DOE RFI 2010-11129
NBP RFI: Communications Requirements

Titled “Implementing the National Broadband Plan by Studying the Communications Requirements of Electric Utilities to Inform Federal Smart Grid Policy”

Submitted by Grid Net, Inc.
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Attention:
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Summary and Highlights

Thank you for the opportunity to provide comments for the Department of Energy RFI 2010-11129, our detailed responses to your questions are below for your consideration. The key points we'd like to get across in our submittal are:

1. **Regulatory and Political requirements demand broadband data transport technologies:** In our opinion the political and regulatory requirements for broader deployment of Smart Grid solutions, in particular deployment deep into the customer premises, is escalating the pressure on utility engineers to solve the problem of building robust wide area data transport networks from the generation plants to the distribution feeder and all the way to the customer premise. This massive proliferation of data, is mostly Internet Protocol (the global standard for data transport) supported data, that must often be moved in sub-second time frames. To truly be a leading industry this fact alone requires every utility to strongly endorse the building of near ubiquitous broadband IP enabled transport networks with bandwidth able to handle vast amounts of two-way data traffic over broad geographic regions for years to come.

2. **The Communication choice is critical and Vital and can only be met by broadband networks:** The communications component of any Smart Grid solution is vital and arguably the most critical link in the smart grid value chain. Therefore, it is vital utilities consider their needs not just for today, but over the next 15-20 years and beyond. . A smart grid is not just collecting metering information with Advanced Metering Infrastructures (AMI), it includes Advanced Distribution Infrastructure (ADI) designed to make secure, real-time distribution system information available to utility decision makers and system operators. Robust ADI will enable a utility to control network assets from the operations center to substations to customer locations. This ADI smart grid must support bandwidth demanding applications such as capacitor bank monitoring, switch control, outage and restoration management, Volt/VAR control, fault detection Isolation & restoration and distributed power management systems. Also, there are surely many applications we can't conceive of, yet we will want bandwidth capacity to support them too. This will require a robust, scalable, secure, low latency, high bandwidth distributed communication network. This is why we believe broadband communication networks are the only choice for enabling all the current and future AMI and ADI needs of a utility and our society.

3. **The communications choice must be as robust and broad as possible:** As a society we want the best and most long-term vision to always be considered. Thus, the backbone communications infrastructure(s) selected to support the broadest range of applications, solutions and initiatives is the only directive possible.

4. **Communications qualities must support multiple qualities only Broadband networks can**: Communication network qualities, such as QoS, device priority access, latency, security, bandwidth, and reliability (level of assurance), will become more important as the elements of the applications become more sophisticated. We anticipate rapid development and deployment of these more highly functioning applications once the physical infrastructure is deployed. Properly planning for these developments requires considering their impact on the

communication network that is chosen to deliver the data.

5. **<u>Licensed spectrum for broadband is the only choice for mission critical and other applications:</u>** Using licensed spectrum in a point-to-multipoint communications network is the right choice for Smart Grid today, and tomorrow. The services delivered over our Smart Grid deployments are just too mission critical to be supported by anything other than this type of network architecture.

Once again, thank you for the opportunity to submit our comments. We also look forward to contributing to the ongoing discussions of what may turn out to be the most important infrastructure project our country will face this century.

Sincerely,

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Responses to Questions

(1) What are the current and future communications needs of utilities, including for the deployment of new Smart Grid applications, and how are these needs being met?

Current and future communication needs of utilities' for Smart Grid applications, as well as work force automation, are being driven by the enabled intelligence of end-point devices (including electrical meters, on-the-grid routers, charging stations and more) as well as more sophisticated back-office applications. The more intelligent these devices, the more sophisticated the applications they're capable of performing, resulting in the need for a more robust communications platform that can provide reliable, secure information in a timely fashion. For example, with simple meter reads, the communication technology requirements are not complex as this application is typically non-mission critical and performed several times a day. If a meter fails to communicate, it will acquire the missed data the next time the meter is scheduled to report and pick-up where it left off. However, if the meter is expected to provide applications such as "Critical Peak Pricing" "Direct Load Control", "Time of Use", or "Outage Notification", the delivery of that information becomes more critical and time sensitive, raising the stakes for both the utility and the consumer. A missed message from the meter or the network results in less accurate data, and the potential for revenue loss, costing the rate payer and/or the utility real money. Future applications for the smart grid contemplate two-way transactions, and as these more complex applications are deployed they'll require an even more robust and secure communications network than what is needed today.

Automated Metering Infrastructure (AMI) – narrowband networks provide a limited support in the short term (next 1-3 years). Beyond simple residential AMI broadband is the only viable solution.

<u>Current Needs</u>
Mesh and other narrowband networks can deliver meter reads…BUT have limited life and are really only useful for metering. Distribution Automation and many of the DR needs (PHEV, Smart PV, etc.) are not supported for the long term with narrowband.
<u>Future Needs</u>
4G Broadband (8+mbps) is the only network solution that will deliver the capabilities over vast geographic areas where Quality of Service (QOS) is required
Automated Distribution Infrastructure (ADI) – Will only be supported by broadband networks

<u>Current Needs</u>
Fiber is supporting this today. But, because of cost is a limited solution across any significant geographic area.

<u>Future Needs</u>

4G Broadband (8+mbps) is the only network solution that will deliver the capabilities over vast geographic areas where Quality of Service (QOS) is required

Grid Net bases these comments on real world experience. Grid Net is meeting these requirements by working with both public and private carriers and Original Device Manufacturers (ODMs) in developing broadband enabled devices incorporating a multitude of broadband technologies (i.e., fiber, Ethernet, 4G wireless, etc.) Grid Net has also developed the underlying Smart Grid Operating System (PolicyNet) that will allow a utility to confidently manage their network of devices over an all IP enabled broadband network, enabling the device itself to implement decisions based on business rules or "policies" that the utility has programmed into the device using PolicyNet. These sophisticated, and often complex mission critical "policies", are distributed from the Grid Net back-office PolicyNet Network Management System over broadband networks (eg, WiMAX) to intelligent end devices for execution. With a broadband network the powerful "policies" Grid Net enables utilities to deploy require for mission critical, low latency capability. Without this broadband the decision and control or polling that is core to a utility's smart grid will not be possible. Mesh and other similar narrowband network architectures with inherent variable and problematic latency are not capable of providing this most important requirement for a true smart grid.

Finally, PolicyNet in conjunction with broadband network services can provide real-time information to a utility's large mobile workforce, allowing more responsive decision making in the field, mesh and other narrowband network technology cannot. Simply told, the multitude of applications that a communications platform is expected to support both in the present and the future demands a broadband network, any other choice is not an adequate network solution.

(2) What are the basic requirements, such as security, bandwidth, reliability, coverage, latency, and backup, for smart grid communications and electric utility communications systems in general—today and tomorrow? How do these requirements impact the utilities' communication needs?

Basic requirements for security, bandwidth, reliability, coverage, latency and backup are determined by the level of sophistication of the applications being driven over the smart grid network. The complexity of a given data transaction really dictates such basic requirements, that is, the more the application is complex, time sensitive, mission critical, and susceptible to security risks,, the more robust the network components must be. For example, a simple meter read may not necessarily be considered a high priority packet. In contrast, an outage notification data packet needs a Quality of Service (QoS) marker to be attached to it to ensure that it gets through despite any interference from other network traffic. Clearly, as the functionality of the end point devices evolve, more advanced applications will be deployed on the devices, requiring not only more bandwidth, but also higher degrees of security, lower latency, and networks that can provide QoS.

Below is a table that matches network elements to specific requirements for smart grid communications.

Network Element	Requirement	Today's Requirement	Tomorrow's Requirement
Bandwidth	Minimum wireless requirements of 3 mbps download and 1 mbps upload	AMI – Low to Med ADI - Med	AMI – Med to High ADI – Med to High
Security	In addition to network security elements, additional packet encryption should be utilized without impacting network performance (i.e. other network elements)	AMI - High ADI - High	AMI – Extra High ADI – Extra High
Reliability	99.9+ to the end device, 99.99+ network availability	AMI – Med ADI - High	AMI – Med to High ADI – High
Coverage	With a public network, must match as utility's service area as much as possible, may require use of multiple network technologies	AMI – Broad (area) coverage ADI – Broad (area) coverage	AMI – Deep (capacity) coverage ADI – Deep (capacity) coverage
Latency	sub 100 ms round trip packet (rtp)	AMI – Med to High ADI – Low – Med	AMI – Low to Med ADI – Low to Med
Backup	In case primary power is cut-off network access points must have access to auxiliary power and be able to operate at the expected service levels for several hours/days	AMI – Med BU requirements ADI – High BU requirements	AMI – High BU requirements ADI – High BU requirements

(3) What are other additional considerations (e.g. terrain, foliage, customer density and size of service territory)?

Designing and deploying a highly reliable wireless network is a complex process. The physics of wireless alone demand attention and experience to properly evaluate and take into consideration all the environmental, geographic, and demographic variables that impact network design and costs. Terrain and foliage certainly impact propagation of wireless signals, but the impact differs based on the wireless band deployed. At lower bands (i.e., 700 MHz), the geographic influences are minimized because the signal propagates farther and penetrates better than with higher frequencies (i.e., 2.3 GHz, 2.5 GHz, 3.65 GHz). This suggests an advantage of lower bands over higher bands, as fewer sites need to be built and deployed to cover a designated service area, saving costs.

However, there is a trade-off for using lower frequencies, namely, reduced bandwidth, which means less capacity. To match the capacities of higher frequency bands, a more dense build (i.e., more sites), particularly in high density population areas, can help to compensate for the compromised bandwidth of lower frequencies, but more sites add cost to a low band network. Balancing such design and cost decisions becomes even more of a factor when the functionality of the wireless network expands beyond a simple machine-to-machine capability to include commercial and/or private (i.e., mobile workforce) broadband features.

Serious consideration must be given to enabling additional new and various financing or funding vehicles to utilities and operators providing service in regions that are remote enough that customer density causes the cost of deploying wireless broadband networks to be prohibitive. We see this frequently in sparsely populated areas like Vermont, Northern California, Upper state New York, Wyoming, Utah, the Carolinas, New Mexico and many many other lightly populated regions of our country.

Also, consideration should be given for more towers and pole access. In many parts of the country foliage and terrain characteristics create needs for radio antenna heights to be above the canopy. The cost difference of being above rather than below is magnitudes different. Special provisions and help to ease the building of additional towers and for extending poles to optimal heights (above the foliage canopy) would be welcomed by both utilities and the network providers alike.

(4) What are the use cases for various smart grid applications and other communications needs?

Use cases for smart grid applications range well beyond automated meter infrastructure (AMI) reading, to include distributed control systems (DCS), EMS/SCADA, distribution automation (DA), substation automation (SA), demand response (DR), and the emerging class of distributed energy resources (DER), which includes distributed generation (DG) – most notably rooftop solar photo voltaic systems (PV) - plug in hybrid vehicles (PEV) and utility-scale energy storage (USES) and community energy storage (CES), as described in the table below.

Distributed Automation (DA)

Distributed Automation Routers		**Latency**	**Security**	**Bandwidth**	**Level of Assurance**
Capacitor Bank Open/Close	Manual control of capacitor	Med	High	Low	High
Capacitor Bank Open/Close	Automated control of capacitor	Low	High	Low	High
Re-closure communications	Grid device to grid device	Low	Med	Med	Low
Re-closure control and feedback display	Automated control of reclosure	Med	High	Low	High
Sectionalizer	Grid device to grid device	Low	Low	Med	Low
Sectionalizer control and feedback display	Automated control from utility NOC	Med	Low	High	High
Monitoring device	Grid device to grid device	Low	Low	Med	Low
Monitoring device	Automated control from utility NOC	Med	Low	High	High
Voltage and current monitor	Grid device to grid device	Low	Low	Med	Low
Voltage and current monitor	Automated control from utility NOC	Med	Low	High	High

Transformer monitor Alarm	Transformer temp element	High	High	Low	High
Transformer monitor Alarm	Transformer voltage sensing element	High	High	Low	High
Transformer monitor Alarm	Transformer open sensing element	High	High	Low	High
Transformer monitor Alarm		High	High	Low	High

Automated Meter Infrastructure (AMI)

Use Case	**Description**	**Communications Needs**			
Meters		**Latency**	**Security**	**Bandwidth**	**Level of Assurance**
Automatic Meter Reading	Interval meter reads	High	Low	Low	Low
Connect/Disconnect	Provision new service, disconnect service	Med	High	Low	High
Demand Response	Time of use pricing	High	High	Low	High
Outage Detection	Report of outages	Low	Med-High	Low	High

Demand Response (DR)

Demand Response Routers		**Latency**	**Security**	**Bandwidth**	**Level of Assurance**
Smart Thermostats	Automated control of on/off to support a predetermined load curtailment algorithm	Low	High	Low-Med	High

Home Energy Management System (HEMS)	Remote control of HEMS to automate residential energy consumption based on predetermined settings, environmental stimuli, and utility feedback	Low	High	Low-Med	High

Distributed Generation (DG)

Distributed Generation Routers		**Latency**	**Security**	**Bandwidth**	**Level of Assurance**
Rooftop Solar PV system	Automated disconnect of PV device from the distribution feeder	Low	Med	Low	High
Rooftop Solar PV system	Automated redirection of power output from the premises to the distribution grid	Low	High	Med	High
Rooftop Solar PV system	Remote management by utility in a high penetration PV scenario virtual power plant mode	Low	High	High	High
Rooftop Solar PV system	Remote management by utility in a virtual power plant mode	Low	High	High	High

Plug In Hybrid Electric Vehicle (PEV)

Plug In Hybrid Electric Vehicle Routers		**Latency**	**Security**	**Bandwidth**	**Level of Assurance**
PEV (vehicle)	Remote management of charging account settlement at a public charging station	Low-Med	High	Low-Med	High
PEV (vehicle)	Automatic discharge of PEV stored energy in a peak demand scenario	Med	High	Med	High
PEV (charging station)	Disablement of charging station functionality in a distribution feeder overload scenario	Low	High	Med-High	High
PEV (charging station)	Economic signal to a charging station to control rate of charge and charging schedule	Low	High	Med	High

Utility-Scale Energy Storage (USES) and Community Energy Storage (CES)

Utility Scale Energy Storage Routers		**Latency**	**Security**	**Bandwidth**	**Level of Assurance**
USES dispatch	Utility dispatch of USES units collocated in distribution substations for voltage regulation	Low	High	High	High
USES management	Utility management of USES units for Ancillary Services	Low	High	High	High
Community Energy Storage Routers					
CES dispatch	Utility dispatch of stored energy in CES units	Low	High	High	High
CES management	Utility management of CES units for charge and discharge	Low	High	High	High

(5) What are the technology options for smart grid and other utility communications?

Utility technology options for smart grid and utility communications can be thought of on several dimensions, including:

- **Network topology:** RF mesh or point-to-multipoint broadband;
- **Spectrum:** licensed or unlicensed spectrum;
- **Ownership:** private or public networks; and
- **Operations:** outsourced or in-house network operations and maintenance, managed or in-house services.
- **Security:** The only real security consideration is a serious cradle-to-grave combined with end-to-end security, which only a well architected embedded solution along with a broadband architected network can offer.

  Mesh and the narrowband multi-hop networks present nearly unlimited entry points for hackers and a multitude of paths for malware and other various software bugs to travel.

  Using unlicensed spectrum (900mhz for example) poses many security issues if not capacity issues (that could be disguised by a malware, DOS or other security attack). We believe it is in the best interest of our utility infrastructure to leverage much of the security built into the public carrier infrastructure and add additional capabilities where and when needed. To build any smart grid option on unlicensed frequency seems to be short sided if not irresponsible given the risks and capabilities of sophisticated hackers out there in the world.

Historically, the primary decision a utility faced was whether to "buy" network access on a public network or "build" their own private network to address utility specific needs. While these two options remain viable in today's technology environment, a middle way has emerged, where a partnership or joint venture between a utility and one or more public network providers who may be seeking alternatives to build-out their next generation wireless footprint, which provides a win-win, with the network providers providing the services required for smart grid and enterprise field force automation and the utility reducing network build-out costs by providing pole and tower access, rights-of-way, etc.

The communication technology choice depends upon the present and future requirements of the utility. While RF mesh may initially be appealing as it represents lower cost of entry for an AMI solution, as the utility deploys more complex, real-time reliant applications as described in the Use Case section above, , security, latency, and reliability come into consideration as well. Utilizing unlicensed spectrum for mission-critical utility functions represents risk beyond the capability to support additional applications. The network signal must be shared with the several other FCC approved devices which may operate in the same frequency, raising the question of availability. The non-real time nature of mesh networks precludes using the network for applications that require real-time capability. And finally, there are inherent security challenges associated with "open" spectrum.

Utilities must also consider whether they want to incur the cost and overhead associated with operating and maintaining a mission critical smart grid network, or rely upon outsourced expertise to do so. The nature of smart grid makes the information generated by these networks more crucial in the day-to-day, minute-by-minute decision making expected from utilities. The volume of data generated, and the multitude of decision points that will naturally follow with the improved intelligence of the grid should not be overlooked. The reliability of the communications component of the smart grid solution, as well as the focus and competency of those responsible for its performance, should weigh heavily in the decision to go forth with either an "outsource" or "in-house" decision.

Finally, in this era of managed services, utilities should consider leveraging the vast infrastructure of public carriers to host the solutions-based applications that allow a utility to administer the multitude of devices that will be associated with their smart grid. Just as "cloud computing" is gaining acceptance across a broad range of traditional back-office applications, management software for smart grid can be expected to follow a similar trend line. With managed services, responsibility for reliability and access to real-time information is transferred to massive network providers, who have considerable experience and resources to bring to bear. Instead of localizing a mission critical application, a utility can virtualize the application, and by the nature of that approach, make the process more secure and accessible.

(6) What are the recommendations for meeting current and future utility requirements, based on each use case, the technology options that are available, and other considerations?
Current communications technology options include wireless and wire line (including power line), licensed or unlicensed spectrum, narrowband or broadband, RF mesh or point-to-multipoint, etc. While each use case has communication technology options that provide the capability to execute the task at hand, it is clear that applications are becoming more sophisticated as more intelligence is added to the edge of the grid, so that technology decisions should include future needs as well as current needs. Clearly, as applications become more advanced, network requirements will move in synch, demanding more flexible, scalable communication platforms to meet the growing need for reliability in data acquisition and distribution.

While a low-cost network may provide for low risk data acquisition, as the value (and the volume) of the data increases, the concern for real-time access, security, reliability, and QoS becomes increasingly important. Each of these elements, rapidly evolving to become *requirements*, is found in the more sophisticated point-to-multipoint communication architectures. In contrast, an RF mesh design that utilizes unlicensed spectrum is unable to meet these emerging requirements because its architecture is fundamentally incapable.

Our recommendations for meeting current and future utility requirements are:

- IP Based Technology: IP based architecture assumes that the network infrastructure may be unreliable at any given network element or transmission medium, and that link and node availability is dynamic. In order to reduce network complexity, intelligence in the network is placed in the end nodes of each data transmission, whether it be meters at the home, or smart grid routers placed on the transmission lines. IP technology has to be the technology of choice for smart grid implementation.

- Broadband Communications: The characteristics of a broadband network are multi-media, multi-point, and multi-rate and provide a cost efficient implementation which provides multi-services. Only broadband networks can deliver quality services over the extended life of smart grid projects.

- Open Standards: The principles of "Open Standards" provide availability for all, no discrimination, rather an open and clear path for all who wish to abide by the standard. This in turn offers those who subscribe to the standard a maximum choice for devices and vendors, at competitive pricing as there are limited royalties or fees associated with implementing the standard. These principles protect the investment and the investor(s) by providing a competitive environment for best-of-breed devices, software, and services.

- Working with existing infrastructure and service providers to maximize ROI: The 4G wireless broadband networks being built today offer a unique opportunity for inventive and strategic partnerships between carriers and utilities. By working together, utilities and public carriers can not only improve the return on their respective investment, but they can also maximize the return to the rate base/tax payer, and cooperatively address co-related issues of National Policy, such as access to Broadband services for unserved and underserved communities.

- Specific wireless pricing plans for utility applications: For their part, public carriers must recognize and address the economic operating realities that utilities face, in particular, how fixed cost investment differs from operating expense. Fundamentally, the issue to be solved on the financial side of the communication equation. is the principle of how the cost of using a public network is almost always treated as an operations expense by the utility. However, the build your own cost for a custom network is capitalized and depreciated. Most ISO's in the US have the real potential to earn a "regulated rate of return on capital expenses". This regulated rate of return is a powerful incentive to build their own. If the DOE could help influence specific rules that treat operator networks as near immediate depreciated assets, some of the real monetary incentive to build their own would diminish.

(7) To what extent can existing commercial networks satisfy the utilities' communications needs?

Today's existing 3G commercial wireless networks provide for only a limited set of a utility's needs, but the next generation wireless technology, referred to as 4G, can effectively deliver the more complete utility solution. By incorporating a number of technological advantages, the next generation 4G wireless networks can integrate in the design of the smart grid solution the capacities, costs, QoS, security, reliability, and latency that will be required in smart grids going forward. The 4G networks of today and tomorrow are engineered from the ground up as data networks, unlike 3G networks that added data capabilities to architectures originally designed for supporting voice services. Such inherent architectural constraints lead to capacity, latency, and cost issues for 3G networks, making it virtually impossible for them to provide the point-to-multipoint functionality required by today's more complex smart grid solutions.

Now is an opportune time for collaboration between utilities and commercial network providers to design the smart grid networks that will be sustainable to meet both present and future utility requirements. The next generation wireless networks truly represent a technological leap from past networking technologies and topologies; they require new equipment and are IP packet-based throughout the entire architecture. This robust design provides the functionality demanded by the smart grid, while still being cost efficient in service delivery. Further, a strategic approach to two national priorities - smart grid and universal broadband access - suggests a synergy that will lead to the development of creative relationships between utilities and commercial wireless providers. Smart grid is natural as an anchor application for a broadband access project. Combined with mobile work force automation as an additional anchor, such an approach could spur next generation broadband wireless projects in underserved markets much sooner than may otherwise be possible based on carrier's commercial access business drivers.

(8) What, if any, improvements to the commercial networks can be made to satisfy the utilities' communications needs?

As providers of mission critical services for their customers, utilities are familiar with service models that provide "five 9's" of availability. Similarly, commercial wireless carriers operate with the expectation of providing highly available service for their customers. Quite often, in fact, when landline telephony services experience an outage, their wireless brethren remain operational. By design, wireless networks, and 4G networks in particular, have many fail-safe features that allow them to continue operations in the event of power failure or catastrophe, e.g., battery and generator backup at cell sites, self-healing backhaul, etc.

Despite such innovations in network design, wireless carriers still have room to "harden" their physical assets to provide the type of service availability preferred by utilities. As commercial operators, wireless providers must balance the demands of their customers for high quality service levels with the market's economic realities of, in this instance, answering the question of who should bear the economic costs of providing that last "9" of availability. A partnership with a utility may well provide the answer to that question going forward.

Aside from having a network designed for high availability, 4G wireless is technologically capable of meeting most utility expectations. All IP-based architecture provides a "flat" network design, (using far less equipment than legacy wireless architectures), which greatly improves reliability, security, and performance, including latency. Data packet QoS is also available, enabling the network to provide utilities with data priority over non-mission critical transactions. Beyond *data* priority, *device* priority assures that mission critical devices gain priority access to the network in the event of an emergency or disaster.

Finally, a key benefit of a public network for a utility is that public networks inherently seek to provide the "latest and greatest" in technology to remain competitive and relevant. As discussed in this response, the definition of the term "Smart Grid" is a moving target. As advancements are made on the hardware and software fronts, the expected functionality of the smart grid will continue to grow exponentially, placing unpredictable demands on the communications network. Utilities who have built their own networks will be faced with ongoing additional investment decisions to keep their network functionality current with rising demands. They will either have to upgrade their network to accommodate new smart grid functionality, or forego investments and work within the constraints of current network capabilities and capacities. And finally, additional capital investments in a utility-owned network will require regulatory approvals as rate-based assets, adding an additional ongoing political hurdle and risk.

(9) As the Smart Grid grows and expands, how do the electric utilities foresee their communications requirements as growing and adapting along with the expansion of Smart Grid applications?

Utilities typically use a 15-20 year business model to justify their investments in a capital project like a smart grid. Considering the evolution of technology over the past 15-20 years, the planning challenge becomes mind boggling with such a horizon. Back in 1990, the internet was a network used almost exclusively by academics, cell phones were expensive analog devices, and Wi Fi and WiMAX were unheard of. Today, it is difficult or impossible to imagine life without the ability to make a phone call or go on-line wherever one is, at home, in the office, in a coffee shop, in an airport or while mobile. While we can't know with certainty what the next 15-20 years will bring, it is only prudent to design a network to support a smart grid today that will be scalable and that will offer upgrade compatibility, so that it is capable of meeting the more complex and demanding requirements of the smart grid as it evolves over that period. Thinking of smart grid communication solutions based on the relatively low bar of addressing the simplistic, minimal application requirements of today won't do. A smart grid communications platform must provide for an expected growth in bandwidth, increasing demands for tighter security, and the flexibility to accommodate new, unplanned purposes. Choosing any communication solution that lacks those minimum features is not only fiscally irresponsible; given that it will be the rate-payer who ends up footing the costs of such a decision, a utility and its regulators are bound to be challenged for that choice, making it politically risky as well.

Beyond envisioning the smart grid as a means to achieve operational and financial efficiency and improved service levels, utilities are looking at advanced communications technology to improve mobile workforce productivity. A broadband solution used to support smart grid functionality can pull double duty by supporting robust field communications, supplying circuit layouts to work crews and improving their ability to service their rate base with real-time diagnostics on grid performance. The ability to anticipate issues and resolve them before they become a service problem is transformative. Becoming proactive and moving away from a historically reactive role may prove to be one of the most significant benefits that utilities derive from new communication technology.

Additional Comments

A few key elements that any interconnecting system – including the Smart Grid – must have are:

1. **Adaptability -** no single communication medium alone is feasible
2. **Longevity -** assume devices (meters, routers, switches, synchrophasors, substations, transformers, etc.) will be required to last for decades
3. **Consumer friendliness** ("plug and play") – functions must be readily transparent to the user
4. **Robust security -** privacy protections and strong authentication must be built into the fabric of the system
5. **Feedback** - develop systems that provide robust feedback capabilities

These elements MUST be pillars or cornerstones of any technology coming into the world of power grids and communications.