Telemetry

(Te-lm-i-tre) noun
The technology of automatic measurement and transmission of data by wire, radio, or other means from remote sources to receiving stations, for the purpose of recording and analysis.
SCADA?
Supervisory Control And Data Acquisition.

What does it do?
And
What are its parts?

SCADA?
Supervisory Control And Data Acquisition.

- Monitoring of remote sites.
  - Including Security Video Surveillance.

SCADA?
Supervisory Control And Data Acquisition.

- Monitoring of remote sites.
- Control functions at remote sites.
- Historical data files (data bases).
- Report generation!
SCADA System Components
1. Central Site
2. Remote Sites
3. Data Dissemination
4. Communications!

Who are SCADA customers?
- Water Utilities
  - Water Plants
  - Distribution Systems
- Wastewater Utilities
  - Wastewater Plants
  - Collection Systems
- Reuse Systems
- Stormwater Utilities
- Lift Station Maintenance
- Companies
“Kinds” of SCADA Systems

- Plant SCADA
  - Inside the fence
  - Process Control (PLC)
  - Wired or Networked

- Remote SCADA
Remote SCADA

- Outside the fence
- Independent Controls
- Radio or Wireless
1. Central Site

- Central Site
- Computer
- Radio Network
- Wired Network
- Plant Network
- LAN Network

System Configuration

- Storm Water Pump Stations
- Well Fields
- Reuse Facilities
- Lift Stations
- Storage Tanks
- Reuse Facilities
- Well Fields
- Lift Stations
- Storage Tanks
- Central Site
- Computer
- Radio Network
- Wired Network
- Plant Network
- LAN Network
Types of Telemetry Systems:
• Based on distance of remote sites?
• Kinds of technology?
• Types of data collected?
• Type of software used?
• PLC or non-PLC based?
• Communications path?

“Wired” Communications vs. “Wireless” Communications
Wired Telemetry Systems:
- Wired (serial cable, 6-pair wire, etc.)
- Telephone lines (auto-dialer)
- Fiber Optical cable
- LAN (Ethernet network)

Wireless Telemetry Systems:
- CDPD (cell-phone)
- Infrared
- Wireless LAN (Ethernet)
- Radio

Terms:
- **Analog**: moving scale, i.e., 4-20 mA or 1-5 Vdc
- **Digital**: on or off (binary)
  - “911” call-out
  - “411” call-in
2. Remote Sites

- Storm Water
- Pump Stations
- Lift Stations
- Well Fields
- Reuse Facilities
- Storage Tanks

- Remote Sites

- Remote Sites

- Remote Sites
Remote Terminal Unit (RTU)

- Lift Station
- Storage Tank
- Pump Station
- Well
- Generator
- Stormwater Gate

System Configuration

Radio
Computer
RTU
Central Site
RTU
Lift Stations
Storage Tanks
Wired Network
Pump Stations
Reuse Facilities
Well Fields
RTU
Radio Network
Wired Network
Local Area Network

3. Communications
Wired vs. Wireless vs. Radio (RF)

System Configuration

Radio Telemetry
Radio Frequencies:

- FCC license
- Frequency Coordinators
- VHF 30 - 300 MHz
- UHF 300 - 1000 MHz
- Trunking System 800 - 900 MHz
- Spread Spectrum 900 MHz, 1W max radio output.

Radio Terms:

- ERP: effective radiating power
- dB: (decibel) measure of change in the gain or loss of volume or power.
- antenna gain: ability of antenna to focus signal strength as measured in dB, and expressed in ERP.
- fade margin: point at which dB loss will cause signal path to go off line.

Antenna Gain:

- each 3 dB gain doubles ERP.
- Example: 2w radio signal thru a 6dB gain antenna would equal 8w of ERP.
Wired LAN Network:

- Ethernet network – IEEE 802.3
- TCP / IP
  Transmission Control Protocol / Internet Protocol
- Internet technology
- SCADA and E-mail on same network.
- 10 Mbps / 100 Mbps

Wireless LAN Network:

- Ethernet network – IEEE 802.3
- TCP / IP
  Transmission Control Protocol / Internet Protocol
- Internet technology
- SCADA and E-mail on same network.
- 10 Mbps / 100 Mbps
SCADA?

- Monitoring of remote sites.
- Control functions at remote sites.
- Journal files (data bases) of historical data.
- **Report generation**
The SCADA computer uses inputs from remote point “A” to control processes or outputs at remote point “B”.

The SCADA computer uses internal programming to control processes at remote points.

- Point-to-Point Applications
- PID Loops

- Point-to-Point Applications
Automated Controls

- **Point-to-Point Applications**
  Sending data from one remote point to another remote point.
  
  Example: Sending a tank float level to a well pump.

Automated Controls

- **PID Loops**
  (Proportional Integral Derivative)
  
  Using a logic controller (PLC) to monitor inputs and control processes.
  Program "loops" for continuous feedback.
Programmable Logic Controller

"PLC shall monitor line pressure, and control booster pumps, in order to maintain 58 psi in the water distribution line."

- **PLC Control Strategy**
- **Formal, signed document**
- **Changeable set-points**
- **Back-up or default program**
- **Acceptance Test/Start up**
Overflow Prevention

Overflow Prevention

Wastewater Collection Flow Management System
Wastewater Collection Flow Management System

- LS Pump Management
- WWTP Inflow Management
- Sediment Elimination

Pump Management

Central Force-Main

- Line Pressure
- Line Capacity

Pump Management - Line Capacity -

LS 43
LS 75
MLS 2
MLS 3
WWTP
Pump Management

- Plant Capacity -

Flow Volume

In-flow

Plant Capacity

Midnight Morning Noon Evening Midnight

Master Lift Station Pump Cycles

"Before" Pump Management
Sediment Elimination

- Undeveloped Area
- Seasonal
- Infiltration & Intrusion
- Slow Growth
-- A central computer is collecting data from remote sites.

-- Rainfall measuring devices can be installed at the remote sites.
Rainfall data can be collected from the remote sites.

With programming, the data can be used to generate rainfall predictions, and flooding alarms.

Rainfall Prediction & Alarm Program

- Daily Total Rainfall.
- Current Rainfall Rate - - Inches/Hour.
- Average Rainfall Last 6-hours.
- Rainfall During Last 30-minutes.
SCADA System Planning
Test: RFP and Contract litigation

“Analyzed” SCADA Requirements:
* Monitor water flow.  Analog Input
* Monitor water tank level.  Analog Input
* Monitor the pump alarm.  Digital Input
* Monitor the Chlorine alarm.  Digital Input
“Analyzed” SCADA Requirements

- Start/stop the VFD drive
- Monitor that VFD is engaged or online.
- Remotely control VFD with changeable set points.
- Monitor the VFD speed.

Digital Output

Digital Input

Analog Output

Analog Input

“Analyzed” SCADA Requirements

- Start constant speed motor
- Monitor that constant speed motor is running
- Stop constant speed motor

Digital Output

Digital Input

Digital Output

Pump Station SCADA Requirements:

- Monitor water flow, tank level, pump alarm, and CL2 alarm.
- Control two pump motors—one VFD, and one fixed speed.

I/O connections to SCADA:

DI = 4  AI = 1
DO = 3  AO = 1
Pump Station SCADA Requirements:

* Monitor water flow, tank level, pump alarm, and chlorine alarm.

* Control two pump motors—one VFD, and one fixed speed.

I/O connections to SCADA:

DI  = 4   AI  = 3
DO  = 3   AO  = 1

PID Control Loops w/ PLC

Alarm Configurations

• Alarm points
• Delays
• “Snooze” alarms
• Virtual alarms

Alarm Enunciation

• Voice at the central
• Voice at the work stations
• Phone call-out w/voice
• E-mail
• Pager
I/O Troubleshooting

Electrical Grounding:

Station Control Panel

RTU

Electrical Grounding:

Station Control Panel

RTU
Analog Signal Troubleshooting:

4 - 20 mA instrumentation:

- Flow
- Pressure
- Position
- Level
- VFD control

Analog Signal Troubleshooting:

Example: monitoring water system pressure of 60 PSI

Which meter scale?

- 0 - 60 PSI
- 0 - 80 PSI
- 0 - 100 PSI
- 0 - 120 PSI
- 0 - 200 PSI

Analog Gauge Accuracy:

Accuracy

(Higher)

Accuracy

(Lower)

0 PSI 120 PSI
4 mA 20 mA
Analog Gauge Accuracy:

Accuracy

(Higher) (Lower)

0 PSI 60 PSI 120 PSI

(4 mA) (20 mA)

Analog Signal Troubleshooting:

0 mA 4 mA 20 mA

-30 PSI 0 PSI 120 PSI

Cyber-Security

"Why is security so important in our business sector?"

Unlike the business IT network, which runs for eight to twelve hours per day, SCADA systems are required to run continuously.

Business systems are relatively passive; whereas, SCADA systems are mostly active, and in many cases, provide both the logic and controls that run a utility's local and remote assets."
In the 1990s, based on customer pressure, many suppliers moved from proprietary systems (e.g. Allen Bradley DF-1, Bristol Babcock BSAP, etc) to open architecture systems.

All hacking tools are freely available on the internet.

Cyber security is an area of great concern to all businesses, especially those in the public sector.

Water and wastewater systems have already been hacked!!!!

Cyber-Security

Shamoon virus (Aramco Oil) Took out 35,000 servers. Erased the OS, and wiped the hard drives!

Russian hackers broke into SCADA supplier’s database, downloaded usernames and passwords, then broke into utility and destroyed a pump by rapidly starting and stopping it!

A utility in Pennsylvania said they didn’t know they were being hacked, until they saw unusual behavior in their system – the hackers were already in!!
7 Steps to Secure Control Systems

• Assess existing system(s);
• Document Policies and Procedures;
• Train Personnel and Contractors;
• Segment the Control System Network;
• Control Access to the system;
• Harden the System Components;
• Monitor and Maintain Security.

Keep the viruses out!!!!!
Video Surveillance

"Can the gentleman in the brown jacket on the bike please dismount! You are in a pedestrian walk zone."

TEST:
Video surveillance cameras are used for:

a. remote operational monitoring and control
b. remote site security
c. looking at people on the beach.
d. both a. and b.
Physical Protection System (PPS)

• Detection
• Delay
• Response

Detection includes Assessment. You cannot conduct a proper Response without Assessment. Fear of Detection can create a Deterrence.
Video Security Objectives:

- I want to "see" the security situation in real-time.
- I want to "see" the security situation just before, during, and after an alarm activation.
- I want "high quality" video recording of all site activity for operational analysis and legal evidence.
- I want to integrate security alarms and video into my existing SCADA system.
Networks:

- Video security networks use the same technologies as your existing networks.

- Your existing networks will probably not be "robust" enough!
Bandwidth!

- Frames-per-second: 30fps is movie quality
- Resolution: 320x240 low / 1280x1024 high
- How often transmitted: “streaming video”

Cameras Operator Interface
Longwatch RVE or Micro

Network

- High speed
- High quality
- 24/7 recording

At the remote site:

- Slower speed
- Less quality
- Event clip transmission

Across the network:
Video & SCADA Integration

Cameras

Longwatch

RVE or Micro

Network

Primary Workstation

& Longwatch VCC

DFS

Hyper SCADA

Server

Video & SCADA Integration

Cameras

Longwatch

RVE or Micro

Network

Primary Workstation

& Longwatch VCC

DFS

Hyper SCADA

Server

DFS RTU

Radio

Hub

Professional Education for I & C

ISA

International Society of Automation.