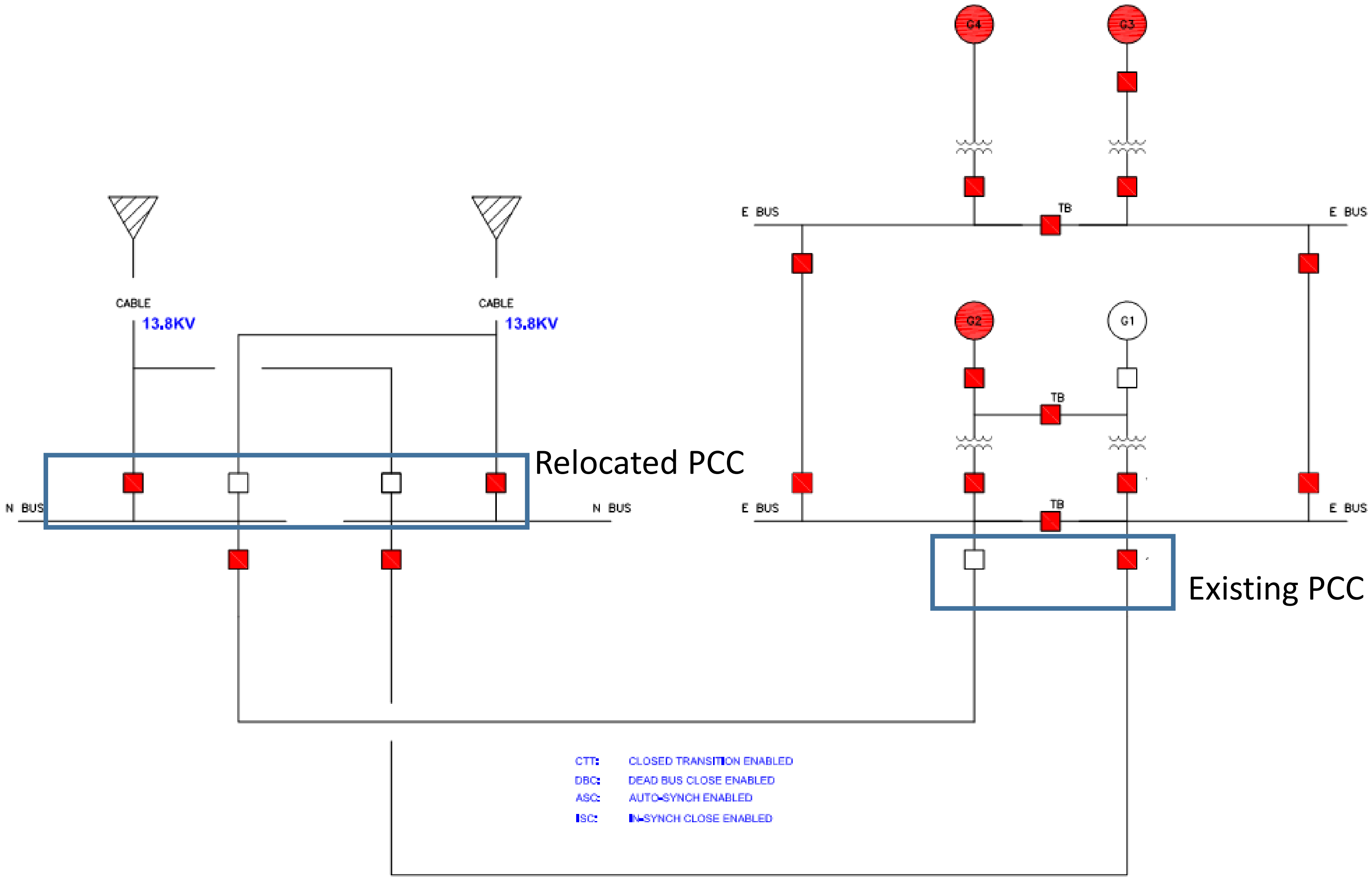
- Spinning reserve is capable of supplying most, if not all, of the Campus Normal Winter load
- Spinning reserve is capable of supplying much of the Campus normal Summer loads with limited Load Shedding interruptions

CAMPUS WIDE MICRO-GRID

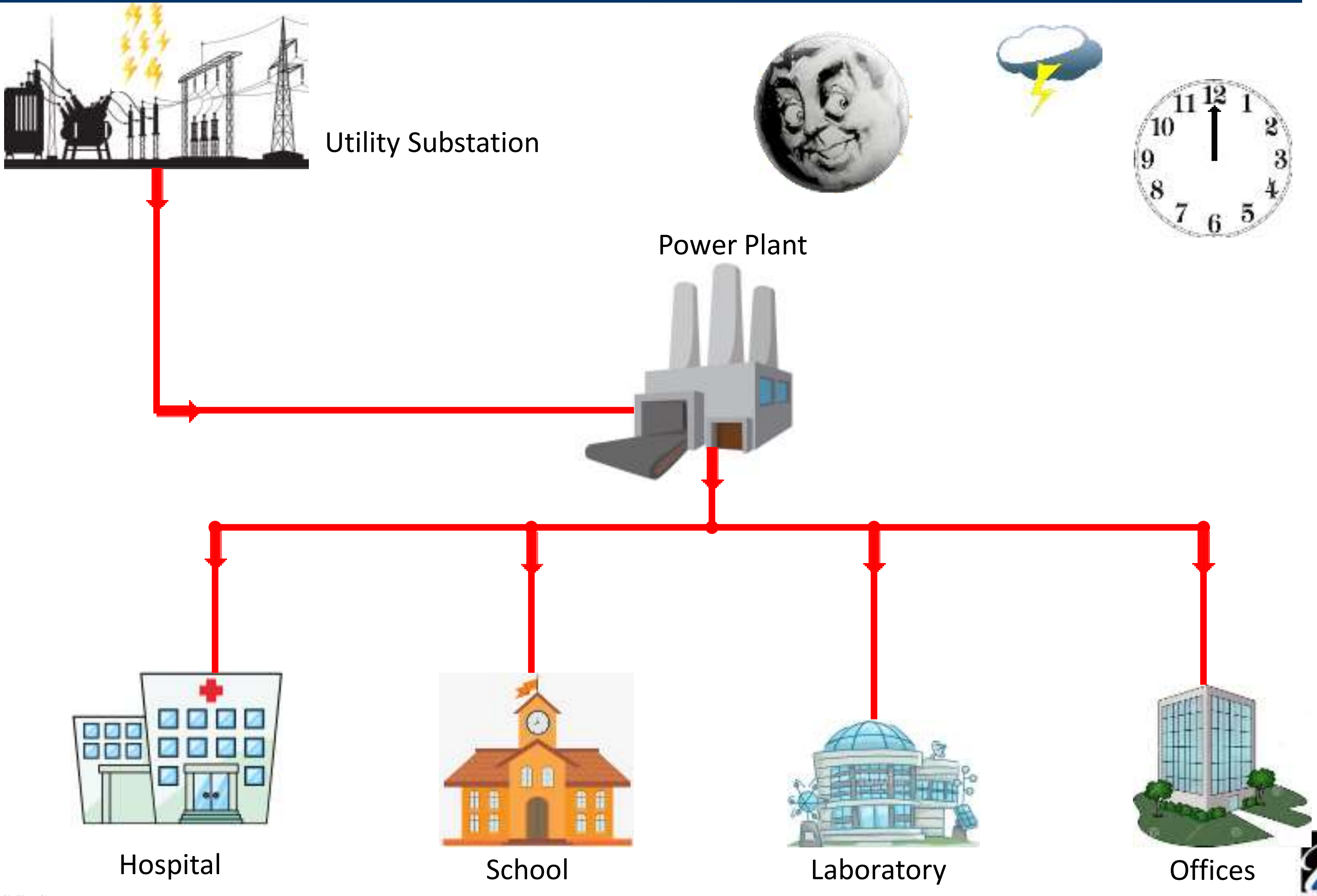
Point of Common Coupling - Relocated

<u>PCC Relocated to the Point of Service</u>

- Expand ILS to the Campus Loads (Normal Bus)
  - Improves matching of the Campus load to the onsite generation
  - Onsite generation is capable of supplying all of the Campus Peak Winter loads
  - Generators are capable of supplying over 70% of the Campus Peak Summer Loads
  - Maintains the NFPA 99 requirement for Critical Loads
- The Power Utility is used as a backup power source


G4
G3
G2
G1
TB
E BUS
N BUS
CABLE
13.8KV
Relocated PCC
Existing PCC
CTT: CLOSED TRANSITION ENABLED
DBC: DEAD BUS CLOSE ENABLED
ASC: AUTO-SYNCH ENABLED
ISC: IN-SYNCH CLOSE ENABLED

Campus-Wide Micro-Grid



Challenges

- Complex Interlocking and Generator Automation
- Reliability/Redundancy
- Event Recording
- Factory Testing Simulation
- Sequencing of Installation

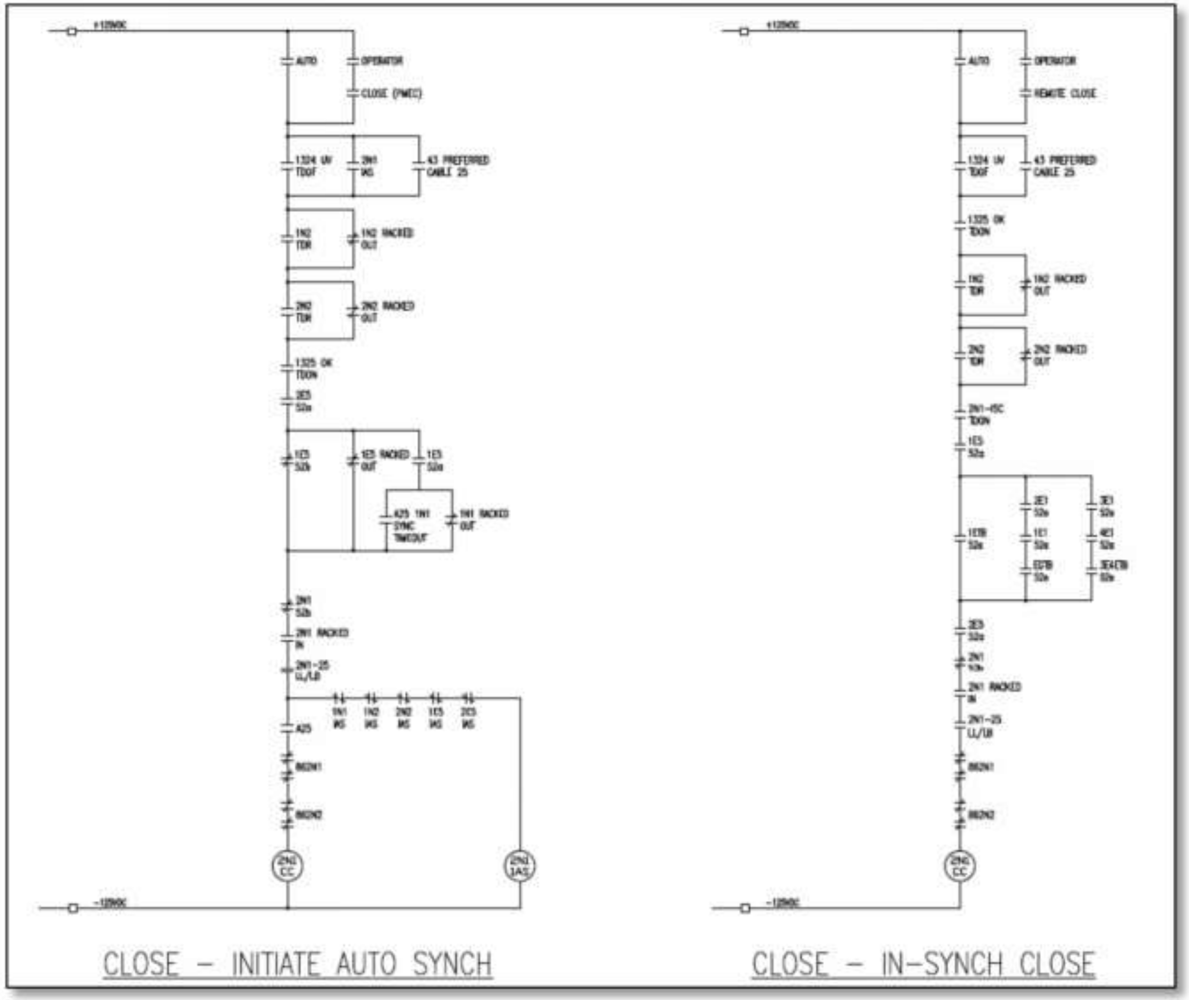
61850 Necessity

- IEC 61850 and PRP

  - The IEC 61850 Generic Object Oriented Substation Event (GOOSE) network is designed to communicate at millisecond speed and is used for high-speed tripping and interlocking within large utility substations

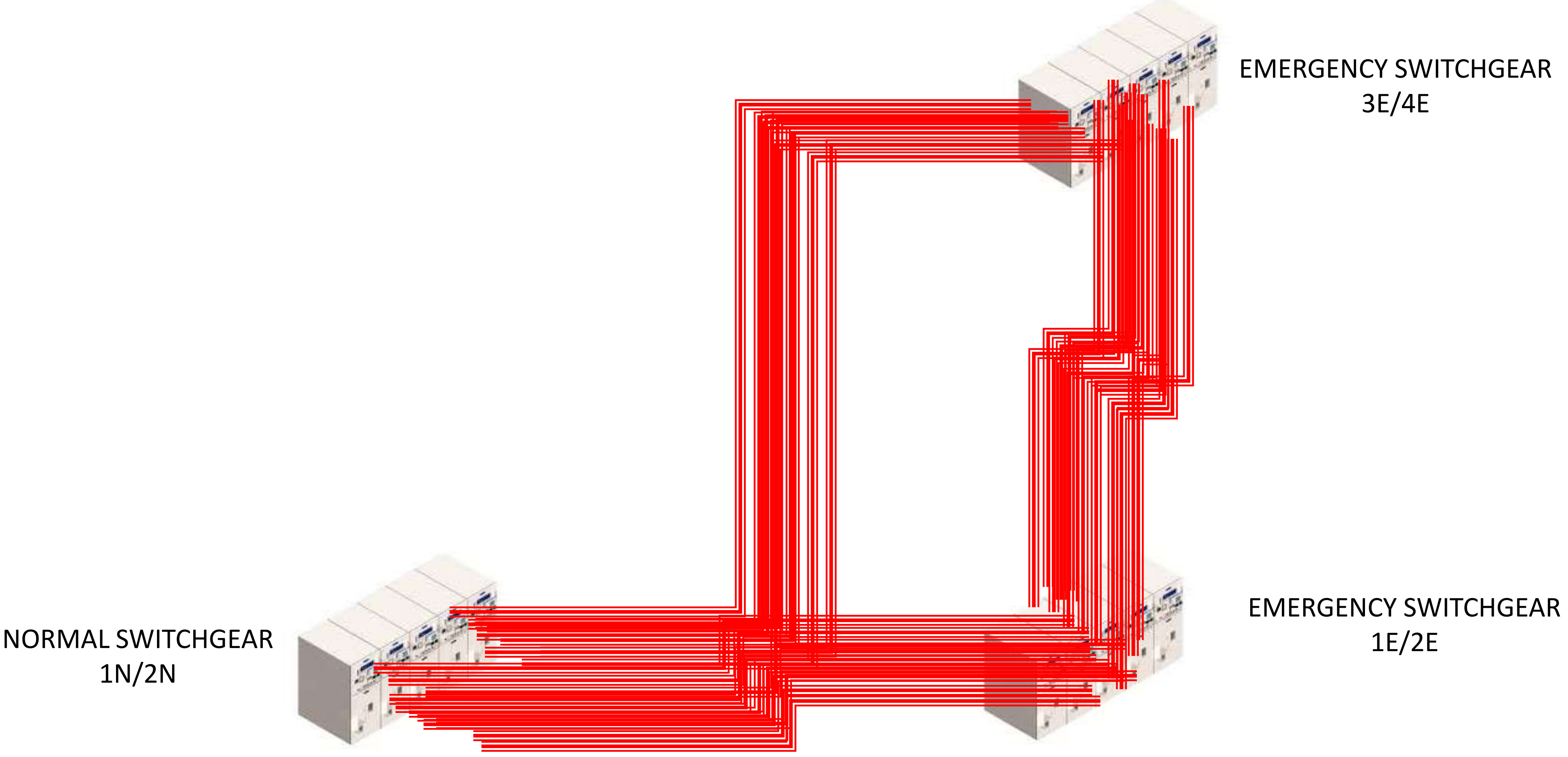
  - PRP is a superior redundancy protocol because of its interruption free switchovers in case of a failed Relay with no time delay, thus offering the highest possible availability.

Complex Interlocking

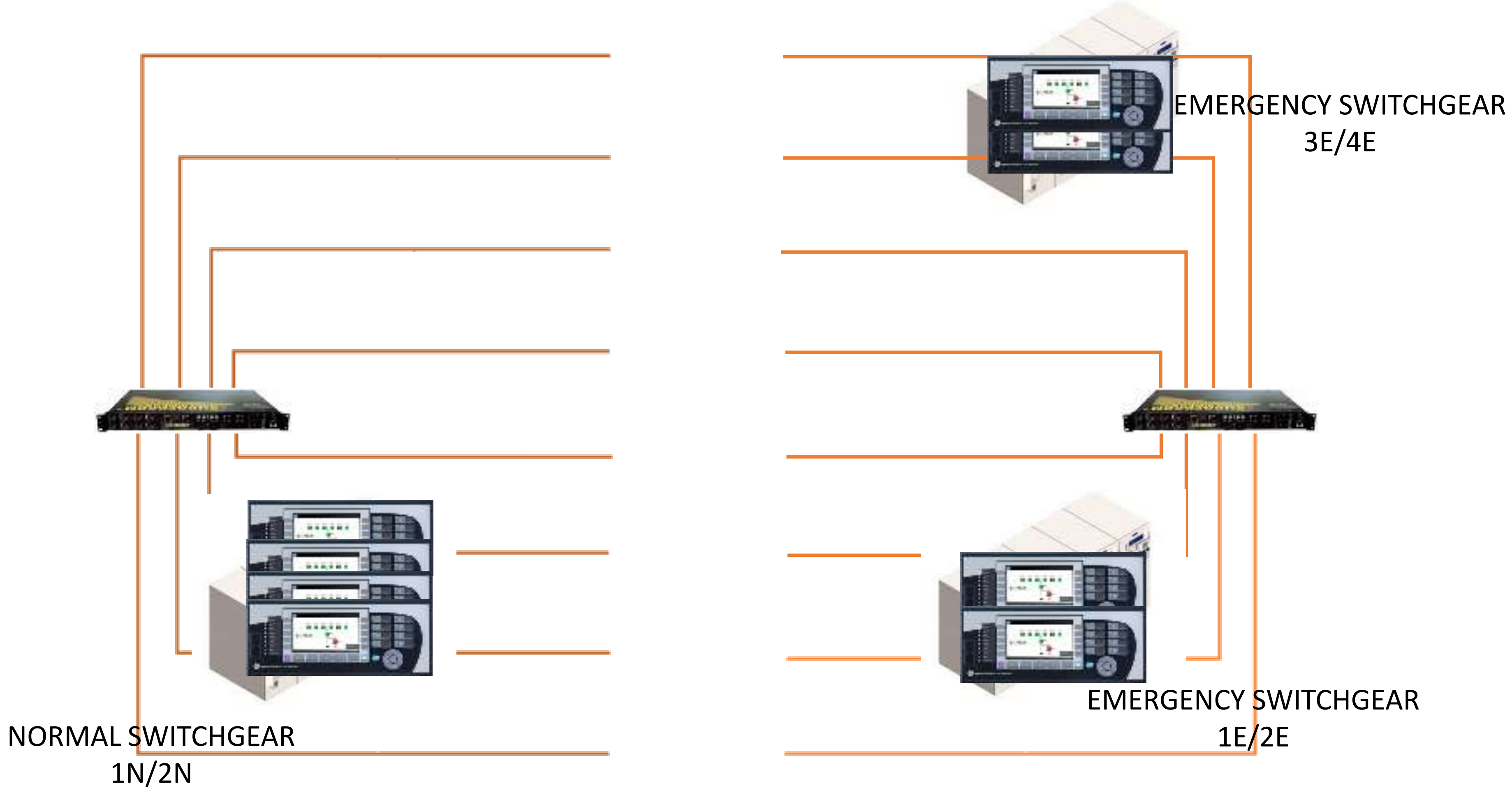


2N1 BREAKER CLOSE PATH – EXAMPLE LOGIC

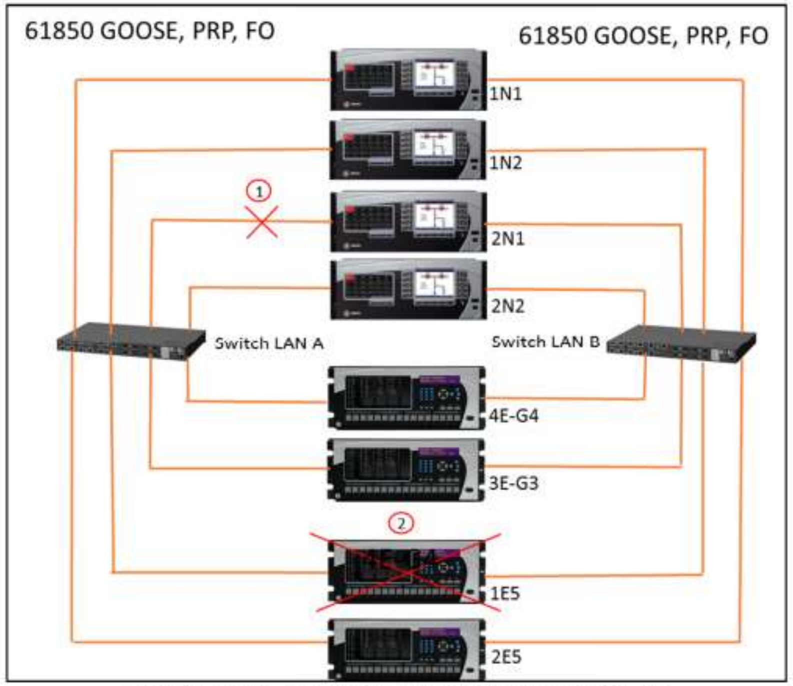
Conventional Hardwired Approach



Complex Interlocking – IEC61850



Reliability/Redundancy - PRP



IEC 61850, PRP NETWORK TOPOLOGY

Case 1 Fault: If a switch fails or a cable breaks the communication redundancy is lost, but not the protection and control functions. That's because messages sent on the healthy network are not disturbed.

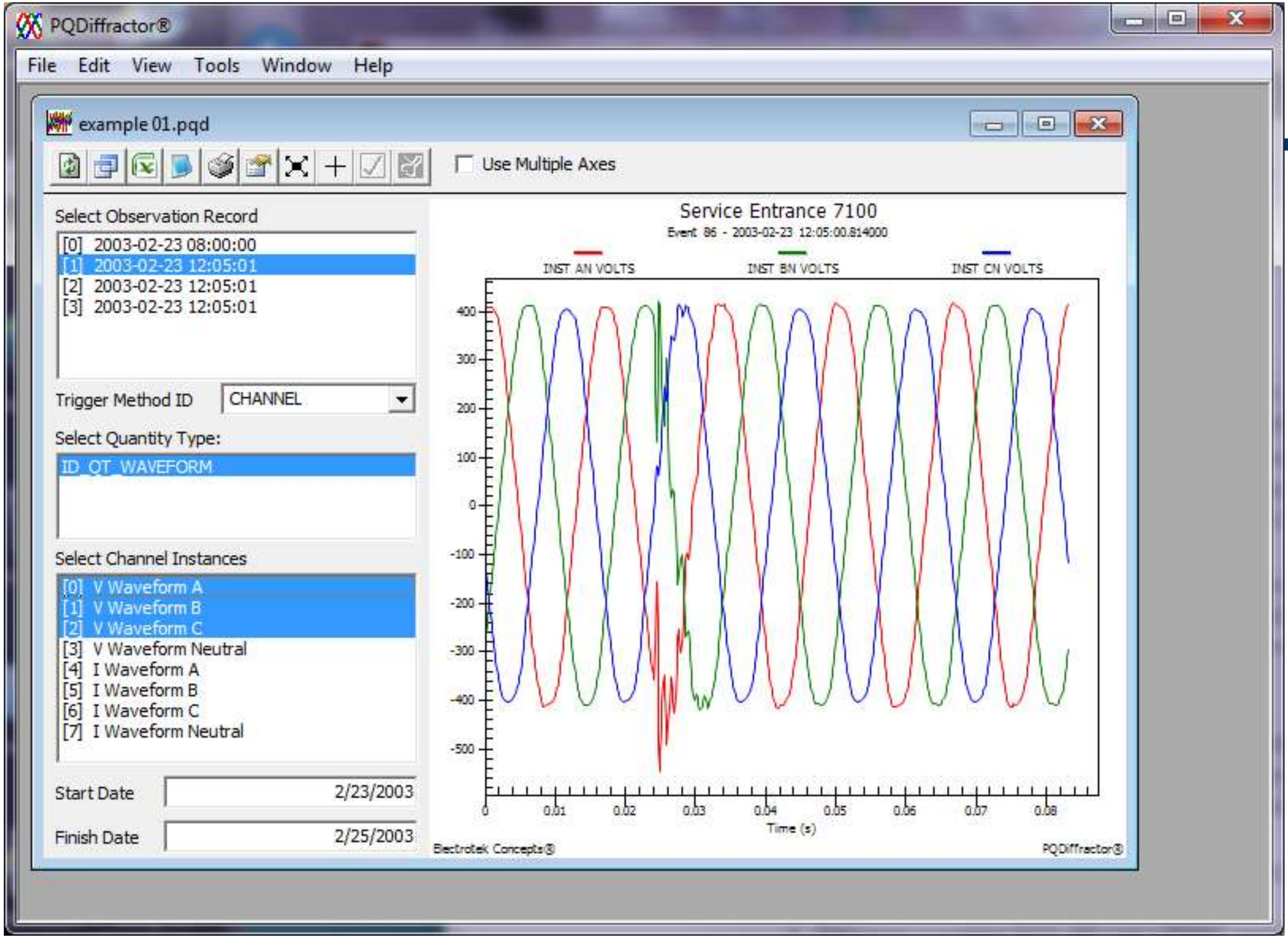
Case 2 Fault: When a Relay fails only its protection and control functions are lost, the other Relays continue to communicate over the redundant LAN to protect and control equipment. In the case of UMMS, the 2E5 relay would transmit all the status signals previously transmitted by the 1E5 relay.

Reliability/Redundancy - Relays

Primary and Backup Relays

1N/2N UR RELAY FUNCTIONALITY

Relay	Voltage	Status	Protection	Controls
2N1	Cable 1325 Cable 1324 2N Bus	2N1 2N2 2N5A	2N1 Breaker	2N1 2N2 (2N2 UR FAIL)
2N2	Cable 1324 Cable 1325 2N Bus	2N1 2N2 2N5A	2N2 Breaker	2N2 2N1 (2N1 UR FAIL)
1N1	Cable 1324 Cable 1325 1N Bus	1N1 1N2 1N5A	1N1 Breaker	1N1 1N2 (2N2 UR FAIL)
1N2	Cable 1325 Cable 1324 1N Bus	1N1 1N2 1N5A	1N2 Breaker	1N2 1N1 (1N2 UR FAIL)


PQDiffractor®
File Edit View Tools Window Help
example 01.pqd
Use Multiple Axes
Select Observation Record
[0] 2003-02-23 08:00:00
[1] 2003-02-23 12:05:01
[2] 2003-02-23 12:05:01
[3] 2003-02-23 12:05:01
Trigger Method ID
CHANNEL
Select Quantity Type:
ID_QT_WAVEFORM
Select Channel Instances
[0] V Waveform A
[1] V Waveform B
[2] V Waveform C
[3] V Waveform Neutral
[4] I Waveform A
[5] I Waveform B
[6] I Waveform C
[7] I Waveform Neutral
Start Date
2/23/2003
Finish Date
2/25/2003
Service Entrance 7100
Event 86 - 2003-02-23 12:05:00.814000
INST AN VOLTS
INST BN VOLTS
INST CN VOLTS
400
300
200
100
0
-100
-200
-300
-400
-500
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
Time (s)
Electrotek Concepts®
PQDiffractor®

Factory Testing Simulation

Thank You

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