GE Digital Energy
Industrial Communications

WiMAX for Remote Oil Production Sites

WiMAX Forum Oil & Gas Event
November 6, 2012
Houston Texas

imagination at work

Contents

- Project Background
- System Design
- Deployment
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- Summary

Project Background

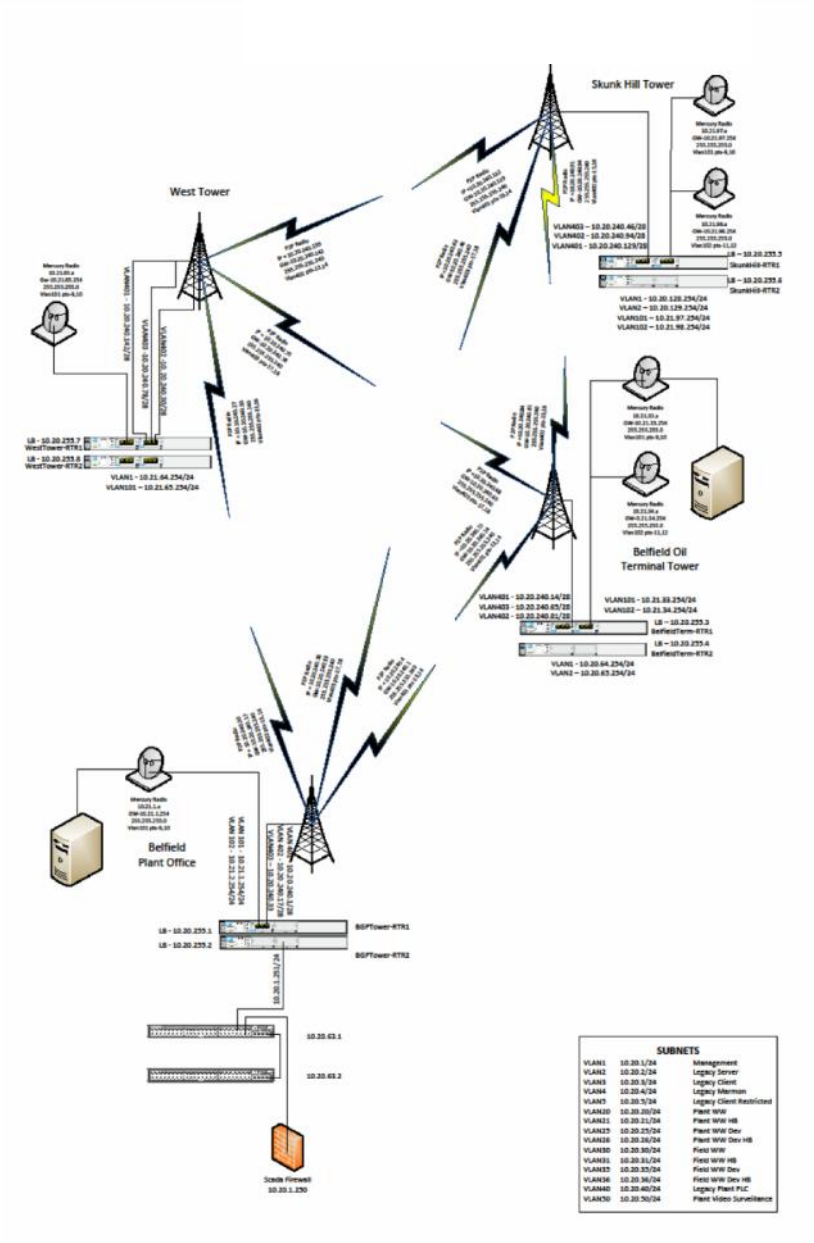
- **GE Customer: Wireless Data Communications out of Liberal, Kansas is a full service partner to GE MDS.**
- **End customer is an oil firm drilling in North Dakota.**
- **Data requirements were low, however video used at one site drove higher throughput requirement.**
- **Customer needed 24/7 SCADA data provided.**
- **Timeline was critical as weather turns in November inhibiting tower construction and radio field deployment.**
- **Outdoors CPEs chosen for several sites.**

imagination at work

Typical Customer Requirements

- **Communications 24/7 from remote locations**
- **Environmental or work conditions cannot interrupt communications**
- **Video data capacity required**
- **Mature technology**
- **No public infrastructure available at sites**
- **Severe environmental conditions**
- **Remote FW upgrade capability**
- **Plug n play – technicians need simplicity for trouble shooting and maintenance of communications infrastructure**

System Design



System Design

Mercury subscribers monitor RTU data

Mercury subscribers gather video & SCADA data

Access Point at plant office consists of 3 base stations for 360 degree MIMO receive & transmission

Access Point at plant office consists of 3 base stations for 360 degree MIMO receive & transmission

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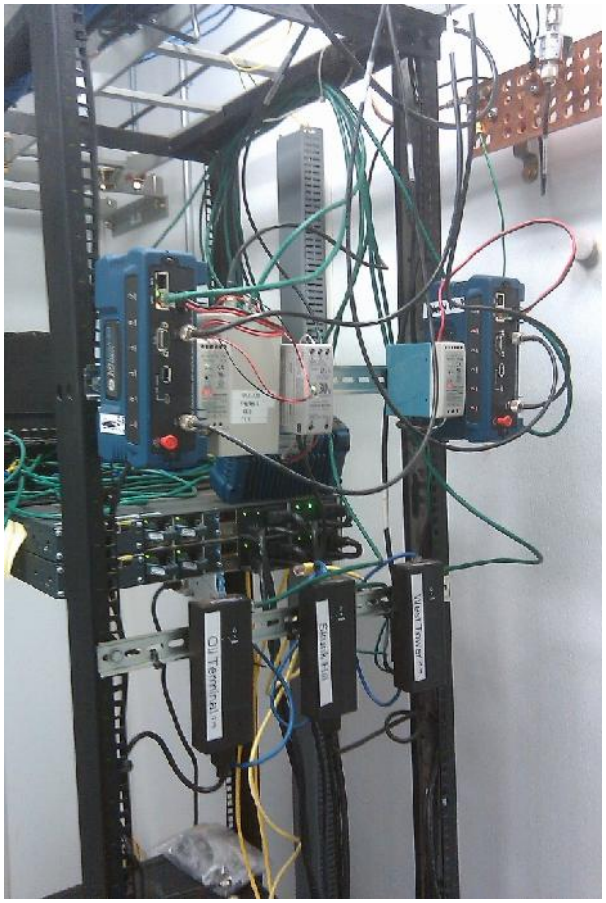
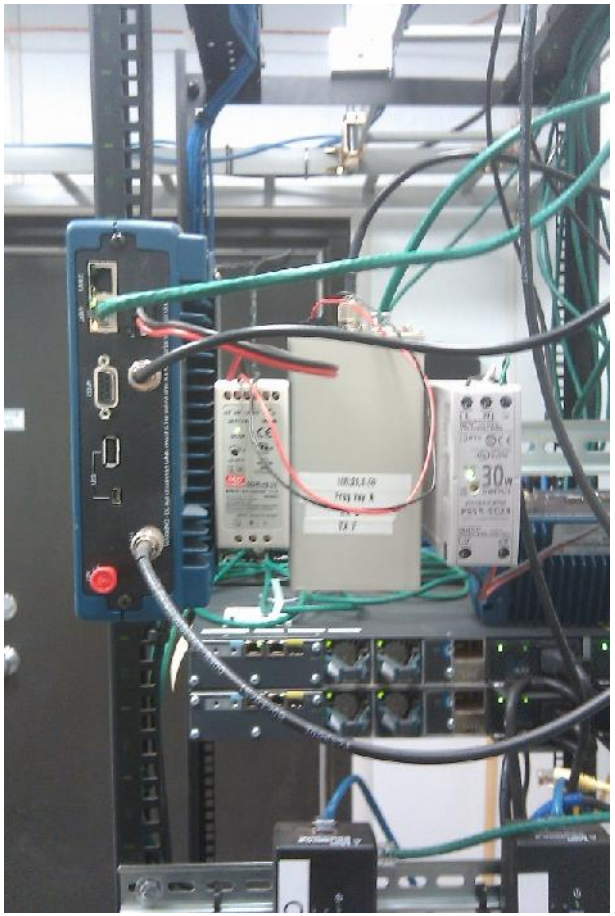
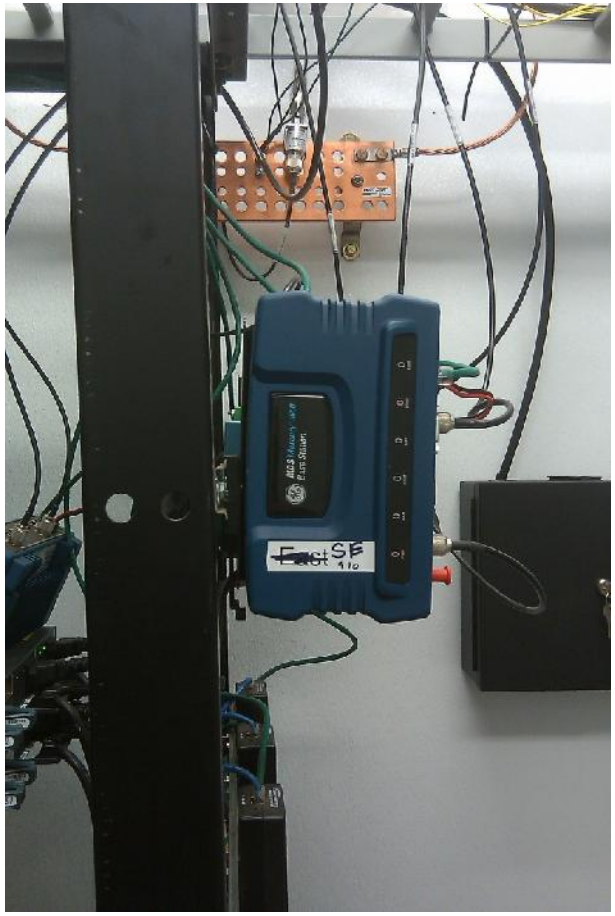
System Deployment

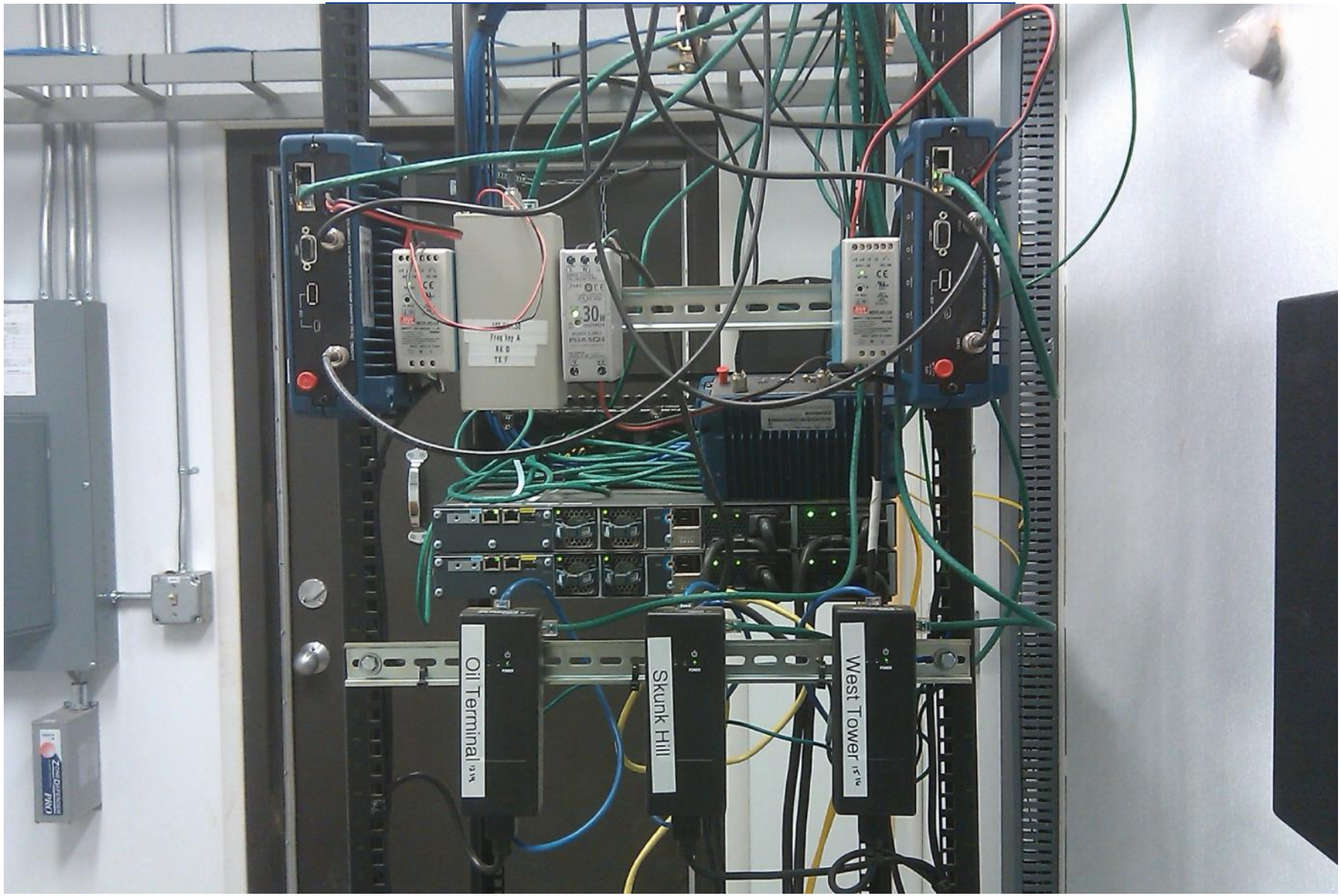






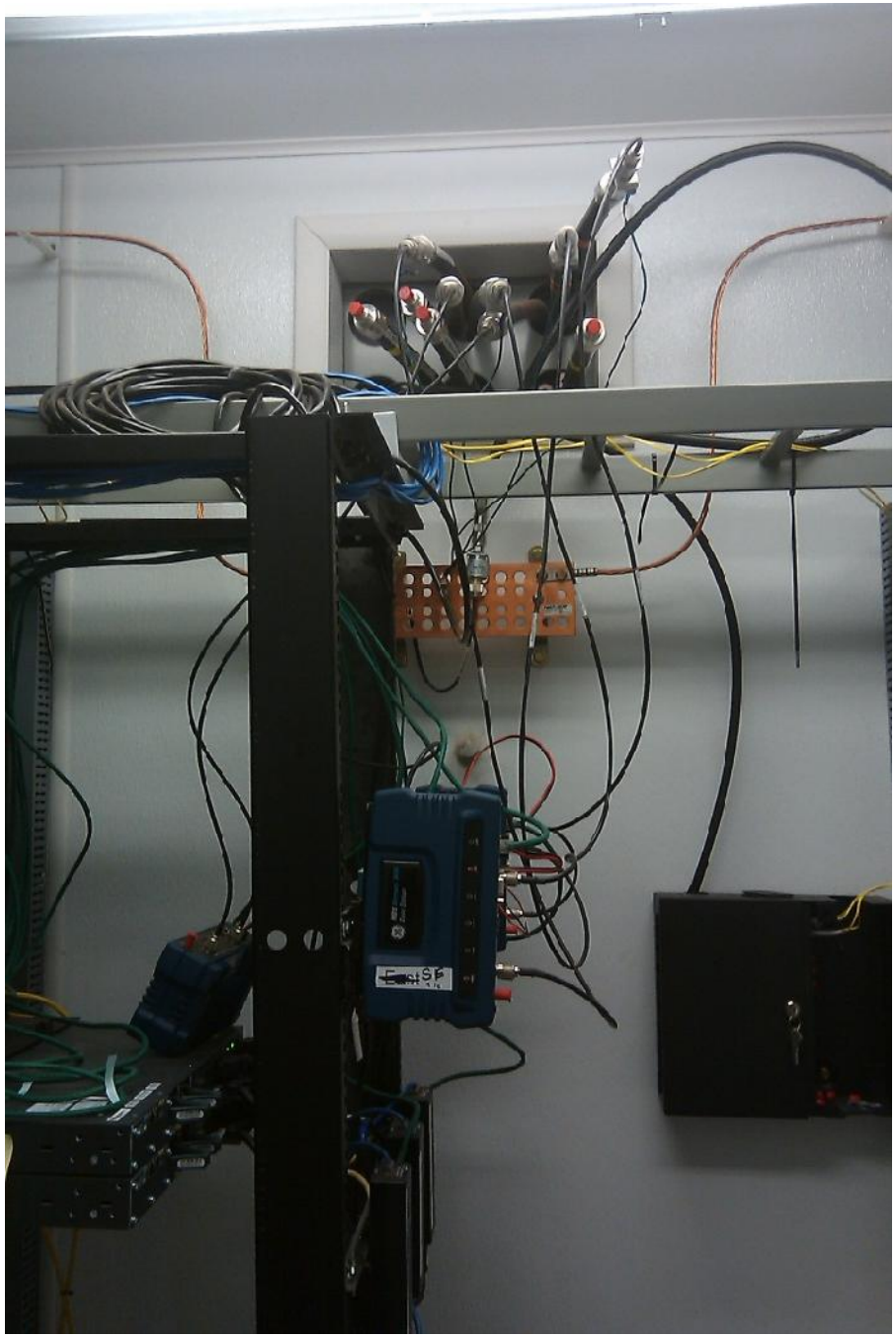
Side views of Plant Office Access Point Deployment

Plant Office Front View



Plant Office Side View

- 3 Mercury 3650 indoor subscribers running MIMO



System Deployment

Mercury subscriber installed at oil well site

System Deployment

Towers also have PtP hi capacity licensed radio

Lessons Learned

- Need onsite system design and services for successful WiMAX implementation
- All accessories should be included in shipment
- Customer support is critical in initial WiMAX deployments
- WiMAX systems are bigger than just a product sale
- SW is never done done
- Higher throughput is required
- Weather constraints drive project timelines

Satellite-Enabled WiMAX Solutions For 'The Patch'

David Hartshorn
Secretary General
Global VSAT Forum
david.hartshorn@gvf.org

The Global VSAT Forum:
Facilitating Sustainable Connectivity

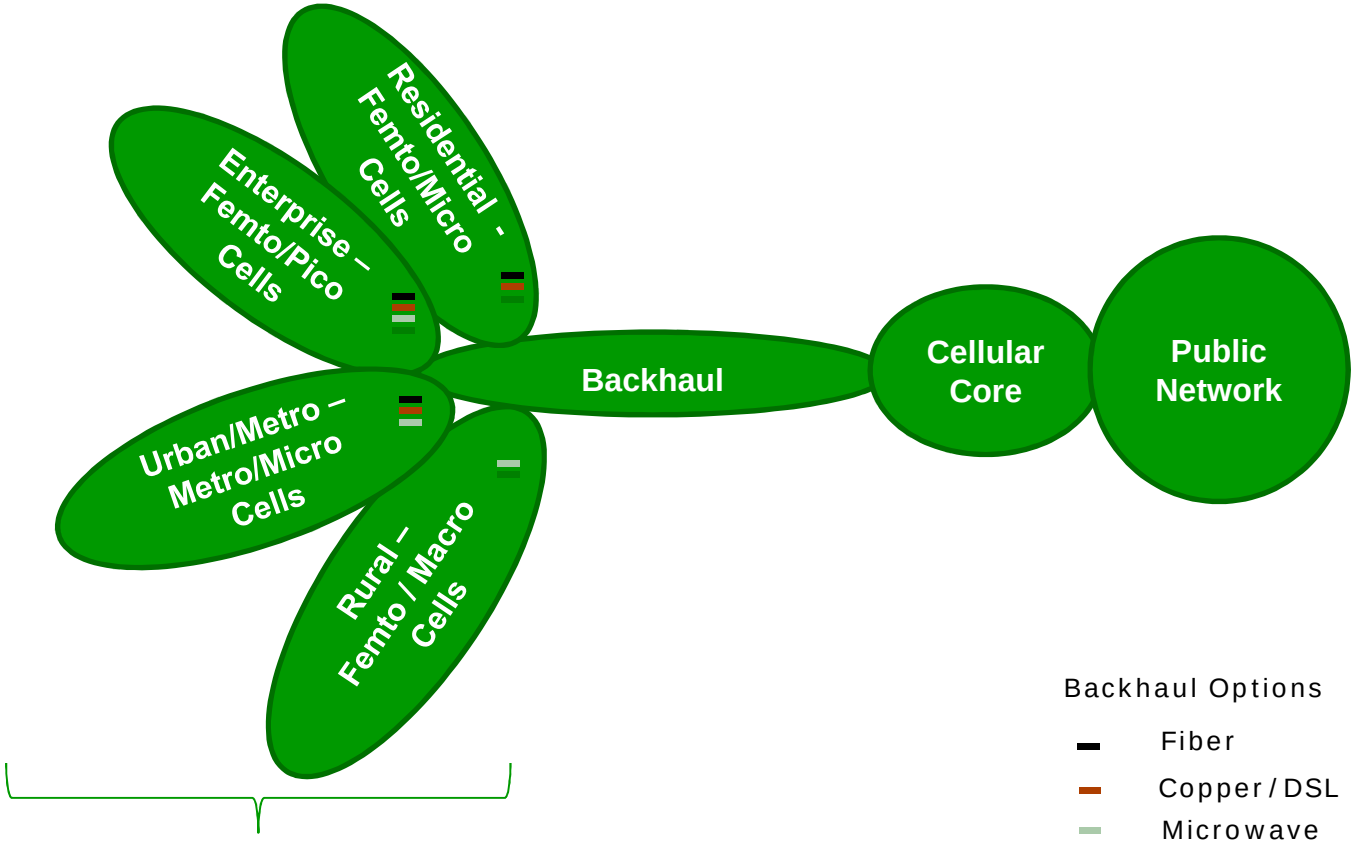
- Global Non-Profit Association
- 200+ Companies Headquartered in 100+ Countries
- Reaching Every Nation in the World
- Facilitating Satellite Systems/Service Provision Thru…

  - ➢ Enabling Effective Regulation, Spectrum Management
  - ➢ Providing Training, Product Testing, Network Validation
  - ➢ Facilitating Sustainable Networks

Wi-MAX-VSAT Integration and Interoperability

Certified for the backhaul of all major wireless access standards GSM, CDMA, and Wimax; Femto

Wireless Backhaul Options



Satellite Backhaul: Hard-to-Reach Areas

Rural Areas

Islands

High Speed Trains

Airplanes

Cruise Ships

Oil Rigs

Communications Are Reducing Operational Costs in the Energy Sector

Existing Networks Are Enabling…

- Automation = Cost Reduction
- Wide-Area SCADA Applications = Improved Logistics
- Remote Real-Time Decision Making = Higher Efficiency
- Real-time Supply Orders = Reduced Operating Costs

Operator of Liquefied Natural Gas Carriers

Need: Effective Crew Morale and Retention Solution

- **Situation**
  - Provides maritime LNG transportation and regasification services
  - Faces strong competition for qualified and trained crew
- **Problem**
  - Vessels often out to sea for days and even weeks
  - Onboard crew require entertainment during down time
  - Current pay-per-minute solution too expensive to provide crew morale services
- **Solution**
  - VSAT solution with unlimited voice, Internet and data connectivity for a fixed price
  - Prepaid phone services, crew calling solutions and email services
- **Result**
  - Crew is able to stay in touch with friends and family back home
  - Competitive advantage in attracting and retaining crew

Provider of Seismic Services to the Energy Industry

Need: Exchange critical data with onshore experts

- **Situation**
  - Provides shallow water and ocean bottom seismic data to oil companies and contractors
  - Management of vessels, work plans and schedules driven by seismic analysis
  - Vessels dispersed in Gulf of Mexico and North Sea
- **Problem**
  - Clients needed real-time reporting capabilities
  - Onshore specialists required instant access to seismic data
- **Solution**
  - Always-on VSAT solution with secure access to the corporate network and the Internet
- **Result**
  - Instant access to remote operations, seismic projects and accompanying detailed studies
  - Better management of vessels
  - Enhanced data and services to clients

Provider of Diving & Pipelaying Services

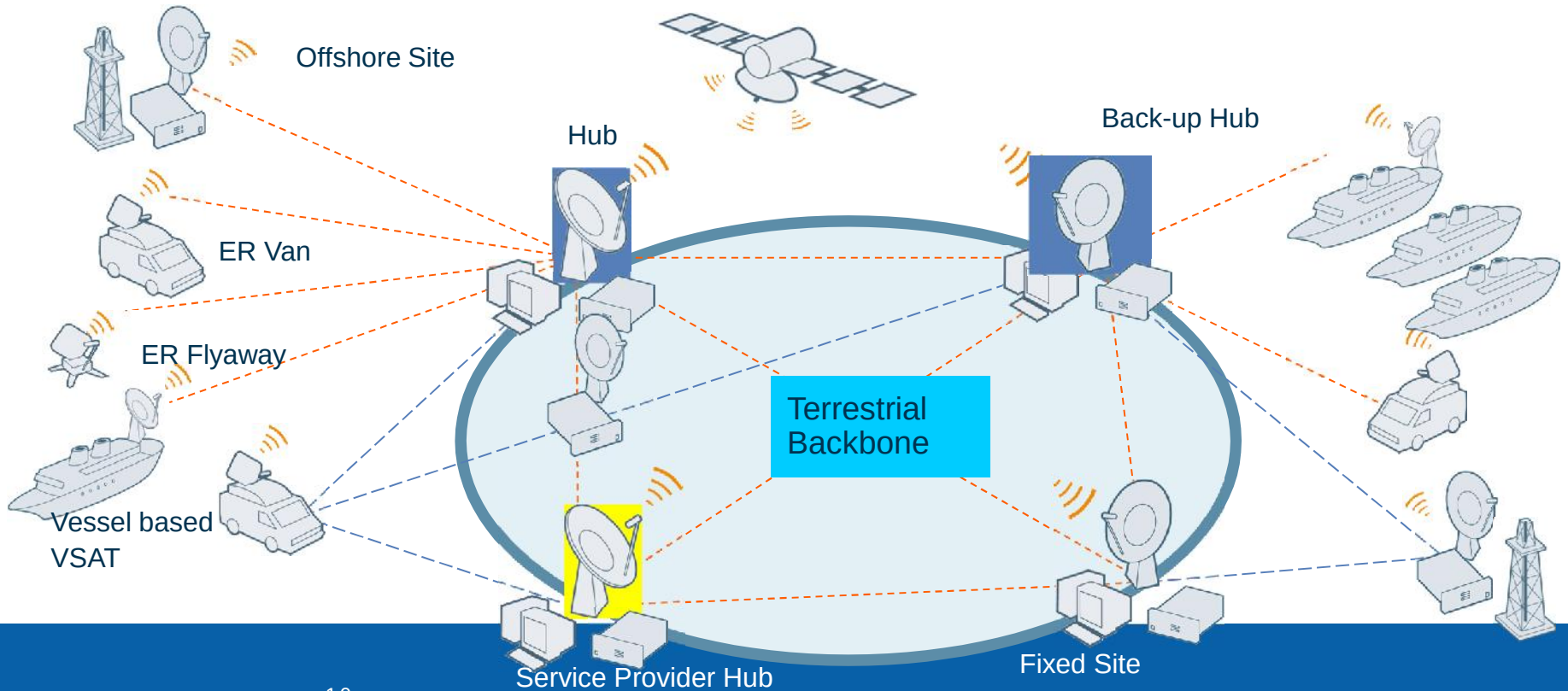
Need: Visual link into the remote sites

- **Situation**
  - Divers investigate subsea structures and their potential damage
  - Clients' decisions are based on divers' discoveries
- **Problem**
  - Difficult to explain verbally to clients the specific damage
  - Hard to grasp the degree of destruction or problems
- **Solution**
  - Remote video streaming service deployed over VSAT
  - Divers video subsea infrastructure that is subsequently shown to clients
- **Result**
  - Real-time monitoring and inspection is now possible
  - Remote video streaming brings clarity and perspective to infrastructure damage
  - Clients are able to see exactly what the divers experience

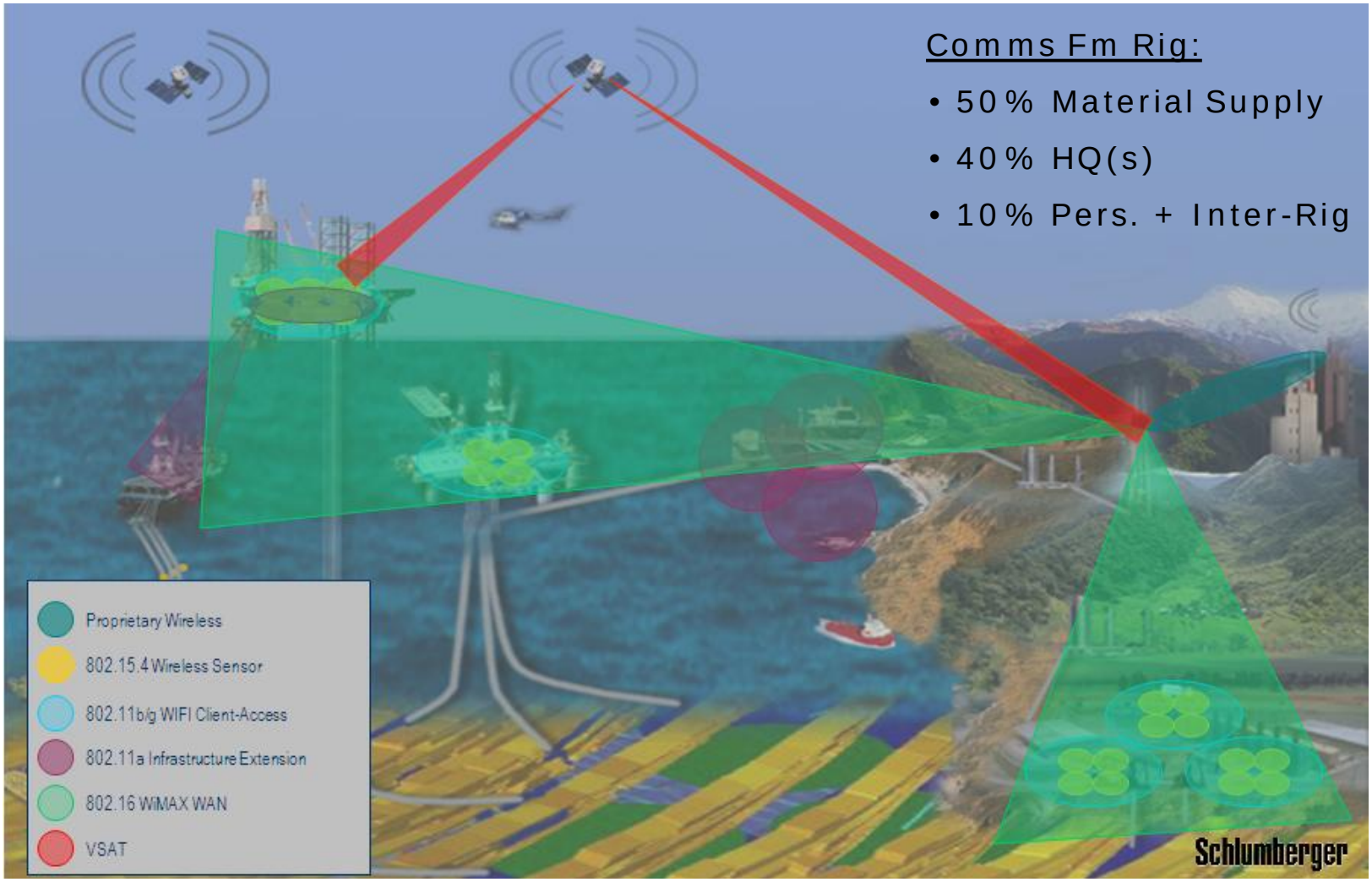
A Big Network Picture

- Terrestrial Backbone, Satellite Overlay
- Fixed, Mobile, Offshore sites
- Dedicated or Shared (VPN's)

- Single Satellite, Multiple Satellite
- Multiple Beams/Cross Strapped
- Fixed sites: Hospitals, Mission Control, Logistics Center

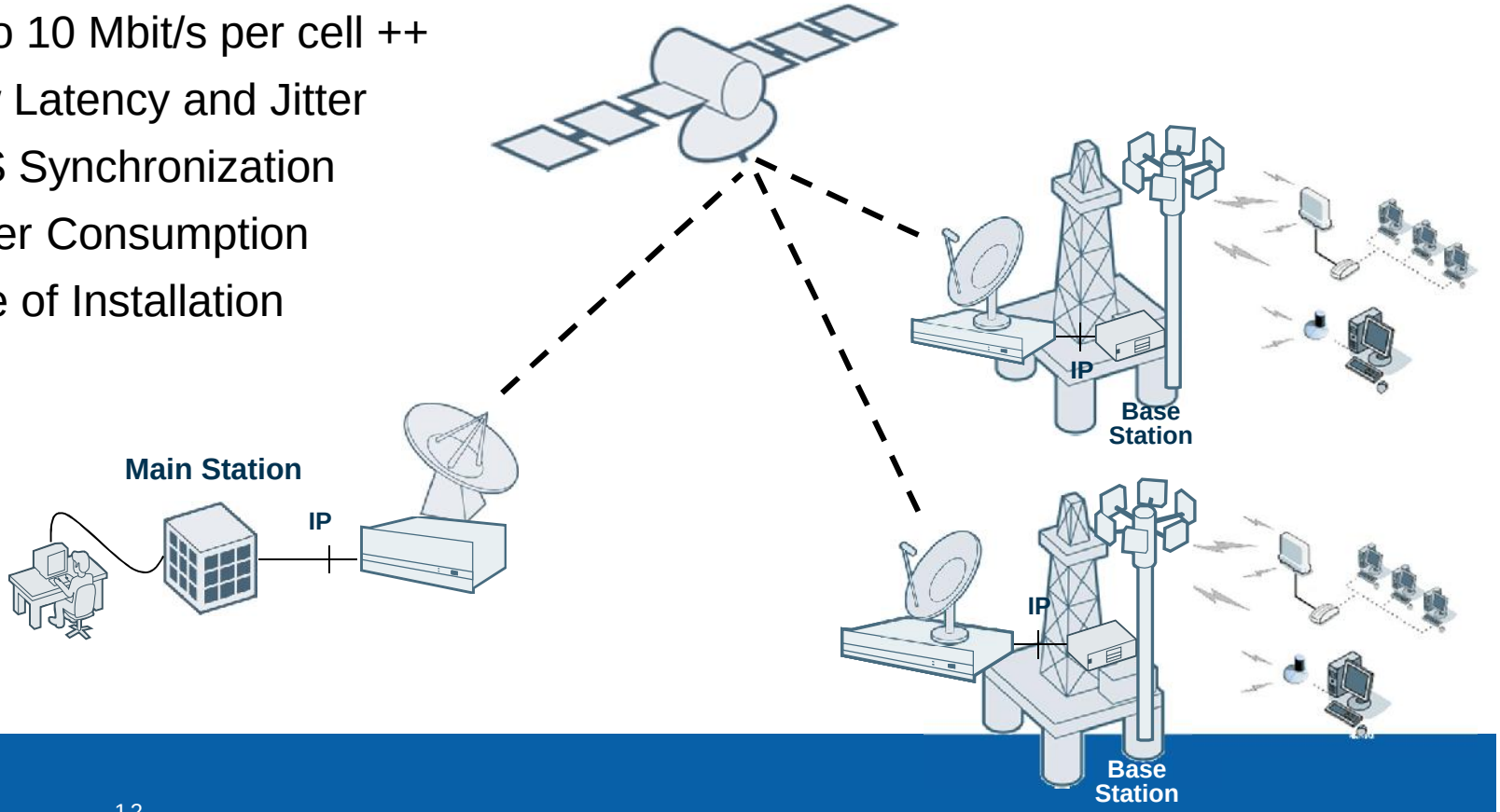


The Satellite & Wireless EcoSystem



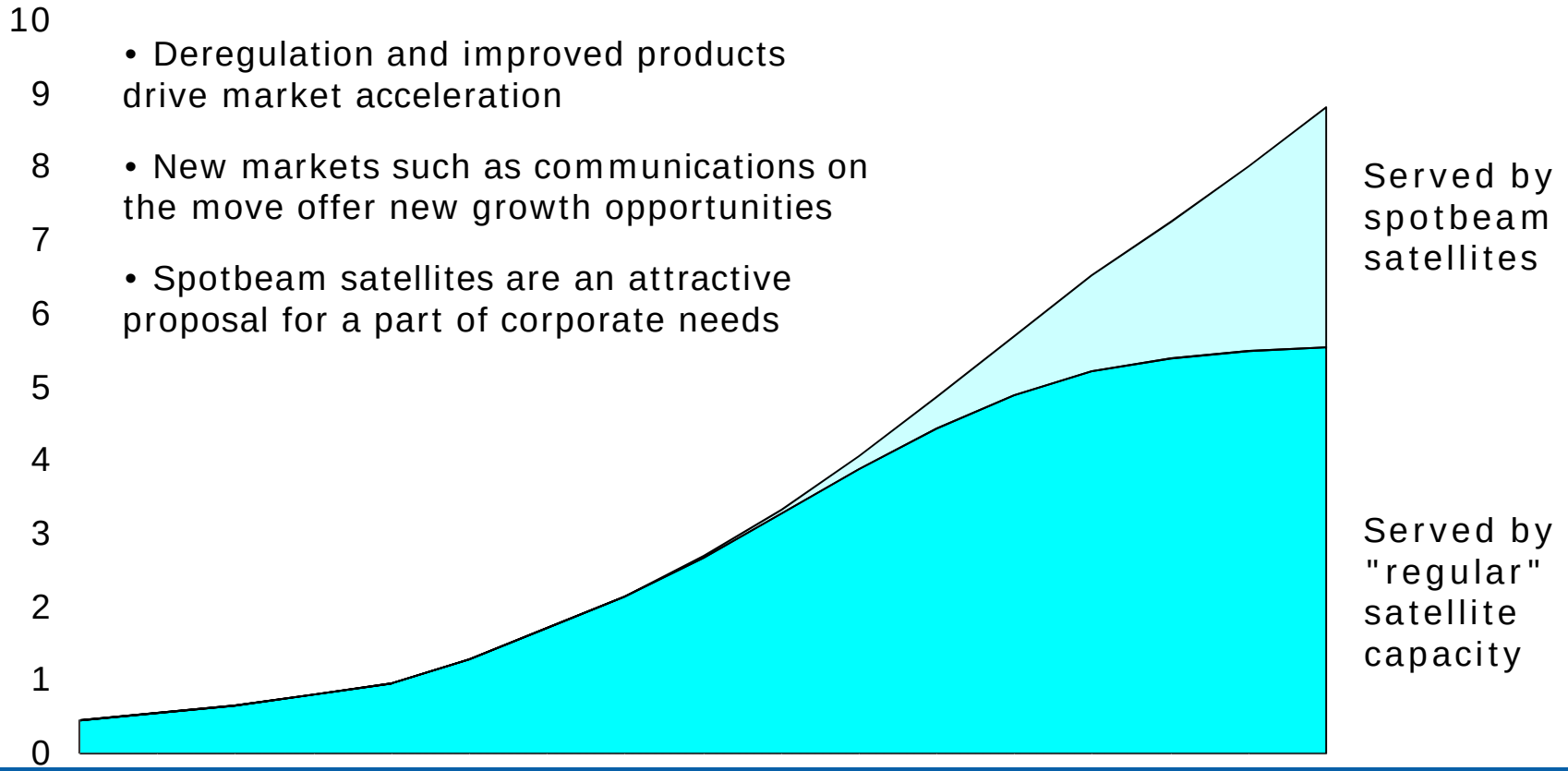
WIMAX Backhaul via *VSAT*

- **IP support with priority handling of voice & data**
  - Use of modulation (8PSK, etc.)
  - Up to 10 Mbit/s per cell ++
  - Low Latency and Jitter
  - BTS Synchronization
  - Power Consumption
  - Ease of Installation



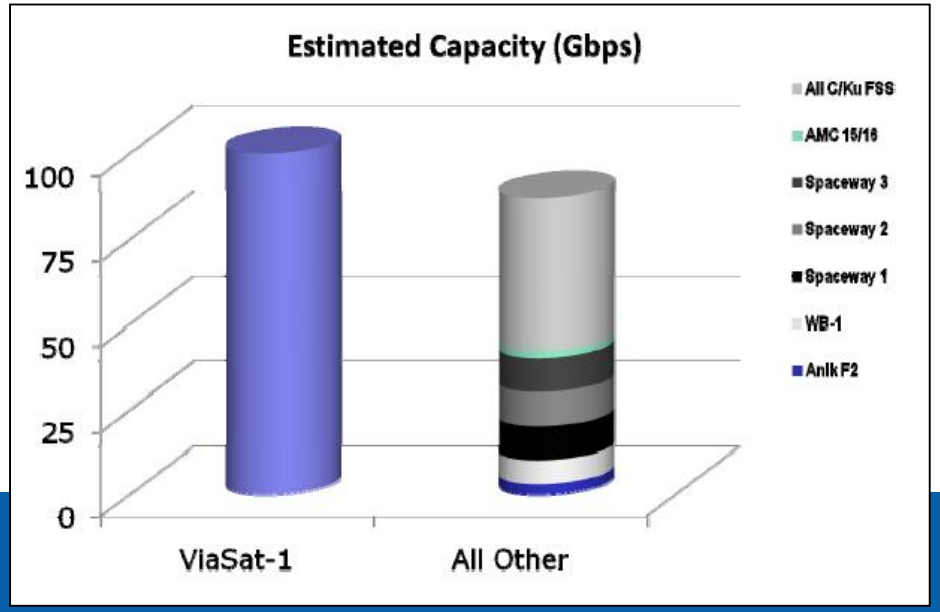
VSAT Deployments, 2000-16

VSAT Terminals in Millions



Bandwidth

- Increasing Efficiencies Thru…
  - TCP/IP accelerators
  - VSAT accelerators
  - Carrier In Carrier
  - TDMA shared bandwidth networks
  - Spotbeam Birds



Hardware

- Smaller Antennas: 60cm C-band and 75cm Ku-band
- Lighter Antennas (less then 25Kg)
- Automated Pointing Antennas
- Simple to Commission/de-Commission

Recent Developments

PRESS RELEASE

O3b Networks, With Support from Google, Liberty Glob
HSBC, To Deploy World's First High-Speed, Low-Cost
System to Transform Communications Access for Billic
Worldwide

--New communications system to enable low-latency trunking for emerg
--

Last update: 2:00 a.m. EDT Sept. 9, 2008

ST. JOHN, Jersey, Channel Islands, Sep 09, 2008 (BUSINESS WIRE) -- O3b Networks Ltd. today announced it will begin deployment of a new global communications infrastructure to provide high-speed, low-cost Internet connectivity to emerging markets in Asia, Africa, Latin America and the Middle East.

Backed with financial and opera
Inc. and HSBC Principal Investr

News Release

HUGHES.

FOR IMMEDIATE RELEASE

Hughes Brings Broadband Internet to Amazonas

First large-scale deployment of WiMAX and WiFi with satellite backhaul in Brazil

Germantown, Maryland, November 24, 2008 — Hughes Network Systems, LLC (HUGHES), the global leader in satellite broadband networks and services, today announced that its Brazilian operating entity, Hughes do Brasil, has won a public tender and signed a 36-month contract with PRODAM - Data Processing Company of the State of Amazonas, to deploy a turnkey broadband network solution that combines WiMAX and WiFi access technologies with satellite backhaul. Using this novel solution, PRODAM will provide high-speed wireless Internet access service to customers throughout all 61 municipalities of Amazonas, including government agencies, small businesses, and the public at large.

Covered by its huge rainforest and with the world's most voluminous river, the State of Amazonas
very of high-speed Internet service on such a large and
t calls for Hughes to install and operate WiMAX and WiFi
ality, together with over 900 wireless customer premises
elivered over its nationwide HughesNet® broadband satellite
high performance, Hughes HX broadband satellite router,
IP traffic over satellite channels to the HX hub located in
the hub is connected to PRODAM's data center and to the

Case Study

Wireless Internet Links Highland Community to the World

Intel, USAID and VDC use WiMAX to bring broadband Internet access to the mountains

Nestled in the Hoang Lien Son mountain range in northern Vietnam is the small, picturesque village of Ta Van. Set in a tranquil landscape of rice terraces and roaming water buffalo, Ta Van is an unlikely highland location for a small technological marvel that holds potential for replication in other remote villages around the world.

With help from Intel, Vietnam Data Communication Company (VDC), a subsidiary of Vietnam Post and Telecommunication Group (VNPT), and the United States Agency for International Development (USAID), Ta Van has managed to establish Internet links with the surrounding region and indeed, the rest of the world...no mean feat for a remote village that previously struggled with weak mobile phone signals and has only two fixed-line phones.

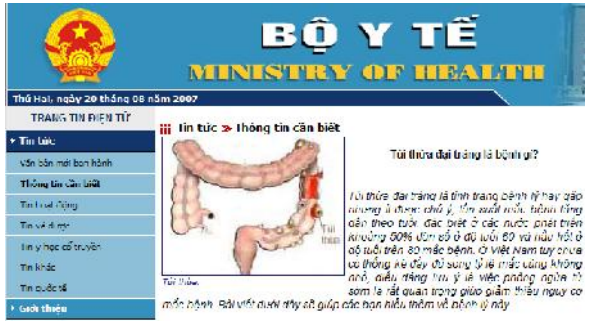
Though still in the early stage, the success of the Ta Van project thus far has its partners optimistic that the solution can be replicated in other remote communities in Vietnam, as well as other underserved regions throughout the world.

VDC

USAID

Applications

- **Community**
  - News, Chat, on-line music
- **Tourism**
  - B&Bs
  - eMail, Blogs, Photo-sites
- **School**
  - Geography, Math, et. Al.
- **Farmers**
  - Crop and disease information
- **Health Clinic**
  - Health and pharmaceutical information



The Prodam Project

THE AMAZONAS STATE

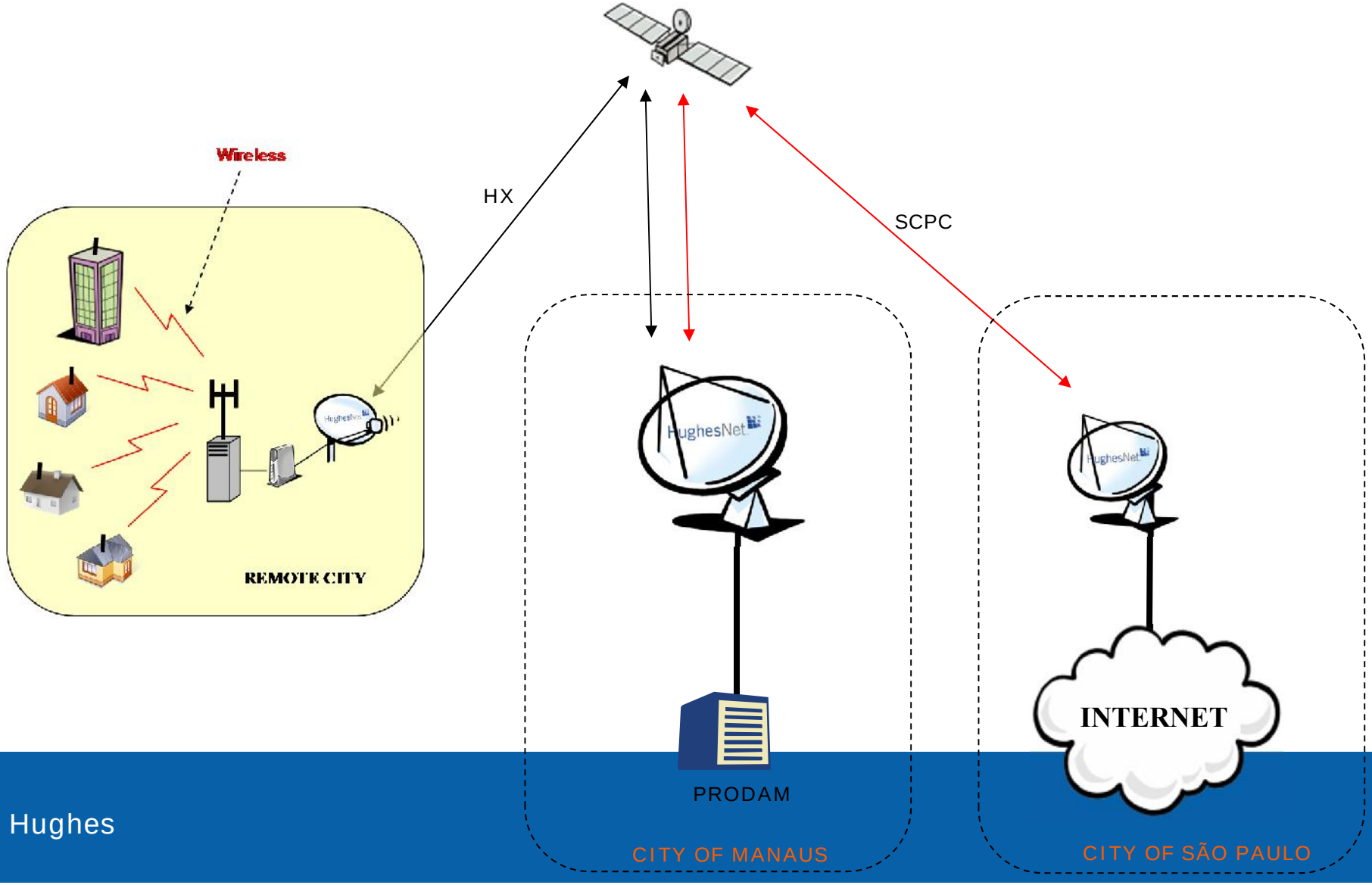
- Biggest state in Brazil
  - 1.6 million km2
  - 6x United Kingdom
- State covered by the Amazon forest
- 3.2m POP total
- Capital is Manaus (1.6m POP)
- 62 counties

Project Overview

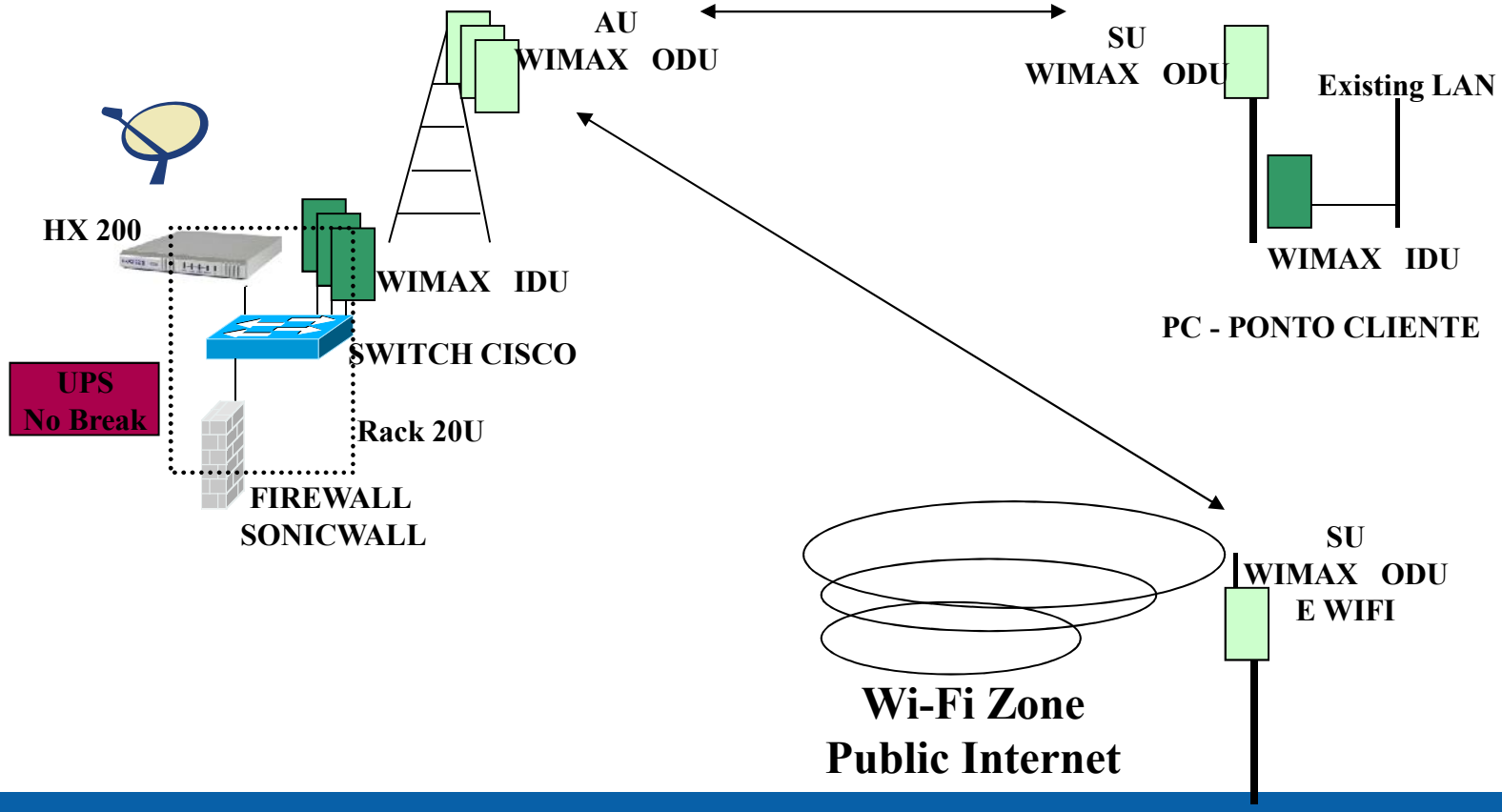
- **VSAT Backhaul for Local Wireless Distribution**
  - HX VSATs
  - ALVARION wireless equipment in the remote cities
  - SCPC link to Sao Paulo for Internet
  - 36 month project

- **Two Phases**
  - First Phase – 15 cities / 15 wireless clients per city
  - Second Phase – 41 cities / 15 wireless clients per city

Project Diagram



Remote Site Details



WiMAX, Satellite, and… CSR in ‘The Patch’

The Win Win Win…

• ***Governments:*** *Achieve ‘Millenium Development Goals’, Higher Standards of Education, Health, Connectivity, New Jobs, Increased GDP, New Taxpayers*

• ***Communities*****:** Access to the world, including education, trade, communication with relatives/ friends and entertainment

• ***Oil Company:*** Lower-Cost, High-Impact CSR Solution

• ***Infrastructure Providers:*** New Business Opportunities

Systems Profile Requirements
O&G Applications
-The Digital Oilfield Transport Network-

Marathon Oil Corporation
David Barker – Sr. IT Business Specialist

Marathon Oil

Agenda

- **Before we define the System Profile**
  - Where do we come from?
  - Where are we today?
  - Where is it all going?
- **System Profile for Digital Oilfield**
  - Ethernet
  - RF
  - Mechanicals
  - OPS & Management
- **WiMAX**
  - Not a bad foundation
  - WIMAX Challenges
- **Marathon Today**

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Before we define the System Profile

- **Where do we come from**
  - Collection of multiple, individual, old networks and protocols
  - No efficiencies, Performances or QoS
  - Little or no remote management… and forced to do in-field programing
  - Little or no real-time applications
- **What we need today**
  - Single IP transport covering all sites (fixed/nomadic)
  - Better Efficiencies, Performances, QoS, Connectivity
  - Remote management and programming
  - Support for new applications being designed for real-time performance
- **Where it is all going**
  - IP all the way to the end-device
  - Real-time, office-like performance and applications... ANYWHERE!

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System Profile for Digital Oilfield

- **Ethernet perspective**
  - The system has to be a simple L2: …it is the transport
  - By-directional QoS per VLAN, to fit the applications
  - > 50 MBPS/sectors
  - < 10ms Latency in the PMP Transport
  - > 150,000 PPS/Sectors

- **RF perspective**
  - Predictable with associated Coverage Planning Tools
  - 8 Mbps at 8 miles
  - Self-Aligning, zero-touch Remote Antenna System
  - MIMO a/b, so we can deliver capacity & distance in the same sector
  - Cover the entire 5.2, 5.4, 5.8 GHz in a single unit, remotely controlled

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System Profile for Digital Oilfield

Mechanicals

- Need Class 1/div 2 remote radio (CPE)
- Powder-coated with rust/H2S proof accessories
- Need -40F to +140F… and all the way to 160F in some instances

OPS & Management

- Remote capabilities on the IP side and the RF side
  - Setup/configuration/management
  - troubleshooting/factory reset command
- Two release of codes present for smoother upgrades
- Pay-as-you-grow capacity with S/W options
- STD-based PoE (connect to Switch or Router)
- AES 128/256 security

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WiMAX not a bad foundation

- **WiMAX: Conceptually is a great idea**
  - It was needed: QoS, solid scheduler, IP-based
  - It was going to be changing Broadband Wireless
  - It was the promise of Broadband for all
  - It promised 70Mbps with low latency
- **Reality: Was not developed for Industrial needs**
  - Yes it has good QoS, Scheduler and it is IP-based
  - But… we needed more capacity and lower-latency
  - But… we needed more remote devices that are rated for our environment
  - And …the 3.65 Spectrum has many restrictions, doesn't offer enough spectrum
- **To meet our needs, WiMAX would need to deliver:**
  - More capacity, lower latency, industrial remotes, zero-touch remotes

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WiMAX Challenges

- **WiMAX Business targets**
  - Current vendors don't target the industrial O&G deployment
  - Manufacturers are targeting the low-cost dongle or CPE
  - Service Provider deployments bank on over-subscription and target consumer revenues
- **WiMAX Technology designed for consumer access**
  - Designed for premium consumer access… not industrial transport
  - We have an access technology… it is WIFI. We needed transport
- **WiMAX Performance not quite enough**
  - We need much more capacity with much lower latency …Up/Down Streams

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The WIMAX Challenges

- **Mechanical Standards not suited for oil and gas**
  - No Class 1/Div 2
  - No enough temperature range (we need -40F to +140F)
  - Not H2S resistant
  - Not durable enough

- **What has to change with WiMAX for the O&G Market**
  - We need powerful remotes with full diagnostics… not dongles
  - Do not allow phone/typing while driving… Mobility is OK as long as we have CAPACITY
  - We can't be over-subscribed, we are broadcasting real-time all the time
  - We are big on security and want to control our own Transport Network
  - It may take 5 hours to drive to a site, we need reliable and remotely manageable remotes

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Advice to the WiMAX community

End-User message to manufacturers & SP's in the room

- **Product manufacturers**
  - Develop industrial-grade and fully remotely managed devices
  - Develop product with higher capacity and lower latency
  - Develop support for more frequency bands
  - Don't focus on mobility, but connectivity
  - Don't focus on access, we have WI-FI for that

- **Service Providers**
  - Don't deliver networks with over-subscriptions
  - Let us manage our Own QoS within your network
  - Deliver 100% coverage
  - Deliver 8-20 Mbps "CBR" in both directions … anytime and anywhere
  - Don't make us pay for alignment … ever

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Marathon Today

- **Our History with WiMAX**
  - Invested a lot in WiMAX - time, energy, trials, equipment
  - Assessed many solutions
  - Tried several WiMAX products at 3.65Ghz

- **What we deployed in the end**
  - Redline/Cisco O&G industrial Solution
- **What we got as a result**
  - a Digital Oilfield Solution that met all our needs
  - A future proof network, not just for today
  - Supporting any data, any time, anywhere…. with real-time performances
  - Delivering 8 Mbps at 8 miles with 5ms latency and no alignment needed
- **Like having Wireless Fiber, on demand**

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Present day activities – Eagle Ford WWDC

- **16 Towers deployed and in use in the Eagle Ford Asset**
  - High-capacity backhaul with super low-latency
  - Multi-point sector antennas provide connectivity for entire field
  - Sectors antennas on towers provide >8 mile coverage radius
- **Redline RAS System deployed in Eagle Ford for drilling rigs**
  - Provides business network, GuestNet and VOIP to rigs
  - WI-FI hotspots at key locations cover the entire drilling rig area
  - WI-FI and MESH WI-FI technology as the access (Edge)
  - "Zero Touch" multipoint transport
  - Network for company man, safety trailer and doghouse comes on automatically after rig move - just raise the mast and apply power

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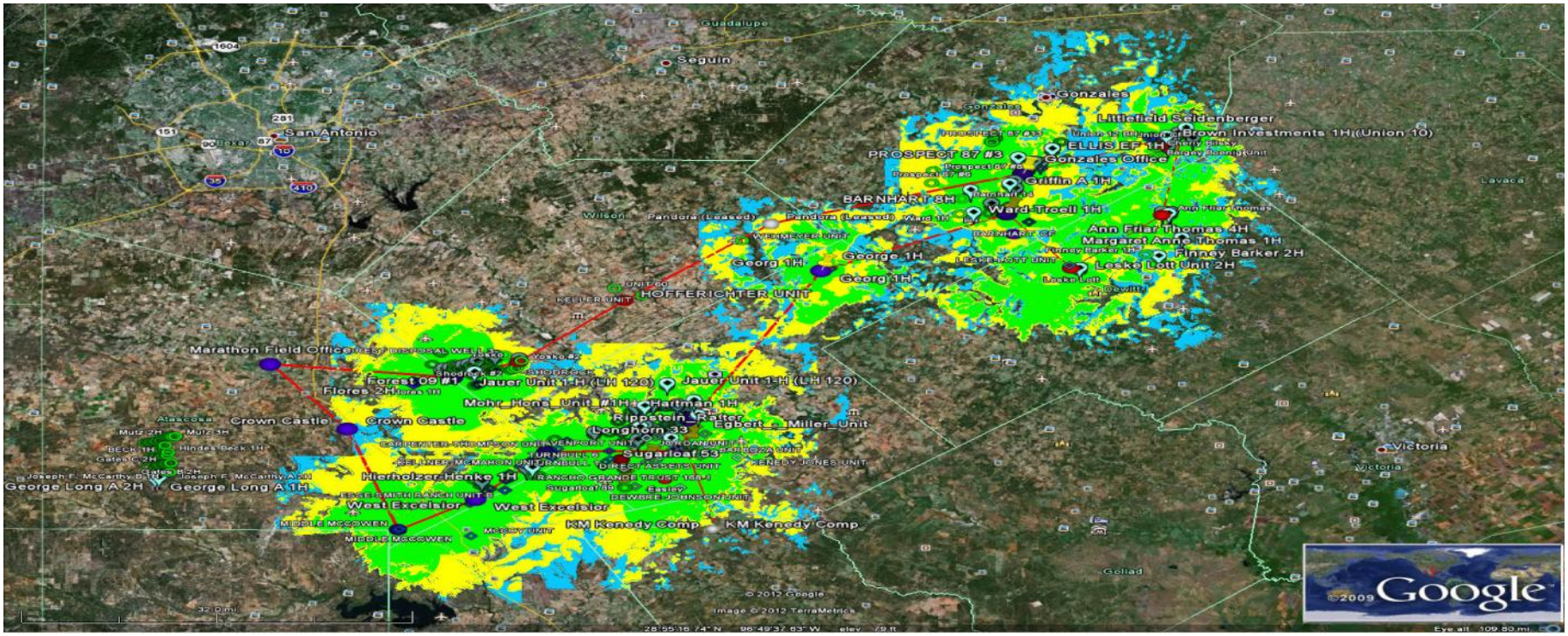
Present day activities – Eagle Ford WWDC

- **Redline's RAS**
  - allows us to leverage the communications network in new ways
  - Enables true nomadic connectivity ANYWHERE for WWDC
  - Much greater bandwidth for multiple applications
  - Commercial and In-House applications
  - BYOD – mobile devices supported ANYWHERE



What's next?

- **The Vision/Goal for the future is to change the way Marathon Oil conducts its business in the field through seamless connectivity and workforce automation**
  - Multiple Concurrent networks: Redline, 3G, 4G services
  - Vehicular "mobility" - maintain connectivity anywhere in the asset
  - Greater HES focus through constant connectivity
  - Ability to work smarter, faster, safer – Video, RFID and Lenell in remote field locations
  - Avoid useless nuisance trips to locations – work remotely
- **Greater return on investment**
  - Productivity increases have been proven
  - Eliminated recurring charges for slower satellite communications

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QUESTIONS

Marathon Oil Corporation
David Barker – Sr. IT Business Specialist

Marathon Oil

Redline Communications

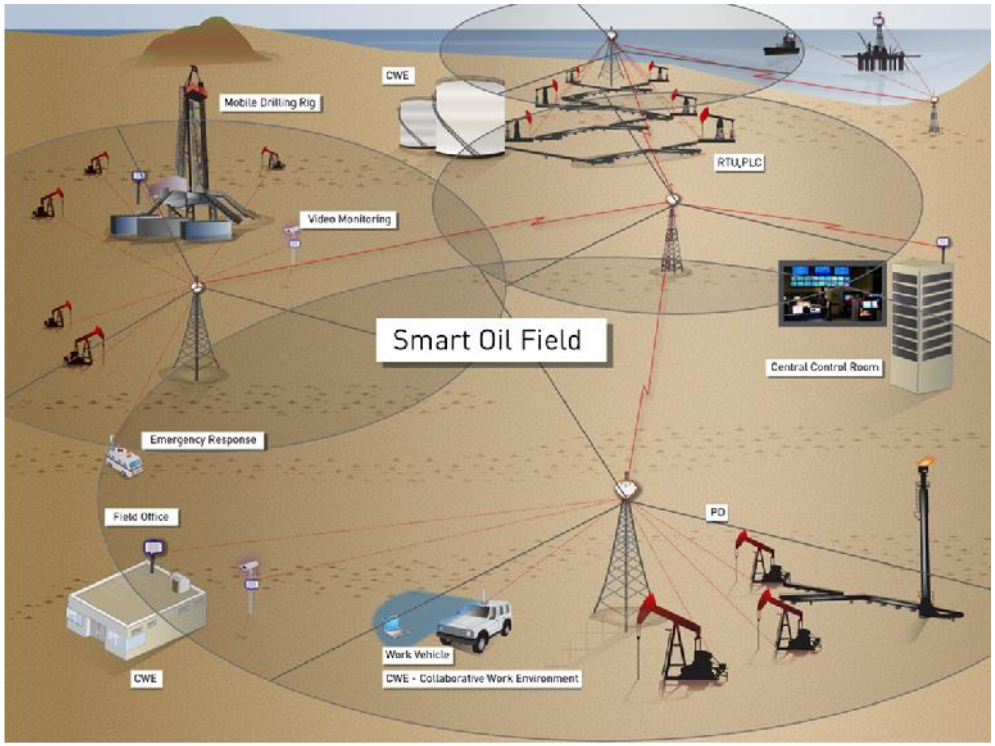
A CASE STUDY

Challenges and Opportunities for the WIMAX in the Digital Oilfield

Louis Lambert, Managing Director – Strategic Accounts

AGENDA

- Introduction
- Client challenges
- The solution
- Next steps
- Questions



redline communications

Client Needs

- **BUSINESS NEEDS**
  - High-performance communication infrastructure for oilfield life-cycle
    - First priority was real-time Drilling/Completion: Highest ROI
    - Operational monitoring/adjustments also required real-time data
  - All users/machines to connect from anywhere, anytime
  - Zero-touch configuration and self-healing systems
  - Round the clock availability for collaboration
  - WI-FI everywhere

redline communications

Client Challenges

- **GEO COVERAGE**
  - The transport network was the biggest challenge
    - Limited existing infrastructure
    - Varied terrain
    - Great distances
    - Harsh winters

redline communications

Client Challenges

- **SECURELY ENABLING MULTIPLE APPLICATIONS**
  - High-capacity, Low Latency, real-time applications
    - Drilling
    - Surveillance
  - Real-time automation & control
  - Ubiquitous field communications
  - Segmenting connectivity for & enabling BYOD Support
    - the various business units
    - guest users (contractors)

redline communications

Client Challenges

- **TRANSPORT TECHNOLOGY CHALLENGES**
  - High Capacity - MBPS and PPS
  - Sub 10ms latency - a “must”
  - ZERO touch alignment for non-fixed assets, i.e.: drilling rigs and pickups
  - Class1 Div2/ATEX Zone 2 certified equipment
  - Leveraging WI-FI as the ubiquitous access technology for users
  - A scalable long term solution

redline communications

Client Challenges

- **IT & LOGISTICS -** building industrial infrastructure is not the core business
  - Replicating the same architecture/methods/procedures….Globally
  - Getting the right infrastructure up… quickly
  - Finding the right partner with Global experience & reach

redline communications

Needed a Solution that was proven!

OXY: Digital Oil field connectivity Texas, North Dakota, Oman.

Shell/PDO: 45,000 Km^2 Smart Field Operation - Oman

Marathon Oil: Semi-Mobile drilling rig connectivity Texas & Oklahoma.

Tatweer: Digital Oil field - Bahrain

Chevron: Wafra digital oil field project in Wafra, Kuwait.

Total Oil: Mobile exploratory Drilling units Offshore platforms at 20 Km.

Pemex: Enhanced oil recovery in the Bay of Campiche, Mexico.

Petrobras: Portable remote offices and mobile drilling rigs in Peru.

ENI: 400 Km of backhaul connectivity in Agiba Egypt.

redline communications

The Solution

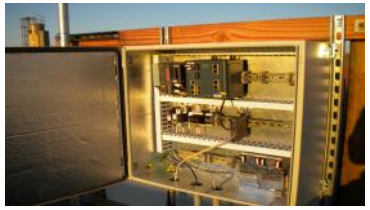
- Addressed and exceeded all client challenges
- Provided outstanding ROI based on significant efficiency improvements for both drilling and field operations

- **Redline high-capacity private wireless transport network**
  - High performance IP communications, anywhere in the Oilfield
  - Network transporting all of the client's applications


Tower Site


Drilling Rig


Mobile Field Office


Well Site

redline communications

Solution Implemented – Some details (phase 1)

- **8 Tower Sites to cover almost 900 square miles**
  - Leveraged 4 leased towers and built 4 new ones
- **A ring-architecture transport backbone**
  - Redline Point-To-Point connecting all the towers
  - Each tower equipped with Redline Multipoint units
    - 4 primary sectors and 4 redundant sectors
- **Connecting**
  - All rigs connected with Redline RAS (Rapid Alignment System)
  - All well, gathering stations, and field offices connected with Redline
  - Now equipping pickups with RAS

Tower Site

redline communications

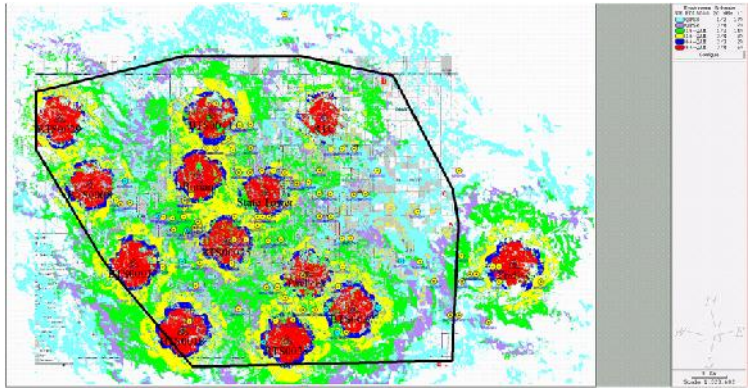
Solution Implemented

- **BUSINESS PERSPECTIVE**
  - Delivered connectivity to all FIXED/NOMADIC users and machines
  - Enabled real-time operational collaboration between field and HQ
  - Eliminated Stop/Gamble decisions: real-time decisions with all needed data
  - ROI less than 1 year for the entire infrastructure CAPEX
    - Avoided some dry wells
    - Increased everyone's efficiency
    - Video monitoring and surveillance reduced field commutes

redline communications

Solution Implemented

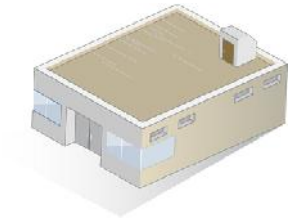
- **GEO COVERAGE PERSPECTIVE**
  - Coverage was delivered for the entire field
  - Critical locations equipped with redundant equipment
  - Prediction maps allow IT/Business to plan, not react
  - Coverage plan was 100% reliable



redline communications

Solution Implemented

- **APPLICATIONS PERSPECTIVE**
  - All field and enterprise applications operating on a single, highly secure infrastructure
  - Guest users can connect via guest WI-FI
  - No more boundaries/limitations between Field and HQ



redline communications

Solution Implemented

- **TRANSPORT TECHNOLOGY PERSPECTIVE**
  - "Wireless Fiber"
  - Payload of 400 MBPS per base station with (ZERO oversubscription)
  - 220,000 PPS on field connections
  - About 5ms latency in the field transport network
  - CLASS 1/div 2 certified equipment
  - ZERO touch alignment for all nomadic devices

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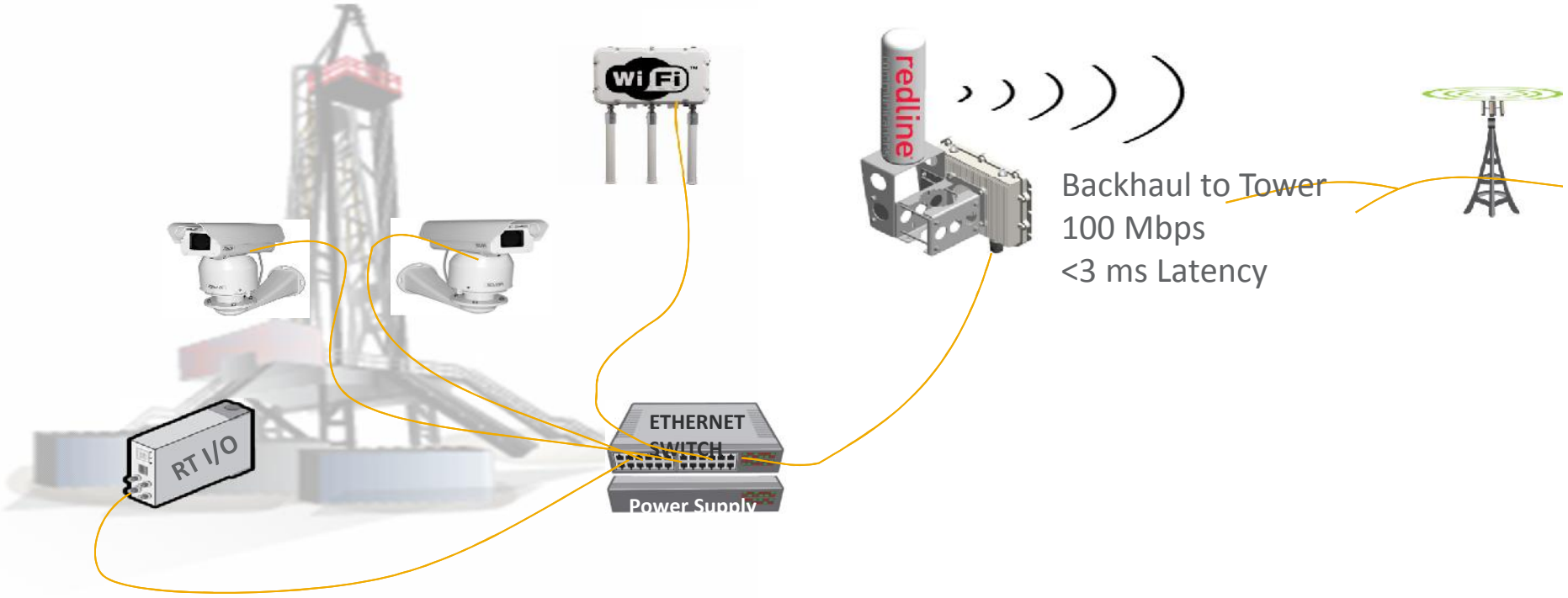
Drilling Rig Sites



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Solution Implemented

- **IT & LOGISTICS PERSPECTIVE**
  - Dependable, high-performance, industrial infrastructure
  - Remote management and upgrades save time and cost
  - Reliable coverage prediction maps



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Client Quote

Redline Enabled the "Carpeted" environment…

-"Instantaneous and uninterrupted access to the all network services, for all users"

- Any data… Anywhere… Anytime
- Redline made The DIGITAL OILFIELD possible

redline communications

Solution Implemented

- **CURRENT PERSPECTIVE**
  - High-performance infrastructure, with “plenty” of headroom
  - Infrastructure is designed and built to last
  - A client-specific “Infrastructure Cookbook” has been developed

- **IMPACT**
  - The infrastructure has enabled the client to change the way they work in the Oilfield
  - They continue to discover additional ROI on the already-paid CAPEX
  - Success has also been replicated in their other fields
  - The infrastructure is now a critical component of every day operations

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Next Steps

- **Next**
- Phase 2 (started)
- The client continues to deploy and enable
  - More fixed/nomadic remote sites getting connected as they are built
  - More video surveillance
  - More corporate IP telephony & services
  - HSE Helmet-Cams… and other applications are now all possible

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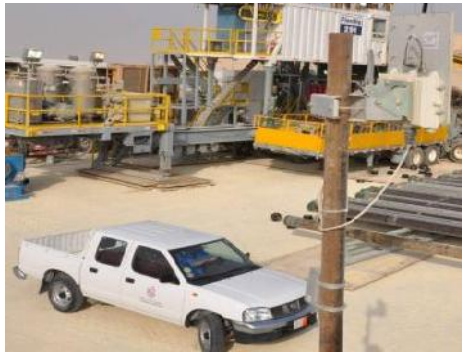
Questions

Smart Drilling

Field Offices



Operational Video Surveillance

Wellhead Automation

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Thank you

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