Comments of the
Bonneville Power Administration

On May 11, the Department of Energy (DOE) issued a Request for Information (RFI) (NBP RFI: Communications Requirements) seeking comments and information from interested parties to assist DOE in understanding the communications requirement of utilities, including, but not limited to, the requirements of the Smart Grid. The RFI also seeks to collect information about electricity infrastructure's current and projected communications requirements, as well as the types of networks and communications services that may be used for grid modernization, including specifically information on what types of communications capabilities utilities think that they will need and what type of communications capabilities the communications carriers think that they can provide.

The Bonneville Power Administration (BPA) appreciates the DOE's thoughtful and detailed focus on these continuing critically important operational communications requirements, which are fundamental to the continued high operational reliability of BPA's telecommunications system, and of the Federal Columbia River Power System (FCRPS).

BPA is a self-financed Federal Power Marketing Administration (PMA) which is organizationally located as a separate and distinct entity within the DOE and is established to market wholesale electric power from the Federal hydroelectric projects in the Pacific Northwest Region. BPA currently markets power from 31 Federal hydro projects and one nuclear plant and operates over 15,000 miles of high-voltage transmission, or approximately 80% of the high-voltage transmission lines in the region. BPA provides transmission on an open-access basis. BPA's service territory covers Washington, Oregon, Idaho, western Montana, and portions of California, Nevada, Utah and Wyoming. BPA's wholesale power customers include public utilities, public utility districts, municipalities, public cooperatives, investor-owned utilities, and a few large industrial customers.

BPA’s operational telecommunications are used for the control, protection, monitoring, operation, dispatch, construction, and maintenance of the power transmission system and ensure its safe, reliable, and efficient operation during normal and emergency power system conditions. Successful operation and coordination of this highly complex power transmission system is only possible through a dedicated, highly reliable, BPA owned, operated and maintained telecommunications system.

BPA appreciates the opportunity to provide comments and information and submits the following comments in response to the DOE RFI.

DOE Request for Information Questions and Responses

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?**

   The Bonneville Power Administration is different from many other utilities in that BPA does not have access to residential or typical business customers. For this reason, both BPA's current communications needs and those associated with Smart Grid efforts are different than those of other utilities. Many utilities are preparing to offer price points to residential and business customers to shape their energy usage habits. This requires installing smart meters with automatic reading, encouraging smart appliances and outlets, and providing two way communications to each point of delivery to monitor and control these devices. Without residential and business customers, this is not a significant effort for BPA. In addition, many utilities are preparing to deploy charging stations for electric vehicles. Since BPA's transmission system operates at a much higher voltage than a distribution utility, rarely dropping below 115 kV, charging stations are not practical to provide.

   What BPA is planning to do is deploy technology to closely monitor the high voltage power system to provide accurate, frequent information about the health and stability of the bulk electric system that it owns and operates, as well as the adjoining bulk electrical systems where they connect to the BPA grid. In addition, BPA currently controls the distributed generation connected to its power grid, tracks the output of the more volatile wind, solar, and other generation, and limits the output when necessary to keep the power grid stable. To do this, BPA uses a combination of analog microwave radio, asynchronous digital microwave radio, SONET systems (both fiber and radio) and a VHF mobile radio system for communicating during emergency restoration and normal maintenance and operation of the transmission lines. One of BPA's high priorities is to replace the remainder of its obsolete analog microwave radios with either SONET or digital radios to enable the BPA to implement new technologies for Smart Grid and other applications throughout BPA's service area. We are currently evaluating the use of a ringed Ethernet system, but with deterministic latency and delay characteristics to set Quality of Service (QoS) for each application. Currently we carry SCADA (Supervisory Control and Data Acquisition), line protection, telemetry, voice channels, and data networks on BPA-owned, maintained and operated communications systems. For Smart Grid applications, we are currently using the SONET system to carry Distributed Generation (DG) controls to manage the volatile wind and solar generation sites.

Efforts are underway to expand BPA's Phasor Measurement Unit (PMU) usage through the Synchrophasor project. The Synchrophasor project is a five-year effort to expand BPA's leadership role in the development of a high voltage transmission system Wide Area Measurement technology. Working with the Western Electricity Coordinating Council (WECC) and eight other partner utilities, the goal is to develop a more reliable power system using the advantages of PMUs, which sample the state of the grid at multiple sites up to 60 times a second. This allows automated, quick reactions to disturbances, and produces a long list of benefits to BPA, including the integration of renewable and intermittent resources (particularly wind generation), automating controls for transmission and demand response, increasing transmission system throughput, and improving system modeling and planning.

We see good potential for use of the modified Ethernet system for data and Situational Awareness (SA) PMU systems, but we have no current plans to use this system for BPA protection systems or controls. Bonneville's initial implementation plans for the Smart Grid applications are to carry these SA applications on the BPA SONET system. We expect to migrate these situational awareness PMU applications to a deterministic Ethernet system within the next 3 years.

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' communications needs?**

The answer to this question will be divided between current and future requirements.

Current Requirements:

Coverage- BPA owns, operates and maintains VHF coverage for all of its high voltage transmission lines. This is both a safety issue and restoration time issue. BPA's coverage area includes virtually all of Oregon, Washington, Idaho, Northern California and Western Montana. Other BPA owned communications systems cover approximately 95% of BPA facilities (substations, maintenance headquarters, and control centers), including critical infrastructure sites. The Synchrophasor project for BPA's Smart Grid effort will include PMU installations at many substation sites. In addition, the distributed generation controls for wind and other generation sites are creating new locations where the BPA must install communications equipment and tie it back to existing Bonneville communications systems. A very small number of BPA facilities, where the bulk electrical system above 115kV is not adversely impacted, are connected by commercially leased lines or circuits carried on other utilities' private communication systems. These include a small number of very low capacity generation sites or lower voltage (115 kV or 69 kV) substations.

Reliability-Many utilities have small capacity, “last mile” requirements for residential and typical business meter reading and price point feedback. These applications might be carried by unlicensed radio and do not have to be in service at all times. If information is not available for a few seconds, there are no detrimental impacts and the signals are resent. BPA has very few of these types of circuits, mainly consisting of low system impact substation SCADA applications at a few less critical locations. Many of our applications are automatic control systems requiring a physical presence of a Substation Operator at the substation or a significant reduction in electrical power transported if the communications systems fail or become non-redundant.

BPA’s reliability is applied circuit by circuit depending upon the service class dictated by the impact to the bulk electrical system BPA’s highest service class requires a circuit availability of 99.93% and a functional availability of 99.98%, end-to-end with both independent circuits in parallel. This applies to the majority of BPA-owned communications systems, including BPA’s distributed generation controls and PMU installations for the Smart Grid effort. For special protection systems, these figures must be calculated according to a WECC methodology that considers the failure rate of all pieces of telecommunication equipment, on a worst-case basis, through which the circuits will be routed. To achieve this, BPA’s most critical microwave paths must meet a one-way availability of 99.99995% which equates to only being out of service for 16 seconds a year. This is often accomplished with the use of frequency-diversity microwave radios. To assure the continued and required very high operational reliability of such operational telecommunications, such physical assets are owned, controlled, maintained and operated by BPA.

Backup- The backup power required at each site is tied to BPA’s reliability and availability requirements, since if the charger / battery plant is out of service, the communications system is out as well. All of BPA’s telecommunication facilities are equipped with a minimum of 8 hour battery backup. Bonneville’s more remote sites have up to 48 hours of battery backup. All telecommunications facilities without two independent AC power sources also have engine generators with fuel tanks that can carry the station load for 21 days. This is required due to the rough terrain and high elevations through which we must route Bonneville radio systems in order to connect BPA substations to each other and to each of BPA’s redundant control centers. Many radio sites are only accessible by snowcat for nine months of the year, so they must be able to run unattended for extended periods of time. While some utilities can meet their requirements with portable, plug-in type emergency generators, that is not practical with BPA’s site accessibility issues.

Latency- Distribution utilities often have a significant amount of time to take corrective actions when an outage or failure on their power system occurs. At voltage levels below 100 kV, there is often time for a power dispatcher to switch a line or other piece of power system equipment out of service before additional damage or outages occur. This is not the case with BPA's transmission system. It consists mainly of 500kV, 230 kV, and 115 kV power lines and substations. The majority of BPA's transmission system is above 100kV and is classed as a "bulk electrical system", with special operating requirements. As such, WECC allows 16.6 ms (1 cycle at 60 Hz) for the communications portion of critical protective relaying circuits to travel from the relay at one station to the relay at another station. This time includes the communication transport system and any equipment between the relays such as transfer trip devices that remotely open the opposite end of high voltage transmission lines. Virtually all of BPA's high voltage substations have at least one if not many transfer trip circuits. Therefore, for almost all substations, latency is critical for at least some of the circuits. In addition, BPA has implemented a large number of Remedial Action Schemes (RAS), also know as Special Protection Schemes (SPS). These schemes are present at nearly all of BPA's critical stations and control large generation sites and regional interties to other transmission operators. Prior to placing a special protection system in service, the utility must certify that the circuit delay is within the WECC requirements. To do this, the worst case timing for the communications route must fall within the latency / delay requirements determined by electrical system studies. If we cannot provide the required latency for the communications circuits, we cannot place the SPS in service. This can result in a requirement to build a new transmission line costing millions of dollars, or a more direct communication transport system to reduce the latency, or not being able to integrate a generation source into the BPA system.

Security- Much of BPA's transmission system is classed as "critical infrastructure" and as such, is subject to additional security requirements beyond that which would apply to a distribution utility. In addition, communication security requirements are presently being revised. The NERC/CIP standards will be upgrading the near-term security requirements that BPA must follow. Currently all operational facilities are physically secure and alarmed. In addition, critical facilities have card readers and video cameras. We expect all operational traffic will soon be required to be encrypted. All operational traffic over commercial carriers, although this is a very small number of circuits as previously stated, is currently brought in through firewalls and is processed in a "de-militarized zone" to check for harmful viruses and other cyber threats. A significant portion of the effort to increase the security of BPA's electrical system has been to remove outside connections to BPA's operational communications system. All "dial-up" connections from the public network to relays and other controls for the power system have been disconnected to prevent outside interference with the power system controls.

Bandwidth- While other utilities have "last mile" traffic requirements, including pulling in smart meter information and sending control signals, BPA does not have these distribution tailored requirements. Bonneville's requirements basically begin with an "aggregator" type at each substation and then move to "backhaul" and "core" requirements as we approach BPA's control centers and link main substations. BPA's bandwidth requirements vary widely. Some small remote substations only require 12 channel, voice grade, systems, while major substations have requirements up to 60 DS1's. BPA's two control centers require considerably more DS1 circuits. Most individual quantities only require a DS0 bandwidth, but they are aggregated on BPA's digital systems into multiple DS1 circuits for transport. Some applications, like PMUs, require a 128 kbps circuit, which is larger than a single DS0. Some substations require direct fiber connections to other substations for direct fiber relaying, when the transmission lines are less than 10 miles in length. Often circuits require the bandwidth to be split over two geographically diverse routes, with no credible single points of failure between the two systems, to meet WECC requirements.

<u>Future Requirements:</u>

Coverage- BPA's use of VHF radios, as noted above, is not expected to change in the future, regardless of any Smart Grid applications. The technology and frequency licensing associated with mobile radio is changing, however. With the future bandwidth for VHF being reduced to 6.25 kHz we expect an increase in the number of VHF sites and number of frequencies required. BPA will continue to require dedicated radio spectrum free from interference to be able to operate, maintain, and restore the bulk electrical system in Bonneville's service area. If radio spectrum is not available through NTIA, BPA's ability to safely and reliably perform these functions in many areas will be compromised.

Reliability- The Smart Grid applications that BPA is participating in now and has identified for the future do not significantly impact our reliability requirements. Much of BPA's telecommunications traffic is already at the highest reliability/availability level specified by WECC, so it will not be impacted unless WECC requirements change. The aspect that might change is an increase in the number of locations that would require this high availability due to large generation projects that must be integrated into the BPA power system. As this occurs, BPA needs to be able to expand and upgrade those portions of the communications systems that now require the higher level of availability to be able to control the large generators. No other changes are expected beyond an increased likelihood of stronger enforcement of the existing requirements.

Backup- The requirements for backup power are not expected to change. The required battery capacities and emergency generator capacities are, however, expected to increase with the addition of a new packet network, mainly due to the power consumption of these devices. In fact, any change from obsolete analog radios to digital radios comes with increased power consumption by the new equipment. To implement the Smart Grid applications on the BPA power system, the analog radios must be replaced with digital radio or a fiber optic system to be able to carry the signals for the Synchrophasor project. Existing small capacity digital microwave systems may need to be expanded to be able to carry the additional traffic. This could trigger the battery and charger capacity increases noted above.

Latency- BPA does not expect future requirements to change. BPA's communication systems are already designed with latency as a high priority. BPA is investigating actions to reduce the physical size, and thus latency, associated with fiber optic rings between 500kV substation and the two control centers. Due to the increased number of generation sites added to the existing fiber rings, the latency of BPA's larger rings are approaching the limit of the WECC requirements for delay. Carefully determined routing of traffic will be especially important in the coming years to keep BPA within the applicable delay requirements.   Smart Grid traffic will fall under this requirement as well.

Security- Beyond Bonneville's current requirements noted above, BPA expects tighter and tighter requirements and enforcement. We expect all operational facilities to require card readers and video cameras. All operational traffic may require encryption and all operational traffic from outside utilities may be brought in through firewalls and a DMZ.   BPA needs to be able to securely transmit all WECC situational awareness data to and from WECC through secure VPN tunnels under the Synchrophaser project.

Bandwidth- As noted in the current requirements, BPA's bandwidth requirements vary widely. However, we only expect the required bandwidth to grow in the future. Small remote substations may still only require a single DS1, while major substations are expected to grow to requiring over 100 DS1's. BPA's two control centers are each expected to require considerably more than 100 DS1 circuits in the future. Most individual circuits riding in the DS1s may still only require a DS0 bandwidth, however. The PMU application is moving toward requiring 256 kbps or more per circuit. Critical circuits will still require the bandwidth to be split over two geographically diverse routes, with no credible single points of failure between the two systems, to meet WECC requirements. As mentioned under Future Requirements – Security, it is expected that bandwidth intensive video cameras will be required at all operational facilities. These increased bandwidth requirements can only be partially met with fiber optic systems. BPA will need even more point to point high capacity, multi-155 Mbps licenses in the 4 and 8 GHz government bands to have the ability to reach more isolated substation with PMUs and distributed generation applications.

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

Most of the large cities are covered by IOUs and smaller cities by PUDs. BPA is a bulk transporter of power serving other utilities and a few direct industrial customers. With a few exceptions, BPA does not serve residential or business customers. Therefore BPA doesn't provide distribution services and so isn't involved in the wireless distribution discussion. A small number of BPA substations are typically located on the edge of cities but the remainder of the substations are located primarily in remote locations near the generation sites or customer connection points with 50 to 60 miles between them. Therefore, BPA fiber or licensed microwave radio communications systems are typically remote and traverse remote areas. Bonneville communications systems not only follow rivers but also cross mountain ranges to close SONET rings. Often there is no cell phone coverage on BPA transmission right-of-ways or at BPA substations or radio stations due to the remote nature of the site. In many rural locations, gun shot and winter icing are prime concerns for BPA's fiber optic telecommunications system, causing BPA crews to be called to perform emergency restoration in very rough terrain.

One of our primary concerns is the loss of federal spectrum. With the loss of the 2 GHz band, BPA is having difficulty finding useable frequencies within Federal government bands. Further losses with the next 500 MHz could be crippling. In addition, we are also investigating forming smaller rings to limit latency for critical protection circuits. On method under discussion is bi-secting larger fiber optic rings with radios, which would require additional radio spectrum in the 4 GHz or 8 GHz government frequency bands.

4. **What are the use cases for various Smart Grid applications and other communications needs**?

As noted in question #1, BPA does not have residential or typical business customers, but rather serves other utilities and municipalities with wholesale power. Due to this, several Smart Grid applications do not apply to BPA, including electric vehicle charging stations, consumer price-point applications, smart appliances, and distribution asset management. BPA is, however, planning to use PMUs extensively for power system dynamic modeling and monitoring. Future plans will add power system control and transient stability applications via the PMUs. Significant sections of BPA's communications systems are still analog radios. These areas will need to be upgraded to digital before PMUs can be used. BPA is also starting to add DG (Distributed Generation) controls for wind and solar projects. Again these controls require digital communications systems. Where solar and wind sites are installed, SONET or other digital communications systems are being installed. Currently we carry SCADA, line protective relaying, telemetry, voice channels, and data networks on BPA-owned communications systems. As this terminal equipment is replaced, it is being upgraded to modern digital equipment where we can carry the digital traffic.

Other Smart grid applications like HAN (Home Area Networks) and demand response have little interest to BPA as we don't have residential customers.

5 What are the technology options for Smart Grid and other utility communications?

For utilities participating in automated meter applications and consumer price point / smart appliance applications, licensed or unlicensed radio in bands below 2 Ghz are likely to be used for "last mile" applications near the end user devices. Satellite or cell phones may also be used for some applications. Beyond the "last mile" applications toward data centers and aggregation sites, this and other information is likely to be carried via licensed radio, fiber optics, or leased line, depending upon the reliability, latency, and data rate required for the applications, as well as the terrain and distance involved.

BPA is actively moving away from analog technology and moving toward exclusively digital communications. Efforts are currently underway to resolve how to provide digital connectivity and capacity where digital communications do not exist on the BPA system. Current communications will be SONET, but we are testing the future use of deterministic Ethernet rings where latency can be controlled with initial circuit provisioning for primary and alternate routes. BPA's first choice of technologies will be BPA-owned SONET rings, which are a combination of licensed 4 GHz and 8 GHz microwave radios and fiber optics. BPA's second choice will be to use Federal licensed, linear non-SONET digital radios within the same frequency bands. The third choice for BPA will be other utilities' FCC licensed private digital systems, especially for utilities following the same WECC requirements as BPA. In rare cases, we are considering using commercially leased lines but only for data collection where latency, utility control and reliability are not critical. BPA is currently investigating MPLS and PBB-TE (both deterministic Ethernet) protocols to use for equipment requiring packet technologies.

As noted in the previous question, often cell phone coverage is not available where BPA crews are working. For this reason, BPA relies on its private mobile radio system to allow high voltage line crews to talk to each other, the power dispatchers, and to call for help in an emergency. As an example of this, two line crews were working on a fiber optic cable restoration in the winter in very rough, mountainous terrain. There is no cell coverage in the area, and BPA's mobile radio was out of service due to a radio outage nearby. When one crew member sustained a knee injury, both crews had to leave the area without completing the restoration because it is not safe to have a crew alone without emergency communications. When the mobile radio service returned, a crew was able to return to the site and complete the fiber cable restoration.

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?

For protection and RAS, the plan is to continue to use BPA owned and operated SONET and asynchronous digital microwave radios. At this time, no other technologies meet the latency and reliability requirements for the bulk electrical system. PMUs will use SONET initially, but we are investigating the use of small deterministic Ethernet rings for data and situational awareness PMUs. The use of control PMUs on Ethernet deterministic rings is not planned for the foreseeable future. BPA is also starting to add DG controls for wind and solar projects due to their volatile nature. Depending upon the circuit type, this will either go over BPA's SONET system or the BPA-planned deterministic Ethernet system. Therefore the identification of an operational telecommunication system that highly reliably meets these requirements is critical. In addition, BPA finds itself challenged by NERC/CIP and its highly protective requirements and the push with Smart Grid for internet use between utilities. Finally, BPA is planning to carry VHF mobile radio traffic over a P.25 system in the immediate future.

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

Any telecommunications system used for the control and operation of the power system must be extremely reliable, secure, high speed, utility-controlled and operated, able to connect to remote locations, and electrically safe. Telecommunication systems must be immune to power system disturbances and to conflicts with other communications traffic in order to restore the power system during emergencies.

BPA sees utilities communication needs separated into four areas. They are System Operations and Maintenance, Emergency Response and Restoration, Business Enterprise and Utility Customer Interface (metering). In the first two areas, latency, reliability, utility control, and response time are critical. These are areas where a utility owned, controlled and maintained communication system is and will continue to be critical.

In Utility Customer Interface and Business Enterprise, a commercial carrier could potentially be considered. Even in these areas commercial carriers would need to meet certain performance standards such as backup power and restoration that they don't currently achieve. It will also take some careful discussion to clearly define which functions are in each of the four areas.

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

The first improvement would be the addition of backup power in the form of adequate batteries and engine generators to support critical communication load requirements for extended outages. Since availability involves restoration, adequate maintenance crews in an area for immediate repair of the commercial network would also be important. Finally, the size (distance traversed) of communication transport systems would need to be reduced with deterministic routing for protection circuits so transmission delays would not jeopardize the transmission system. As a side note, the utility telecommunication requirements do not fit the historical model of a commercial carrier. Utility telecommunications tend to have smaller bandwidth requirements at many, widely dispersed rural locations, with high availability and diverse routing requirements.

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?

Distribution utilities will see a large increase in the amount of data they are handling from both homes and businesses. Much of the data acquisition is currently being accomplished manually with meter readers. In addition, even automated meter reading will need to change to two way communications to send pricing information back to the residential or business customer. Load variances due to electric vehicle charging stations will be an issue for distribution systems as well. These can be multiplied by the sheer number of known Smart Grid applications and the ones yet to be developed, and then added to the utilities current long list of communications requirements. This is a huge communications requirement.

Although BPA doesn't participate in a large number of these applications, BPA does participate in a few Smart Grid applications and several core applications outside of Smart Grid that will highly impact other Northwest utilities. BPA has communications to over 400 sites and owns, operates and maintains the majority of the bulk electric system in the Pacific Northwest. Utilities throughout the Northwest and into California, New Mexico, Canada, and beyond are interconnected to BPA's system and depend upon the correct operation of BPA's protection schemes. To accomplish this now and in the future, BPA relies, and will continue to rely heavily on high-speed, highly reliable communications systems that are owned, operated and maintained by BPA.

In the future, BPA will require a deterministic Ethernet network or similar type system for best use of Smart Grid applications like PMUs. The challenge will be building a network that meets the high reliability requirements. To build out BPA's network to be a true mesh would be prohibitively expensive due to mountain ranges and distances. Since reliability and outage time combine to determine availability, BPA will continue to rely extensively on its field crews for rapid response to outages of both transmission and communication facilities.

Also, protection and RAS circuits will remain on BPA's SONET system for now, since no other existing and foreseen communication system will meet our requirements. As BPA continues to add wind and solar projects, power system volatility will continue to increase. More monitoring and controls will be required for generation control. Further monitoring of the transmission lines and substations, along with more sophisticated security systems, will likely at least double communications requirements. BPA will also be replacing its existing analog VHF system with a digital P.25 system due to age and reduced spectrum requirements for VHF radios. This will cause BPA to increase the number of VHF radio sites, and so number of radio licenses will also increase. With greater reliance on Smart Grid, active monitoring of transmission lines, video surveillance at remote sites, along with line crew safety, will lead to greater bandwidth demands. BPA is just completing the "make whole" replacements required when part of the 2 GHz spectrum was lost. The 4 GHz and 8 GHz government spectrum is getting congested in several locations within BPA's service area, making radio licenses hard to obtain.

Recent discussions regarding opening up the federal spectrum to shared non-federal use in these frequency bands must also consider BPA's requirements for dedicated Federal spectrum to operate and maintain a highly reliable transmission system. BPA will continue to work collaboratively with NTIA and other executive agencies and regulatory bodies to accomplish joint objectives. Access to Federal spectrum will be a continuing requirement for existing operations as well as interconnecting new renewable and other generation resources to the transmission system.