Small Hydro and Technical Workshop

SCADA Systems for Remote Plant Operations

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Abstract

• H2O Power operates 48 hydroelectric units
• Distributed across 8 generating stations across Ontario
• Prior to Remote SCADA addition, all plants were manned (26 personnel)
• After Remote SCADA addition, all plants are now unmanned (6 Operations personnel for fleet-wide remote control)
• Oshawa Operations Center is responsible for the remote operation
• Existing SCADA system was installed in phases between 2008-2010
• Computer hardware was at the end of its useful life
• Replacing the computers also required upgrading the SCADA software
About H2O Power

• Installed capacity 151 MW
• Annual energy production > 870 GWHrs
• Real time operation of 8 hydro stations, 3 high voltage switchyards, 2 transmission corridors on 3 river systems
• Active participant in the Ontario Energy market
• Generation commitments to the Ontario Independent Electricity System Operator (IESO)
## Summary of Plants & Capacities

<table>
<thead>
<tr>
<th>Plant</th>
<th>Location</th>
<th>River System</th>
<th>Nameplate Capacity</th>
<th>Turbines</th>
<th>Originally Built/Upgraded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twin Falls</td>
<td>Iroquois Falls</td>
<td>Abitibi River</td>
<td>27.5 MW</td>
<td>5 Vertical Francis</td>
<td>1922/2013</td>
</tr>
<tr>
<td>Iroquois Falls</td>
<td>Iroquois Falls</td>
<td>Abitibi River</td>
<td>30 MW</td>
<td>9 Vertical Saxo Kaplan 3 Horizontal Double Francis</td>
<td>1914/2004</td>
</tr>
<tr>
<td>Island Falls</td>
<td>Smooth Rock Falls</td>
<td>Abitibi River</td>
<td>44 MW</td>
<td>4 Vertical Francis</td>
<td>1925/2019</td>
</tr>
<tr>
<td>Fort Frances</td>
<td>Fort Frances</td>
<td>Rainy River</td>
<td>12.8 MW</td>
<td>8 Vertical Propeller</td>
<td>1909/2018</td>
</tr>
<tr>
<td>Sturgeon Falls</td>
<td>Bennet Township</td>
<td>Seine River</td>
<td>8.4 MW</td>
<td>2 Vertical Francis</td>
<td>1927/2016</td>
</tr>
<tr>
<td>Calm Lake</td>
<td>Bennet Township</td>
<td>Seine River</td>
<td>9.5 MW</td>
<td>2 Vertical Francis</td>
<td>1928/2016</td>
</tr>
<tr>
<td>Kenora</td>
<td>Kenora</td>
<td>Winnipeg River</td>
<td>5.5 MW</td>
<td>6 Vertical Propeller</td>
<td>1906/2019</td>
</tr>
<tr>
<td>Norman</td>
<td>Kenora</td>
<td>Winnipeg River</td>
<td>12.8 MW</td>
<td>5 Vertical Propeller</td>
<td>1926/2018</td>
</tr>
</tbody>
</table>
H20 Power Locations

Map courtesy of Google
Kenora & Norman
Fort Frances /Calm Lake/Sturgeon Falls
Twin Falls/Iroquois Falls/Island Falls
Existing SCADA

• Inter-site communications achieved by a Primary Wide Area Network
• Back up by a Secondary WAN operating over a satellite link
• Local redundant servers at each plant location
• Combined quad-redundant servers at the Primary and Backup remote Operations Control Centers
SCADA Multi-Master Communication

**PLANT**
- CLPGP1 - Primary Server
- CLPGG2 - Secondary Server

**PGP to PGP Communication Via TCP/IP Socket**

**REMOTE**
- Fort Frances Control Centre
  - FFCRPGP1A
  - FFCRPGP2A

- Oshawa Control Centre
  - Side A
    - OSCRPGP1A
    - OSCRPGP2A
  - Side B
    - OSCRPGP1B
    - OSCRPGP2B
Typical Unit Controller Layout

- ABB SCADA HMI for Local and Remote SCADA Control
- ABB AC500 PLC for Switchyard, Substation, & Spillway Gate Controls
- 3rd party for Unit Sequences and Governor Controls
- SEL Data Concentrator to communicate to legacy devices
Existing Issues

- Existing SCADA is dependent on computer hardware
- Computer hardware has reached the end of its useful life
- Existing Microsoft operating system is beyond extended support, security patches are no longer available
- Existing Oshawa Operations Center physical workplace arrangement is not ergonomically optimized to support Operations
Existing Oshawa Operations Center
Existing Oshawa Operations Center
Existing Oshawa Operations Center
Project Goals

1. To replace obsolete PC & Server hardware and Operating Systems and re-establish compliance with the latest NERC CIP Cyber Security policies;
2. To improve SCADA communications speed and efficiency;
3. Execute the upgrade with minimal impact to Operations and Generation;
4. Improve system backup control capabilities
Project Solution

- ABB provided a new version of SCADA which is designed to operate on virtual machines
- Solution reduces the space & power requirements
- Enables more flexibility in operations and future upgrades
- Embedded server and LTSB versions of the computer operating systems for long-term stability
- Improved reliability by adding backup servers in a geographically diverse third location (Iroquois Falls Regional Office)
- Enhanced Cyber Security via Patching Disk services
Scope of Work

- Specification & supply of Dell Servers (24), Dell Operation Workplaces (23), Dell LCD 55” monitors (3) + LCD 27” monitors (9), and 10G network switches, and KVMs
- Microsoft Windows 2016 Server, Windows 10 Pro, & VMware ESXi 6.0 licenses
- McAfee Antivirus Scan software
- ABB Ability™ Symphony® Plus Operations SCADA and Historian software
- Conversion engineering of existing SCADA graphics and tag database
- Staging and loading of complete system at ABB facility
- Comprehensive Factory Acceptance Test with H2O Power at ABB facility
- Drawing updates
- Site installation support and commissioning
Project Execution

The project execution consisted of three distinct phases:

a) Engineering Conversion
b) System Testing
c) Site Commissioning and Testing
Project Execution – Engineering Conversion

- Included the traditional conversion of the existing graphics and tag database
- Opportunity to conduct graphic refinements and updates to reflect the current operations
- Perform alarm rationalization exercises
- H2O Power actively engaged to provide input and ensure that the new system met all their requirements
Projection Execution – System Testing

- Side-by-side visual comparison of the existing SCADA vs the new SCADA to confirm graphics and navigational aspects were correct
- Integrated system test to ensure network communications such as Multi-Master Server-to-Server, and Client-to-Server connections
- Historian data collection testing and Historian Reports verifications
- Redundancy fail-over
- Auto-start on power recovery
- H2O Power actively engaged to provide input and ensure that the new system met all their requirements
Projection Execution – Site Commissioning & Testing

- Existing SCADA & new SCADA systems were run in parallel at the Oshawa & Fort Frances Control Centers
- Enabled ABB to commission/decommission one station at a time without any disruption
- With initial parallel SCADA system installed, the first Generation Station was then upgraded
- Testing & fine tuning of the network settings were conducted to optimize performance
- H2O Power were an integral part of the commissioning phase
## Commissioning Timeframe

<table>
<thead>
<tr>
<th>Location</th>
<th>Start</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oshawa Operations Centre (initial)</td>
<td>January 15, 2018</td>
<td>January 17, 2018</td>
</tr>
<tr>
<td>Fort Frances Operations Centre</td>
<td>January 22, 2018</td>
<td>January 25, 2018</td>
</tr>
<tr>
<td>Iroquois Falls Operations Centre</td>
<td>January 29, 2018</td>
<td>February 1, 2018</td>
</tr>
<tr>
<td>Norman GS</td>
<td>February 1, 2018</td>
<td>February 8, 2018</td>
</tr>
<tr>
<td>Network &amp; Satellite Fine Tuning and Testing</td>
<td>February 12, 2018</td>
<td>February 17, 2018</td>
</tr>
<tr>
<td>Twin Falls GS</td>
<td>February 20, 2018</td>
<td>February 23, 2018</td>
</tr>
<tr>
<td>Island Falls GS</td>
<td>February 26, 2018</td>
<td>March 1, 2018</td>
</tr>
<tr>
<td>Kenora GS</td>
<td>March 5, 2018</td>
<td>March 8, 2018</td>
</tr>
<tr>
<td>Iroquois Falls GS</td>
<td>March 12, 2018</td>
<td>March 16, 2018</td>
</tr>
<tr>
<td>Calm Lake GS</td>
<td>March 19, 2018</td>
<td>March 22, 2018</td>
</tr>
<tr>
<td>Sturgeon Falls GS</td>
<td>March 26, 2018</td>
<td>March 29, 2018</td>
</tr>
<tr>
<td>Fort Frances GS</td>
<td>April 2, 2018</td>
<td>April 5, 2018</td>
</tr>
<tr>
<td>Oshawa Operations Centre (final)</td>
<td>April 9, 2018</td>
<td>April 12, 2018</td>
</tr>
</tbody>
</table>
Challenges

1. Satellite bandwidth communication issues
   • latency delays with the backup satellite link were discovered
   • there are too many hops between the end-to-end connections
   • issue is with the satellite service provider to resolve

2. Network switches
   • Experienced several failures with the new network switches
   • Subsequently replaced with another manufacturer brand
Project Goals - Recap

1. To replace obsolete PC & Server hardware and Operating Systems and re-establish compliance with the latest NERC CIP Cyber Security policies;
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3. Execute the upgrade with minimal impact to Operations and Generation;
4. Improve system backup control capabilities
Project Goals - Recap

1. To replace obsolete PC & Server hardware and Operating Systems and re-establish compliance with the latest NERC CIP Cyber Security policies

☑️ virtualizing PC hardware improves platform and lifecycle independence

☑️ ABB SCADA & Windows O/S provides patches for NERC CIP compliance policies
Project Goals - Recap

2. To improve SCADA communications speed and efficiency

✓ The new ABB SCADA communications is noticeably faster due to the new Server hardware upgrade and Windows embedded version 64 bit Operating System
Project Goals - Recap

3. Execute the upgrade with minimal impact to Operations and Generation

- transition to the new ABB SCADA was executed in parallel with the existing system
- the phased transition approach was a positive impact to Operations, no negative impact on Generation operations
Project Goals - Recap

4. Improve system backup control capabilities

✅ backup servers added at the Iroquois Falls site, providing a second point of backup control
Oshawa Operations Center - modernized control room
SCADA System Overview Graphic
SCADA Generation Overview Graphic
Conclusions

• key to success was the creation of a focused ABB + H2O Power project team
• same core team together for the entire project
• collaborative environment between ABB and H2O Power
• To ensure future long-term sustainability, H2O Power has also engaged with ABB to provide the following value-added service solutions:
  • Cyber Security Patch Disk services to support NERC CIP compliance
  • Software Maintenance Program to ensure continued support and maintainability
✓ The net result is a modern SCADA solution for a flexible future.
Questions?

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