General Overview of SCADA

"Applying Adaptive Management and Emerging Technologies to Improve Water Utilities in Tropical Islands"

Water and Wastewater Conference
June 12, 2017

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Project Team

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Pete Diaz, P.E.
Project Manager
Hagåtña, GU

Allen Randall, P.E.
Electrical Lead
Orange, California

Gene Moe
Instrumentation Lead
Albuquerque, New Mexico

Kunal Raithatha
Instrumentation Engineer
Camarillo, California

GUAM WATERWORKS AUTHORITY

Calvin Yam
Project Manager/Electrical Engineer
Fadian, GU

Barbara Cruz, P.E.
Senior Engineer Supervisor – Electrical
Fadian, GU

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Outline

01 Background
02 SCADA Introduction
03 SCADA Master Plan
04 Guam Projects

Background

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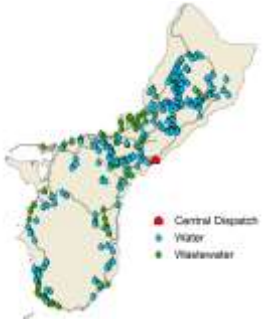
01 Background: Existing GWA Facilities



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System	Site Type	Quantity
Water	Wells	120
	Springs	2
	Reservoirs	39
	Booster Stations	36
	PRVs	73
	Master Meters	65
	Treatment Plants	1
	Total Water:	**336**
System	**Site Type**	**Quantity**
Sewer	Pump Stations	77
	Treatment Plants	7
	Total Wastewater:	**84**

Source: GWA SCADA Master Plan, 2014.

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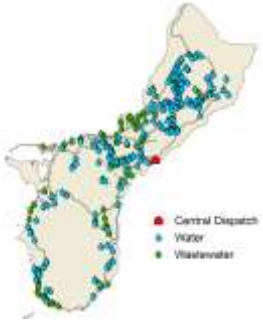
01 Background: Existing Operations



- Largely standalone
- Focus on **local** monitoring, control, data archiving, and alarm notification
- Many sites manually operated
- No central SCADA infrastructure

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01 Background: Existing Operations

- Recent improvement projects make remote sites "SCADA ready" (e.g. new control panels), but not fully implemented
- Information gathered through rovers visiting each facility and recording field information.

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01 Background: Problem

- No real-time snapshot of system conditions
- Use of staff resources are inefficient
- Reactive approach
  - Abnormal conditions are discovered during routine checks or triggered by customer complaints
  - Often abnormal conditions present for some time
- Quality of service, customer satisfaction and protection of public health and safety are negatively impacted

01 Background: Ultimate Goal

- An integrated, robust, secure SCADA System
  - Daily tool for to meet organizational objectives
  - Real-time view of operating conditions and alarms
  - Automation and control of processes
  - Proactive approach
    - Island-wide roving connection to the SCADA System to view process conditions, statuses and alarms using mobile device
  - Historian database(s) and report generation tools
  - Support water hydraulic model, computerized maintenance management system, standby generation management, asset management

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SCADA Introduction

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02 SCADA Introduction: What is it?

Supervisory **C**ontrol **A**nd **D**ata **A**cquisition

A system that…

- *Acquires sensor and operational data from the field*
- *Processes the data and applies logic to control equipment locally*
- *Allows for remote supervision and monitoring of operational conditions, and capable of executing control over equipment remotely*

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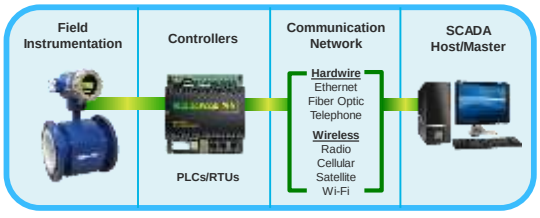
02 SCADA Introduction: Overall Structure



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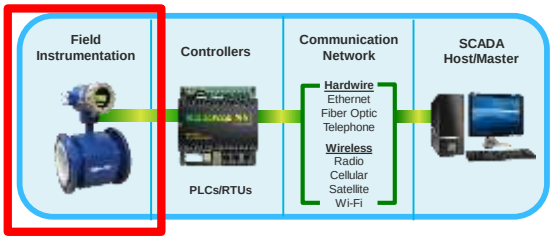
02 SCADA Introduction: Field Instrumentation



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02 SCADA Introduction: Field Instrumentation

You can't control what you don't measure.

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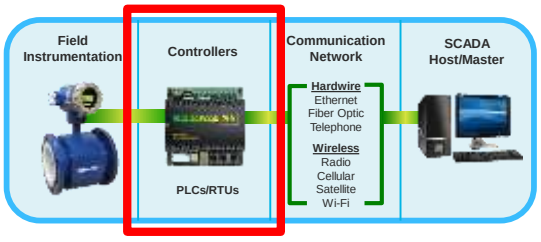
02 SCADA Introduction: Controllers



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02 SCADA Introduction: Controllers

Programmable
Logic
Controller

What's the Difference?

Remote
Telemetry
Unit

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02 SCADA Introduction: Controllers

PLCs

- More effective in local area networks (e.g. treatment plants)
- Best suited to wired, high-speed networks
- Emphasis on firmware/software functionality and hardware modules for plant applications

RTUs

- More effective in wireless, wide area SCADA networks
- Operate well on both high- and low-speed networks
- Emphasis on communications, interfacing a broad array of hardware communications protocols
- Alarm management, historical data logging and flow calculation functionality internal to RTUs

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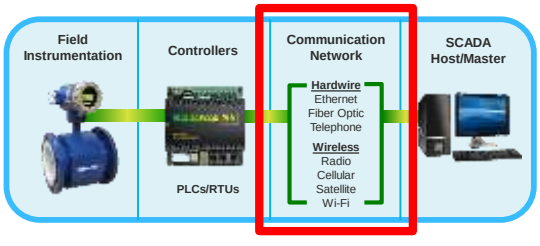
02 SCADA Introduction: Communication Network



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02 SCADA Introduction: Communication Networks

- Hardwire Option:
  - Ethernet cable, fiber optic cable, telephone wire, or coaxial cable

- Wireless Options:
  - Radio, cellular, satellite, or Wi-Fi.

- Could include a combination of options
- Trends: wireless for wide area networks; Ethernet for local area networks

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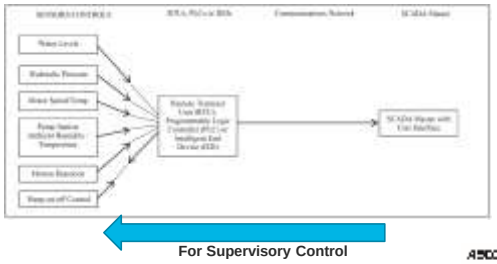
02 SCADA Introduction: Communication Networks

- Provides a conduit for flow of data
- Without it, SCADA systems cannot exist



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02 SCADA Introduction: Cyber-security

- Potential Threats:
  - Hostile governments, terrorist groups, disgruntled employees, and other malicious intruders
  - Water/Wastewater facilities offer the huge potential to disrupt operations
- Critical Infrastructure:
  - Defined as the physical and IT assets, networks and services that if disrupted or destroyed would have a serious impact on the health, security, or economic wellbeing of citizens and the efficient functioning of a country's government.

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02 SCADA Introduction: Cyber-security

- Typical Mitigation Measures
  - Physically securing the hardware and transmission media, and employing common cyber security defenses such as password protection and anti-virus utilities.
- Other Highly Effective Methods:
  - Encryption/decryption is the act of manipulating information until it appears almost meaningless to the casual observer.
  - Authentication is the process by which one part of a SCADA system proves its identity to another.

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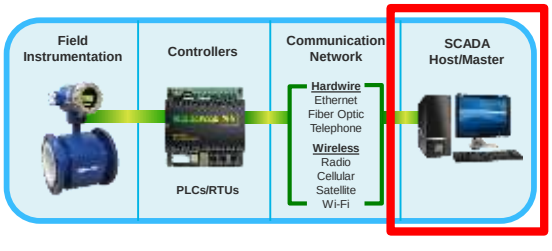
02 SCADA Introduction: SCADA Host/Master



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02 SCADA Introduction: SCADA Host/Master

- Hardware and software for viewing of graphical displays, alarms and trends to monitor, maintain and control processes or equipment
- Software drivers contain the different types of protocols to communicate with remote devices such as RTUs and PLCs.
- Includes real-time database, alarm and event journal, historic archive

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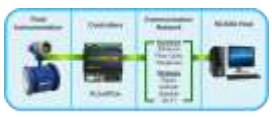
02 SCADA Introduction: Local Area vs. Wide Area



- Local Area
  - Local site SCADA
  - Individual water and wastewater plants, pump stations, etc.
- Wide Area
  - System-wide SCADA
  - Entire water and wastewater system

SCADA Master Plan

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03 GWA SCADA: Planning for the Future

- SCADA Master Plan
  - High-level roadmap
  - Implementation Plan
  - Costs
  - Risks and Mitigation

http://guamwaterworks.org/engineering/engineering-documents/

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03 SCADA Master Plan: Scope

- Define the scope:
  - Planning Horizon: 20 yrs
  - Implementation Plan: 6yrs
    - Central SCADA
    - Island-wide Communications
    - Remote Site/Facility Improvements

Over 400 sites considered:

System	Site Type	Quantity
Water	Wells	120
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	Reservoirs	39
	Booster Stations	36
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	Total Water:	**336**
System	**Site Type**	**Quantity**
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Source: GWA SCADA Master Plan, 2014.

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03 SCADA Master Plan: Implementation Plan

- Consider Phasing:
  - Based on prioritization, funding, other CIP projects
  - Initial phase – will result in a wide-reaching project including highest priority sites; develop standards and designs.
  - Additional phases should be reevaluated as the owner gains experience with SCADA.

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03 SCADA Master Plan: Implementation Plan (continuation)

- Standby Generation Control
  - To include control capability to remotely start generators and transfer sites from utility power to onsite backup power.
- Provide information to support other Applications
  - Computerized Maintenance Management System to generate preventive maintenance schedules
  - Water Hydraulic Model Application to calibrate the model and improve accuracy

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03 SCADA Master Plan: Cost Estimates

Major Investment

Description	Phase A - Initial Project	Phase B - Add Sites	Phase C - Add Instruments
Quantity of Sites:	210	134	N/A
Construction Cost[1]	$13.9 M	$5.6 M	$4.8M
Budgetary Project Cost[2]	**$23.2 M**	**$10.6 M**	**$7.2 M**
Annual Maintenance Cost[3]	$0.55 M	$0.79 M	$ 0.76 M

Notes:

1. In 2014 dollars; Cost to construct
2. Includes construction cost, training, engineering and construction support services, tax, contingency and escalation.
3. Cost to maintain includes additional GWA Staff (Instrument Techs, PLC Programmers, SCADA Developers) and Consultants (SCADA Developers).
4. Master Plan did not estimate cost savings for efficiencies gained.

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03 SCADA Master Plan: Risks and Mitigation

- Technical Risks
  - SCADA doesn't deliver the functions as promised
    - Avoid errors by developing appropriate design documentation and assuring requirements are met during construction.
    - Conduct a Pilot Study
  - Communication system doesn't provide the required level of service
    - Project criteria to include benchmarks for response times and system uptimes
    - Conduct a Pilot Study

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03 SCADA Master Plan: Risks and Mitigation

- Lifespan Risks
  - Inconsistent implementation of SCADA
    - Exercise discipline in early development and use of standards
    - Enforcement during new and rehab projects
    - Continue training
  - SCADA hardware/software become obsolete
    - Choose vendors with major market share
    - Keep products relevant with reasonable upgrades to later versions

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03 SCADA Master Plan: Risks and Mitigation

- Organizational Risks
  - Lack of staff buy-in; resistance to change
    - Staff at all levels should be consulted in the process
    - Management support is needed to endorse "cultural" change; address perceived threat to job security
    - Staff participation in testing, training, providing useful and meaningful procedures and documentation

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03 SCADA Master Plan: Risks and Mitigation

- Financial Risks
  - Projected budgets aren't available
    - Master Plan includes phased approach
    - Push out projects as funding is available.
  - Budgets don't match market conditions
    - Design process should include estimating
    - Make adjustments to scope to match market conditions with budget expectations

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Guam Projects: GWA SCADA Implementation

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04 GWA SCADA Implementation - Project Update

- SCADA Phase A-I Project
  - Scope: Install SCADA system at 19 remote sites
  - 16 Water Facilities
    - 13 Wells, 1 BPS, 2 Reservoirs
  - 3 Wastewater Facilities
    - 1 Treatment Plant, 2 Pump Stations
  - AECOM is providing engineering design and construction support services

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04 GWA SCADA Implementation - Project Update

- Communication Network
  - Guam Power Authority's (GPA) Island-wide Radio Mesh Network
- Partnership with GPA
  - MOU between GPA and GWA
  - To build out and expand the GPA's network to meet GWA's communications needs
- Consolidation Use:
  - Shared resources, cost, responsibilities
  - Aim to reduce expenses and improve capabilities

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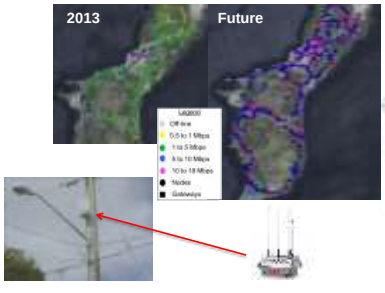
04 GWA SCADA Implementation - Project Update

- Consolidated Island-wide Radio Mesh System



GWA Facilities

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04 GWA SCADA Implementation - Project Update

- GPA Radio Mesh Network Expansion

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SCADA Implementation - Project Update

- (Central) SCADA System Project
  - Joint project between GWA and GPA
  - To provide a fully-functioning, cyber-secure SCADA System
  - To include standby generation control, and support Computerized Maintenance Management System, Water Hydraulic Model, and leak detection management
  - AECOM is providing engineering support services on behalf of GWA for this project.

SCADA Implementation - Project Update

- Critical Wastewater Pump Station Repairs – High Water Alarms Project
  - Scope: Install SCADA system for high water alarms at 19 remote pump stations.
  - New field instrumentation, controllers, and autodialers to send alarm notification through cellular network to GWA Operations Staff
  - AECOM is providing design and construction support services.

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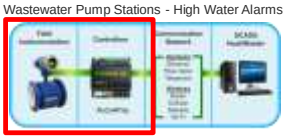
Other GWA Projects with SCADA component

- Reservoirs
  - Northern and Southern Guam Water Reservoirs (Design)
  - Central Guam Reservoirs (Design)
  - Yigo/Astumbo Tanks (Construction)
- Water Production Wells
  - "D-Series" Well Rehabilitation (Construction)
  - "A-F Series" Well Rehabilitation (Design)
- Water Hydraulic Modeling Data Collection
- Sewer Pump Stations
  - Baza Gardens Cross Island Road Sewer Conveyance (Design)
  - Bayside Sewer Pump Station Improvements (Design)
  - Critical Wastewater Pump Stations - High Water Alarms (Construction)



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Questions

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Back-up Slides

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