Campus Wide 61850 Microgrid
for a Tri-Generational Critical Care Campus
at UMass Medical School
PRESENTERS

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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

Utility Substation

Power Plant

Hospital

School

Laboratory

Offices
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
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.
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
PCC Relocated to the Point of Service

- 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
Campus-Wide Micro-Grid

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CampusEnergy2019

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Challenges

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

NORMAL SWITCHGEAR 1N/2N

EMERGENCY SWITCHGEAR 1E/2E

EMERGENCY SWITCHGEAR 3E/4E
Complex Interlocking – IEC61850

NORMAL SWITCHGEAR
1N/2N

EMERGENCY SWITCHGEAR
3E/4E

EMERGENCY SWITCHGEAR
1E/2E
Reliability/Redundancy - PRP

**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.
Primary and Backup Relays

<table>
<thead>
<tr>
<th>Relay</th>
<th>Voltage</th>
<th>Status</th>
<th>Protection</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N1</td>
<td>Cable 1325, Cable 1324, 2N Bus</td>
<td>2N1, 2N2, 2N5A</td>
<td>2N1 Breaker</td>
<td>2N1, 2N2 (2N2 UR FAIL)</td>
</tr>
<tr>
<td>2N2</td>
<td>Cable 1324, Cable 1325, 2N Bus</td>
<td>2N1, 2N2, 2N5A</td>
<td>2N2 Breaker</td>
<td>2N2, 2N1 (2N1 UR FAIL)</td>
</tr>
<tr>
<td>1N1</td>
<td>Cable 1324, Cable 1325, 1N Bus</td>
<td>1N1, 1N2, 1N5A</td>
<td>1N1 Breaker</td>
<td>1N1, 1N2 (2N2 UR FAIL)</td>
</tr>
<tr>
<td>1N2</td>
<td>Cable 1325, Cable 1324, 1N Bus</td>
<td>1N1, 1N2, 1N5A</td>
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</tbody>
</table>
Event Recording

IEEE 1588 / PTP

Precision Time Protocol

Over the GOOSE Network via Network Switches

GOOSE Triggered Events and Oscillography

An event on one bus triggers an event on every other 13.8 kV Bus.
Factory Testing Simulation
MICROGRID/61850 EXECUTION

- Commissioning and Interim Modes of Operation
- "Brown Field" Plant
- Need to maintain existing modes of operation until complete cutover
- Any changes are much easier to implement as no additional wiring is necessary.

Logic/Test/Implement Commissioning / Sequencing
Thank You