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WiMAX FORUM® & Smart Energy Working Group

A WiMAX Case Study

January 27, 2014

Eugene Crozier, Wireless Specialist Powertech Labs

Powertech

Powertech Labs

Founded in 1979 as Powertech Labs Inc.

A subsidiary of BC Hydro, with extensive knowledge of all aspects of the utilities industry

A large multidisciplinary laboratory, based in Surrey, British Columbia (11 acre site; 200,000 sq. ft.; 19 labs)

Over 30 years of specialized engineering expertise

145 employees: technologists, professional engineers and PhDs

Global customer base: 300+ customers, including many Fortune 500s

Powertech

Smart Grid Center

- An integrated test lab facility at Powertech
  - Setup and operation by Powertech
  - Established spring 2012
- Simulates the current and future utility environment
  - telecom and network infrastructure
  - proof of concept for innovative technologies
  - management and operating systems
  - relays and physical devices
- Allows for interoperability, integrated and non-integrated system performance testing for future devices, management systems, telecom and data network options to support future grid applications.
  - serving utilities and commercial clients

Powertech

FLISR (Fault Location Isolation Service Restoration)

WiMAX is used as a communications medium at a number of BC Hydro's site on the Gulf Islands to support FLISR.

- The key reasons for the choice of the sites were;
  - Remote of the sites.
  - Rural and forest conditions.
- Regular power outages.
  - Environmental constraints limit the amount of power line clearance.
  - Storm conditions generally result in damage to the power systems.
- Difficult access.
  - Ferry and rural roads.
  - With inclement weather access is difficult.
- Two aspects to reducing the outage time.
  - Pinpointing fault location, repair teams know where the fault.
  - Understanding what the fault is, repair team know what to do.
- Fault location and service restoration needs to be robust, reliable, and proactive.
  - Reliability reinforced by a wireless system with features to migrate.
    - Precipitation.
    - Non-line of sight.
    - All sites need to have standby power.
  - Fault location needs to be fast in order to minimize the damage to the transmission and distribution system.

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FLISR
(Fault Location, Isolation, Service Restoration)

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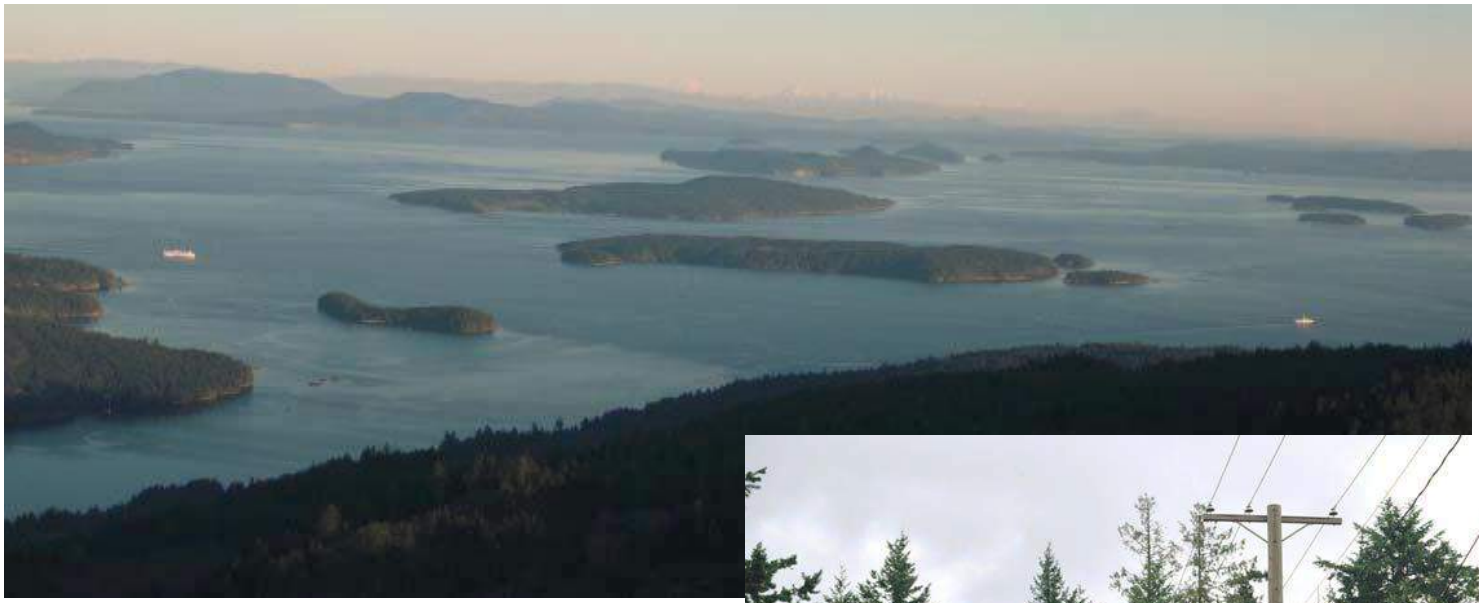
The view



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FLISR
(Fault Location, Isolation, Service Restoration)

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

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

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

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FLISR
(Fault Location, Isolation, Service Restoration)

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FLISR
(Fault Location, Isolation, Service Restoration)

Fault located investigation complete (3 hours)

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FLISR
(Fault Location, Isolation, Service Restoration)

Repairs Made
(10 mins)

British Columbia
Gulf Islands

Feeder #2
GLS 25CR52

Sturdies Bay
10.4km powerlines
430 customers

Feeder #1
SAL 25CB64

12834

Mayne
10.7km powerlines
1394 customers

Repairs made
(10 mins)

12839

Saturna Island
6.2km powerlines
482 customers

Salt Spring Island
24.1km powerlines
926 customers

12998

13012

Pender Island
11.3km powerlines
2046 customers

Time:
02:15:00

# of Customers without service:
926

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FLISR
(Fault Location, Isolation, Service Restoration)

Restore normal configuration via remote control (10 mins)

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FLISR
(Fault Location, Isolation, Service Restoration)

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

No 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

FLISR Benefit is 440,890 customer outage minutes for this event

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Powertech

Wireless IoT Platform for Smart Grid

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Key Concepts

- Why Wireless?
- What is the Internet of Things (IoT)?
- IBM IoT Wireless Platform
- Band Agility
- Channel Agility
- Multi-platform Solution
- Architecture
- Project Examples
- Latest Innovation - MOTE

Why Wireless? - Paradigm Shift

- To handle today's volume, velocity and variety of data, enterprise data centers must become more dynamic and flexible
- One way to think about this is to imagine entire IT infrastructures that are as programmable as individual systems
- This new model is known as the "software-defined environment," and cloud computing is its first manifestation. However, it will not be the last
- Software defined networking and software defined radios are fast followers to the data center and cloud computing innovation shifts
- This new model optimizes the entire computing "stack" – compute, storage and network resources – so that it can adapt to the type of work required

Why Wireless? It is important for IoT enablement of critical industry infrastructure

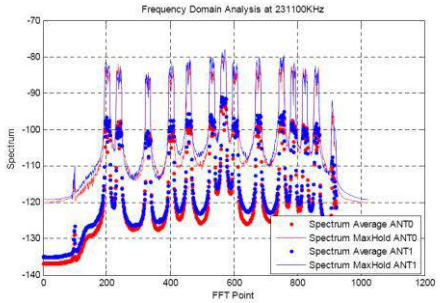
Petroleum and gas

Power Grid

Manufacturing

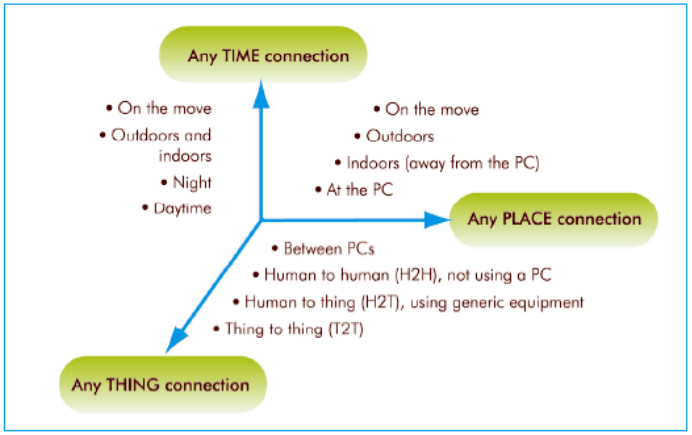
Stable wireless communication in harsh environment

- From Narrow band (VHF/UHF) to Broadband
- Massive number of connections (>1000)
- Spectrum Resource Optimization
  - –Spectrum sharing in the same spectrum range (ISM or non-ISM)
  - –Prevention of illegal radio jamming
- Different range coverage, e.g.
  - – 100m to 5km wireless coverage for feeders, factory, field, etc.
  - – approximately 30km wireless coverage for distribution grid in rural area
  - – approximately 200km wireless coverage for transmission grid power line monitor, pipe management
- Low power: e.g. terminal devices with battery
- Low latency: e.g. sub 30 ms for fault detection and control
- “Flat” deployment to reduce risk and cost: e.g. to reduce the number of equipments



Internet of Things (IoT) – What is it?

- The Internet of Things is a third generation (Web 3.0) model of the internet
- It is immersive in nature in that it encompasses all objects (Things)
- It leverages the traditional client-server model and adds in the peer-to-peer model
- It permits devices, sensors, and objects of any kind to interact with each other ubiquitously on a machine-to-machine (M2M) level without user requests, demands or acknowledgements



Source: ITU, adapted from Nomura Research Institute.

- The current Web 2.0 model is a client-server design that leverages Human-to-Machine (H2M) connections as its main interaction approach
- IoT is highly dynamic and varies its configuration autonomously as a Self Organizing Network (SON)
  - Self-planning
  - Self-configuring
  - Self-optimizing
  - Self-healing
- The dynamic aspect can remap the network based upon:
  - Time
  - Place
  - Application
  - Need
- The IoT is a distributed and federate model, but it can also support a centralized model, so it is very flexible and a hybrid of the architectures

Software Defined Networks

IBM Software Defined Network for Virtual Environments creates a more responsive network by creating a virtual network for virtual machines. This virtual network is decoupled and isolated from the physical network much like a virtual machine is decoupled and isolated from its host server hardware. This approach provides several advantages:

- Virtual networks can be created without any changes to the existing network
- Since the physical network does not have to be changed, it can be wired once
- Provisioning and administration can be simplified and automated
- IP and MAC addresses can be reused permitting logical separation of networks for multi-tenancy
- Significant benefits to both CapEX and OpEX

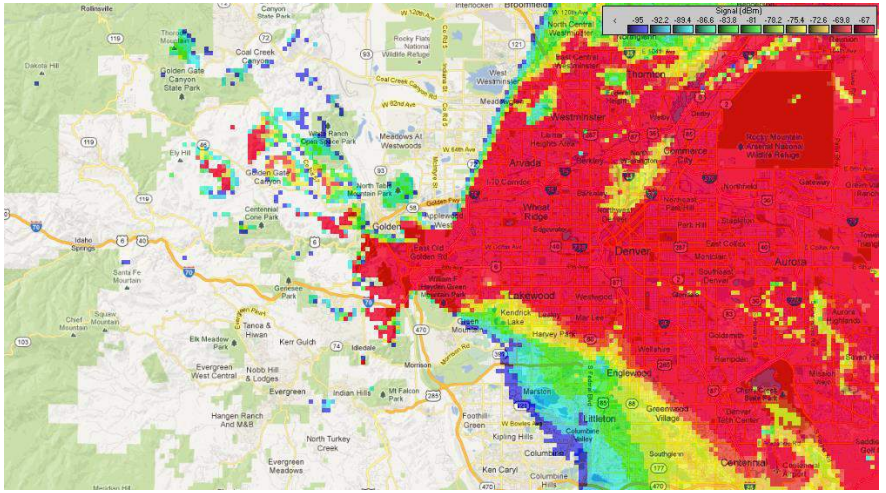
IBM IoT Wireless Platform – What is it?

- It is a next generation microwave radio platform that is software defined as opposed to a hardware design model
- It uses standard or ruggedized IBM pSeries server operating with a hardened LINUX operating system
- The radio is in two parts - an indoor unit and an outdoor unit
- The indoor unit is an IBM pSeries server and can be located up to 20 km away from the outdoor units
- It is able to simultaneously support multiple radio standards
- Both the base station and the CPE are fully software defined, so they can co-host other compatible applications that can further enhance the design
- The platforms are agile so they can be changed in the field and updated from a central location to reduce OpEx and better manage the asset with longer life and reduced risk
- Tight integration can be had with the core optical network as well as extensions off of the CPE
- A highly secure model with end-to-end encryption that can co-host software defined firewalls at the edge
- Specific apps for the edge points can be nested in the CPE for control and interface requirements
- The cost for the platform is dramatically lower to capitalize and operate compared to a traditional hardware platform
- It offers an ultra low latency for compliance with IEC-61850 and other time sensitive solutions

Band Agility

- The IBM IoT Wireless Platform can be configured to operate at any channel plan and band from 1 MHz to 6 GHz
- The filtering is software defined with sharp edges
- Possible bands include:
  - **232 MHz (Sensing and Data Collection)**
  - 450 MHz (LMR)
  - 700 MHz (Emerging for First Responders)
  - 800 MHz (870-880 MHz for UK and EU)
  - **900 MHz (ISM – 902-928 MHz)**
  - 1400 MHz (FDD)
  - **1800 MHz (TDD)**
  - 2200 MHz (Various uses globally)
  - 2485 MHz (ISM – Wi-Fi)
  - 3650 MHz (Cognitive Compliance)
  - 4900 MHz (First Responder's Band)
  - 5250 MHz (UNII-1 – 5150-5250 MHz) (USA and Canada)
  - 5350 MHz (UNII-2 – 5250-5350 MHz) (USA and Canada)
  - 5725 MHz (UNII-2e – 5470-5725 MHz) (Worldwide)
  - 5825 MHz (UNII-3 – 5725-5825 MHz) (USA and Canada)

  Bolded spectrum is either developed or under development

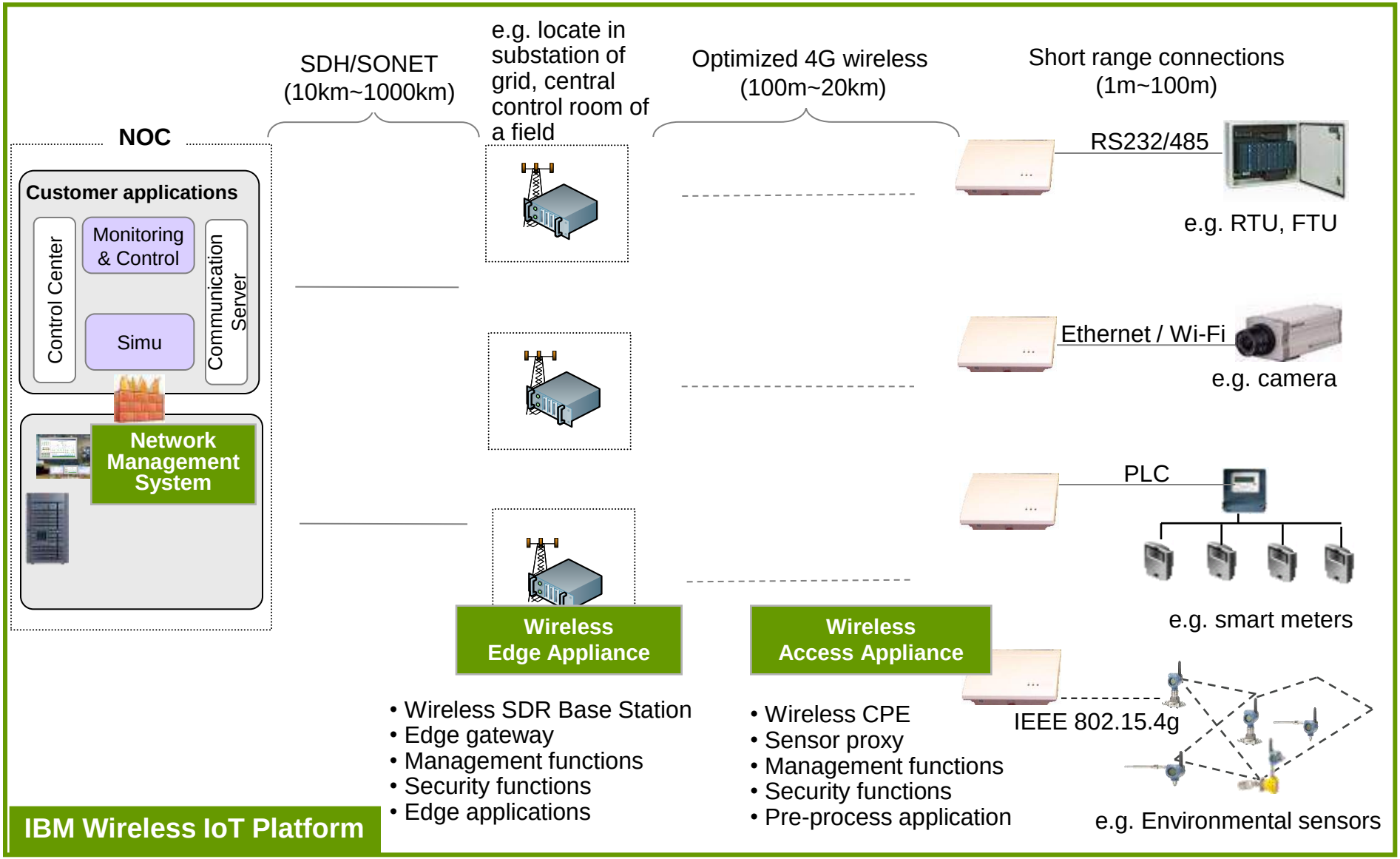


- Pilot radio being prepared as one three-sector base station and 20 CPE at 902-928 MHz
- New bands can be configured in 90 days at the factory and then an additional 60 days for testing and regulatory approvals

Multi-Platform Solution

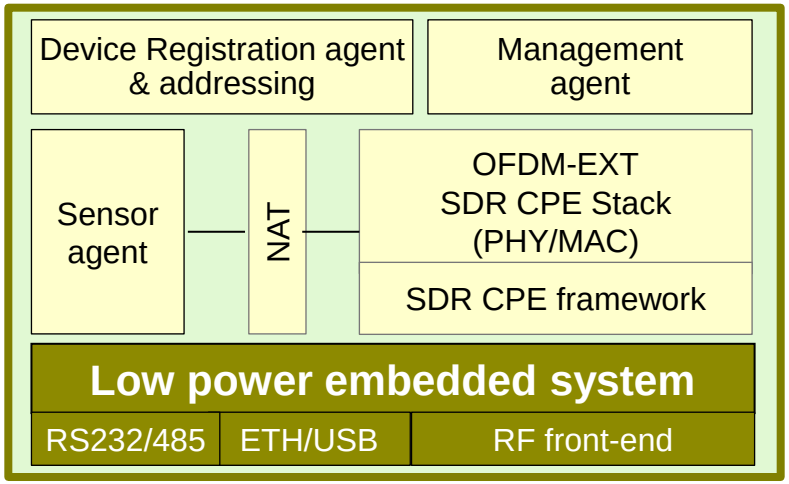
- The IBM IoT Wireless Platform can simultaneously operate multiple networks
- Options available today include:
  - LTE
  - Wi-MAX
  - GSM (HSPA)
  - CDMA (EV-DO)
- Radios can operate as Point to Multipoint (P2MP), or Point to Point (P2P) so the base station can be a fixed link and a P2MP base station at the same time
- Wi-MAX permits meshing and therefore range extension is possible as CPE relay one to another to the base station

Architecture



Wireless Access Appliance : Flexible and Low Power

Wireless Access Appliance



Product certification from China State Radio Regulation Committee (SRRC)

- Base band + RF: Modular design for easy customization
- SDR: capability for different standards
- Rich hardware interfaces: support different terminal connections.
- Outdoor design: compliant with environmental regulation (IP65)

System and algorithm optimization for: Lower cost, higher performance, smaller size

V1.0 outdoor

V1.1 outdoor, low cost, smaller size

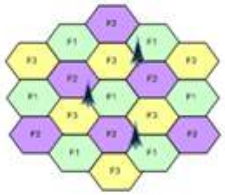
V1.2 outdoor, low cost, high performance

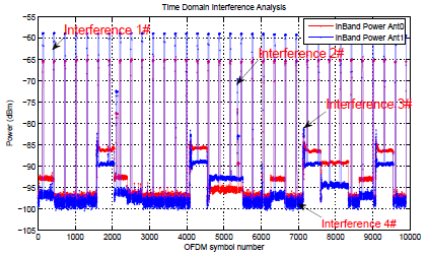
V1.3 indoor, low cost, module for meter

Outstanding performance through network analysis and continuous optimization

Cognitive Radio for spectrum optimization and management

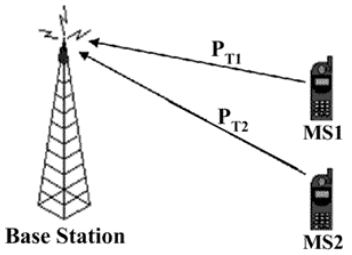
- Key technology to ensure stable communication with strong interference





Power management for low power and Green

- Open and close loop power control technology based on network analysis
- CFR technology

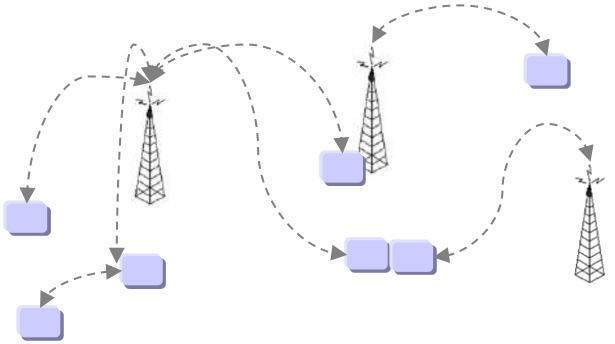


Cross layer optimization for QoS

- Optimization based on the network quality analysis and service quality requirement

Software Defined Network for flexible topology support

- Enable different topology through SDN, to support various applications



Demonstrated Advanced Performance through customer pilots

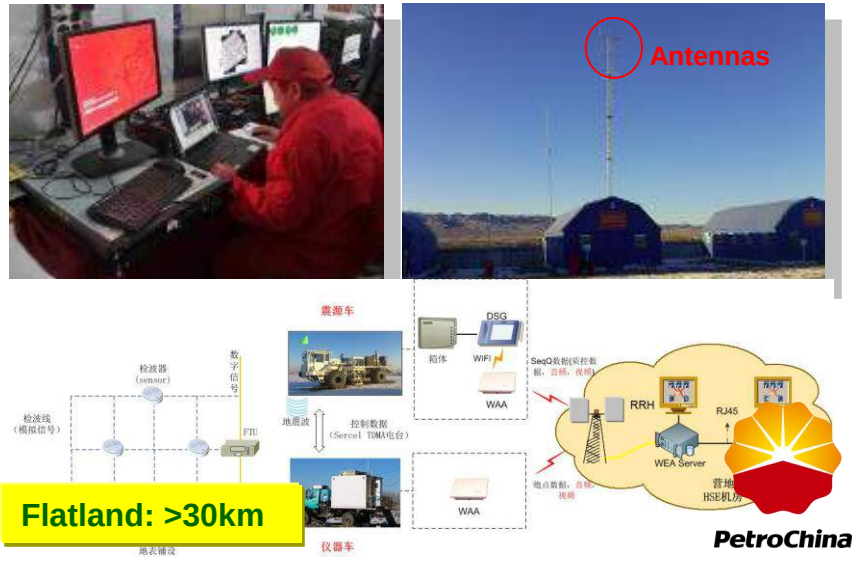
A. Hainan: Video surveillance on the sea

Sea: ~20km

B. Shanxi: Pipeline construction

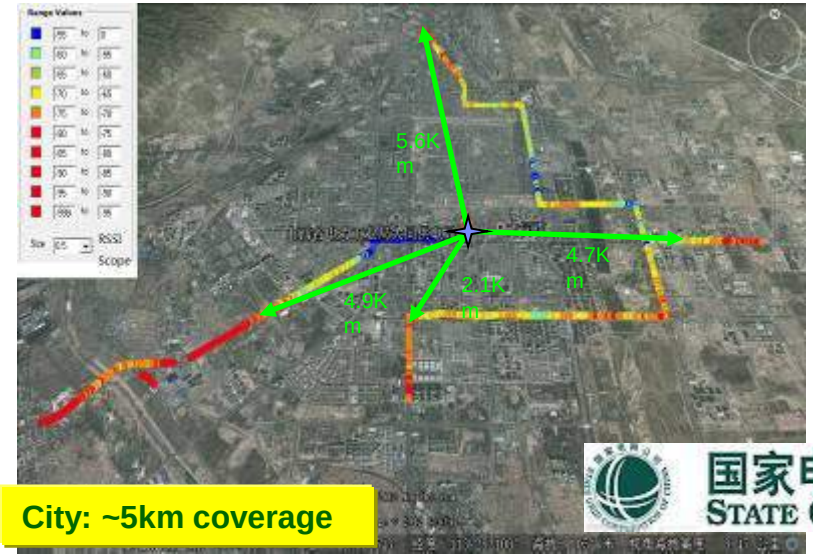
Mountain area: ~7km coverage

C. Xinjiang: Digital Exploration



Flatland: >30km

D: Shanxi: Distributed Grid Monitoring



City: ~5km coverage

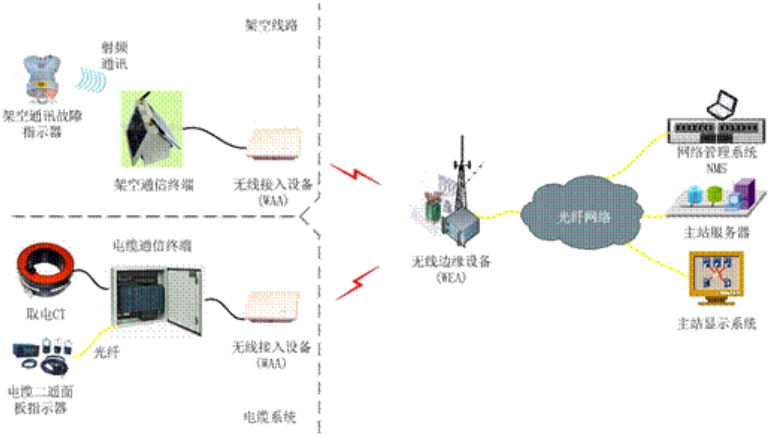
Provide value to customer through solution integration

A. Smart meter infrastructure

- Value: Long distance and high receiver sensitivity, for in-building and underground communication.
- Finished integration with Great Power.

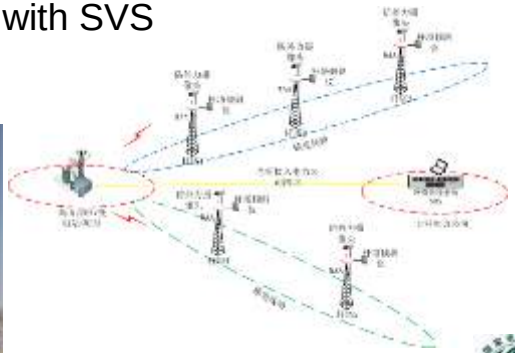
B. Distribution Grid Automation

- Value: Stable communication with low latency.
- Finished integration with two DGA applications



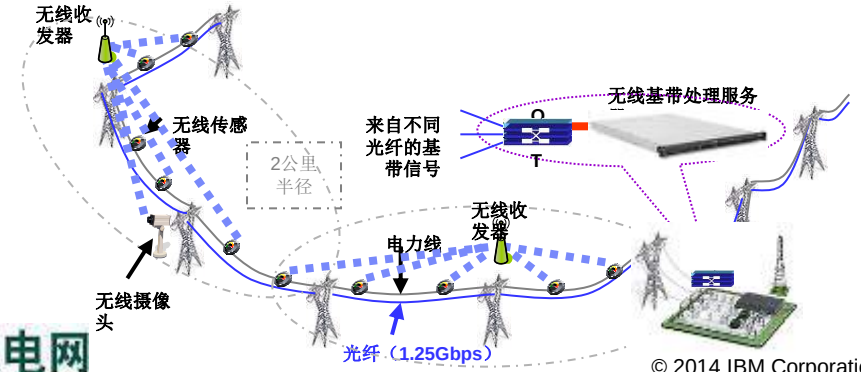
C. Video surveillance for power tower

- Value: High throughput, low cost and reduce backhaul bandwidth
- Integrating with SVS



D. Power line monitoring

- Value: Long distance and flexible topology
- Joint proposal with CEPRI

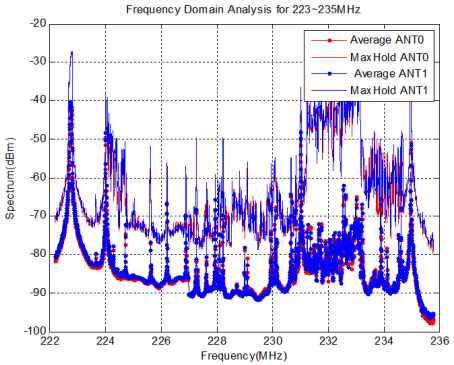


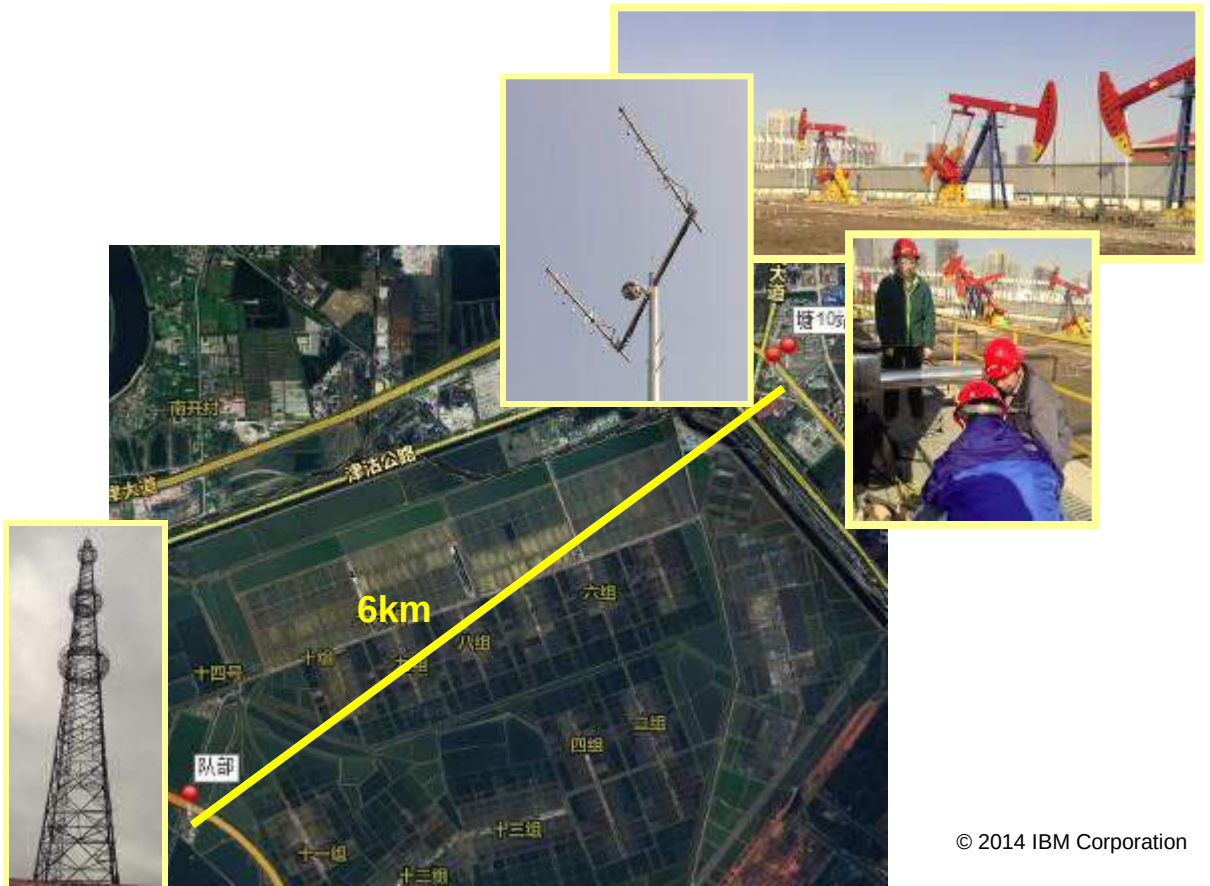
国家电网 STATE GRID

The latest pilot: Support Video Surveillance of Oil Field

- Tianjin oil field pilot is led by IBM
- Requirement: To support high definition surveillance (1080p) for oil field (~ 6km distance)
- Result:
  - Through spectrum optimization provided stable radio communication with CRC error < 0.1%.
  - Through the cross layer optimization supported the smooth HD video streaming with QoS guarantee.

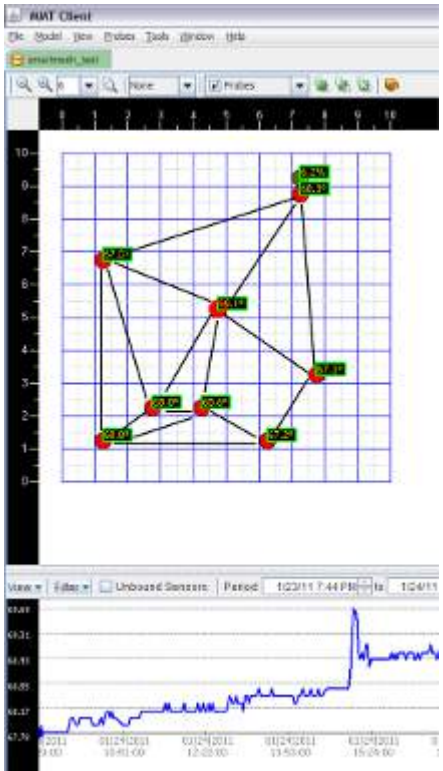
Fig.1 Spectrum interference

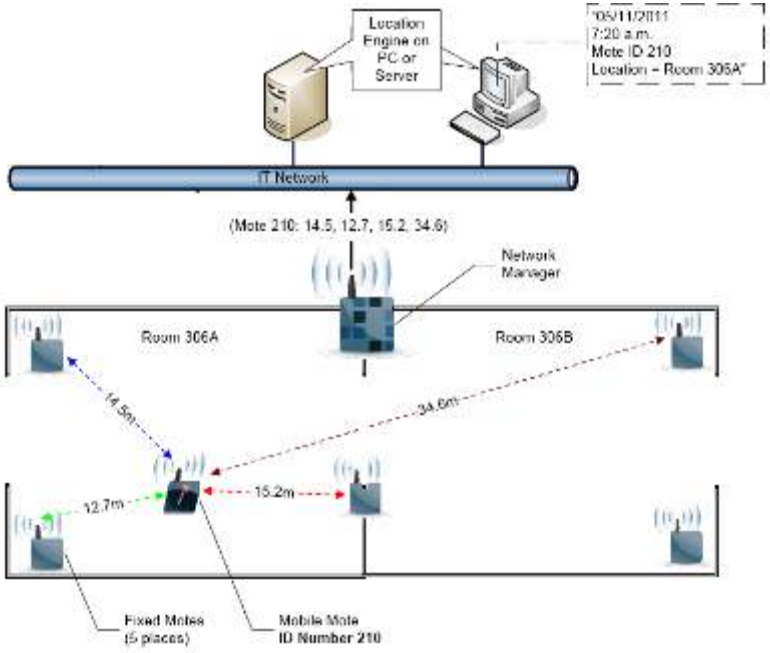




Low-Power Mote Technology (LMT)

- **LMT—a general wireless data gathering and control technology**
- **World's lowest power consumption**
  - 5 to 7 year lifetime with two AA batteries
  - Forms mesh network, highly reliable, robust and scalable
  - All data transfer secure and encrypted
- **Very flexible and modular design**





By

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Thank You

About the Author

Michael James Martin, MA, MBA, GDM, SCPM, PMP, CBNT

Michael Martin is an IBM Senior Executive Consultant in the Global Center of Excellence for Energy and Utilities based in Toronto, Canada. He consults primarily on complex RF systems used for smart meter and smart grid systems. Mr. Martin possesses an extensive post-secondary education and is a dedicated life-long learner. In his free time, he is pursuing a third masters degree, flies small Cessna and Piper airplanes, camps in his motorhome, and plays with RF stuff.

GE
Digital Energy

Grid Automation
Industrial Products – WiMAX Case Studies

Craig Tedrow
Product Architect

Judy Lestrange
Product Manager

Agenda

1. Product Summary
2. Case Study
3. Partnering with Customers

imagination at work

Product Summary

MDS Mercury Series

What is it?

The MDS Mercury Series is a highly secure, purpose built, industrial-grade communications platform for mission critical applications. The MDS Mercury Series is available today in 3 frequencies designed to facilitate wireless, high throughput networking requirements :

- 5800MHz- global, unlicensed WiMAX solution
- 1800MHz- a product specific for the frequency available to Canadian Utilities
- 3650MHz- a lightly licensed solution for US, Canadian and Australian markets

Products offered in the MDS Mercury Series include base stations, indoor and outdoor subscriber units.

Value Proposition

•**System Solution Flexibility** - Numerous connection and packaging options provide customers with the ability to build out a communications infrastructure solution specific to their business and geographic requirements.

•**Advanced Security Features** - Dynamic key rotation, device authentication using EAP-TLS & Radius server, IEEE 802.1x port blocking, secure remote access methods, physical security and tamper alarm controls for packaging options.

•**Ease of use Network Setup & Management** - easily manage base station and subscriber configuration at any computer with web enabled services. Additionally, GE's PulseNET EMS, manages device statistics and provides alarms for tamper, voltage deviation, power outage and restoration.

Change & Technology Drive Innovation

Distribution & Substation Facilities

- High per circuit assets
- Shortened response time for outages
- Increased application use and demand for real-time visibility into distribution and substation facilities.

- ➢ Justifies infrastructure build
- ➢ Encourages cost-effective communications
- ➢ 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

Mercury 3650
Oil/Gas Application - SCADA Backhaul

- End customer: Whiting Petroleum – oil firm drilling in North Dakota
- Data requirements were low, however video used at one site drove higher throughput requirement
- Decision made to use WiMAX technology
- Timeline was critical as weather past November inhibits tower construction and radio field deployment
- Customer required 24/7 SCADA data.
- Outdoor subscriber units (ODUs) chosen for several sites

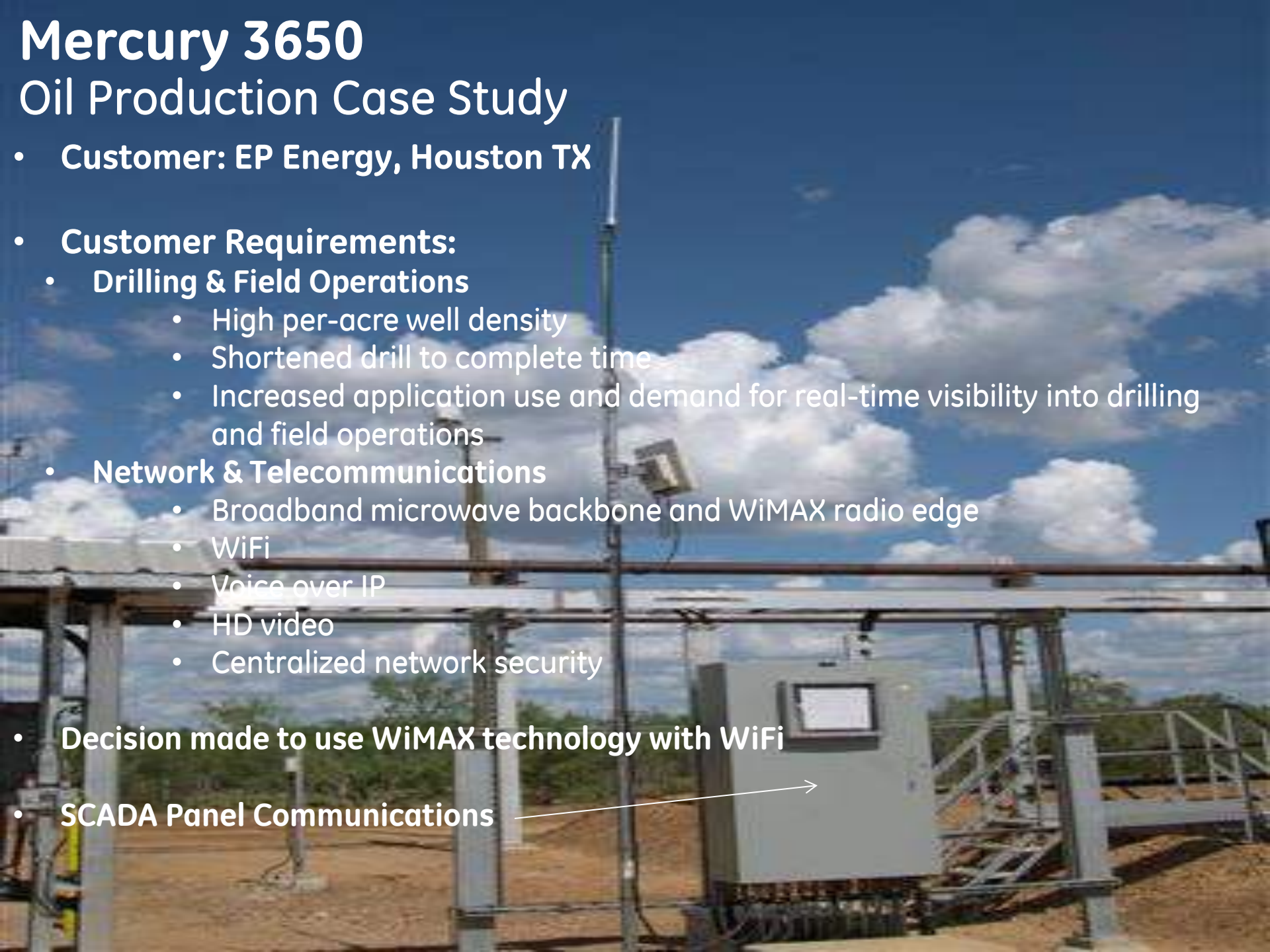
Mercury 3650
Oil Production Case Study

- **Customer: EP Energy, Houston TX**

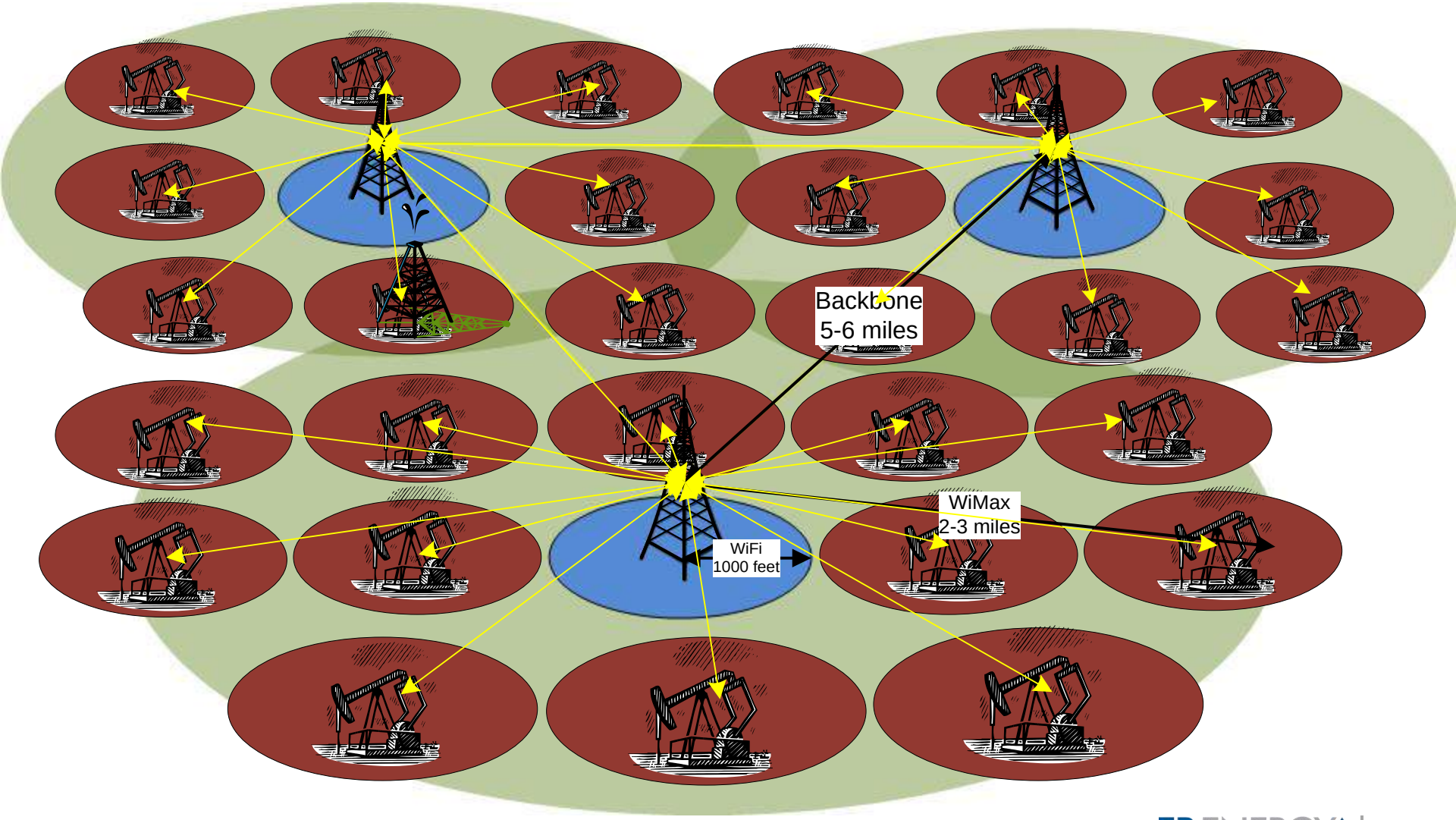
- **Customer Requirements:**
  - **Drilling & Field Operations**
    - High per-acre well density
    - Shortened drill to complete time
    - Increased application use and demand for real-time visibility into drilling and field operations
  - **Network & Telecommunications**
    - Broadband microwave backbone and WiMAX radio edge
    - WiFi
    - Voice over IP
    - HD video
    - Centralized network security

- **Decision made to use WiMAX technology with WiFi**

- **SCADA Panel Communications**



WiMAX Field



Backbone Tower Location

Drilling Rig Communications Package

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

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

Application Mercury in Mining Transportation

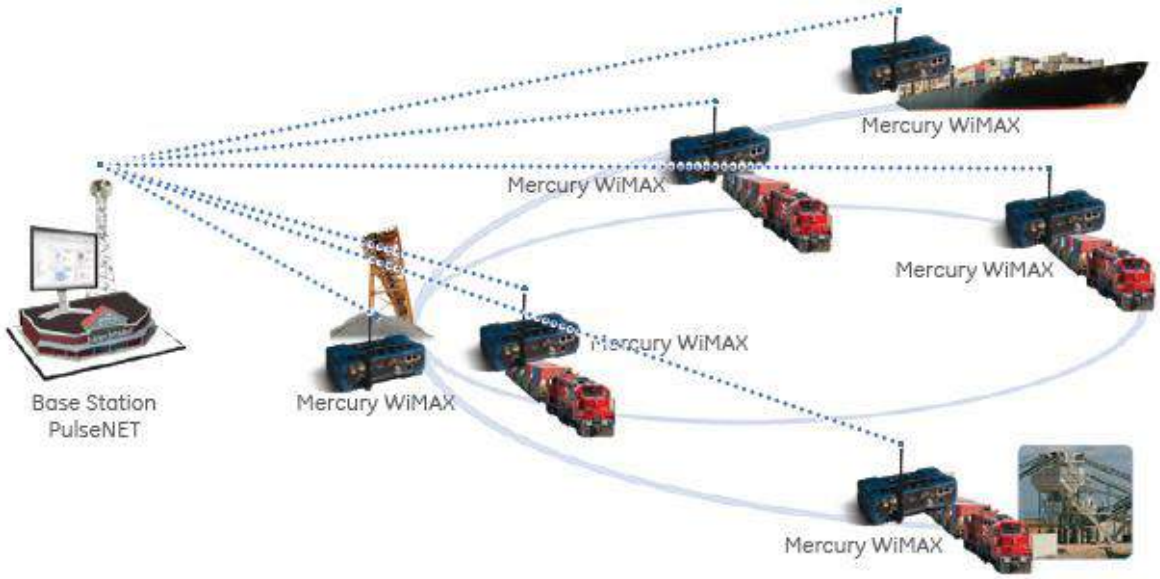
Customer: MRX– Perth, Australia

Requirements:

- Mobile tracking of locomotives
- Seamless handover of data
- High reliability required for unmanned locomotives

Solution:

- 2 AirSynergy base stations & 1 ASN Gateway
- Mercury 3650e indoor subscriber (IDU) in each locomotive



Application: Mercury in Utility AMI & DA

Customer: Town of Danvers, Danvers Massachusetts, USA

Requirements:

- WiMax backhaul for 28 AMI collector sites
- 99.999% reliability
- Low latency required for distribution equipment

Solution:

- Mercury 3650e subscribers at collector sites
- Base stations at selected sites
- Outdoor subscribers with WiFi used for workforce automation

MDS Mercury Technical Specifications

WiMAX operation: 802.16-2005 (16E) with demonstrated interoperability

RF Channel Bandwidth: 3.5, 5, 7, 10MHz

MIMO: 2x2 on subscribers and base stations

Power output: 30dBm per channel, 23dBm for 3650 ODU

ODU Antenna: integrated 18dBi for 3650 & 5800 MHz

Indoor units: dual TNC antenna connections

Mobility: standard WiMAX hand-offs with ASN gateway integration

Modulation: Adaptive with QPSK, 16QAM, 64QAM

Transmit power: 30dB EVM at 64QAM and 30dBm

Convergence sub layer: Eth-CS

MDS Mercury Technical Specifications

Networking
- 2 Ethernet ports
- 1 RS-232 serial port
- IEEE 802.1d Ethernet bridging
- Terminal server TCP/UDP serial data encapsulation for SCADA devices

Security
- User account management via RADIUS with 3 user levels
- PKMv2 with user issued X.509 certificates for EAP-TLS authentication

Device management
- Local console, SSH, HTTP/S
- SNMP v1/2/3 with MIB-II and proprietary MIBs
- Network-based firmware upgrades using FTP, SFTP, or TFTP
- Local event logging with syslog forwarding

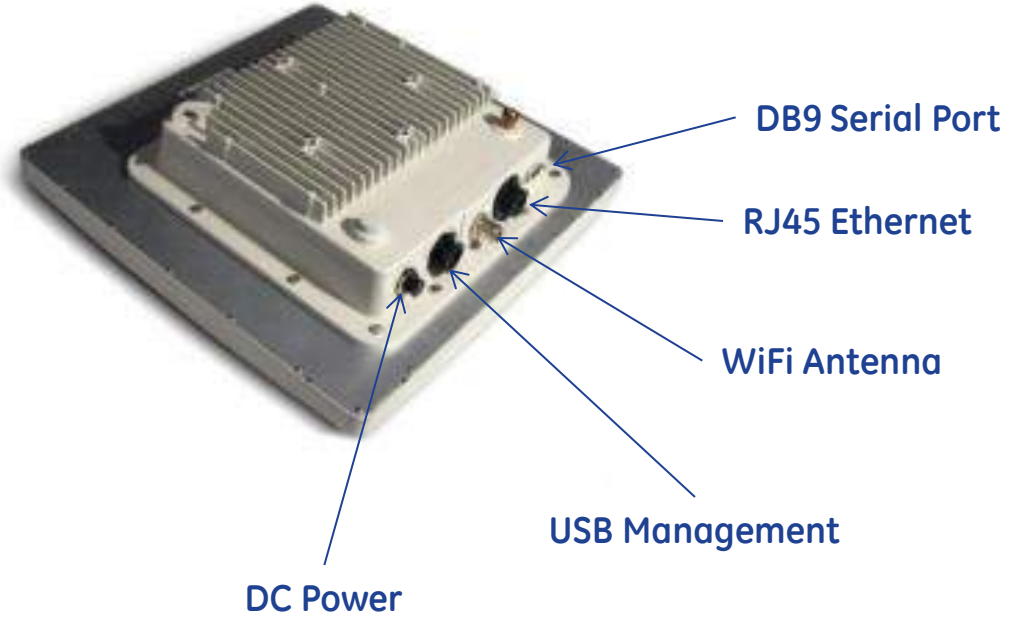
Power input – 10 to 60 VDC for BS & SU. PoE for ODU

Environmental, physical, regulatory
- FCC, IC, ETSI
- IEEE 1613
- Class 1 / Div 2

MDS Base Station and Subscriber Unit Details

Note: antenna connections shown are 1800 & 3650 indoor subscriber and base station.
Mercury 5800 indoor subscriber & base station antenna connector shown in photo above

MDS Outdoor Unit (ODU) Details



MDS Mercury Series

Mercury Product Models

Frequency Availability: 1800, 3650, 5800MHz

Base Station + Indoor Subscriber Unit

- 2 x 30 dBm (1800 & 3650), 2 x 23 dBm (5800)
- MIMO Matrix A/B
- -40º C to +70º C
- IEEE 1613 compliant
- CSA Class 1 / Div 2 certification
- 2 Ethernet ports, 1 Serial port, USB, GPS
- Built-in WiFi (Subscriber Unit only)

Outdoor Subscriber Unit

- 2 x 23 dBm (3650 SU), 2 x 30 dBm (1800 SU), 2 x 18 dBm (5800 SU)
- MIMO Matrix A/B
- -40º C to +70º C
- IEEE 1613 compliant
- 1 Ethernet port, 1 Serial port, 1 USB Host
- Integrated antenna
- Power over Ethernet (POE)
- 10-60 VDC option
- Optional built-in WiFi

Packaged Model

- Provides integration with Mercury, iNET, SD and third party AMI collector boards
- IEEE 1613 compliant
- CSA Class 1 / Div 2
- NEMA 4x
- Pole mount ready
- Physical tamper alarm
- Designed for easy field troubleshooting and maintenance
- A/C input and 8-hour battery backup

Additional Offerings

MDS PulseNET NMS

- Network Management Software for MDS & 3rd Party Devices – PulseNET
- Assessment & implementation services
- Hosted on or off-site Network Operations Center capabilities

Mercury Installation Kits

- Pre-tested for compatibility with MDS devices
- Facilitates easy, single source ordering
- Panel, sector and ODU antennas
- Connector kits with a jumper, grounding and weatherproofing
- Cable in a variety of diameter and prices
- Field-rated power supplies

Mercury Technical Differentiators

Technical Feature	Customer Value
User ports handle 16.5 kV ESD without damage.	Reduces field failure due to atmospheric conditions, & thunderstorms
Products designed to operate from -40 to +70 degrees C	Cold start at -40 degree allow uncompromising operation of system
True MIMO design, instead of MISO	Two full transmit chains provides improved range & throughput over competition. MISO hinders uplink centric application.
Built to last	Cast aluminum enclosures double as heat sinks while withstanding shock and vibration
ODUs use highest in-class gain antennas	“size matters” 6 dB advantage provides double the range
FW fully field upgradeable; Ease of use	Customers have access to latest product enhancements when they are released. No license or special SW required for upgrade
Built-in alarm monitoring and event logs	Event logs may be sent to an external server for view on a handheld device.
Customizable for networks	Allows customers to work with existing network design

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WiMAX Communications for Canadian Utility Applications

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Utilities

BC hydro FOR GENERATIONS

ENMAX

Power Stream YOUR CURRENT CONNECTION

FORTIS BC™

Hydro Québec

Industry

GE Energy

TELVENT

vizimax

The Valley Group a Nexans company

ALSTOM

Schneider Electric

S&C ELECTRIC COMPANY Excellence Through Innovation

RUGGEDCOM INDUSTRIAL STRENGTH NETWORKS™

Academia R&D

UBC

McGill

BCIT BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY bcit.ca

Powertech


INTELLIGENT ENERGI
SmartGridGB
For an intelligent future
Japan Smart Community Alliance
SmartGrid CANADA
sgi
smartgridireland
switch2smartgrid
smartgrid The Norwegian Smartgrid Centre
Elder
SMARTGRIDS FRANCE
EDSO for smart grids
SMART GRIDS FLANDERS
KSGA Korea Smart Grid Association
GRIDWISE ALLIANCE
ITRI Industrial Technology Research Institute
ISEA
The Israeli Smart Energy Association
सत्यमेव जयते
SGA
GSGF
Global Smart Grid Federation

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ONTARIO CONTEXT

Government/Regulator Support for Smart Grid

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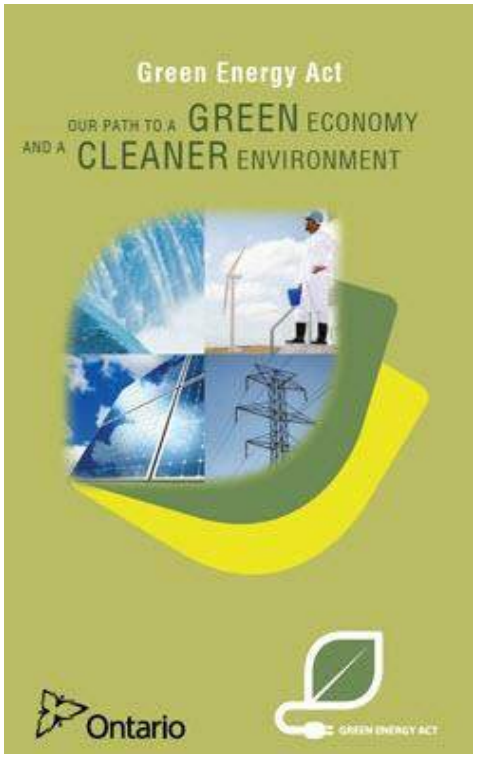
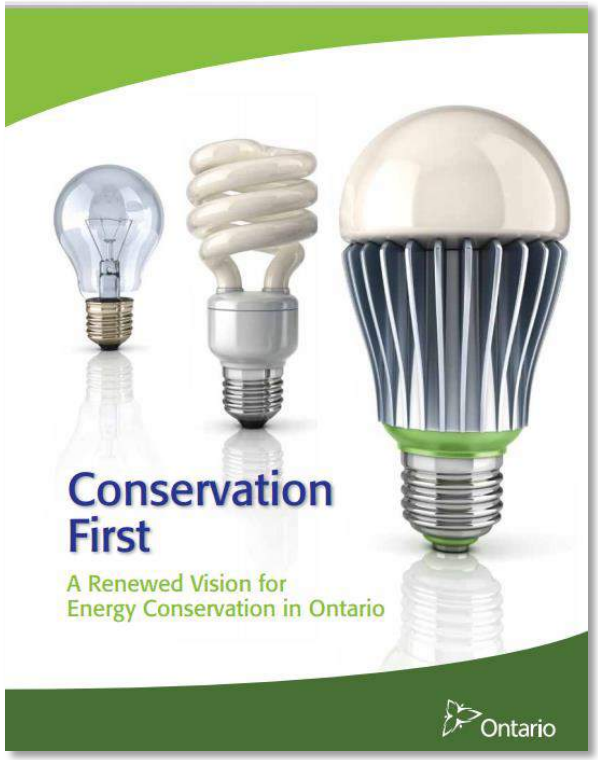
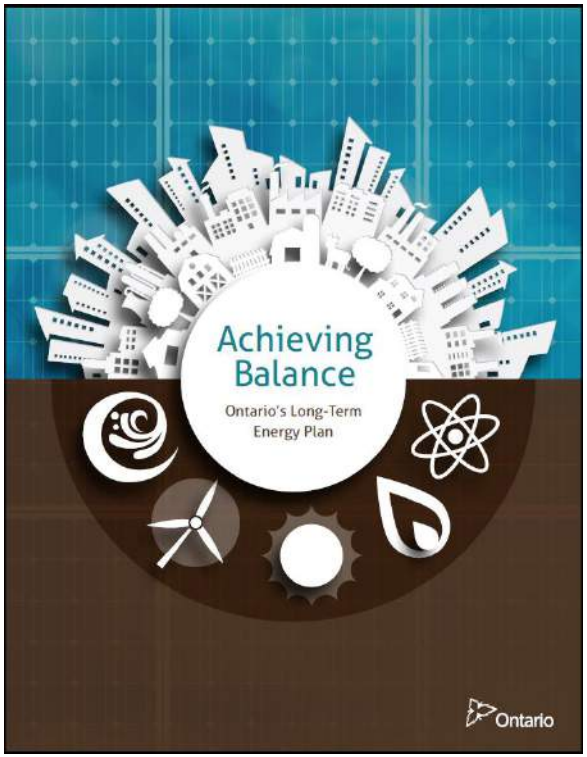


May 2009



Jul 2013



Dec 2013

Ontario Faced a Looming Resource Gap

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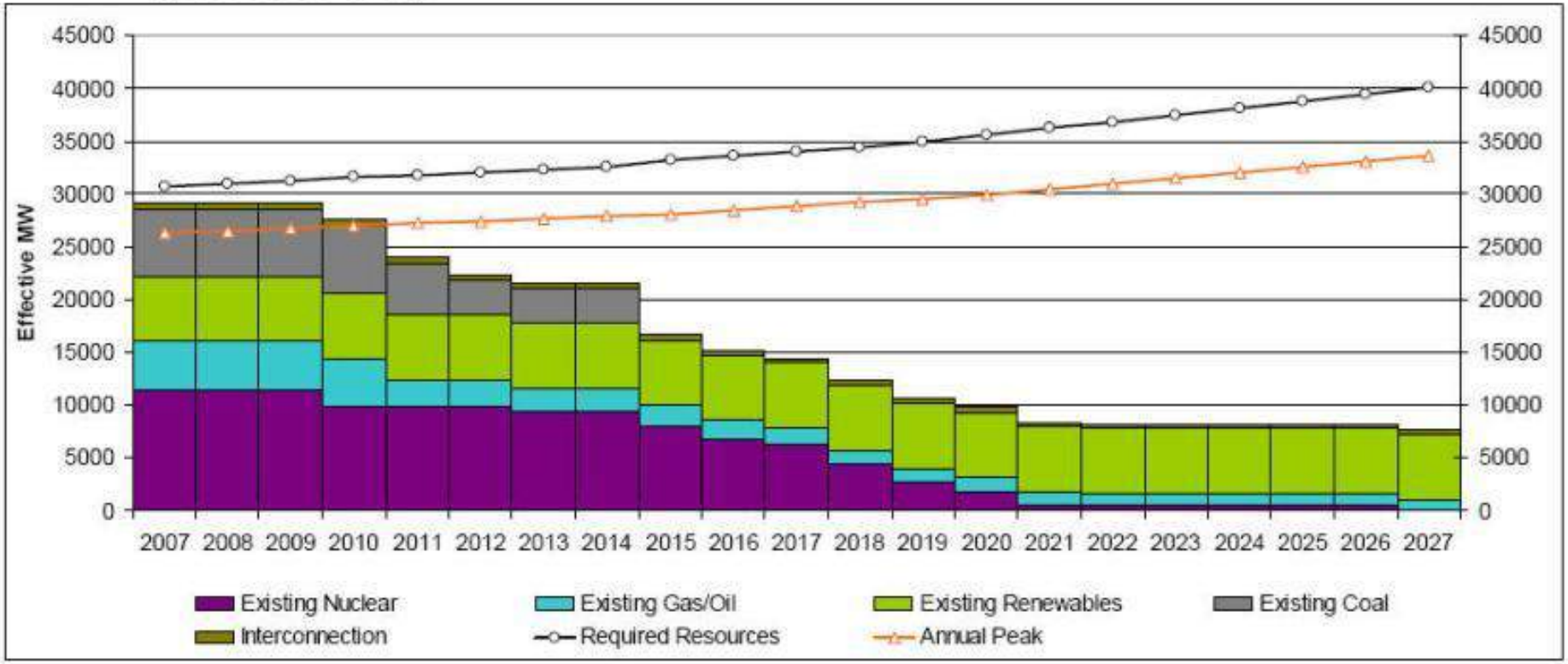
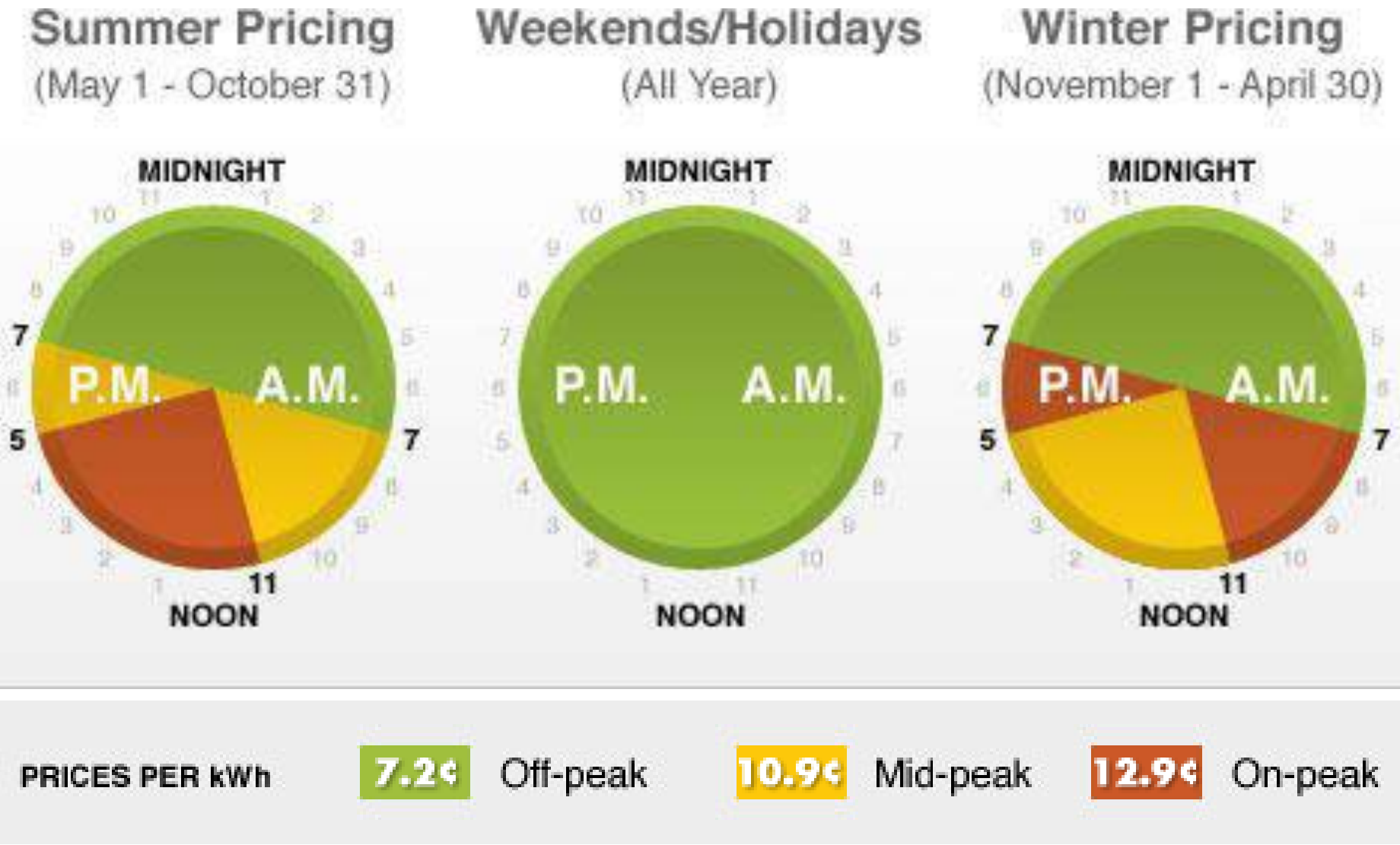
Figure 1: Contribution of Existing Resources Towards Resource Requirements (Effective MW)



Source: OPA

10,700MW by 2018

Largest Market in World on Mandatory Residential Time of Use Rates



Ontario's Energy Supply Mix

SUPPLY TYPE	FUEL TYPE	LOCATION	CURRENT/PROPOSED PRICE (kWh)
Peaking fuel for reliability*	8% natural gas	various plants	8.5¢ - 14¢
Renewable Opportunities**	TBD% – new renewables portfolio	wind solar biomass biogas landfill gas new hydro	8¢ - 44.3¢
	1-2% rooftop solar***		53.9¢ - 80.2¢
Baseload 76%*	53% nuclear	Pickering Darlington Bruce	6¢ - 7¢
	23% hydroelectric	Niagara Falls St. Lawrence River Northern rivers	5.7¢ - 6.2¢

* Existing supply

** Emerging supply

*** 1% = approximately 100,000 residential rooftops

Proliferation of Distributed Generation

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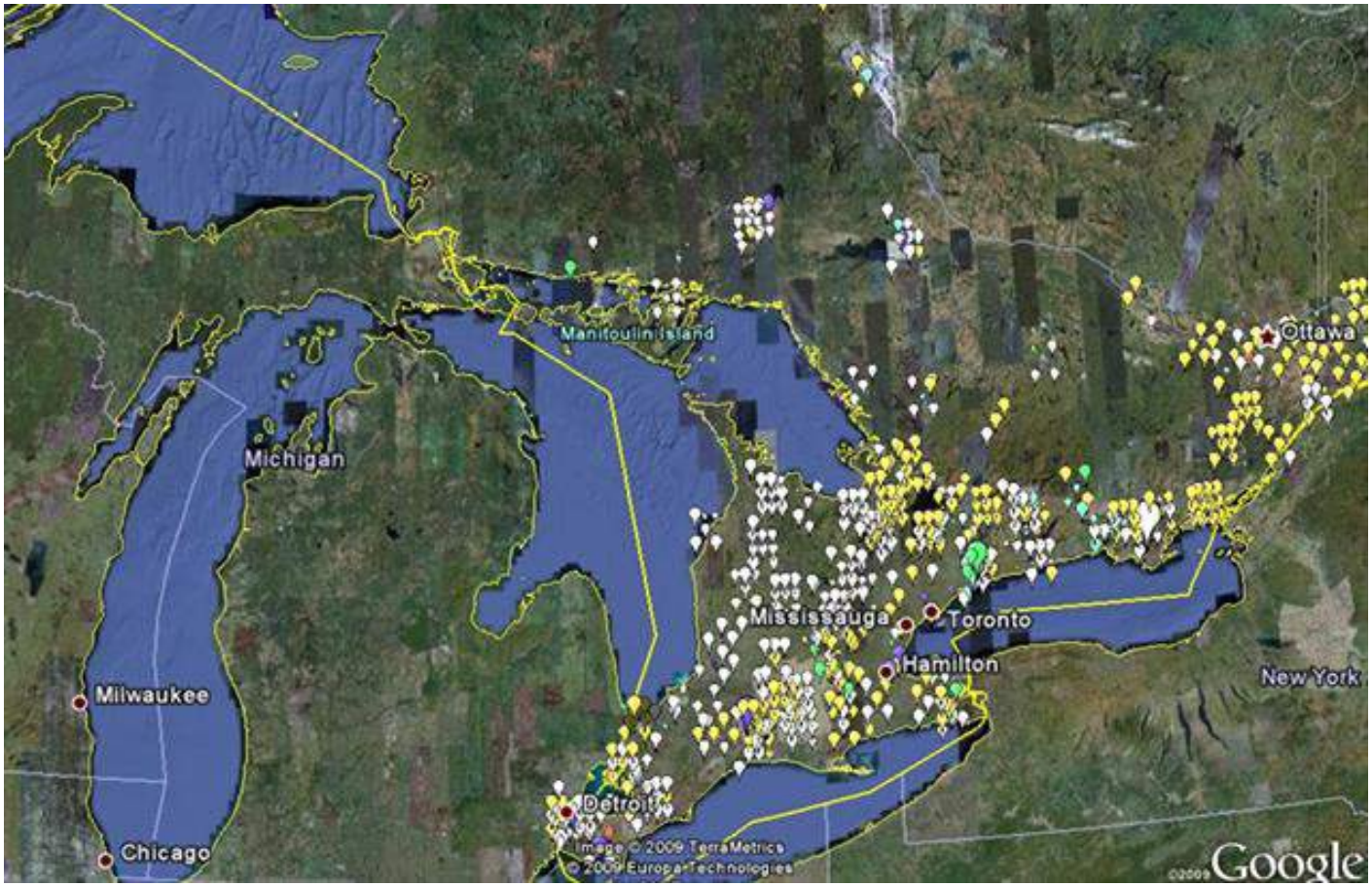
FIT (10kW+)
10,000+ applications received for 20,000+ MW



Proliferation of Distributed Generation

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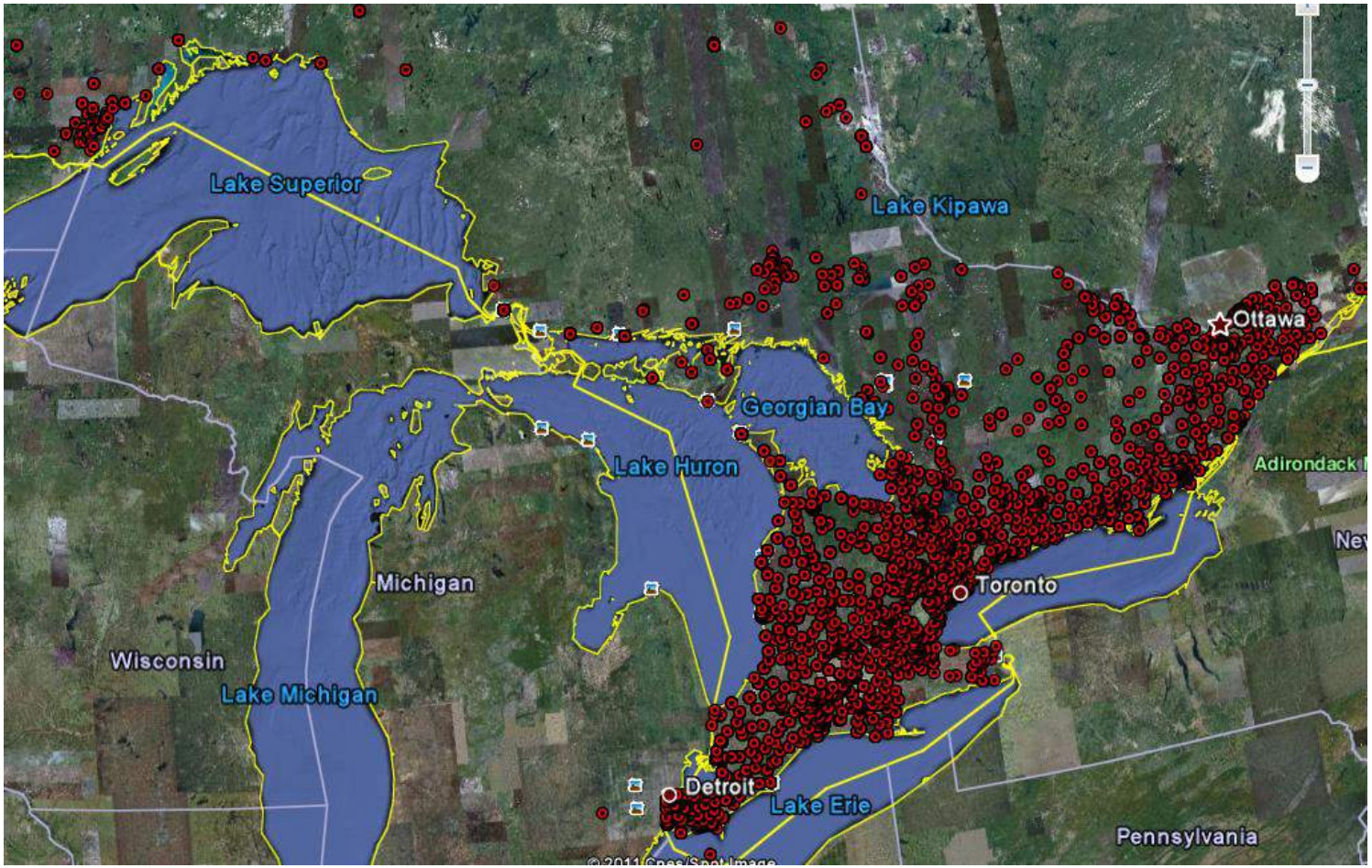
MicroFIT (<10kW)
40,000+ applications received for 350+ MW



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CASE STUDY

Hydro One Advanced Distribution System Project

System at a Glance

Transmission:

28,600 km
Hydro One's transmission wires would measure this far if stretched end to end

96%
Hydro One owns and operates 96 per cent of Ontario's transmission assets, by capacity

276
Transformer Stations (TS) and Switching Stations (SS)

640,000 km²
Geographic area served

48,000
Towers

Customers:

112
Large industrial customers

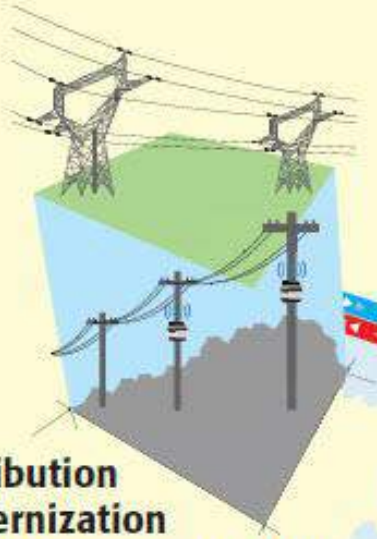
1.3 million
Distribution customers (homes, farms, seasonal, small business)

20
Remote Communities served through 18 distribution systems

Subsidiaries:
Hydro One Networks Inc.
Hydro One Remote Communities Inc.
Hydro One Telecom Inc.
Hydro One Brampton Networks Inc.

Electricity Utility of the Future

hydro one



Distribution Modernization

- Initial roll-out of smart grid technology in Bruce and Grey Counties to remotely diagnose problems and operate equipment to increase reliability and safety and reduce costs

Enterprise Systems

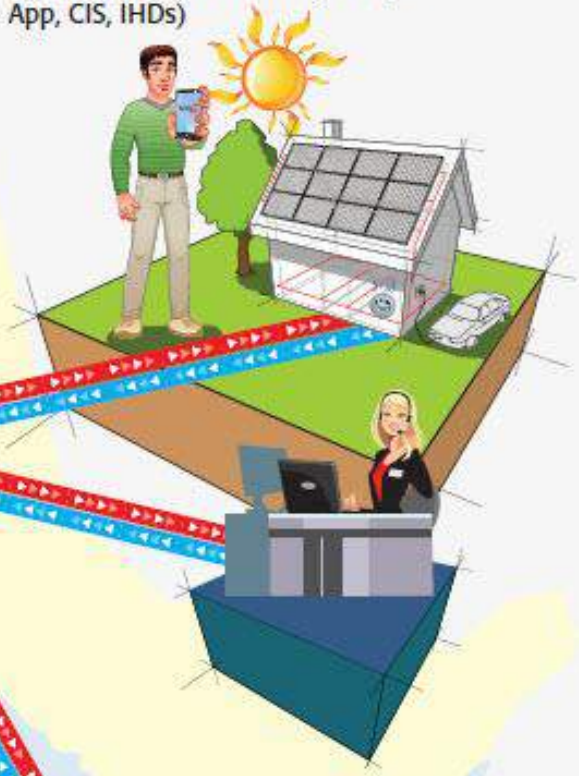
- SAP– for Asset Management, Supply Chain, Finance, HR and Customer Service

Operational Systems

- NMS, DMS, OMS, ODS, GIS

Customer Service

- Enhanced customer service through new information and applications (Smart meters, TOU Portal, Outage App, CIS, IHDs)



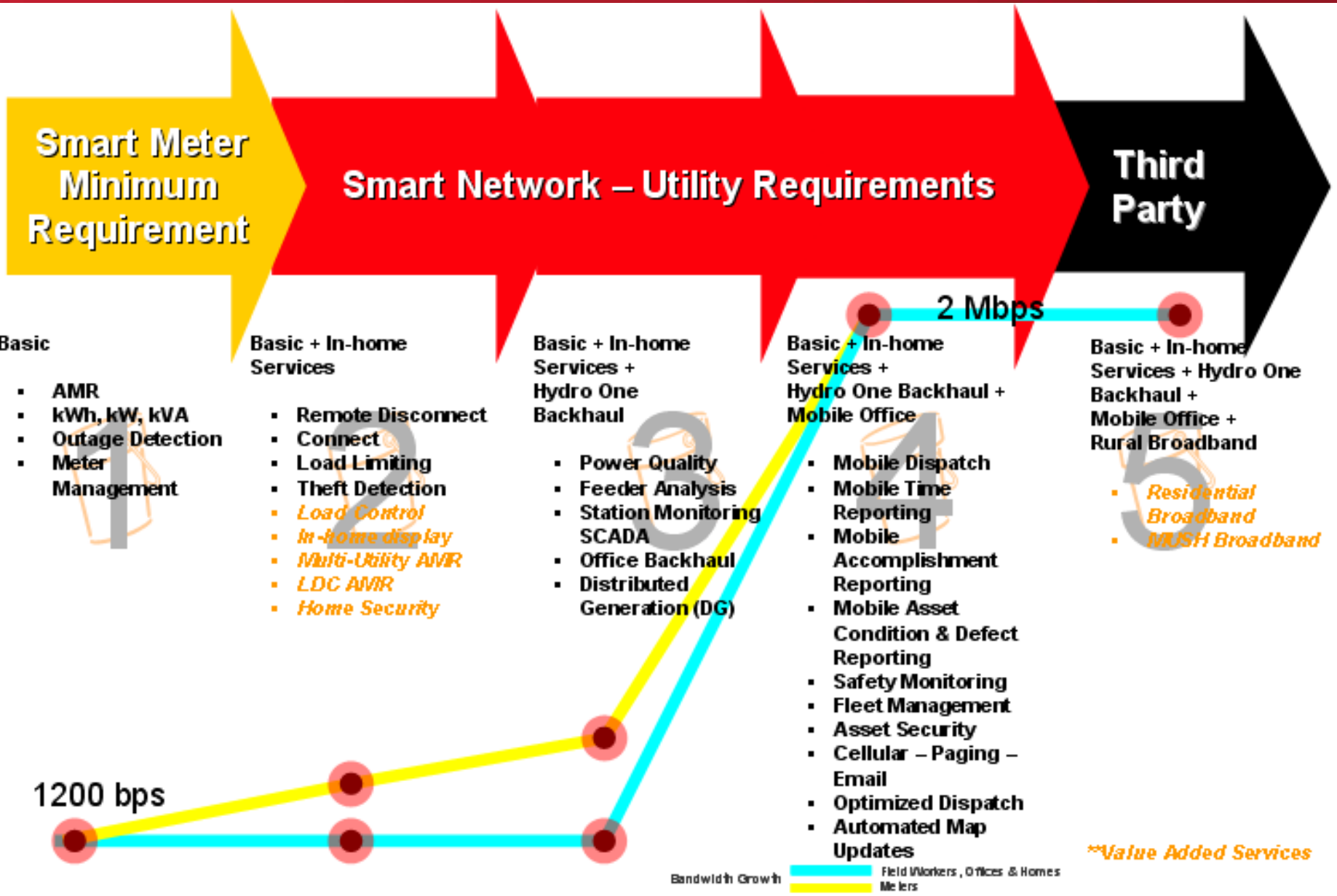
Mobile Worker

- Next generation wireless field communication devices to increase efficiency

Asset Management and Analytics

- Asset Analytics to optimize investment plans lowering maintenance and capital costs

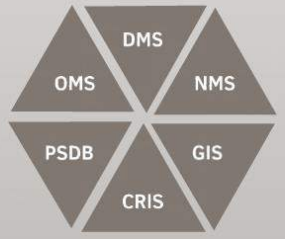
Business Case Started in 2005



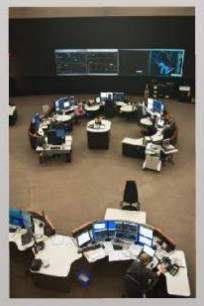
Holistic Smart Grid Approach Based on Four Technology Pillars

hydro one

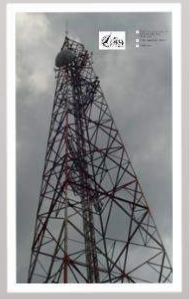
Enterprise Information and Integration



Distribution Management System and other Power System Applications



Wireless Communication Network

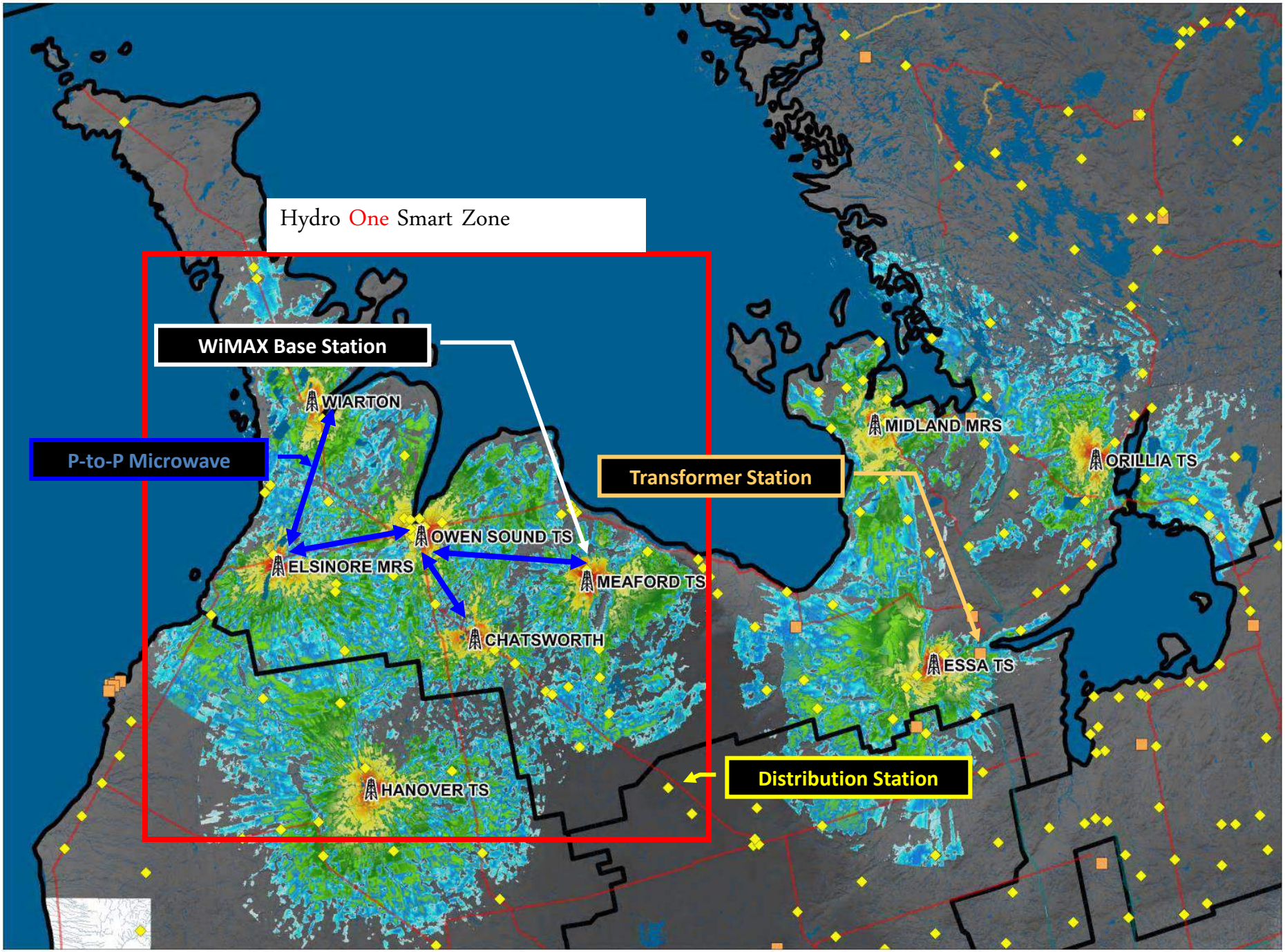


Station Automation, Protection and Intelligent Electronic Devices

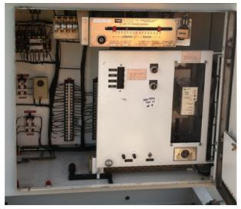
A Collaborative Approach to Success

UTILITIES TELECOM COUNCIL
SERVICE
EXCELLENCE
INNOVATION
UTC
APEX
AWARD
Sponsored by MOTOROLA

- Hydro One spearheaded, together with 5 other large Canadian utilities, a proposal to regulator for a dedicated wireless spectrum for utility operations
- Acquired the 30 megahertz (MHz) sub-band at 1800-1830 MHz
- A world first!


Hydro One Smart Zone
WiMAX Base Station
P-to-P Microwave
Transformer Station
Distribution Station
WIARTON
OWEN SOUND TS
ELSINORE MRS
MEAFORD TS
CHATSWORTH
HANOVER TS
MIDLAND MRS
ORILLIA TS
ESSA TS

WiMAX Enabled Utility Applications

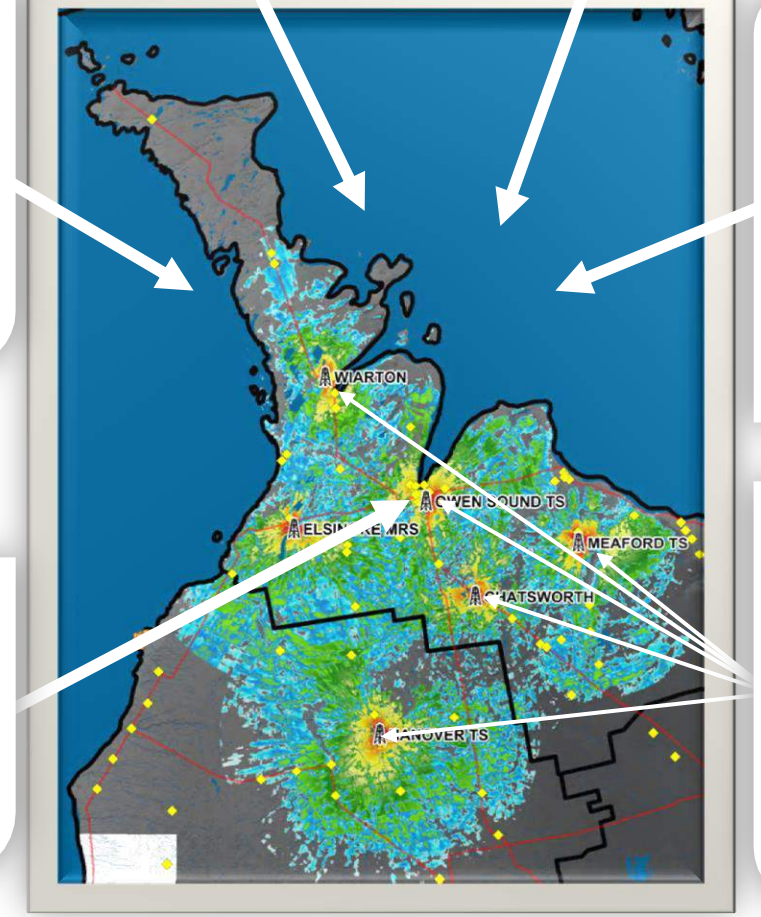

Old Controller


New Controller

44 kV Regulating Station Controller Upgrade


44kV Joslyn VBM Switch


27 kV Gridshield Recloser w/ RER620 Controller

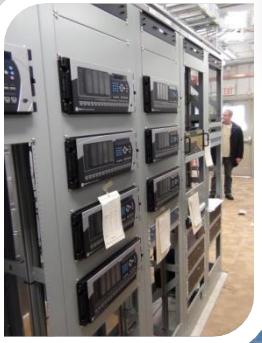




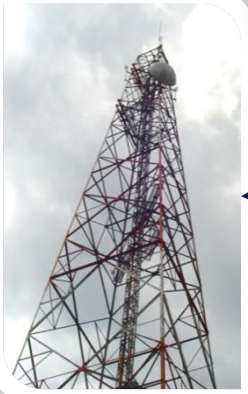
8 kV Capacitor Bank w/ M6280 Controller


New WiMAX CPE's

Factory Built & Commissioned



New Protection, Control & Telecom Building


New WiMAX Base Towers

Top 3 Technical Challenges for WiMAX Networks

1. Using existing (Layer 2) IEC 61850 “outside the fence” presents many technical challenges to ensure consistency of network performance (e.g. Latency).

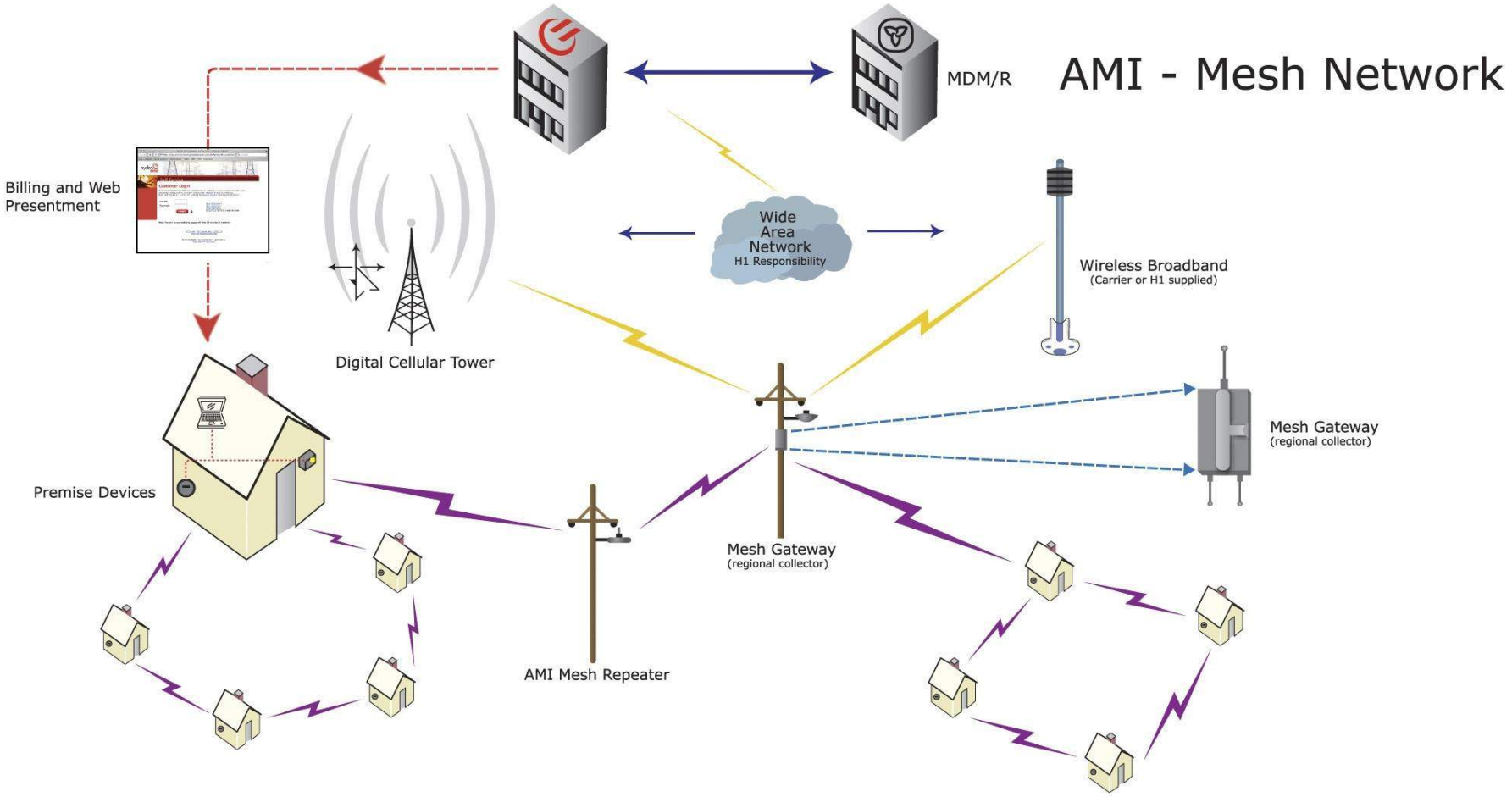
2. Distributed or ASN-less configurations (Standalone mode) are not standard but preferred.

3. Ensuring an equivalent carrier-grade communications infrastructure (e.g. meeting availability objectives).

Public Carrier vs Private Network

Third Party Public Telecom Carrier		Utility Owned Private Network
A. Not able to provide coverage during Force Majeure storms and events	→	A. Utilities are Force Majeure companies – electricity is basis of everything
B. Monthly subscription fee model with growing number of smart grid devices	→	B. Adds to Utility OM&A instead of Capital Rate Base at low costs of capital
C. Wireless Coverage based on business case	→	C. Utility obliged to server all customers everywhere

Support Business Case by Providing Smart Meter Data Backhaul



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Alex Bettencourt
MANAGING DIRECTOR
SmartGrid Canada
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CenterPoint Energy

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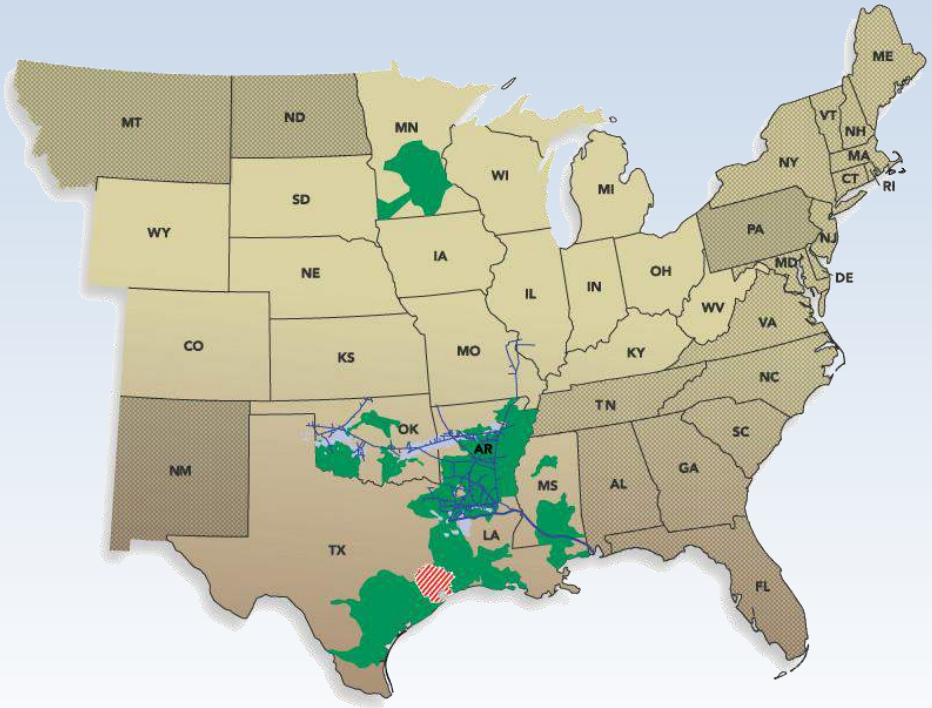
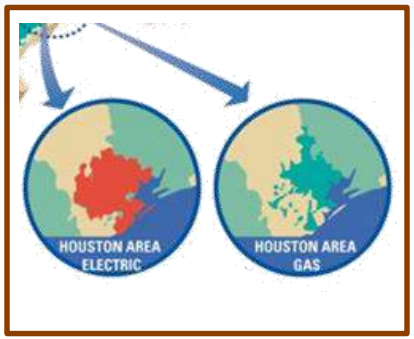
CenterPoint Energy's Smart Grid Communications Network Deployment & Operations
&
The Role of WiMax

Chuck Hackney
Director
Telecommunications Services

CenterPoint Energy (CNP)





- Electric Transmission & Distribution
- Interstate Pipelines
- Field Services
- Natural Gas Distribution
- Competitive Natural Gas Sales & Services

- Headquartered in Houston, TX
- Serving 5.5 million electric & gas customers
- $22.8 billion in assets
- $7.5 billion in revenue
- More than 8,700 employees
- Over 135 years of service to our communities
- Electric transmission and distribution
  - Over 2.2 million customers in Houston area
  - 17.3 GW peak demand
  - 80 GW hours delivered annually
  - 232 substations
  - 3,742 miles of transmission
  - 48,733 miles of distribution

CenterPoint® Energy

Smart Grid Communications Deployment

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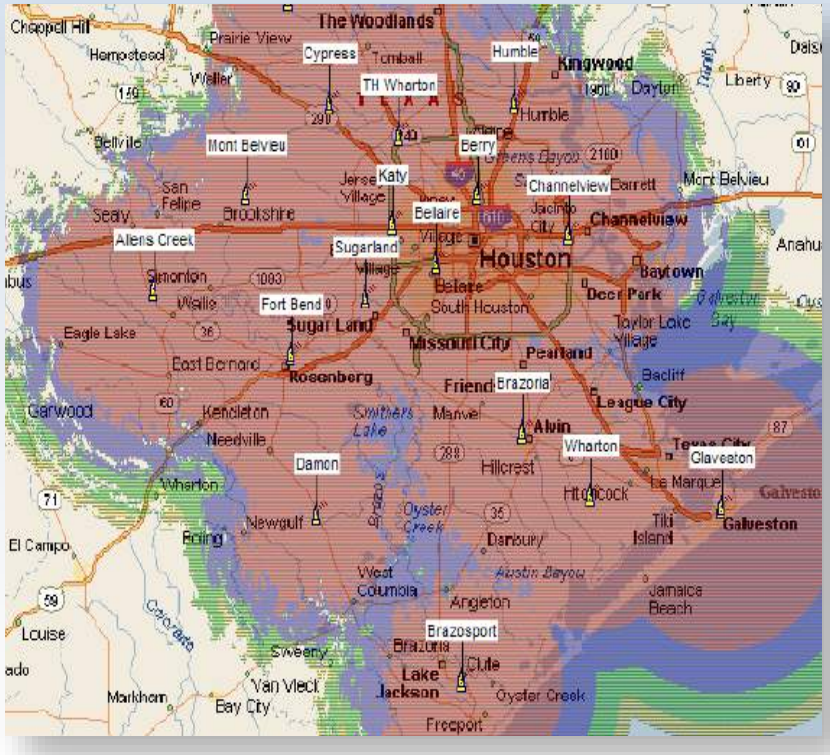
Purpose:

- Architect and build an end-to-end communications network to support the Advanced Metering System and Intelligent Grid.

Timeframe: 42 months

Objectives / Scope:

- Provide communications coverage to CNP's entire 5,000 sq. mile electric service area
- Deploy approximately 5,500 cell relays (meter data collectors) and 140 WiMAX tower sites that communicate with 2,300,000 meters.
- Provide redundant two-way communications to end points, i.e., meters, grid devices.
- Utilize a dual communication (active-active) path architecture that is scalable to meet Smart Grid communication needs
- Provide required data throughput capacity
- Perform reliably, i.e., storm conditions
- Comply with cyber security standards



CenterPoint Energy

Components of our Advanced Metering System (AMS)

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JANUARY 27

Meter Data

Smart Meter RF LAN network connected to cell relay

Cell Relay (Meter Data Collector)

WiMAX Aggregation Site

Fiber / Microwave Backhaul

Communications

Data Center Systems

Meter Data Collection Engine → Meter Data Management System → Legacy Systems → Consumer Energy Management Portal

Consumer Access

Combined with back office computer systems and integration, our AMS provides:

- Daily register reads
- Daily 15 minute interval reads
- Remote connect / disconnect / on-demand reads
- Consumer access to their data via consumer portal

CenterPoint® Energy

Communications Technology Direction

Communication Components Considered

Technology	Benefits	Challenges
Cellular	• Most Geographic Coverage (typically) • No additional infrastructure for backhaul • Broadband coverage • Rapid deployment	• High variable expense cost for data usage • Reliance on cellular infrastructure • Rapidly changing environment and technologies
WiMAX	• Engineer according to requirements • Build for the future (higher bandwidth) • Potential for synergies within field network • Rapid deployment (once in place)	• Infrastructure cost • Achieving coverage, i.e., geographies, meter density in certain areas • Permitting
Hardline	• Proven technology • Able to configure/size accordingly	• High fixed expense cost • Difficult to manage individual circuits • Reliance on carrier infrastructure • Long Installation timeframes
BPL\PLC	• Utilize existing infrastructure • The “Broadband” promise • Large “theoretical” geographic coverage	• Frequency interference • High price point • Limited success in field trials

Most deployments rely on multiple technologies to achieve a full coverage cost effective solution

CenterPoint® Energy

Communications Technology Direction

Result: Hybrid Solution

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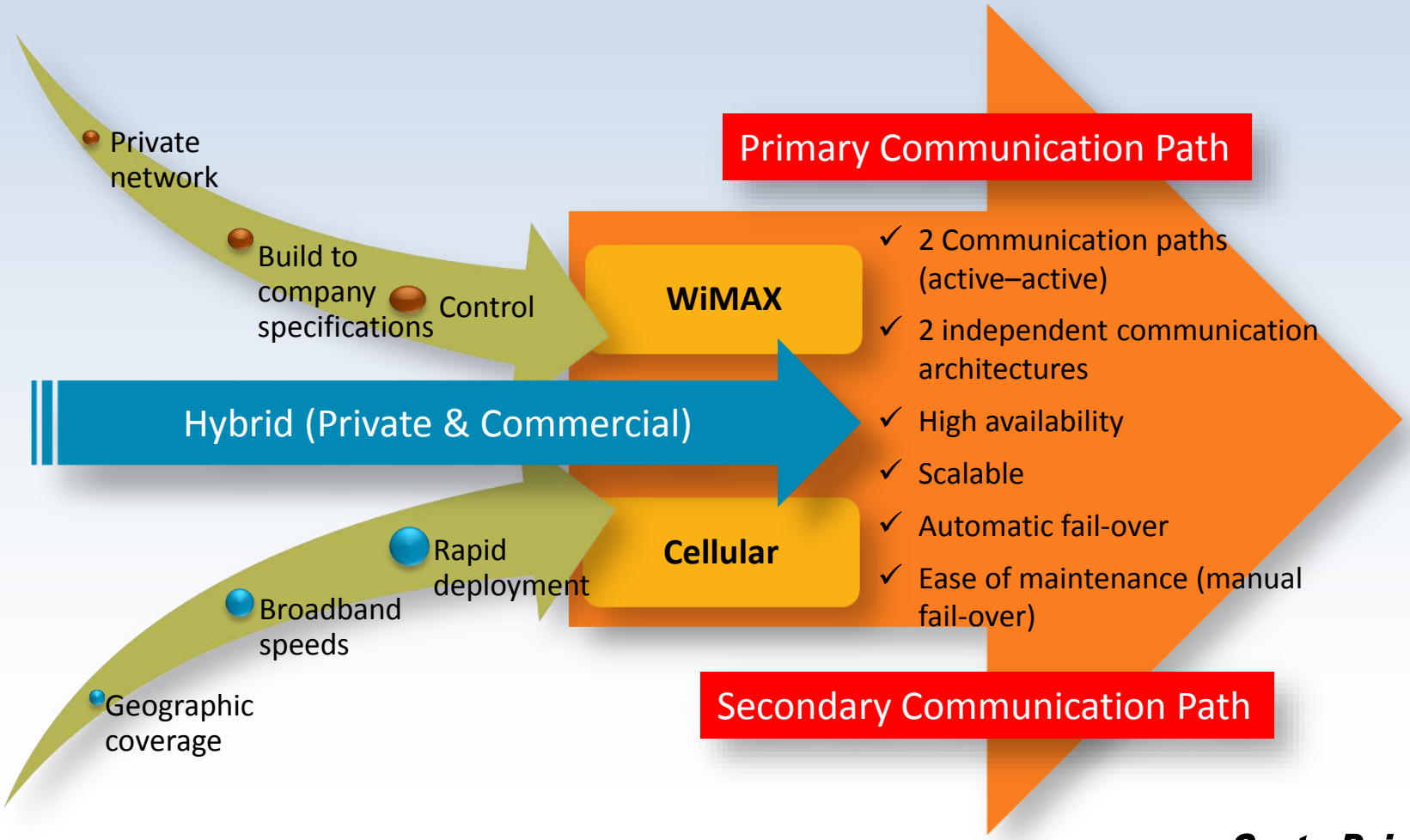
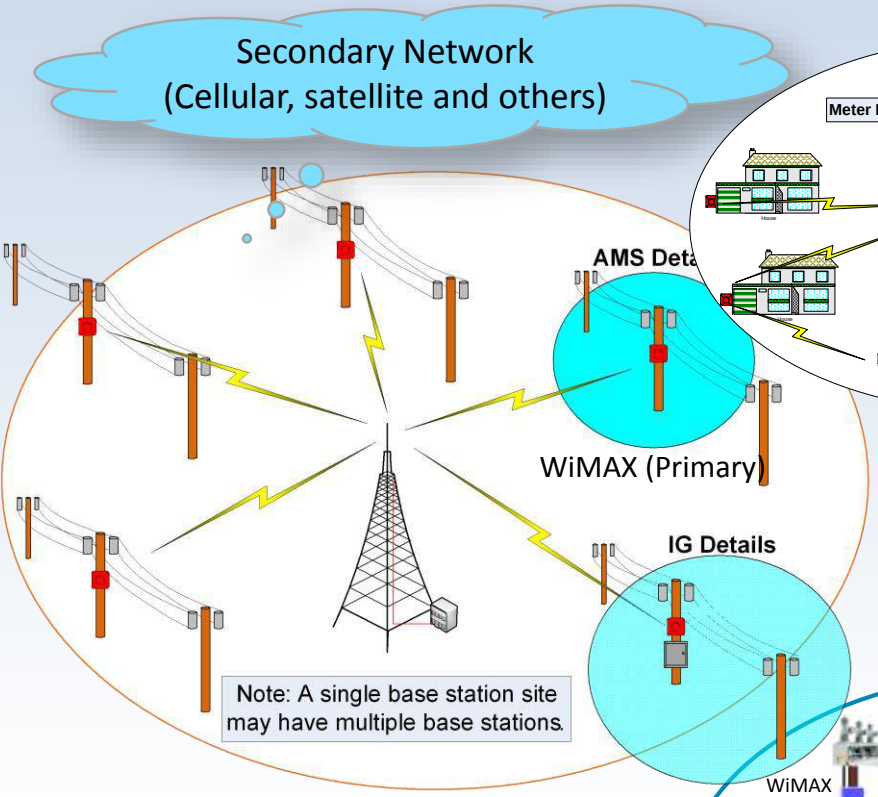
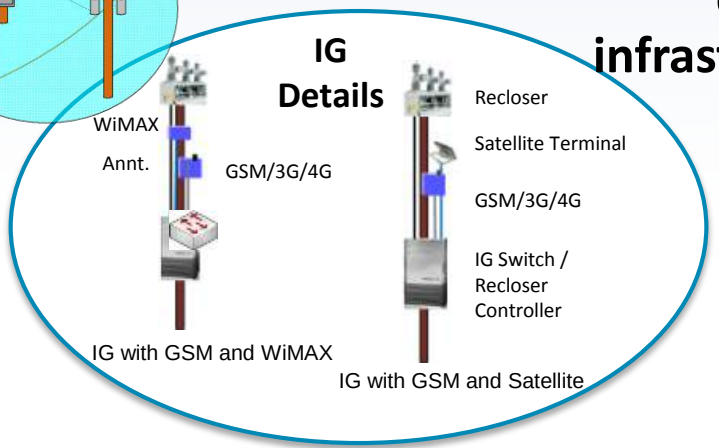


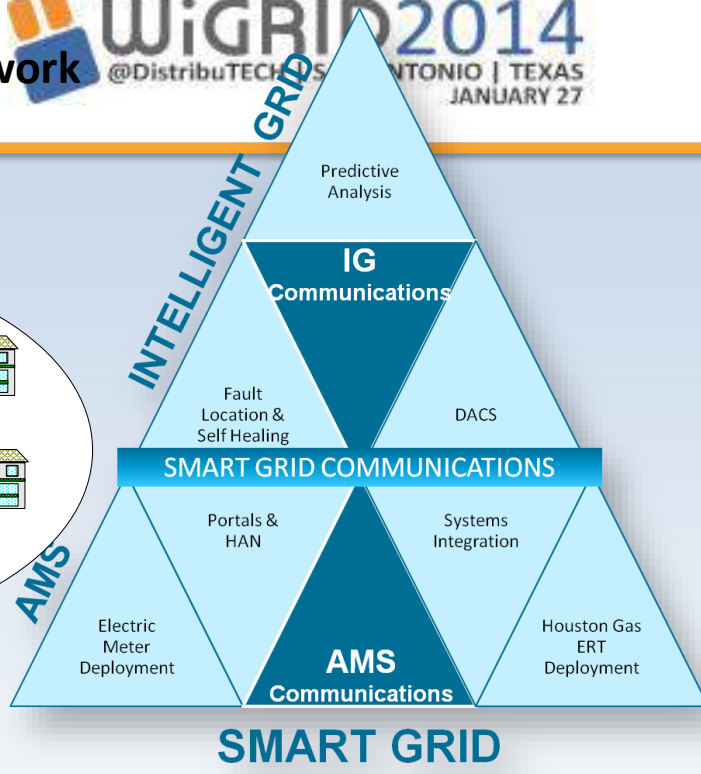
CenterPoint Energy

Communications Technology

Overview of Dual-Path Smart Grid Communications Network







WiMax provides the common communications infrastructure for both AMS and IG.

Deployment Considerations…

Close coordination with the meter deployment

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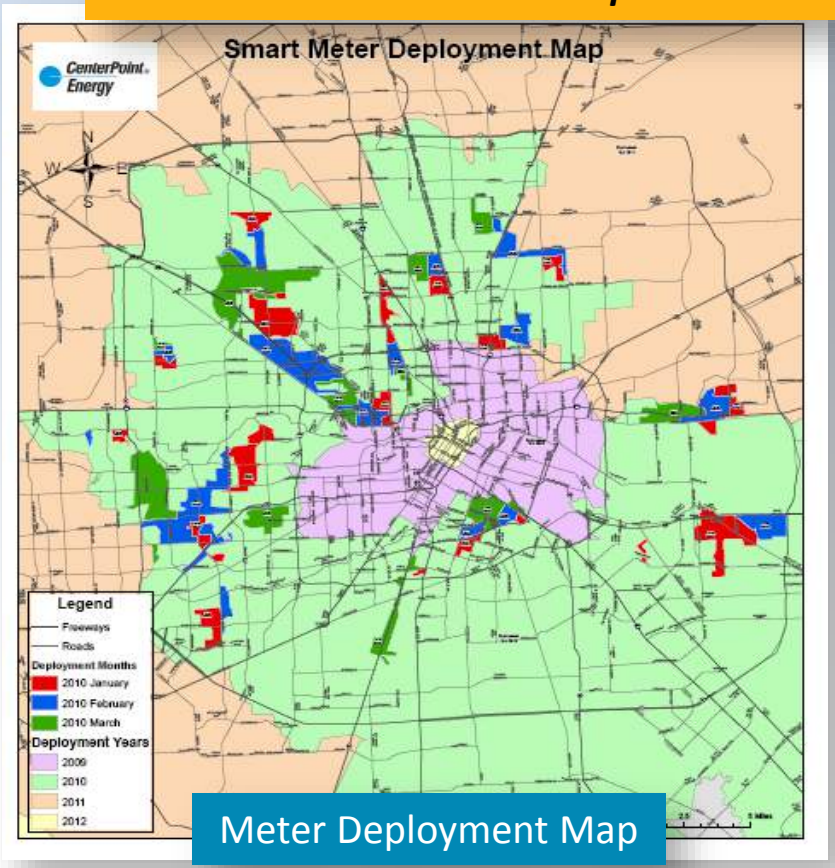
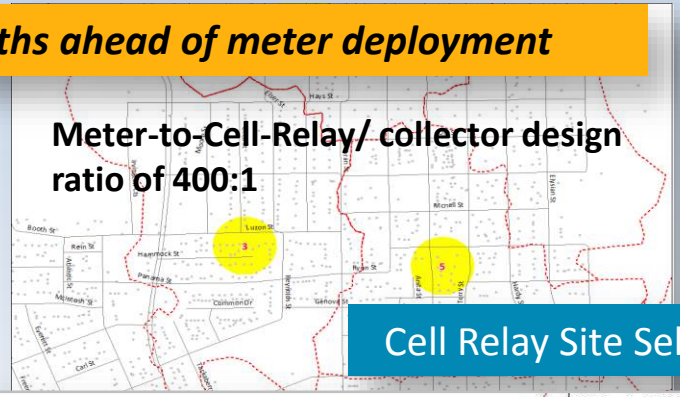
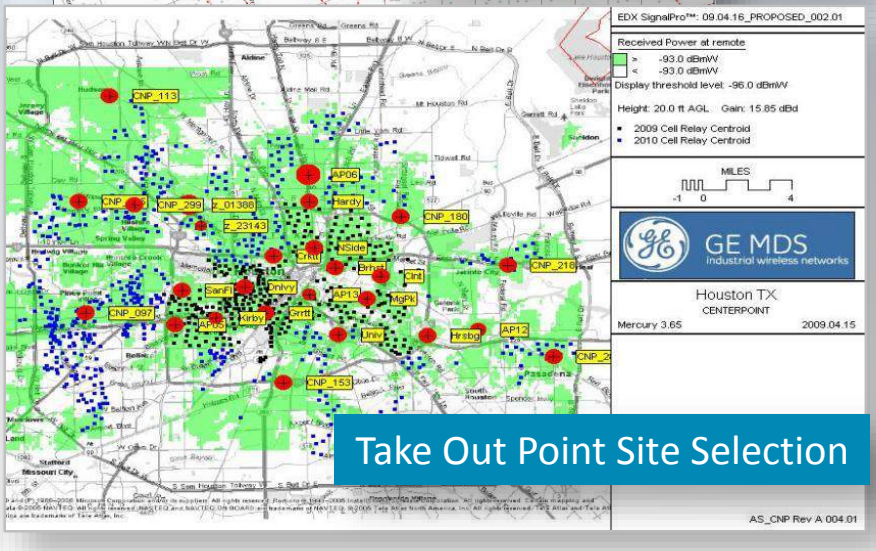
Network communications in place three months ahead of meter deployment



Meter Deployment Map



Cell Relay Site Selection



Take Out Point Site Selection

CenterPoint® Energy

Deployment Considerations…

Be prepared to meet aggressive time lines

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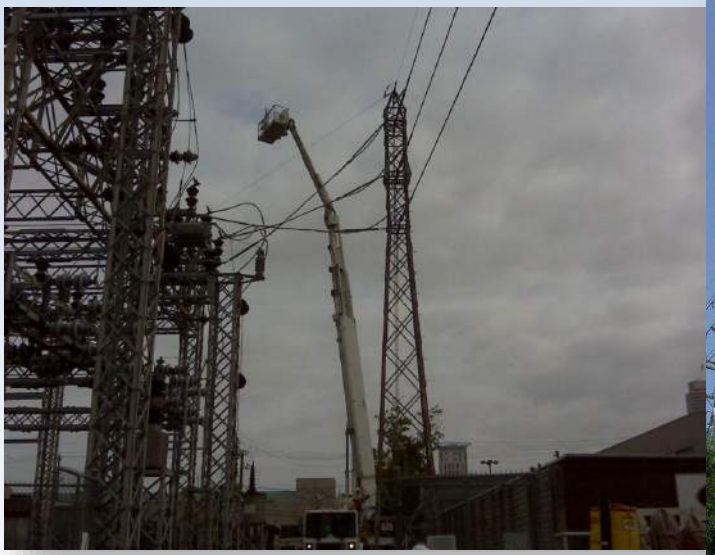
Cell Relay site selection process
in the absence of a permanent TOP



WiMAX antennae were placed on top of a 150’ crane to test signal strength at planned cell relay sites

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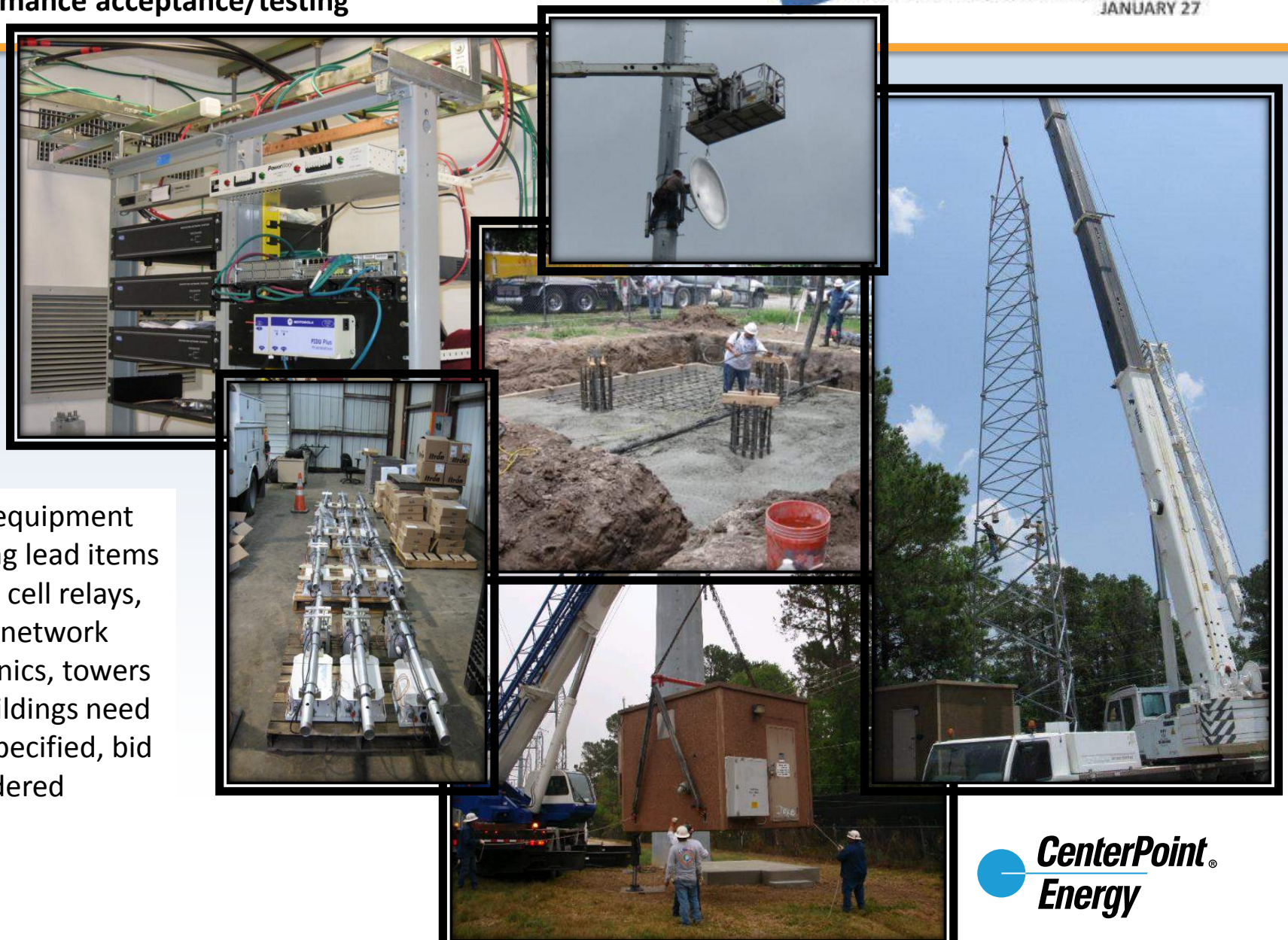
Deployment Considerations…

Manage suppliers, field coordination, construction and performance acceptance/testing



Major equipment and long lead items such as cell relays, radios, network electronics, towers and buildings need to be specified, bid and ordered

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Deployment & Operational Considerations…

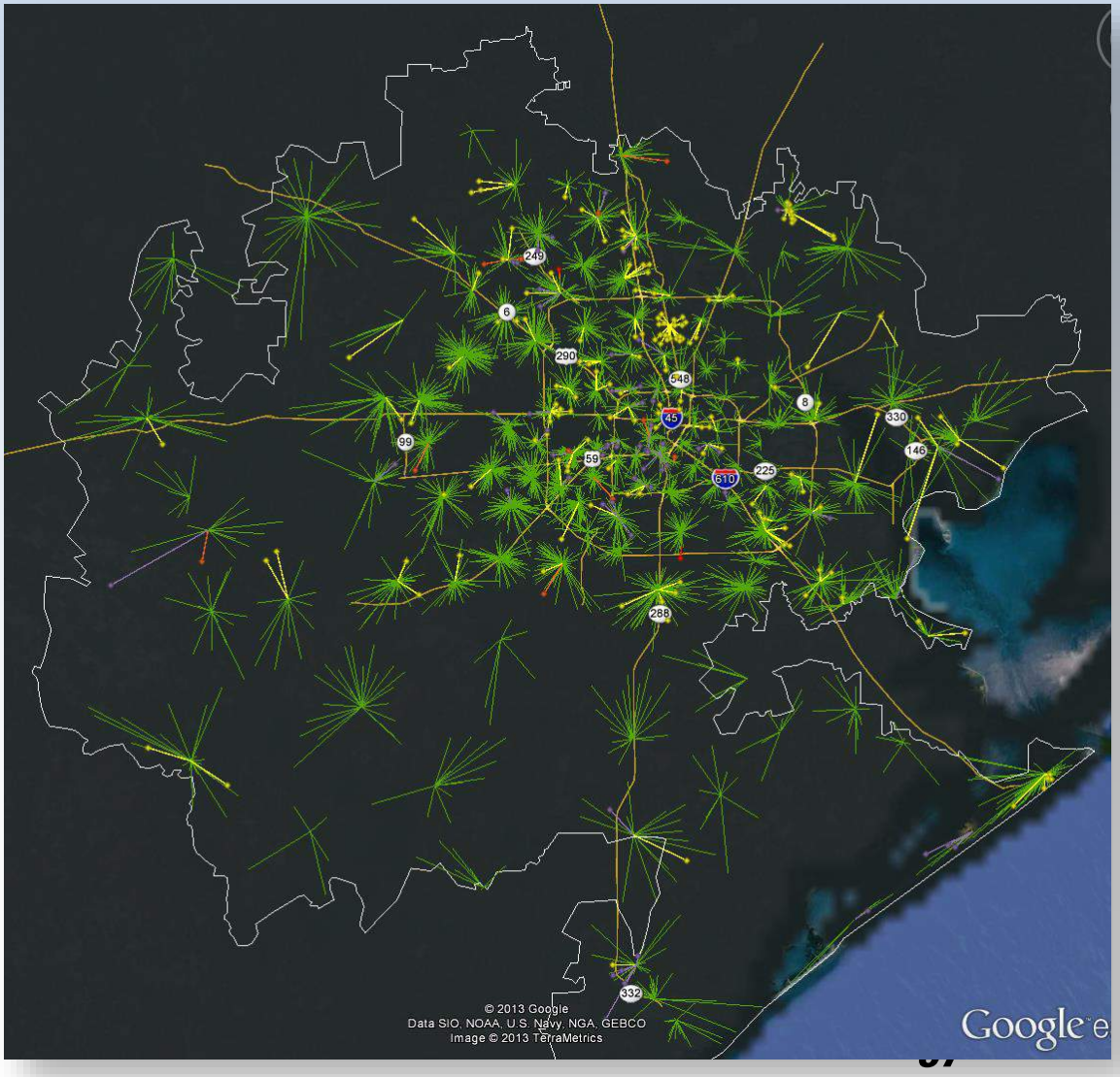
Engage Network Operations at the project onset

- Establish an operational strategy that parallels deployment; operations input in the network design is critical to an effective operation.
- Establish Network Control Center that enables complete end-to-end network visualization and management
- Fully leverage data analytics as part of the monitoring and management; it is a valuable tool in the alerting of potential network issues
- Establish a solid acceptance process for the handoff to production

Deployment & Operational Considerations…

Implement dashboards and data analytics into day-to-day network operations

CNP has moved to a greater utilization of and reliance on automation technology and data analytics; a premium has been placed on network uptime, resiliency and reliability



Outcomes of the deployment

WiMax Has Been A Key To Our Success

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- **Deployed 2.3 million meters, 140 150' WiMax Towers (Aggregation Points), and 5,500 WiMax Connected Meter Data Collectors in 42 months**
  - WiMax has performed well. In excess of 99.9% availability.
- **Implemented an Network Operations Control Center**
- **Collect 220 million reads per day (15-minute interval usage)**
  - 99.9% successful read rate
  - 99.5% successful automated service order rate
- **Over 7 million service orders with average time to execute < 30 min.**
  - Over 700,000 gallons of fuel saved
  - Over 6,300 tons of CO_2 emissions avoided
- **Power Off Notifications (PONs)/ Power Restore Notifications (PRNs) integrated into Outage System**
  - Proactive Outage Notifications
  - Meter alerts integrated into Analytics System

Digital meter

Cell Relay

WiMax Tower

CenterPoint Energy

Questions?

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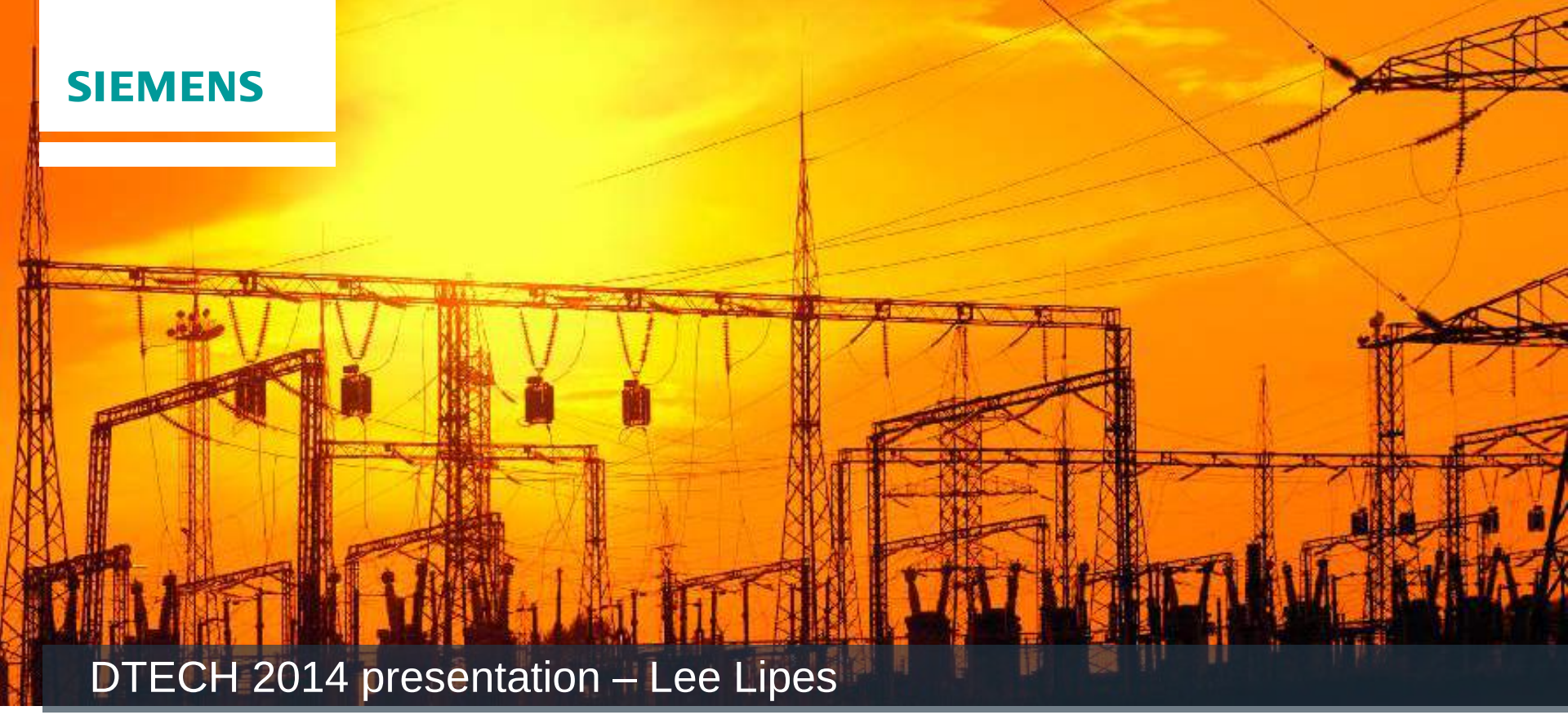
Thank You

Chuck.Hackney@CenterPointEnergy.com



SIEMENS

DTECH 2014 presentation – Lee Lipes

Wide Area Automation

Introduction

WIMAX Fit for Electric Power

Feeder Automation

Distributed Generation

Why WiMAX for Private Network?

WiMAX is the only technology available that meets the needs of the energy market in a standards based way

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

RUGGEDCOM WIN Multi Service Solution

Applications

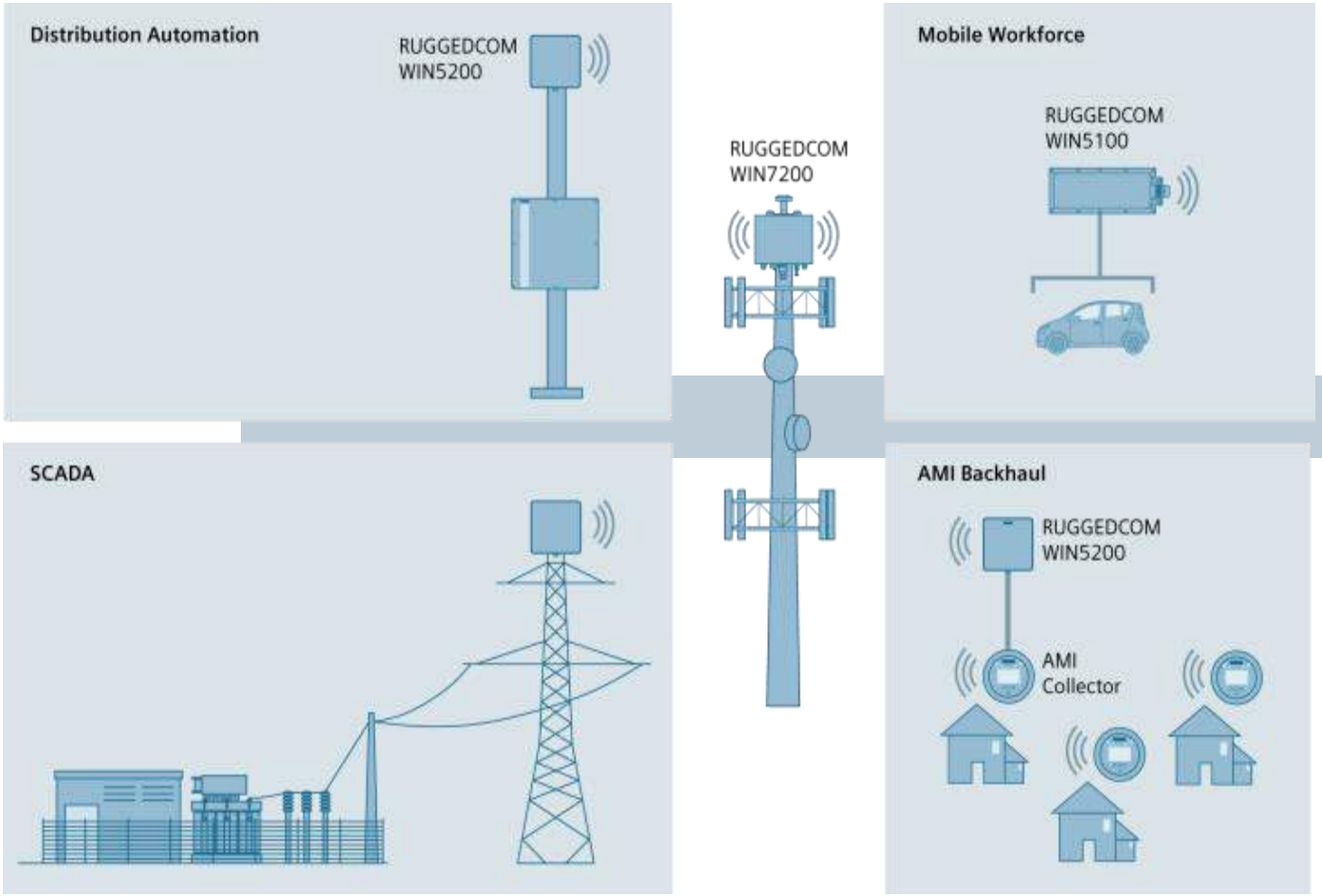
- AMI Backhaul
- SCADA
- Distribution Automation
- Mobile Workforce

Broadband Rates

- 10-40 Mb/s throughput

Wide Area Wireless Coverage

- 5-40km Range



The WiMAX Gaps

WiMAX was originally designed for service provider mobility networks

As such there is some optimization required for industrial customers

Major areas include:

1. Frequency bands available for industrial customers
2. Ethernet based for industrial protocol support
3. Distributed architectures for scale, simplicity and single point of failure elimination
4. Traffic pattern optimization
5. Hardened equipment to relevant standard (IEC 61850, EN50155, ATEX…)

WiMAX can be used but requires optimization for industrial markets

The role of WIGRID and the SEWG

Leverage the ecosystem of wimax **standards based** equipment but tailored to the needs of energy customers

Ethernet based systems with **distributed architectures**

More data going **upstream** than in conventional ISP model

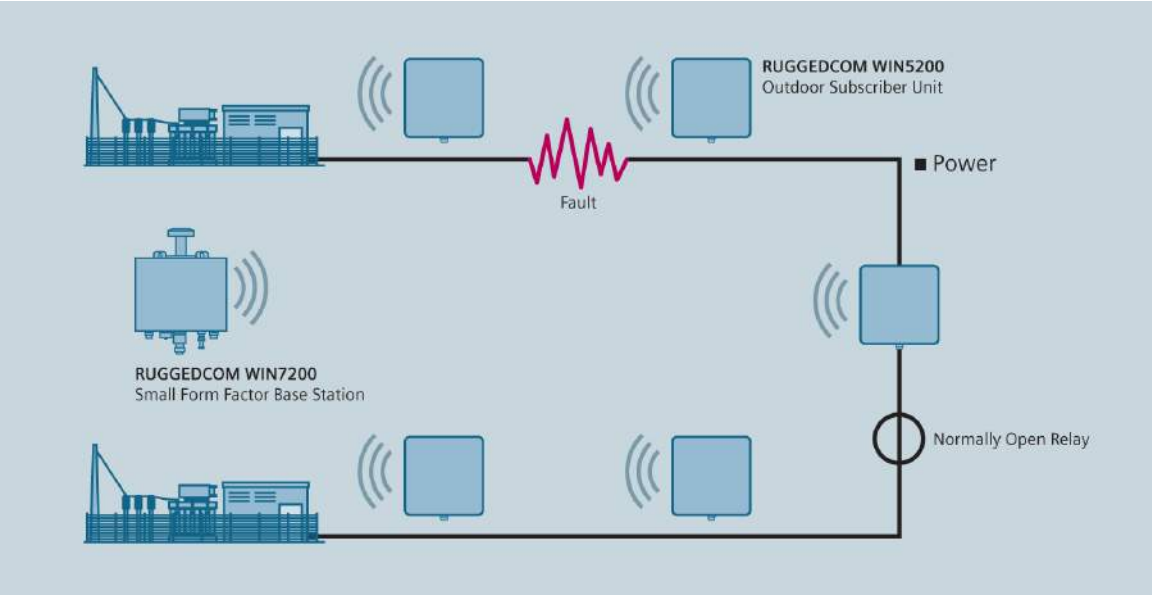
Longer range required for geographically dispersed networks

Frequency bands which can be used by private companies (**5.8, 3.65, 1.8, 1.4** GHz)

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

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

Fault Detection, Isolation & Restoration



Detect fault

Communicate between switches / reclosers to locate fault

Isolate fault by restoring power to unaffected areas

Present mode of operation is very manual and requires coordination with field personnel and truck rolls in some cases

Service restoration can be more than 1 hour

“Self healing” distribution grid with rapid service restoration is the goal

Standards based solutions desirable

Case Study- A&N Virginia

Electric Cooperative on the East coast of the United States

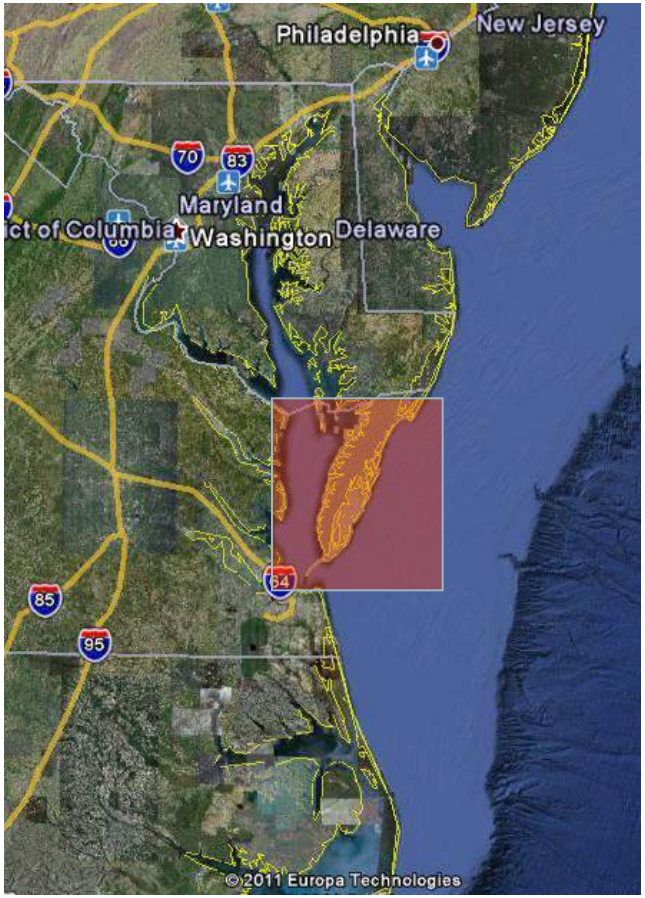
- Covers 3 counties over two States
- Total revenue of $22.4M
- Total customers 11,389

Project / Business Drivers

- Needed to improve reliability of supply to local hospital
- Lots of accidents and storms
- Improve reliability indices

Scalable and reproducible across service territory

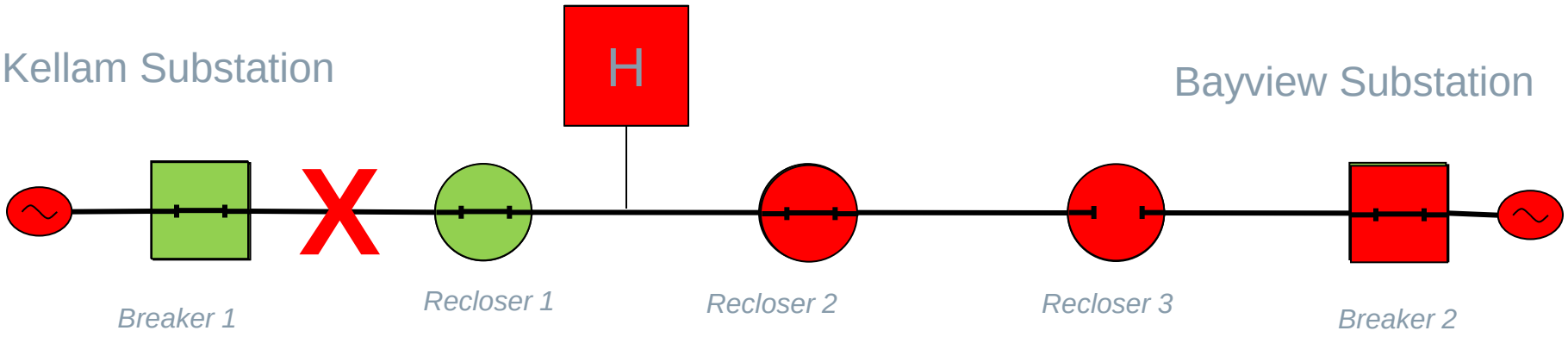
Based on standards



Solution Description

- Decentralized solution – Logic is driven down the field device level
- Uses communications to exchange data among distribution devices to perform Fault Detection, Isolation and Service Restoration (FDIR) self-healing logic to create a safer, more reliable power system
- IEC 61850 is accepted as an open Smart Grid protocol
- GOOSE messaging provides ultra-fast data exchange allowing devices to make intelligent decisions, as a group, to self heal the loop
- Using the IEC 61850 standard allows the recloser and/or switch to become an extension of the substation logic
- Several messages are exchanged to restore fault and therefore low latency communications is quite important to overall restoration times

Electrical System



1. The automation system locates the faulted line section
2. Breaker 1 opens to disconnect fault
3. Recloser 1 opens to isolate faulted line section
4. Recloser 2 closes to restore power to the unfaulted line section
5. Breaker 1 recloses to determine if it is sustained fault
6. Breaker 1 trips using overcurrent function and lockout activates

Communication System Architecture

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Network Operations Center

Core network
6 miles

5 miles

0.5 miles

9 miles

0.1 miles

Kellam

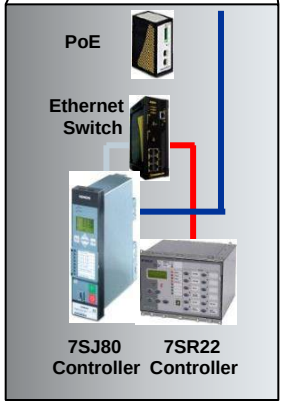
Recloser 1

Recloser 2

Recloser 3

Repeater site

Bayview



DNP3 Serial

IEC 61850 Cat 5 Ethernet

Control Cable

Quality of Service Considerations

SIEMENS

Unsolicited Grant Service (UGS)
- For TDM services like E1 & T1 (or fractional E1 or POTS type)
- Fixed size data packets (frames) on a periodic basis

Enhanced-Real Time Polling Service (ert-PS)
- For voice applications (like VoiP not POTS)
- Fixed bit rates with Guaranteed rate and delay

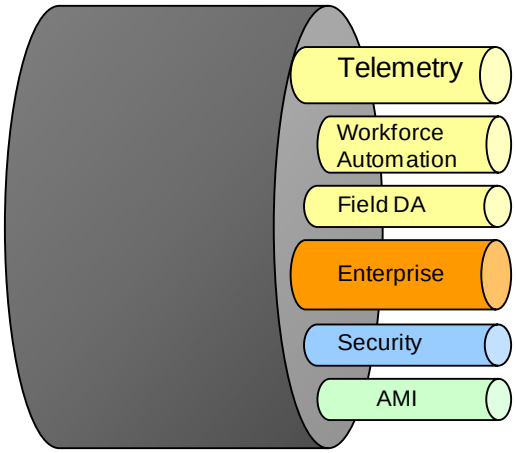
Polling interval at the start of connection

Real Time Polling Service (rt-PS).
- For real time services where some jitter is not a problem.
- Variable bit rates with Guaranteed rate and delay
- Service parameters: CIR (non-oversubscribed)

Non Real Time Polling Service (nrt-PS)
- Variable bit rate services
- Guaranteed rate required, guaranteed delay not required
- Service parameters: CIR with oversubscription

Best Effort (BE)
- For service with no rate or delay guarantees- Broadband service type connections
- Only MIR is defined

	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
DA	Yes	No	Yes	Yes	Nail up low BW
Field Workers	No	Yes	No	No	Set a max BW to not effect other apps
AMI	Yes	Yes	No	No	Make sure data can get through and scale



Communication System how it works…

In order to keep latency low, but allow for maximum scalability real time polling service was used

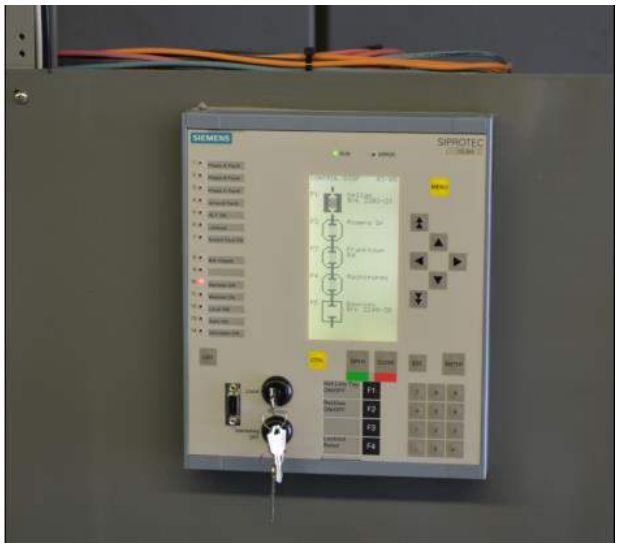
Polling interval is set to 5 miliseconds, HARQ is set on

- GOOSE has sequence numbers to take care of out of order messages

For multiservice network QoS very important

- Committed information rate of 500 kb/s per end point
  - VLAN based classification
  - Multicast traffic support
  - Real time polling

SDFA Installation (A&N Phase 1)



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Results & Lessons Learned

System was first tested and installed during Hurricane Irene in August 2011 with very reliable results

System is able to restore power in under 300 msecs

- Backup generators were not triggered at hospital

Power system design should also look at communications considerations

- Recloser locations where RF path is checked

Bandwidth during a major event can be quite significant

Accomodating Renewable Energy

Government initiatives around the world are promoting/legislating utilities to accommodate renewable generation

However the grid currently is not properly set up to accommodate power production in the distribution network

Increased communication capability is required in order to remotely monitor and control power production

Production may be owned and operated by third party which adds complexity

Communication drivers

- Remote trip to prevent islanding in case of outage

- Maintenance shut down of embedded generators for safety purposes

- Monitor generator output to aid in managing distribution system power flow

- Monitor generator status to identify generators that have not properly shut down

Communication Needs

Low latency for transfer trip function

Long range to cover entire territory

Large scale to accommodate more than 50 generation facilities

Bandwidth to accommodate monitoring and control functions

Reliability since protection and safety is involved

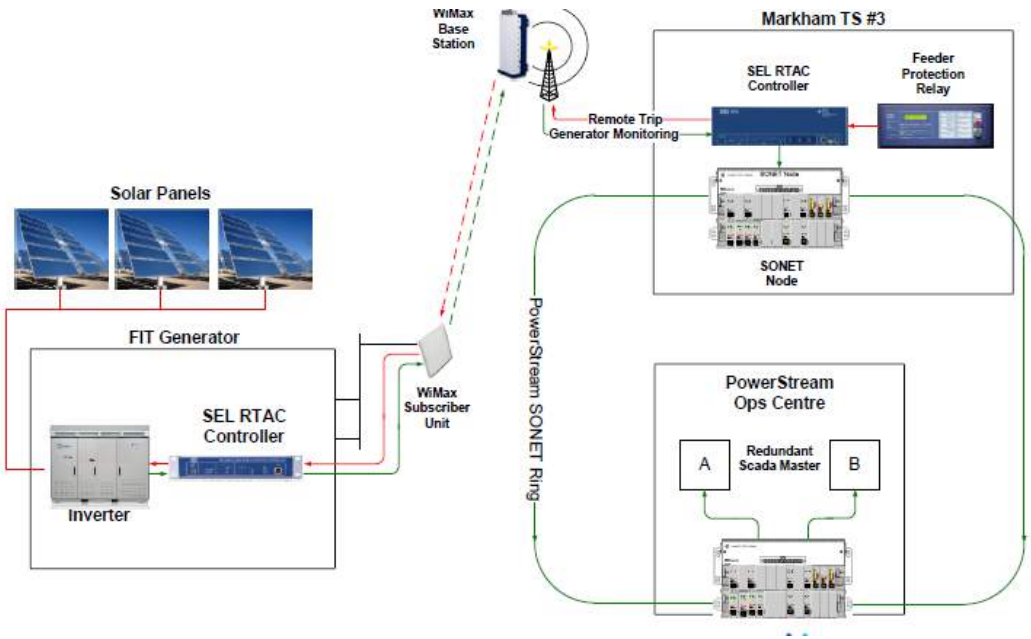
Cost of solution ongoing and upfront are also factors

Communication alternatives

	Leased lines	Cellular	Narrowband pt-pt	Narrowband PMP	WIMAX
Reliability					
Latency					
Range					
Scale					
Bandwidth					
OPEX					
CAPEX					

Deploying a private broadband wireless network proved to meet all the requirements

Network Diagram



WiMAX used in 1.8 GHz band to provide connectivity to generation sites

Solution is leveraging 61850 for transfer trip function

IP also used for monitoring generators, QoS used to differentiate traffic

Licensed frequency provides interference protection

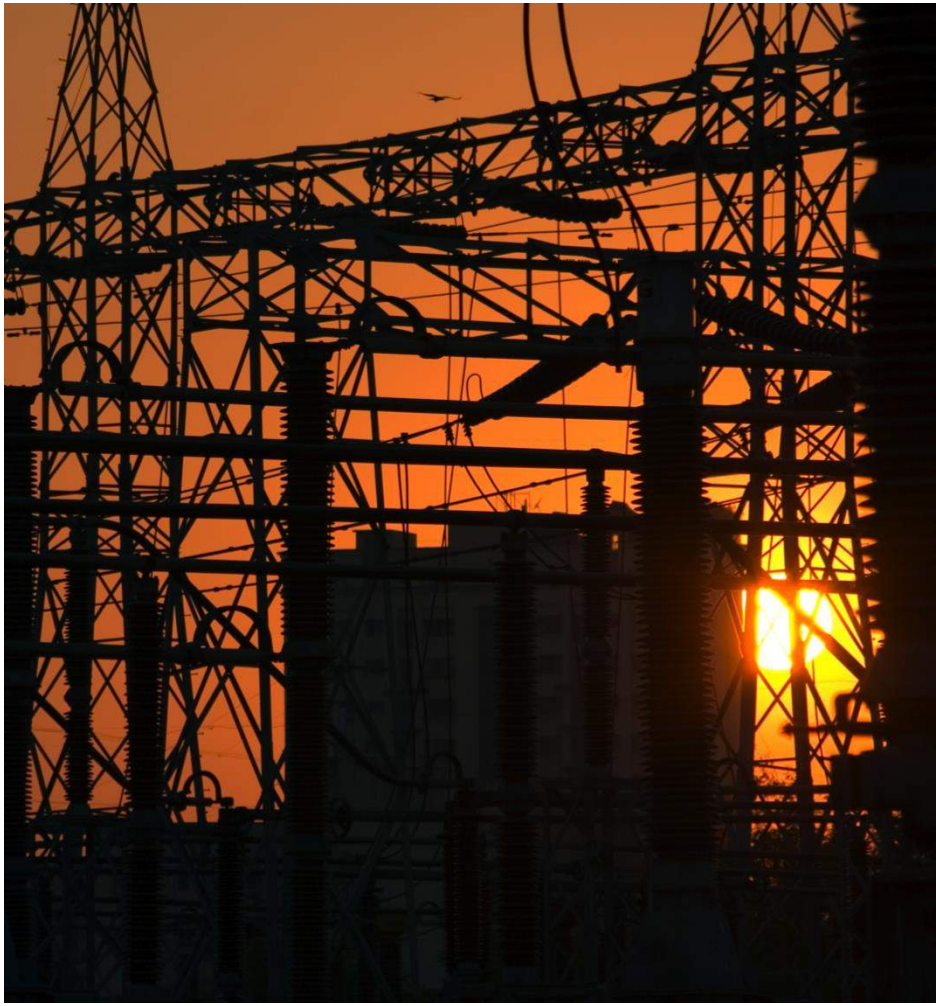
Infrastructure now in place can be used for other applications

Summary

Increasing need for automation in the grid driving the deployment of private networks

WiMAX is being used today by many utilities for a variety of critical smart grid applications

Feeder automation and DG control are two key applications with large growth potential



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InovCity Aparecida

Developing a smart grid project in EDP Brazil

It is a global player with a strong presence in the Iberian peninsula, Brazil and the United States

edp renováveis

Wind Power

22% of EBITDA

Listed subsidiary: EDP Renováveis (EDP has 77.5%)
IPO in Jun-08
Wind Power: 6.9GW
Major wind operator worldwide (present in 11 countries)

Brasil

21% of EBITDA

Listed subsidiary: EDP Brasil (EDP has 51%)
Presence since 1996
Hydro Power: 1.8 GW
2 electricity distribution concessions

Portugal

39% of EBITDA

Privatisation in 1997 (IPO)
Single electricity distributor
Power generation: 9.9 GW (ex-wind)
(from which 4.7GW is hydro)

Spain

18% of EBITDA

Presence since 2001
Power generation 3.9 GW (ex-wind)
2 in gas distribution

In Brazil currently operates in an integrated manner...

5th largest private generator installed capacity

Generation

- 17 hydroeletric plants
- 2.012 MW of capacity
- Pecém thermoeletric (360 MW) under construction
- Jari hydroeletric (373 MW) under contruction

3rd largest wind energy provider worldwide

Renewable

- 83,8 MW of capacity and 120 MW planned.
- Long pipeline de project

4th largest private distributor in energy sold

Distribution

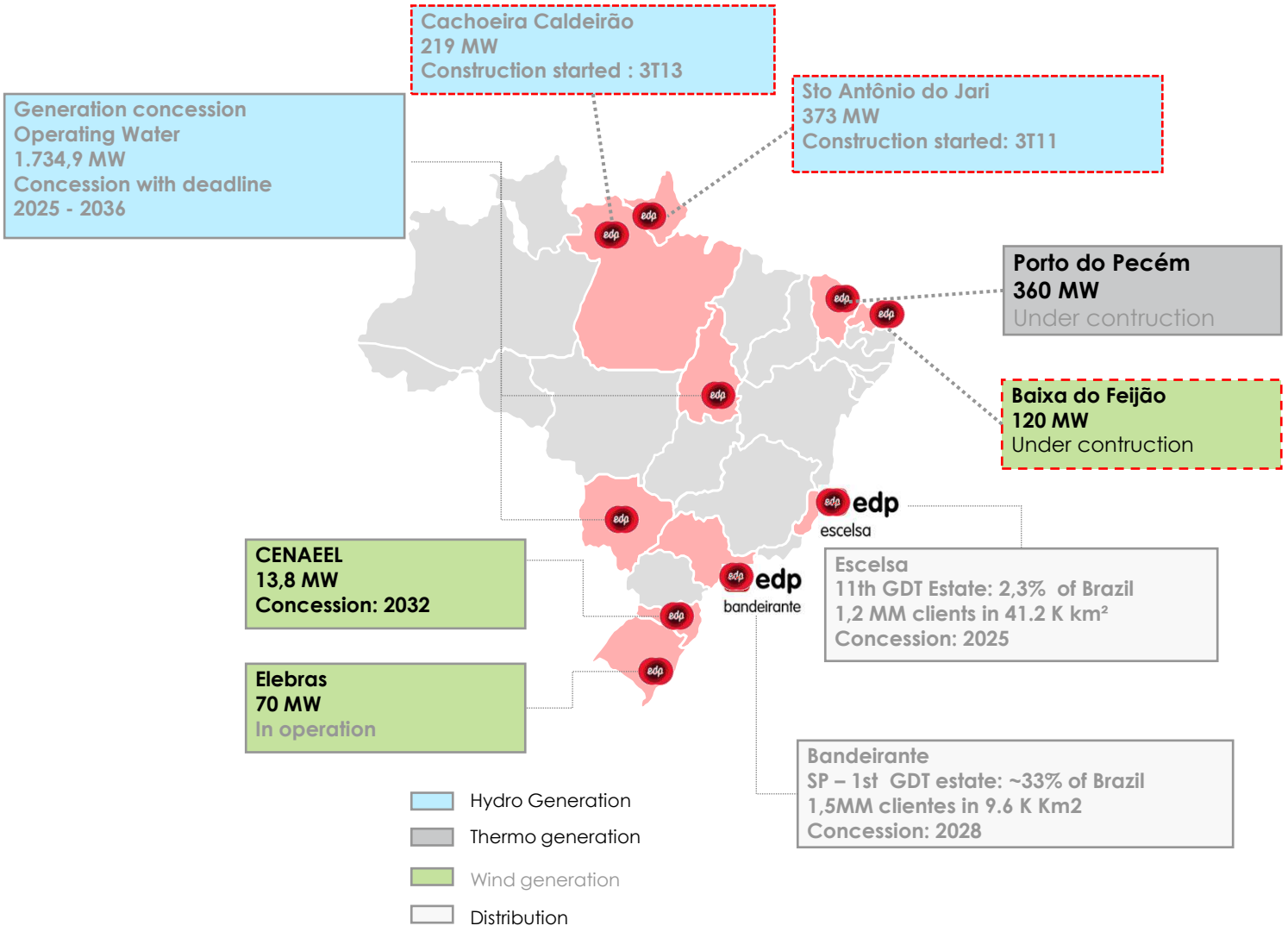
- 2 Utilities:
  - Bandeirante (SP)
  - Escelsa (ES)
- 23.749 GWh Distributed Energy
- 3 million clients

3rd largest private trader

Energy Trading

- 10.831 GWh commercialized in 2012

... And with a presence in several states



Ecil Energia - InovCity partner

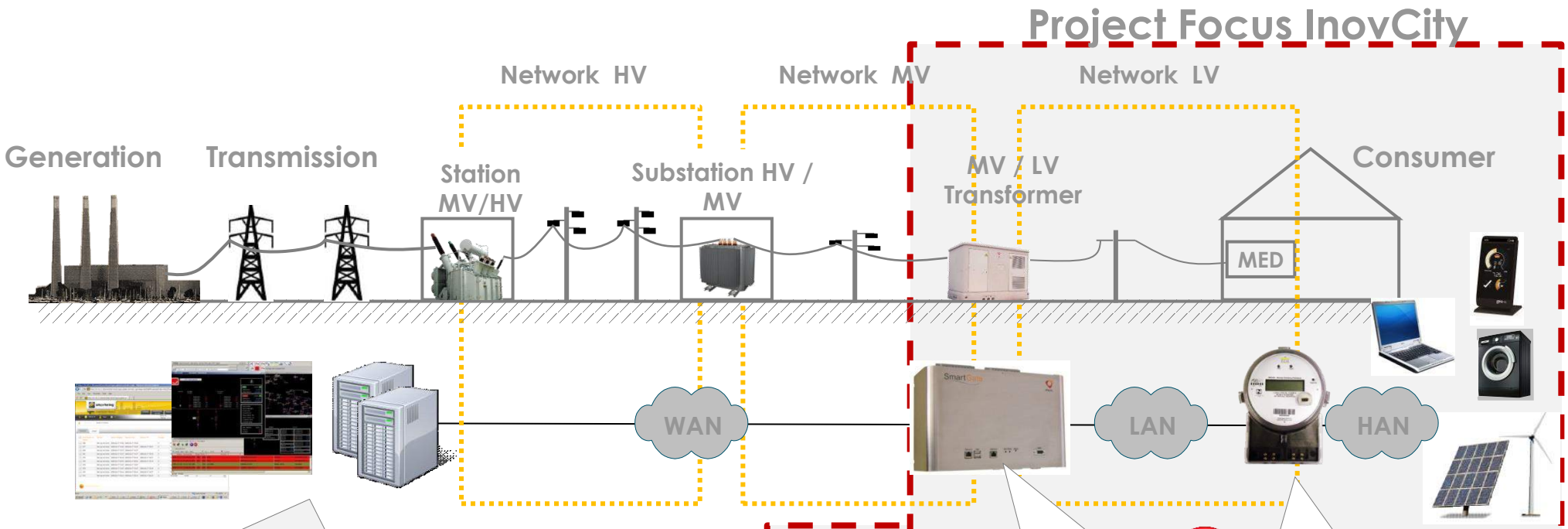
About Ecil

- Is a Brazilian company, part of Ecil Group, a 85 years old company.
- Works with products and solutions to Smart Grid Market
- Has a strong R&D Time that creat solutions to solve local problems
- Employee more than 200 engineers and technicians
- Work with solutions in automation, smart meters, reclosers and network infrastructure

Business

- Innovative technology solutions for the electric power market.

The EDP group already has several smart grid solutions, with InovCity complement the BT network



A

Central Systems & Automation Network (commercial & technical)

- SCADA system in operation (COS) since 2003 with disaster recovery
- 100% of SEs automated
- 100% of customers HV and MV telemetering
- 38% of customers with Automatic Transfer Loads

B

Information Network

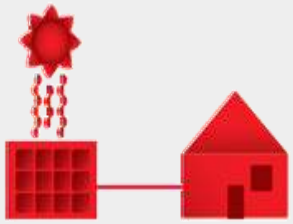
- Control and monitoring of load and temperature
- Metering and energy balance
- Microgeneration and flow control
- ...

C

Smart meter

- Measurement
- Remote operation
- Circuit breaker
- flexibility Tariff
- HAN interface
- ...

InovCity - 1st Stage: 6 Different Areas

Efficient Public Lightening	Energy Efficiency	Distributed Generation	EV Support	Smart Metering	Community Awareness
					
LED	More efficient lamps, refrigerators and showers donated to low income consumers	Solar PV panels performance test	Electric vehicles	Smart Meters: 100% LV units	Educational programs within local institutions

InovCity – Main characteristics

APARECIDA PROJECT (INOVCITY)

METERS LV
TOTAL: 13,850

MONO: 1,550
BI: 10,900
TRI: 1,400

ZIGBEE
Coordinator
&
CPEs WiMAX

A1: 01
A4: 34
MT: 6
CME: 11
ETs: 485

200 units

SW – Management

1. Grid Management
2. Loss Management
3. Process Flags
4. Metering Portal
5. CCS Integration
6. Tariff Management

InovCity – Meter and Coordinator (100% Brazilian Technology)

METER

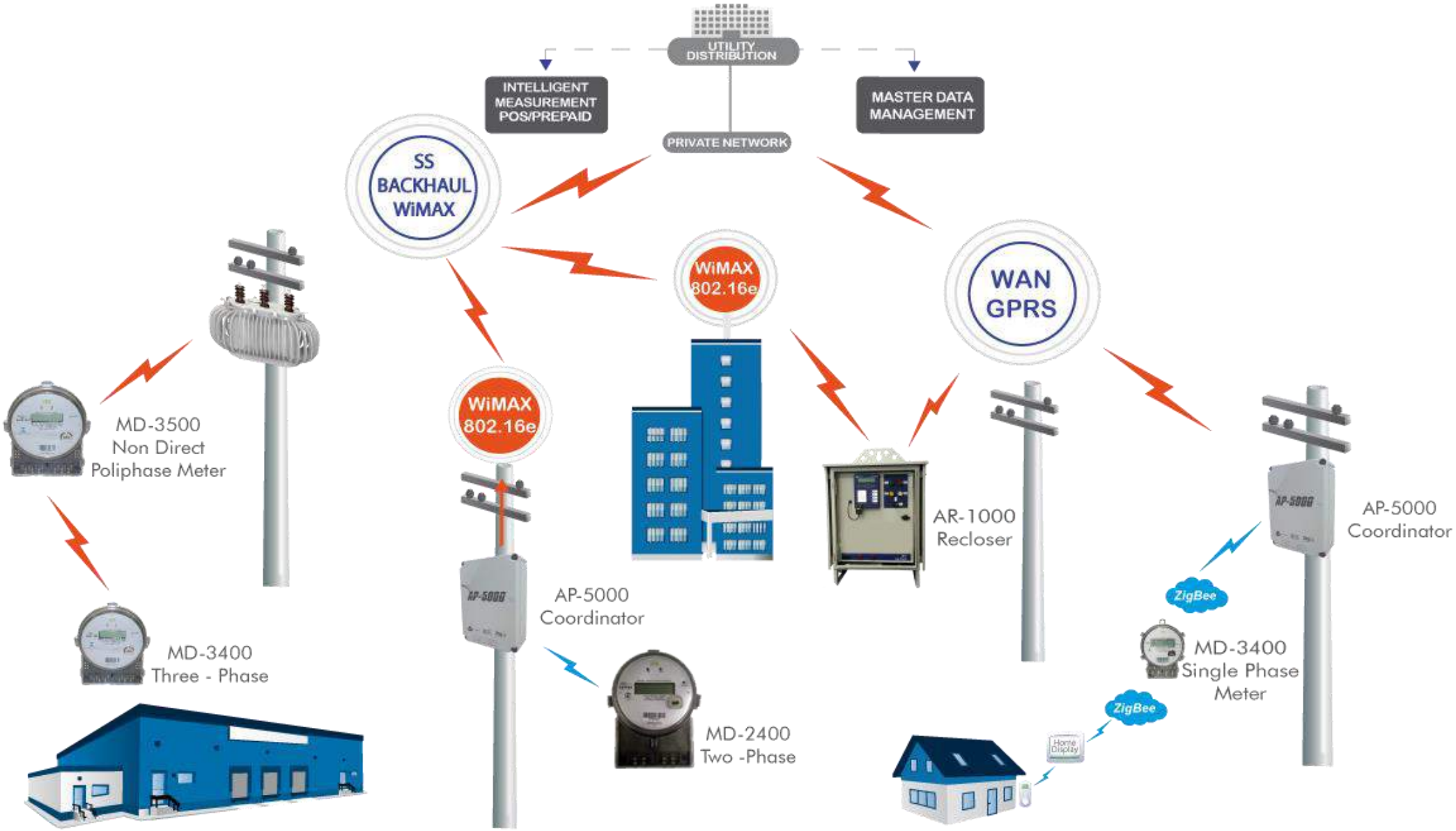
COORDINATOR

R&D: EDP Regulatory Budget and *Ecil Energia* Technical Development

InovCity – ZIGBEE Gateway

- Up to 8 Zigbee networks
- 8 directional antennas
- GPRS/GSM/ 3G compatible
- Ethernet, Bluetooth, Wi-Fi and WiMAX
- Backup Battery
- IP66 – External Use Installation

InovCity – Architecture

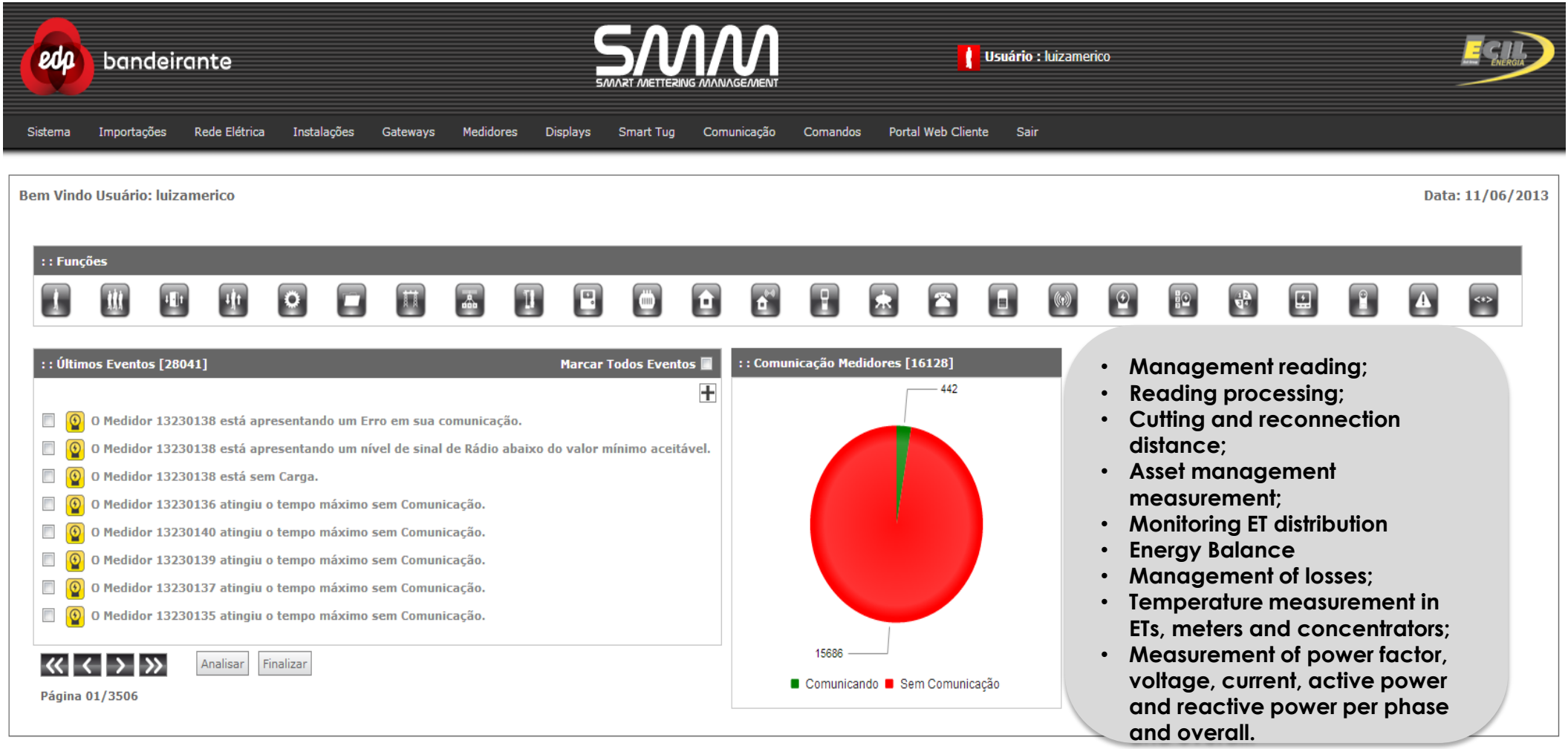


InovCity – Internal Topology Home

InovCity – Smart Metering Management

System responsible for collecting telemetry in addition of being the manager of the solution applied in InovCity, showing the status of the components installed in the city of Aparecida

Smart Metering Management



- Management reading;
- Reading processing;
- Cutting and reconnection distance;
- Asset management measurement;
- Monitoring ET distribution
- Energy Balance
- Management of losses;
- Temperature measurement in ETs, meters and concentrators;
- Measurement of power factor, voltage, current, active power and reactive power per phase and overall.

System responsible for collecting telemetry, in addition to being the manager of the solution applied in InovCity, showing the status of the components installed in the city of Aparecida.

The meter used was developed in R & D project and is approved by INMETRO – EDP with ECIL

MD-1400

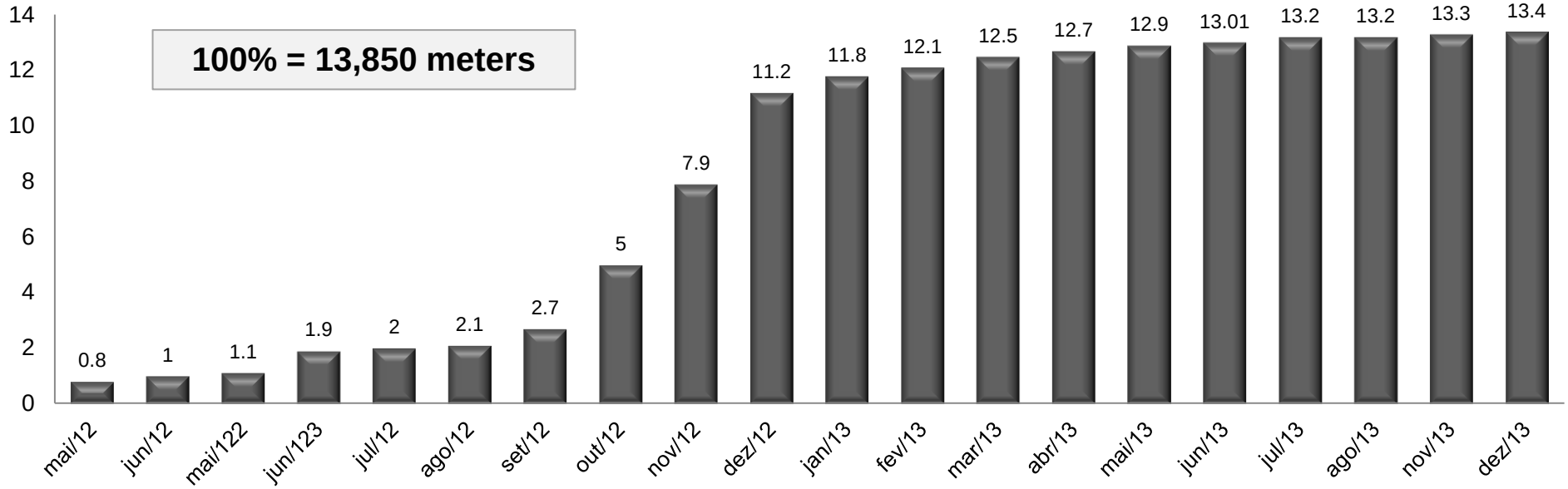
- Control "on line" of energy
- Consumption in homes;
- Cut / remote on;
- Fraud Alerts;
  - Inversion quadrant;
  - Number of dismissals;
  - Meter no load;
- Measurement in 4 quadrants (for purposes of fraud);
- Measuring active energy;
- Optical port for communication; Communication Zigbee Mesh, 2.4 GHz;
- Applications in AMR and AMI;
- Measuring active energy;
- LCD display with 6 digits.

MD-2400 E MD-3400

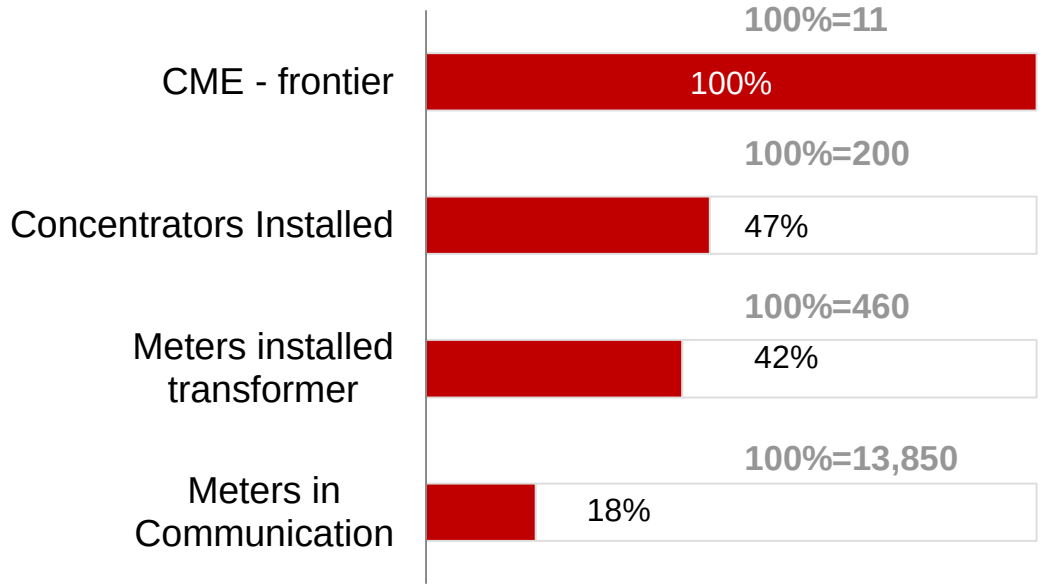
- Measurement of neutral current;
- Measurement of active and reactive power;
- Memory mass to 37 days;
- Support future prepaid metering; Battery and SuperCap for internal
- RTC;
- DIC and FIC.

Meters and Energy Balance

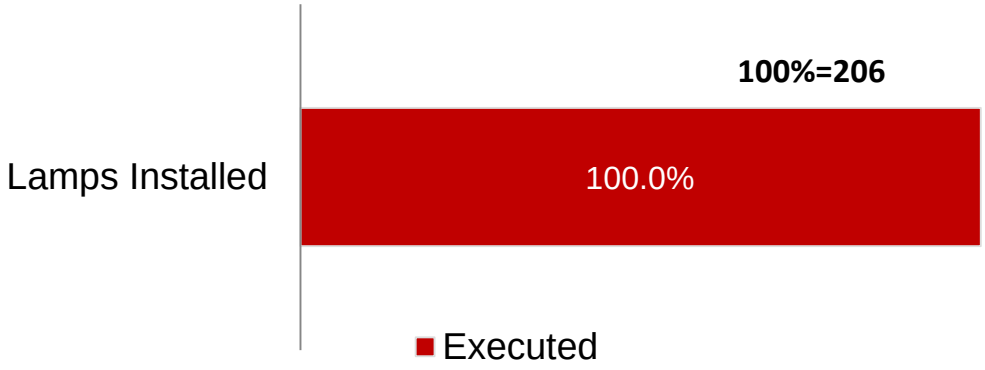
Meters installed



*Status in 24/10/2013



Public Lighting - Execution



Before

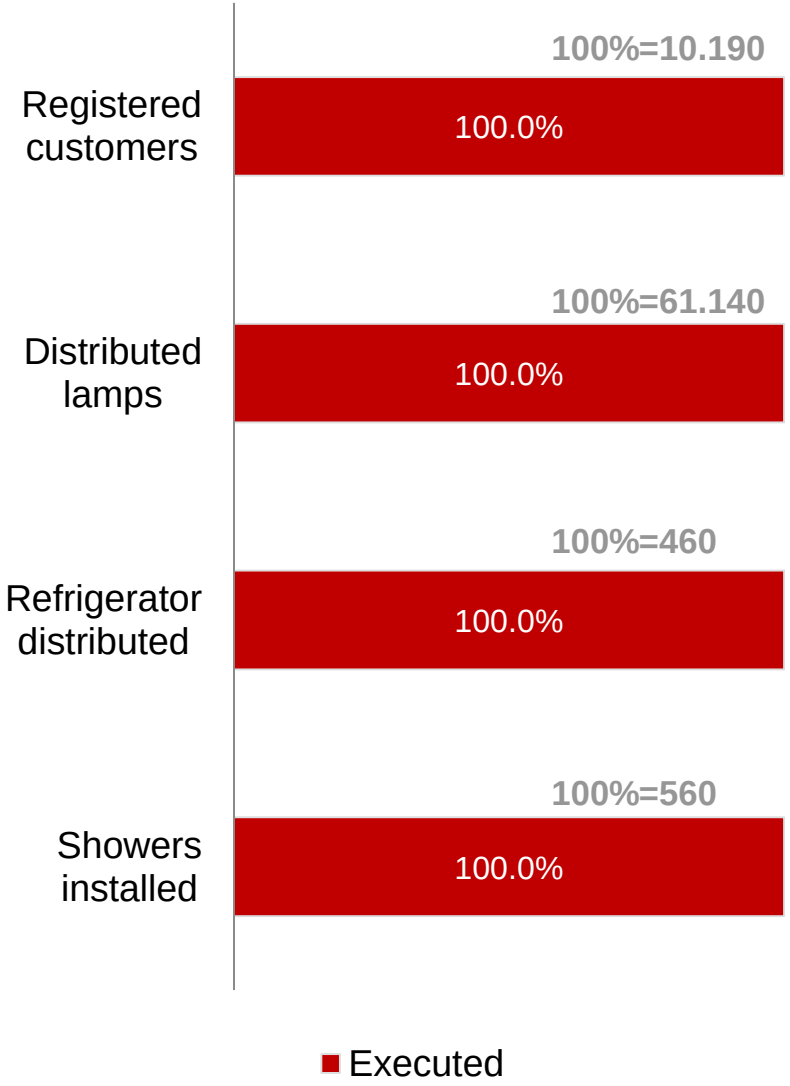
After

Other information

- Installation of the LED IP occurs in two distinct regions of the city
- Improving the quality of lighting (increased CRF) and reduced power consumption

Energy Efficiency

Main indicators (ref. 06 de março)



Other information

Main Advances

- Held the efficiency of the building of the Municipality
- Performed the installation of solar panels in the neighborhood Sonho Meu II

Electric Mobility

Social Work / Community Involvement

Social Actions and community involvement

Main actions

- 230 teachers trained
- 5,100 school kits distributed
- Lectures energy efficiency to 3,500 people
- Creating weekly program on regional radio

The project allowed InovCity a great learning experience for the company

Operations

- Logistics facility
- Monitoring and constant monitoring
- Team on the ground 100% dedicated

Telecommunications

- GPRS
- Network management "ZigBee“
- Creation of own telecommunications network

Communication with the client

- Community Involvement
- Specific channels for the project

Management Stakeholders

- Roadshow regular main entities
- Regular participation in decision making

Knowledge Management

- Registration problems
- Changing internal processes
- Training of employees

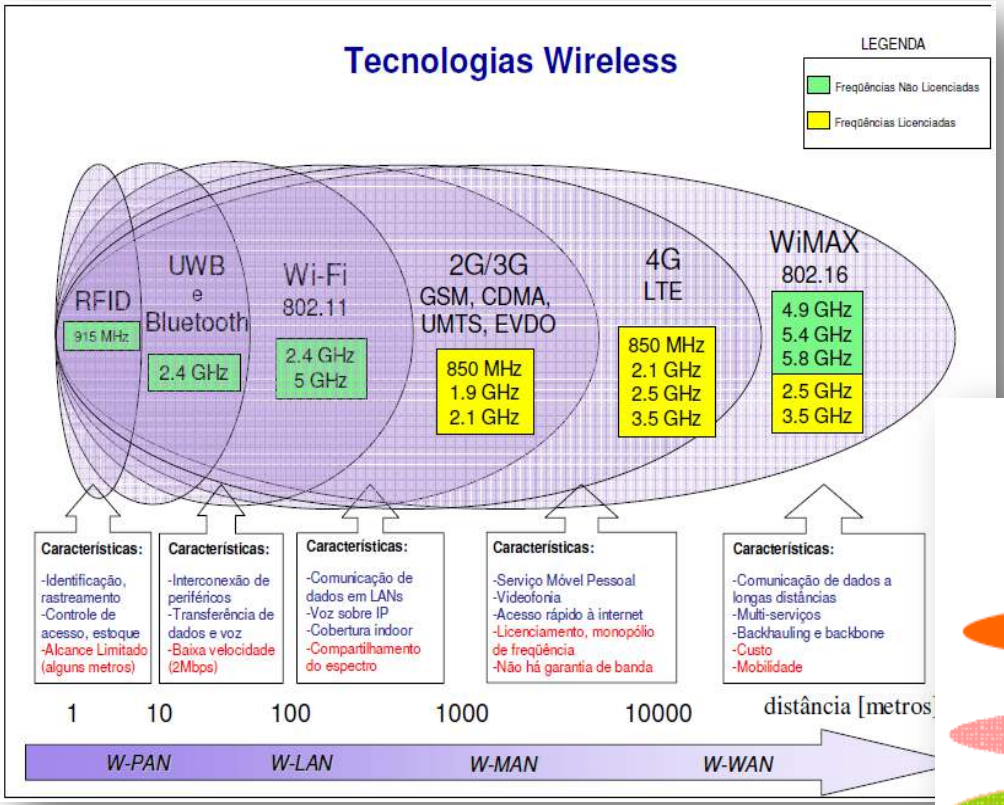
Evaluation money

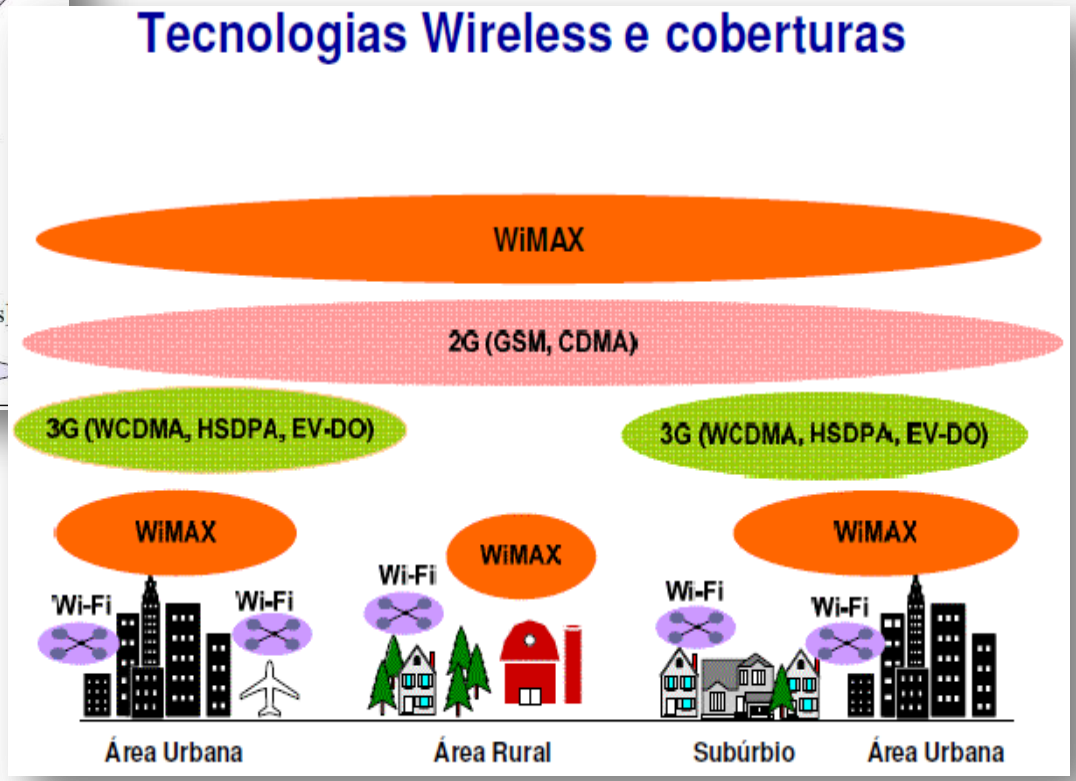
- Business case design and simulation of rollout

Definition of Backhaul technology InovCity Aparecida

- Why use your own Backhaul?
  - Poor GPRS network coverage
  - Low bandwidth capacity on public networks
  - Needs of high data traffic
  - High operating cost in public networks
  - Poor carriers investments

Worldwide Interoperability for Microwave Access
Definition of technology InovCity Aparecida

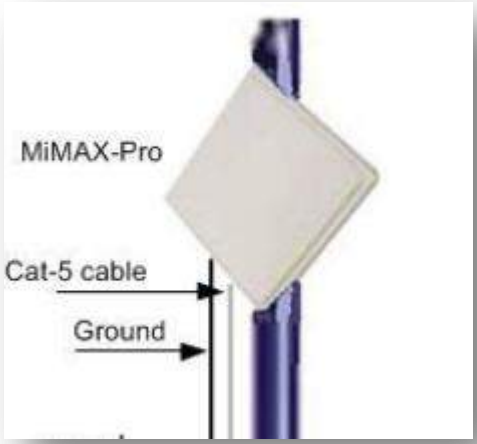




Main characteristics of WiMAX

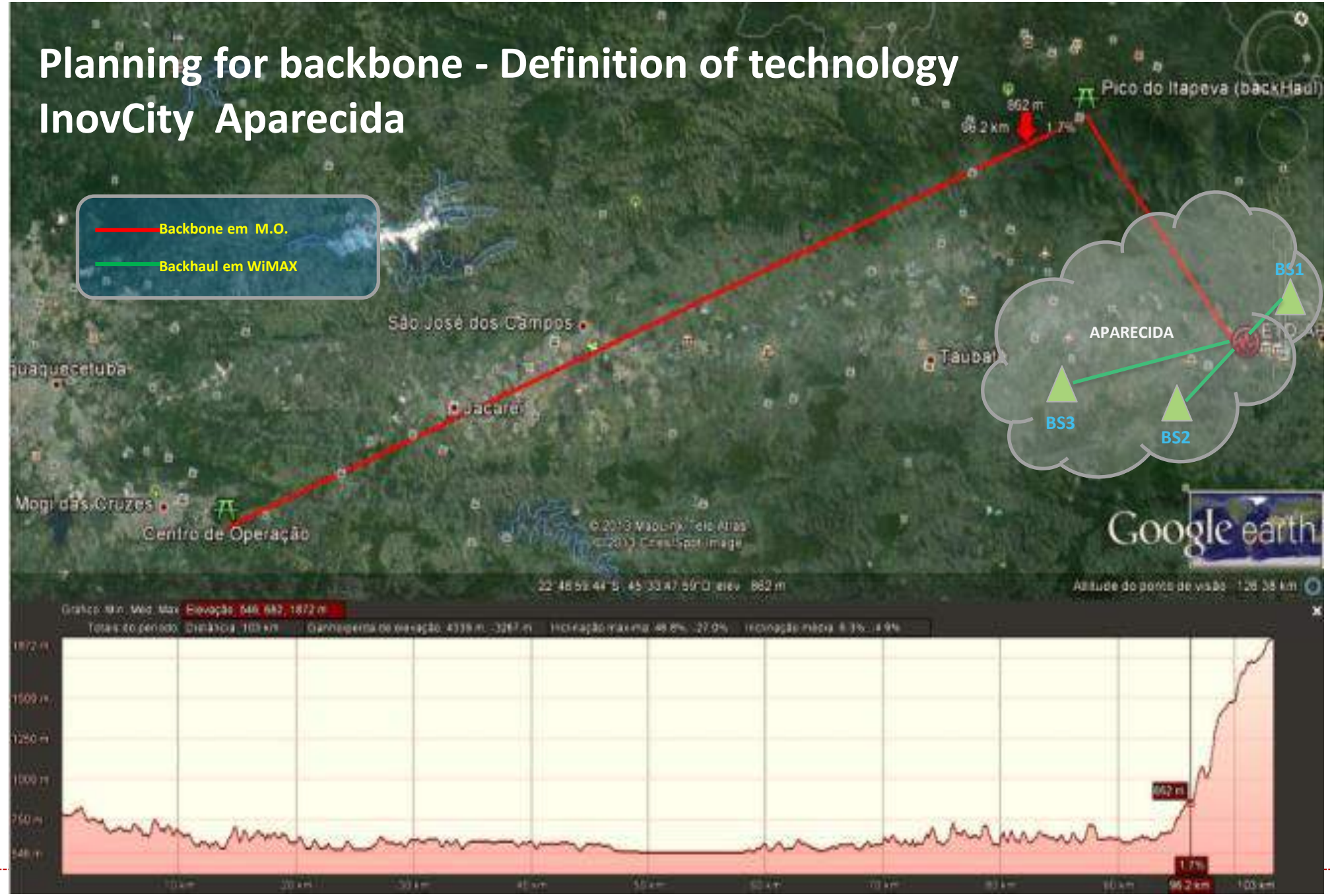
Figure 1 – MiMAX Pro V80 560I Frequency Ranges

Frequency Band	Channel Bandwidth
5.470 – 5.950 GHz in TDD mode	• 3.5 MHz • 5 MHz • 7 MHz • 10 MHz



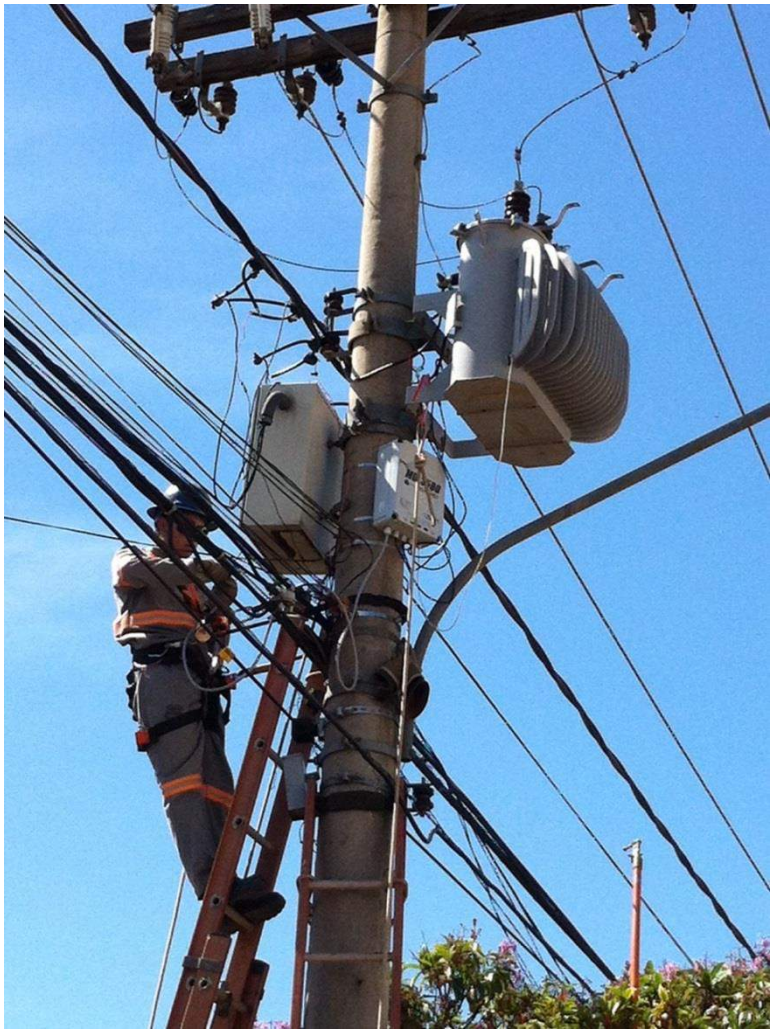
- Adaptive Modulation - QPSK, 16QAM, 64QAM
- IEEE 802.16e mobile WiMAX
- Output Power: 23 dBm
- Antenna - Integrated Dual Polarization directional security
- Key management PKMv2 - 802.16e
- X.509 digital certification for authentication of devices
- Device and methods of user authentication EAP-TLS and EAP-TTLS-cripitografia (MD5, MSCHAPv2) 3DES and AES (CCMP)
- Multi-language support

Telecommunications - backbone network and WiMax in Aparecida



InovCity – WiMax

- 4 Base Satations
- 200 CPE
- Server AAA Autentication



Thank you!

jeferson.marcondes@edpbr.com.br

live our energy!!

KEEP

CALM

AND

THE LIGHTS

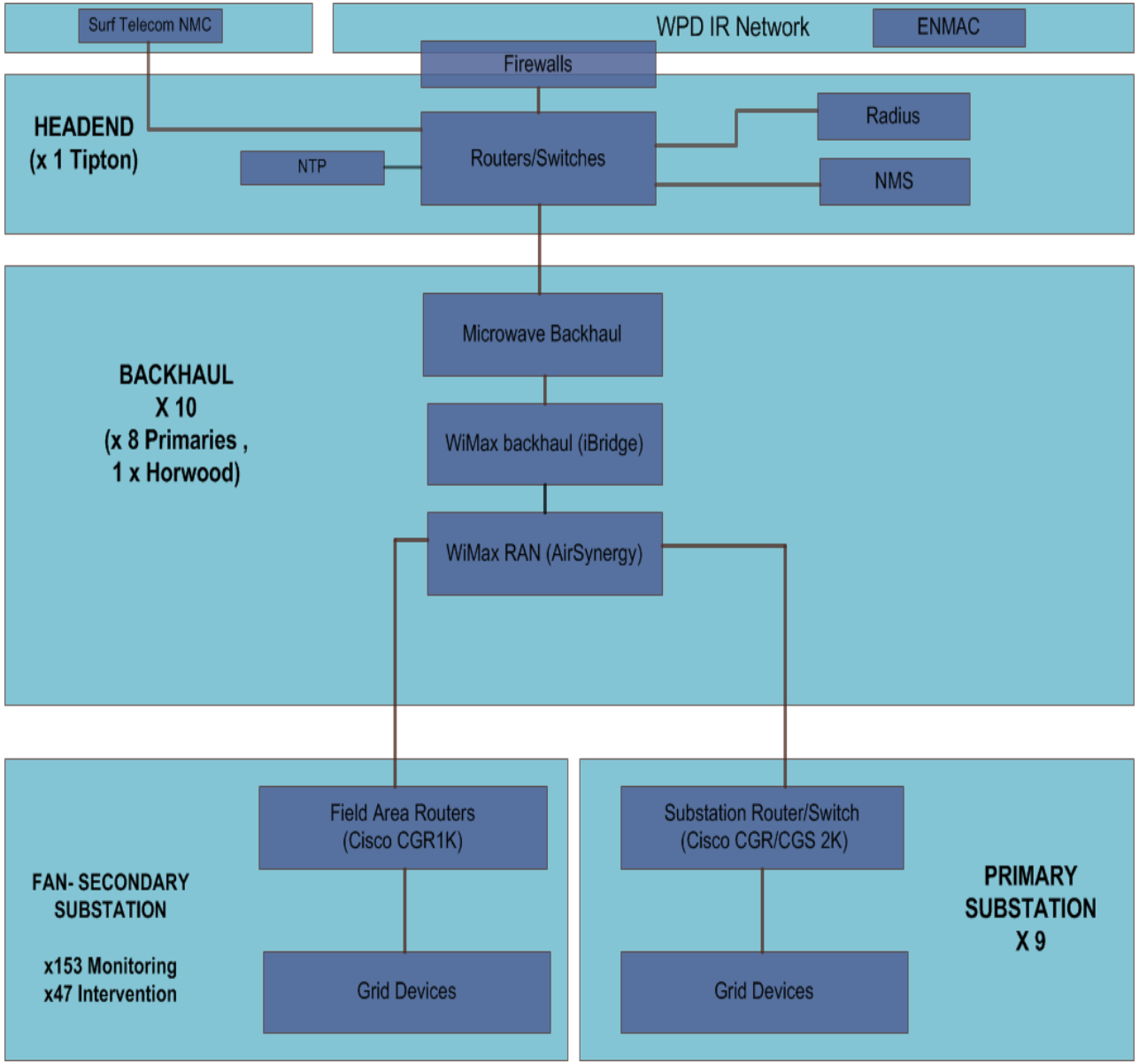
ON

Project FALCON Grid Devices

Technique 1 - Dynamic Asset Rating	• Maximizing network capacity usage by monitoring assets temperature and load, then using this to calculate real-time asset capacity	Gridkey LVM Alstom P341 DAR Tollgrade Lighthouse
Technique 2 – Automatic Load Transfer	• Changing the configuration of the network to improve the flow of power via re-routing of load through areas of spare capacity to accommodate peaks	Gridkey LVM Alstom P841 PMU Linak iCom Schneider T200e
Technique 3 – Meshed Networks	• Maximizing network capacity usage by monitoring assets temperature and load, then using this to calculate real-time asset capacity	Gridkey LVM Alstom P141 GE D20 RTU
Technique 4 – Energy Storage	• Using power stored in batteries on the network, to alleviate the problem by reducing the Network peak load requirements	Gridkey LVM GE Battery Storage

Communications Network Architecture

- MoD 1.4 GHz spectrum
- 9 IP-based AirSpan AirSynergy pico-cells
- 200 Cisco CGR 1000 with AirSpan WiMax module



Communications Recommendations

Requirement	Recommendations
Robust	• Private WiMax network to provide required bandwidth (2 Mbps – 10 Mbps) • Hardened CPE with Integrated communication equipment (IP +WiMax) • 100ms Latency + High availability
Cost Effective	• Standard IP Communication Protocols • Multi Service: Open Standards - Device Interoperability – Flexible • Optimize operating costs
Security, Security, Security	• Network layer + application layer security • Active authentication & monitoring • Security built into the devices & architecture

Preliminary Findings

Pilot Objective	Result
Distributed Generation	Network monitoring has shown we can accommodate about 20% more PV installations than previously expected (caused by overly cautious modelling software)
Dynamic Asset Rating + Load Control	Voltage optimization and control if rollout out across GB could result in saving on customer bills of over $300m a year (up to $15 on every domestic customer connection)
Dynamic Asset Rating	State estimation can be used effectively to complement physical monitoring (making the “big data” challenge slight less daunting).
Dynamic Asset Rating + Load Control	Massive savings and benefits from network automation for outage management. The financial benefit is from a reduction in regulatory penalties for outages.

"Being able to develop a robust telecommunications network is a critical element in our strategy, especially given the forecasted uptake in low-carbon technologies. We are pleased to be working alongside Cisco to develop the Falcon communications solution, and we are hoping it will help other utilities to develop their own smarter grids."

—Roger Hey, Future Networks Manager, Western Power Distribution

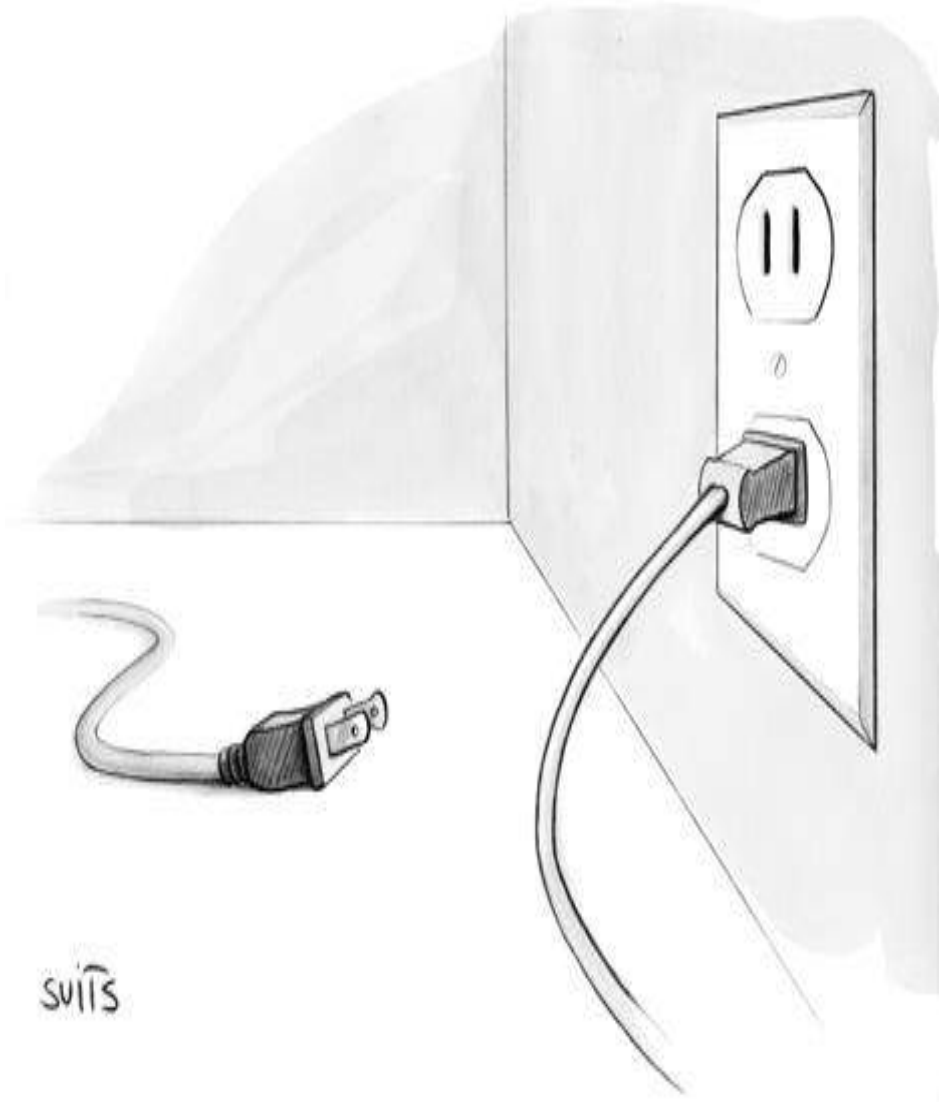
Lessons Learned

Lesson Learned	Detail
Open Standards & Architecture is the way to go	• Complex solution with components from many different technologies from many different vendors • An IP-based communications platform maximizes grid-device flexibility and allows for a modular design
Lots of unforeseeable integration issues	• Expect Trial and error • Ensure vendor-supported, stringent interoperability testing • Involve players early and often. Resource for integration challenges and program management.
Design WILL Evolve	• Plan for a formal design phase • Create a modular design with deployment templates to reduce costs & complexity • Design-in Security & QoS from the outset • A well documented design will allow for easier changes

Multi Service Communication Platform

Leonard gets very excited about the new network.

Plug & Play



WESTERN POWER DISTRIBUTION
FALCON

Highly Secure

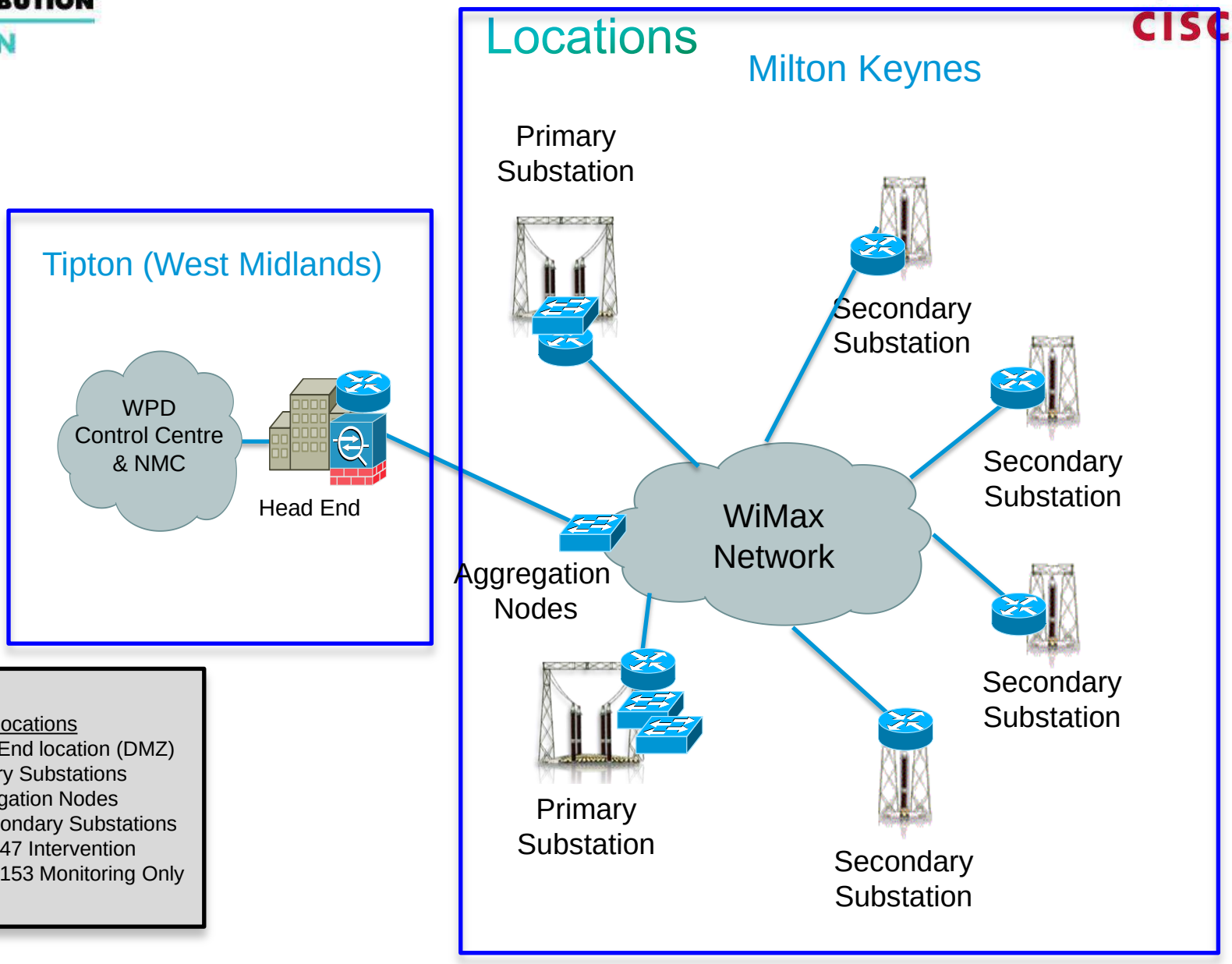
CISCO

"Its a foolproof computer network, sir,
that no one can break into, not even a kid."

Requires People, Processes & Tools

You guarantee uptime if we sprinkle this powder on the network?

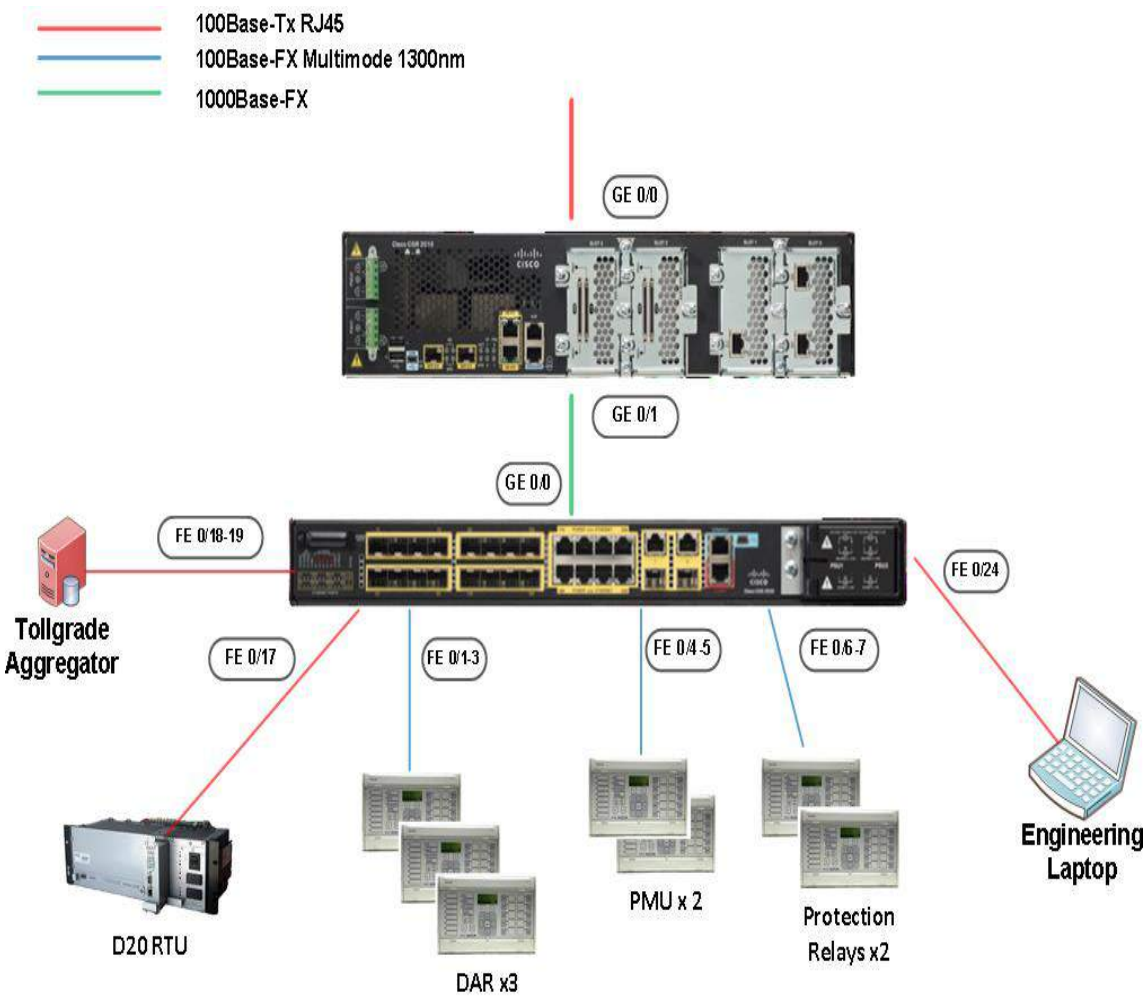
Thank you.



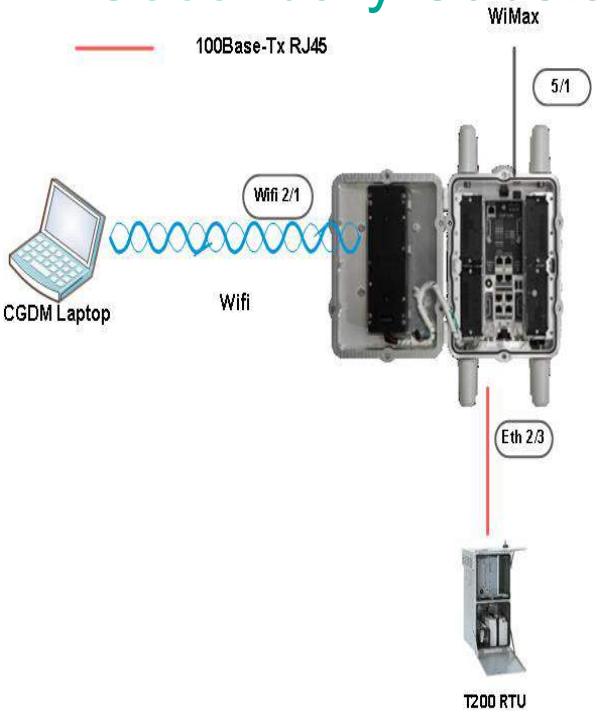
Locations

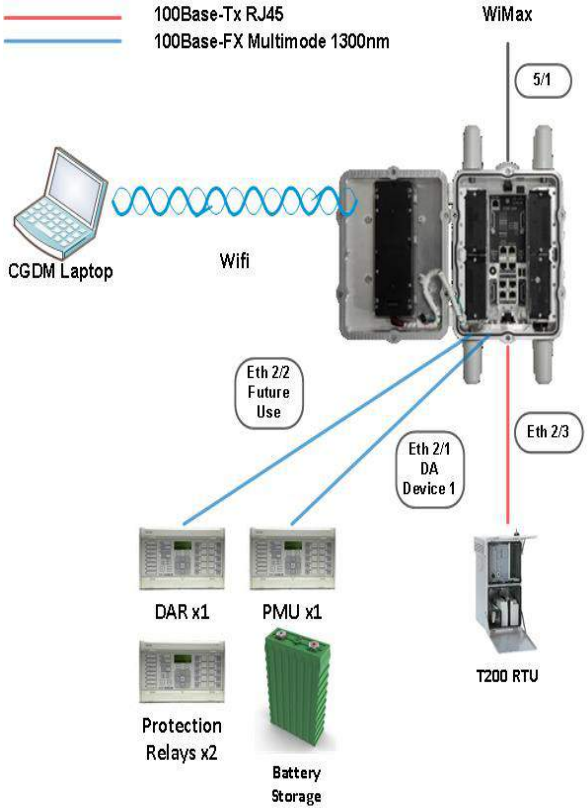
- 1 Head End location (DMZ)
- 9 Primary Substations
- 2 Aggregation Nodes
- 200 Secondary Substations
  - 47 Intervention
  - 153 Monitoring Only

Primary Substation



Secondary Substation





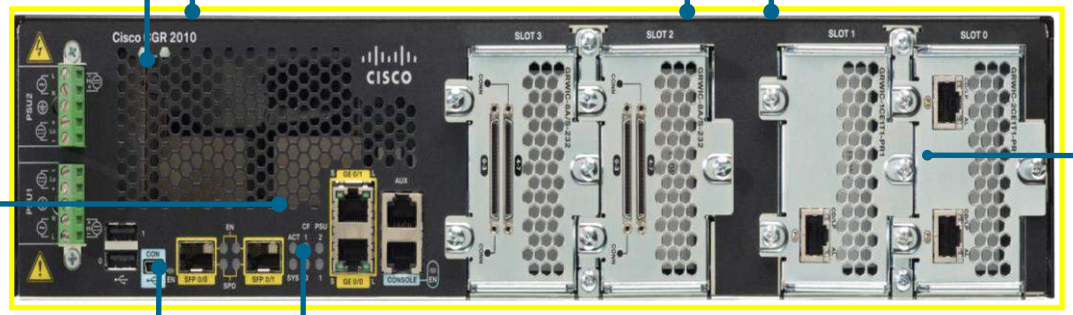
Connected Grid Router 2010 (CGR2010)

Multi-core Network Processor
- Leveraging ISR G2 technology
- Integrated HW Encryption

Substation Hardened
- Substation Compliant - IEC61850-3 and IEE1613
- Fixed Memory

1588 Hardware Ready
- HW ready for 1588 PTP

Convection Cooling
- No fans and/or moving parts
- Increased Operating Temp



Modular Grid Router WIC (GRWIC)
- Based off HWIC design
- Double wide expansion capability
- Field Replaceable

GE Ports
- Dual combo Copper/SFP GE ports
- Rugged SFP support

USB
- Console over USB
- Convenience storage
- Security credentials

Front or Rear Mount Capability
- Redundant LED placements at front and rear of router

Field Replaceable Redundant Power Supplies
- High Voltage PS: 85 – 265VAC 88-300VDC
- Low Voltage PS: 24-60VDC

Connected Grid Switch (CGS2520)

Substation Hardened
- Substation Compliant IEC61850-3 and IEEE1613

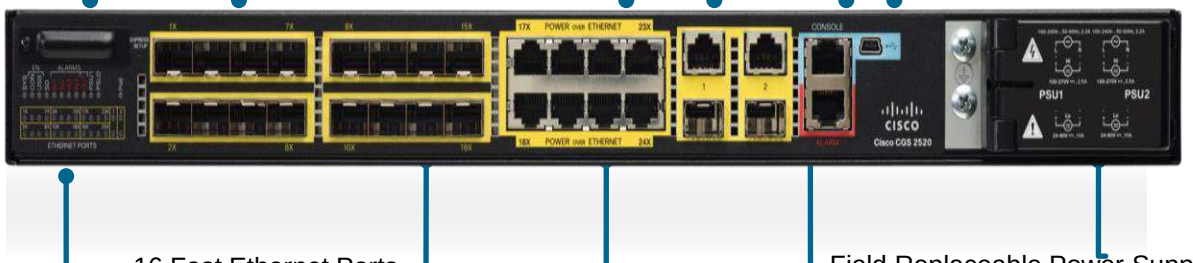
CG Swap Drive
- SD Flash

GE Ports
- Dual purpose
- 10/100/1000 Copper
- 100/1000 SFP ports
- Rugged SFP support

IEEE 1588 v2/PTP
- Power Profile c37.238

Console
- Console over USB
- Console over RS232

Conductive Cooling
- No fans and/or moving parts
- Increased Operating Temp**



16 Fast Ethernet Ports
- 100M SFP

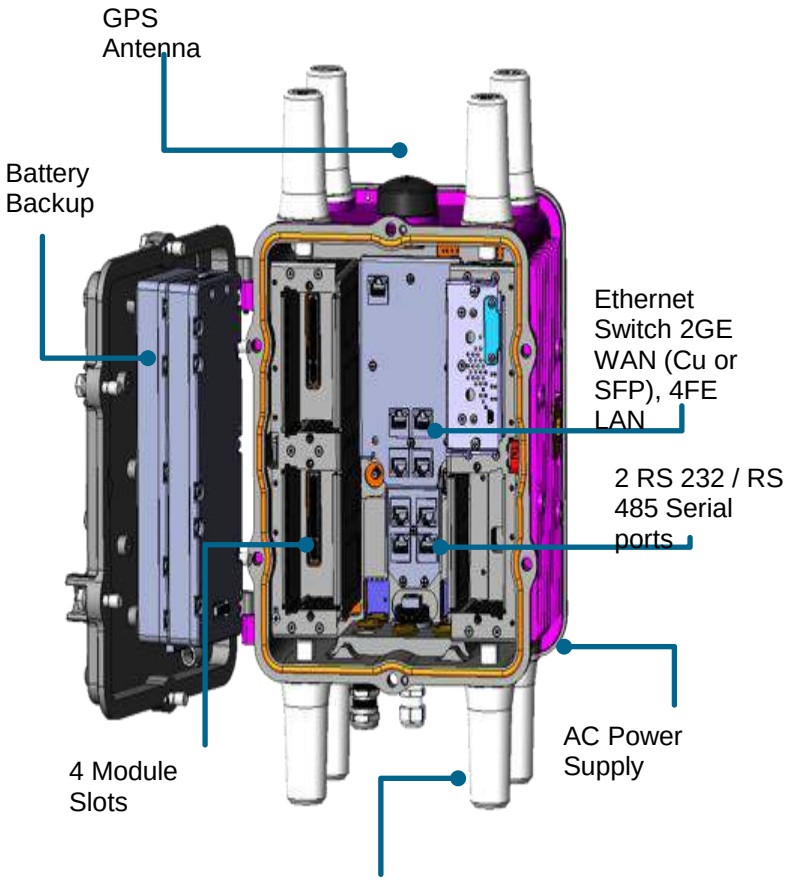
Front or Rear Mount Capability
- Redundant LED placements at front and rear of router
- System, Alarm and Port Status LEDs

8 Fast Ethernet Ports
- 10 /100M Fixed Copper PoE

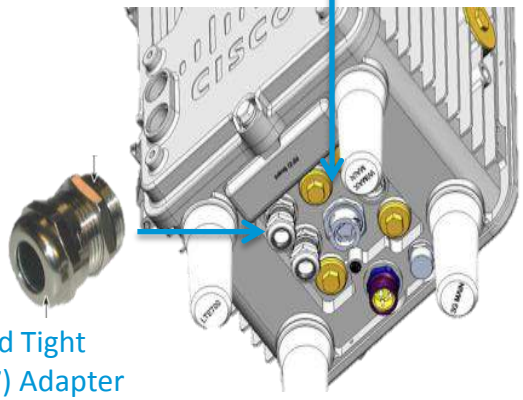
Field Replaceable Power Supplies
- High Voltage PS: 85 – 264 VAC 88-300 VDC
- Low Voltage PS: 24-60 VDC

Alarm Contacts
- FOUR Alarm Inputs
- ONE Alarm Output

CGR1240 Under The Cover



Ruggedized, IP67 Ethernet (RJ-45) connector



Liquid Tight (IP67) Adapter

- Dimensions: **30.5 cm (H) x 20.3 cm (W) x 19 cm (D)** = 12” (H) x 8.0” (W) x 7.5” (D)
- Antennas shown above are optional; can be deployed with external antennas

Preliminary product visualization; final product design may vary