WiMAX FORUM®

WiMAX Oil & Gas 2014

@ OilComm HOUSTON, TX | NOVEMBER 5

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WiMAX Oil & Gas 2014

November 5, 2014
Houston, TX

Greg Kunkle
Keller and Heckman LLP
1001 G Street, N.W.
Washington, DC 20001
202-434-4178
kunkle@khlaw.com

Preliminary Word

- This presentation provides information about the law. Legal information is not the same as legal advice, which involves the application of law to an individual's specific circumstances. The interpretation and application of the law to an individual's specific circumstance depends on many factors. This presentation is not intended to provide legal advice.
- The information provided in this presentation is drawn entirely from public information. The views expressed in this presentation are the authors' alone and not those of the authors' clients.

Presenter

- **Greg Kunkle** practices in the area of telecommunications, assisting corporate clients and trade associations with various legal and regulatory matters including matters before the Federal Communications Commission.
- Greg regularly assists clients in identifying and acquiring wireless spectrum through a variety of means, including spectrum leasing, purchase and sale of licenses, and the FCC's auction process. His spectrum acquisition practice spans several frequency allocations.

FCC's View

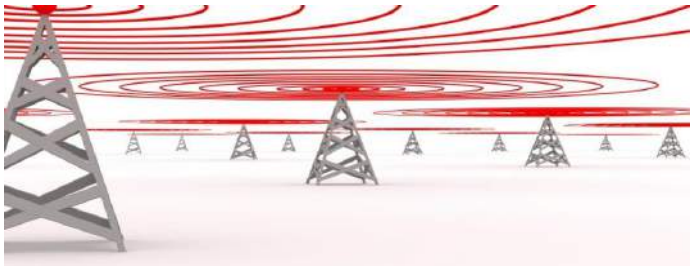
FCC's View

- 2013 - "While there are no "utility-specific" frequency bands […] there is a wide range of bands and services that […] could be useful to meet the utility industry's varied needs."
  - Including 700-960 MHz; 4.9 GHz band; 5925-6425 MHz; 23 GHz, 27 GHz, 31 GHz, 38 GHz; the 70/80/90 GHz bands

FCC's View

- 2014 – "SCADA, smart grid and similar applications […] are not dedicated to communications to prevent human injury and property damage, but are also used for day-to-day facilities management and other purposes that primarily serve the business needs of the licensee."

Spectrum Resources



Spectrum Resources

- Point-to-Point
- Two-Way Voice
- Narrowband Point-to-Multipoint
- Broadband Point-to-Multipoint

Point-to-Point

- **Licensed Bands**
  - 6 GHz, 11 GHz, 18 GHz
    - Some congestion but generally available
- **Unlicensed Bands**
  - 2.4 GHz, 5.8 GHz
    - Secondary

Two-Way Voice

- **VHF/UHF**
  - **Generally shared**
  - **Exclusive spectrum congested in many areas**
- **800/900 MHz**
  - **Congested in many areas**

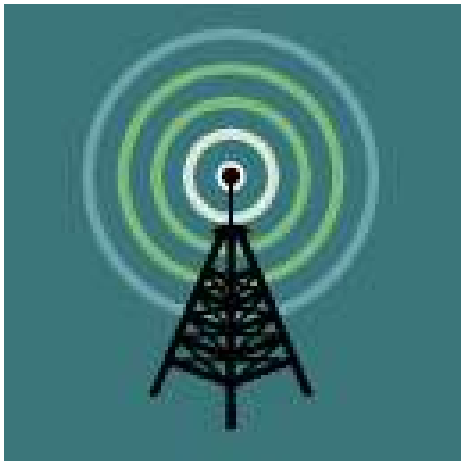
Narrowband Point-to-Multipoint

- **941/932 MHz, 952/928 MHz**
  - Generally 12.5 kHz
  - Primary
- **450-470 MHz**
  - 6.25 kHz, 12.5 kHz, 25 kHz
  - Generally secondary, some primary
- **150-170 MHz**
  - 6.25 kHz, 12.5 kHz, 25 kHz
  - Secondary and mobile use required except for very narrow bandwidth channels (6 kHz, 3 kHz)

Broadband Point-to-Multipoint

- **Unlicensed**
  - 900, 2.4, 5.8
  - TV White Spaces
- **Hybrid Licensed/Unlicensed**
  - 3.65-3.70 GHz
    - Weak interference protections
    - Possible Rule Change?

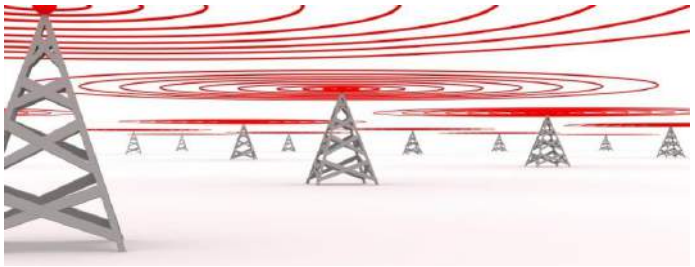
What's Missing???



What's Missing

- Point-to-Point
- Two-Way Voice
- Narrowband Point-to-Multipoint
- Broadband Point-to-Multipoint

Options



Auctioned Spectrum

	Narrowband ≤ 25 kHz	Midband 25 kHz to 500 kHz
CMRS Paging	YES	YES
AMTS (217/219 MHz)	YES	YES
220-222 MHz	YES	YES
Narrowband PCS (901/930/940 MHz)	YES	YES
MAS (928/959, 932/941 MHz)	YES	Some

Regulatory Considerations

- **Spectrum Eligibility and Use Restrictions**
  - Waivers often required
- **Co-Channel and Adjacent Interference Protection: Rights and Obligations**
- **Construction/Substantial Service Showings**
  - Benchmarks and timing considerations

Type of Agreements

- Asset/License/Frequency Purchase Agreements ("APA")
  - Assignments
  - Partitions (portion of area)
  - Disaggregation (portion of spectrum)
- Leases and Subleases
- Challenges of lease v. purchase
  - Limitations and restrictions on use
  - Subject to (Sub)Lessor vagrancies
  - Shifting financial arrangement

Future Options

- FirstNet – 700 MHz
- Pacific DataVision – 900 MHz
- 4.9 GHz
- 3550-3650 MHz
- Broader Spectrum Effort

Thank you

Greg Kunkle
Partner
Keller and Heckman LLP
1001 G Street, N.W.
Washington, DC 20001
202-434-4178
kunkle@khlaw.com

www.khlaw.com

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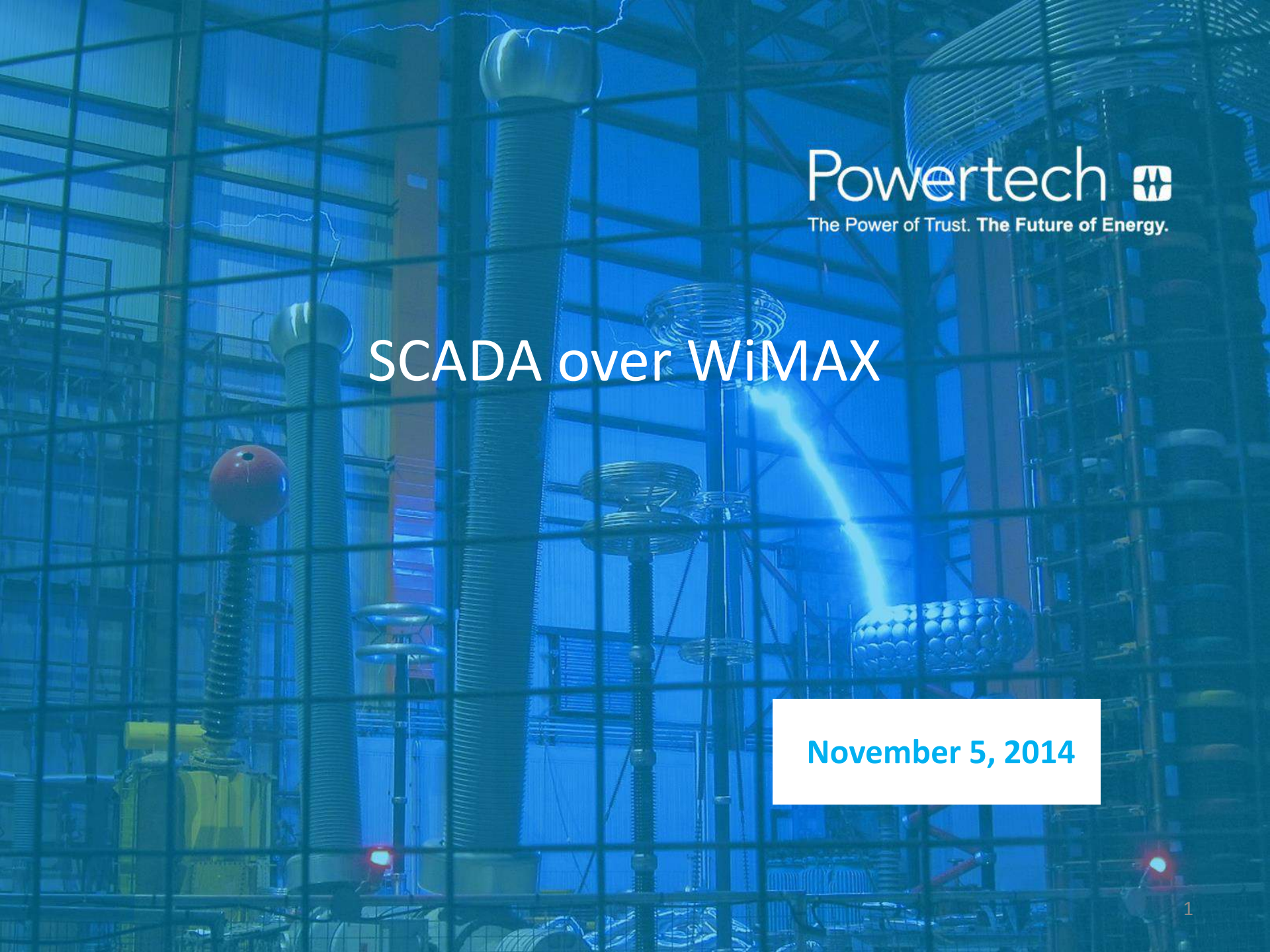
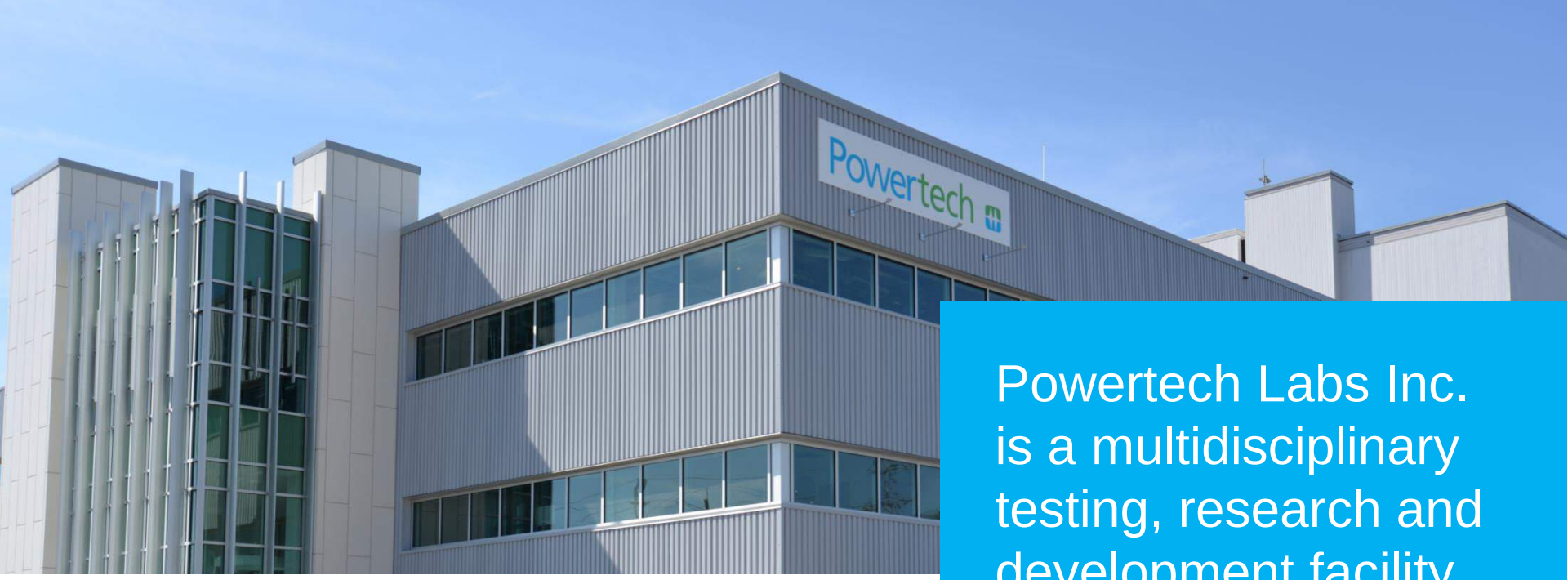


SCADA over WiMAX

November 5, 2014



Powertech Labs Inc. is a multidisciplinary testing, research and development facility.

We offer a one-stop-shop approach for businesses that require technical engineering expertise, standards and code testing, as well as quality testing and failure analysis services.

Powertech is a subsidiary of BC Hydro. We provide specialized testing and investigation services to support BC Hydro's capital assets: generation, transmission and distribution

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

Outline

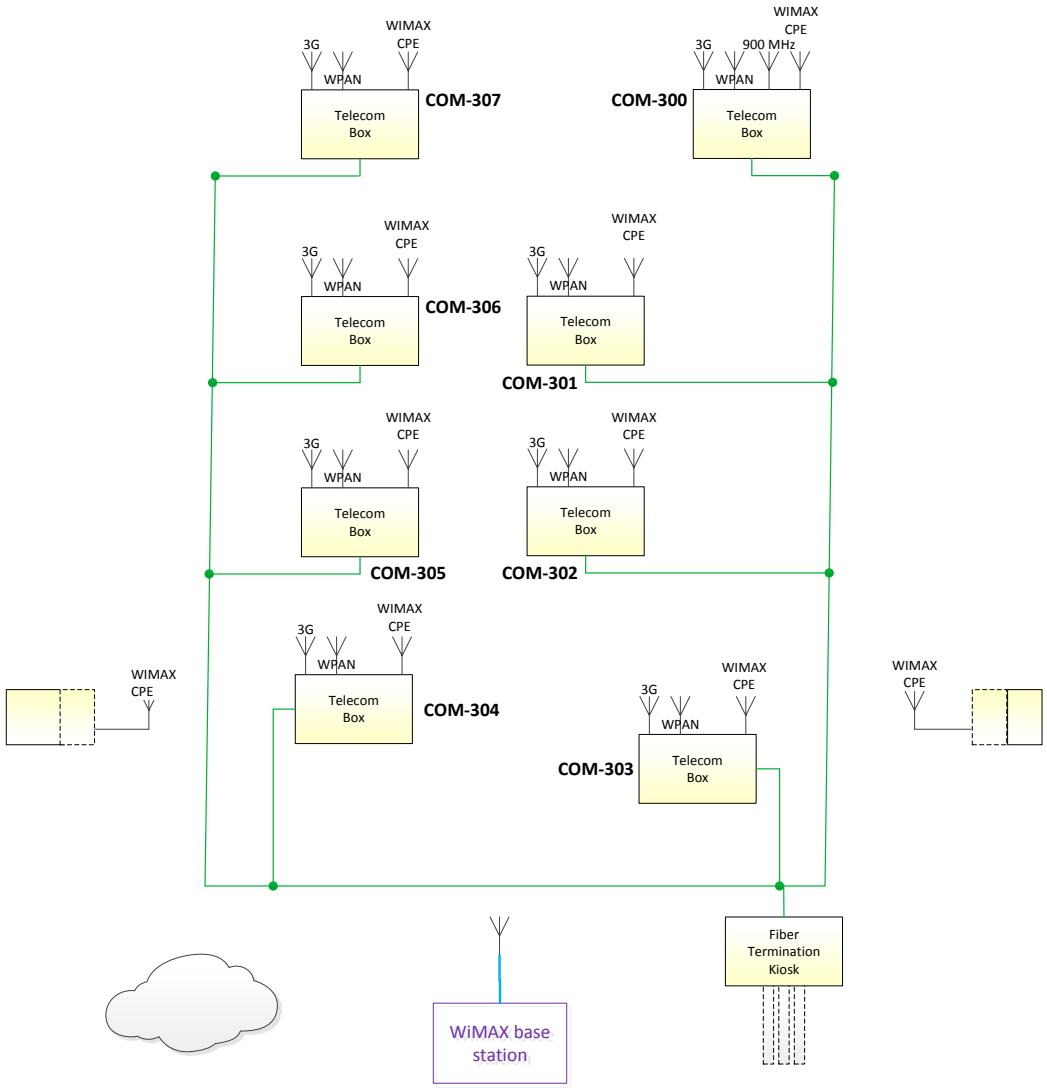
- Suitability of WiMAX for SCADA
  - Other options
  - SCADA test network
- WiMAX Smart Energy Use Cases
- WiMAX quality of service
  - Definitions
  - QoS example
- Network examples
- Conclusion

Suitability of WiMAX for SCADA

- Other options

	Implementation	Pros	Cons
Point to Point radio	Relatively easy	Throughput and latency and symmetrical	Deployment is difficult for a large number of remote sites.
Cable (Electrical)	Depends on the environment	Can be economic in some environments	Distance limited, needs repeaters to maintain throughput.
Cable (Optical)		Very good throughput and latency and symmetrical	The environment needs to be supportive.
Cellular	Easy	Fast deployment, availability of equipment.	Coverage and quality of service
WiFi	Relatively easy	Availability of equipment	No protection from interference
Mesh	Relatively	Ease of deployment	Throughput reduces and latency increases significantly with mesh depth
Proprietary point to multi-point	Relatively easy	Ease of deployment	Equipment availability may be limited
WiMAX point to multi-point	Relatively easy	Ease of deployment and availability of equipment	In some area spectrum availability may be limited

SCADA test network



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WiMAX Smart energy Use Cases

- WiMAX Smart Energy use cases baseline

WiMAX Forum® System Profile Requirements
for
Smart Grid Applications

Requirements for WiGRID

WMF-T31-002-R010v01

WMF Approved

(2013-02-05)

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WiMAX Smart energy Use Cases

- WiMAX Smart Energy use case communication requirements

Use Case	DL (kbit/s)	UL (kbit/s)	Latency (ms)	Packets per Sec	Msg. Freq.	Payload Type	Active / Idle	Predictability
1 - Situational Awareness	1.0 kbit/s	5.0 kbit/s	1000 ms	5 pps	5 sec	TCP	1sec / 5sec	Good
2 - Monitoring	~10 kbit/s	~300 kbit/s	100 ms	100 pps	100 ms	TCP and UDP	Active	Good
3 - Control	1.0 kbit/s	5.0 kbit/s	100 ms	10 pps	1 sec	TCP	1sec / 5sec	Random
4 - Protection	150 kbit/s	150 kbit/s	20 ms	100 pps	100 ms	UDP	Active	Random
5 - Metering Regional Collector	5 kbit/s	64 kbit/s	1000 ms	20 pps	100 ms	TCP	Active	Good
6 - Remote Site Communications	500 kbit/s	500 kbit/s	100 ms	100 pps	20 ms	TCP	Active	Good
7 - Direct Smart Meter Reading (AMI)	0.05 kbit/s	1.0 kbit/s	5000 ms	1 pps	5 min to 6hr	TCP	100ms / 4secs	Good

Channel bandwidths by frequency band

Channel bandwidth by frequency bands for WiGRID						
	1.4 GHz		1.8 GHz	2.3 GHz	3.65 GHz	5.8 GHz
Duplex	FDD (A & B)	TDD	TDD	TDD	TDD	TDD
3.0 MHz	Should	Must		May	May	
3.5 MHz			Should	Must		Should
5.0 MHz		Should	Must		Must	Must
7.0 MHz					May	
10.0 MHz			Must		Must	

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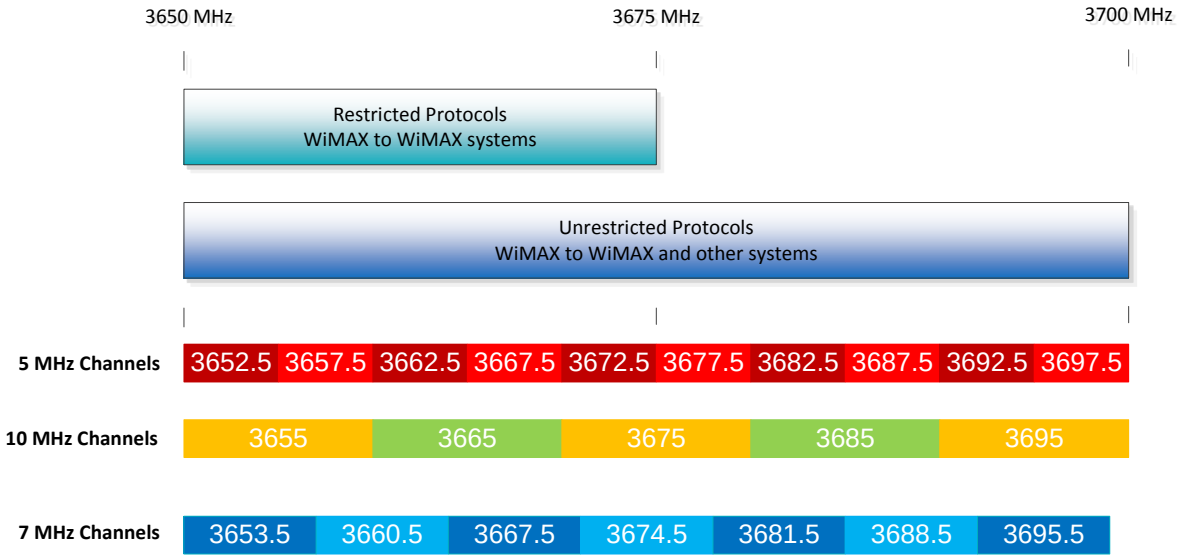
Usable frequency bands

- Channel plan
  - 3.65 GHz



  - Capacity

Capacity by bandwidth			
	Max with QPSK 1/2	Max with 64 QAM 5/6	Cell capacity at edge
5.0 MHz	2.2	11.0	2.5
7.0 MHz	2.8	14.3	3.2
10.0 MHz	4.4	22.4	5

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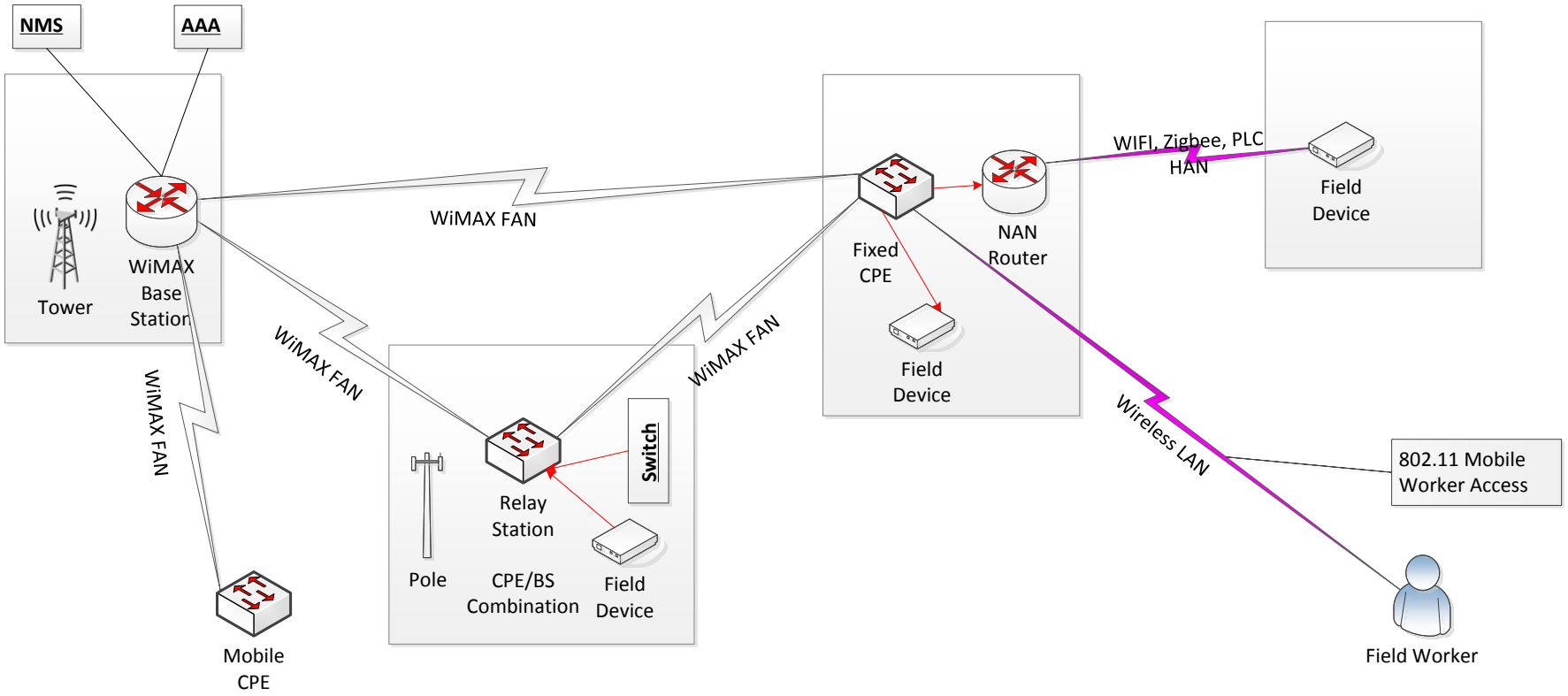
WiMAX Quality of Service Definitions

QoS Category	Applications	QoS Specifications
UGS: Unsolicited Grant Service	VoIP, T1 replacement	Maximum Sustained Rate Maximum Latency Tolerance Jitter Tolerance
rtPS: Real-Time Packet Service	Streaming Audio or Video	Minimum Reserved Rate Maximum Sustained Rate Maximum Latency Tolerance Traffic Priority
ErtPS: Extended Real-Time Packet Service	Voice with Activity Detection (VoIP)	Minimum Reserved Rate Maximum Sustained Rate Maximum Latency Tolerance Jitter Tolerance Traffic Priority
nrtPS: Non-Real-Time Packet Service	File Transfer Protocol (FTP)	Minimum Reserved Rate Maximum Sustained Rate Traffic Priority
BE: Best-Effort Service	Data Transfer, Web Browsing, etc.	Maximum Sustained Rate Traffic Priority

WiMAX Quality of Service Example

Service Profile Configuration										
UL SF Name	Classification Rule Priority (0-255)	Direction	Scheduling Service	Min Rate	Max Rate	Traffic Priority	RT Interval Grant	UGS Interval Polling	HARQ-MAX Retries	MAX Latency
UL Medium-RT	0	UL	RT	Medium	1.5 Mbps	5	3 min	N/A	3	0
UL Low-RT	1	UL	RT	Low	1.5 Mbps	5	3 min	N/A	3	0
UL Low DA-UGS	2	UL	UGS	Low DA	128kbps	7	N/A	3 min	3	20 ms
UL Medium DA-UGS	3	UL	UGS	Medium DA	192kbps	7	N/A	3 min	3	20 ms
UL High DA-UGS	4	UL	UGS	High DA	256bps	7	N/A	3 min	3	20 ms
UL-SCADA-RT	5	UL	NRT	(SCADA)4.7kbps	1.5 Mbps	5	3 min	N/A	3	0
UL-High-RT	6	UL	RT	High	1.5 Mbps	5	3 min	N/A	3	0
DL SF Name										
DL Medium-RT	0	DL	RT	Medium	1.5 Mbps	5	3 min	N/A	3	0
DL Low-RT	1	DL	RT	Low	1.5 Mbps	5	3 min	N/A	3	0
DL Low DA-UGS	2	DL	UGS	Low DA	128kbps	7	N/A	3 min	3	20 ms
DL Medium DA-UGS	3	DL	UGS	Medium DA	192kbps	7	N/A	3 min	3	20 ms
DL High DA-UGS	4	DL	UGS	High DA	256kbps	7	N/A	3 min	3	20 ms
DL-SCADA-RT	5	DL	NRT	(SCADA)4.7kbps	1.5 Mbps	5	3 min	N/A	3	0
DL-High-RT	6	DL	RT	High	1.5 Mbps	5	3 min	N/A	3	0

WiMAX based SCADA network



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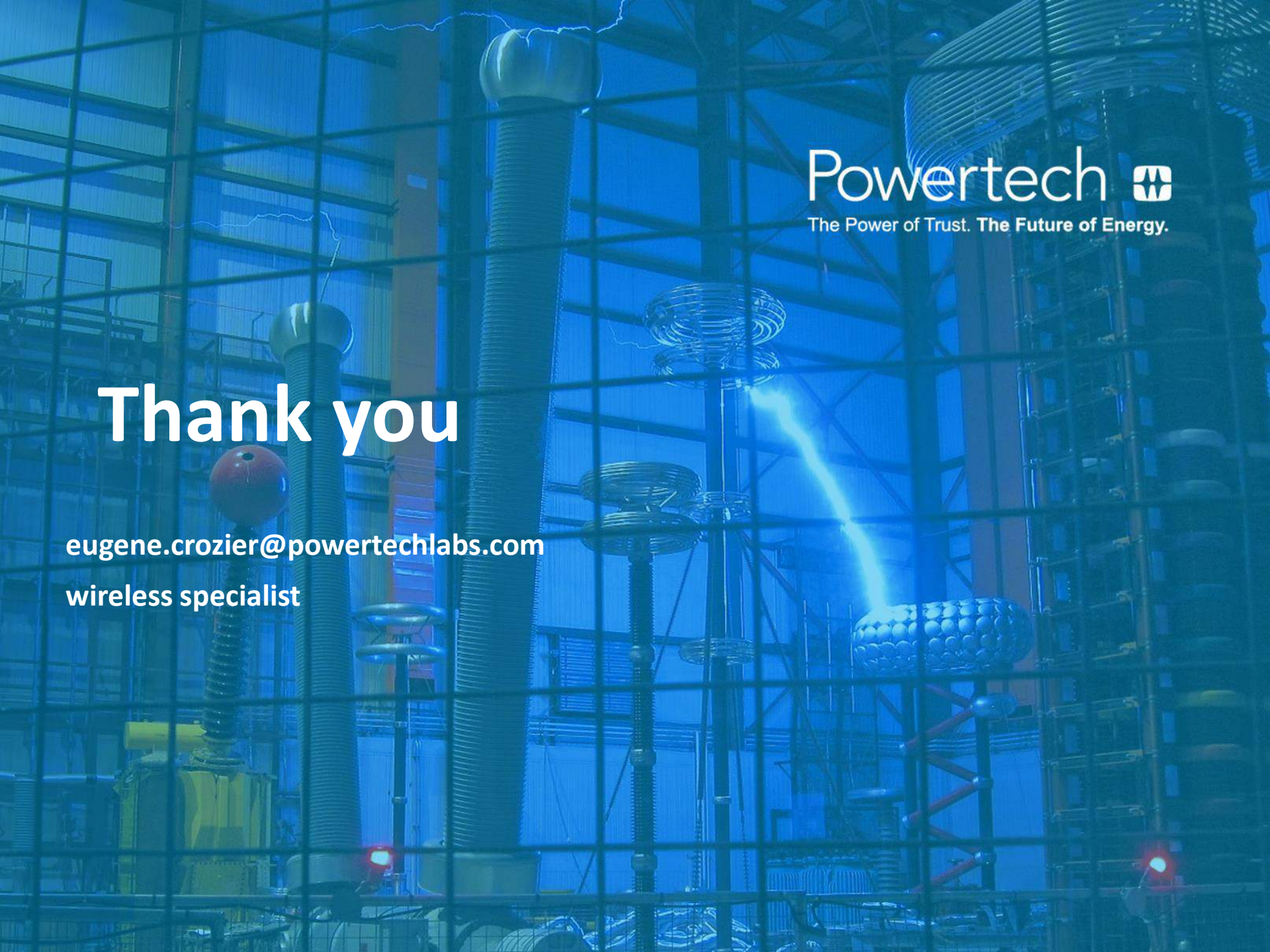
Conclusions

- WiMAX can provide a good solution for SCADA end devices.
- Can be part of a larger network.
- Understanding of the end using devices.
- Calculate or find.
  - Throughput needed, continuous, peak, frequency.
  - Latency tolerable.
  - Response time.
  - Security requirements.
  - RF plan.
- Decide on the QoS parameters.
- Verify and or test the solution.
- Smaller networks don’t intense verification, but larger network are difficult to simulate.
- Optimize after deployment.



Thank you

eugene.crozier@powertechlabs.com

wireless specialist

Digital Oilfield Application Solutions

Judy LeStrange, Sr Product Manager
GE Wireless
judy.lestrange@ge.com

Imagination at work.

Oct 24, 2014 | Version 1.9

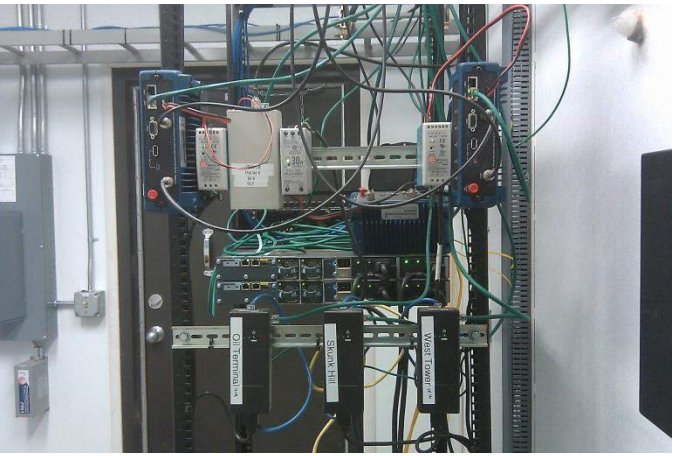
Agenda

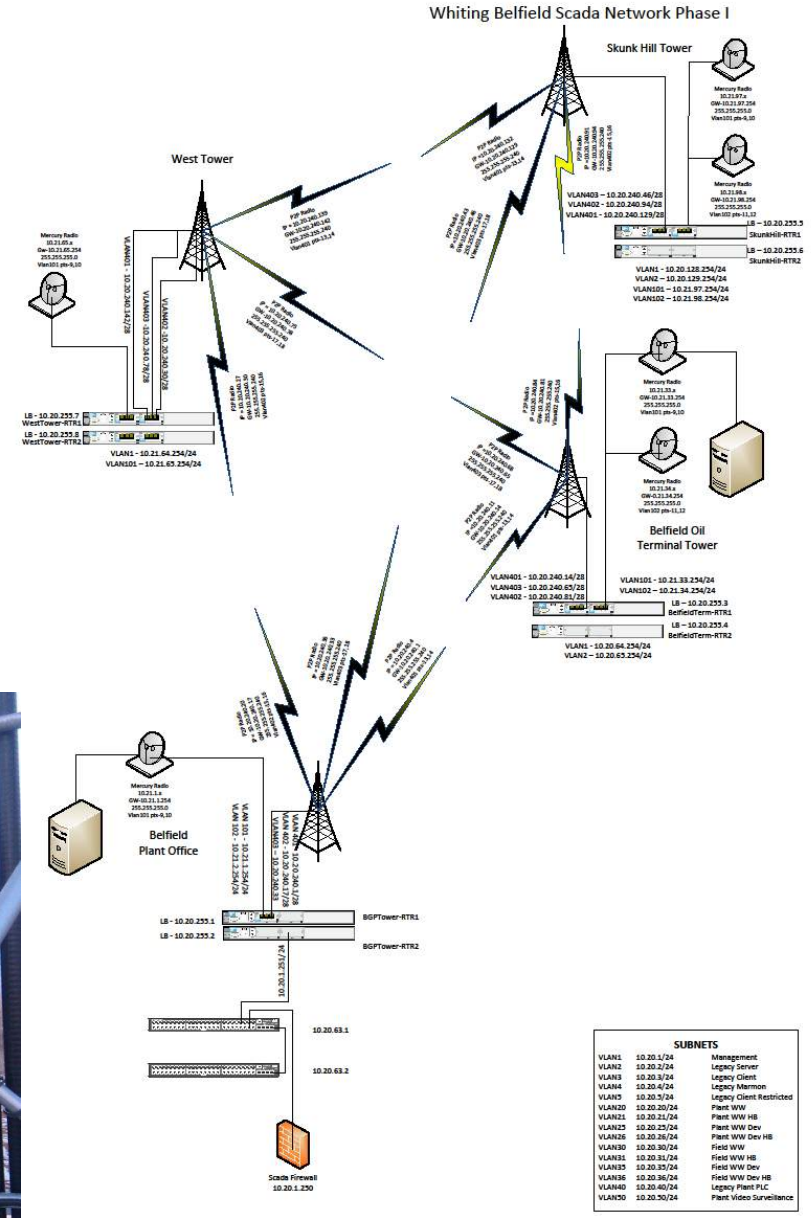
1. Industry Challenges
2. Orbit MCR Product and Features Overview
3. Oil & Gas Applications

Industry Challenges

Case study 2012

- **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.**





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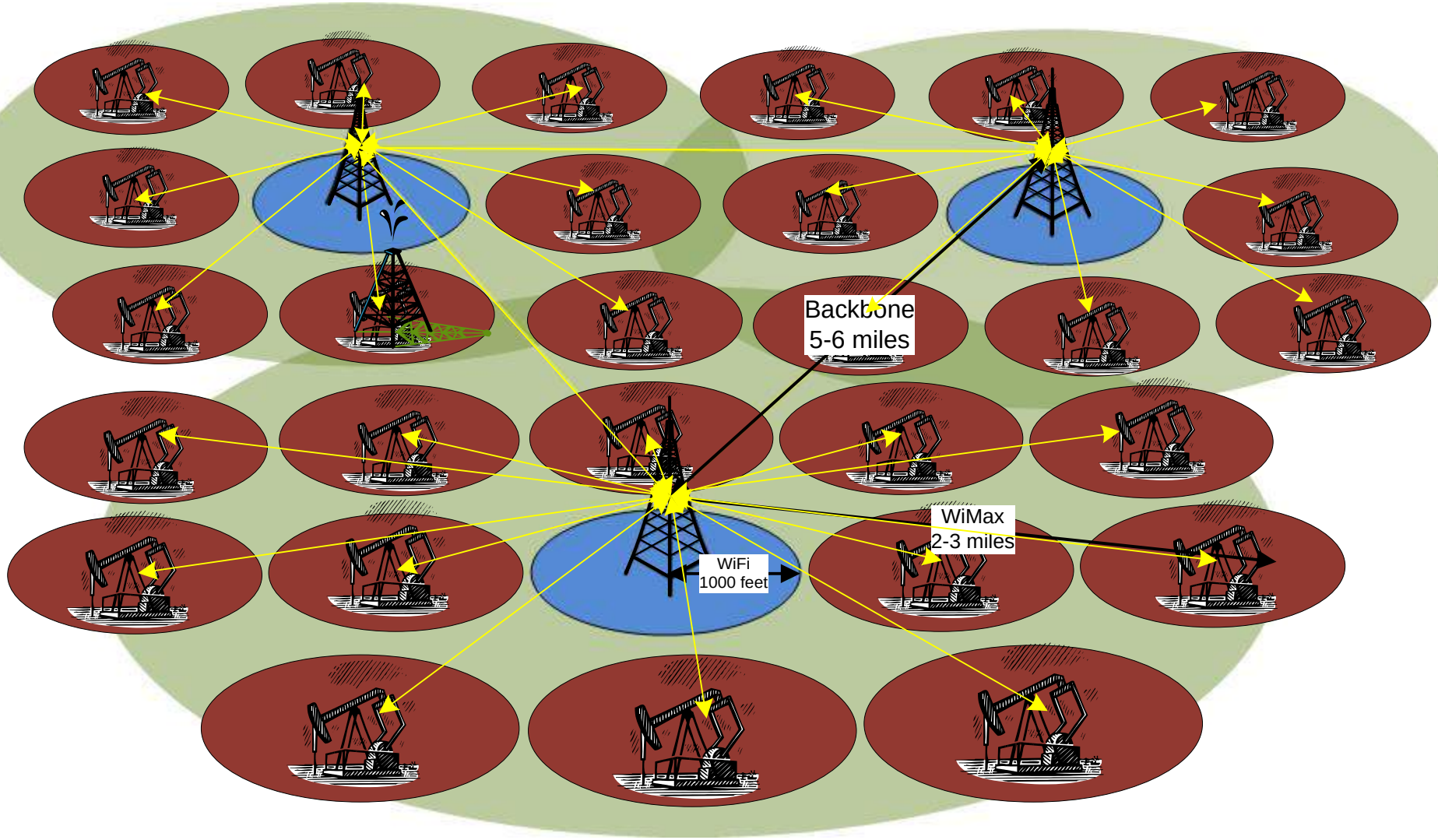
Case study 2013

- 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

Mission:

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

EP Energy WiMAX Field



O&G Applications Challenges & Requirements

Challenge	Networking Requirement
Deployment in harsh physical environments with little access to electricity	Ruggedness and hardening of networking equipment, low power consumption suitable for solar sites
Communication access to applications must be reliable	High Availability and longevity of communication equipment and reliability of communication links
Networking assets must be secure and resisting to cyber attacks and intrusion	Support for local and central authentication, communication encryption, secure firmware
Ability to operate multiple applications on same network infrastructure	Support for SCADA/remote monitoring applications, Video, Workforce mobility
Cost-effective reachability into rural areas with no cell coverage	Support for long range private and unlicensed networking
Investment Protection: Network needs to accommodate future applications	Investment commitment from vendor and flexibility to support future technologies

Orbit MCR Product and Features Overview

Orbit MCR Introduction

- Multi-service, multi-access, hardened M2M gateway supporting a wide range of networking and wireless technologies
- Purpose-built for mission-critical industrial applications
- Enables application convergence to optimize CAPEX & OPEX
- Architected using a state of the art cyber security framework
- Designed as a “platform”:
  - ✓ New Linux-based ORBIT OS
  - ✓ Separation of Data and Control Planes
  - ✓ Modular software architecture
  - ✓ Modular hardware architecture

Orbit's Fit Within GE Wireless Portfolio

Wireless

Fiber

Data Acquisition
Sensors & Measurement

WiYZ
Mesh for Serial, Analog & Digital I/O Sensors

Netio
Unlicensed For Analog & Digital I/O Sensors

SD Series
Licensed for IP/Serial

entraNET
Unlicensed for IP/Serial

TransNET
Unlicensed for Serial

X790 Series
Licensed Redundant, Full-Duplex Master Station

DGT
Unlicensed Distributed Generation Trip Control

LAN Extension
Converged Applications

Orbit MCR Series
Converged Communications 3G/4G, High Perf Unlicensed, Wi-Fi, Ethernet, Serial

Mercury Series
1.8 GHz and 3.65GHz WiMAX

iNET Series
Long Range 512Kbps Unlicensed for IP/Serial

Backhaul
Long Range High Capacity

Intrepid/Ultra
2.4, 5.4, 5.8GHz Unlicensed and 4.9GHz Licensed Microwave

Intrepid HC MC/OIP
Up to 38GHz Licensed Microwave

Intrepid P2MP
5.4 and 5.8GHz Unlicensed Multipoint Microwave

Transport
Gigabit Backbone

JungleMUX SONET
OC-48 Transport & Access Multiplexer With GiGE

TN1U SDH
STM-16 Transport & Access Multiplexer With GIGE

TN1Ue SDH
STM-16 Transport & Access Multiplexer With Gigabit Ethernet

Access
Granular Provisioning

JungleMUX T1
T1 Access Multiplexer With Integrated CDAX

E1MX
E1 Access Multiplexer With Integrated CDAX

E1MXe
E1 Access Multiplexer With Integrated CDAX

PulseNET NMS

VistaNET NMS

The Goods Under the Hood

Superior Ruggedness & Reliability

Ruggedized die-cast aluminum enclosure provides enhanced thermal dissipation for extended reliability.

Diverse Wireless Support

Dual Wireless NICs enable mix-and-matching of various RF technologies for augmented deployment flexibility

Advanced System Performance

Modular, high performance processor, ASIC/hardware-accelerated data plane, and advanced QoS enable deterministic data processing and transmission.

Comprehensive Security Framework

Industry leading, standards-based security controls provide authentication, integrity, and confidentiality through strong cryptographic algorithms in addition to a full stateful firewall. Objective: protect the user, device and network.

Orbit MCR Features Overview

Quality / Reliability

- Highly rugged hardware design
- Built with IPC-610 Class 2
- World class automated PCBA manufacturing equipment
- Automated Final Testing Suite
- HALT& HASS Testing
- ATEX approved for EU
- IEEE 1613 , IEC 61850-3
- CSA Class 1, Div. 2, UL 508, UL 1604 compliant
- EN 60079-0:2012, EN60079-15:2010 ATEX for EU
- -40º to 70º C
- Designed & Manufactured in Rochester, NY

Security & Management

- Stateful Firewall
- IPSec VPN tunnel encryption
- Secure boot
- Digitally signed Hardware
- Digitally signed Software
- Signed (by customer) SW image
- Magnetometer tamper detection/alert
- AAA/RADIUS Authentication
- Event logging, syslog/TLS
- Secure management SSH, HTTPS, SNMPv3
- iPERF throughput diagnostic
- GUI & Juniper-style CLI mgmt

Networking

- Layer 3 routing capabilities
- Layer 2 switching capabilities
- Advanced L2-L4 Quality of Service classification and policing
- Concurrent bridging and routing across NICs
- ModBus RTU/TCP/UDP
- Low latency IEC 61850 GOOSE Support
- Serial/Terminal Server
- PAT/NAT/NTP/DNS/DHCP etc...
- Ethernet, RS232/485
- USB console management

Comms Flexibility

- 2 wireless NIC Cards
- CDMA and GSM Cellular
- High Perf 900 MHz Unlicensed
- WiFi with dual SSIDs
- Support for Point to point, point to multipoint and Mesh architectures on 900MHz ISM
- Variety of M2M deployment architectures

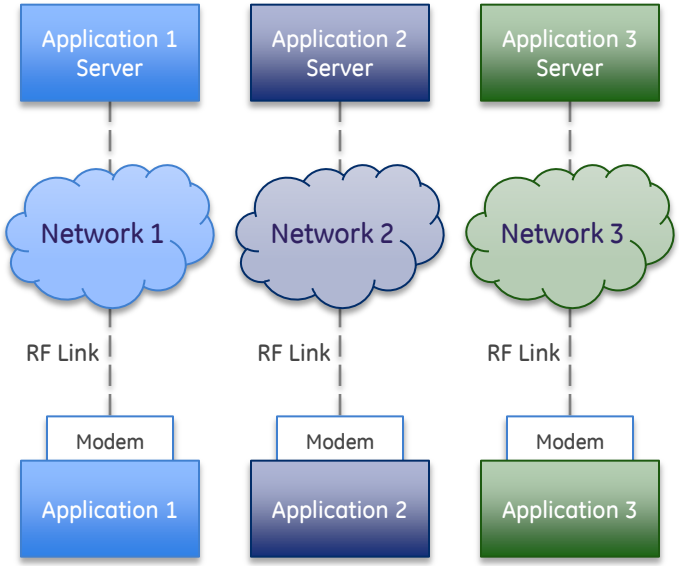
imagination at work

Orbit MCR Features Categorization

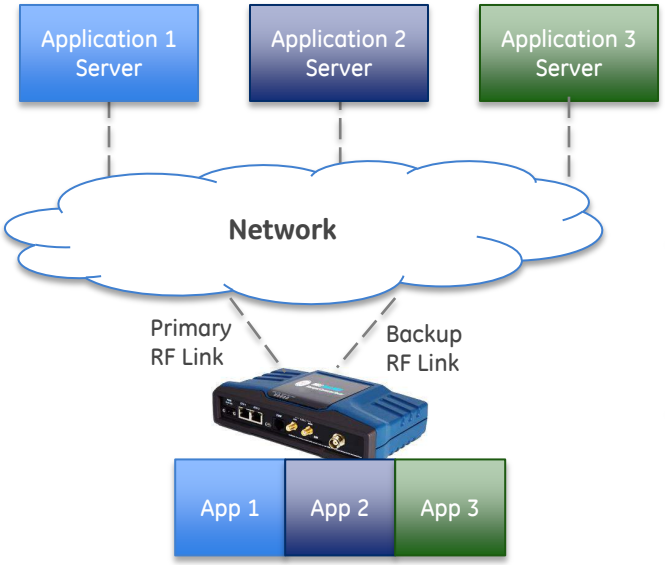
Capabilities	Applicability	Benefits
Router	Route between NICs or VPN	Flexible network design options
Switch	Bridge between NICs	Support of Layer 2 environments and IEC61850
Security	Authentication, Firewalling	Protection for user, device, and network
IPSec VPN	VPN server/client, Encryption	Encrypt & tunnel between sites, meet regulations
Advanced QoS	Apply to any NIC or port	Meet application SLA via deterministic networking
Redundancy	Routing / Path	Improve High Availability and network up time
Serial Server	Modbus/TCP/UDP	Connect into legacy install base
Various RF	ISM, Cellular, Wi-Fi, Licensed	Choices of RF based on application and terrain

Legacy vs Modern Converged Networks

Legacy Purpose-Built Networks



Modern Converged Networks



WAN Side:
- Ethernet
- RF Mesh (future)
- 4G LTE
- 3G Global
- 900MHz unlicensed
- Bridging
- Routing

Access Side:
- Secure WiFi
- Fast Ethernet
- Serial (Modbus)
- Bridging
- Routing

- Dedicated network per application
- Point to point, no flexibility
- Mostly proprietary protocols
- Different RF technologies meant different vendors
- High cost of maintenance, operation
- Low capabilities`
- Low security

- ✓ Advanced QoS allows a single-box-solution for a mix of applications of different criticality
- ✓ Combined switching and routing between any interfaces allows for a variety of deployment scenarios
- ✓ Various network media technology including cellular, licensed, unlicensed, Wimax, Ethernet, Serial etc…
- ✓ Single platform, multiple deployment architectures
- ✓ Highly secure communications with VPN and firewalling
- ✓ Very easy to use through GUI and Web Wizards

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Modern Network Convergence Requirements

Convergence Requirement	Orbit Solution
Internet Protocol Enabled	Support for IPv4 & services (PAT/NAT/DNS/DHCP/NTP, etc…)
Flexible RF/network access options	4G/3G Cellular, 900MHz ISM, Wi-Fi, Ethernet, Serial, (Wimax, 15.4g/6LowPAN and Licensed Narrowband on roadmap)
Routing capabilities	Routing between any RF or physical interfaces allow for flexible positioning of Orbit in the network as a CPE or RF Aggregation
Support for IPv6 (native, tunneling)	IPv6 support with 6LowPAN will enable Internet of Things (IoT) applications (roadmap)
Switching/bridging capabilities	Full bridging capabilities between physical and RF interfaces (except for cellular) allow for flexible traffic flow designs
Deterministic behavior for critical traffic	Advanced L2-L4 Quality of Service functionality guarantee the mixing of critical and non-critical traffic on the same network without compromising critical traffic SLAs
Open Standards	Orbit built around standard-based protocols and architectures for industry compliance and interoperability
Modularity	Modular hardware architecture down to CPU board level is a future-proof investment protection
Advanced and comprehensive security	IP Sec VPN encryption, Firewalling, AAA/Radius, Signed Firmware/Hardware allow the transport of any type of L2 or L3 traffic securely
Edge or FOG Computing	Planned support for CPU virtualization enables distributed data crunching (running Apps) to support Big Data initiatives

imagin

Convergence: Utilizing the same wireless infrastructure for a multitude of applications. Application-specific determinism is guaranteed by advanced QoS and higher bandwidths.

Orbit Cyber Security Framework

Data & Communication Security

- Access Control
- Authentication
- Data plane security

- Username/password login
- Role based access control
- EAP-TLS authentication
- IPsec VPN Encryption
- Firewall & Stateful Packet Inspection
- AES 128 & 256-bit encryption

Administrative Security

- Secure device management
- Certificate management
- Audit and logging

- SSH, HTTPS, Netconf
- Complete certificate services
- Multi-tier PKI integration
- Extensive event logging
- Syslog-over TLS

Manufacturing Security

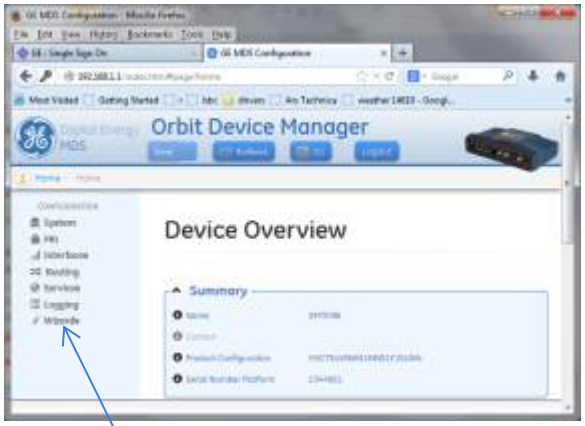
- Secure development
- Secure firmware
- Vulnerability tracking

- Secure coding practices
- Third party testing
- Digitally signed firmware
- **100% designed and manufactured in Rochester, NY USA**

Intuitive GUI and Secure Device Management

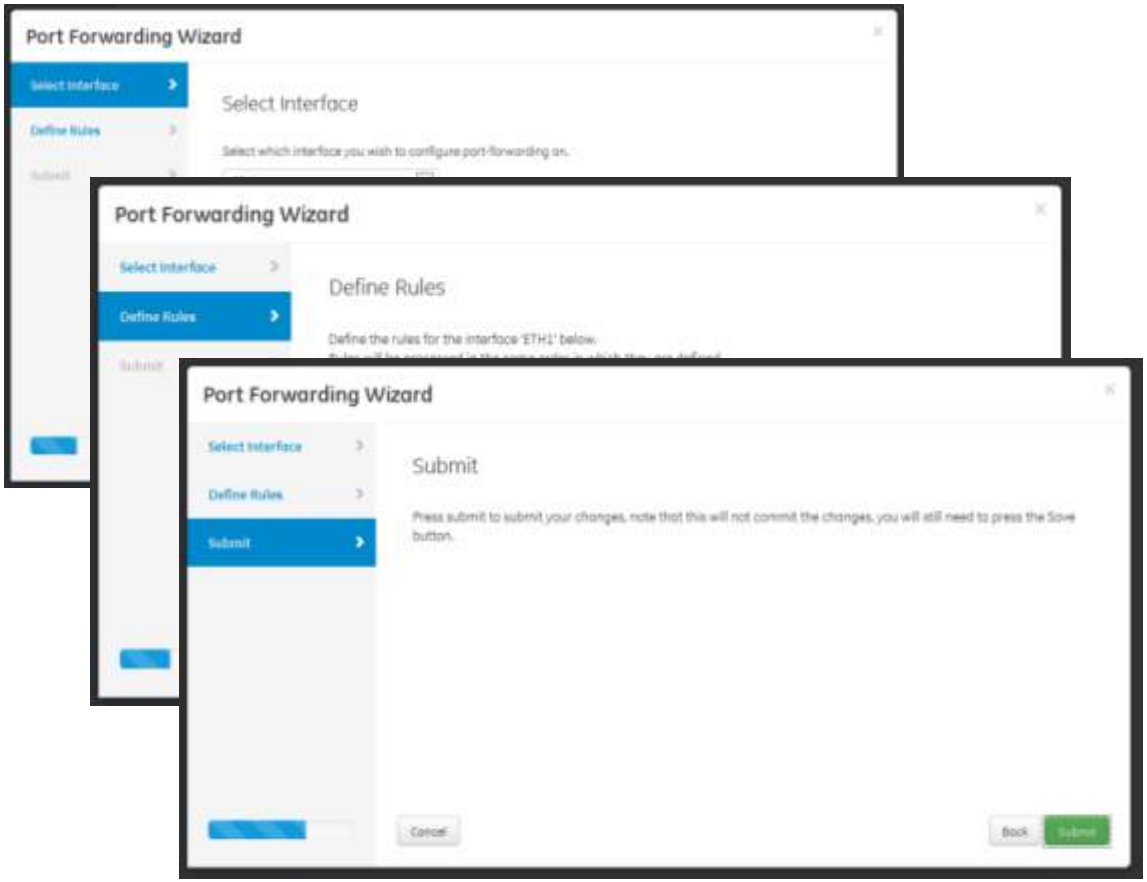
- Multiple options for interfaces:
  - Web / HTTPS
  - SNMP v1/2/3
  - SSH command line interface (CLI)
  - NETCONF with YANG models
- Local and RADIUS user authentication
- Integration with GE MDS PulseNET NMS
- NTP client to synchronize time of day
- System restore points for configuration rollback
- Role based access control with three defined roles
- Local event logging with forwarding via syslog client
- Configuration scripts with user-defined configuration snapshots
- Digitally signed firmware images and network-based download
- Magnetometer for protection against physical tampering and theft

Configuration Wizards: VPN, NAT, Forwarding, Firewall, Etc …



Link to wizards

Example: port forwarding



imagination at work

Industrial Hardening and Ruggedness

- Built to last from the ground up
- Hardened cast aluminum enclosure
- Industrial hardening and endurance
- Power: 10-60VDC

  Consumption:
  4 watts average (20% duty cycle)
  3 watts in receive | 8 watts peak

- IEEE 1613 & IEC 61850-3 & ATEX compliant
- CSA Class 1, Div. 2, UL 508, UL 1604
- -40 to +70 Celsius operating temp

Ran over by a Truck

+

Shot at with a 12-gauge

+

Landed on pavement from a 100 feet vertical fall

=

Orbit MCR-4G still fully functional!

Orbit MCR Core & Device Roadmap

- **IPv4 Routing** (OSPF, RIPv2)
- **Layer 2 Tunneling** (L2TPvx)
- **Full IPv6 Support**
- **CoAP, DTLS, Lightweight M2M Agent**
- **Cloud Service Integration**
- **Orion Processing Engine**
- **Orbit Family of Products With Various Form Factors & Functions For More Flexible M2M Integration:**
  - ✓ Master Station
  - ✓ Lightweight edge router: Small footprint, low power, low cost, single NIC
  - ✓ Controller/Sensor class: Small footprint, low power, low cost, single NIC

Master Station

Edge Orbit Routers

Orbit Sensor/Access Nodes

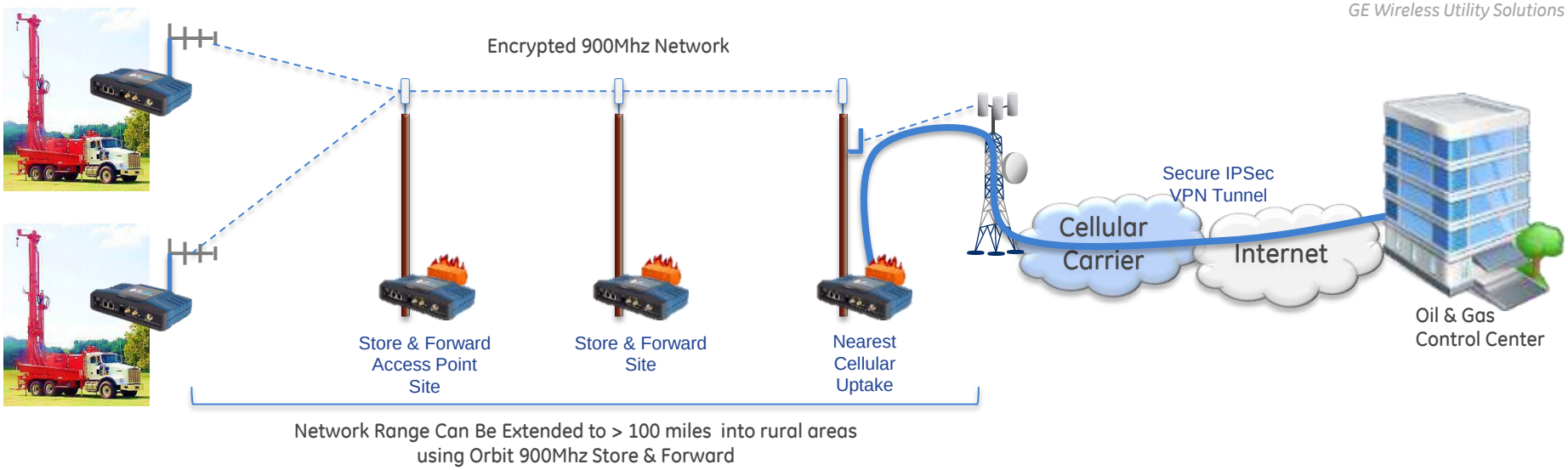
Orbit
Oil & GAS Applications

Oil & GAS Applications

1. Cost-Effective Networking for Rural Well Drilling
2. Extended Range Pipeline Monitoring & Control
3. Performance Mesh for High Density Oil Fields
4. Extending the Network to the Sensor with WiYZ
5. The Connected Oil Field: Monitoring, Control, Workforce

Cost Effective Connectivity For Oil Drilling

GE Wireless Utility Solutions

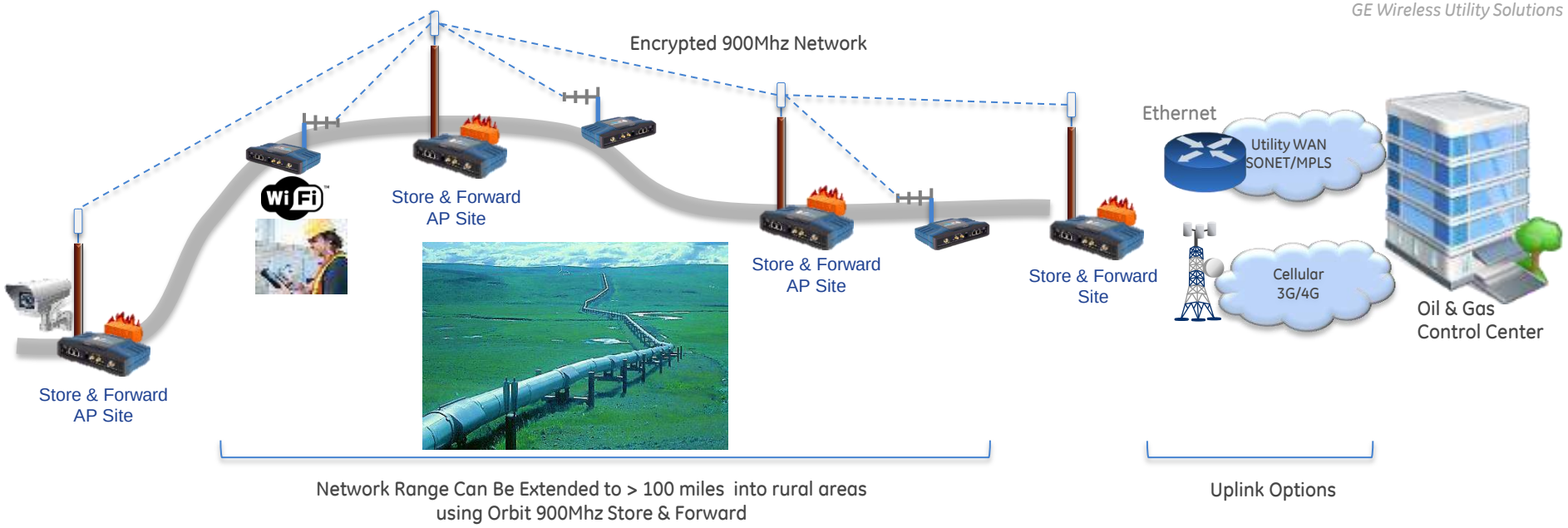


Application Characteristics

- Digitized oil drills generate gigabytes of data from drill sensors which are required to be transferred to headquarters for analysis and feedback on drilling location adjustment. Traditionally monitoring computers would write data on hard drives which are then transported after the drilling to headquarters for analysis.
- Extending a direct communication link into oil drills enables real-time analysis and feedback from headquarters. However most often drilling operations take place in rural areas with no cell coverage. Satellite communication is expensive, and building microwave towers is slow and expensive too.
- Orbit's 900Mhz store-and-forward solution enables up to 1.25Mbps of half-duplex bandwidth to be extended via up to 8 hops, with distance of up to > 30 miles between hops. Either hops can act as an access point to downstream orbit remotes located at drill sites.
- Orbit's solution is fast to deploy, cost-effective, requires no licensing, and is flexible enough to permit uplink of cellular or 900Mhz to headquarters.

Long Range Pipeline Monitoring & Control

GE Wireless Utility Solutions

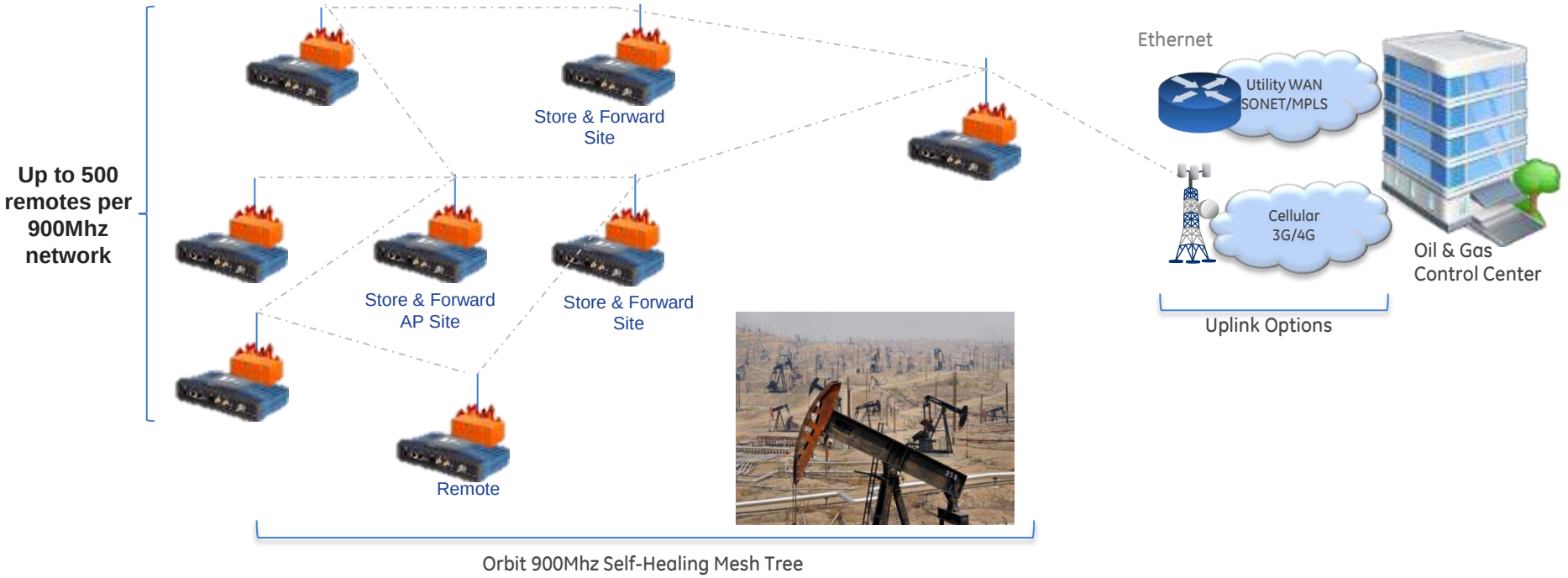


Application Characteristics

- Oil pipelines applications can include cathodic protection telemetry and alarms, pressure and flow sensing, asset monitoring, video security, workforce remote access. Pipelines often extend through rugged terrain and remote areas with no cost-effective access to backhaul networking or nearness to cellular networks.
- Orbit's high performance 900MHz solution offers a store-and-forward technology which can extend to more than 30 miles between any two hops, and with a total of 8 hops per network. The same store-and-forward hops can simultaneously serve as an Access Point site for surrounding sensors within a range of up to 30 miles. In select sites, secure Wi-Fi access can be provided for maintenance workforce access or for WiFi-enabled video security devices. The total scalability can be up to 500 total remotes per Orbit 900MHz network.
- All communication paths, including WiFi, 900Mhz Access Point, and 900 MHz store and forward are encrypted using enterprise class 128/256bit key encryption technologies.

Self-Healing High Density Oil Fields Network

GE Wireless Utility Solutions



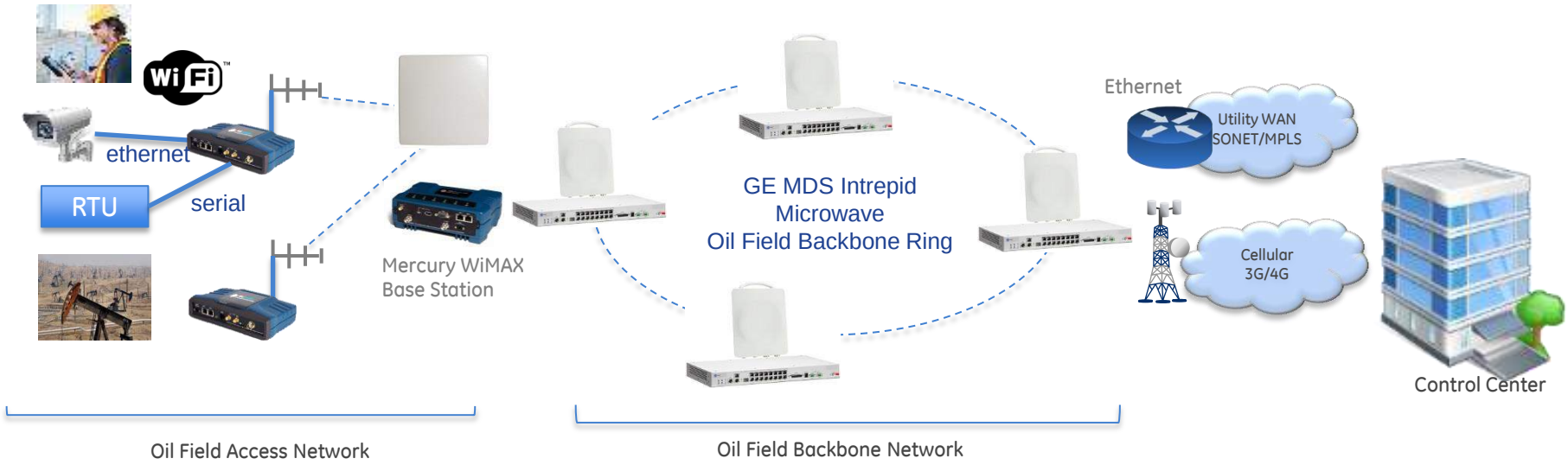
Application Characteristics

- Orbit's 900MHz technology allows for higher RF sensitivity and gain and an extension of more than 30 miles between any two hops (based on terrain). Its Store-and-Forward technology allows for the daisy chaining of up to 8 hops to further extend coverage.
- A combination of Store-and-Forward and Access Point functionality enables Orbit to form a self-healing tree mesh network with a scalability of up to 500 nodes per network to allow network coverage for large oil fields.

imagination at work

The Connected Oil Field

GE Wireless Utility Solutions



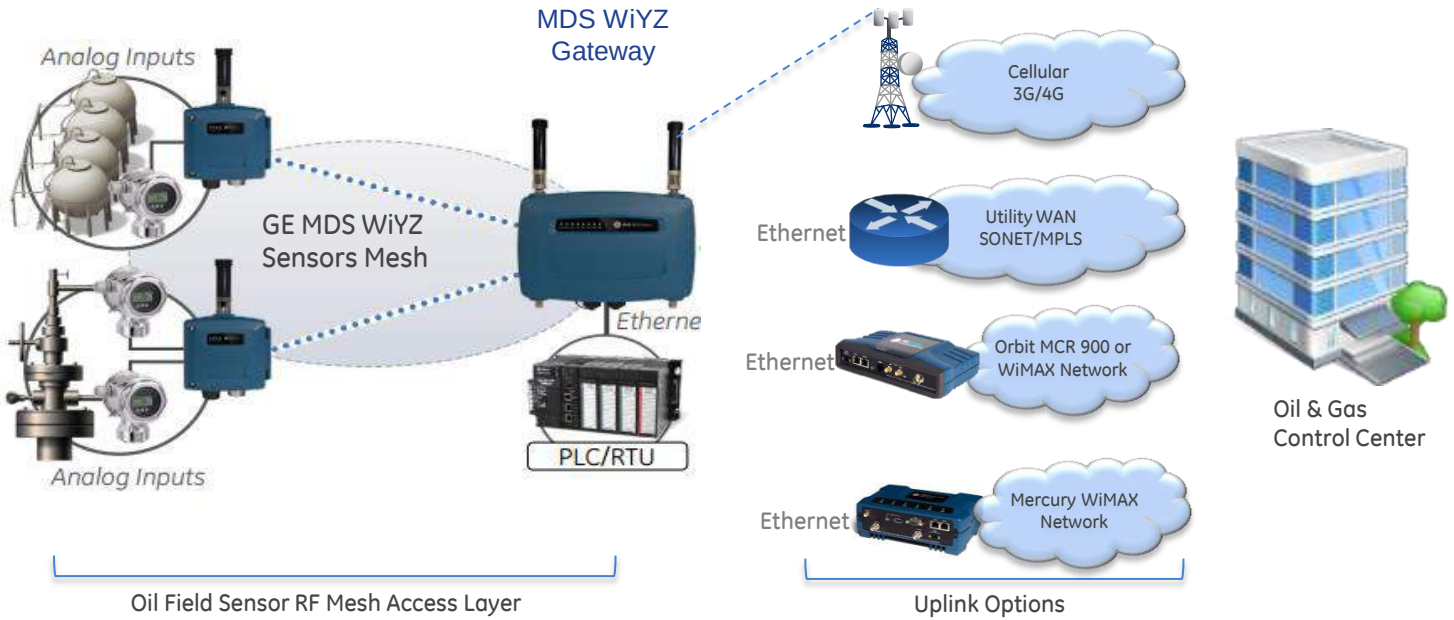
Application Characteristics

- A large oil field network can be layered for the purpose of organizing and optimizing traffic flow and distribution. The backbone network is where all aggregation traffic flows and it connects the access network as well as the uplink/backhaul network.
- In this example, a GE MDS Intrepid microwave solution is used for the backbone of an oil field forming a redundant Layer 2 ring with capacity exceeding 300Mbps. And an Orbit MCR 900MHz Network, WiMAX or an SD Master/SD Series licensed network could be used at the Access layer of the network
- 128 or 256 bit encryption could be enabled end-to-end over the RF links, and in addition IPSec VPN encryption can be enabled on top for added layers of security. Firewalling can be enabled at each Orbit site to provide traffic filtering for security and QoS optimization purposes.

imagination at work

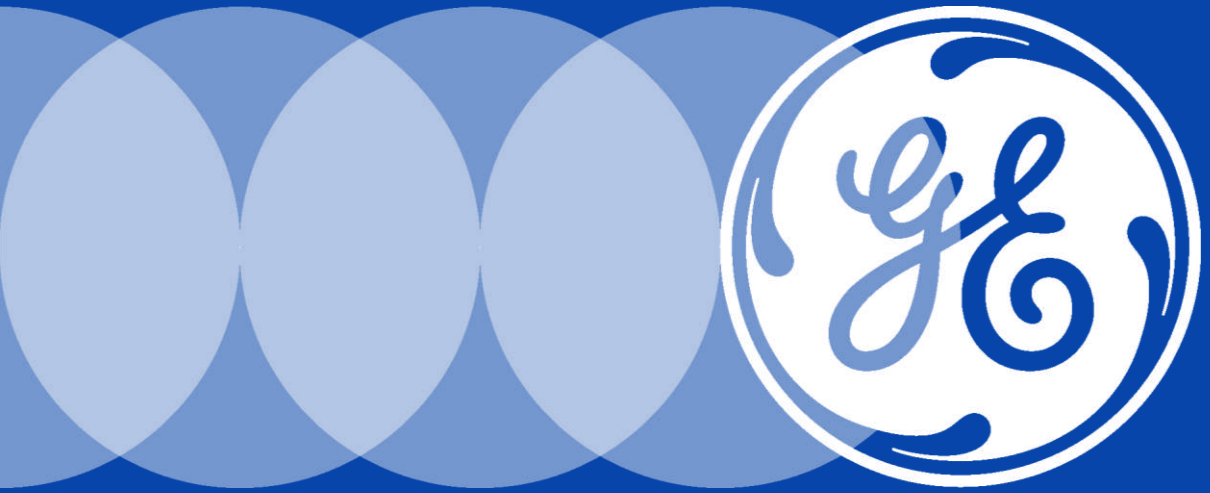
Extending The Network to the Sensor

GE Wireless Utility Solutions



Application Characteristics

- GE MDS WiYZ offers a gateway + remotes solution where remotes carrying I/O ports transport data over IP and an RF mesh network with a range of up to 1200 feet up to the WiYZ gateway. The gateway acts as an aggregation point for downstream sensors.
- In turn, the gateway connects upstream to an Orbit device for backhaul, or for enabling the creation of a core network for large scale oil fields.



BACKUP

The Importance of Standard 4G Solutions

November 2014

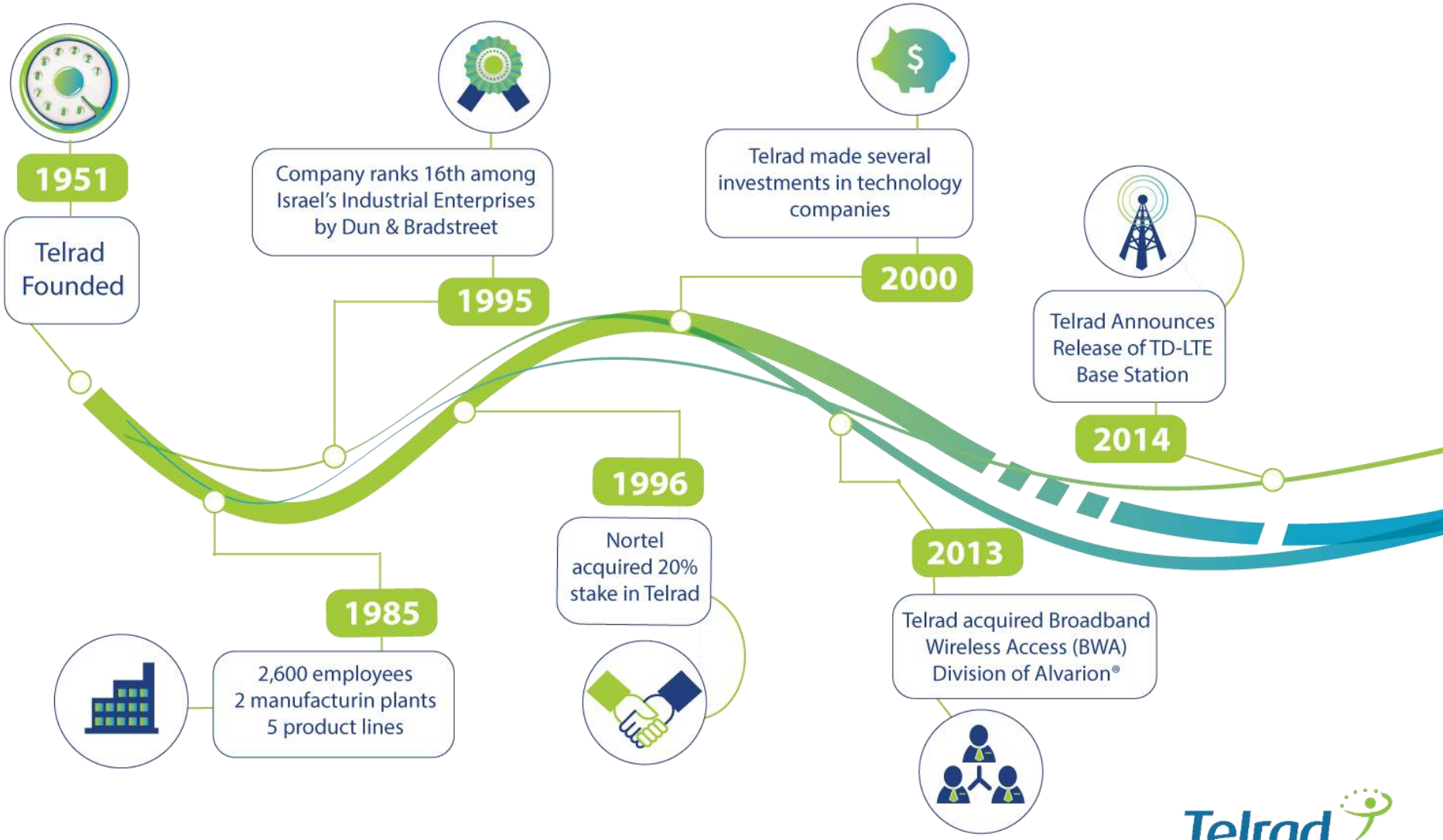
Chris Daniels

General Manager, North America

Telrad

We're on your wavelength.

Telrad's 60+ Year Telecom Legacy



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Applications

- Offshore drilling
- Exploration
- Pipeline monitoring
- Digital oil field

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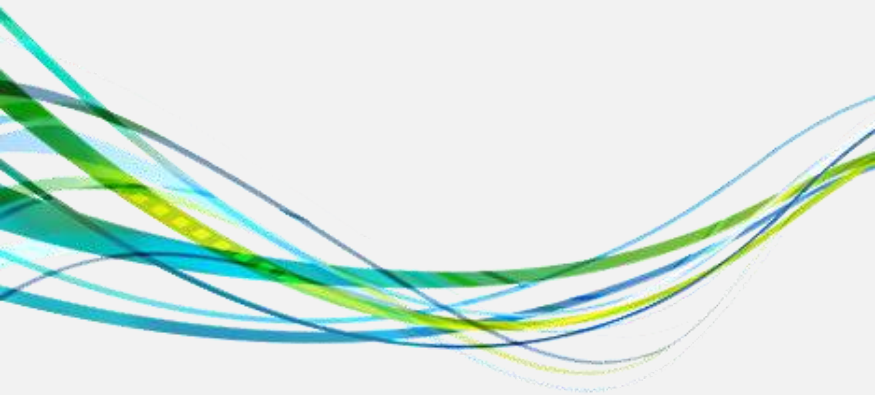
Requirements

Wireless Solution Must …

- Provide adequate throughput today with scalability for tomorrow
- Provide consistent performance
- Provide reliable connectivity in LOS and NLOS conditions
- Provide important features
  - Layer 2 services
  - Static IP capabilities
  - Uplink prioritization over downlink
  - Local data termination
- Be straightforward to install and maintain
- Allow for simple authentication
- Address industry specific requirements and standards



Proprietary or Standards Based?

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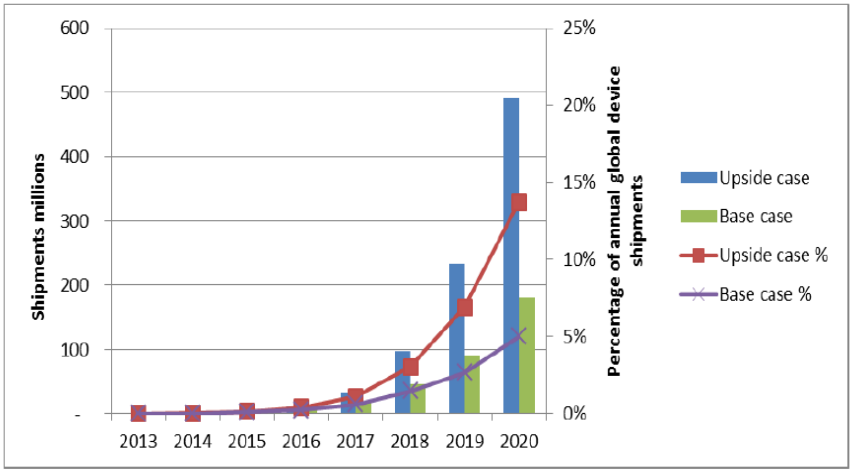
Proprietary 802.11x/802.16/etc…

- Upsides
  - High throughput and excellent performance in LOS conditions
  - Solutions targeted at specific applications
  - UL/DL is typically dynamic
  - Offer important features like layer-2 bridging, static IP, etc…
  - Straightforward to install and operate
  - Perceived as low cost
- Downsides
  - Poor performance in NLOS conditions
  - Non-standard solution
    - Single company driving the technology forward
    - Potentially stranded investment
    - No ecosystem of devices
  - Limited scalability
  - CAPEX may be low, but TCO is not always

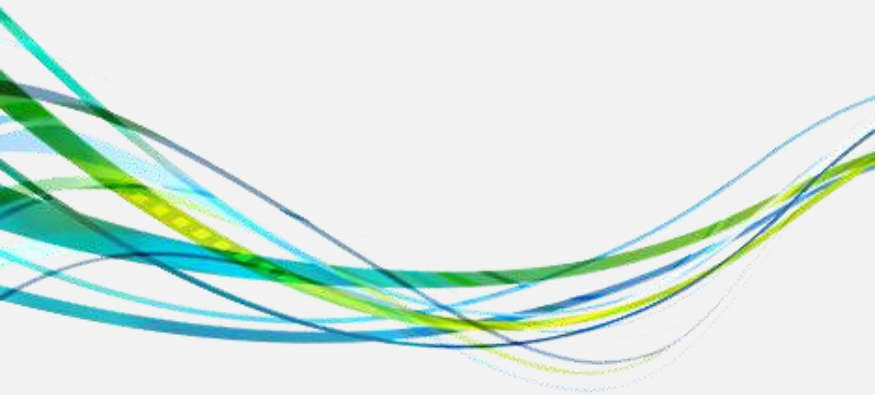
Telrad

Standards Based Solutions

- Global community driving the technology forward
  - Competition driving development cycles
  - Advanced feature set
- End-user ecosystem driven by a mass consumer market
  - Greater end-user device options
  - Cost decreases as the market grows
- Standards based interoperability protects your investment
  - Fate of your network is not tied to an individual company
  - Option to leverage multiple vendors



Forecast of Global Shipments - Band 42/43 Devices. Source: *Innovation Observatory.*

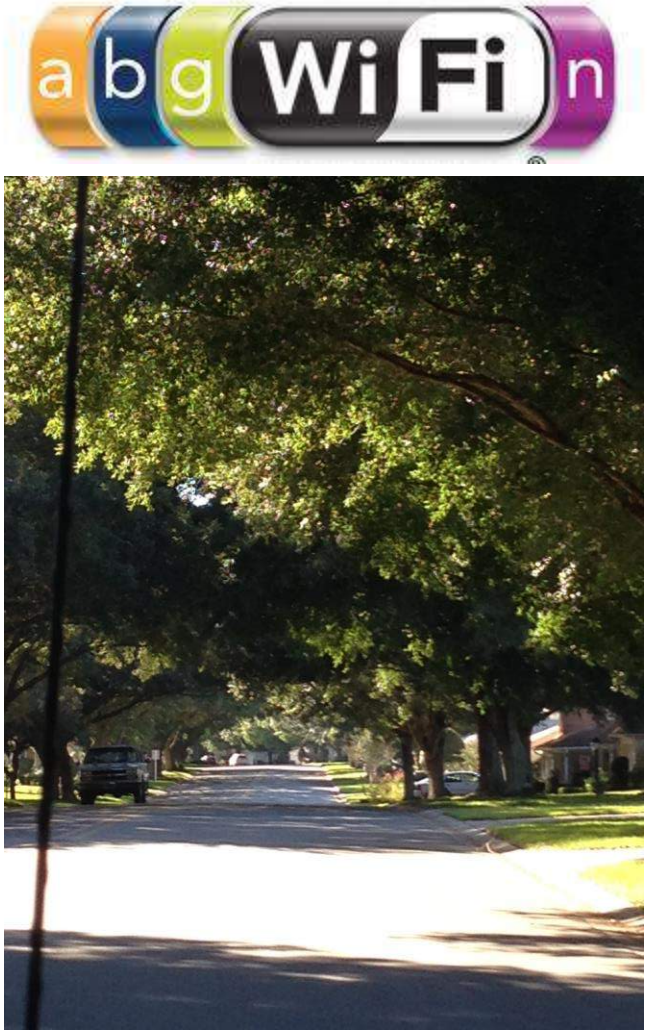


Which Solution is Best?

Telrad

Standards Based WiFi

- Upsides
  - Standards based with a vast ecosystem
  - UL/DL bandwidth is dynamic
  - Excellent performance in LOS conditions
  - Initial CapEX is typically low
  - Easy to install and operate
- Downsides
  - Poor performance in NLOS conditions
  - Limited coverage
  - Limited scalability
  - No path to future technology
  - CAPEX may be low, but TCO is typically not



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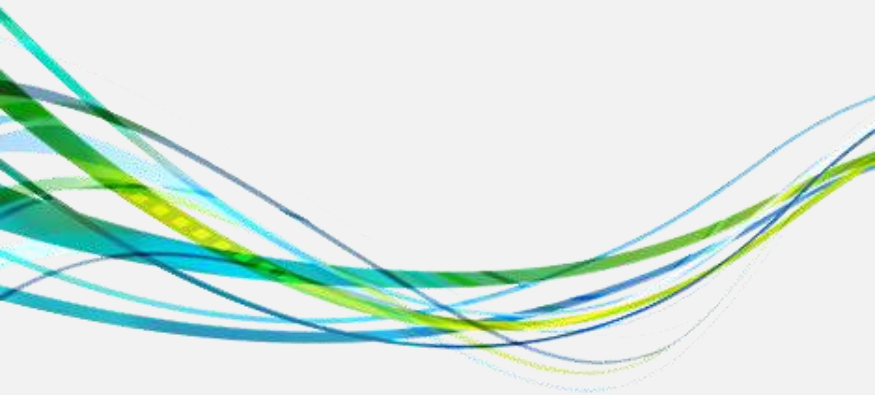
WiMAX 802.16e

- Upsides
  - Standards based, mature technology
  - Highly scalable
  - Ecosystem of devices for specific applications
  - Solutions available that allow prioritization of the uplink
  - Excellent performance in NLOS conditions
- Downsides
  - Mature standard
  - Comparatively low throughput per CPE due to 10MHz chipset limitation
  - Requires a slightly more complex infrastructure than WiFi and proprietary
  - Chipset availability as we move to TD-LTE

TD-LTE (WiMAX Advanced)

- Upsides
  - Wider channels provide greater capacities
  - Scheduled protocol provides predictable latency
  - Sub 20ms latency
  - Advanced feature set
  - Excellent performance in NLOS conditions
- Downsides
  - 3GPP is primarily a mobile standard, fixed is an afterthought
  - Most LTE solutions are focused on tier-1 mobile networks and HetNet
  - Authentication is extremely complex
  - Core is extremely expensive
  - Layer 2 services, static IP, and other features are not addressed by 3GPP
  - SIM cards required in all CPE



What To Look For In An LTE Solution

Telrad

Telrad's Focus is Fixed LTE

- Standards based, but focused on fixed
- Layer 2 bridging capability
- True static IP
- Simplified and cost effective core
- AAA integration
- DHCP server integration
- Appropriate level of mobility

Telrad

BreezeCOMPACT

- ✓ Telrad SDR Technology
- ✓ Dual Sector / Carrier
- ✓ Embedded EPC
- ✓ Flexible site and spectrum topologies
  - ✓ Wide band tunable Radio (up to 300Mhz)
  - ✓ 2.3, 2.5, 3.5-3.7, and 5GHz bands
- ✓ 4x4 MiMO
- ✓ 3GPP Releases 9, 10, and beyond

Telrad

Telrad EPC Advantage

- Telrad EPC solution provides simplicity and cost effective pricing
  - Smooth migration for WiMAX services enabling advanced IP and L2 (Eth/ VLAN) services as was supported in WiMAX
  - Interworking with AAA system using Radius protocol (similar to WiMAX) - provides simplified integration into the operator's back-office systems
  - Telrad EPC-integrated HSS (suitable for small-scale networks)
  - Full-scale interworking with Operator's HSS 3rd party vendor
  - Pays as you grow strategy with scalable cost effective MC-EPC or embedded EPC

Telrad

CPE7000 CPE Portfolio

Specifications	
Data and Voice Capabilities	1 Data + 2 Voice lines
Frequency	3.4-3.8GHz (B42, B43) *2.3-2.7GHz (B40, B41)*
Radio Configuration	1TX x 2RX
Transmit Power	27dBm WiMAX *23dBm LTE*
Weight	1.2 kg
Internal Antenna Gain	15dBi
Power Consumption	7 W
Environmental standard	*IP67*

3GPP limitation: Tx Power of 23dbm (WiMAX is 27dbm)

Telrad

SIM Card is Provided

- SIM cards may be purchased together with CPE7000
- Beneficial for small-medium operators and enterprise
- Not a requirement for tier-1 operators who purchase customized SIM cards

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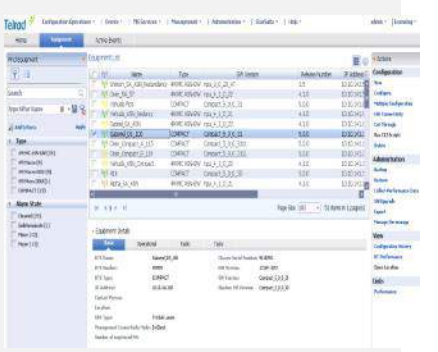
Star-Suite Network Management Solution

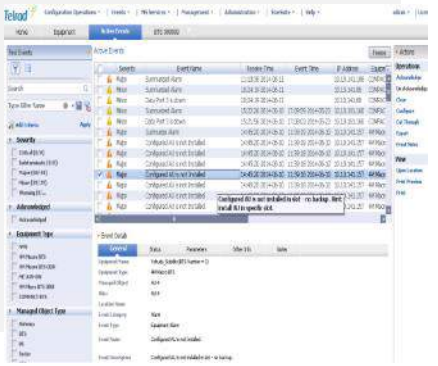
StarACS
CPE Management

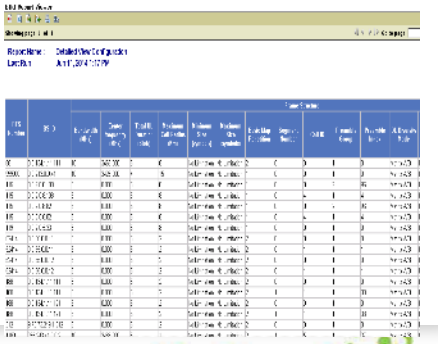
StarManager
Network Management

Star-Suite Network Management Solution

StarQuality
Network Performance







Telrad

Smooth Transition from WiMAX to LTE

- Operators not sure how to make transition
- Telrad offers a versatile, scalable transition to LTE
  - Leveraging a standard that enables operators to run both WiMAX and LTE concurrently
- WiMAX operators can offer broadband services using their current platform – and introduce LTE slowly (or quickly) as ecosystem matures
- Using an SDR, dual mode solution operators can offer fixed, nomadic and even mobile support to their subscriber base

Radical Broadband Wireless Innovation. **It's what we do.**

Telrad

The Telrad Advantage

- LTE standards base solution, with a focus on fixed
- Superior NLOS performance
- Excellent capacity for both LOS and NLOS scenarios
- Consistency in service offering to your customers
- High level of scalability
- SDR technology provides a nearly future proof solution
- Smooth migration from WiMAX to LTE
  - Existing 802.16e networks
  - Proprietary solutions based on 802.16e

LTE Products

	Product	
	Base stations	Compact1000 (3.4-3.7, 3.6-3.8 GHz) Compact2000 (3.4-3.6 GHz) Compact3000 (2.5-2.7 GHz) Compact3000 (2.3-2.4 GHz)
	CPE	CPE7000 (3.4-3.8GHz) CPE7000 (2.3-2.7GHz)
	SIM Card	Telrad SIM
	Telrad EPC	MME, SGW, PGW
	HSS	3rd Party HSS or Internal HSS in EPC
	NMS	LTE NMS including : Configuration management, performance monitoring and CPE management ACS

Thank You!

www.telrad.com

Telrad

We're on your wavelength.

Delivering Effective 4G Broadband Internet to Remote Oil & Gas Production Facilities

Presentation

For

WiMAX Forum at Oil &Gas Comm

November 5, 2014

Carl-Johan Torarp
Founder/Chairman/CEO
cjtorarp@localoop.com
612-327-3303

LocaLoop

Today's Reality

- ***Speed to market & profitability*** - hampered by legacy communication technology
- Fragmented systems from price-gouging vendors – no interoperability and low accountability
- Inefficient and high-latency inhibits real-time data transfer / reporting / monitoring
- No single cost-effective solution across the entire well site's life cycle (exploration through production)
- Web enabling of field operation not viable
- Worker's well-being and quality of life a distant and low priority

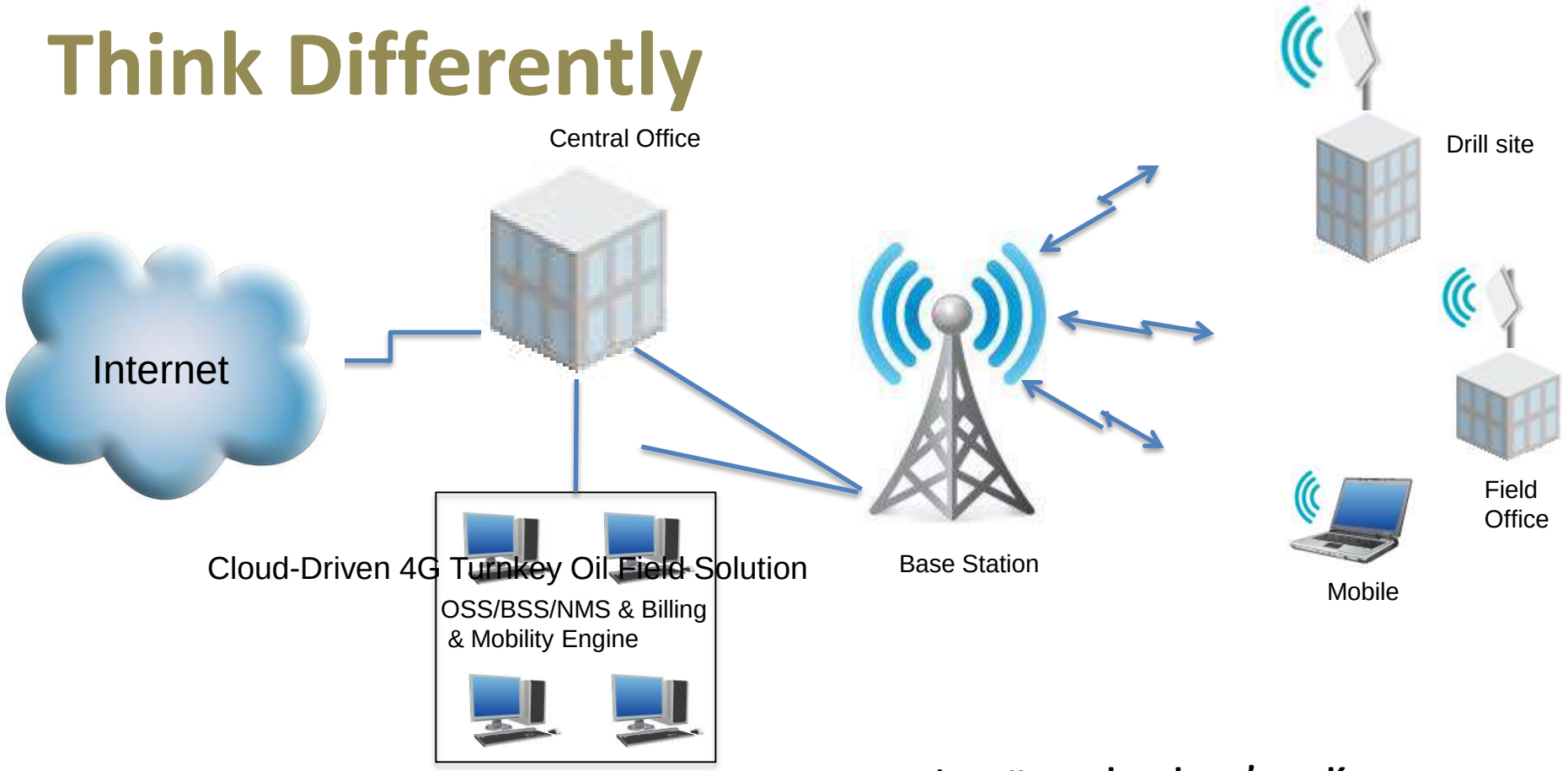
The Four Key Communications Infrastructure Challenges in the "Oil Patch"

1. Cost Effectively deploying and managing broadband services
2. Need for high-performing, secure, reliable fixed and mobile services
3. Scaling services up – and down – based on needs of the business (exploration through to production)
4. Insuring worker satisfaction and on-site quality of life

LocaLoop & Service Providers: Meeting the Challenges

1. Cloud-based SaaS / IaaS business and operational intelligence, real time, 24x7
2. Nimble and standards-based 4G local infrastructure – located where it's needed
3. Single solution over the oil field's life cycle
4. Seamless fit – from business needs to personal life-style communications

Think Differently



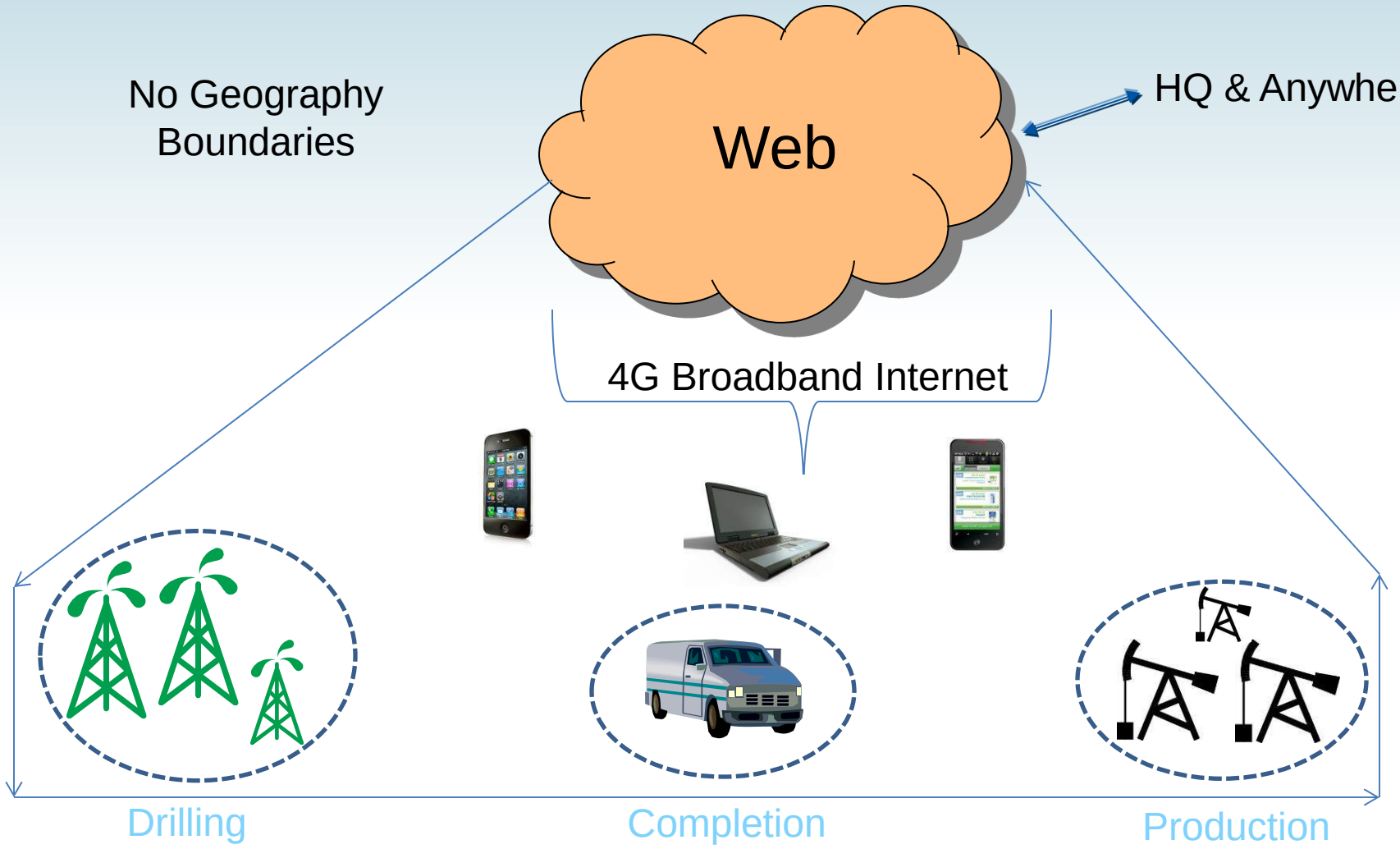
Cloud-Driven 4G Turnkey Oil Field Solution

	Legacy (Satellite & Cell)	LocaLoop's synKro Platform
Initial capital investment	$$$$	$
Ongoing yearly operating costs	$$$$	$
Single Solution for oil field life cycle?	No	Yes

4 Patents

LocaLoop

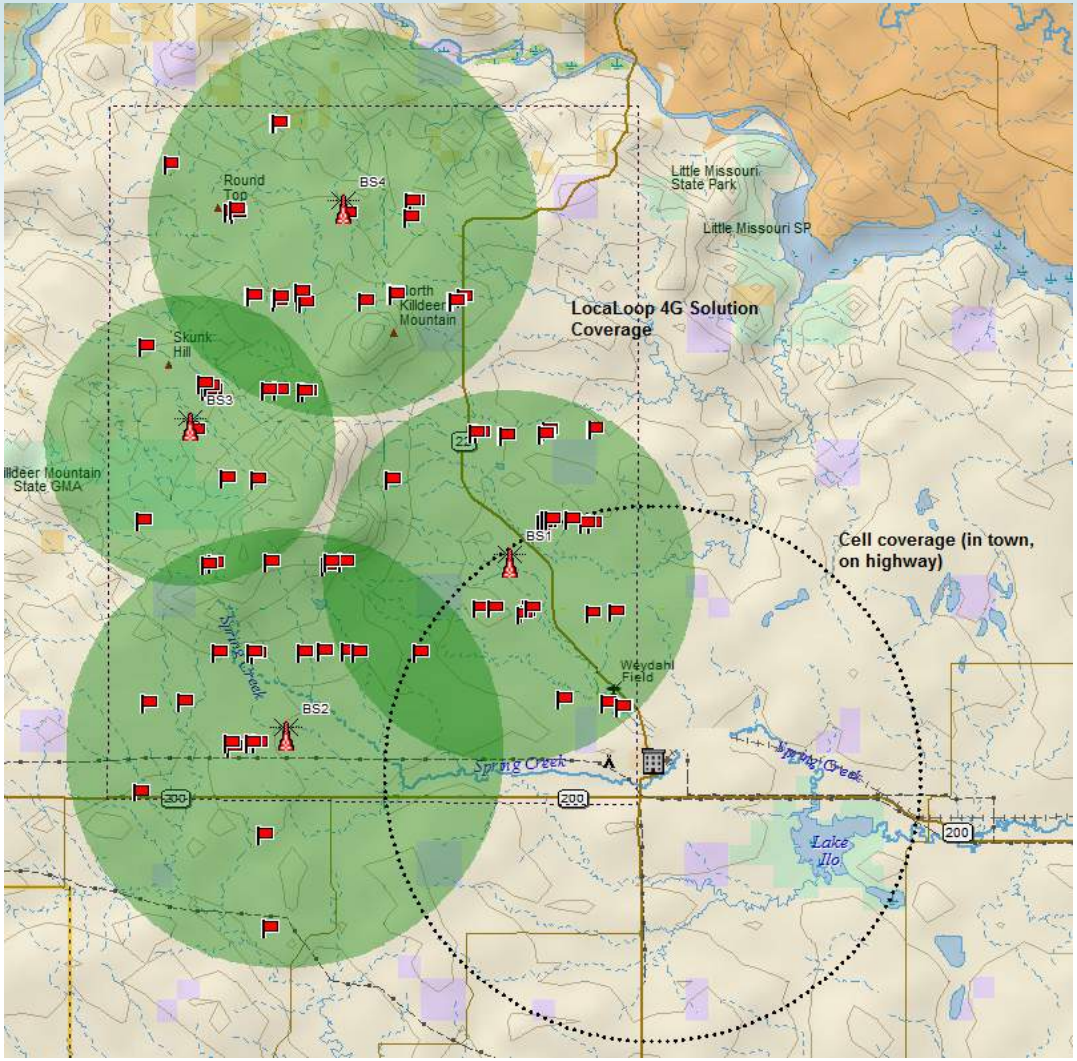
Internet Protocol Data Umbrella For All Field Operations



Private Mobile & Fixed 4G WiMAX / LTE / Wi-Fi Network

LocaLoop

4G Solution Deployment



- Legacy cell provider's focus are towns and highways
- LocaLoop's 4G focus is where it's needed!
- Each location has broadband service and next-generation Wi-Fi connectivity around the site
- Fiber connections to the Internet and the cloud
- Cloud based business and network management 24x7 from anywhere

LocaLoop

Life-cycle Services

- Drilling
  - Intensive 24x7 work on-site. High capacity Internet connectivity
- Completion
  - High capacity services remains
- Production
  - Long term connectivity with security, reliability and low maintenance overhead
- Plus - Wide Area Mobility
  - Access to broadband Internet within the coverage area at all times…on or off the site.

LocaLoop Service Model For Service Providers

What LocaLoop does:

- Provide complete 4G turnkey business system
- Ready to go SaaS/IaaS synKro cloud platform
- Pre-deployment RF planning and engineering, training and tech support
- 4G infrastructure & installation
- Manage the network via automated NOC
- Oil & Gas market adapted hardware for consistent performance and cost optimization
- Lease financing

What service providers do:

- Obtain frequency license
- Facilitate build-out with your local contacts and presence
- Establish & staff in-territory for endpoint installation and support
- Manage the day-to-day operation of the network via the synKro application platform

LocaLoop

Consumer Retail vs Oil & Gas Services

Business Models

Existing: Consumer Business Model

- Many individual accounts, prepaid service month-to-month

New: Oil & Gas Business Model

- Service providers have long term contracts with operators

Both Built on a Proven Business Model

The Service Provider: Creates revenue from services, owns and operates the network, installs and manages endpoints

LocaLoop, Inc: Revenue from SaaS / IaaS fee per endpoint along with its Intelligent Capacity Services™

LocaLoop's synKro SaaS / IaaS Business System

Existing: Consumer Model

- Consumer's "MyAccount" portal (B2B2C)

New: Oil & Gas Model

- Operator's corporate portal (B2B2B)

Both Built on a Common SaaS / IaaS Platform in Production

Service provider: SaaS / IaaS portal for business and network management

LocaLoop: Sysop for customer and network management

Consumer – Web Portal

- Allows individual consumers to manage their account
- Demographic (Name, address, etc)
- Payment (Credit card details)
- Services & Devices
- Secure messaging to service provider

Operator - Web Portal

- Allows operators to view and manage their account
- Business Information: Invoices & Payments
- Locations and Application Usage
- Order Management (moves, adds, changes)
- Secure messaging to service provider; trouble ticketing

Operator's Business Portal

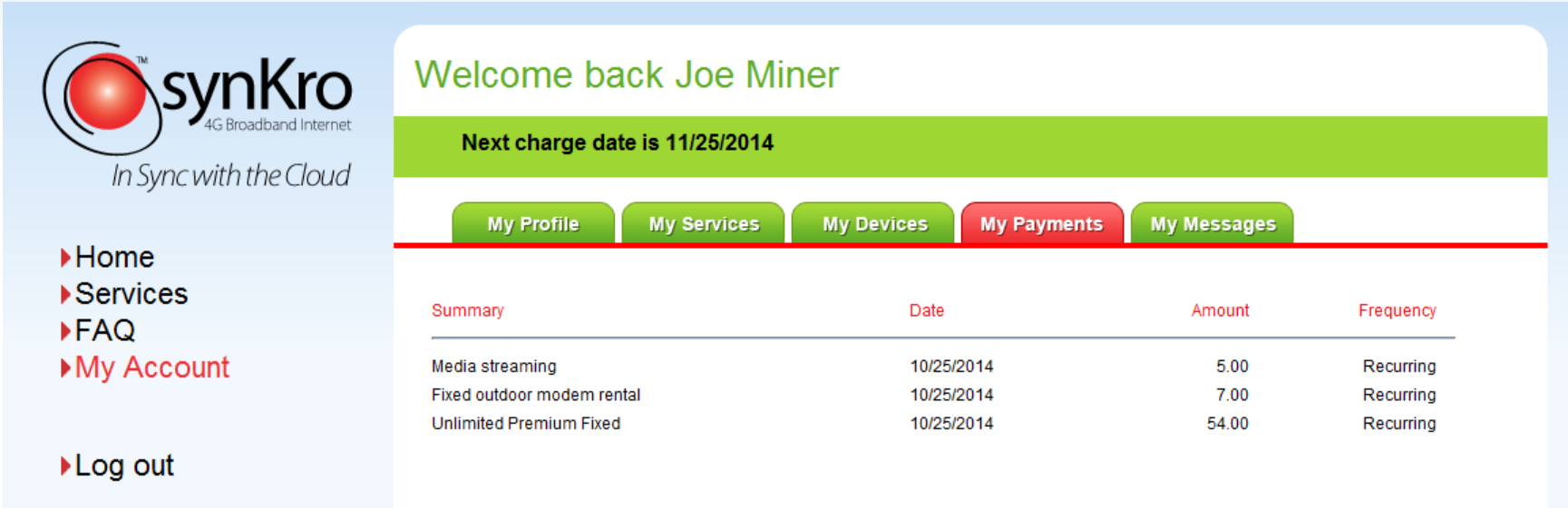
Operator's Business Portal provides on-line web access to the service and payment status and history with the service provider.

Transaction ID	Work Order	Line Item	Create Date	Submit Date	Amount	Tax	Location
2199869501	C2389	Install Pad	10/15/2013	10/15/2013	350.00	0.00	Wilder45A
2199869505		DrillingServices	10/15/2013	10/15/2013	1,200.00	0.00	JamesCreek6
2199870200		Site Work - Billable	10/15/2013	10/15/2013	945.78	0.00	(Field)
2199870200		Site Work - Billable	10/15/2013	10/15/2013	1,245.34	0.00	TenMile23
2199870200		Site Installation	10/15/2013	10/15/2013	500.00	0.00	MandyRanch36
2199870200		DrillingServices	10/15/2013	10/15/2013	1,200.00	0.00	PeanutValley45S
2207168890		Production Services	10/15/2013	02/21/2014	350.00	0.00	CobaltCreek843
2207168890		Production Services	10/15/2013	02/21/2014	350.00	0.00	Oberstar249
2207168896		Production Services	02/21/2014	02/21/2014	350.00	0.00	(Field)
2207168896		Site Installation	02/21/2014	02/21/2014	500.00	0.00	PeanutValley90N
2207168900		DrillingServices	02/21/2014	02/21/2014	1,200.00	0.00	ArtisanMtn983
2207168900		Production Services	02/21/2014	02/21/2014	350.00	0.00	JustinFarm234
2207168907		Site Work - Billable	02/21/2014	02/21/2014	1,245.34	0.00	TenMile23
2207168907		Site Work - Billable	02/21/2014	02/21/2014	945.78	0.00	(Field)
2213998398		DrillingServices	02/21/2014	05/28/2014	1,200.00	0.00	TenMile23

LocaLoop

Consumer's Portal

Provides on-line web access to payment history, next charge date, credit card information, services and secure messaging to service provider's customer support staff.



Operator's Network View

Acme Resource Extraction, Inc.

Business Mgmt. | Billing | Users | Network Mgr. | Messages

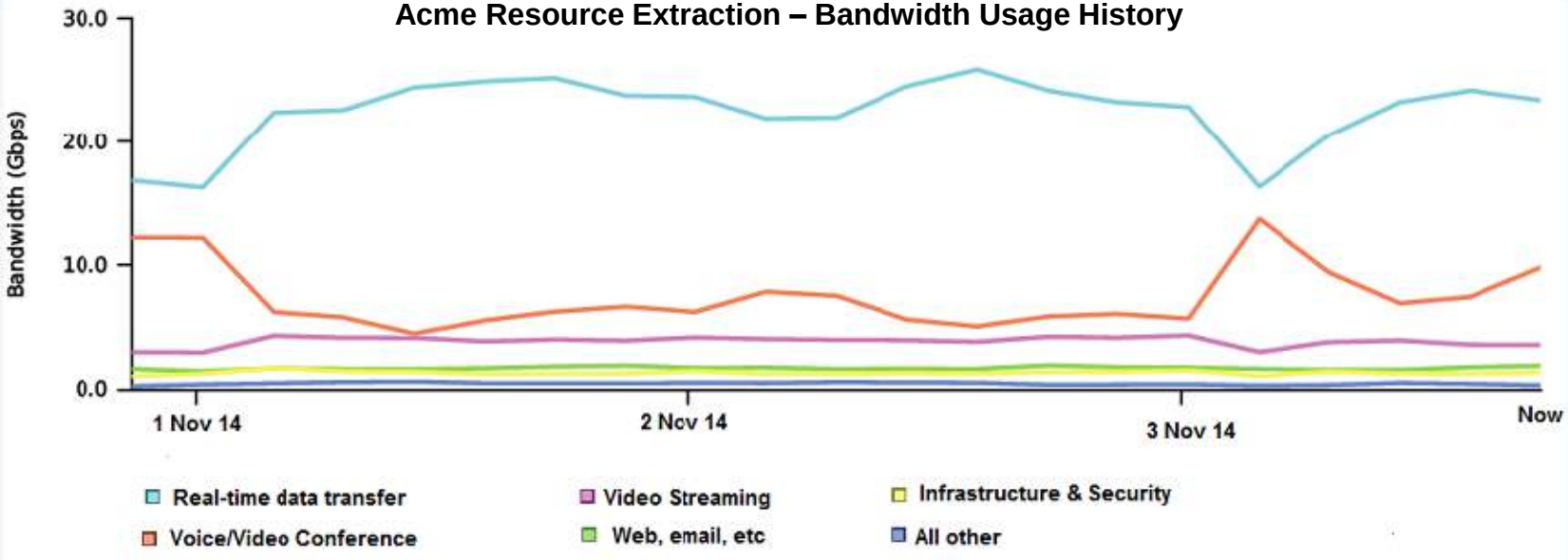
Acme Resource Extraction – System Status

Refresh

	Region:	Bakken		Locations:	56
Phase	Drilling:	10	0	0	2
	Completion:	19	1	0	0
	Production:	31	0	1	4

● - Normal ● - Caution ● - Offline ◆ - In work

Acme Resource Extraction – Bandwidth Usage History



LocaLoop

Service Provider – Network

- Network Status Dashboard
- Detailed Network View & Management
  - Regions, Sites, Base Stations and Sectors
  - Coverage mapping and localization
- Intelligent Capacity Services™
  - Bandwidth Consumption
  - Bandwidth Capacity Order Management

LocaLoop

Network Dashboard

Active Endpoints
174
as of 07:15 AM, 01 Nov 2014

Refresh

Base Station Status as of: 07:15 AM, 01 Nov 2014

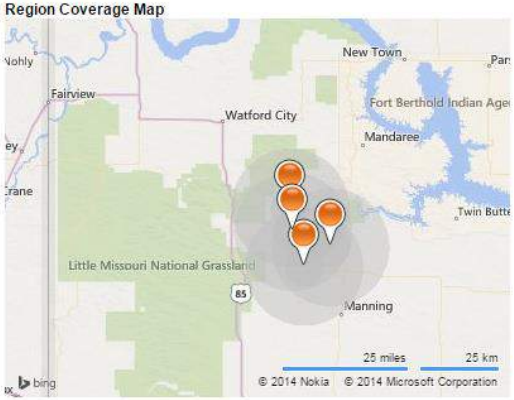
Region Name	Site Name	Base Station Name	BSID	Active Endpoints	Status
Bakken	BS1-Bice	BS1-Bice	45B2	44	ONLINE
Bakken	BS2-Chase	BS2-Chase	0C31	24	ONLINE
Bakken	BS3-SkunkHill	BS3-SkunkHill	E7A0	42	ONLINE
Bakken	BS4-SpringCreek	BS4	3421	39	ONLINE
Bakken	Williston Central	WC_North	96C2	25	ONLINE

Service Provider Portal - Network

System
Regions
Sites
Base Stations
Sectors
Gateway
FileStore

Region
All
New Region

Region Coverage Map



Export to CSV | Reset View | Show Customization Window

Drag a column header here to group by that column. Click a column header to sort in ascending / descending order. See totals on the bottom of the grid.

Show	Region Name	Site Name	Base Station	Base Station Status	Sector
	Bakken			All	
☑	Bakken	BS1-Bice	BS1-Bice	Active	01BS4
☑	Bakken	BS2-Chase	BS2-Chase	Active	01BS4
☑	Bakken	BS3-SkunkHill	BS3-SkunkHill	Active	01BS4
☑	Bakken	BS4-SpringCreek	BS4	Active	01BS4
☐	Bakken	Williston Central	WC_North	Active	01WC_N

Record Count:

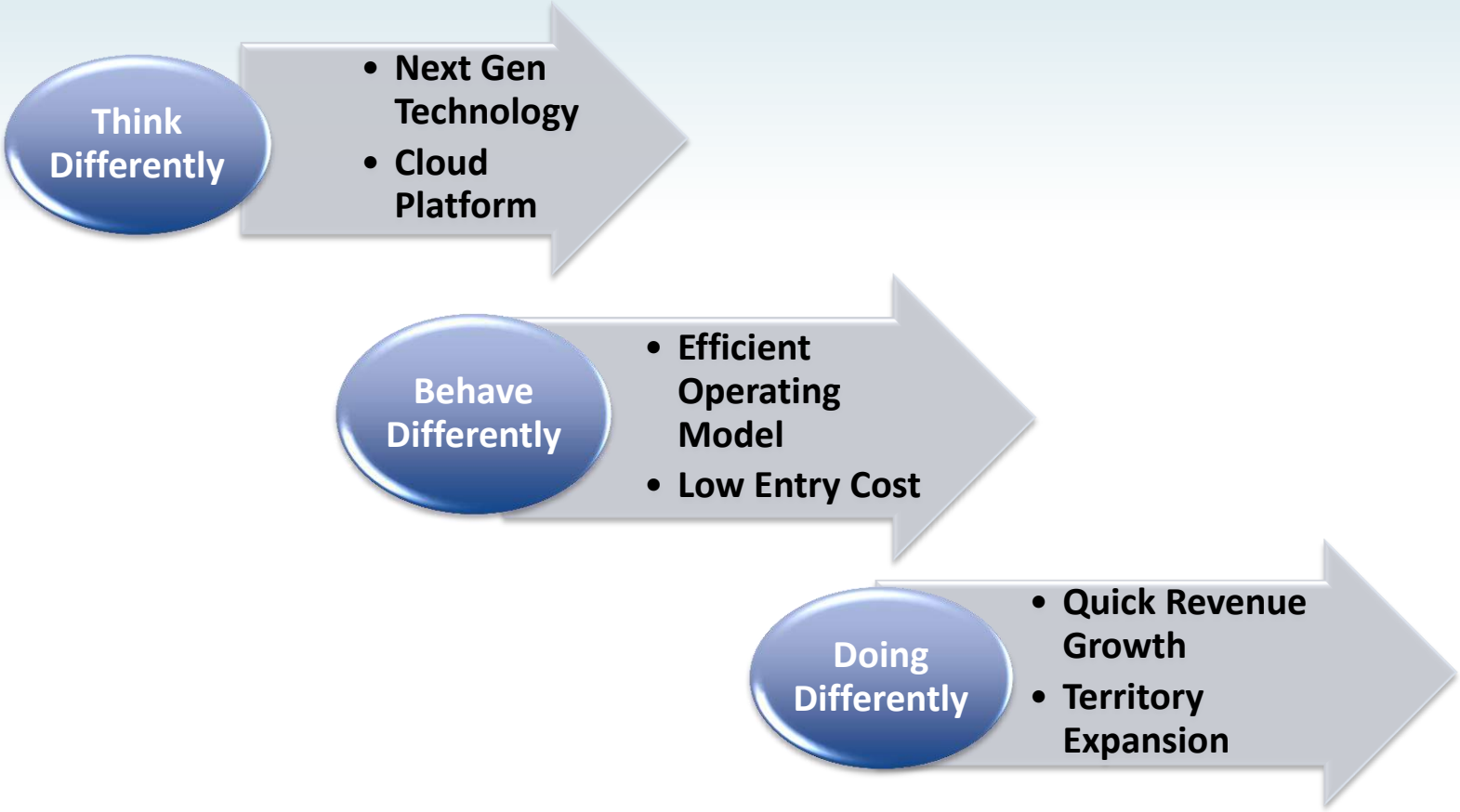
First Prev 1 of 1 Next Last Records per page: 25

Export to CSV | Reset View | Show Customization Window

Business Models with LocaLoop

- Multiple business models
  - Joint ventures with LLI
  - Independent Service Providers
  - Oil Field Service Companies
  - Captive (oil company owns the network)
  - Service provider to both Consumers and Oil & Gas field operators

Getting it Done in Partnership with LocaLoop



Thank You

LocaLoop

Demo network

www.synkro4g.us

Login: NickSAdmin / Synkr#o

Region – Bakken

Subscriber

Joe Miner

Joeminer / Oilpatch701

SESWC4166 Asssociated CPE

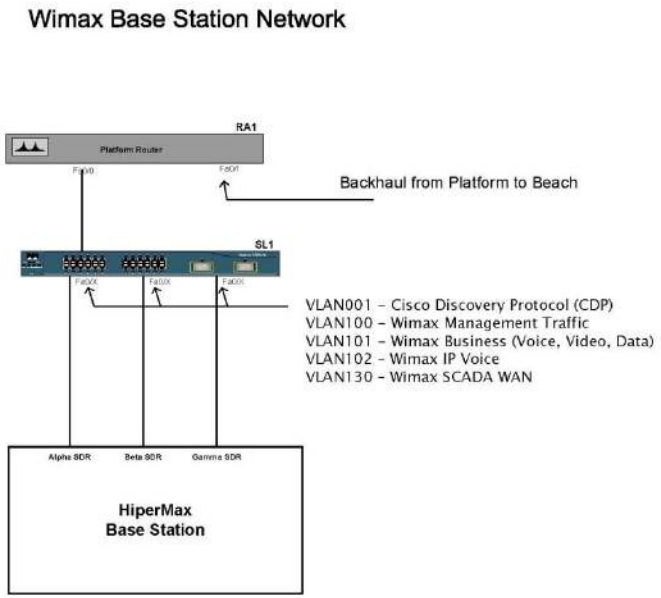
Project Overview
Gulf of Mexico Wimax

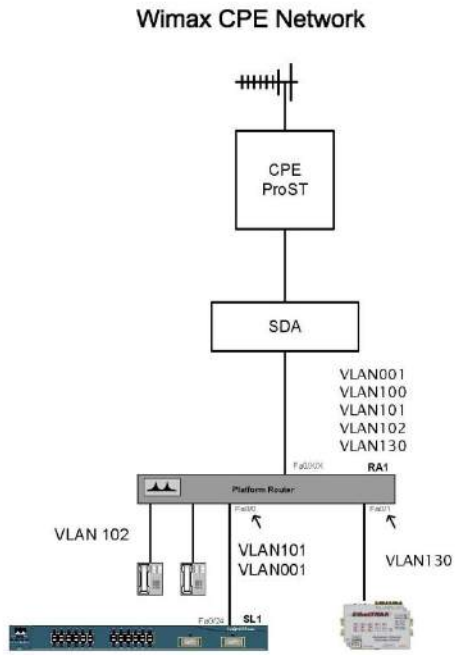
Al Sinopoli, P.E, RF Engineering Architect
Oilcomm 2014, Houston, TX

Gulf of Mexico Wimax Strategy

- Provide area-wide Wimax coverage to Chevron operating areas within the US Gulf of Mexico
- Replace lift-boat and drill-ship point to point connectivity with Wimax connectivity
- Replace low speed last mile links for small platforms with Wimax connectivity
- Use newly acquired licensed 700 MHz spectrum for sites > 12 miles from coastline
  - 17 Sites, including planned deepwater platforms
- Use the then-new (2008) “pseudo-licensed” 3.65 GHz spectrum for sites < 12 miles of coastline (areas where our 700 MHz licenses were not valid):
  - 9 Sites, including our shorebase facilities
- Use common equipment vendor for both frequency bands. TDD on both bands!
- Use the 802.16D standard, due to limited mobility requirement and long distance profiles
- Create a test laboratory to stage equipment and CPE’s for deployment
- Budgeted $2.5MM, not including the $1.6MM paid the FCC for 30 MHz of GOM spectrum, for capitalized materials and labor

Gulf of Mexico Wimax
Simplified Network Connectivity





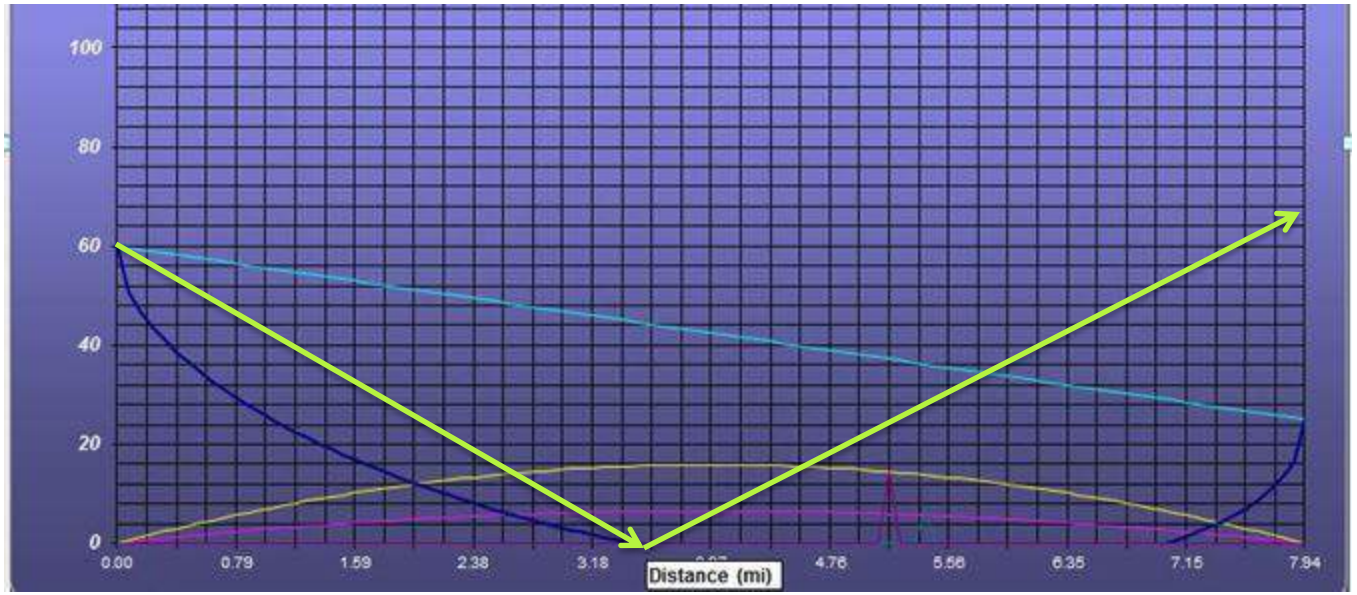
VLAN Separation of Services (Voice, Data, Scada)

Gulf of Mexico Wimax
RF Design

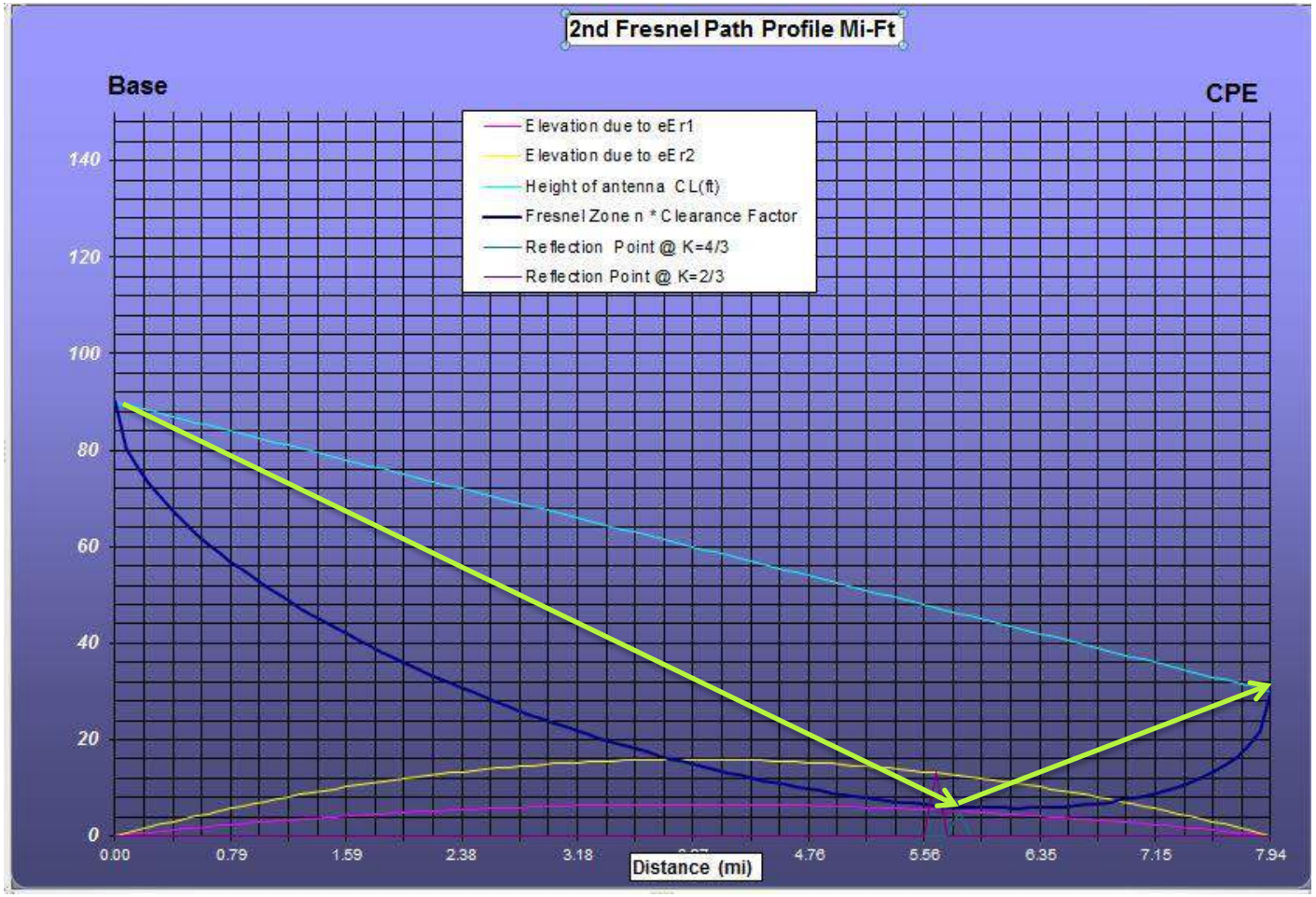
- Leveraged EDX SignalPro for predictive analysis
  - Signal Strength
  - Interference
  - Capacity
  - Diversity planning
- Performed Site Surveys at each location to generate accurate Bill of Materials and realizable designs
- Complied with hazardous area classification requirements and worked with each field to avoid operational issues (crane loading areas, expansion plans, etc.)
- Took advantage of flexibility in mounting of wimax equipment to balance environmental versus RF considerations (a combination of outdoor and indoor deployments)

Gulf of Mexico Wimax
Over-Water Diversity: Why MIMO Mode A is a Must

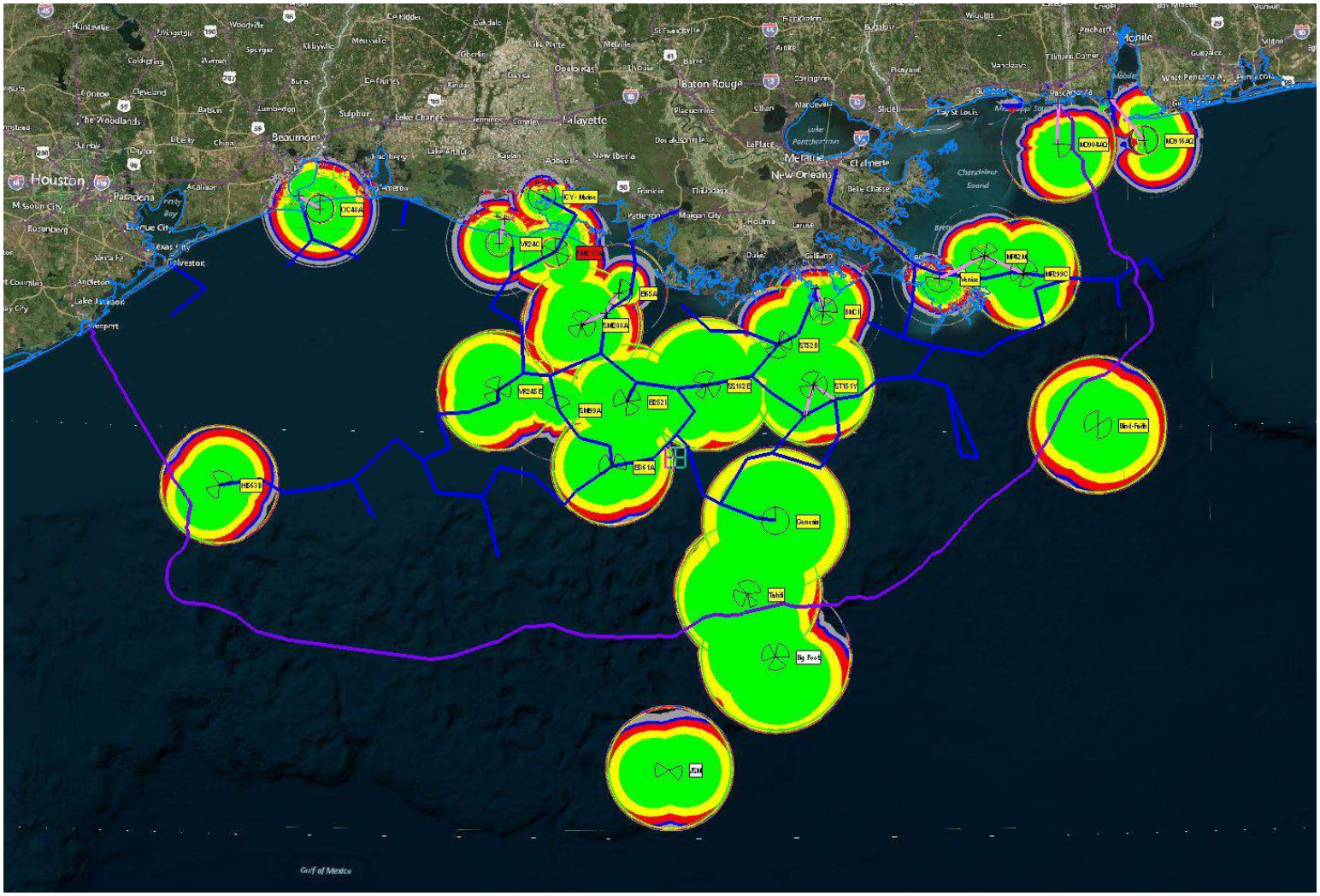
- Reflections from water cause destructive interference
  - Plane of reflection: Vertical Plane
  - Due to rapid sea-state changes, ground elevation changes complicate the problem
  - Mitigate by using Mode A
- To solve, heights must be engineered to “bury” the reflection



Gulf of Mexico Wimax
Over-Water Diversity: Why MIMO Mode A is a Must



Gulf of Mexico Wimax
Predictive Coverage



Gulf of Mexico Wimax
System Statistics: 2014

Coverage Area includes 22% of the U.S. Gulf Of Mexico

- Approximately 27,500 square miles

Approximately 250 CPEs in place, with about half in use at any time

Uplink and downlink busy hours different

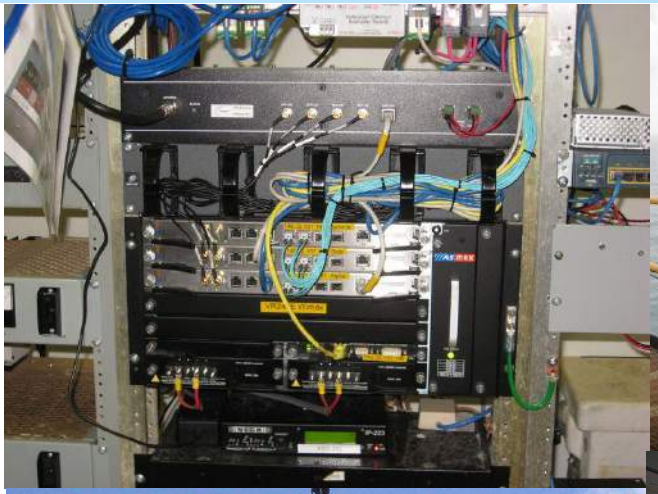
- Scada data limits uplink rates
- Business data/Internet limits downlink data rates

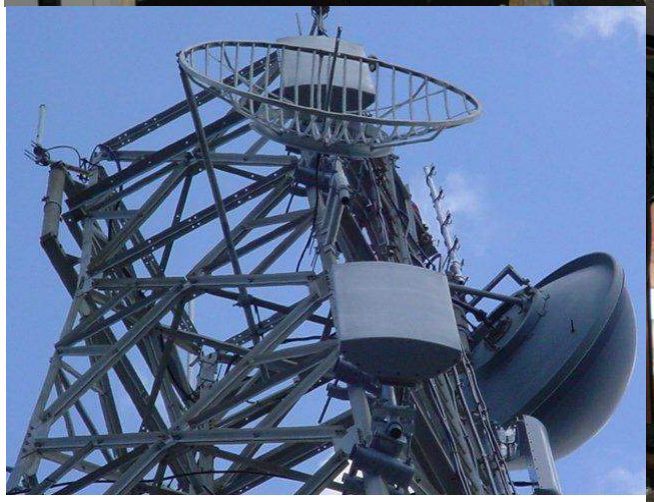
Spectral efficiency approximately 2:1 (10 MB per 5 MHz carrier)

Gulf of Mexico Wimax Project Timeline

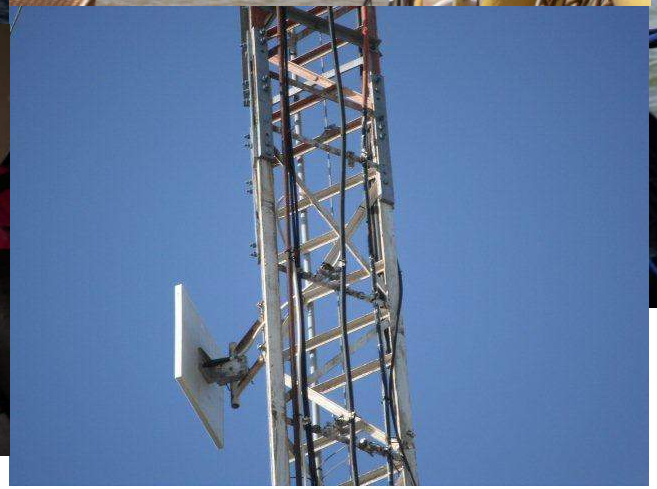
Pre-deployment	Deployment	Post-Deployment
✓ 700 MHz licenses obtained at Auction (Feb 2008) ✓ Conducted deployment trial with Airspan Networks (June 2008) ✓ Entered into Procurement Agreement with Airspan Networks (November 2008) ✓ Entered into Production Agreement on 700 MHz equipment with Airspan (November 2009) ✓ RF Engineering and drawing packages completed for each site (Continual)	✓ Began 3.65 GHz deployments (November 2008) ✓ Received 700 MHz radio equipment (May 2010) ✓ Began 700 MHz deployments (May 2010) ✓ Completed 3.65 GHz deployments (May 2011) ✓ Completed 700 MHz deployments (November 2011) ✓ CPE Installations completed throughout the timeline	✓ Financial lookback completed (April 2012) ✓ Service center monitoring via Airspan applications and the use of Solarwinds SNMP monitoring solutions fully implemented (December 2011) ✓ Continuing to operate at a projected savings of over $570K per year versus prior systems

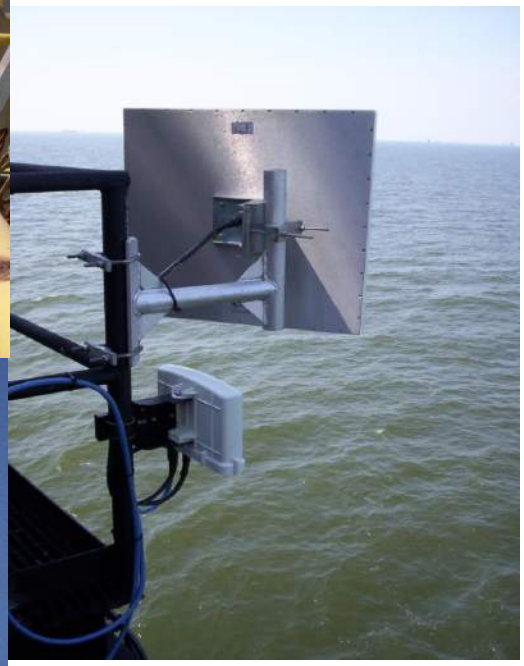
Gulf of Mexico Wimax
Base Station Photos





Gulf of Mexico Wimax
CPE Photos





Gulf of Mexico Wimax
Major Lessons Learned

- RF and network engineering attention to detail, including the use of EDX for radio planning, were key enablers to a reliable system
- Space diversity and low Signal-to-Noise key to maximize throughput at a given reliability
- Seasonal propagation variations reduce output on certain links
- Attentive site survey critical to reducing installation issues
- Backhaul stability and network trunk readiness will affect system performance
- Service profiles for CPEs need to be adequately planned and configured
- Supervision and verification of installation in order to assure things are done right is critical

Gulf of Mexico Wimax
Major Lessons Learned

- Subscriber and operational expectations should be set at the onset. The reliability of a wimax or any multipoint system will never be greater than that of a properly engineered point-to-point system.
- While the budget was slightly exceeded (we spent $2.8M), the return on investment was more than double the original estimate. The system paid for itself after 2 years in operation, when factoring in drillship operation savings.
- Wimax is successful if implemented properly and adequately supported by a core team
- Consider migration plan as technology changes. Current product is end of life on Dec 31, 2014 and conversion to newer system in 2016 is being planned.

SIEMENS

RUGGEDCOM WIN

802.16e WiMAX Application: Oil &Gas

Special Requirements of the Oil & Gas Market

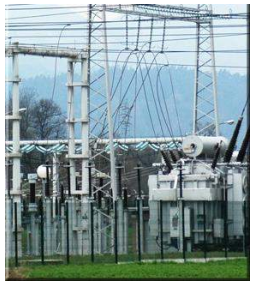
Remote deployments – reliability and long product life cycles - not easy to upgrade or replace hardware

Rugged Environment - rain, salt, humidity, 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 share access. A simplified topology and a layer 2 approach work best

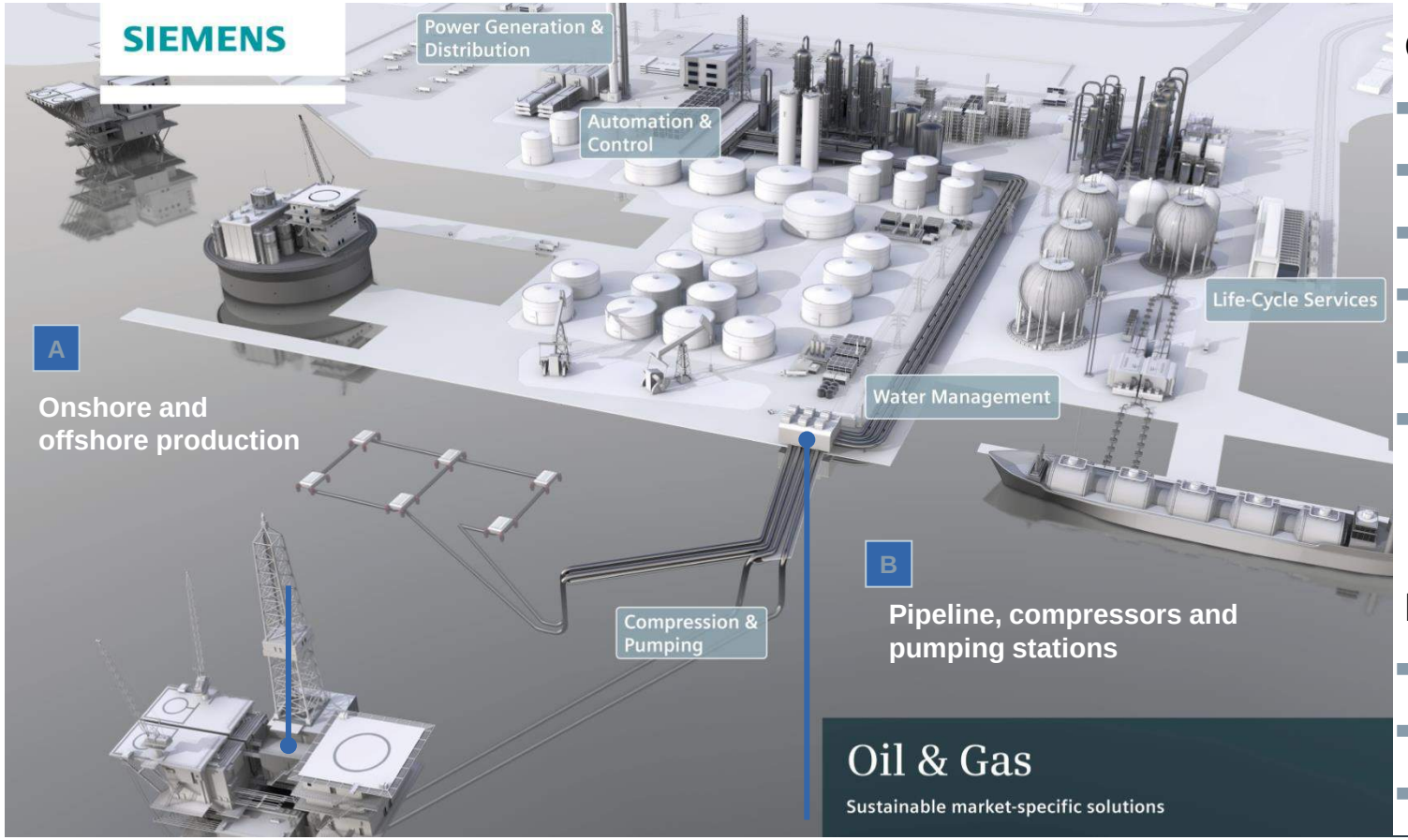


The environment and goals of a wireless network for oil and gas applications is unique

Wireless applications available for production and pipeline market segments

SIEMENS

Major applications



A

Onshore and offshore production

- Wireless connection of mobile applications
- Wellhead monitoring and control
- Gas field control and monitoring
- Rig external communication (radio)
- Rig power management & monitoring (SCADA)
- Rig internal communications

B

Pipeline, compressors & pumping stations

- Pipeline SCADA
- Data aggregation in rugged environments
- Process analytics

WiMAX for Private Network wireless communications

A proven point-multipoint wireless solution meeting the needs of demanding customer environments in a standards-based approach

- **Established Ecosystem –** Non-proprietary and interoperable
- **Range / Throughput –** Broadband capacity over several miles
- **Scale –** Synchronized TX/RX intervals eliminates self-interference
- **Quality of Service** – Configurable service flows to customize for multiple applications over a single infrastructure
- **Security**- Must meet the needs of Critical Infrastructure customers

WiMAX QOS - 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 that controls bandwidth utilization

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 and some licensed freq bands**)

Drive - **interoperability** around this “energy profile”

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

Oil/Gas Exploration - Application Challenges

Marine Seismic sea floor mapping

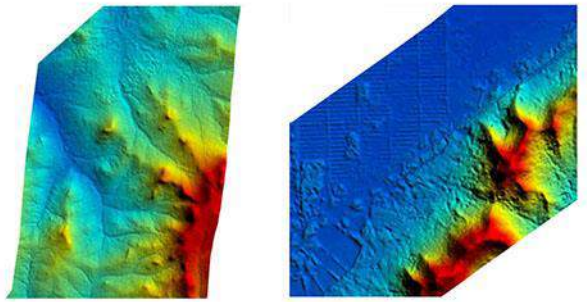
- Mobile environment: Master/Streamer ship - communication to supply & work vessels
- Airblast collection of data
- Changing topology, 20-40 km distance requirement
- Mapping resolution – broadband needed

Extremely harsh environment

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

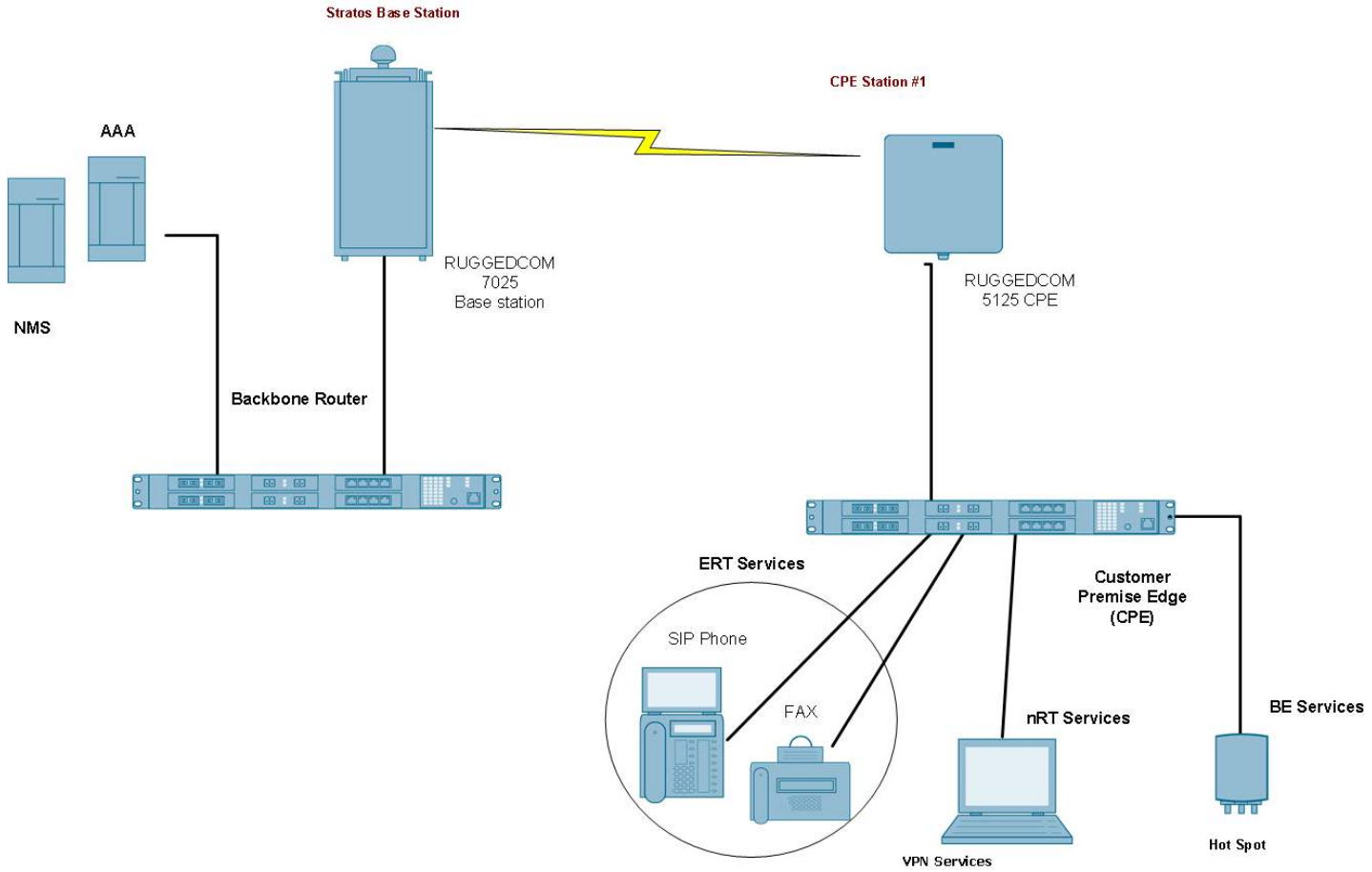
RUGGEDCOM WIN WiMAX Solution

- Omnidirectional base station on the master vessel
- 2.5 GHz freq selection- uses high TX power base station
  - Capable of 40km
- Omnidirectional Subscriber/CPE radios
  - Minimize antenna aligning
- Mobile handoff as needed – NO ASN gateway
- Secure Layer 2 transport:
  - Production data – mapping results
  - VOIP to/from slave vessels
  - Video to/from slave vessels
  - AAA authenticated



Solution Architecture

RUGGEDCOM WIN wireless broadband technology



- Standards-based WIMAX system in licensed, band supporting nomadic and mobile
- 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-tiered service with guaranteed QoS.
- Low, controllable latency

Summary

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

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

WIMAX is a standard which is well 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

Mike Dalton
Regional Sales Director, Wireless
Siemens Industry, Inc.
NAM RC-US I IA SC FA

Phone: 480-282-8651

Mobile: 480-428-9765

Email:

mike.dalton@siemens.com

www.usa.siemens.com

Glen Sprouse
Regional Sales Manager - Industrial
Siemens Industry, Inc.
NAM RC-US I IA SC FA

Phone: 770-642-1660

Mobile: 678-896-5299

Email:

glen.sprouse @siemens.com

www.siemens.com/ruggedcom

3650 MHz Band
7 Year Review

Jim Johnston jim@jts.net

November 5, 2014

Background on 3650 – 3700 MHz

- 2005 – FCC Report and Order:
  - Open the 3650 – 3700 MHz band
  - For terrestrial wireless broadband operations
- 2007 - November 17
  - Start date for filing applications
  - Nationwide non-exclusive Licenses

Four Steps to License

- ★ Use the ULS - (FCC Universal Licensing System)
- ★ Examine the ULS for Nearby Stations
  - Protected incumbents Federal & Non-Federal
  - 150 km circular protection zones established around each grandfathered Fixed Satellite Service (FSS) Earth station
- ★ Use FCC-certified equipment
  - Fixed, base and mobile equipment operating in the band must incorporate a “contention-based protocol”
- ★ Register each fixed and base station using ULS
  - Use is not authorized until base station is registered

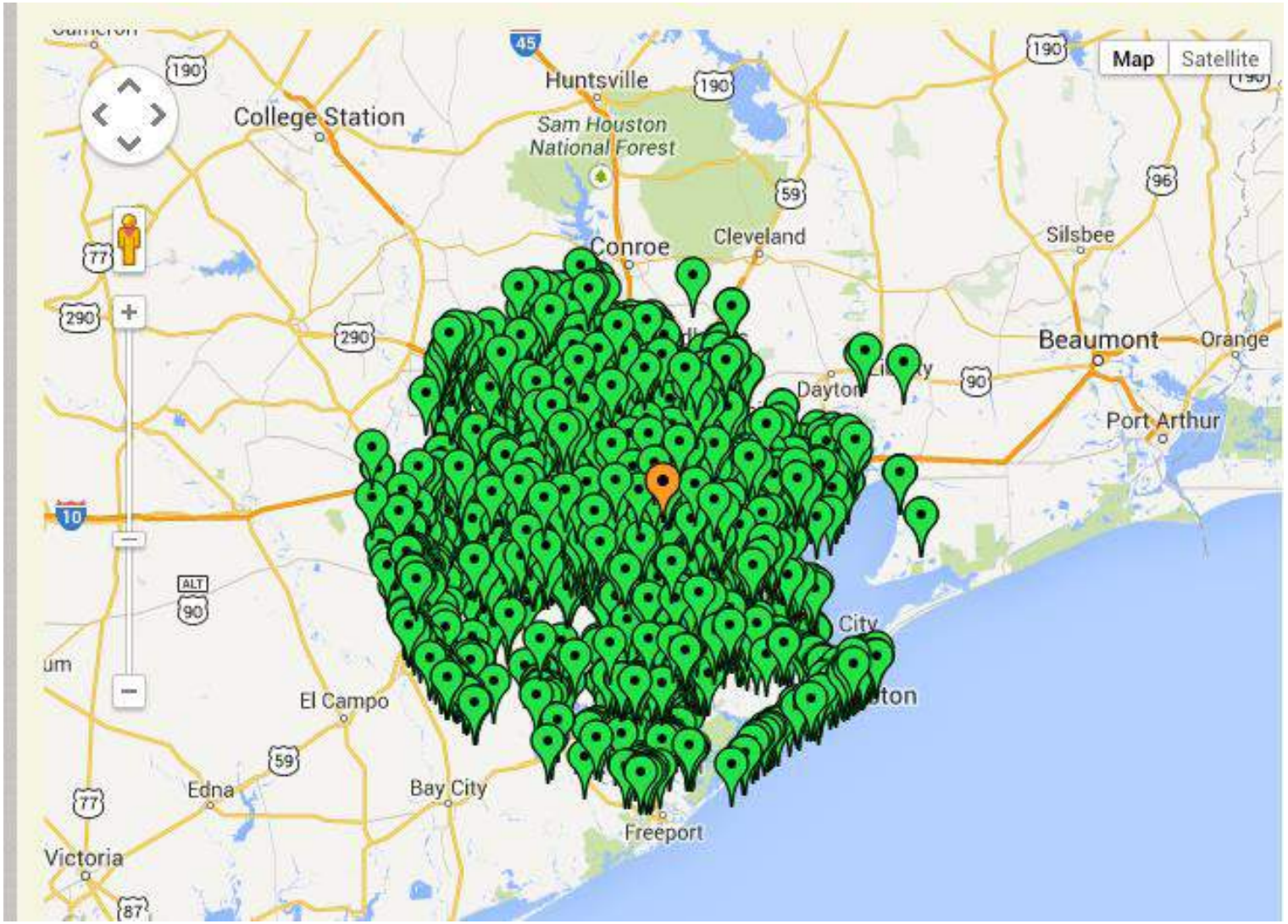
Unrestricted or Restricted Operation

- Unrestricted contention protocols are broadly compatible and function to prevent interference with other, dissimilar contention technologies on the market. Equipment using an unrestricted protocol can operate on all 50 megahertz (3650-3700 MHz) Limited spectrum
- Restricted contention protocols prevent interference with other devices incorporating the same or similar protocols. Equipment using a restricted protocol can operate only on the lower 25 megahertz (3650-3675 MHz)

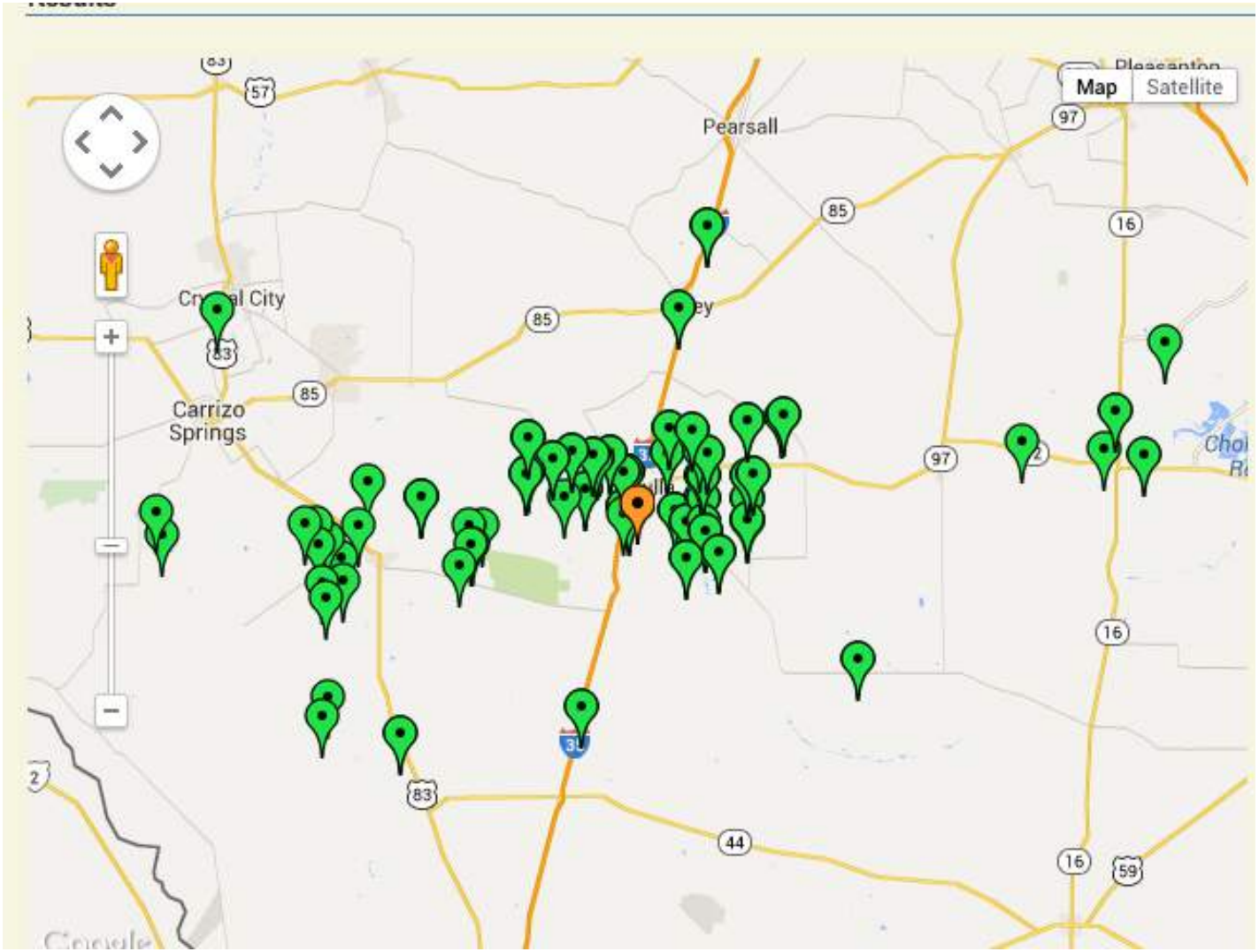
Interference - Section 90.1319(d)

- FCC left it to licensees to work it out on their own
- Licensees should examine this database before seeking station authorization, and make every effort to ensure that their fixed and base stations operate at a location, and with technical parameters, that will minimize the potential to cause and receive interference.
- Licensees of stations suffering or causing harmful interference are expected to cooperate and resolve this problem by mutually satisfactory arrangements.

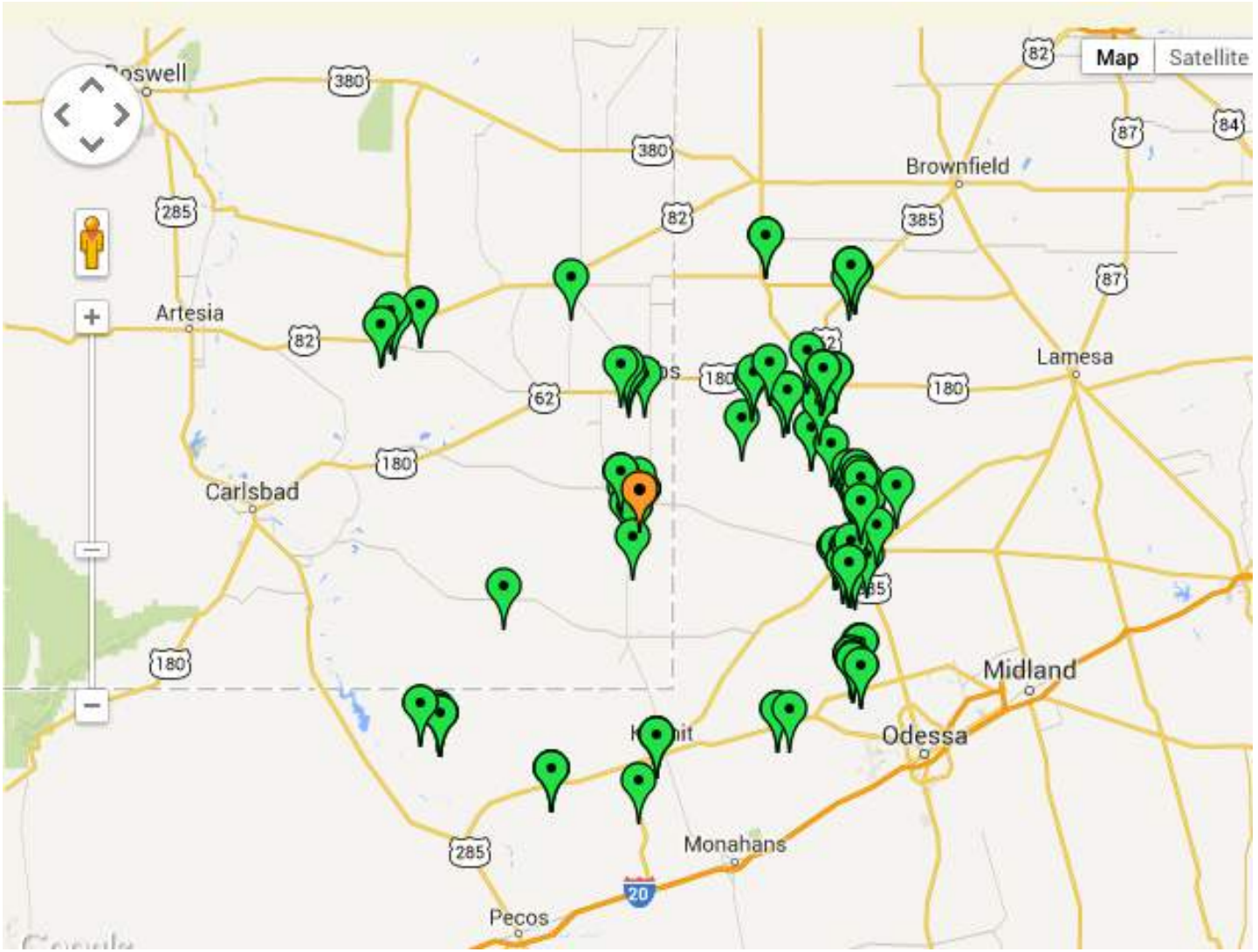
Near OilComm



Catulla Springs, TX



Hobbs, NM



Top 10 States - Base Stations

Texas	12904
California	3409
Illinois	1927
Oklahoma	1757
Ohio	1680
Missouri	1644
Utah	1416
Nebraska	1224
New Mexico	1218
Michigan	1026
Puerto Rico	1026
Gulf Mexico	253

7 Years Later

- About….
  - 2600 active nationwide licenses
  - 45,200 base stations deployed
    - 3 or 4 base stations for 360 degree coverage
  - 22,000 unique base station locations
    - WISPs
    - Municipal, County
    - Utilities
    - Oil & Gas

Summary

- Adoption Rate is low
  - Contention, QOS
  - Interference FUD
- Difficult to determine who your neighbors are
  - Use Comsearch's free tool
  - http://www.comsearch.com/interactive_solutions/3650MHz_Quick_Look/overview.jsp
- Few areas have contention
  - Mostly competing WISPs
  - Adjacent Municipalities
  - Lot of room in band for more users
- Development has slowed

CelPlan
Wireless Global Solutions

Spectrum in Oil & Gas Applications

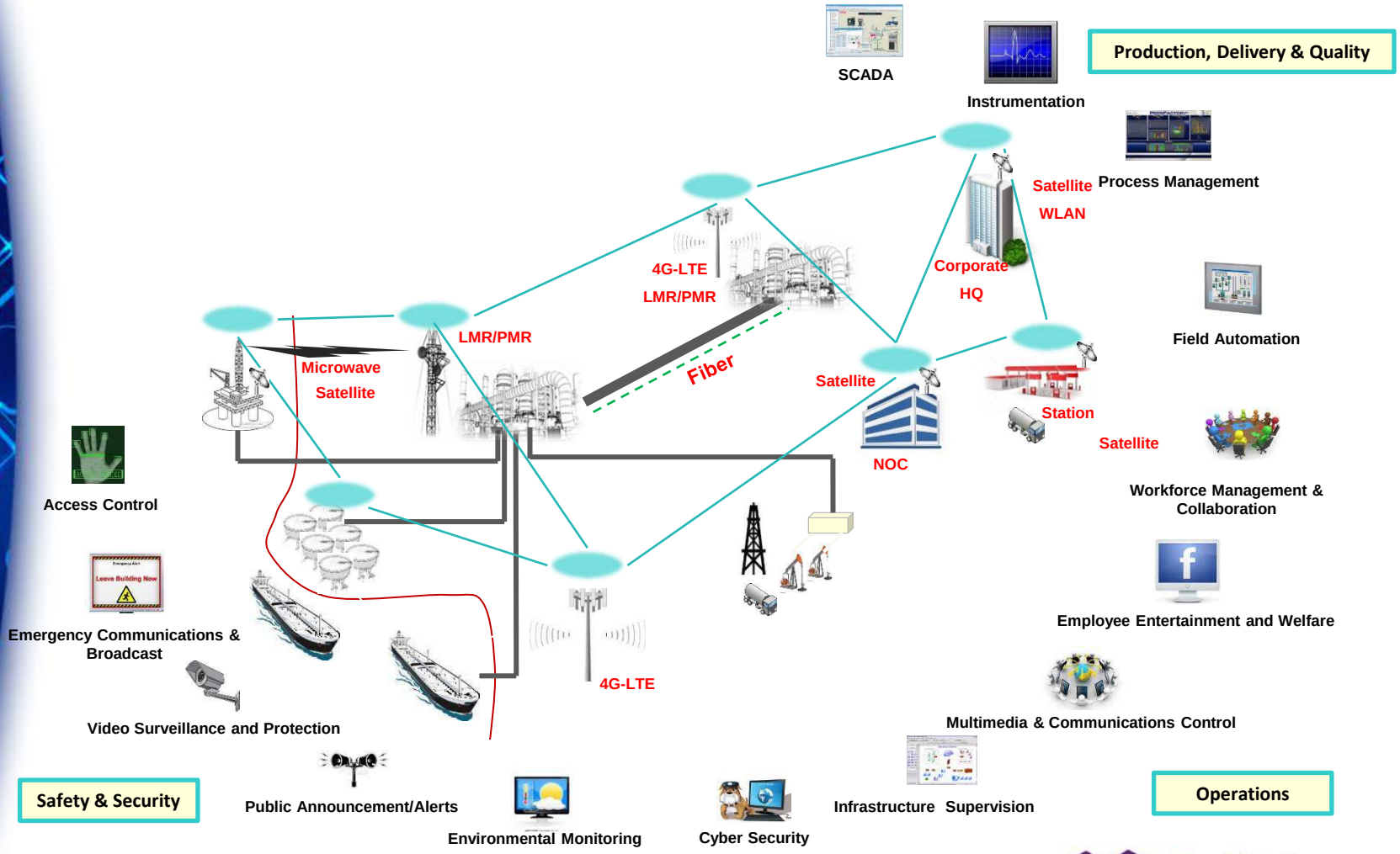
WiMAX FORUM®
WiMAX Oil & Gas 2014
@ OilComm HOUSTON, TX | NOVEMBER 5

About CelPlan

- Employee owned enterprise with international presence
  - 20+ years in business
  - Headquartered in Virginia
  - 450+ employees
- Leading planning, design and optimization software tools for all applications and wireless network technologies
- Specialized engineering, planning, design an optimization services
  - Proven and demonstrable worldwide WiMAX and LTE network planning and deployment expertise
- Field measurements and RF propagation characterization
- RFP preparation, vendor selection and deployment support
- High-level Consulting
- Technology Training
- Managed Services

CelPlan
Wireless Global Solutions

Oil & Gas Communications Complex



Growing need for Spectrum

- Multitude of applications driving ever-growing bandwidth utilization
  - Satellite: offshore, onshore remote operations, back-up
  - Point-to-point: terrestrial microwave links
  - LMR/PMR/4G-LTE: ground mobile communications
  - WiFi: WLAN
- Mission critical applications require spectrum dependability
  - Licensed, coordinated spectrum
  - Unlicensed spectrum limited to provisional and temporary use

Efficient Use of Limited Resources

- Proper design of wireless networks
  - Air interface technology and frequency bands are fit for purpose
  - Coordination and coexistence with neighboring bands and users
  - Scalability, as network and usage grow
  - Integration between different networks and applications
    - Geography
    - Technology
    - Environment
  - Adequate design tools
    - Air interfaces and technology are increasingly complex
  - Knowledgeable and experienced design and engineering support
    - Air interfaces and technology are increasingly complex!

Case 1: Offshore - Petrobras (Brazil)

- 1,500+ point-to-point microwave links
  - Licensed and coordinated ITU bands: 6, 7, 8 GHz and others
  - Multiple air-interface technologies
  - Provisional WiMAX unlicensed links: 5.8 GHz
  - ANATEL (Brazil's FCC equivalent) centralized frequency utilization and coordination database (STEL)
- Point-to-Multipoint
  - WiMAX: 1.5 GHz band, TDD, 5 MHz channels; 3.5 GHz band pending regulatory approval)
- LMR/PMR field deployments
  - P25 and DMR
  - VHF (170 MHz) and UHF (850 MHz)
- Satellite
  - L, C, Ku bands
  - Leased channels (SCPC) and subscription-based services

PETROBRAS

Case 2: Onshore – Oil & Gas Company in Oman

- 90+ sites in a greenfield WiMAX onshore network
  - 5.8 GHz band (unlicensed); 10 and 20 MHz channels
  - Hybrid fixed/mobile applications
  - Data collection from 4,500 wellheads, 200 semi-mobile drilling units, camp sites (fixed) and emergency vehicles
  - Application throughput requirements ranging from 40 kbps to 5.3 Mbps

In Summary

- The wireless communications requirements for Oil & Gas are complex and bandwidth demand is growing
- Each application requires specific technology and spectrum solutions
  - Design and deployment must be supported by adequate tools and knowledgeable engineering
- Spectrum availability and suitability is a key factor in the definition of a new network to support Oil & Gas operations

Thank you!

Gustavo.nader@celplan.com

Presentation to WiMAX Oil & Gas
November 5, 2014

SPECTRUM AVAILABILITY FOR OIL INDUSTRY REQUIREMENTS - WIDEBAND AND BROADBAND

- Spectrum Alternatives For the Oil and Gas Industry
- Upper 700 MHz A Block Specifics

Robert Finch
Select Spectrum
703 635 2686
rfinch@selectspectrum.com

Benefits from the Digital Oil Field

- Accelerated exploration and development
- Enhanced production pates and total yield
- Collaboration between various sites and workers including mobile staff
- Improved safety and operational uptime
- Improved efficiency/reduced operating expenses
- Improved data security when moving off of common carriers

Select Spectrum

rfinch@selectspectrum.com

Communications Requirements for Field Telecommunications "FT"

- **Communications to distant developed and remote sites**
- **Fast deployment** including to areas without line of sight
- **Varying transmission speeds** from very low speed to true broadband
  - Most applications have narrowband and wideband – not true broadband – requirements
  - Rapid growth of data requirements
- **High reliability** including in extreme environments
- **Extreme Data Security**

Select Spectrum

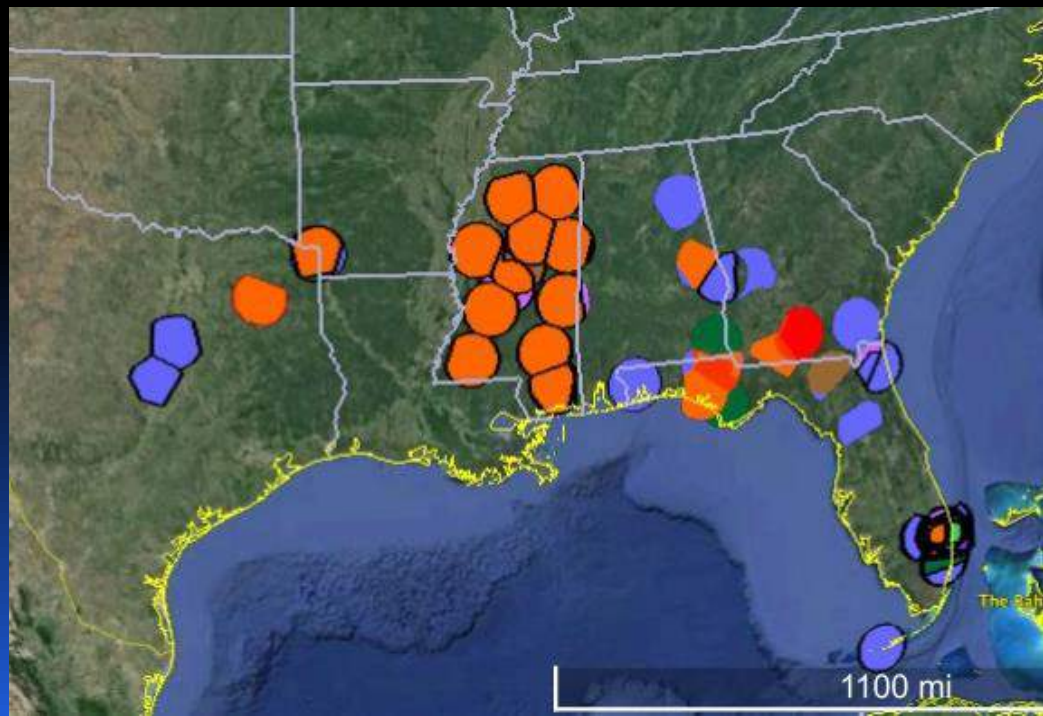
rfinch@selectspectrum.com

Existing / Potential Wideband and Broadband Spectrum for Oil & Gas

- 217+219 MHz AMTS (2 MHz Total)
  - Licenses expiring 4/2015 and may be terminated
- 218 MHz IVDS no licenses available in most areas
- 220 MHz . Mostly narrowband. Railroads targeting band
- **Upper 700 MHz A Block – Recommended in Utilities Telecom Council White Paper**
- NPCS (900 MHz) less contiguous spectrum and not universally available
- 2.5 GHz (Sprint dominated; cost and license availability issues)
- 3.65 and 3.5 GHZ ("lightly licensed"; power, interference, incumbent and auction issues)

2.5 GHz – True Licensed Spectrum for WiMAX or LTE

- Up to 22.5 MHz/ License and 194 MHz overall
- Most Controlled by Sprint + small operators
- Many rural areas open for future licensing
- TX, OK, AR, LA offering planned for 2015

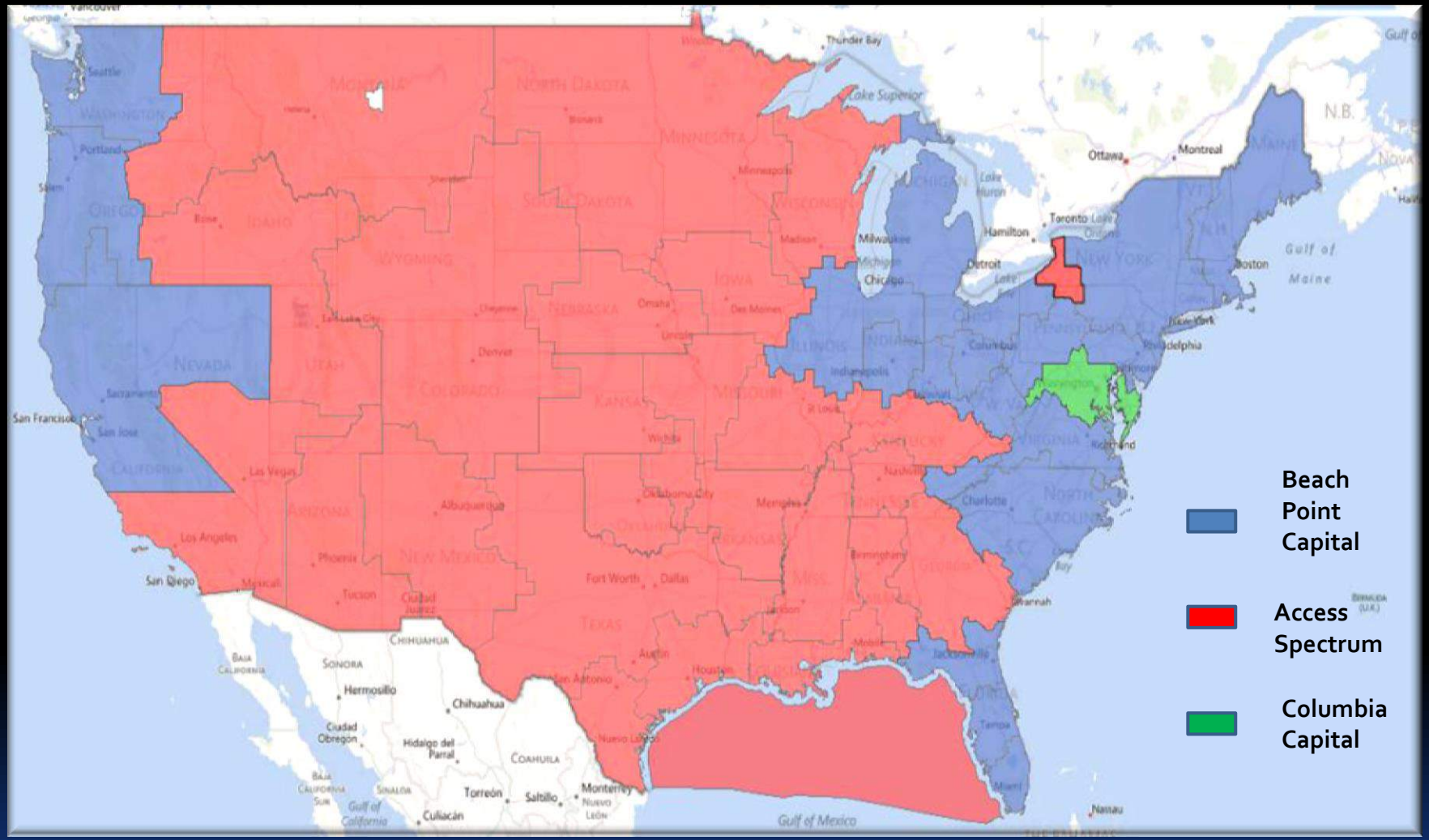


Select Spectrum

3.65 and 3.5 GHz (NPRM 12-354)

- 3.65 GHz. "coordination is each licensee's responsibility" (no protection)
- Proposed "spectrum sharing" Citizens Broadband Radio Service (CBRS) at 3550-3650 (or 3700) MHz
  - Federal incumbent exclusion zones
  - Annual auctions of "Priority Access Licenses"
  - General Authorized Access (unprotected) for 1/2 the spectrum
  - Power limits well below licensed spectrum (small cells)
  - Spectrum Access System dynamically assigns channels
  - 354 comments from all national wireless carriers, Google, etc.
- FCC proposes to move 3.65 GHz operations to 3.5 GHz rules

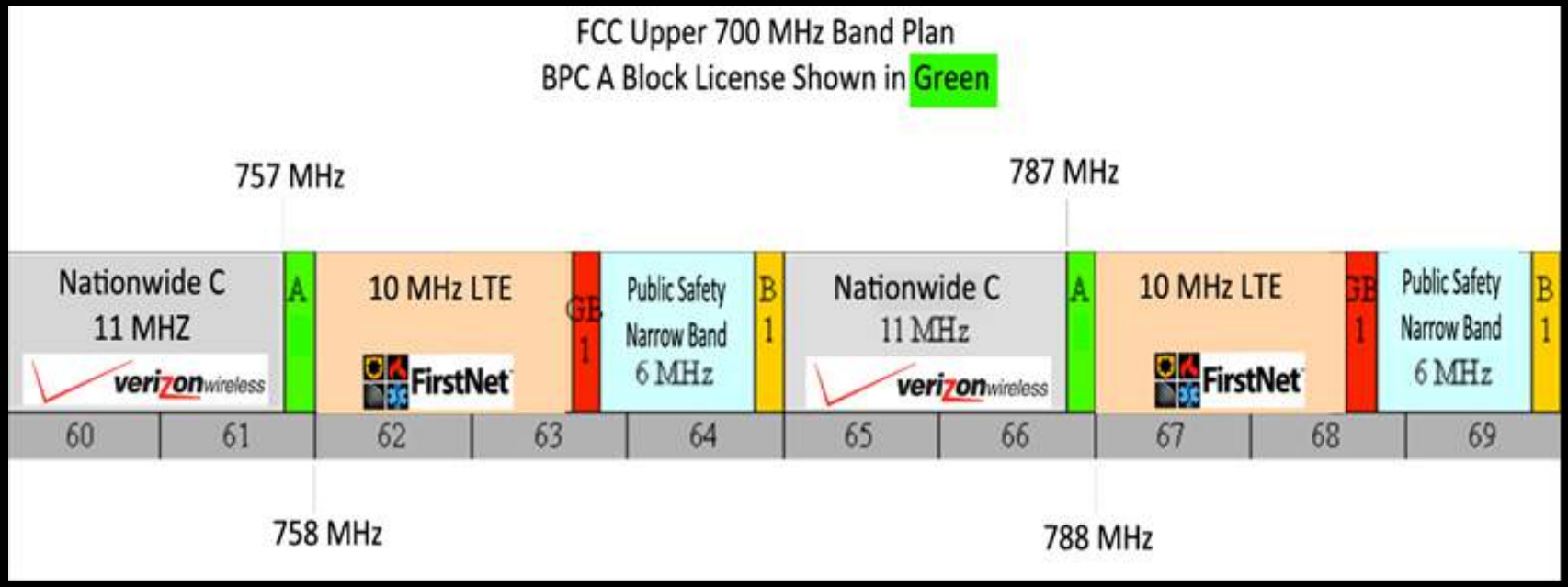
UPPER 700 MHz A BLOCK



- Licensed in 52 major Economic Areas (MEAs)
- All three owners now cooperating to sell the licenses Nationwide

Select Spectrum

Upper 700 MHz A Block



- Exclusive 2 x 1 MHz licenses, between Verizon and FirstNet with same interference protection rules
- Maximum Power is 1000W ERP lower / 30 W ERP upper band
- Fixed or Mobile

Technical Aspects – Upper 700 MHz A Block

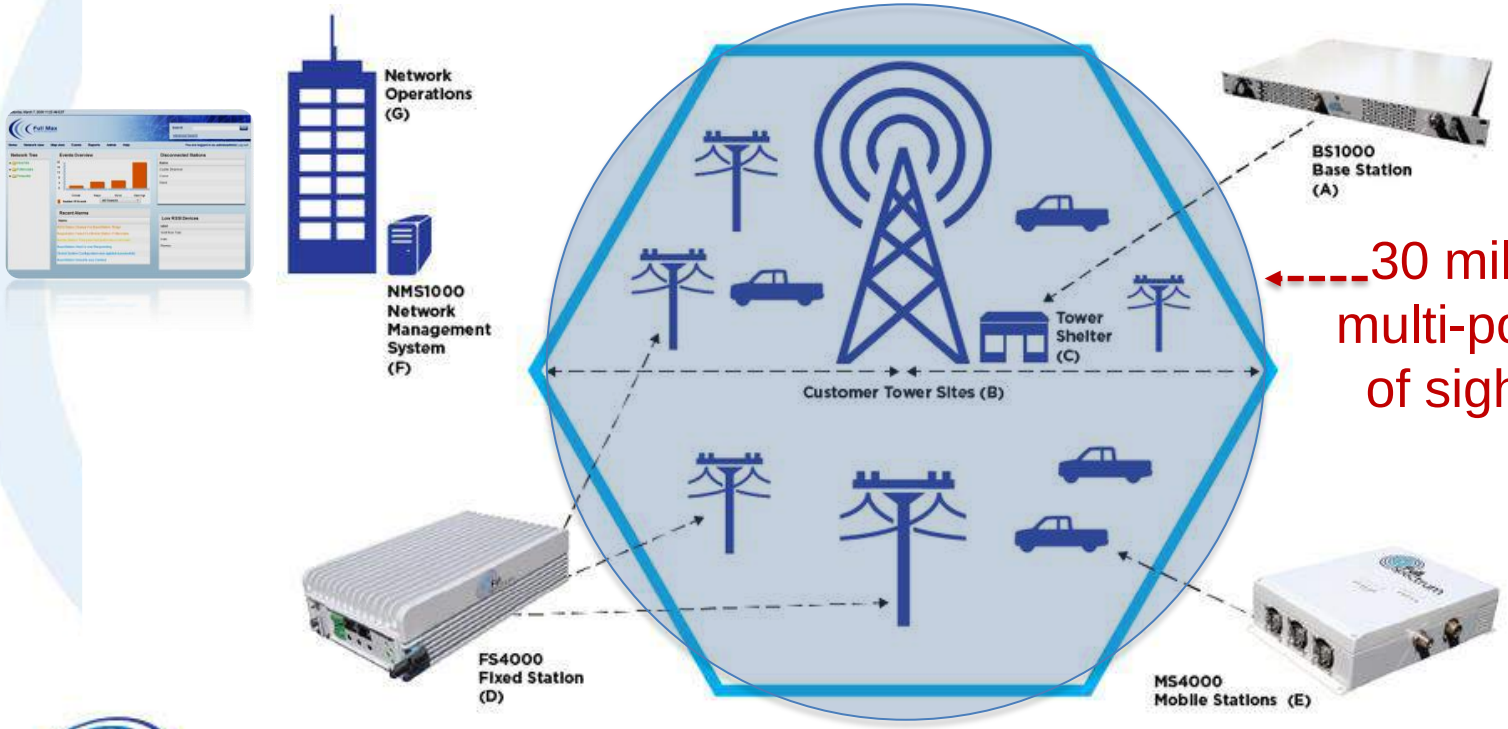
- Transmit power:
  - Up to 1000 Watts ERP at 1000' AAT at 757-758 MHz
  - Up to 30 Watts ERP at 787-788 MHz
- Superior propagation over terrain and through foliage
- Fixed or Mobile operation
- TDD or FDD
- Capacity estimate: 4 Mbps per tower site
- Equal interference protection with adjacent bands – OOBE attenuation ≥ 43 + 10 log P dB

Use and Equipment Availability – Upper 700 MHz A Block

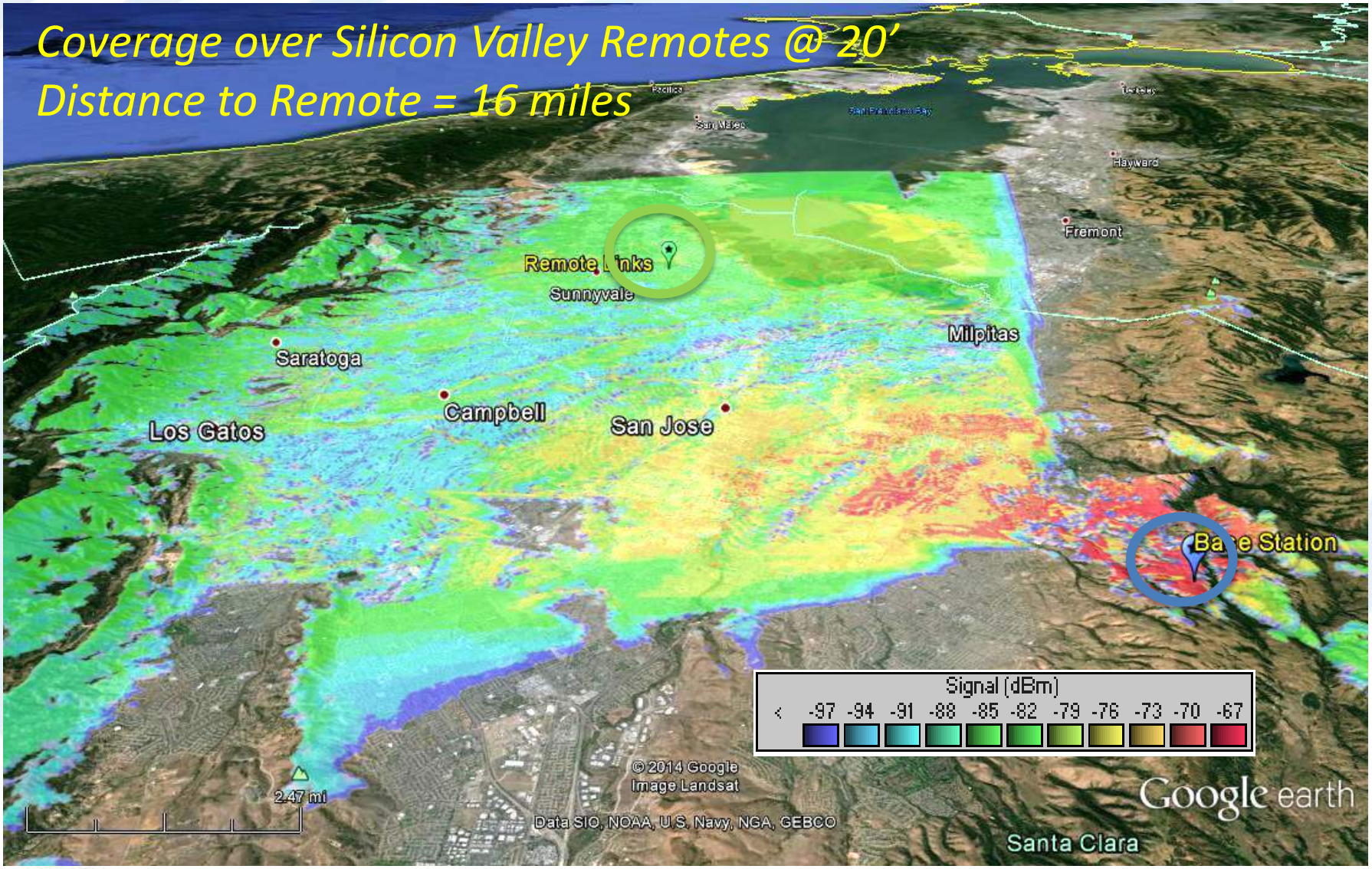
- System deployed: Great River Energy in Minnesota – very satisfied
- Other companies interested. RFPs and trials (example – Salt River Project) in progress
- Currently available equipment:
  - Full Spectrum
  - 4RF
  - ConVergence Technologies/Apex9
  - Tait
- Other manufacturers will modify equipment for band if customers are prepared to order (CalAmp, Carlson Wireless & others)

Example Full Spectrum OFDMA. Variant of 802.16e (Mobile WiMAX) 200 kHz to 5 MHz channel widths

- FullMAX provides 30 miles of non-line of sight, point-to-multipoint coverage from a single base station. (LTE provides 3 miles)
- 2,800 square miles with FullMAX vs 30 square miles with LTE
- Most cost effective private network for smart infrastructure



Coverage over Silicon Valley Remotes @ 20’
Distance to Remote = 16 miles



Full Spectrum

Spectrum Alternatives for Oil & Gas

- **Licensed**, Unlicensed, ~~or Hybrid~~
- (**Private**, Public, ~~or Shared~~)
- **Area,** Site or Pt-Pt
- Narrowband, **wideband** or broadband
- Free, admin fee, **purchased or leased**
- **Equipment matching requirements**
- **Available now** or subject to future government decision

Select Spectrum

rfinch@selectspectrum.com

Presentation to WiMAX Oil & Gas
November 5, 2014

QUESTIONS AND COMMENTS

Robert Finch
Select Spectrum
703 635 2686
rfinch@selectspectrum.com

The 3550-3650 (3700) MHz Band: An Update

Doug Gray dgray.tcs@gmail.com

November 5, 2014

Background

- NPRM – Issued Dec 12, 2012:
  - Rules for CBRS[1] in 3550-3650 MHz band and …
  - Suggested inclusion of 3650-3700 MHz
- FNPRM – Issued Apr 23, 2014:
  - Conditions for inclusion of 3650-3700 MHz
- Our Concern: Impact on Incumbents in the 3650-3700 MHz Band
  - > 2,500 Incumbents, > 39,000 Sites
  - > 100 Oil, Gas, Water, Electric Utilities (CII)

3650-3700 MHz Band is an important enabler for CIIs striving to meet the mandates of Title XIII of the Energy Independence and Security Act of 2007

[1] CBRS: Citizens Broadband Radio Service

WiGRID

WiMAX FORUM®

Proposed Rules for CBRS are Unfavorable for CII/SG

- 3–Tier Licenses: Federal Incumbents, PAL, GAA
- Interference managed by ‘Spectrum Access System’ (SAS)
- Small cell deployment
- Short license term 1 year (5 years with stacking)
- License areas by census tracts (4,000 pops avg.)
- Limited definition for ‘Contained Access’ (indoor)
- Market-driven bidding process for ‘Priority Access License’ (PAL)
- 5 Years for incumbents to comply

WiMAX Forum Response

- Exclude the 3650-3700 MHz band from proceedings
  - Rules are untested - 'IF IT'S NOT BROKEN, DON'T FIX IT'
  - Proposed rules for CBRS not consistent with CII requirements
  - Significant costs for incumbents (after 5 yr. 'grandfather' period):
    - Stranded investment
    - CBRS compliant equipment
    - Potential service and/or operational disruptions
    - Revised cell deployment in accordance with new license boundaries and small cell conformance
- Limited spectrum alternatives for CIIs to meet SG mandates of Title XIII of EISA of 2007
- Alliance with API, UTC, various utilities & equipment vendors

WiGRID

WiMAX FORUM®

Summary of FNPRM Filings

- 66 Comments were filed by July 14th deadline
  - >20 opposed inclusion of 3650-3700 MHz band
  - 6 supported inclusion only if proposed rules were modified
- 31 Reply Comments were filed by Aug 15th deadline
  - 15 opposed inclusion of the 3650-3700 MHz band
  - 3 supported inclusion only if proposed rules were modified
- The rest either supported inclusion or made no mention of 3650-3700 MHz band
  - Supporters of inclusion did not offer alternatives for compensating incumbents
  - Many focused on the ‘Exclusion Zone’ issues

Going Forward

- Planned Meeting with FCC – Week of Dec 8th
  - With API, UTC, GRE, plus 1 or 2 additional (TBD)
  - Restate our position – exclude 3650-3700 MHz
  - Emphasis on negative impact for CIIs
  - More prudent option: 'SANDBOX' approach[1] for CBRS

[1] **FCC COMMISSIONER JESSICA ROSENWORCEL, IEEE GLOBECOM 2013, ATLANTA, GEORGIA, DECEMBER 11, 2013** ("…..I think we need to build more sandboxes in Washington—and at the FCC. …. without the benefit of having tested our thoughts in the real world, we unveil a finished product, cross our fingers, hold our breath, and hope everything turns out for the best…..." http://www.fcc.gov/document/remarks-commission-jessica-rosenworcel-ieee-globecom-2013

Summary

- The 3650-3700 MHz band has proven to be an important wireless solution for Critical Infrastructure Industries (CII) including SG deployments to meet the mandates of Title XIII.
- Excluding the 3650-3700 MHz band from the CBRS proceeding will protect existing incumbents and remove uncertainties that are preventing new entrants.

- Probably won't have a final FCC ruling until early next year.
- Still time for other entities to submit an input.

Smart Energy Working Group
WiGRID Profile and Certification

November 5th, 2014

Eugene Crozier, Chair, WiMAX Forum Smart Energy Working Group
Rich Hawkins, COO - WiMAX Forum

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 beneficial to vendors and industry users.
- We promote WiMAX (WiGRID) Interoperability and Certification based on the Smart Grid Profile using the Certification Testing Events.

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:

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

WiGRID Certification Events

- 1st WiGRID Certification Testing Event hosted by Electric Power Research Institute (EPRI) in Knoxville TN at the end of October 2013
- The Following Companies Participated
  - GE Digital Energy
  - Siemens
  - Cisco
- The Result is 2 Base Stations and 3 Mobile Stations Successfully Certified for Interoperability
- Frequency bands were 1.8GHz, 3.65GHz, and 5.8GHz
- Future event to be held as the ecosystem expands
- Plans to add an accredited lab facility in 2015 for individual product certification