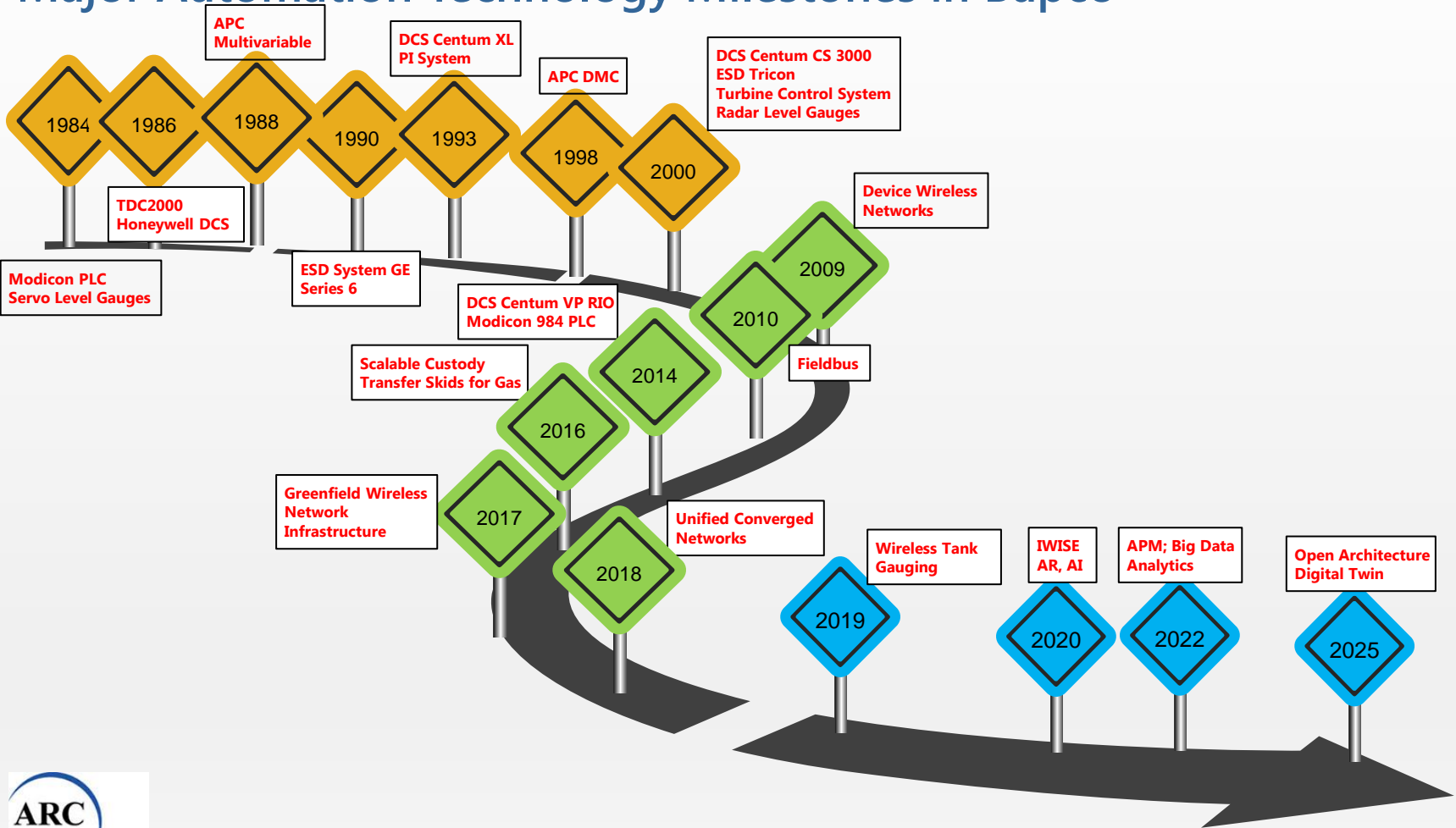


NOVEL CELLULAR APPROACH TO GREENFIELD WIRELESS DEVICE NETWORKS - ALBA GAS STATION (AGS)

*Parameswaran V
Bharadwaja Prabhala
Bahrain Petroleum Company
6 February 2019*

- ❖ 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.

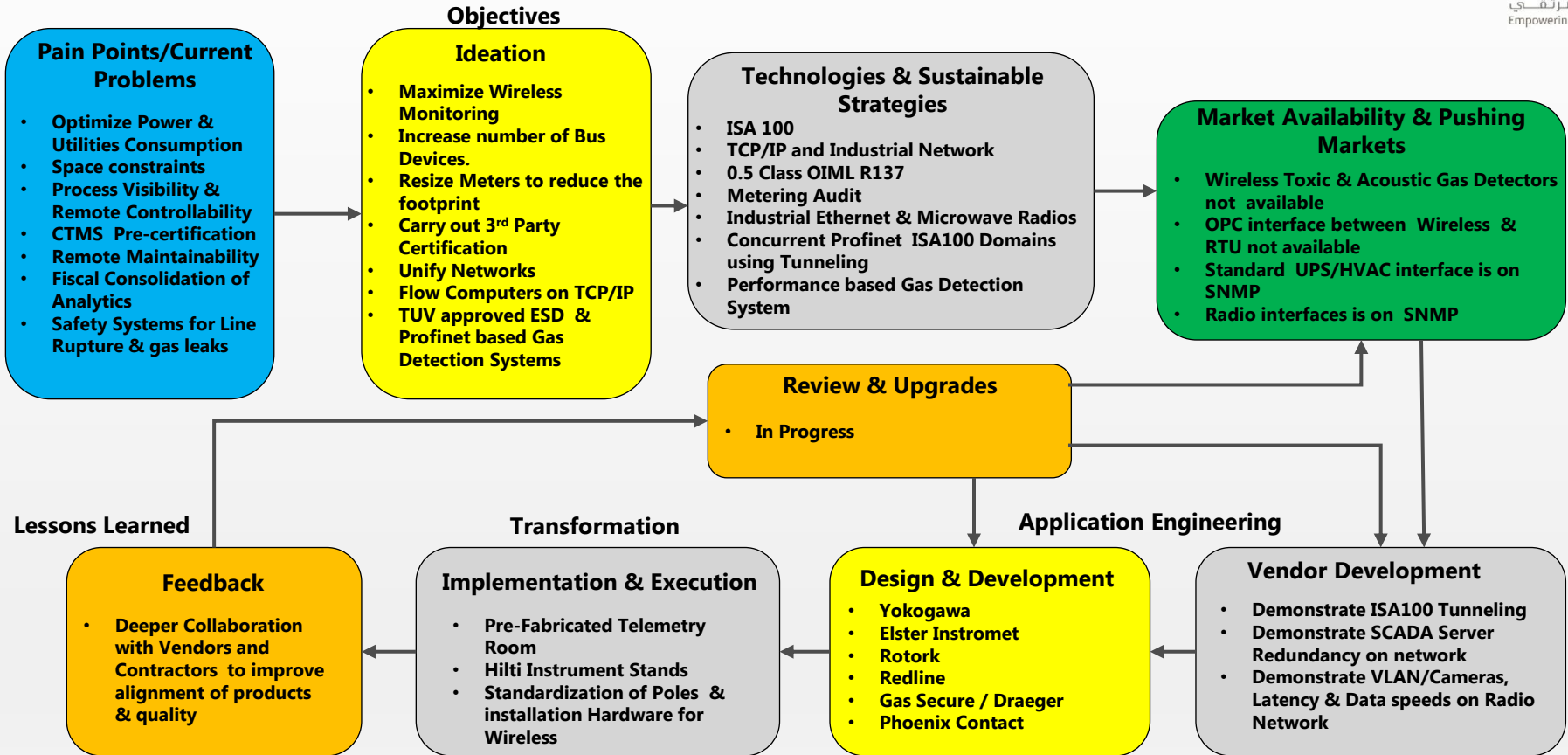
Major Automation Technology Milestones in Bapco



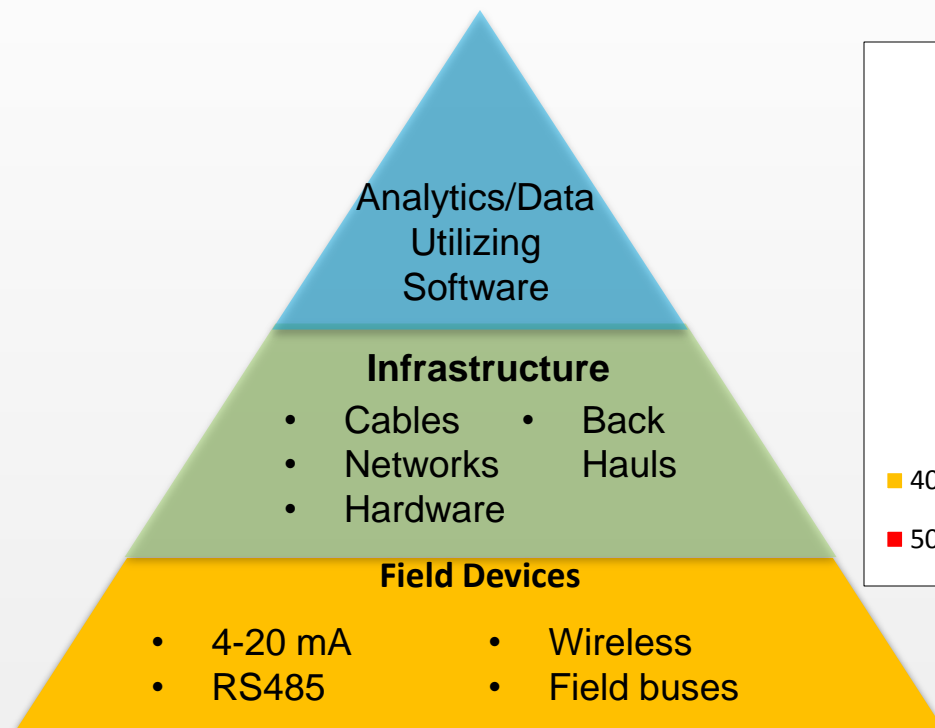
ALBA GAS STATION (AGS)

- 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.
- Comprises Gas Pre-conditioning Systems, Condensate Knock-out/Transfer Systems and Vent/Flare Management Systems.
- DESIGN OBJECTIVES
 - ❖ Energy Optimization
 - ❖ Low Utility Index
 - ❖ Large Data Rates
 - ❖ Reducing Capital Costs
 - ❖ Infrastructure Foundation for Future Analytics

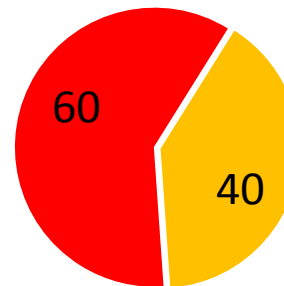
Anatomy of Innovation



Instrument Distribution



INSTRUMENTATION RATIO



■ 40-50% Monitoring

■ 50-60% Critical monitoring/Controls/Safety

Equipment

Cost / Channel

DCS

US\$
25,000

PLC

US\$
15,000

Device
Wireless

US\$
5,000

Total Inst Loops (Process)

239

Wired Inst Loops *

137

Wireless Inst Loops

102

* Includes ESD and CTMS Packages which have wired instruments.

ALBA Gas Station Project

Project Summary	
Internal Man hours	14,600
External Man hours	19,100
Packages (RFQs)	15
FDS / Technical Specifications	16
Vendor Documents / Drawings	400 (approx.)
Instrument Loops (Total)	400+

Project Summary	
Project budgeted cost	13.17 MM
Actual cost	8.0 MM
Saving	5.17 MM
Total cost of the Project	21 MM
Time to complete the Project	18 Months

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


بابكو
Bapco
دوماً نرتقي
Empowering Progress

PHYSICAL PLOT PLAN OF THE PLANT

The diagram shows a rectangular plot divided into four quadrants by a horizontal and vertical solid line. The left boundary is a dashed line. A vertical dimension line on the far left indicates a height of 50 ~ 100 m. A horizontal dimension line below the top-left quadrant indicates a width of 50 ~ 100 m. In the top-left quadrant, there is a rectangular box containing four circular symbols, each with an 'X' inside, representing wireless instruments. A label 'PACKAGE WIRELESS INSTRUMENTS' with an arrow points to this box. Below the box, a solid black dot is labeled 'ACCESS POINT/GATEWAY' with an arrow. In each of the other three quadrants (top-right, bottom-left, and bottom-right), there is a single solid black dot representing an access point/gateway.

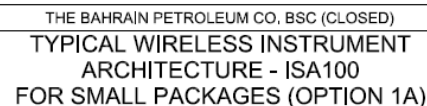
1. PHYSICAL PLOT OF PLANT SHALL BE GEOGRAPHICALLY DIVIDED INTO SEVERAL CELLS.
2. EACH CELL IS DIVIDED BY 50-100 X 50-100 METERS DEPENDING ON DENSITY OF INSTRUMENTS.
3. EACH CELL IS TO BE COVERED BY AT LEAST ONE ACCESS POINT OR GATEWAY. ALL ACCESS POINTS/GATEWAYS SHALL BE REDUNDANT.
4. THE POWER SUPPLY 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 POWERED VIA FIELD INSTALLED "FENICO" 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 SWITCH BOXES SHALL BE CONNECTED ON A F/O 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.
14. TIME STAMPING OF THE MEASURED PARAMETER SHALL BE PROVIDED AND THE NETWORK SHALL BE TIME SYNCHRONIZED WITH THE CONTROL SYSTEM.
15. REQUIRED FIREWALLS AND OTHER TOOLS SHALL BE PROVIDED TO SAFEGUARD THE NETWORK IN TERMS OF CYBER SECURITY.

DOMAIN	INSTRUMENT	REPEATER	ACCESS POINT	NMS/GATEWAY
DOMAIN 1	744-PIT-0700 744-AIT-0104 744-PIT-0206	744-UY-0001X1 (X1.....99)	744-UY-0001AA 744-UY-0001AB 744-UY-0001BA 744-UY-0001BB	744-UY-0001A 744-UY-0001B (REDUNDANT)
DOMAIN 2	744-PIT-0010 744-PIT-0003 744-PIT-0107	744-UY-0002X1 (X1.....99)	744-UY-002AA 744-UY-002AB 744-UY-002BA 744-UY-002BB	744-UY-0002A 744-UY-0002B (REDUNDANT)

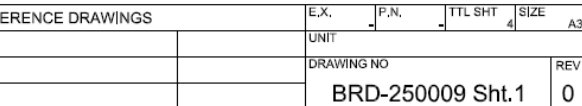
	THE BAHRAIN PETROLEUM CO, BSC (CLOSED)	REFERENCE DRAWINGS		E.X.	P.N.	TTL SHT	SIZE
	TYPICAL WIRELESS INFRASTRUCTURE GUIDELINE			UNIT			
				DRAWING NO			
				BRD-250009 Sht.4			
				REV			
				0			

بابكو
Bapco
دوماً نرتقي
Empowering Progress

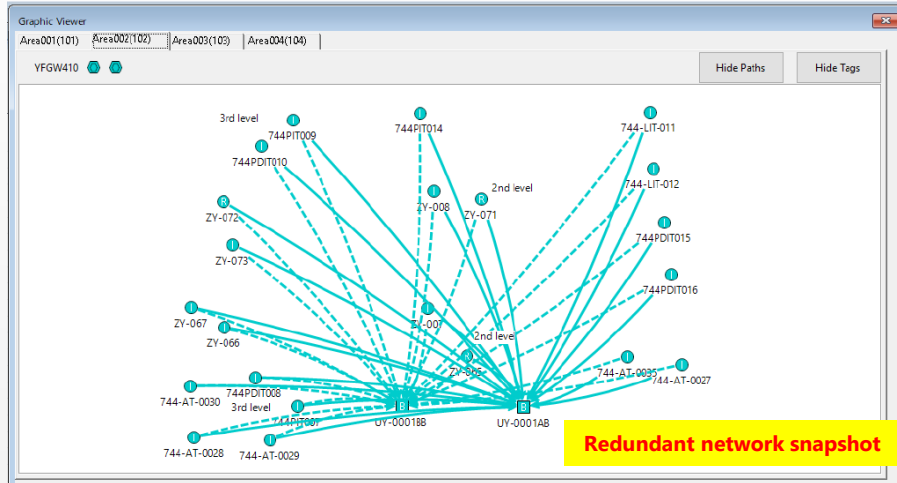
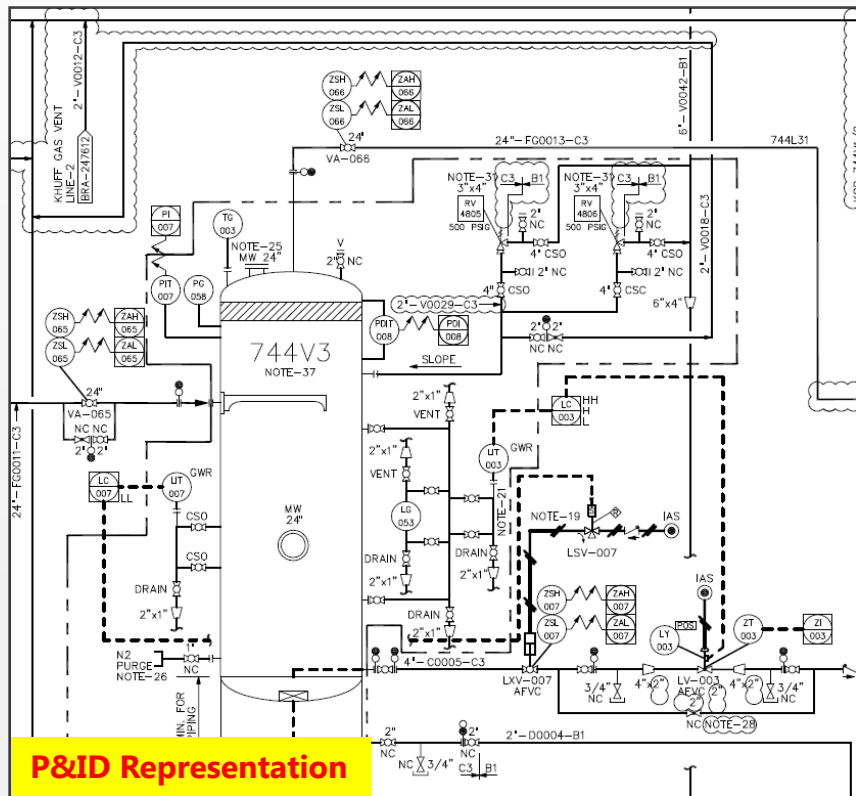
بابکو
Bapco



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 GRID.
3. THE SWITCH BOX CONTAINS DC UPS, PATCH PANEL AND ETHERNET SWITCHES.
4. ALL SWITCHES SHALL BE "MANAGED INDUSTRIAL SWITCHES".



P&ID Representation & Device Wireless Link Performance



Network Performance

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

AGS Device Wireless Plot Plan and Layout

■ Wireless Network ID 101

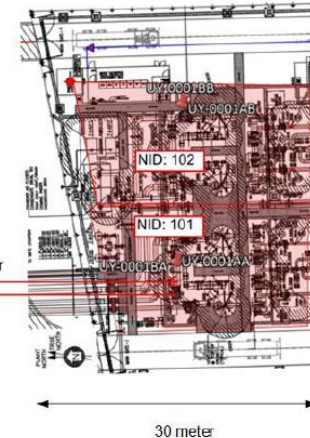
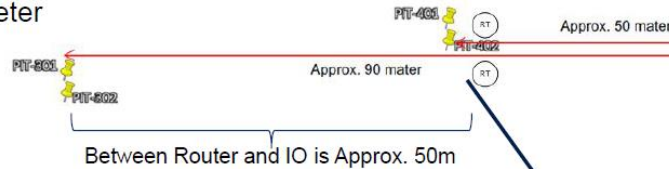
- ◆ 1st hop: Within 20 m
 - Dense object (Pipe, Tank, Structure)
- ◆ 2nd hop: Maximum Approx. 90 m from Access Point
 - Sparse Object
 - Wireless Router is used to secure the LOS (Line-of-Sight) from AP and Wireless Transmitter.

■ Wireless Network ID: 102, 103, 104

- ◆ 1st hop: Within 20m
 - Dense object (Pipe, Tank, Structure)

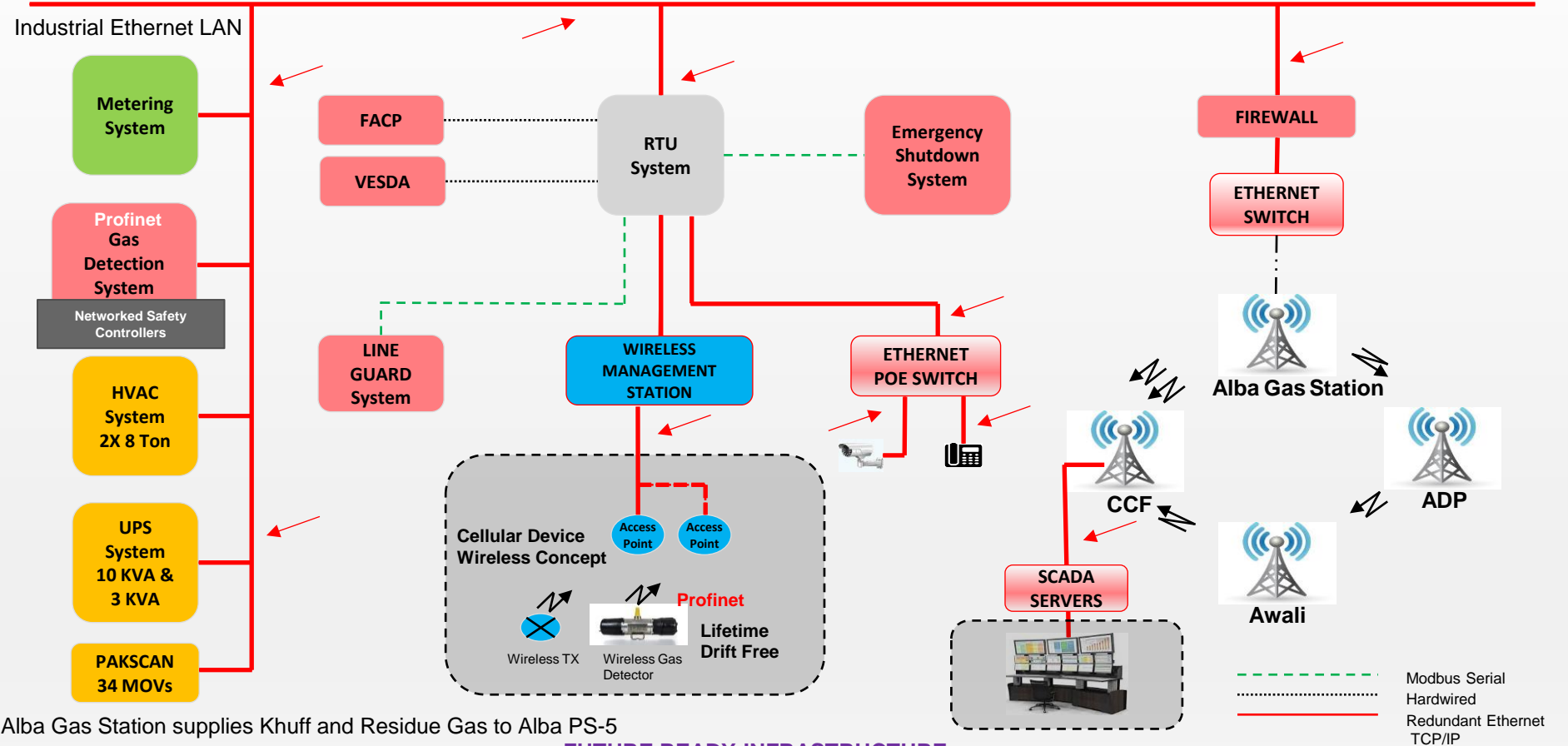
-  Access Point
-  Wireless IO
-  Wireless Router

20 meter



Wireless Transmitters are installed on the pipe rack.

ALBA GAS STATION SYSTEM ARCHITECTURE



Alba Gas Station supplies Khuff and Residue Gas to Alba PS-5

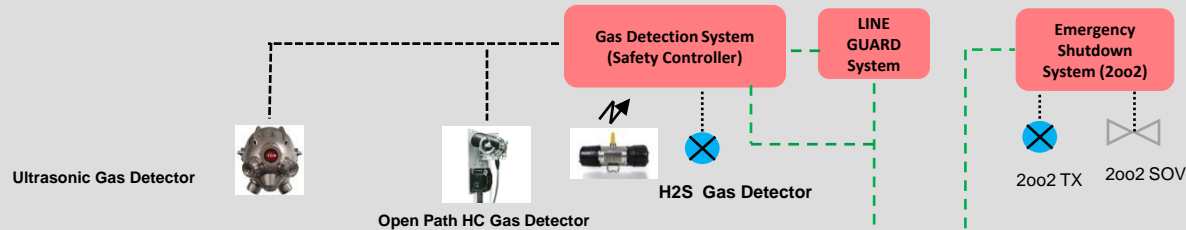
SAFETY & RELIABILITY IN ENGINEERING DESIGN

Safety Relief Valves

Flare System

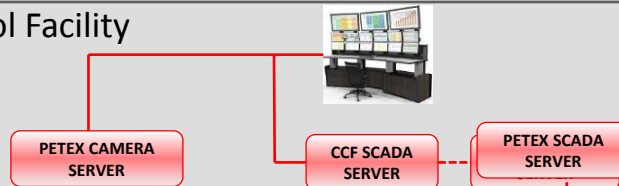
Layer 4

Safety Systems



Layer 3

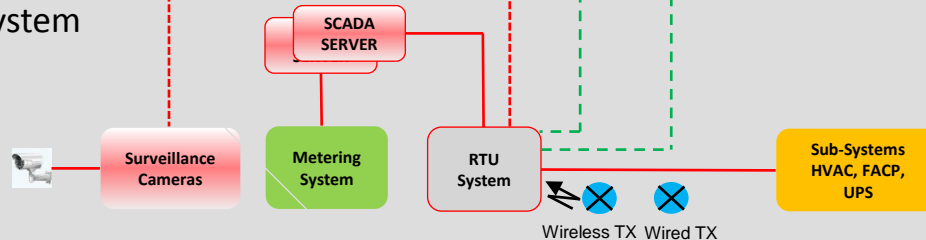
Main Central Control Facility



Layer 2

Basic Process Control System

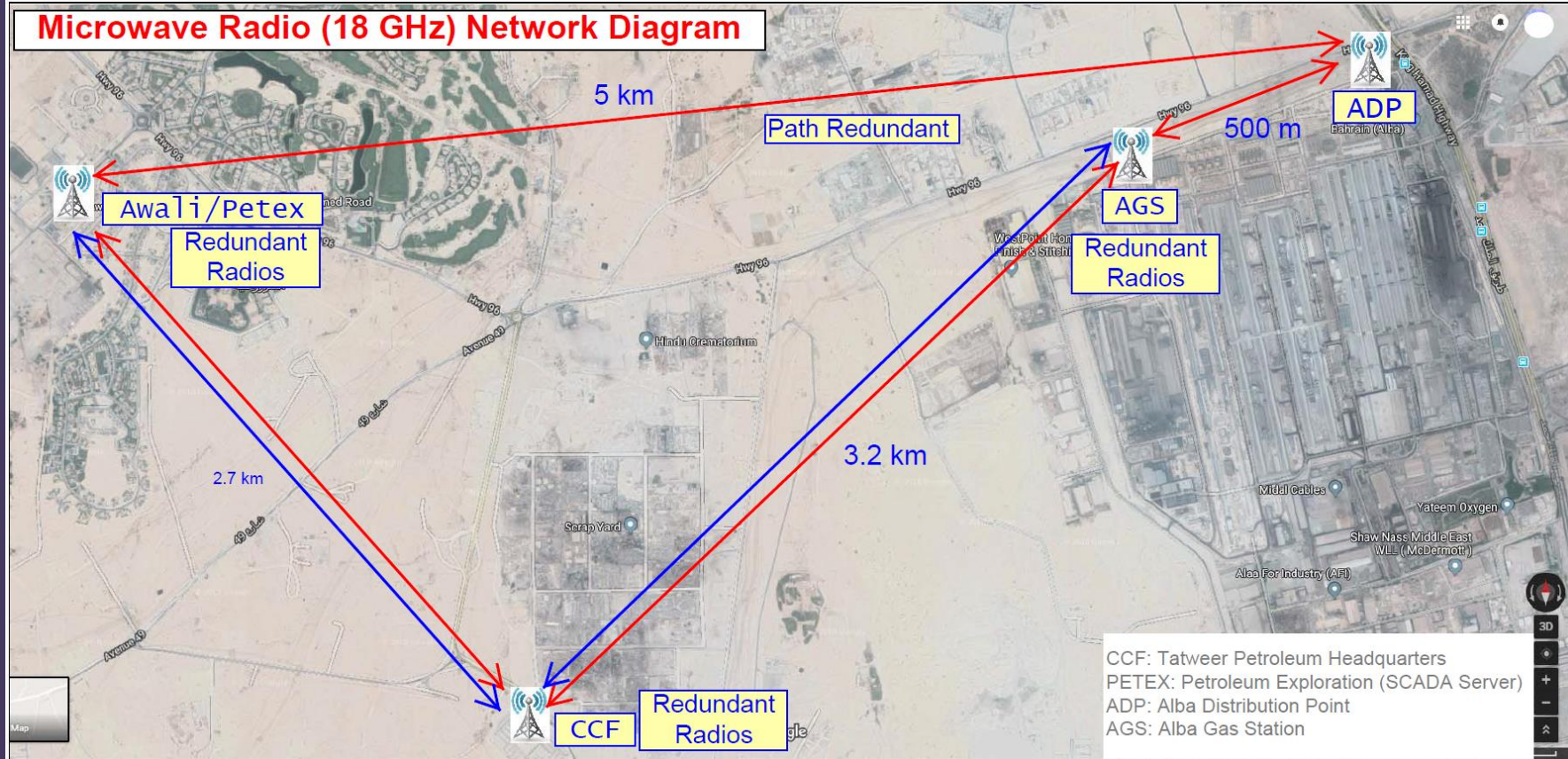
Interface between the BPCS and the CCF is via Microwave Radio



Wireless TX Wired TX

Layer 1

Microwave Radio (18 GHz) Network Diagram



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

AGS Project Collaborators

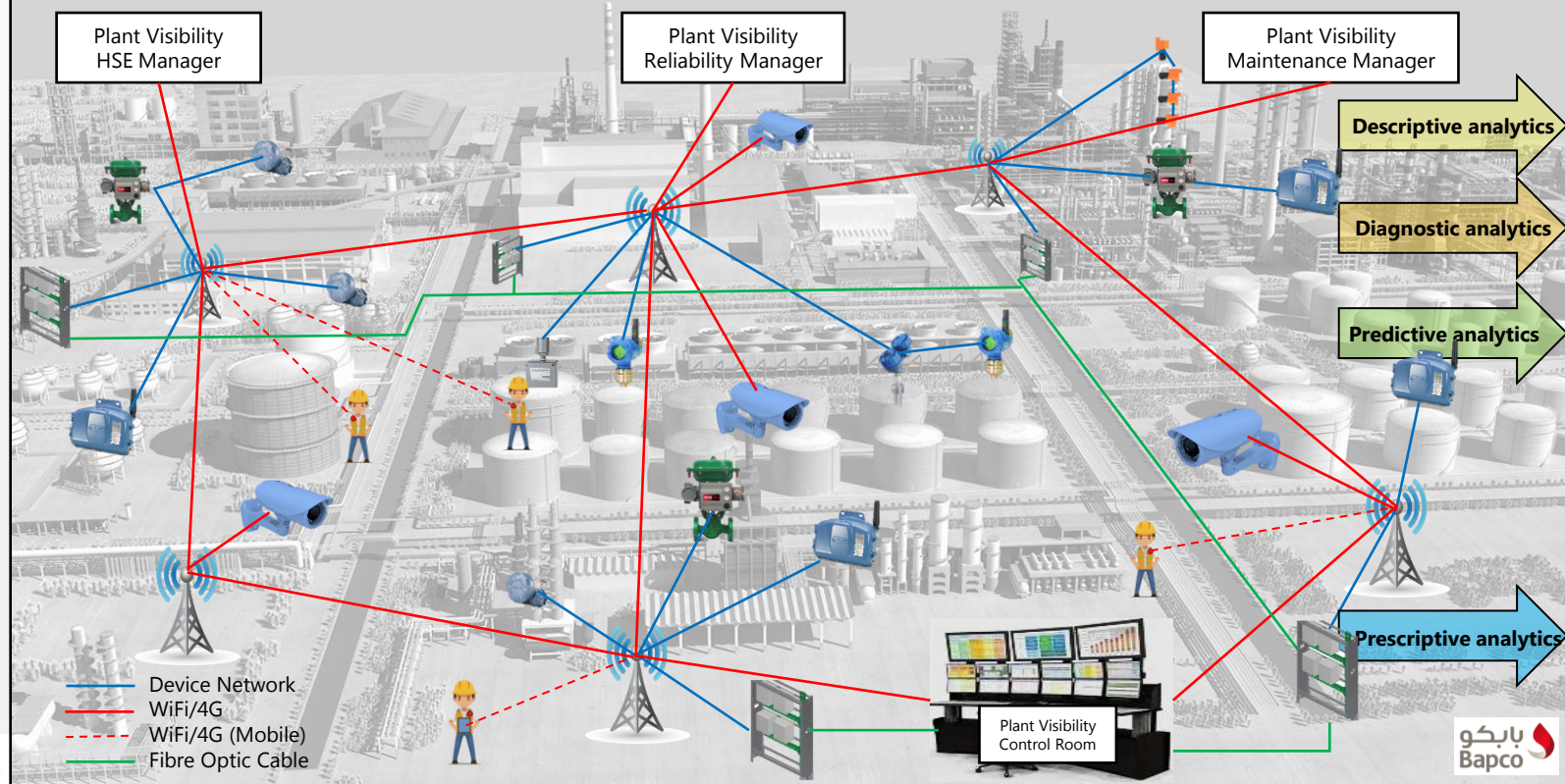


Lessons Learned

- ❖ 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)



Thank you