




CRN Smart Grid Summit

Communications Infrastructure for the Smart Grid

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About the Presenter:
Rick leads the System Design and Communications Department, providing automation and communications planning consulting and engineering services, including: technology work plans,; strategic communications plans; and automation planning. This department also provides deployment services for: SCADA; distribution automation; substation automation and design; AMI; demand response; GIS; MWM; AVL; OMS; IVR; and a variety of automation applications. The communications media deployed include: land mobile radio; fiber; microwave backbones; mobile data; and others. Rick has over 25 years of professional relevant experience with an emphasis on the business side of technology. He has an MBA from Cardinal Stritch University in Milwaukee, WI.

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2

Agenda

*The deployment of a communication network for AMI, Demand Response, and various forms of Distribution Automation involves **five** basic steps:*

1. Complete a Multi-Application Communications Assessment
2. Define Communication System Requirements
3. Create and Select Communications Architecture
4. Select Communication Media technology
5. Select Communication Media vendors

What is Driving the Need for Communications Infrastructure?

New Applications at Substations



New SCADA & DA Applications



Mobile Voice

New Demand Response & DG



Control Center Integration

Mobile Data



Backbone Data Transport



AMI

Approach for Communication Projects

Approach 1: Develop a communication solution for a single application.

- For example: *AMI only* without considerations for SCADA, load management, mobile radio, DA, etc.
- DA without considerations for other applications.
- Mobile service orders without considering mobile voice or the backbone.
- Load Management, etc. without considering AMI or the Intelligent/Smart Grid.

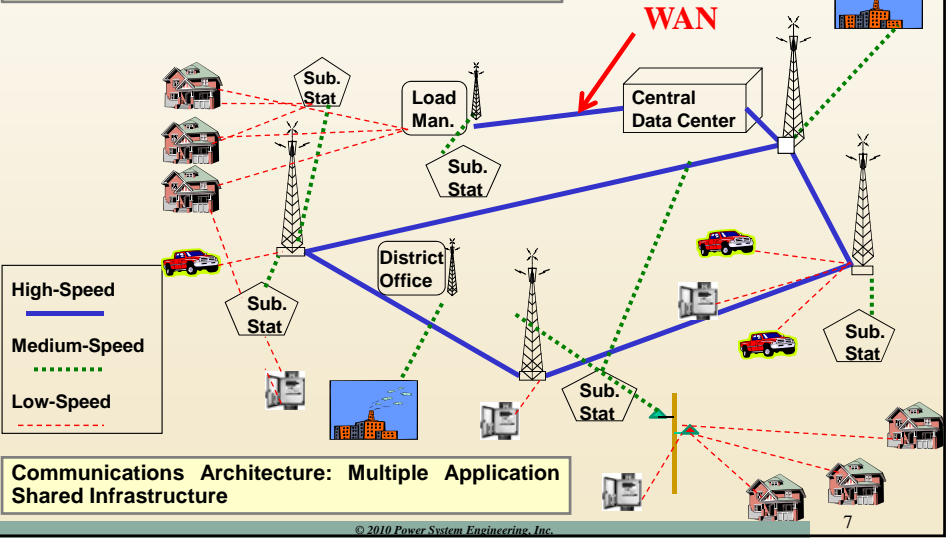
Approach for Communication Projects

Approach 2: Develop a communication solution for multiple applications. Sometimes this can be called a Strategic Communications Plan.

Define the business requirements for the applications. For each application (e.g. SCADA, line device sites, video-security, load management, AMI, others) identify:

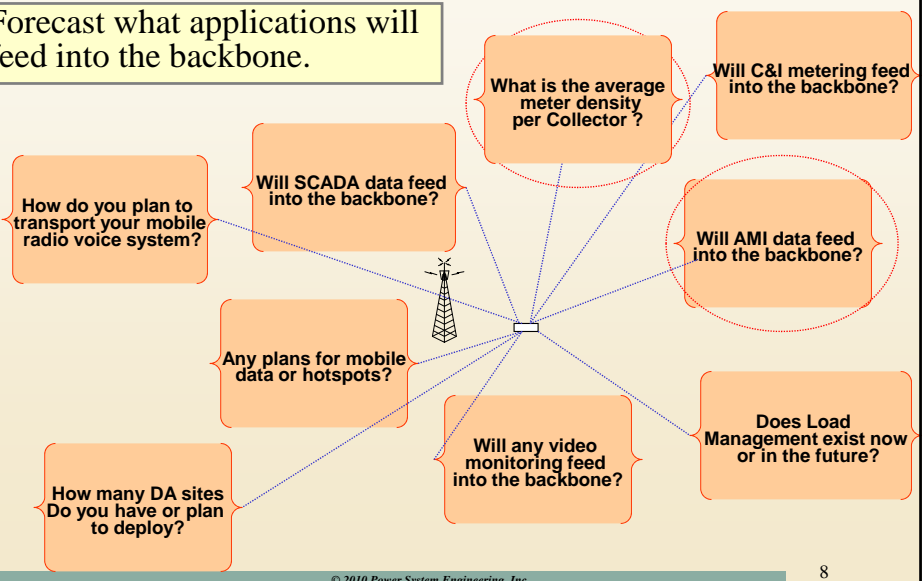
Utility Data Communications

New Trends in Utility Communications



Approach for Communication Projects

Forecast what applications will feed into the backbone.



Data Communication System Characteristics

All data communications systems are specified by a set of characteristics.

A few of the most common ones are:

- Throughput
- Latency
- Reliability
- Error Rate
- Topology
- Directionality (duplex, simplex, etc.)
- Packet Switched and Circuit Switched
- Applications that run on the link
- Security Needs


Frequency Alternatives for Mobile Voice or Data

What is the major difference?

Frequency and Propagation Impact

The lower the frequency the better the coverage

150 MHz 400 MHz 700 MHz 900 MHz 2.4 GHz

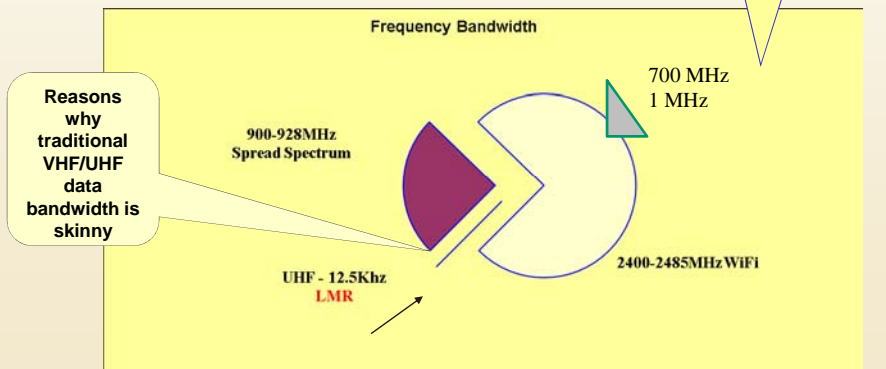
 Better Propagation

Source: Power System Engineering (www.powersystem.org)

Introduction – Communication Basics

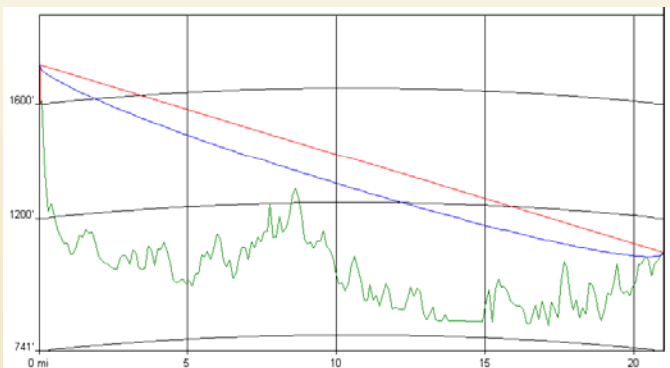
Radio Bandwidth Allocation

Data bandwidth is dependant on the various technologies



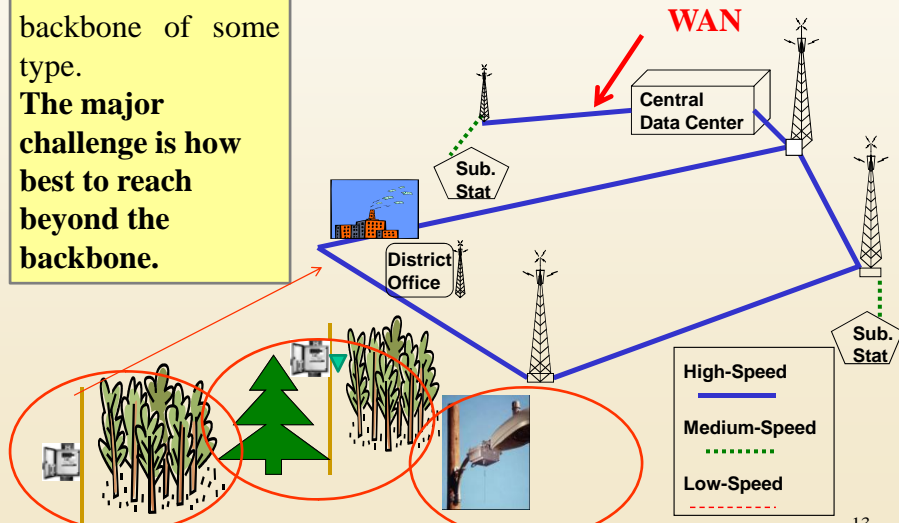
Line-of-Sight (LOS)

- 700MHz and higher frequencies generally require Line-of-Sight over longer distances to achieve reliable communications
- LOS is assessed with path studies



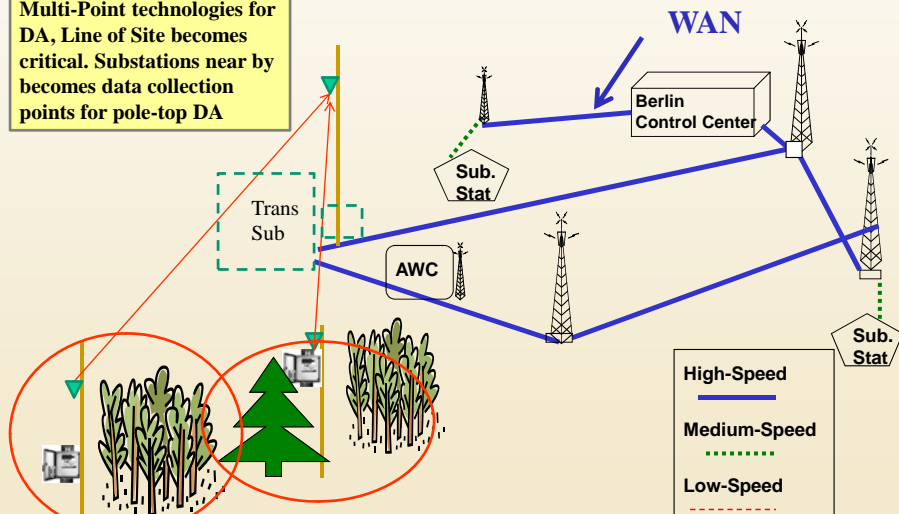
Utility Data Communications

Most utilities have a backbone of some type.
The major challenge is how best to reach beyond the backbone.



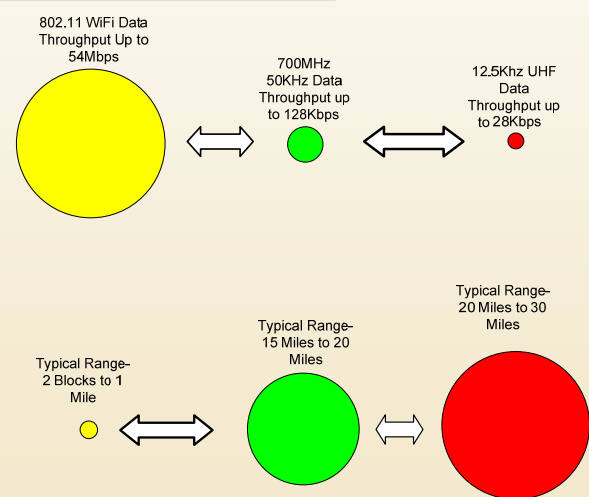
Use of Substations As DA Nodes

If NU shifts to Point-to-Multi-Point technologies for DA, Line of Site becomes critical. Substations near by becomes data collection points for pole-top DA

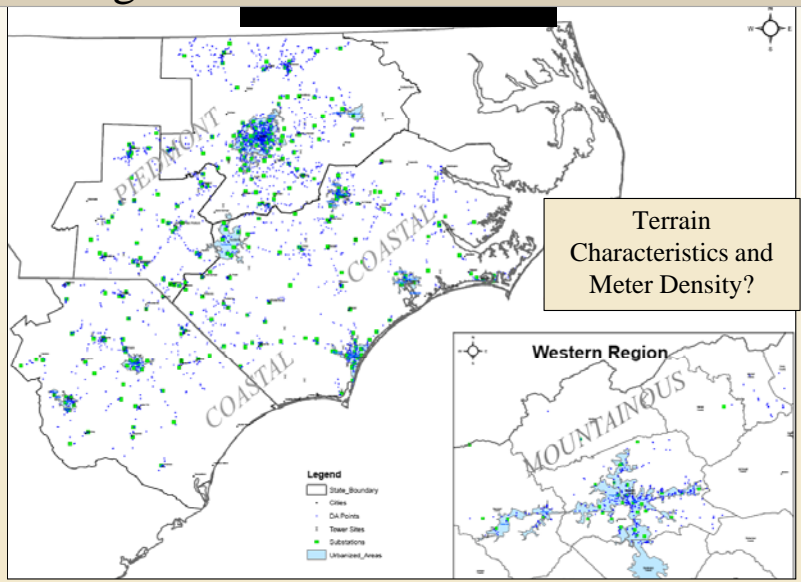


Coverage vs. Throughput

For Any Wireless Data Application



Coverage: Where Do You Need to Reach?



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Requirements For Utility Automation

- **AMI Take-Out Points**
- **Home Area Networks (Smart Metering)**
- Substations
- Distribution Automation (DA)
- Mobile data
- Other Applications

Communication requirements at tower sites will vary based on how many field locations and applications will feed into the tower sites.

Communication Requirements for Substations

Distribution substations have become regional nodes for a variety of utility automation applications including:

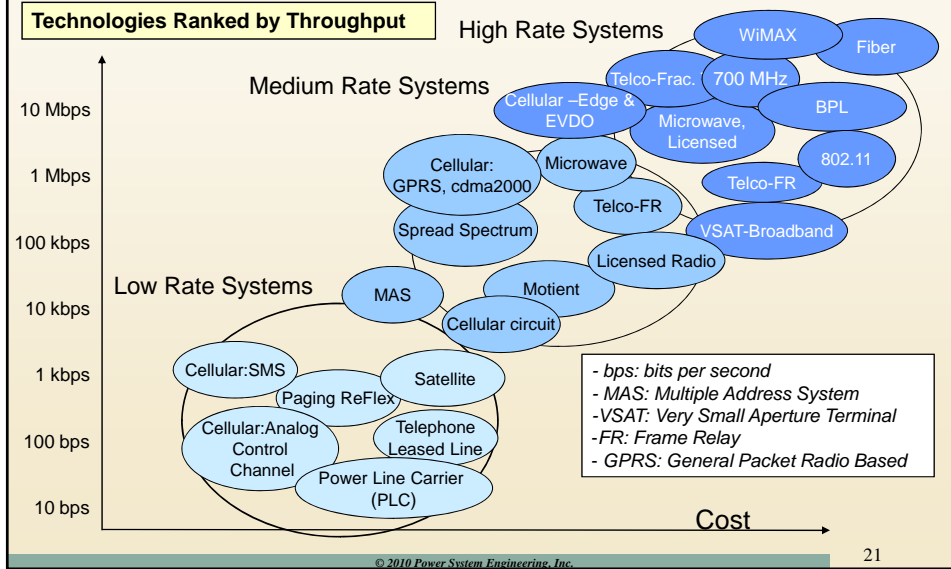
- SCADA
- AMI via PLC or Nodes for Fixed Wireless Take-Out points
- Direct connect via Ethernet into substation IEDs
- Video monitoring
- Communication hubs or concentration points for down-line DA
- Hot-spots for mobile data

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Summary Data Communications Landscape



Communications Architecture Alternatives

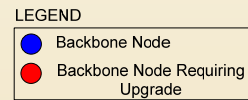
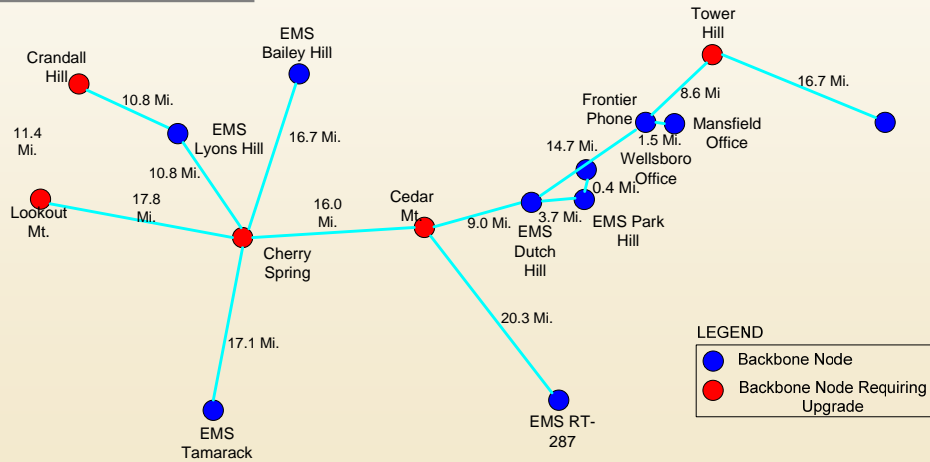
Redundant (ring-based) and Non-Redundant

SONET, MPLS, Gig Ethernet, or Carrier Grade Ethernet

of Network Tiers

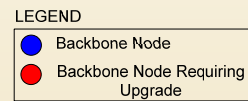
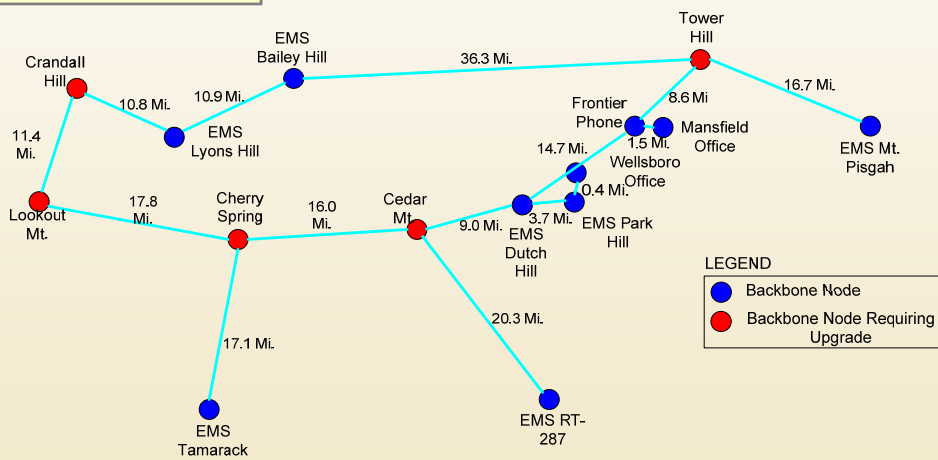
Non-Redundant Microwave Backbone

Illustrative sample



Redundant Microwave Backbone

Illustrative sample



Ethernet Packet Switched (IP) Trend

Predominantly packet-based network traffic is:

- The most cost-effective technology.
- The easiest to operate, support, and maintain.
- The most bandwidth efficient.
- The direction that the telecommunications industry is heading.
- Is software configurable and most Gig Ethernet supported hardware also supports MPLS.
- Has rigorous compliance standards and testing required.
- Dynamic in allocation of data bandwidth.
- Has improved QoS enforcement.

SONET is no longer the green-field chosen technology.

- Legacy transport for circuit-switched, not IP-switched technologies.
- Utilities are moving away from circuit-switched applications.

Agenda

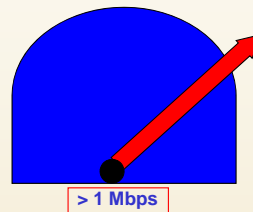
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High Rate Systems

When you need to move serious data > 10 Mbps...

- Primary Purpose:
 - ✓ Most commonly used in the backbone with tower-to-tower connectivity as the substations feed into the towers.
 - ✓ Can also be used to connect district offices with the main office.
 - ✓ Sometimes for substations.

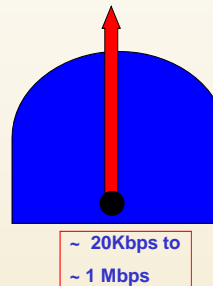


High Speed Backbone Communication Media Choices

Technology
Fiber (private or telco leased)
Licensed 6, 12 and 18 GHz Point to Point Microwave
Unlicensed 5.8 GHz and 2.4 GHz Point to Point Microwave

Medium Rate Communications Media

- Primary Purpose:
 - ✓ Most commonly used to connect substations with the main office
 - ✓ Fixed Wireless Node communications: AMI Backhaul
 - ✓ Also used for DA backhaul located on distribution poles



Most wireless products for substations are point-to-multipoint.

“Last Mile” Communication Media Choices

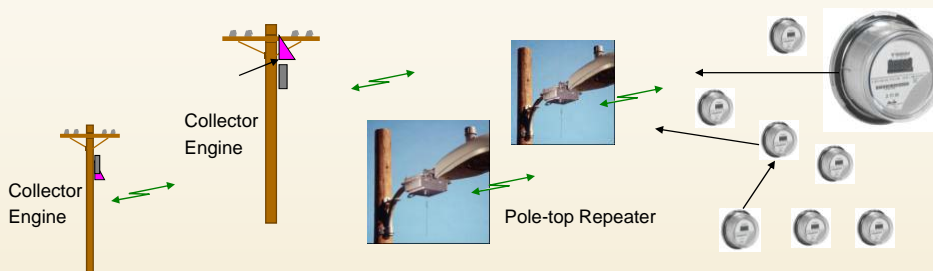
Technology	Technology
Unlicensed 900MHz Spread Spectrum	Satellite, VSAT
Unlicensed 900 ISM WiMax Point-to-Multipoint	3.65 GHz WiMax: Point-to-Multi Point
Unlicensed 900 ISM Mesh	Licensed WiMAX from Full Spectrum – Software-Defined Radio
Cellular: 2.5/3G and now 4G Cellular	(40 MHz, 220 MHz, 450 MHz, 700 MHz or 900 MHz)
Arcadian 700MHz Licensed	Licensed 150 MHz to 450 MHz 50 KHz channels and in the future 200 KHz channels
Mesh 2.4 GHz/5.8GHz, or UHF/VHF	MPLS Telco services

AMI Technology Comparison Overview

First, consider the context for the different types of AMI.

900 MHz and 2.4 GHz ISM	900 MHz Licensed	220 MHz Licensed with Hybrid 900 MHz ISM	PLC
Itron	Sensus	Tantulus	Landis & Gyr
Elster			Aclara
Landis & Gyr			Cooper/Cannon
Trilliant			

AMI Technology Alternatives – Fixed Network



Two-Way Fixed Network AMI:

As a way to expand coverage, depending on the vendor:

- meters will talk to meters
- collectors will talk to collectors (some vendors)
- both collectors and meters will talk to each other

The number of actual locations where a third-party communications take-out will be necessary will vary greatly by AMI vendor.

Sophisticated Vendor Ranking Approach for RFP Projects

Moving Forward Towards Deployment

PSE Project Methodology



Strategic Planning Approach

- Continuous interaction with project team
- Formal project management process
- Best balance between technology costs and functionality
- Address security, interoperability, and regulatory requirements
- Risk mitigation assessment
- Create the most favorable contract terms and costs
- Formal testing

Sample from RFP Analysis

Key Criteria	Criteria Wt. / Rank	Rank			
		2 A Vendor	3 B Vendor	4 C Vendor	1 D Vendor
Ease of Coverage/propagation with non -line-of-sight	17	2	1	0	3
Ease of Coverage/propagation with line-of-sight	13	3	2	0	1
Throughput and latency – (field results)	12	1	3	0	2
Critical questions score	10	1	1	2	3
Specifications score	10	3	1	1	2
Level of redundancy / self-healing of network / mesh support architecture and system design	8	2	1	0	3
Risk assessment of vendor wireless business and proposed product maturity	7	1	2	3	1
Co-existence with other wireless products	6	3	2	0	1
General ease of maintenance including mature network management software	6	1	3	2	1
Scalability potential of solution to AMI	4	1	2	3	1
Security – hardware and NMS	4	2	2	2	1
Strength of re-bid design	4	3	1	1	2
Radio split mounted w/ passive components on top of tower and active components at ground level	1	2	2	2	2
Integrated RS-232/485 port with IP encapsulation of serial data	0	3	2	1	2
Total Vendors Ranking Points		28	25	17	25
Total Vendors Weighted Ranking Points		198	173	89	199

PSE would like to thank you for your time and the opportunity to speak at this event.

Thank You.



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