NOVEL CELLULAR APPROACH TO GREENFIELD WIRELESS DEVICE NETWORKS - ALBA GAS STATION (AGS)

Parameswaran V
Bharadwaja Prabhala
Bahrain Petroleum Company
6 February 2019
Bahrain Petroleum Company (BAPCO)

- State owned (erstwhile CALTEX) Oil & Gas Company engaged in Exploration, Refining, Storage, Marketing, Training & Development and Environmental initiatives in the Kingdom of Bahrain.

- Owns a 270,000 BOPD Refinery, over 14 million barrels of storage facilities, a Marketing terminal and a Marine terminal for transfer of petroleum products.

- 95% of the company’s Refined products are exported.

- Refinery under going capacity expansion from 270,000 to 360,000 BOPD.
Major Automation Technology Milestones in Bapco

1984
- APC Multivariable
- Modicon PLC Servo Level Gauges
- TDC2000 Honeywell DCS

1986
- ESD System GE Series 6

1988
- DCS Centum XL PI System

1990
- APC DMC

1993
- DCS Centum CS 3000 ESD Tricon Turbine Control System Radar Level Gauges

1998
- DCS Centum VP RIO Modicon 984 PLC

2000
- Device Wireless Networks

2009
- Fieldbus

2010
- Unified Converged Networks

2014
- Wireless Tank Gauging
- IWISE AR, AI
- APM: Big Data Analytics

2016
- Greenfield Wireless Network Infrastructure

2017
- Scalable Custody Transfer Skids for Gas

2018
- Open Architecture Digital Twin

2019
- IWISE AR, AI

2020
- APM: Big Data Analytics

2022
- Wireless Tank Gauging

2025
- Open Architecture Digital Twin
- APM: Big Data Analytics
ALBA GAS STATION (AGS)

- A new Gas Distribution Network Station designed to supply High Pressure Khuff Gas and Low Pressure Residue Gas to the upcoming Alba Line 6 Expansion.


- DESIGN OBJECTIVES
  - Energy Optimization
  - Low Utility Index
  - Large Data Rates
  - Reducing Capital Costs
  - Infrastructure Foundation for Future Analytics
Anatomy of Innovation

Pain Points/Current Problems
- Optimize Power & Utilities Consumption
- Space constraints
- Process Visibility & Remote Controllability
- CTMS Pre-certification
- Remote Maintainability
- Fiscal Consolidation of Analytics
- Safety Systems for Line Rupture & gas leaks

Ideation
- Maximize Wireless Monitoring
- Increase number of Bus Devices.
- Resize Meters to reduce the footprint
- Carry out 3rd Party Certification
- Unify Networks
- Flow Computers on TCP/IP
- TUV approved ESD & Profinet based Gas Detection Systems

Technologies & Sustainable Strategies
- ISA 100
- TCP/IP and Industrial Network
- 0.5 Class OIML R137
- Metering Audit
- Industrial Ethernet & Microwave Radios
- Concurrent Profinet ISA100 Domains using Tunneling
- Performance based Gas Detection System

Market Availability & Pushing Markets
- Wireless Toxic & Acoustic Gas Detectors not available
- OPC interface between Wireless & RTU not available
- Standard UPS/HVAC interface is on SNMP
- Radio interfaces is on SNMP

Objectives

Implementation & Execution
- Pre-Fabricated Telemetry Room
- Hilti Instrument Stands
- Standardization of Poles & installation Hardware for Wireless

Design & Development
- Yokogawa
- Elster Instromet
- Rotork
- Redline
- Gas Secure / Draeger
- Phoenix Contact

Vendor Development
- Demonstrate ISA100 Tunneling
- Demonstrate SCADA Server Redundancy on network
- Demonstrate VLAN/Cameras, Latency & Data speeds on Radio Network

Feedback
- Deeper Collaboration with Vendors and Contractors to improve alignment of products & quality

Transformation
- In Progress

Application Engineering
Instrument Distribution

**Analytics/Data Utilizing Software**

**Infrastructure**
- Cables
- Back
- Networks
- Hauls
- Hardware

**Field Devices**
- 4-20 mA
- RS485
- Wireless
- Field buses

**INSTRUMENTATION RATIO**

- 60% 40-50% Monitoring
- 40% 50-60% Critical monitoring/Controls/Safety

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost / Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCS</td>
<td>US$ 25,000</td>
</tr>
<tr>
<td>PLC</td>
<td>US$ 15,000</td>
</tr>
<tr>
<td>Device Wireless</td>
<td>US$ 5,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Inst Loops (Process)</th>
<th>Wired Inst Loops *</th>
<th>Wireless Inst Loops</th>
</tr>
</thead>
<tbody>
<tr>
<td>239</td>
<td>137</td>
<td>102</td>
</tr>
</tbody>
</table>

* Includes ESD and CTMS Packages which have wired instruments.
# ALBA Gas Station Project

## Project Summary

<table>
<thead>
<tr>
<th>Internal Man hours</th>
<th>14,600</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Man hours</td>
<td>19,100</td>
</tr>
<tr>
<td>Packages (RFQs)</td>
<td>15</td>
</tr>
<tr>
<td>FDS / Technical Specifications</td>
<td>16</td>
</tr>
<tr>
<td>Vendor Documents / Drawings</td>
<td>400 (approx.)</td>
</tr>
<tr>
<td>Instrument Loops (Total)</td>
<td>400+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project budgeted cost</th>
<th>13.17 MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual cost</td>
<td>8.0 MM</td>
</tr>
<tr>
<td>Saving</td>
<td>5.17 MM</td>
</tr>
<tr>
<td>Total cost of the Project</td>
<td>21 MM</td>
</tr>
<tr>
<td>Time to complete the Project</td>
<td>18 Months</td>
</tr>
</tbody>
</table>
Challenges

- Tight Project Schedule: 1 Year to complete and hand over
- Unmanned Station & Remote Location
- Process Controllers/Shutdown Systems – Wide Area Remote Operation from Central Control Facility
- 100% Unit availability - any upset is critical to the operation of the 1,792 MW Alba Power Plant affecting the Smelter operation.
- Unavailability of secure utilities like Power and Air.
- Surveillance Camera and communications in the Unit to enhance Security.
- CTMS design to 100% compliance to 3rd Party Audit.

Reliability of SCADA Servers and Radios
Cellular Concept & Tagging – Device Wireless

NOTES:
1. PHYSICAL PLANT OF PLANT SHALL BE GEOPHYSICALLY DIVIDED INTO SEVERAL CELLS.
2. EACH CELL IS DIVIDED BY 50-100 X 50-100 METERS DEPENDING ON DENSITY OF INSTRUMENT.
3. EACH CELL IS TO BE COVERED BY AT LEAST ONE ACCESS POINT OR GATEWAY. ALL ACCESS POINTS/GATEWAYS SHALL BE REDUNDANT.
4. THE POWER SUPPLY FOR THE GATEWAYS/ACCESS POINTS SHALL BE PROVIDED BY FIELD POWER SUPPLY UNIT MOUNTED IN A SWITCH BOX ON A TYPICAL JUNCTION BOX STANDARD.
5. ALTERNATIVELY, THE GATEWAYS/ACCESS POINTS CAN BE PROVIDED VIA FIELD INSTALLED “TINO” POWER SUPPLY BASIS THE LOAD CAPACITY.
6. THE POWER SUPPLY SHALL BE SUITABLE FOR MULTIPLE ACCESS POINTS AND GATEWAYS INSIDE THE CONTROL ROOM.
7. ALL SWITCHING BOXES SHALL BE CONNECTED ON A F/F COMMUNICATION TO THE CONTROL SYSTEM.
8. POWER SUPPLY IN SWITCH BOX SHALL BE EITHER DC UPS OR FED FROM CENTRALIZED UPS.
9. ALL WIRELESS INSTRUMENTS, POWER SUPPLIES AND BOXES SHALL BE CERTIFIED FOR THEIR RESPECTIVE ELECTRICAL AREA CLASSIFICATION.
10. THE COMMUNICATION FROM THE ACCESS POINTS/GATEWAYS SHALL BE TCP/IP ETHERNET AND THE DATA SHALL BE COMMUNICATED IN OPC.
11. THE WIRELESS DATA SHALL BE INTERFACED TO THE CONTROL SYSTEM VIA REDUNDANT AND RELIABLE OPC SERVER.
12. WIRELESS NETWORK SHALL BE ON A “MESH NETWORK CONFIGURATION”.
13. WIRELESS NETWORK SHALL INCLUDE THE REQUIRED NETWORK MANAGEMENT TOOLS.
15. REQUIRED TOOLS AND OTHER TOOLS SHALL BE PROVIDED TO SAFEGUARD THE NETWORK IN TERMS OF CYBER SECURITY.

WIRELESS NETWORK TAGGING PHILOSOPHY

THE BAHRAIN PETROLEUM CO. BSC (CLOSED)
TYPICAL WIRELESS INFRASTRUCTURE GUIDELINE

REFERENCE DRAWINGS

<table>
<thead>
<tr>
<th>DRAWING NO</th>
<th>REV</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRD-250009 Sht.4</td>
<td>0</td>
</tr>
</tbody>
</table>

© ARC Advisory Group • 9
Cellular Concept for Small Packages - Device Wireless

NOTES:
1. Wireless instruments are to be supplied in small package(s) by vendor.
2. Package wireless instruments shall be linked to global access points
   provided for process plant areas in the plant.
3. The switch box contains LPS, Patch Panel, and Ethernet switches.
4. All switches shall be managed Industrial switches.

PHYSICAL PLANT PLAN OF THE PLANT

THE BAHRAIN PETROLEUM CO. BSC (CLOSED)

REFERENCE DRAWINGS

TYPICAL WIRELESS INSTRUMENT
ARCHITECTURE - ISA100
FOR SMALL PACKAGES (OPTION 1A)

GLOBAL ACCESS POINT
(PROCESS PLANT AREA)

PACKAGE WIRELESS INSTRUMENTS

SWITCH BOX
NOTES 5 & 6

FIELD
CONTROL ROOM

MEDIA CONVERTER

CONTROL SYSTEM

ACCESS POINTS
(REDUNDANT)

WIRELESS INSTRUMENTS

SIDE DATER

ETHERNET
Network Performance

- Concurrent Domains for Process & Safety Instruments
- Link stable
- PER <10% (acceptable range)
- RSSI < -75dB
- System architected using Standard 5 meter poles

P&ID Representation
AGS Device Wireless Plot Plan and Layout

- **Wireless Network ID 101**
  - 1st hop: Within 20 m
    - Dense object (Pipe, Tank, Structure)
  - 2nd hop: Maximum Approx. 90 m from Access Point
    - Sparse Object
    - Wireless Router is used to secure the LOS (Line-of-Sight) from AP and Wireless Transmitter.

- **Wireless Network ID: 102, 103, 104**
  - 1st hop: Within 20m
    - Dense object (Pipe, Tank, Structure)

Wireless Transmitters are installed on the pipe rack.
Alba Gas Station supplies Khuff and Residue Gas to Alba PS-5
SAFETY & RELIABILITY IN ENGINEERING DESIGN

Safety Relief Valves

Flare System

Safety Systems

- Gas Detection System (Safety Controller)
- LINE GUARD System
- Emergency Shutdown System (2oo2)
- Ultrasonic Gas Detector
- Open Path HC Gas Detector
- H2S Gas Detector
- 2oo2 TX
- 2oo2 SOV

Main Central Control Facility

- PETEX CAMERA SERVER
- CCF SCADA SERVER
- PETEX SCADA SERVER

Basic Process Control System

- Interface between the BPCS and the CCF is via Microwave Radio
- Surveillance Cameras
- Metering System
- RTU System
- Sub-Systems HVAC, FACP, UPS

Wireless TX Wired TX
Benefits & Performance Metrics

- Procurement Strategies to minimize lead time; Maximize Wireless instruments to save construction time.
- Remote control of the complete process & elimination of data mapping saving time.
- RTUs connected to Multi-level SCADAs with equalized FAST/TOOLS S/W and Triple redundant geospatial SCADA Servers.
- Early detection of dormant problems & remote maintenance of Systems via Unified converged networks.
- Improved Safety and Reliability through design.
- Reduced power consumption of devices (Current power consumption ~ 3KVA) and modular 10KVA/3KVA UPS for ease of maintenance & future expansion.
- 3 Cameras and 1 IP phone for surveillance and communication with future network capacity of 70 Cameras.
- 0.5 Class OIML R137-1 Ultrasonic Flow Meters (CTMS audited by Kelton, UK)
- Redundant high speed (800 MBPS) Microwave Radios (18 GHz) with 1+1 configuration and path redundancy.
ALBA GAS STATION
ALBA GAS STATION

Pre-fabricated Telemetry Room

Custody Transfer Metering Skid
ALBA GAS STATION

Wireless Instruments for Pressure, Temperature and Position Indication
Lessons Learned

- Deeper collaboration with Vendors required to meet objectives
- More engagement needed to improve local expertise
- Vendors need to be encouraged to align products to Industrial Ethernet and Digital Networking
DIGITAL INFRASTRUCTURE PERSPECTIVE

Industrial Wireless Infrastructure & Safety Enterprise (IWise)

- Plant Visibility HSE Manager
- Plant Visibility Reliability Manager
- Plant Visibility Maintenance Manager

Device Network:
- WiFi/4G
- WiFi/4G (Mobile)
- Fibre Optic Cable

Analysis Types:
- Descriptive analytics
- Diagnostic analytics
- Predictive analytics
- Prescriptive analytics

Plant Visibility Control Room
Thank you