WiMAX FORUM®

Oil & Gas 2013

@ OilComm HOUSTON, TX

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CelPlan® Wireless Global Technologies

SIEMENS

Smart Energy Working Group Standpoints & WiGRID PlugFest Appraisal

November 6th, 2013

Ballroom of the Americas C (Hilton Americas), Houston

Eugene Crozier, Chair, WiMAX Forum Smart Energy Working Group

Craig Tedrow, Vice Chair, WiMAX Forum Smart Energy Working Group

WiMAX FORUM® Oil & Gas 2013 @ OilComm HOUSTON, TX

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Smart Energy Working Group

- The Smart Energy Working Group (SEWG) comprises WiMAX vendors, industrial operators and industry research organizations.
- The focus of the SEWG is to promote the use of WiMAX Technology in industrial networks.
- Based on existing WiMAX technology the SEWG has developed a series of system requirements and system profiles for Smart Grid applications. However these applications have synergy with Oil and Gas communications networks.
- These WiMAX Smart Grid System Profiles (aka WiGRID) are the basis for equipment interoperability, which is benefical to vendors and industry users.
- We promote WiMAX (WiGRID) Interoperability and Certification based on the Smart Grid Profile using the plugfest events.

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Key Smart Energy Requirements

- Layer 2 convergence
- Uplink centric profiles
- Focus on low latency
- No centralized core required (no ASN Gateway)

WiMAX documents

The WiMAX Forum working groups have developed and approve the following documents for Smart Grid and Energy applications:

•**WiMAX Forum® System Profile Requirements for Smart Grid Applications**. This document outlined a series of use cases for Smart Gird applications.
•**WiGrid System Profile**. This document highlighted the additional WiMAX equipment requirements based on the applications.
•The **WiGRID Protocol Implementation Conformance Statement** (PICS). This is used by equipment vendors to verify their equipment against the System Profile document.
•SEWG **PlugFest Guidelines Document** (Test Procedures). This details the equipment tests to verify interoperability.

Smart Grid Use Cases

Smart Grid applications are mainly based on the following use cases that are detailed in the system requirement document;

Use Case	Direction	Latency (ms)	Predictability
1 – Situational Awareness (WASA)	Mainly UL	1000	Good
2 – Monitoring	Highly UL	100	Good
3 – Control	Mainly UL	100	Random
4 – Protection	Symmetrical	20	Random
5 – Metering Regional Collector (DAP)	Mainly UL	1000	Good
6 – Remote Site Communications	Symmetrical	100	Good
7 – Direct 4G Smart Metering (AMI)	Mainly UL	5000	Good

WiGRID Certification

Key items for WiGRID Certification are:

- Adherence to the WiGRID System Profile based on the system Requirements.
- Host PlugFest events to support a WiGRID Certification model that is both efficient and cost effective
- Demonstration of interoperability during the PlugFest event against a number of use cases.
- WiMAX Forum will promote WiGRID certification as a clear statement of the benefits of WiMAX technology to industrial users.

Plugfest and Certification Events

- 1st Plugfest event hosted by Powertech Labs in Canada
- 2nd Plugfest and certification hosted by Electric Power Research Institute (EPRI) in Knoxville TN at the end of October 2013.
- Following companies participated in the event;
  - Cisco
  - GE Digital Energy
  - Siemens.
- The plugfest event was successful and the certification results are due in the following week.
- There is planned to be further certification events as the eco-system expands.

Plugfest Results

- All companies involved successfully interoperated.
- Frequency bands were 1.8, 3.65, and 5.8 GHz

EP ENERGY

I.T. MAXConnect

September, 2013

History

Drilling, Completion, Construction - Satellite Communications

- High cost
- Low bandwidth
- High latency
- Difficult remote IT support
- Limited voice & video capability
- Difficult to provide contractors with wireless, Internet, and email access

Production, SCADA, Measurement – Microwave Radio

- Limited bandwidth
- No network access at the well
  - Limited system visibility & reporting
- Inefficient serial communication
  - Single connection per device
  - Long polling cycles – not real-time
  - Limited end device visibility
    - Difficult to Troubleshoot
    - No device level monitoring

Change & Technology Drive Innovation

Drilling & Field Operations

- High per-acre well density
- Shortened drill to complete time
- Increased application use and demand for real-time visibility into drilling and field operations

➢ Justifies infrastructure build
➢ Encourages a cost-effective rig move process
➢ Requires higher performing network

Network & Telecommunications

- Broadband microwave backbone and WiMAX radio edge
- WiFi
- Voice over IP
- HD video
- Centralized network security

➢ Provides a high bandwidth, low latency network
➢ Simplifies network access for all users
➢ Leverages centralized phone system
➢ Advances monitoring capability
➢ Improves risk mitigation

Our Mission

Develop a scalable, repeatable, and cost-effective digital oilfield communications solution to meet the current and future needs of EP Energy field operations.

Project Considerations

- Field Connectivity
- Site Mobility
- Field Applications and Reporting
- Voice
- 99% Communication availability
- Frequency of Polling
- Bandwidth utilization
- Total number of devices, users, and protocols
- Integration of current technology (IP telephony, WiFi, CygNet)
- Network and data security
- Device monitoring, management, and support
- Power Efficiency
- Remoteness of field locations
- Scalability

Customer Considerations

Drilling

- Video
- Accessibility to shared Documentation (Well CAD Drawings)
- Real time Drilling Monitoring – PVTs

Construction

- Accessibility and bandwidth to shared Documentation (Site CAD Drawings)

Reservoir Engineering

- Flexibility to add Well Monitoring Communications
  - Build up test
  - Flow Test
  - Down Hole Monitoring

Production

- Remote Maintenance
- Field monitoring and event alarming
- Radio
- Asset management

SCADA/Measurement

- Remote Maintenance
- EFM (Electronic Field Measurement) Gas and Liquid
- PLCs communications
- Safety and Control System
- Power Grid
- POC (Pump Off Control)
- Gas Lift
- ESP
- Chemical Injection
- Tank
- Well
- Separators
- Compressors
- Pumps

Customer Considerations

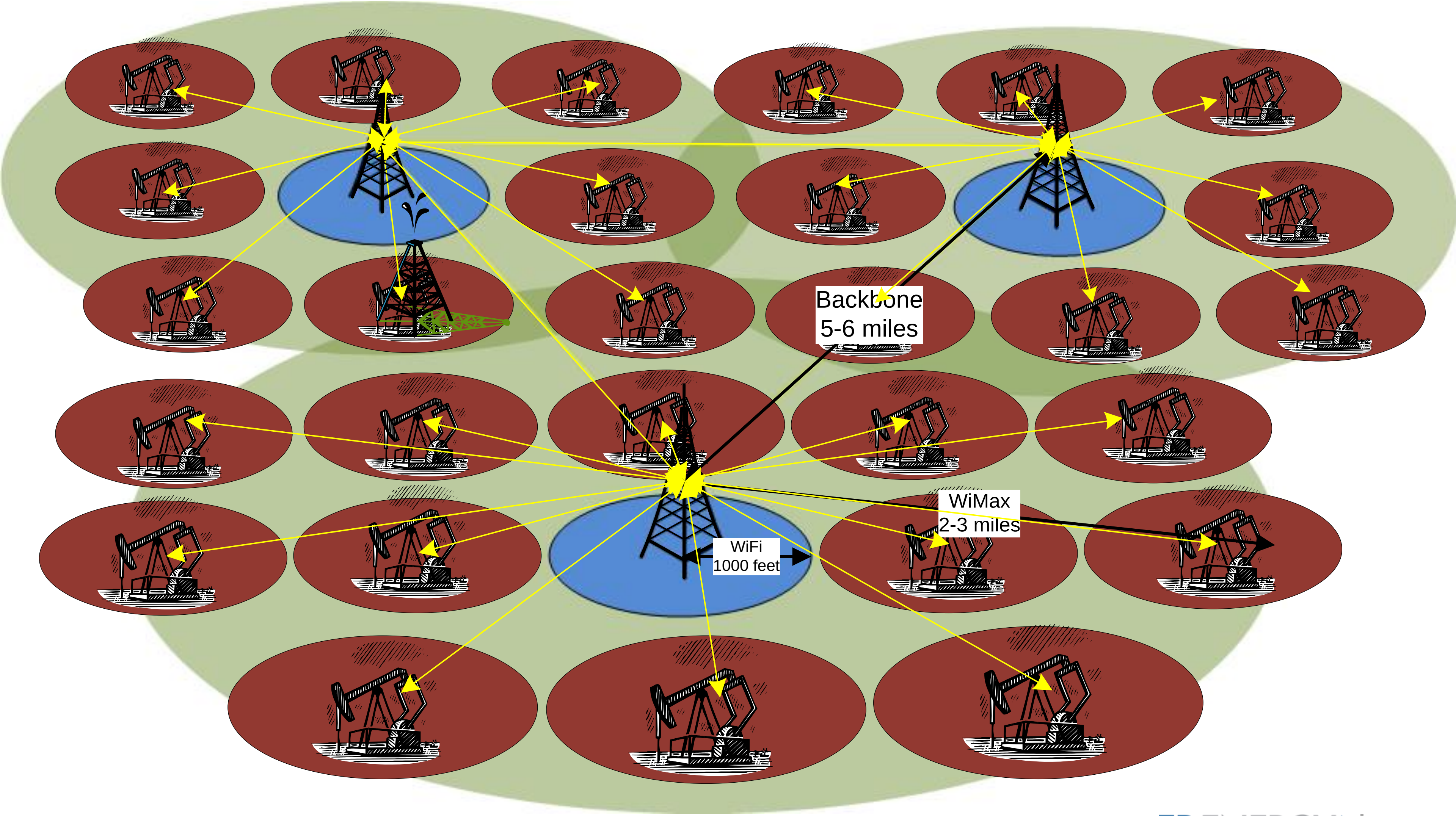
Facility Security

- Cameras/DVRs
- Access Control
  - IP Intercom
  - Gate Controls
  - Card Readers
- Integration with existing systems
  - SCADA
  - Cisco CallManager

IT

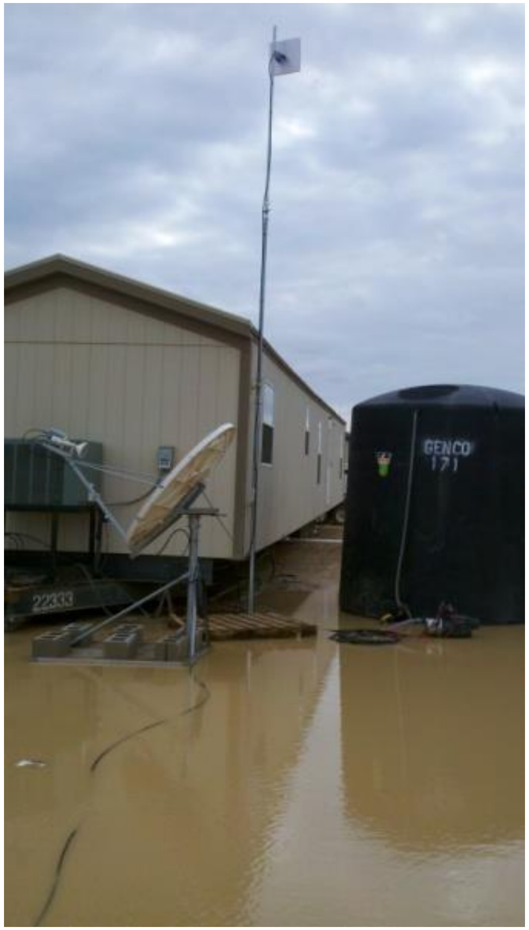
- Ease of use
- Low administrative overhead
- Remote management, monitoring, diagnostics, and support
- Secure connectivity of users/devices
- Integration with existing systems
  - Network Infrastructure
  - Cisco CallManager
- Enablement of future technologies
  - Cisco Jabber

WiMAX Field



Backbone Tower Location

Drilling Rig Communications Package



SCADA Panel Communications

Cost Savings Case Study

Old Way
Satellite (High Latency, Low Bandwidth)

Case Study #1

Field 1
$910,400

Case Study #2

Field 2 - New field projection
$1,422,500

New Way
EPE MAX Connect (Low Latency, High Bandwidth)

Field 1
$120,800
Savings - $789,600 per year

Field 2
$188,750.00
Savings - $1,233,750 per year

Production Operations

- There could support an average of 70 wells or more per tower location.
- An estimated SCADA radio communications count could be around 5 per well and even more at the CPFs (Central Process Facilities). Partnering with vendors and developing low cost Wi-Fi communications and device solutions could potentially reduce hardware and installation cost as much as 80% and provide almost instant data platform to field devices.

- An example is that EP Energy can take advantage of off the shelf radio solutions that will cost less than $200.00 verses $1200.00 radio infrastructure or even eliminate cabling.
- It has proven that Well Head and SCADA Wi-Fi network connectivity reduces travel and reporting time
- Reduce risk and improving Safety – Operation's support personnel can evaluate the real-time data for the need to be deploy and if the environment is safe.
- Accelerate the deployment and integration of IP field devices and communications

Intangible Benefits

Drilling, Completion, Construction – IT MAXConnect

- High bandwidth
- Low latency
- Improved remote IT support
- Voice & video capability
- Simplified and secure contractor access to wireless, Internet, and email
- Extension of collaboration tools to the field (web and video conferencing, IM)

Production, SCADA, Measurement – IT MAXConnect

- High bandwidth
- Network access at the well
  - System visibility & reporting
- Efficient IP communication
  - Multiple connections per device if needed
  - Short polling cycles – near real-time
  - Visibility to the end device
    - Simplifies troubleshooting
    - Allows device level monitoring

Customer Feedback

"The WiMax that was installed in the field is working fantastic! It is working so much faster than the satellite system that was here. It is almost like being in the office. We were not doing our reports out here due to the time. I believe that this will save us up to a couple hours/day on computer. Thanks Again." – Construction Supervisor

Challenges and Concerns

Geographic challenges (Remote areas, proximity to communication towers)

Environmental challenges (Weather, H_2S, Area Classification)

Infrastructure challenges (Land, Power)

Physical security (Theft)

Network security (Unauthorized Access)

Support model (CPF/Well Deployment, Rig/Well Completions moves, Device Additions, Break-Fix)

Feedback needed for continuous process improvement

Will benefits be leveraged throughout the organization?

How do we maximize the potential of the solution?

Emergency/Temporary Communications

- Operations is planning to have a local support staff of 50 to 150 field contract and EP Energy personnel during the Wolfcamp development.

- EP Energy began construction on new office and warehouse in the Big Lake area. Our temporary WiMAX/WiFi communications package was utilized to quickly provide service to the temporary office facility.

Environmental & Infrastructure Challenges

- Use of solar power systems when commercial power is unavailable
- Use of Class I/Div II equipment in hazardous areas
- Weatherproof enclosures protect equipment from the elements
- No climate control necessary

IT Initiatives

Implementation of Cisco Identity Services Engine (ISE) will automate and simplify access control and security compliance for wired and wireless devices.

- Secure access control through device and user-specific authentication and authorization methods
- BYOD supported through identification, onboarding, and enforcement of secure access for virtually any mobile device
- Guest wireless network with Internet and email access will eliminate the need for costly 3rd party satellite services
- Wireless portal will allow business sponsors to add guest wireless users, thus removing the need for IT involvement in guest wireless provisioning

Current and Future Development

Low-cost WiFi terminal server

Smart WiFi Wireless Transmitter

Smart WiFi Tank Radar Gauges

WiFi HD Camera and NVR (Network Video Recorder) System

Power Monitoring

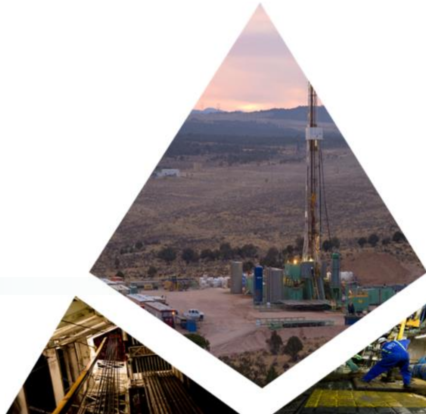
IP Intercom

IP Environmental Monitoring

Collaboration

SCADA - Event Alert

Questions



CelPlan Field Experience

Integrated Wireless Network Management

Petrobras

Petrobras

- Petrobras has ten of thousands of wireless deployments countrywide
  - SCADA
  - WiMAX
  - Backhaul
- Designs were done regionally and did not perform uniformly
- CelPlan designed a centralized system that gives access to 250+ professionals
- All the designs are regionally designed, but centrally approved
- The system provides access to the local FCC (ANATEL) and allows for automatic licensing applications and search of available frequencies for backhaul

Reliability Centric Design

Design done for a Mineral Extraction Company in Brazil

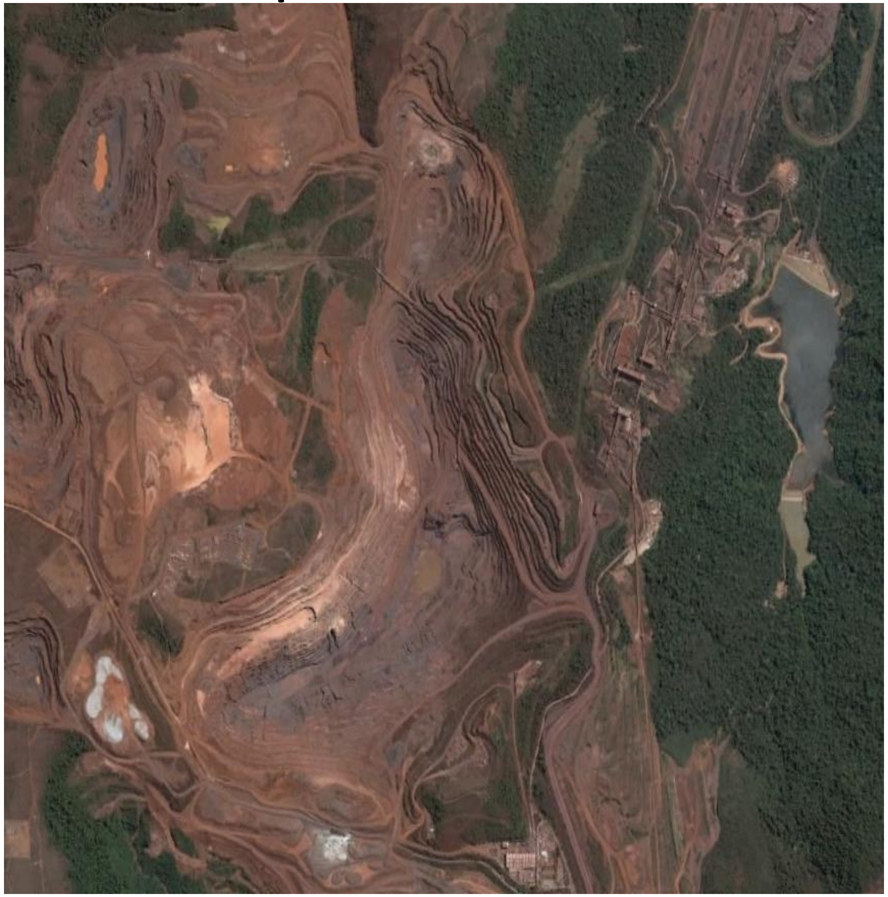
Focus on Reliability

Reliability

- Ore extraction project in North East of Brazil required a reliable high throughput communication system
- WiMAX technology was chosen due to its features, like TDD, fading resilience, flexible data size, segmentation and non proprietary fully IP based infrastructure.
- CelPlan did the design and frequency plan complying with all network requirements
  - Network continues to operate even with two simultaneous failures

Iron Ore Extraction

- Ore is extracted, loaded on trains and transported to the port area



Iron Ore Storage

- Ore is stored until ships are available for transportation

Iron Ore Loading

- Ore is loaded on conveyor belts and transported to ships

Iron Ore Loading

- Monstrous machines on rails process and load the ore
- Operator has limited vision inside the machine and relies on several high definition video cameras to operate
- Environment inside the machines is noisy, vibrating and highly susceptible to equipment damage

Remote Machine Command

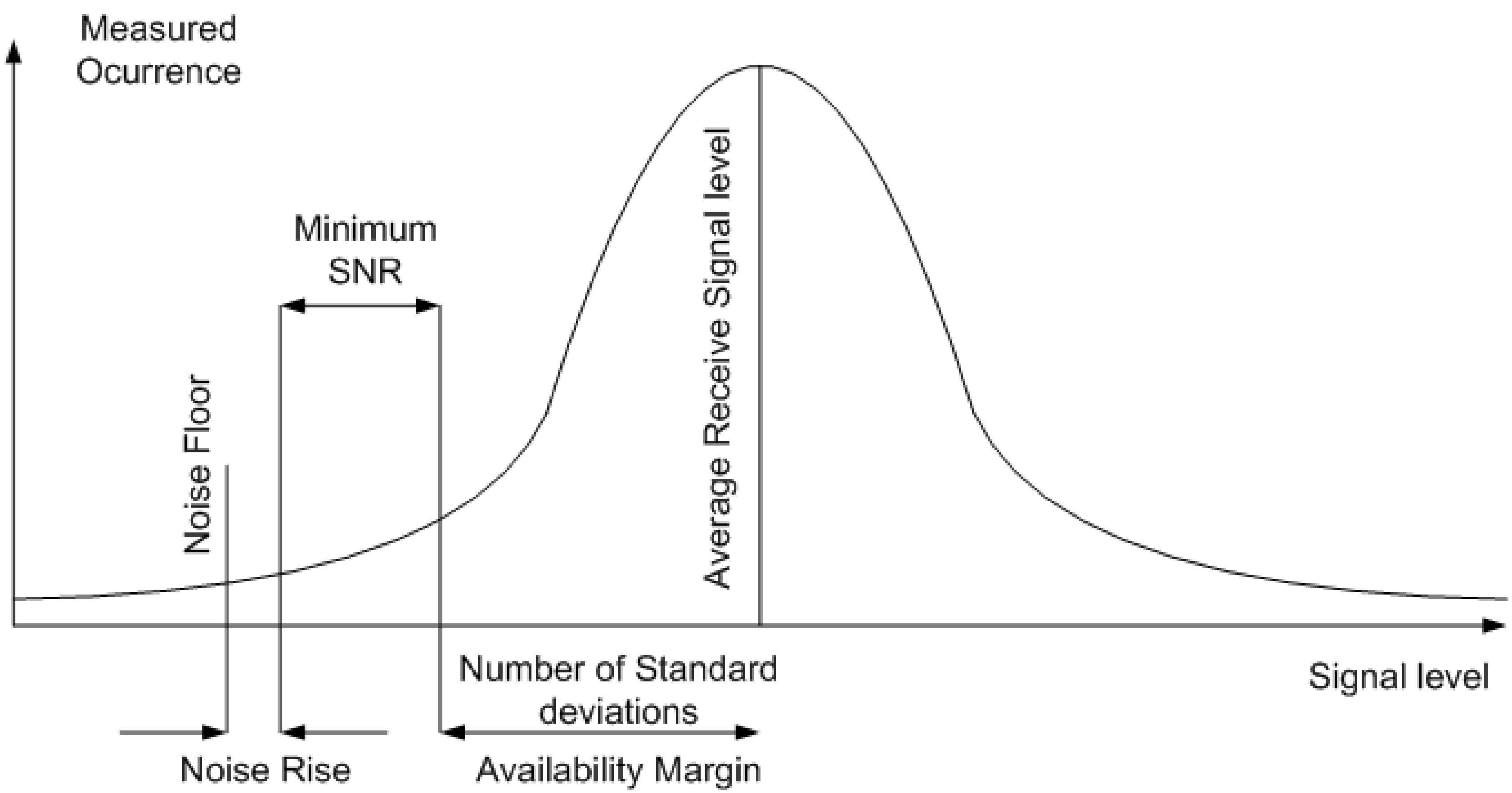
- The command of each machine was transferred to an operation Center
- The cost of a non operational machine is very high
- A high Reliability network was required
- Four WiMAX Base Stations were assembled in the periphery of the ore deposit field
- Redundant Video Cameras are able to connect to any of the WiMAX systems
- The system was designed to recover from double failure in each machine and triple failure at the WiMAX nodes

Low latency design

Toronto Hydro

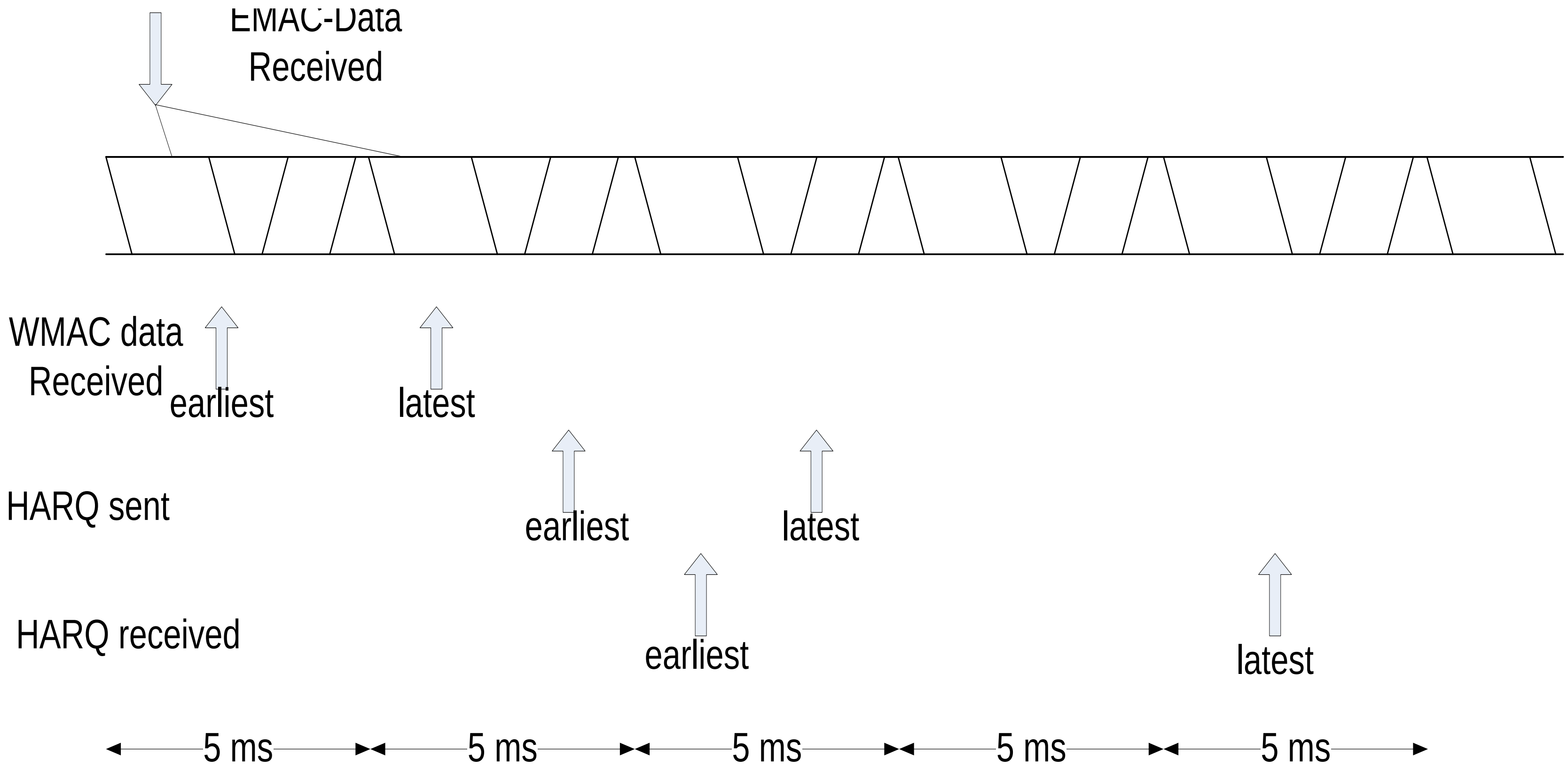
Availability Margins

- Wireless Signal Availability



Latency x HARQ

- Latency for WiMAX TDD
  - Function of frame size



Latency

- Requirement: 30 ms
- One HARQ cycle: 15 ms
- Two HARQ cycles: 25 ms
- One ARQ cycle: 50 ms

	Earliest (frames)	Latest (frames)
First HARQ cycle	2	3
Extra HARQ cycle	1	2
ARQ cycle	4	6

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consulting | technology | outsourcing

Deploying WiMAX Industrial Networks to Achieve Operational Efficiencies

WiMAX Oil & Gas 2013

Vaibhav J. Parmar

WiMAX FORUM®
Oil & Gas Event 2013
@ OilComm HOUSTON, TX | NOVEMBER 6th

High performance. Delivered.

Introduction to Accenture's Network Consulting Practice

Experienced Team & Extensive Credentials

- **Global Organization with 500+ Dedicated Professionals**
- **Alignment with Industry Groups**
- **In-Depth Industry Expertise**
- **Cisco Certified Reseller (Gold Status)**

Broad Scope of Services

- **Addressing Wired (MPLS, SONET, Ethernet, etc.), Wireless (3G/4G, WiMAX, WiFi, LMR, etc.) and Operations (NOC, OSS/BSS) solutions**
- **Providing full lifecycle of project services:**
  - Plan & Design: strategy, requirements, architecture, vendor selection, deployment planning
  - Build: systems / telecom integration, deployment, testing, PMO
  - Run: infrastructure managed services, NOC

Vendor Alliances and Industry Participation

Wireless Applications in Industrial Environments

Typical Industrial Environments

- Manufacturing facilities
- Oil and gas refineries
- Warehouse and distribution sites
- Mines
- Offshore rigs
- Large construction sites
- And many others…

Typical Wireless Applications in Industrial Environments

People & Asset Management

Voice & Data Comms

Automation

Safety & Security

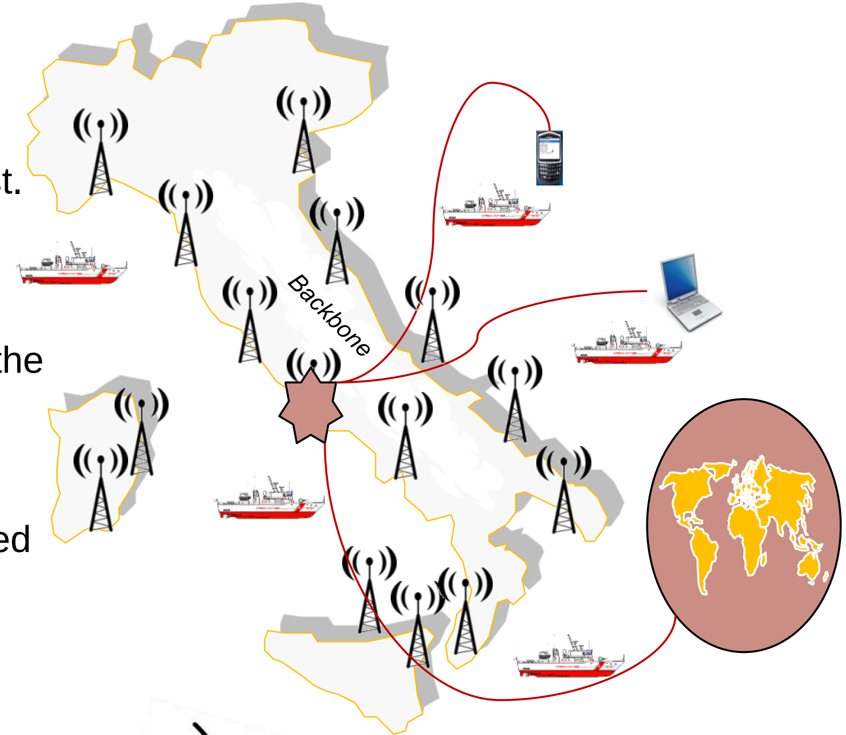
Requirements and Challenges in Industrial Environments

Safety Concerns	• Access points rated for Class 1/Division 2 hazardous environments like manufacturing plants are now available in the market. • Wireless access from intrinsically safe PCs, handheld devices and cameras.
Operational Reliability	• To avoid interference emphasis is put on RF filtering and immunity to electromagnetic interference (EMI) and radio frequency interference (RFI). • The ability to customize access points with a complete array of antennas ensures the ability to achieve the coverage pattern and range required.
Multi-path Interference	• Multi-path interference can seriously degrade RF signals in an industrial landscape like refineries. • Use of diversity antennas is a possible solution to such a problem.
Compatibility	• Suitability and adoptability of the physical and software interfaces to the industrial applications. • New products like gateways enable interconnectivity between different systems.
Power	• Power over Ethernet is a valuable feature used to power remote access points without having to run conduits and electrical wiring.
Coverage	• Industrial installations cover greater areas than commercial installations. • There are industrial solutions with high power and high gain antennas that are very effective in extending the distance.

Example Case Study:
Italian Coast Guard WiMAX Network

Project Background

The Italian Cost Guard wanted to build up its own next generation broadband wireless network in order to be more effective in all patrolling activities at sea and near Italian coast.



How Accenture Helped

The project covers 15 main offices and 325 boats of fleet. Accenture provided the client with a tailored radio design for the peculiar context.

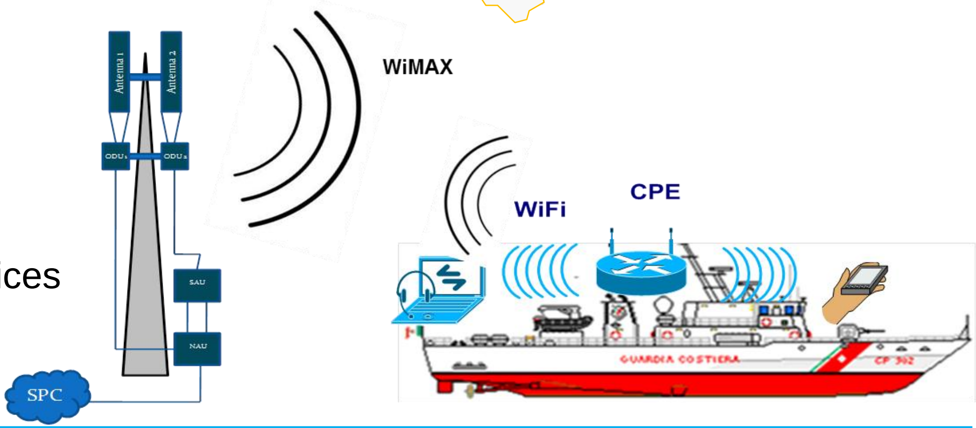
The Mobile WiMAX system features include:

- Radio coverage up to 12 nautical miles offshore
- CPE for the fleet boats, including onboard antennas, fixed and mobile devices
- Service data center for audio, video and data services
- First and second level remote operations with field and onboard dispatch

High Performance Delivered

Main benefits include:

- Stay competitive in the European environment
- Reduce communications costs
- Adopt modern, efficient and interactive new services
- Innovate technology Infrastructure
- Maximize reuse of existing infrastructure



Questions?

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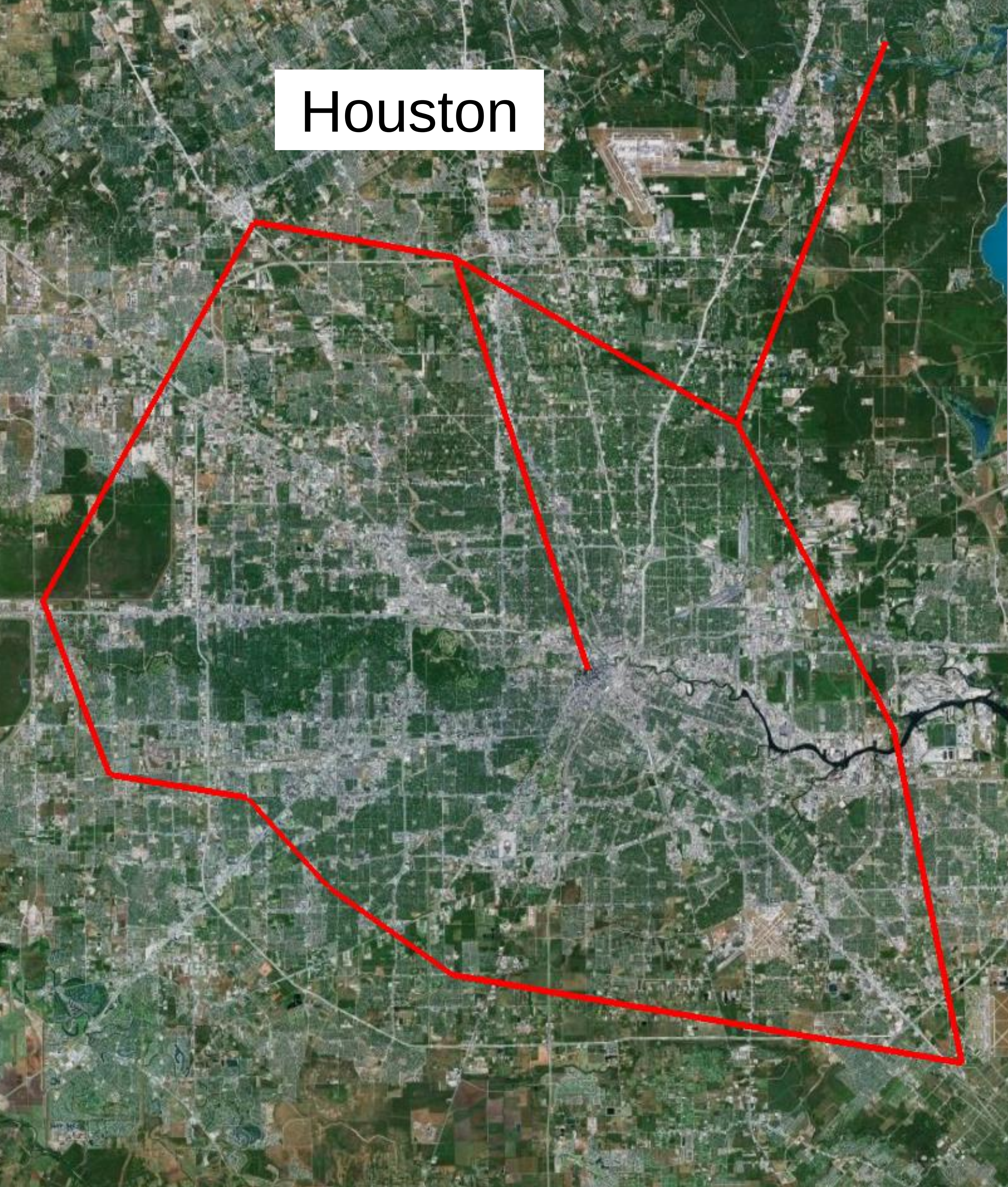
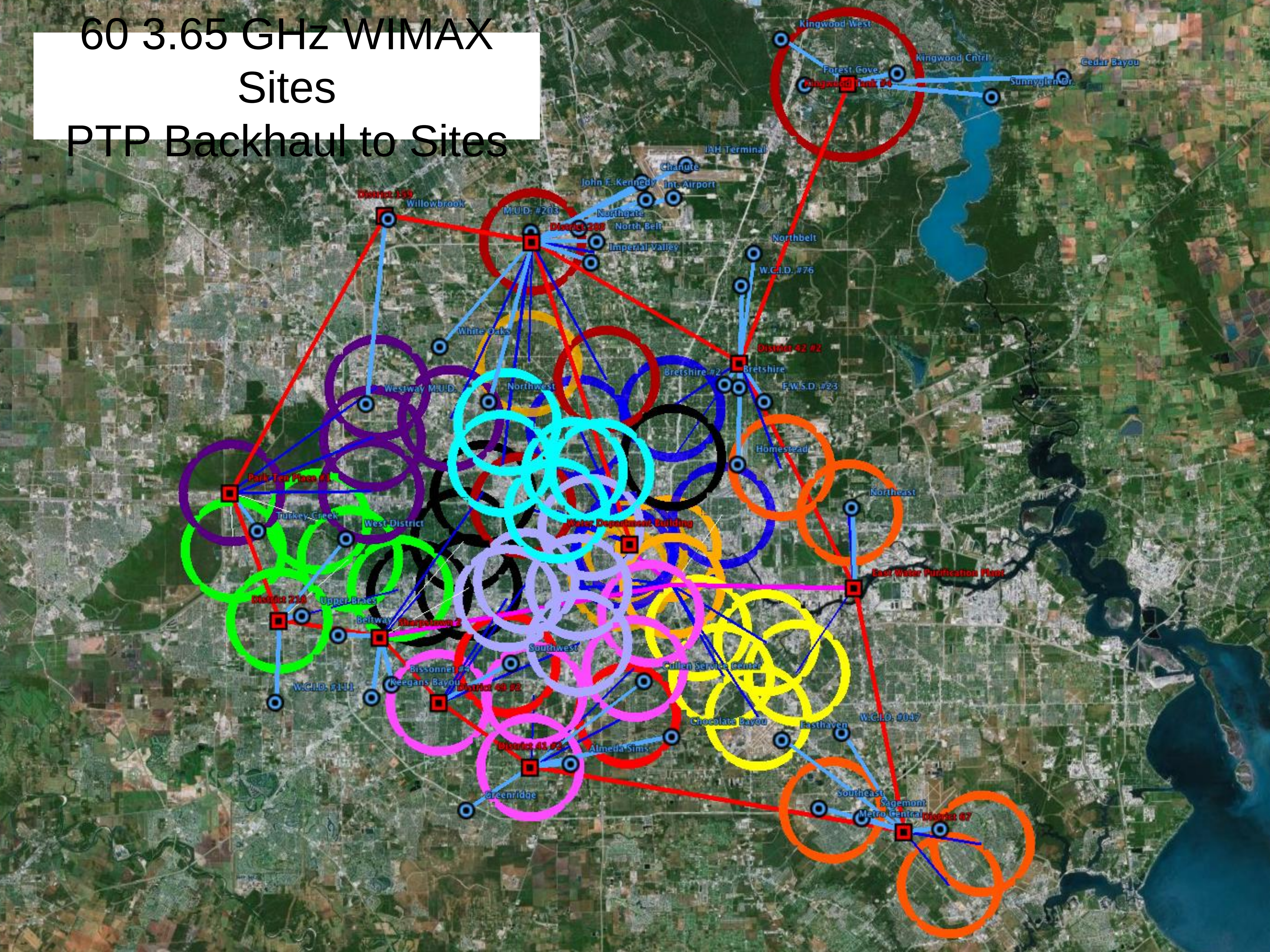
Lessons Learned

WiMAX Deployment
City of Houston


Houston

60 3.65 GHz WIMAX Sites
PTP Backhaul to Sites



Lessons Learned

- **RNP - Radio Network Plan**
  - Don’t build without - Looking for 85% to 90% Predictability
  - Types of users
    - Bandwidth Requirements, Symmetry (uplink-downlink ratio), QOS, Range
  - Frequency Band, Channel Re-use
    - Sectors, Channels Widths, Azimuth, Down tilt of antennas, Non-Overlapping Channels
  - Path Calculation
    - Obstructions, Calculated RSLs, SNR’s
  - CPE Deployment Options
    - Height, Locations, Flexible Mounting Systems, Multiple Vendors
- **Post-Install Survey & Documentation**
- **Software to push profiles, software upgrades**

Services - Savings

- **36 Water Production Sites**
- **400,000 Water Meters (300,000 today)**
- **464+ Wastewater Lift Stations**
- **1800 Intersections**
- **80 Fire Stations**
- **40+ Police Stations & Annexes**
- **1600+ School Zone Flashers**
- **Video Surveillance Deployments**

- **Water Department Savings**
  - 4,000 Truck Rolls a month in Water Department
  - Repurpose 200 Meter Readers to Maintenance
  - Early Leak Detection on Water Mains
  - Over 10 Million $ year on leased circuits

- **Virtualized Data Center**
- **Consolidated Staffing 24/7 Centers**

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The use of WiMAX technology in an industrial network to improve operational efficiency.

Eugene Crozier, Wireless Specialist

November 6th 2013

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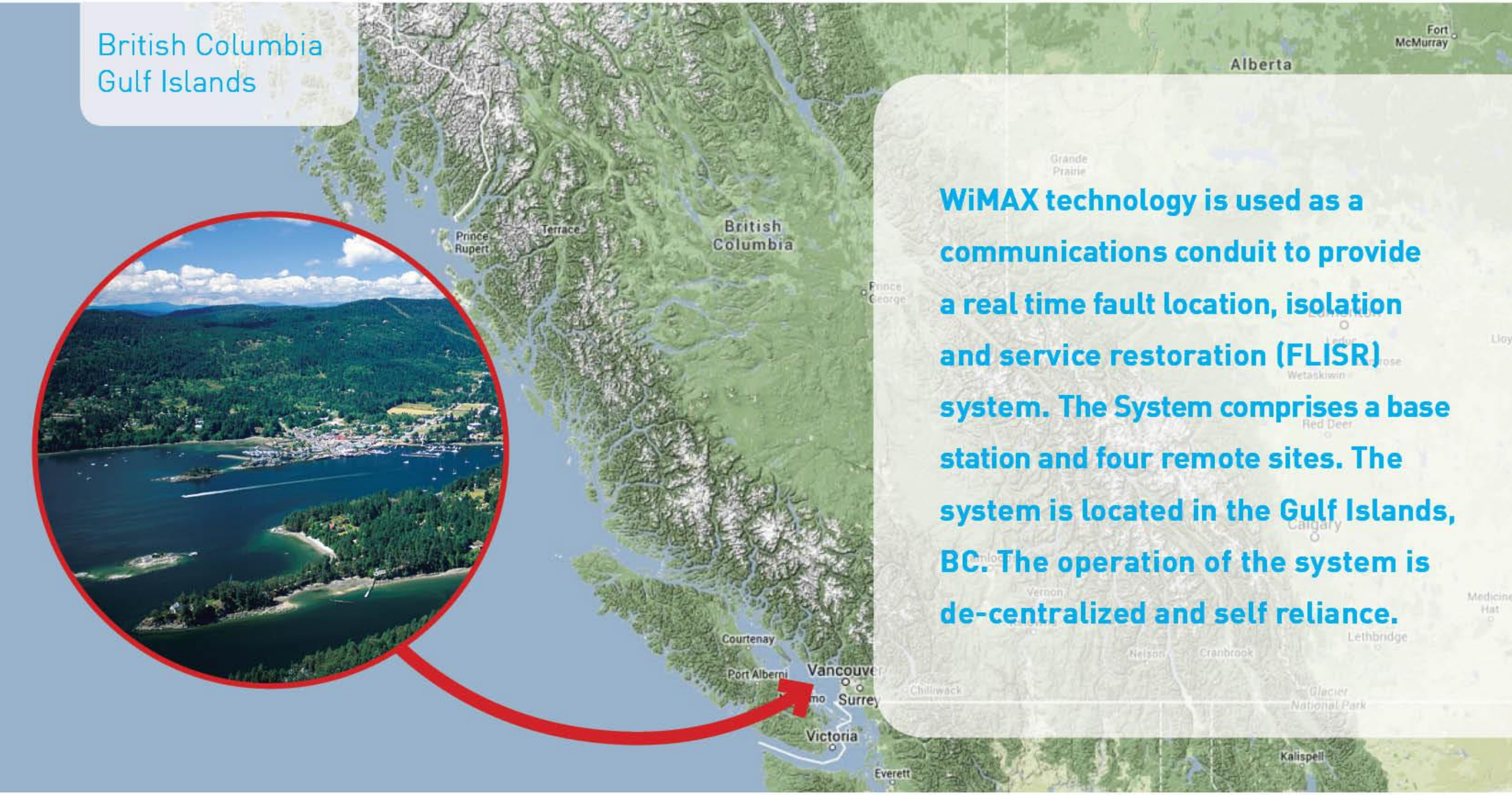
WiMAX
system introduction

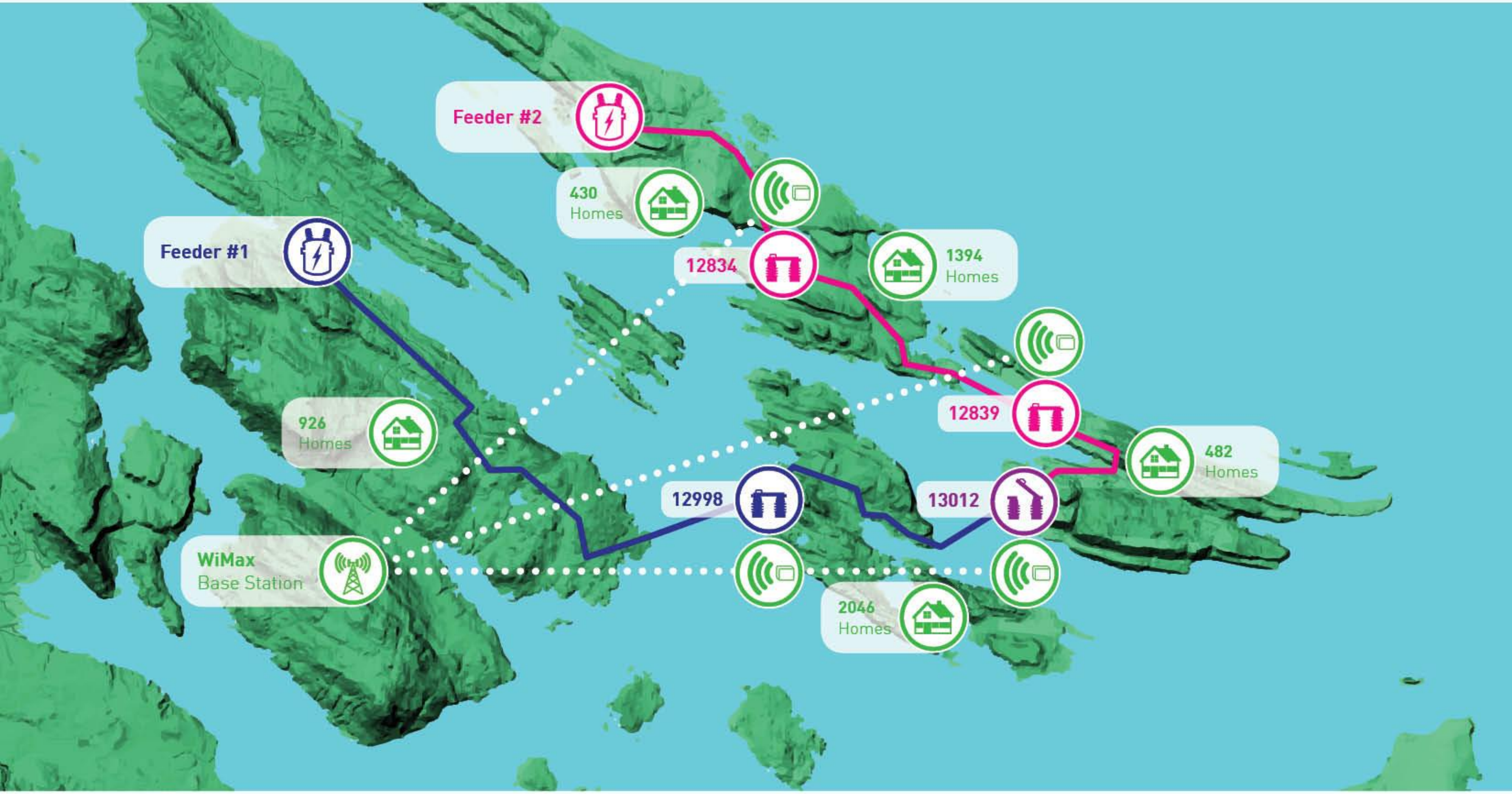


WiMAX technology is used as a communications conduit to provide a real time fault location, isolation and service restoration (FLISR) system. The System comprises a base station and four remote sites. The system is located in the Gulf Islands, BC. The operation of the system is de-centralized and self reliance.

Electricity Transmission
& Distribution

Gas and Oil
Pipelines

WiMAX & FLISR
(Fault Location, Isolation, Service Restoration)



WiMAX & FLISR
(Fault Location, Isolation, Service Restoration)

WiMAX & FLISR
(**Fault Location**, Isolation, Service Restoration)

Powertech

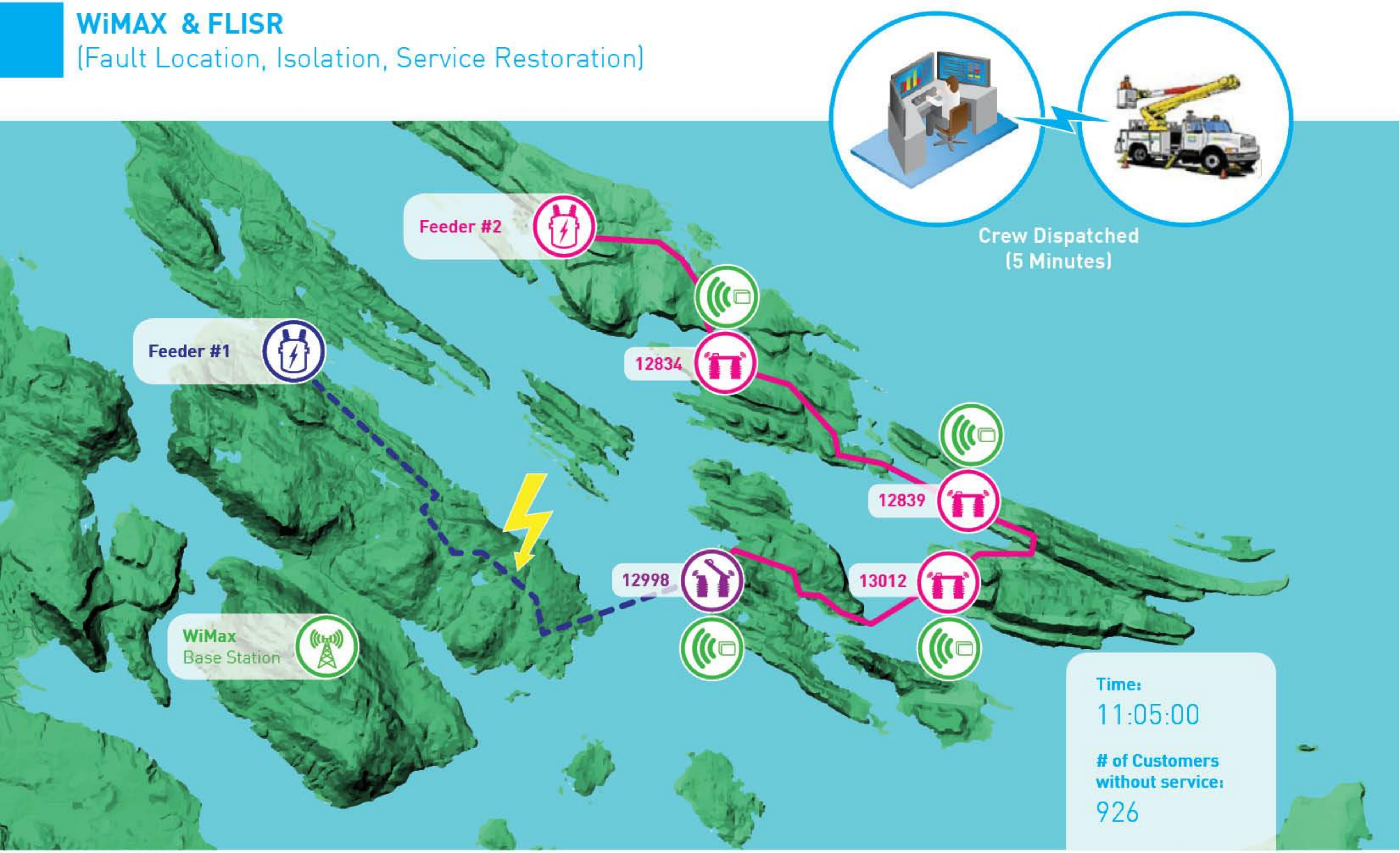
WiMAX & FLISR
(Fault Location, **Isolation**, Service Restoration)

Powertech

WiMAX & FLISR
(Fault Location, Isolation, **Service Restoration**)

Powertech

WiMAX & FLISR
(Fault Location, Isolation, Service Restoration)



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WiMAX & FLISR
(Fault Location, Isolation, Service Restoration)

WiMAX & FLISR

(Fault Location, Isolation, Service Restoration)

WiMAX & FLISR

(Fault Location, Isolation, Service Restoration)

Restore normal configuration via remote control (10 mins)

Time:

02:25:00

# of Customers without service:

0

WiMAX & FLISR
(Fault Location, Isolation, Service Restoration)

With WiMAX & FLISR

Time Line (Duration)	Activity	# Customers without service	Cumulative customer outage (mins)
11:00:00 (0 mins)	Fault Occured	0	0
11:00:02 (2 sec)	Fault located by line recloser	2972	0
11:00:30 (30 sec)	Fault isolated downstream	2972	0
11:00:32 (2 sec)	Service restored downstream	926	0
FLISR Operation Complete			
11:05:00 (5 mins)	Crew dispatched	926	4,630
02:05:00 (185 mins)	Crew arrives on scene	926	171,310
02:15:00 (195 mins)	Fault investigation complete - fault located	926	180,570
02:25:00 (205 mins)	Repairs made	926	189,830
02:35:00 (215 mins)	Service restored using remote control	926	199,090

Without WiMAX & FLISR

Time Line (Duration)	Activity	# Customers without service	Cumulative customer outage (mins)
11:00:00 (0 mins)	Fault Occured	0	0
11:00:00+ (0 mins+)	Fault cleared by line recloser	2972	0
11:00:30 (30 sec)	Customer calls to report lights out	2972	0
11:05:00 (5 mins)	Crew dispatched	2972	14,860
02:05:00 (185 mins)	Crew arrives on scene	2972	549,820
02:15:00 (195 mins)	Fault investigation complete - fault located	2972	579,540
02:25:00 (205 mins)	Repairs made	2972	609,260
02:35:00 (215 mins)	Service restored by manual switching	2972	639,980

The overall results are an almost 70% reduction in customer outage minutes. The use of WiMAX technology in similar industrial networks enable the same types of operational benefits.

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THANK YOU

Eugene Crozier, Wireless Specialist

November 6th 2013

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The Power of Trust. **The Future of Energy.**

Deploying WiMAX Industrial Networks to Achieve Operational
Lessons Learned & Trends

Oilcomm 2013 - Houston

Louis Lambert

Agenda

Deploying WiMAX Industrial Networks to Achieve Operational Efficiencies

Lessons Learned

- **3 questions**
- **Where did we learned these lessons from?**
- **Lesson Learned & Trends**
  - **Solution Perspective**
  - **Organizational Perspective**
  - **Lessons Learned ….in Pictures**

Lessons Learned – From these clients

OXY: Digital Oil field in Texas, North Dakota, California, Oman.

Marathon: Digital Oil field in North Dakota & Texas

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

Tatweer: Digital Oil field - Bahrain

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

Total Oil: 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.

redline communications

Lessons Learned & Trends

Solution perspective – Architecture

- IP Field Telecom Architecture Standards have to be developed & replicated

- The Field Wireless Network had 3 distinct architecture components
  - The Wireless Backhaul Layer - (PTP between Towers)
  - The Wireless Transport Layer is best when it is simple L2 - (PMP Transport)
  - The Wireless Access Layer needs to be WIFI - (Ground Level Wireless)

- Various BU's Networks may start with a physical separation… but moving to VLAN Segmentation.

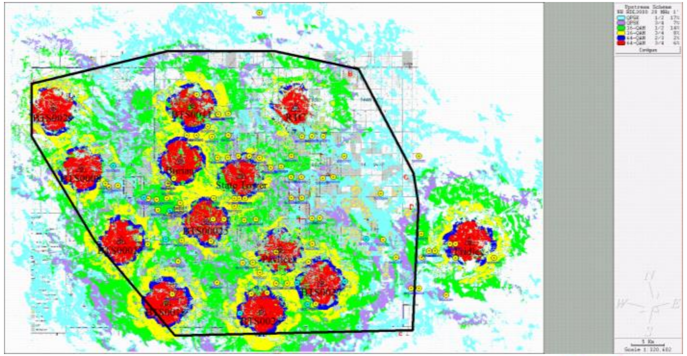
- End-to-end security requirements now stating the need for AES, FIPS 140-2 and 509

redline communications

Lessons Learned & Trends

Solution perspective - RF Planning

- Start with a Holistic RF coverage and Capacity planning ... Then deploy in phases
- Coverage designed to cover the entire asset
- Prediction maps that are meaningful to IT & the BU's so they can plan and not react
  - 6' Pickups
  - 10' & 20' Well Sites
  - 35' Rigs
- Leverage all the spectrum bands available
  - 4.9-5.8 GHz
  - 3.x GHz
  - 2.5 GHz
  - White space



Lessons Learned & Trends

Solution perspective - Solution Design

- RF design start only after proper holistic RF planning
  - Do it right the first time & Need various types of Remote Radio (Fix, Auto Acquiring, Auto Tracking)
- Infrastructure Design and Component Selection have to be Carrier/Industrial Grade
  - The network is mission critical to the business, the safety and efficiency of the asset
  - Design compromise for cost savings purposes can cost lives and excessive downtime
- Redundancy pays for itself with the first failure
  - Ring design between towers
  - Redundant Tower systems
  - Auto acquisition systems

redline communications

Lessons Learned & Trends

Solution perspective - Deployment & Execution

- Corporate Standards & Best Practices -> applied locally
- Centralized Monitoring with field visibility and capabilities
- Operational model design to be replicated

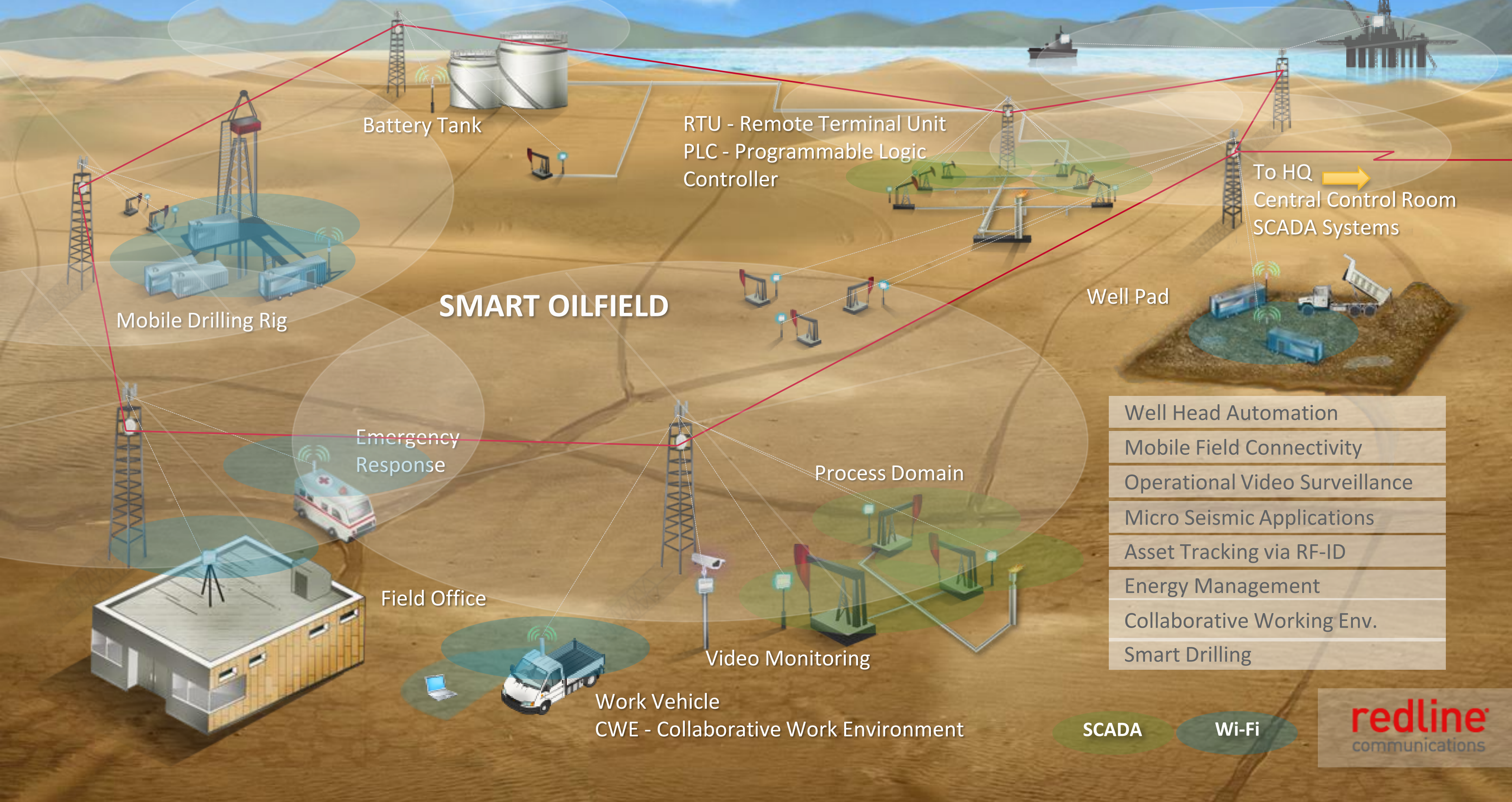
Lessons Learned & Trends

Solution perspective – Organizational Perspective

- Although Shared Wireless Network Infrastructure will happen, it is taking time.
- IT , Automation, Drilling, Completion, HSSE and others are learning to share Infrastructure
- Cross-Business Collaboration & collaboration enabling technologies are breaking the legacy silos that motivated the various BU's to build their own infrastructure.
- Shared Field Wireless Infrastructure is not only inevitable, is will become a must!
  - Everyone in the field wants high-capacity, low-latency anywhere & anytime.

redline communications

Redline Provides the Wireless Transport Layer to Enable Digital Oilfields



Redline Virtual Fiber™ Technology

- Highest Capacity in Broadband Multipoint Transport
- Unparalleled coverage with multiple solutions/configurations
- Industry’s most robust, reliable, & secure industrial radio
- Self-aligning system saves time, money, repetitive mobilization
- Multiple spectrum – Global spectrum coverage
- Most deployed PMP transport system by Oil Co. in recent years

redline communications

Build to last Tower Sites

- **Carrier Grade**
  - RF Planning
  - Tower sites selection
  - Tower /Shelter
  - Set-up
  - Project Management

redline communications

Built to last Power

- **Carrier Grade**
  - AC Distribution
  - DC Distribution
  - Grounding
  - Remote management
  - Set-up
  - Documentation

redline communications

RAS - Self Acquisition systems
Virtual Fiber

Drilling Rigs

Trailers

Long-Range

Nomadic - Mobile

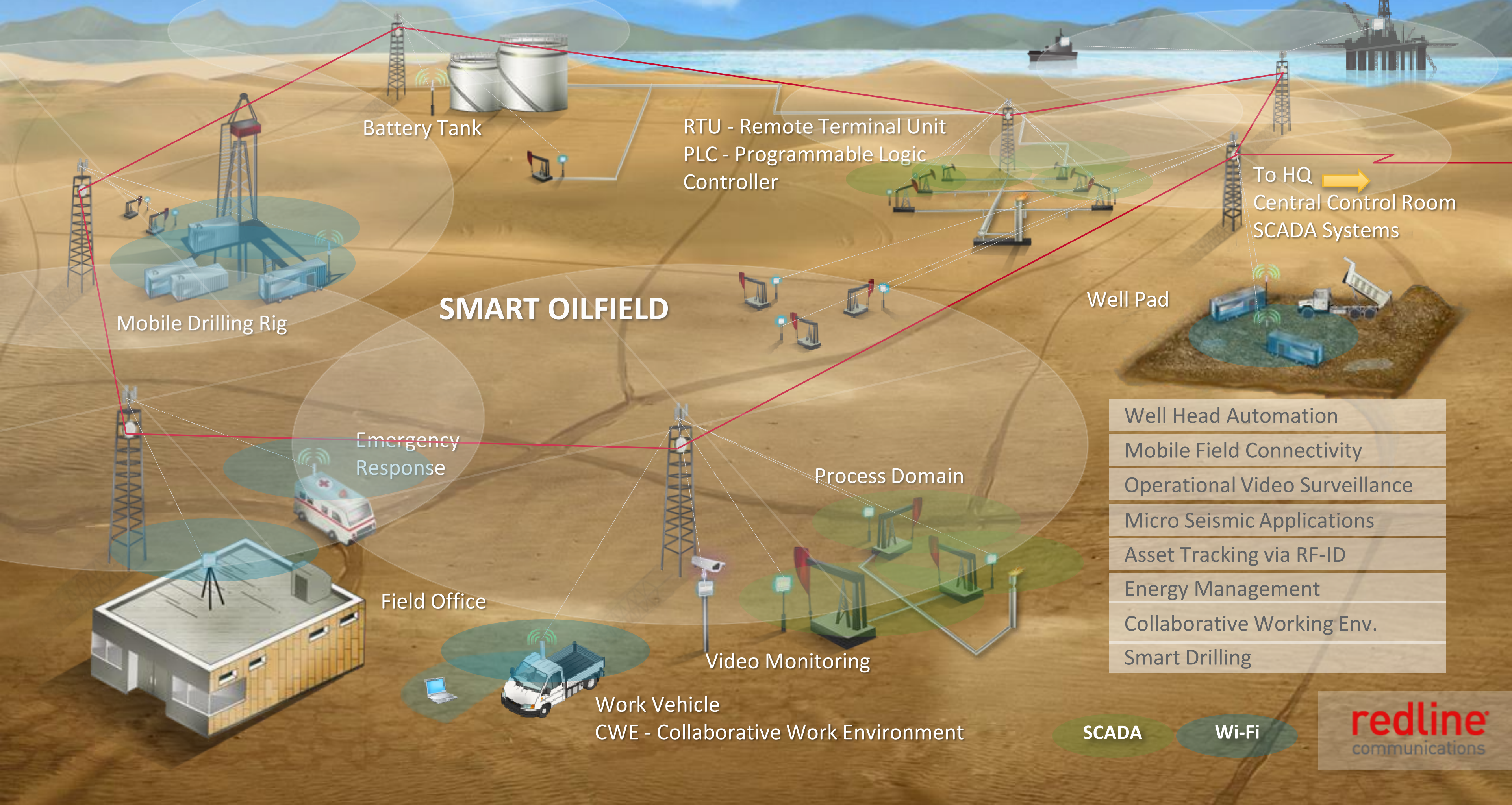
Broadband

redline
communications

Fit for purpose Well Site Cabinet & SCADA

- Carrier Grade
  - Power
  - Battery
  - Set-up
  - Documentation
- SCADA
  - IP only
  - IP + Serial

Redline Provides the Wireless Transport Layer to Enable Digital Oilfields



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RUGGEDCOM

Standards based solutions for Oil &Gas

Agenda

- Energy Market Trends
- The WiMAX Fit
- Unique Needs of the Energy Market
- Case study
- Contact

Trends

Increasing Safety & Security Using Video Surveillance

Scaling Centralized Resources

Providing Connectivity to Remote Drilling Sites - Portability

Replacing & Upgrading Legacy SCADA Systems

Upgrading Safety Systems

Increasing remote capabilities for monitoring and control results in escalating communications requirements

Core applications available for production and pipeline market segments

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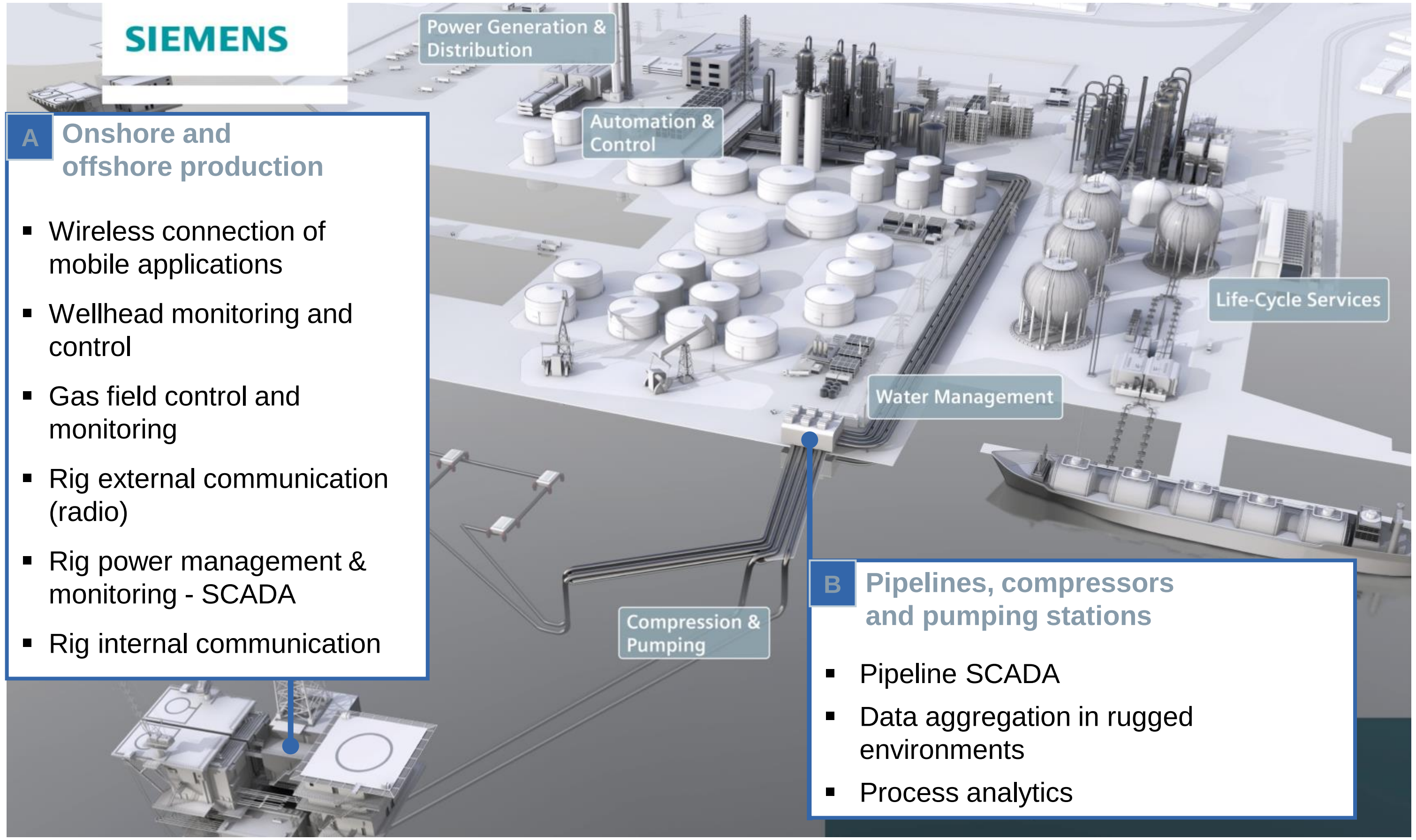
Oil & Gas: Major applications



A

Onshore and offshore productions

- Wireless connection of mobile applications
- Wellhead monitoring and control
- Gas field control and monitoring
- Rig external communication (radio)

B

Pipelines, compressors & pumping stations

- Pipeline SCADA
- Data aggregation in rugged environments

The risk of leveraging consumer mobile wireless networks

- ***Public wireless networks are getting better at delivering "always on" data services...***
  - But, coverage is still centered around populated areas, and not necessarily where energy companies need it.
  - Networks are increasing data coverage overall as 3G spans almost the whole coverage map and LTE networks are still just emerging.
  - $/bit rates are still voice centric…
  - User data traffic is increasing exponentially with no separation of network infrastructure between commercial and industrial subscribers.
- ***Network availability is improving with most sites backed up by battery…***
  - But little has been done to ensure minimum throughput and data service up time requirements are met.
  - Cellular traffic and unavailability increases when you need the network throughput the most.
  - SLA's are difficult to obtain.

Cellular networks are a great alternative for non time sensitive applications or where very high reliability is not required

Why WiMAX for Private Network?

WiMAX is the only technology available that meets the needs of the energy market with a standards-based solution:

- **Ecosystem –** A long technology lifecycle is demanded, a standards-based solution required
- **Range / Throughput -** scaling over huge areas of tens - hundreds of square miles with broadband rates
- **Scale –** Reduction of self interference is required
- **Quality of Service -** Multi-service networks
- **Security**- Must meet the needs of Critical Infrastructure Protection

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Managing multiple services/ application types

	CIR	MIR	Jitter	Latency	QoS Goal
SCADA	Yes	No	No	No	Reserve BW and prioritize
Voice	Yes	No	Yes	Yes	Real time capability
Video	Yes	No	Yes	Yes	Real time capability
Control data	Yes	No	Yes	Yes	Nail up low BW
Field Workers	No	Yes	No	No	Set a max BW to not effect other apps

Quality of service is much more important in wireless networks

Special Requirements of the Oil & Gas Market

Remote deployments – not easy to upgrade or replace hardware

Rugged Environment - rain, salt, high temperatures, low temperatures, vibration, etc.

Hazardous locations – depending on deployment model, ATEX / IECEx / Class 1 Div 2 may be required

Security - Infrastructure is a prime target for hackers

Simplified infrastructure - IT / Telecom groups need to be streamlined

The environment and goals of a network for oil and gas is different than that of a mobile operator

What about private LTE networks?

LTE has won the battle for 4G evolution in the mobile operator / carrier space but :

1) Does LTE come in the frequency bands available for private network use?

2) Does LTE really provide an advantage in Oil & Gas specific use cases ? Can you use it off the shelf?

3) Is LTE simple to deploy?

4) What is the upfront cost?

5) Is a private LTE hardware solution really a proprietary solution?

Today's LTE solutions are aimed at mobile network operators and is not optimized for industrial networks

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The role of WIGRID and the SEWG

Purpose - Leverage the ecosystem of WiMax **standards-based** equipment, but tailor it to the needs of energy customers

Provide - **Ethernet** based systems with **distributed architectures.**

Provide - More data going **upstream** than in a conventional ISP model

Provide - **Longer range** required for geographically dispersed networks

Provide - Frequency bands which can be used by private companies (**5.8, 3.65 GHz**)

Drive - **interoperability** around this "energy profile"

Providing the benefits of 4G network technology optimized for Energy's needs

The Challenge

Augmenting network services to offshore oil rigs

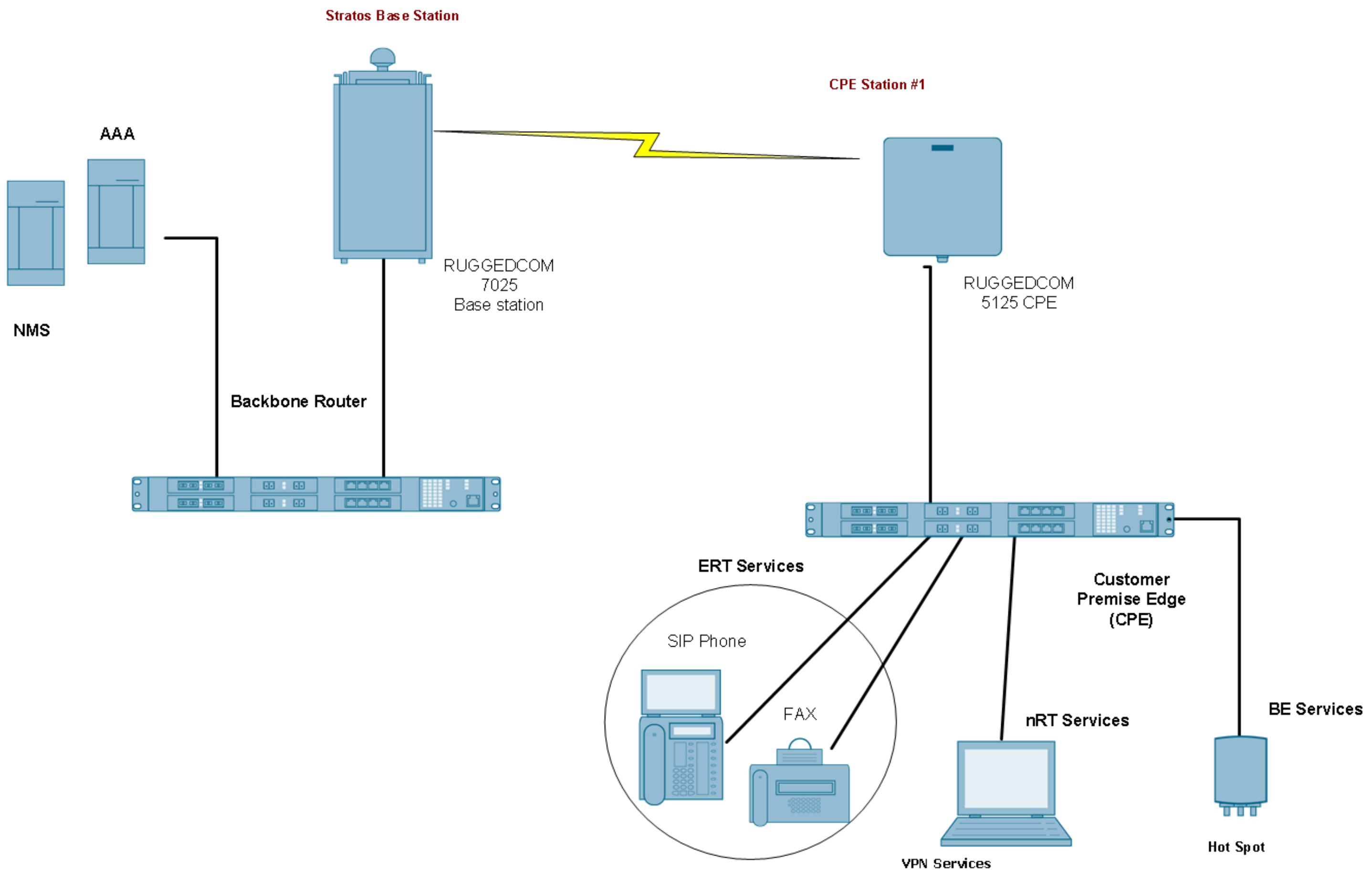
- Demand for greater bandwidth & lower latency than VSAT
- Multi-service applications like voice, and WIFI consumer access
- Network spread over thousands of square miles of extremely harsh terrain

Extremely harsh environment

- Corrosive salt water
- Hazardous location
- Connection over water, heavy multipath conditions

Foto: Ulrike Sinzel

RUGGEDCOM WIN wireless broadband technology

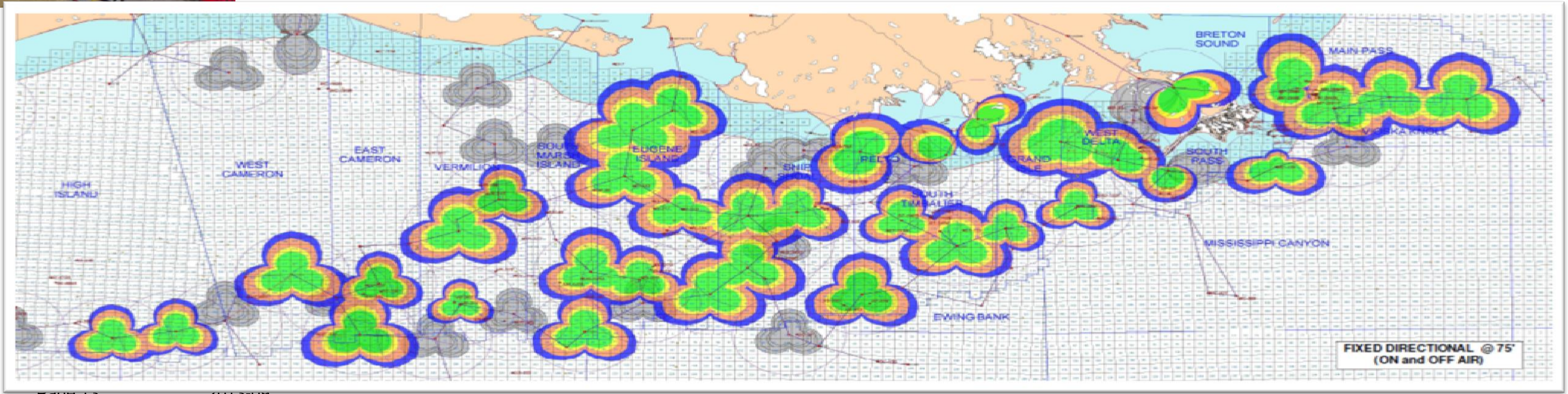


- Standards-based WIMAX system in licensed, lightly licensed and unlicensed bands.
- Provides broadband rates over long distances.
- Provides robust equipment for rugged conditions.
- OFDMA based to provide reliable connections over water.
- Up to 40 Km range.
- Multi-service with guaranteed QoS.
- Low, controllable latency
- Nomadic and mobile services to surrounding vehicles and vessels.

Experience

Stratos Offshore Services

- Provided 100+ base stations covering thousands of square kilometers in Gulf of Mexico.
- Multi service network in licensed 2.5 GHz band
- All offshore connectivity, in place since 2011



Summary

The need for communication technology in the oil field is increasing at a rapid pace

The remote nature of the communications means implementation of long technology lifecycles

WIMAX is the standard which is best suited to meet the range, security and throughput needs of the oilfield

WIGRID is establishing interoperability around frequencies and use cases required for the energy market

Contact

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WiMAX Profiles for Oil & Gas

Jim C Johnston, RCDD

Oil & Gas Applications

- IP to WellHead
- SCADA
- Real Time Voice, Video, Data
- WiFi Hotspots
- Office in the Truck - Nomadic
- SubContractors & Service Providers

Data

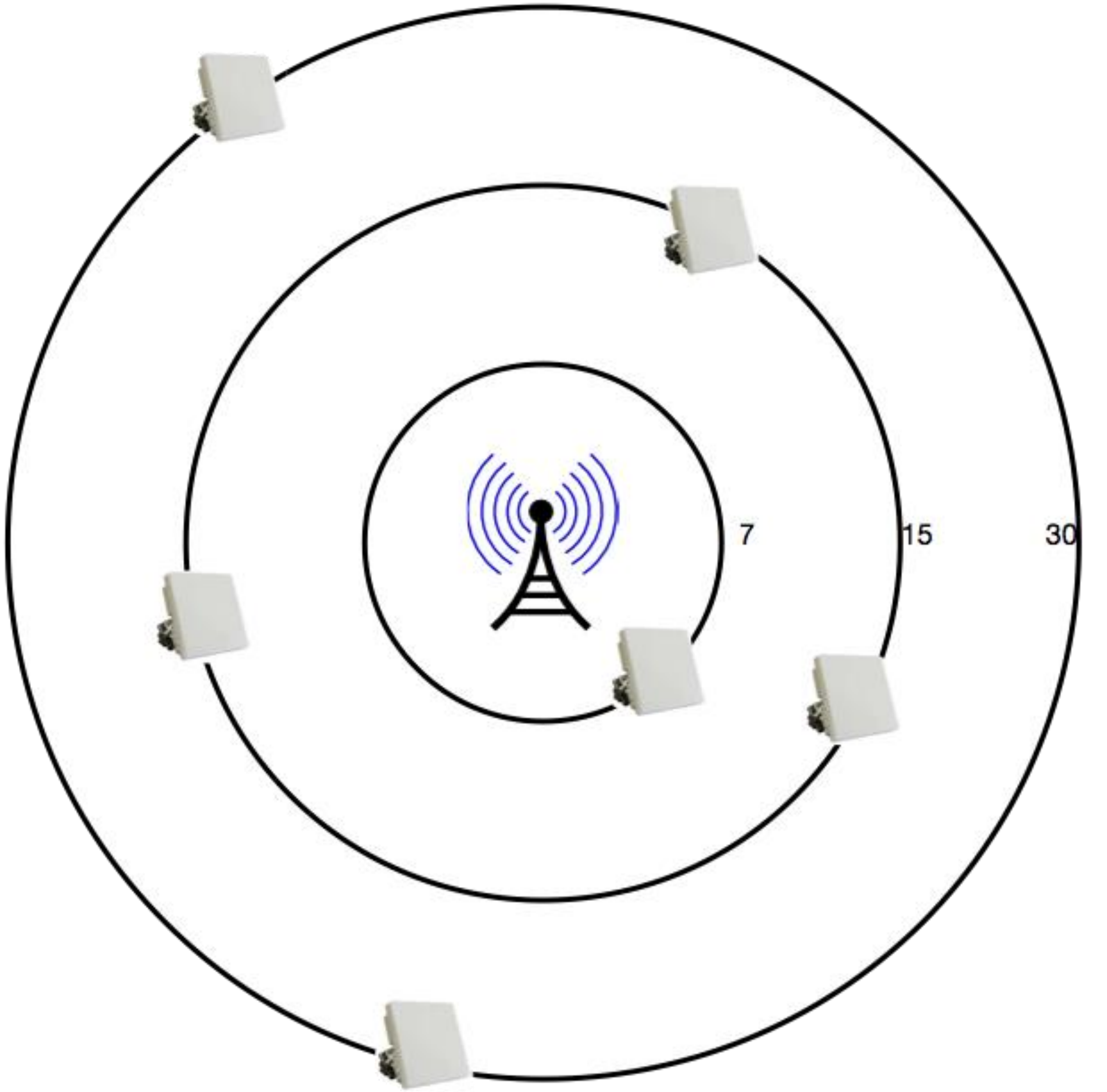
- Forensic
- Real-Time
- Predictive

What's Important

- Coverage
- Connectivity
- Reliability
- Throughput
- Latency - "Tag" for Priority

Profiles

- 802.16 Allows Many Variables
- Profiles define a subset of parameters for interoperability
- Default profiles optimized for broadband (WISP)
- Type of Application, VOIP, SCADA, Video
- Operating Range
- VLANs for QOS
- CPE Fixed IP or DHCP



Key Parameters for Uplink & Downlink

- Latency
- Traffic Bandwidth (kbit/s)
- Packets per second
- Traffic (Message) Frequency
- Traffic Payload Type (TCP/UDP)
- QoS Type (Real-time, BestEffort, UGS)
- Active / Idle Ratio
- Traffic activity predictability (Random, Regular)
- MIMO antenna on CPE facilitates better uplink

Application Traffic Profiles

Communications Requirement Summary

Use Case	DL (kbit/s)	UL (kbit/s)	Latency (ms)	Packets per Second	Message Frequency	Payload Type	Active/ Idle	Predictability
1-SCADA	~10	200	1000	30	10 sec	TCP	1 sec/ 5 sec	Good
2-Video	~10	1000	100	200	20 ms	TCP & UDP	Active	Good
3-Hotspot	1500	2000	100	200	5 min to 6 hr	TCP	1 sec 5 sec	Random
4-Controls	150	150	20	100	100 ms	UDP	Active	Random
5-Keyless Entry	~5	10	1000	10	1 hr to 6 hr	TCP	1 sec/ 5 sec	Random
6-Drilling Operations	2000	2000	50	800	20 ms	TCP	Active	Good
7-VLAN2	xx	xx	xx	xx	xx	TCP/UDP	100 ms/4s	Good

Channels & Symmetry 3.65 GHz Band

Channel Capacity 3 bits/Hz

(varies with distance)

- **3.5 MHz - 10.5 Mbps**
- **5 MHz - 15 Mbps**
- **7 MHz - 21 Mbps**
- **10 MHz - 30 Mbps**

Symmetry Downlink/Uplink

(varies with vendor/channel)

- **75/25**
- **60/40**
- **50/50**
- **30/70**

Key Differences Broadband vs Oil & Gas

WiMAX FORUM
Oil & Gas Event 2013
@ OilComm HOUSTON, TX | NOVEMBER 6th

	WiMAX for Broadband	WiMAX for Oil & Gas
Frequency Bands	• Primarily Licensed • Dedicated Bands country by country	• No bands specifically allocated in the US • Under-utilized bands, share with others • Some networks will use "lightly" licensed or license-exempt spectrum • Smaller channel bandwidths - spectrum sharing • Interference management important
UL & DL Traffic	• Downlink is dominant	• Uplink is dominant
End-Users	• Mobile • Relatively few per base station • Download files can be large	• Primarily fixed • Many users per base station • Uplink packet sizes tend to be small
Mobility Requirements	• Important	• High mobility not important • Nomadic is important for mobile workforce
Security Requirements	• Privacy concerns	• Very important • Protection against malicious attack very important
Network Robustness	• Important	• Very important • Support for Relaying, Multi-hop and self configuring (no single point-of-failure)
Latency	• Important for latency-sensitive applications, VOIP, Real Time Gaming	• Varies by payload • QOS by Application • Real-time Video UL
Coverage	• Ubiquity very desirable	• Strategic locations • Extended range and multi-hop and/or relay for rural coverage

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Conclusions

- Standard, out-of-box profiles are not optimal for Oil & Gas
- Extended Range
- QOS by application
- Higher uplink to downlink ratios are needed
- CPE spends more time transmitting, more power needed at CPE
- CPE with MIMO more efficient, higher uplink modulation with better signal

Thank You

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Design Options for an Effective Data Broadband Network

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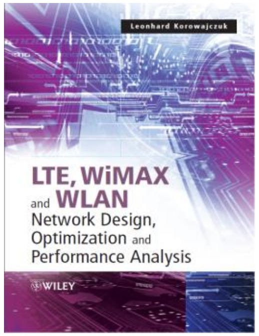
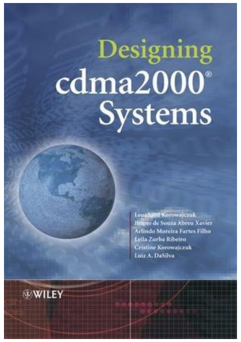
WIMAX Forum

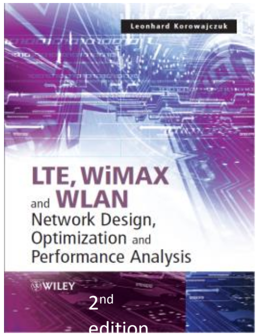
Oil& Gas 2013

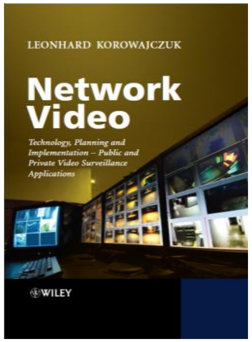
Presenter

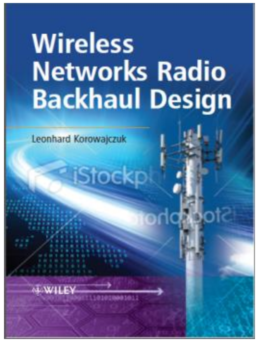
- **Leonhard Korowajczuk**
  - CEO/CTO CelPlan International
  - 45 years of experience in the telecom field (R&D, manufacturing and services areas)
  - Holds13 patents
  - Published books
    - “Designing cdma2000 Systems”
      - published by Wiley in 2006- 963 pages, available in hard cover, e-book and Kindle
    - “LTE , WiMAX and WLAN Network Design, Optimization and Performance Analysis ”
      - published by Wiley in June 2011- 750 pages, available in hard cover, e-book and Kindle
  - Books in Preparation:
    - LTE , WiMAX and WLAN Network Design, Optimization and Performance Analysis
      - second edition (2014) LTE-A and WiMAX 2.1(1,000+ pages)
    - Network Video: Private and Public Safety Applications (2014)
    - Backhaul Network Design (2015)
    - Multi-Technology Networks: from GSM to LTE (2015)
    - Smart Grids Network Design (2016)

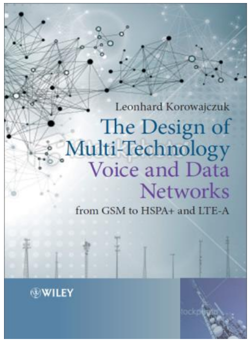










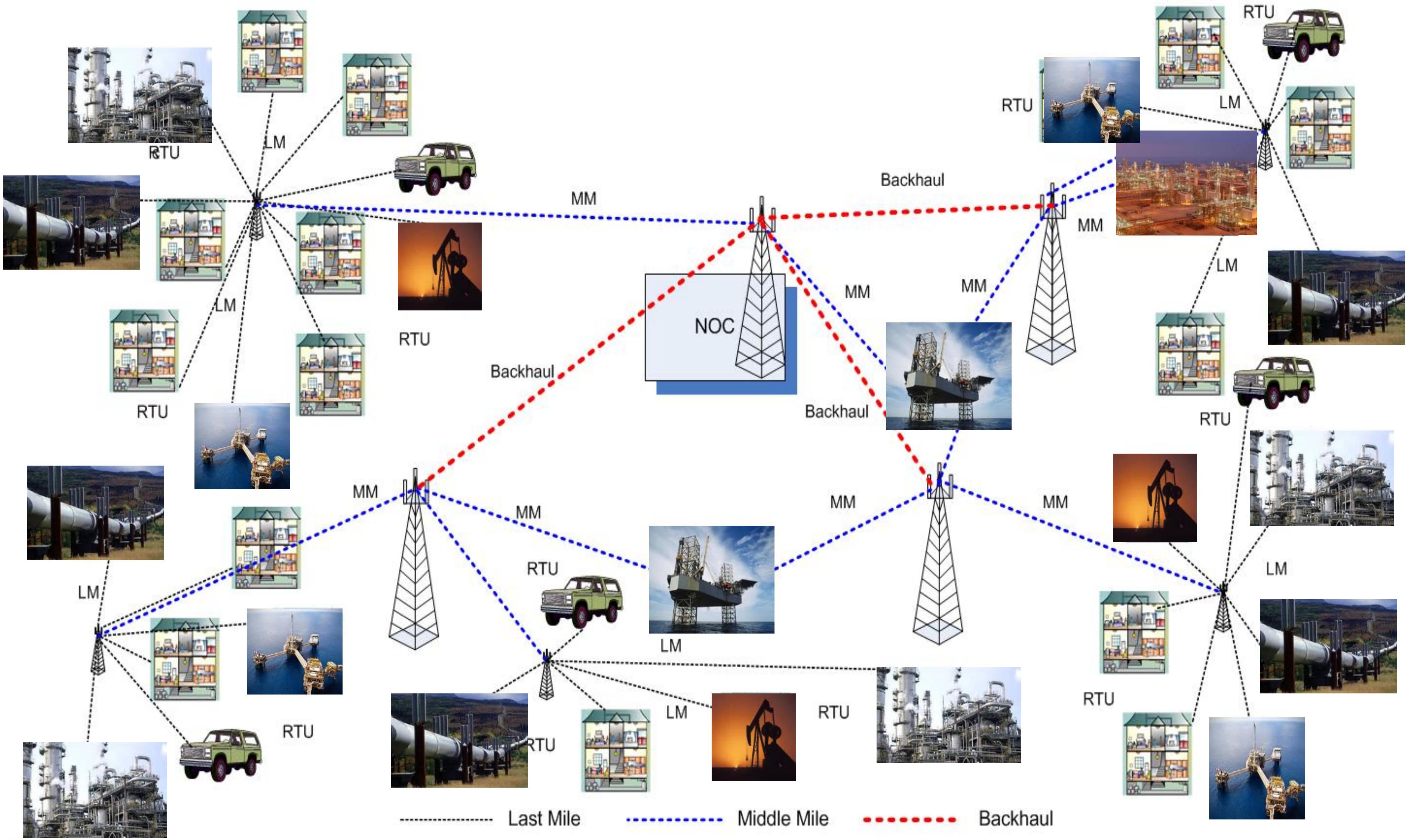


CelPlan International

- Employee owned enterprise with international presence
  - Headquarters in USA
  - 450 plus employees
  - Revenues of US$ 40M
  - Twenty (20) years in business
- Subsidiaries in 6 countries with worldwide operation
- Vendor Independent
- Network Design Software (CelPlanner Suite)
- Network Design Services
- Network Optimization Services
- Network Performance Evaluation
- Services are provided to equipment vendors, operators and consultants
- High Level Consulting
  - RFP preparation
  - Vendor interface
  - Technical Audit
  - Business Plan Preparation
  - Specialized (Smart Grids, Aeronautical, Windmill, …)
- Network Managed Services
- 2G, 3G, 4G, 5G Technologies
- Multi-technology / Multi-band Networks
- Backhaul, Small cells, Indoor, HetNet

Broadband Data Wireless Architecture

Broadband Data Wireless Architecture



Broadband Data Wireless Architecture

- Remote Units
- Interconnection Network
  - Communications Network
  - Communication Network Technology

Architecture- Remote Units

- Remote Terminal Unit (RTU)
  - Distribution Automation (DA): up to 10,000 RTU
    - Polling and autonomous messaging (RTU: 1kbps)
    - Mission Critical (Latency: < 20 ms, Availability: 99.999%)
    - DH (Design Hour) total traffic: 10 Mbit/s
  - Advanced Metering Infrastructure (AMI)- up to 10,000,000 RTU
    - Polling (RTU: 10 bps)
    - Non mission critical (Latency: non critical, Availability: 99.0%)
    - DH total traffic: 100 Mbit/s
  - Mobile Force (MF): 5,000 RTU
    - Low throughput conversational and text (RTU: 1 kbps)
    - Non mission critical (Latency: conversational , Availability: 99.9%)
    - DH total traffic: 5 Mbit/s
  - Video Network (VN): 1,000 RTU
    - High throughput uplink (2 Mpixel, 1 fps, H.264): (RTU: 1 Mbps)
    - Non mission critical (Latency: video, Availability: 99.9%)
    - DH total traffic: 1 Gbit/s

Architecture- Interconnection Network

- Last Mile (LM) Concentration Points (CP)
  - Point to Multipoint (PtM) non LOS (non Line of Sight)
  - Latency: non critical (100 ms)
  - Availability: 99.99%
- Middle Mile (MM) Concentration Points (CP)
  - Point to multipoint mainly LOS (Line of Sight)
  - Latency: 20 ms
  - Availability: 99.999%
- High capacity Backhaul
  - Point to Point (PtP) LOS
  - Latency: 10 ms
  - Availability: 99.999%

Communications Network

- Commercial
  - Not recommended for last mile (LM) or middle mile (ML)
  - Throughput can not be guaranteed
  - May be considered as a temporary solution
- Proprietary
  - Requires spectrum availability
  - May be expensive
  - Full control
- Shared
  - Provisioned by third party
  - Some implementations allow for bandwidth segregation
  - Growth and expansion may be tricky

Communication Network Technologies

- Cable / ADSL
- All-Dielectric Self Supporting (ADSS) fiber
- Optical Ground Wire (OPGW)
  - Fiber to the Home (FTTH)
  - Fiber to the Node (FTTN)
- Wireless over Power Line
- Licensed Point to Multipoint Wireless / Point to Point Wireless
  - Cellular
  - Satellite
  - WiMAX/LTE
  - Proprietary

Wireless Communication Technology Alternatives

- VHF and UHF Narrow Band (SCADA)
  - 12.5 to 50 kHz bandwidth
  - 100 kbps marketing throughput
- Commercial Cellular
  - Cdma2000, EVDO
  - GSM, EDGE, HSPA
  - Wi-Fi
    - Contention based protocol
    - Throughput drops exponentially with number of users, mainly in mesh configurations
- Satellite
  - Limited throughput
  - Emergency situations
- OFDM Based (4G)
  - WiMAX
    - 200 kHz to 20 MHz
    - Up to 8 MBps (10 MHz TDD)
    - Based on commercial IP infrastructure
    - WiGRID specification
  - LTE
    - 200 kHz to 20 MHz
    - Up to 8 MBps (10 + 10 MHz FDD)
    - Based on operator specific infrastructure

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CelPlan Wireless Solutions & Consulting

Wireless Communication Technology Alternatives

- The overall solution should be a mix of the listed alternatives
- WiMAX is the most adequate technology
  - Higher spectral efficiency
  - Available for licensed and unlicensed bands
  - TDD oriented
  - Powerful interference avoidance and control
  - Possible frequency reuse of 1, through segmentation and zoning
  - Compatible with regular IT infrastructure
  - Best cost to capacity ratio
  - WiGRID specification specially developed for Smart Grids

Typical System Characteristics

- Reliability
  - Hardware dependable (redundancy)
- Availability
  - Link dependable (redundancy, repetition)
- Latency
  - Delay (confirmation, repetition)

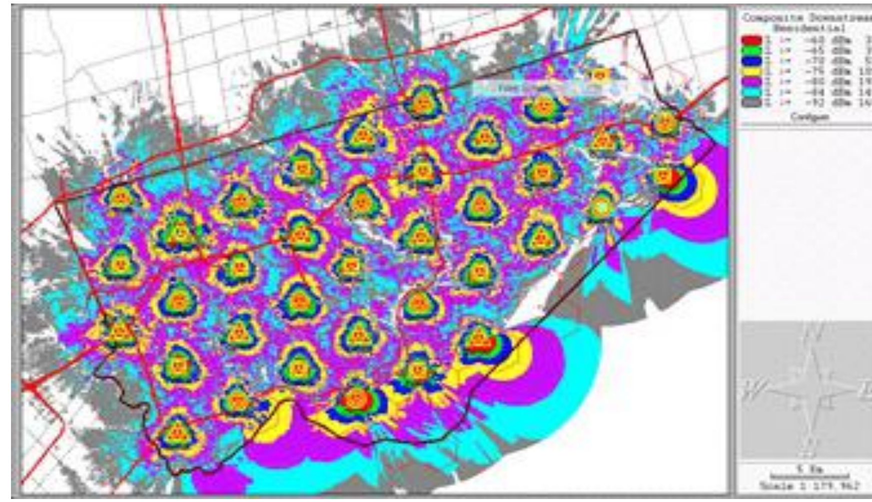
Typical Values							
	Application				Communication		
	AMI	SCADA/MF	DA	Video	LM	MM	Backhaul
Reliability (%)	99.00	99.9	99.999	99.00	99.99	99.999	99.9999
Availability (%)	99.00	99.9	99.999	99.00	99.99	99.999	99.9999
Data Throughput (kbps)	0.01	1	1	1,000	1,000	20,000	100,000
Type	TCP	TCP	TCP	UDP	IP	IP	IP
Latency (ms)	10,000	1,000	25	-	100	20	10
Technology					WiMAX	WiMAX	PM/WiMAX
Band (MHz)					220, 700, 900	2,500, 3,500	6,000, 12,000, 18,000

Network Design

- A mixed network (Wireline and Wireless) is the best solution
- Broadband Wireless network should be utility owned
  - WiMAX is the best technology
- Robust protocol must be used for Network Automation
- A comprehensive design covering the whole network should be done since the beginning
- A professional design must be done covering all applications

Network Design

- RF propagation model is used to calculate the average signal level
- M2M traffic is simulated as a load to the technology of choice
- Service area and capacity are determined
- Availability and latency are calculated
- A proper design saves significant amounts (CAPEX and OPEX) along the life of the network



Signal Level (dBm)

Dynamic Traffic Placement Simulation

WiMAX x LTE

WiMAX x LTE

- **WiMAX**
  - Conceived as TDD
  - More mature technology
  - Internet compatible technology
  - More economical
  - Better specifications
- **LTE**
  - Conceived as FDD
  - Better marketing
  - Supported by 2G European vendors
  - 2G compatible technology
  - More expensive
  - Flawed specifications being fixed
  - Should prevail with traditional operators

WiMAX x LTE - Interference Control

- **WiMAX**
  - Common channels use different locations in each cell
  - Pilots use different locations in each cell
  - Permutation scheme (PUSC) is responsible for interference averaging
  - Many different cyclic prefixes
  - Reduced overhead
- **LTE**
  - Common channels use same location in all cells
  - Pilots use same locations in all cells
  - No permutation scheme to control interference
    - ICIC (Inter-Channel Interference Control) scheme left to vendors
  - Two cyclic prefixes only
  - Large overhead

Thank You!

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Questions?

THANK YOU!

Declan Byrne

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