Implementation of Automation Projects Using a SCADA Master Plan

Speakers:
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Norman Anderson, Westin Engineering, Inc.
Jeff Martin, Carollo Engineers, Inc.

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Presenters

• **Manoj Yegnaraman, P.E.** has over 13 years of experience in Instrumentation and Control System design, specifically for the Water and Wastewater Treatment Industry. Manoj has a B.E. in Instrumentation and Control Engineering from University of Madras, India, and an M.S. in Electrical Engineering from University of Alabama.

• **Norman Anderson, P.E.** has over 13 years experience in the design and commissioning of Process Control Systems for the Water Sector. Norman has an M.S. in EE from Iowa State University and an M.S. in Physics from the University of Florida.

• **Jeff Martin** has over 27 years of experience in planning, design, project management, strategic planning, and business management in the areas of computer systems, instrumentation, process automation for water, wastewater, industrial, aquaculture, mining and military systems.
Here’s the outline…

• Range of SCADA systems in our industry

• Control System challenges

• Typical automation project categories

• Polk County Case Study

• SCADA Master Plan Steps

• SCADA Master Plan Outcomes
Range of SCADA systems in our industry

- SCADA system in a box…

Photo courtesy: The Internet!
Range of SCADA systems in our industry

- Here’s our SCADA System – Is red running or stopped?

Photo courtesy: The Internet!
Range of SCADA systems in our industry

• When you have everything integrated…

“Jones, I am not sure you fully understand Social Networking. Twitter is not intended for broadcasting our production data and machine alarms.”

Photo courtesy: The Internet!
Range of SCADA systems in our industry

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Photo courtesy: The Internet!
Range of SCADA systems in our industry

Photo courtesy: The Internet!
Control System Challenges

• Management:
  – Difficulties in making key decisions due to unavailability of big picture data

• Engineering:
  – Dealing with inconsistencies in control system architecture

• Operations and Maintenance:
  – No remote access to all process data

• IT:
  – Cyber Threats
Typical automation project categories

- This is what our end users go through during the implementation of an automation project:
  - Small, medium or large
  - Short vs. Long duration
  - Internal vs. Use of external resources
  - Automation only project vs. Part of a bigger project
  - Existing vs. New facility
  - Multiple facilities vs. Single facility involved in a project
There is a solution to these concerns…

System-wide SCADA Master Planning

POLK COUNTY
Polk County – Case Study

• Total Area: 2011 sq mi; Population: 666,149 (2016)
### Polk County – Case Study

- **Facilities**
  - 3 regional WWTFs and 4 packaged WWTFs
  - 36 WPFs
  - Over 305 Lift Stations
  - Central Monitoring Facility
  - Other Facilities such as Well sites, Booster Stations, Meter Stations, Reclaim Water Store/Re-pump facilities and Facility interconnects

- **Communication between different facilities**
  - Different technologies/frequencies using Wireless Radio, Metro-E, Cellular and Auto dialer for alarms
Polk County – Case Study

• Challenges:
  – Varying Network Architectures
  – Mix of SCADA and IT networks
  – Different Hardware and Software platforms
  – Disparate communications to facilities
  – Non-availability of centralized management
  – Non-availability of remote access to process data and other software applications
  – Non-availability of communication to certain facilities
SCADA Master Plan Steps

• Approach to SCADA Master Plan
  – Analysis of existing infrastructure
    o Condition assessment and individual staff interviews
  – Obtained desired local and remote data access needs
  – Created Automation Standards using workshops with the Utility Staff
    o Communication infrastructure, SCADA Architectures, Hardware, Software
  – Identified and prioritized specific automation projects with estimated construction costs and project allocation
SCADA Master Plan Steps

• Find the critical needs
SCADA Master Plan Steps

Polk County Utilities
Integrated SCADA Conceptual Goal
Figure 5.1

Wastewater Treatment Facilities (WWTFs)
- Flow & Pressure Data
  - Valve Control
  - Alarms & Historical Data
- Reuse Facilities

Water Production Facilities (WPFs)
- Flow Data
  - Valve Control
  - Alarms & Historical Data
  - Facility Interconnects

Base 1
- Process Alarms & Historical Data
- Remote SCADA Data Access
- Lift Stations

Mobile Access
SCADA Master Plan Steps

Polk County Utilities
Integrated SCADA Architecture - Communication Block Diagram

- WWTFs 3 Regional & 4 Local/Small Architectures
- Holly Hill - Metro-E
- Private Cellular Network
- Facility Interconnects
- >300 Remote Lift Stations Local/Small Architectures
- Mobile Access
- WPFs 36 Local/Small Architectures
- Disaster Recovery Site

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SCADA Master Plan Steps

Polk County Utilities
Typical SCADA Architecture - Regional

Base 1 Core Network

Microwave Backbone

IT Network

CCTV Network

Maintenance Network

Process Control/SCADA Network

Router/Firewall

Workstations

CyberKey System

Metro Fiber Backup Link

Active ONLY during failure of Microwave Backbone

I/O Network

UPS Ethernet

Fieldbus Diagnostic

Smart Device Webserver

PLC A

PLC B

PLC C

PLC D

Redundant Virtualized Servers

Workstations

Engineering Workstations

Thin Clients

Printers

Wireless Access Points

Time Server

I/O Network

I/O Network

I/O Network

I/O Network

Keys:

1. Redundant virtualized servers configured for:
   - Primary I/O & HMI Server
   - Secondary I/O & HMI Server
   - Primary Terminal Server
   - Secondary Terminal Server
   - Historian Server
   - Read-only Domain Controller

2. Microwave communication between the treatment facility and Base One on-call response center

3. I/O Network includes instruments, VFDs, RV/SSAs, MCCs, and other field devices
SCADA Master Plan Steps

• What was modified from this plan?
  – Have not used maintenance network yet, created a separate network management network instead
  – Separate firewalls for IT and SCADA systems
  – Putting thin clients outside the plant network level and utilized Citrix instead of terminal services
  – Decided against in-plant wireless networks
  – Time server located centrally and connected to the separate networks, servers on those networks act as backups.
  – Core network required a lot more different networks than we thought

• Key here is that the master plan is not a static document but dynamic in order to maximize its use
## SCADA Master Plan Steps

### Develop core projects and timeline

<table>
<thead>
<tr>
<th>Rank</th>
<th>Priorities - Description</th>
<th>Project</th>
<th>Design</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Base One / Core Network</td>
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<tr>
<td></td>
<td>SCADA Access / Local/Remote/Core Network Firewall</td>
<td>Budget</td>
<td>X</td>
<td>I</td>
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<tr>
<td></td>
<td>New VTS Master Application Development / Historian Setup</td>
<td>In Progress</td>
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<td></td>
<td>Base One Facility Design</td>
<td>In Progress</td>
<td></td>
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<td></td>
<td>New Core Server System</td>
<td>Budget</td>
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<tr>
<td></td>
<td>Integrate the WPF (~36), LS (~130) and other (~10) Raco Dialers with SCADA system via OPC using existing comms</td>
<td>Plan</td>
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<td>2</td>
<td>Communications</td>
<td></td>
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<td></td>
<td>Changeover Communications of existing WPF &amp; WW facilities (25)</td>
<td>Plan</td>
<td>I</td>
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<tr>
<td></td>
<td>Changeover Communications of existing LS facilities (90)</td>
<td>plan</td>
<td>II</td>
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<td></td>
<td>WIFI Development Designs and Implementations (NW, SW WWTF)</td>
<td>Plan</td>
<td>X</td>
<td>III</td>
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<td></td>
<td>Develop an overall network communications plan</td>
<td>Plan</td>
<td>X</td>
<td>IV</td>
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<td>- Paper Study</td>
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<td>IV.A</td>
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<td></td>
<td>- Telemetry Communications Survey</td>
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<td>IV.B</td>
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<td></td>
<td>Wi-Fi Implementation for Critical WPFs</td>
<td>Plan</td>
<td>V</td>
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<tr>
<td>3</td>
<td>Historian and Reports</td>
<td></td>
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<tr>
<td></td>
<td>Planning a central historian</td>
<td>Plan</td>
<td>X</td>
<td>I</td>
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<tr>
<td></td>
<td>Design development of the central historian</td>
<td>Plan</td>
<td>X</td>
<td>II</td>
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<tr>
<td></td>
<td>Implementing Central Historian Design</td>
<td>Plan</td>
<td>III</td>
<td></td>
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<tr>
<td></td>
<td>Implementation of Reports and interconnection with other applications/utilities</td>
<td>Plan</td>
<td>IV</td>
<td></td>
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</tbody>
</table>

Determine if CIP improvements, R&R, or Operating Expense to enable budget planning and scheduling staff resources.
# SCADA Master Plan Steps

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<tbody>
<tr>
<td>4</td>
<td>Facility Upgrades by Architecture</td>
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<tr>
<td></td>
<td>Standard Facility Detailed Design</td>
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<td></td>
<td>- Small WPF/non-communicating</td>
<td>Plan</td>
<td>X</td>
<td>I</td>
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<td></td>
<td>- Booster/Valve Station (Reuse, Interconnect, etc.)</td>
<td>Plan</td>
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<td>II</td>
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<tr>
<td></td>
<td>- Lift Station Retrofits - 8 types (total of 300 lift stations)</td>
<td>Budgeted</td>
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<td>III</td>
</tr>
<tr>
<td></td>
<td>- Large and Small WPF Retrofits (Mann Road, Hodge St, Holly Hill, South County Jail, Pollard Road, Imperial Lakes, Providenc, VanFleet, Babson Park No. 1 and 2)</td>
<td>Future</td>
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<td>IV</td>
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<td></td>
<td>- Small WWTF’s</td>
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<td></td>
<td>-- SunRay WWTF</td>
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<td>Implementation of Standard Design</td>
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<td>- Small WPF/non-communicating (25)</td>
<td>Plan</td>
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<td>- Booster(3)</td>
<td>Plan</td>
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<td>II</td>
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<td>- Valve Station (Reuse, Interconnect, etc.)(20)</td>
<td>Plan</td>
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<td>III</td>
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<tr>
<td></td>
<td>- Lift Station Retrofits - 8 types (total of 200 lift stations)</td>
<td>Plan</td>
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<td>IV</td>
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<tr>
<td></td>
<td>- Large and Small WPF Retrofits (Mann Road, Hodge St, Holly Hill, South County Jail, Pollard Road, Imperial Lakes, Providenc, VanFleet, Babson Park No. 1 and 2)</td>
<td>Future</td>
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<td>V</td>
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<td>- Small WWTF’s</td>
<td>Plan</td>
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<td>VI</td>
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<td>-- SunRay WWTF (may be there is an interim HMI upgrade)</td>
<td>Plan</td>
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<td>VII</td>
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<td>- Large WWTF Design and Implementation with Plant Upgrades (SW, NW)</td>
<td>Plan</td>
<td>x</td>
<td>VIII</td>
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<tr>
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<td>- North East WWTF</td>
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<td>IX</td>
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<td>5</td>
<td>Training</td>
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<td></td>
<td>Security training</td>
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<td>Historian training by VTSCADA</td>
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<td>Historian training by GE</td>
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<td>Report training</td>
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<td>Hardware/Software Discipline Training</td>
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<td>6</td>
<td>Cyber Security</td>
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<td>Develop a cyber security plan in place</td>
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<tr>
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<td>Add a managed service contract in place</td>
<td>Plan</td>
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<tr>
<td>7</td>
<td>Hardware/Software Standards</td>
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<td>Deploying remote clients at individual facilities to view the entire SCADA system (Zero Client Architecture at Base 1)</td>
<td>Plan</td>
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<tr>
<td></td>
<td>Review and update equipment based on hardware standards</td>
<td>In Progress</td>
<td>N/A</td>
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<tr>
<td></td>
<td>Review and update equipment based on software standards</td>
<td>In Progress</td>
<td>N/A</td>
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<tr>
<td>8</td>
<td>Physical Security</td>
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<td></td>
<td>NW CYBER LOCK ADDITION</td>
<td>Budgeted</td>
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<td>IA</td>
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<tr>
<td></td>
<td>SW CYBER LOCK ADDITION</td>
<td>Budgeted</td>
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<td>IB</td>
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<td></td>
<td>NW CCTV ADDITION</td>
<td>Budgeted</td>
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<td>IC</td>
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<td>SW CCTV ADDITION</td>
<td>Budgeted</td>
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</table>

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SCADA Master Plan Outcomes

• Initial Outcomes
  – Completed a needs analysis to determine a basis of the SCADA system
  – Standardized the SCADA System control equipment
  – Developed the Framework for a Countywide application
  – Improved trending of data
  – Rationalized current alarms in accordance with industry standards ISA 18.2
SCADA Master Plan Outcomes

- Base 1 remodeled
- Network connectivity expanded
- Year 1 projects complete

Added a new core network with VPN access

Enhanced Trending Capabilities
SCADA Master Plan Outcomes

Example Lift Station Standardized Graphic Screen

Lift Station and WPF Upgrades on schedule
159 LS and 19 WPFs
SCADA Master Plan Outcomes

- 3 years ahead on CCTV deployments
  - In-house development sped up the process and reduced cost
- 3 years ahead on cyberlock deployments
- 2 years ahead on thin client deployment
- Goal of 100% connectivity is within site.
Summary

Key points of this presentation:

• SCADA Master Planning:
  o Provides for a long term planning of managing a Utility’s water/wastewater facilities
  o Allows to create a SCADA/I&C standards document while going through the Master planning process
  o Continued evaluation of the plan helps find efficiencies and keeps the plan fresh
Questions and Comments?