SCADA System Upgrade of a Major Water System

John Walker, Regional Water Supply
Mark Robertson, Insyght Systems Inc.
Abstract

• A complete SCADA retrofit of two large Water Plants, plus over 70 remote facilities supplying drinking water to the City of London and 20 surrounding municipalities—approximately 400,000 people

• The area includes over 4,500 square km from Grand Bend, on Lake Huron to Port Stanley, on Lake Erie.
Abstract

- The new SCADA system includes controller and distributed I/O, operator interfaces, historical data collection, automated reporting, and document management systems
- Project requirements will be compared to actual implementation, with lessons learned.
Presentation Outline

• Who are we? (John and Mark)
• Project Drivers
• Project Goals and Targeted Benefits
• Implementation Strategy
• Final Construction Solution
• Significant Improvements Gained
• Lessons Learned
Presenters

- John Walker
  - Operations Manager
  - Regional Water Supply
  - SCADA Project Manager
- Mark Robertson
  - President
  - Insyght Systems Inc.
  - Sr. Project Manager
- On project from beginning to end
Elgin Area Primary Water Supply
Project Drivers

- Existing SCADA servers, software, and PLC’s were at the end of their asset life
- No longer able to get spare parts
- Unreliable wide area communication
- Increased demands by regulators for better operation
Project Goals and Targeted Benefits

- Up to date, reliable SCADA system
- Significantly better documentation of the SCADA system
- Implementation using SCADA standards
- Optimized water treatment plant automation strategies
- Much greater access to historical SCADA information
Implementation Strategy

- **SCADA Construction Contract**
  - $9 million contract
  - Includes 8 municipalities
  - Replacement of controllers and SCADA servers for 5 regional centrals
  - 2 large, 1 small water plant
  - 2 wastewater plants
  - 60 remote water and wastewater stations across 1,500 square miles (30x50 miles)

- **SCADA WAN Contract**
  - One tender
  - Third party WAN Provider
  - Over 100 WAN links
  - Five Contracts by SCADA Network
  - Performance Based contract
Lake Huron Primary Water Supply SCADA System

• Water Plant
  – Redundant SCADA Servers
  – 13 Operator View Clients
  – FactoryTalk Data Collection and Reporting Server
  – SDMS Server
  – Redundant ControlLogix
  – 20 Remote FLEX I/O systems using ControlNet Coax and Fiber
  – DeviceNet to power monitors
  – Wireless SCADA Client network everywhere

• Remote Sites
  – CompactLogix at 10 valve chambers, reservoirs, and water booster stations

FactoryTalk® AssetCentre

DeviceNet®

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Typical Plant Architecture

**Area 1**
- **SCADA Server #1**
  - FT Directory Server
  - (1) HMI Server
  - (1) Data Server
  - RSLinx Enterprise
  - W2K3 SP1 Server O/S
  - Dual Xeon 2+GHz, 2G Ram
- **SCADA Server #2**
  - (User Supplied) Domain Controller
  - W2K3 Server O/S
  - DNS Server
  - DHCP Server
  - Pent 4 2+GHz, 512M Ram

**Control Ethernet**
- Control Room
- Lab Room
- Ports
- Chemical Room
- Switch
- Access Points
- 5 Clients

**Corporate Ethernet**
- SCADA Workstation
  - FTView SE Client
  - WinXP Pro
  - Pent. 2+GHz, 256M Ram
- Switch
- Fiber Optic Ethernet
- Distance 1 km

**Area 2**
- **SCADA Server**
  - (1) HMI Server
  - (1) HMI Client
  - (1) Data Server
  - RSLinx Enterprise
  - W2K3 SP1 Server O/S
  - Dual Xeon 2+GHz, 1G Ram

**Low Lift Pump Station**
- FTView SE Client to use Main HMI Server with ability to switch to Standalone as backup to loss connection to Main

**SCADA Terminal Server & EDMS Server**
- Windows Terminal Server
- SQL 2000
- FT Transaction Manager
- FT VantagePoint Server
- FT AssetCentre
- W2K3 SP1 Server O/S
- Dual Xeon 2+GHz, 2G Ram, RAID 5

**Low Lift Pump Station**
- CMPLX

**Historical Data Backup Requirements**
- SQL is to backup to a second SQL package off site through the Operations WAN on a daily basis

**HMI System Parameters**
- Control System
  - 600 Digital I/O Points
  - 250 Analog I/O Points
- Main HMI Server
  - Unlimited Display Count including Pop Up
  - 5000 Tags Total
  - 1000 Historical Tags
  - 1 single project with 2 areas
- Low Lift Pump Station
  - FTView SE Client to use Main HMI Server with ability to switch to Standalone as backup to loss connection to Main
- Historical Data Backup Requirements
  - SQL is to backup to a second SQL package off site through the Operations WAN on a daily basis
Elgin Area Primary Water Supply SCADA System

• Water Plant
  – Redundant SCADA Servers
  – 11 Operator View Clients
  – FactoryTalk Data Collection and Reporting Server
  – SDMS Server
  – Redundant ControlLogix
  – 12 Remote FLEX I/O systems using ControlNet Coax and Fiber
  – Modbus to Particle Counters
  – Wireless SCADA Client network everywhere

• Remote Sites
  – Low Lift
    • ControlLogix
    • Back up SCADA Server
  – Elgin Middlesex Pump Station
    • ControlLogix
    • Back up SCADA Server
  – CompactLogix at 3 valve chambers and surge tank

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Municipality of Central Elgin SCADA System

- **SCADA Central**
  - Redundant SCADA Servers
  - 8 Operator View Clients
  - FactoryTalk Historian Server
  - SDMS Server
  - Automated Paging System
  - Remote Internet Access through corporate network to SCADA screens

- **20 Remote Facilities**
  - MicroLogix1100 at 10 wastewater pumping stations
  - MicroLogix1100 at 12 water valve chambers and towers
  - Upgraded SLC500 at small water plant
  - Upgraded SLC500 at small wastewater plant
City of St. Thomas SCADA System

- SCADA Central
  - Redundant SCADA Servers
  - 6 Operator View Clients
  - FactoryTalk Historian Server
  - SDMS Server
  - Automated Paging System
  - Remote Internet Access through corporate network to SCADA screens

- 20 Remote Facilities
  - MicroLogix1100 at 10 wastewater pumping stations
  - MicroLogix1100 at 12 water valve chambers and towers
  - Upgraded SLC500 at small water plant
  - Upgraded SLC500 at small wastewater plant

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APAM SCADA System

• SCADA Central
  – Redundant SCADA Servers
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  – FactoryTalk Historian Server
  – SDMS Server
  – Automated Paging System
  – Remote Internet Access through corporate network to SCADA screens

• 12 Remote Facilities
  – MicroLogix1100 at 2 wastewater pumping stations
  – MicroLogix1100 at 10 water valve chambers and towers
**Typical SCADA System Design**

1. **SCADA (Ethernet)**
   - (SCADA HMI data)
   - **SCADA Servers**
   - **SCADA Web Server**
   - **Local SCADA Historical Data EDMS**

2. **Real Time Control (RTC) (Ethernet)**
   - (Real time control and data collection)
   - **Firewall(s)**
   - **Internet Link**
   - **Front End Communication Controllers (FECs)**

3. **Remote I/O Networks**
   - (real time control and data collection)
   - **Instrument Network (Fieldbus)**
   - (smart instruments, etc.)
   - **Instrument Network (Ethernet)**
   - (uninterruptible power supplies, energy management data, etc.)

4. **Wireless SCADA (Ethernet)**
   - (SCADA HMI data via wireless routers)

5. **Plant Operations/Security/Internet Access for WaterTrax (Ethernet)**
   - (desktop applications, email)

6. **Contract Operator and Regional Water Supply VPNs (Ethernet)**
   - (desktop applications, email)
Significant Improvements- SCADA Technology

- Hot standby SCADA Servers that actually work!
- Hot standby dual ControlLogix provide full redundancy for plant control
- Very reliable plant SCADA system
- Reliable wide area network links using Ethernet
- Backup local data storage at remote sites for regulatory reporting
- SCADA Document Management Systems (SDMS)
System Diagnostics
Significant Improvements - Operations

- Vastly improved chemical dosing control
- Improved filtration and backwash control features
- Better plant flow control
- Real time CT calculations for compliance reporting
- Much better alarm management
- Remote paging of alarms
- Remote access to SCADA system from anywhere, via Internet
Operational Improvements in Filtration
Significant Improvements - Data Management

- Automated off site historical data backups
- SQL database provides much improved data queries and reporting
- Local data storage at remote sites prevents data loss - which greatly helps with compliance reporting
- Access to historical data from RWS headquarters as well as at the plants
# Instant Water Quality Information

## Lake Huron WTP: Water Quality

### Raw Water

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<thead>
<tr>
<th>Parameter</th>
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<th>Value</th>
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<tbody>
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### Settled Water

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<td>Turbidity CLF00_AT4</td>
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<td>Particles CLF00_AT8</td>
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<td>Chlorine Residual CLF00_AT6</td>
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### Clear Well

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<th>Parameter</th>
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<tr>
<td>Chlorine Residual CLW01_AT2</td>
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### Plant Discharge

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<td>pH HLP00_AT3</td>
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<td>Conductivity HLP00_AT4</td>
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<tr>
<td>Total Flow HLP00_FT2</td>
<td>MLD</td>
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</tbody>
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Unack Aim: 0, Sup: 0
### Elgin Area WTP: Particle Counters

#### Filter 01 Particle Counter FLT01_AT2

<table>
<thead>
<tr>
<th>Physical Channels</th>
<th>Size (µm)</th>
<th>Value</th>
<th>Virtual Channels</th>
<th>Size (µm)</th>
<th>Value</th>
<th>ANN Value</th>
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<tbody>
<tr>
<td>CH1</td>
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<td>18</td>
<td>DC1</td>
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<td>18</td>
<td>Predicted</td>
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<tr>
<td>CH2</td>
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<td>12</td>
<td>DC2</td>
<td>3</td>
<td>12</td>
<td></td>
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<tr>
<td>CH3</td>
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<td>7</td>
<td>DC3</td>
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<td>7</td>
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<td>CH4</td>
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<td>DC4</td>
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<td>DC5</td>
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<td>DC7</td>
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<td>DC8</td>
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**Unit Diagnostics**
- Cell Condition: 97%
- Flow Rate: 100.0 mL/min
- Frequency: 60 s
- Mode: Online

#### Filter 02 Particle Counter FLT02_AT2

<table>
<thead>
<tr>
<th>Physical Channels</th>
<th>Size (µm)</th>
<th>Value</th>
<th>Virtual Channels</th>
<th>Size (µm)</th>
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<tr>
<td>CH1</td>
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**Unit Diagnostics**
- Cell Condition: 90%
- Flow Rate: 100.0 mL/min
- Frequency: 60 s
- Mode: Online

#### Filter 03 Particle Counter FLT03_AT2

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**Unit Diagnostics**
- Cell Condition: 95%
- Flow Rate: 100.0 mL/min
- Frequency: 60 s
- Mode: Online

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**Unit Diagnostics**
- Cell Condition: 81%
- Flow Rate: 100.0 mL/min
- Frequency: 60 s
- Mode: Sampling Mode
Lessons Learned- WAN

• Detailed scope of work
  – Ensure uptime requirements are met without conditions
• Service provider should be experience in municipal/industrial applications – not just residential!
• Contract should have an ‘out clause’ or have a 1 + 4 year frame.
• Beware of Latency!
Lessons Learned - Technology

• Don’t make assumptions
  – Alarm/event viewer

• Operations input during design and implementation process is critical and was missing because of Contract Operations relationship

• Ensure scope of work is highly detailed
  – Time stamp issues – all process logs should be started at the same time!
  – Time interval issues – e.g. 5 minutes on the minute!
  – Engineering units – ensure they are the same and all present!
Lessons Learned- Contract Management

- Be aware that scope changes = schedule increase
- Money = time to complete
- Need better leverage to keep Contractors on schedule
- Leading edge vs. bleeding edge
John Walker, Regional Water Supply
Mark Robertson, Insyght Systems Inc.