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Department of Energy
Office of General Counsel
1000 Independence Avenue, SW., Room 6A245
Washington, D.C. 20585

RE: NBP RFI: Communication Requirements

Dear Sir or Madam:

Southern California Edison (SCE) appreciates the opportunity to respond to the National Broadband Plan Communication Requirements of Electric Utilities.

Smart Grid requires a ubiquitous, secure, and reliable telecommunications infrastructure. Therefore, SCE greatly appreciates DOE's focus on understanding the current and future requirements of Utilities, so that Utilities can partner with Carriers to comprehensively meet the requirements leveraging each other's strengths.

In the attachment to this letter, we provide SCE's responses to the nine questions provided by the Department of Energy.

We thank you again for the opportunity to provide this information. We look forward to working with the Department of Energy, Federal Communications Commission, and other interested parties on the development of Utility Communication Requirements.

If you have any further questions or need additional clarifications please contact Solomon Tessema, Director, IT-Technology and Risk Management at (626) 543-6122.

Sincerely,

Solomon Tessema

Solomon Tessema
Director of IT-Technology and Risk Management
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(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 current communication needs of SCE include: telephony, data, video, voice dispatch, mobile data, grid monitoring, grid control, tele-protection, customer communication, load management, automated meter reading, and collaboration capabilities ranging from virtual meetings to e-learning.

SCE is using a combination of private, leased, and shared telecommunication networks to support these requirements. Those applications that require high availability, low latency, and stringent security rely on a private telecommunications network (SCEnet). A combination of transport media are used to cost-effectively support the varying bandwidth requirements in different parts of the network: fiber optic, microwave, satellite, and mesh wireless network. Similarly, voice dispatch capability needed for routine and emergency communication relies on a private mobile radio system to insure no congestion during emergencies, and ubiquitous coverage throughout our vast territory, even in remote areas where SCE crews work on electrical equipment.

Applications that do not have unique Utility requirements (e.g., SmartConnect backhaul) are supported by carrier networks. Carrier networks are also used for 800 service, long distance, internet access applications, and a variety of other applications.

Moving forward, to effectively support the rollout of Smart Grid applications, SCE's strategy is as follows:

- *Upgrade the capacity and functionality of the SCEnet high-speed backbone network to effectively manage the expected explosive growth of traffic for Smart Grid and other enterprise needs.*
- *Upgrade SCEnet transport and expand the reach of broadband to another additional 100 distribution substations.*
- *Build a next generation, secure, high-speed substation Local Area Network.*
- *Leverage 4G wireless Field Area Network to replace legacy systems, significantly expand distribution automation capability, and enable mobile broadband.*
- *Build a high-speed inter-Utility network to support wide-area-situational awareness.*
- *Leverage smart meter capabilities to communicate with devices on the Home Area Network (HAN).*
- *Continue to leverage carrier services where it makes sense to do so.*

(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?

A Smart Grid requires a two-way data communication network that connects the generation-to-customer electric system with service providers, system operators and markets. This communications network must support applications that monitor and manage the flow of electricity across the transmission and distribution system and its consumption at customer premises. In addition, the Smart Grid applications that this network must support vary widely in their needs regarding bandwidth, latency, reliability, and security.

Network reliability and coverage, bandwidth, packet jitter and latency requirements are the most critical issues when developing the technical requirements for the Smart Grid network. For example, the communications network needs to provide real-time, low latency capabilities for applications such as Centralized Remedial Action Schemes (CRAS), Tele-Protection, Transmission and Substation SCADA, Phasor Measurement, and Load Control Signaling. These requirements drive the need for high-speed fiber optic, and/or microwave communications to support those capabilities. On the other hand, applications such as automatic meter reading and data beyond SCADA, which are more latency-tolerant, could utilize communications technologies such as unlicensed wireless mesh, broadband wireless, licensed wireless, and satellite. Applications supporting the Transmission &

Distribution Crew of the Future present a different class of requirements challenges such as reliability without power, coverage and mobility.

Our service territory spans 50,000 square miles of cities, mountains, and deserts. Since our crews work on power system equipment located in remote regions not served by Carriers, we often rely on private wireless or wired networks. Reliability is also of paramount concern for critical monitoring and control of the power system. This communications must be available even when the power system is not.

In sum, Smart Grid communications require security, bandwidth, reliability, coverage, latency, and backup; however, each area of communications has different levels of requirements.

For high-speed backbone network, we need extremely high bandwidth (up to multi-giga bits per second), highly reliable, fault tolerant, fast convergence, low latency, with quality of service, scalability, manageability, and traffic steering.

For applications such as tele-protection circuits and C-RAS fault detection and fast switching to avert transmission grid failure, we do not need high bandwidth; however, we need extremely low latency communication, from 3 to 8 milliseconds.

Field Area Network (FAN), on the other end, requires wide geographical coverage and low to medium bandwidth, depending on specific use cases. FAN enables a communication within the distribution grid from the meter to the distribution substation.

Below, is a more detailed mapping of networks and associated communication requirements.

Categories	Throughput	Latency	Burstiness*	Geographical Coverage
1. Inter-Utility Network	10-100 Mbps	< 50 ms for now < 8 ms in the future	High	Western Electric Coordinating Council (WECC)
2. High-Speed Backbone Network	~ 3.3 Gbps	< 150 ms	High	Data centers, Transmission substations, generation stations, major office buildings
3. Tele-protection & Other Low-Latency Network	< 1 Mbps	< 8 ms	High	Transmission and many distribution stations
4. Substation Bus Network	10 – 20 Mbps	< 8 ms	High	All substations
5. Field-Area Communication	1 Mbps downstream / 384 Kbps upstream; Total > 375 Mbps	< 150 ms	Medium	Entire SCE service area
6. Premise Area Network	4 Gbps	< 50 ms	Medium	Entire SCE service area

** Burstiness is a measure of the variability of traffic (i.e., the peaks and lows)*

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

SCE is one of the nation's largest electric utilities, serving more than 14 million people in a 50,000 square-mile area of more than 180 cities. SCE utility crews operate in wide geographical areas many of which are in remote areas far from populations centers. Utility assets such as reclosers, capacitor banks, and regulators are typically distributed in remote areas.

SCE's vast service territory requires the use of technologies such as microwave and satellite, since the cost of connecting all areas with fiber optics is cost prohibitive. It also requires the build out of private networks where commercial networks are not available.

Finally, terrain is a factor in some rural areas, and WiMAX broadband wireless may offer the best solution, where wire-line systems would suffer from high deployment and maintenance costs.

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

SCE has identified the following ten broad Smart Grid use cases (or benefit categories):

1. ***Provide Customer Benefits*** *by improving grid reliability, enhancing customer communications, and by empowering customers to better manager their energy usage and costs*
2. ***Reduce Peak Demand*** *through demand management programs and services.*
3. ***Increase Energy Conservation & Efficiency*** *by enabling integration of customer energy management systems and grid energy management systems; this integration can reduce system losses.*
4. ***Reduce Operating Expenses*** *by lowering the cost of planning and support functions, operating costs and energy costs.*
5. ***Avoid, Reduce or Defer Capital Investments*** *by increasing capacity utilization, extending the useful lives of grid assets, optimizing energy procurement practices, and investigating new technologies.*
6. ***Increase Utility Worker Safety*** *by providing tools and information that allow them to perform their work in a safe manner.*
7. ***Improve Grid Resiliency and Reliability*** *by reducing the frequency and duration of outages and service interruptions, and by improving power quality, accommodating great diversity of energy resources, and increasing grid security.*
8. ***Reduce Greenhouse Gas Emissions*** *by integrating renewable energy resources with the electric delivery system, and promoting the adoption of electric vehicles.*
9. ***Promote Energy Independence*** *by facilitating electricity-based transportation.*
10. ***Promote Economic Growth & Productivity*** *by fostering the development of California's clean technology economy, and associated job growth*.

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

SCE has developed a series of Smart Grid use cases which specify hundreds of distinct Smart Grid scenarios or applications. The end-to-end functionality of many of these individual applications is enabled by multiple communications network technologies, each with their own performance requirements. Specific communications requirements for any given Smart Grid application will drive the selection of communication technologies designed to support it.

Specific technology supporting each particular application varies based on factors such as bandwidth, latency, and reliability. The table below lists some of the Smart Grid applications and the associated communication technologies which may be employed for each application.

	Network Requirements			
Infrastructure/Applications	**Bandwidth**	**Latency**	**Reliability**	**Technology Option**
High-speed Backbone	H	Milliseconds to Seconds	H	Optical Transport (DWDM, SONET) MPLS and IP-based fabric
Inter-utility Area Network	H	Milliseconds to Seconds	M	Wired and wireless (using both unlicensed and licensed spectrum) carrier-owned/utility company-owned wireless networks satellite, microwave
Phasor Measurements	H	Milliseconds	H	Fiber optic, microwave, broadband wireless
Tele-Protection Network	L	Milliseconds	H	IEC 61850, Hardened Routers/switches
Remedial Action Scheme	L	Milliseconds	H	Fiber optic, microwave
Centralized Remedial Action Scheme	H	Milliseconds	H	Fiber optic, microwave
Protective Relaying	L	Milliseconds	H	Fiber optic, microwave, low latency wireless, copper
Substation LAN	L	Milliseconds	H	IEC 61850, Hardened Routers/switches
Transmission and Substation SCADA	M	Milliseconds to Seconds	H	IP-based Fiber optic, microwave, copper lines, satellite
Field Area Network	M	Seconds to Hours	M	Wired and wireless (using both unlicensed and licensed spectrum) carrier-owned/utility company-owned wireless networks satellite, microwave
T&D Crew of the Future	H	Seconds	H	Broadband Wireless
Outage Detection (thru Fault Indicators, Protection systems or advanced meters)	L	Minutes	H	Fiber optic, microwave, broadband wireless, unlicensed wireless mesh
Distribution Automation (routine monitoring)	L	Minutes	M	Microwave, satellite, unlicensed wireless mesh
Distribution Automation (critical monitoring and control)	L	Seconds	H	Microwave, satellite, unlicensed wireless mesh
Distributed Generation monitoring	L	Seconds	H	Microwave, satellite
Distributed Generation control	L	Seconds	H	Microwave, satellite
Advanced Metering (meter reading, disconnect, communication to HAN)	M	Seconds to Minutes	M	Unlicensed wireless mesh, Power Line Carrier (PLC), Zigbee
Data Beyond SCADA	M	Minutes to Hours	M	Microwave, broadband wireless, satellite
Outage Detection (thru Fault Indicators, Protection systems or advanced meters)	L	Minutes	H	Fiber optic, microwave, broadband wireless, unlicensed wireless mesh
Premise Area Network	H	Seconds to Minutes	M	Wired and carrier-owned/utility company-owned wireless networks satellite, microwave
Dynamic Pricing	L	Minutes	M	Internet, ZigBee
Plug-in Electric Vehicle	L	Minutes	M	Zigbee, Power line carrier
Demand Response	L	Minutes	H	Zigbee, Power line carrier, paging systems
Home Area Network Interface	L	Minutes	M	Wired or wireless broadband, Zigbee

Legend:
L- Low
M – Medium
H – High

(6) What are the <u>recommendations</u> for meeting current and future utility requirements, based on each use case, the technology options that are available, and other considerations?

SCE has not finalized its Smart Grid communication design to the point of identifying all recommended technologies. However, the following technology options are the most promising at this point:

(1) High-speed Backbone:

- *Multi-protocol Label Switching (MPLS) and IP-based fabric technology options at the high-speed backbone will allow for real-time control, information and data exchange to optimize system reliability, asset utilization, and security. MPLS: offers improved networking capabilities and greater flexibility to accommodate the additional networks and their particular operational requirements. MPLS offers a flexible environment and highly scalable architecture that enables SCE to continue supporting legacy services while gradually incorporating new IP applications for grid control and business applications. We plan to deploy MPLS at the high-speed backbone.*

- *Dense Wave Division Multiplexing (DWDM) provides future-proof backbone transport infrastructure to support the soaring bandwidth demand for smart grid and other enterprise applications. DWDM will enable the network to effectively scale in capacity without requiring expensive network overbuilds.*

- *End-to-end IP-based Fabric: highly secure communications infrastructure for the smart grid, from generation to consumption. It will enable common management, total visibility, and coordinated control. It will also increase reliability and resilience.*

- *Continue to use advanced fiber optic, microwave and satellite networks for communication between various facilities.*

(2) Migration from IPV4 to IPV6 protocol to meet the strategic addressing needs for Smart Grid that will require connectivity to millions of end points.

(3) Substation LAN:

- *IEC 61850 protocol to transform the substation communications networks from serial (i.e., SCADA RTU) to IP-based communications using IEC 61850-compliant IEDs and utility-grade rugged IP routers.*

- *Hardened and advanced routers and other networking equipment with scalable architectures to enable reliable and secure two-way communication between substation SCADA equipment and the EMS.*

(4) Field Area Network:

- *WiMAX is a promising technology option for the FAN. SCE could own and operate WiMAX licensed, license-exempt, and 3.65 GHz quasi-licensed frequencies, point-to-point and point-to-multipoint broadband wireless. WiMAX IP solutions provide advanced features such as low latency, enhanced coverage and capacity, increased security based on standardized WiMAX protocol and quality of service.*

- *SCE could leverage a dedicated spectrum for this purpose if it is allocated by the FCC.*

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

Commercial networks are capable of meeting some SCE needs. For example, SCE plans to leverage commercial networks to provide cost-effective backhaul for approximately 5.3 million meters in its AMI system, known as Edison SmartConnect^{TM}. Commercial networks may also be suitable for routine communications with small, dispersed distribution systems, or the monitoring of certain grid devices in the field. However, most current commercial communications networks do not meet the reliability and coverage requirements for applications such as Land Mobile Radio (LMR). Also, they do not meet the latency, availability, and security requirements for critical command and control grid applications that must have real-time or near-real-time response, such as phasor measurement monitoring, remedial action schemes, and line differential protective relaying. The uncertain rollout timeframe of new generation carrier services is also a concern for Utilities.

In sum, the use of commercial networks for critical grid control applications is limited because they currently lack adequate coverage, power supply backup, latency control, congestion management, quality of service, Service Level Agreements, and dependable rollout timeframes.

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

Commercial carriers need to meet Utility industry's unique requirements demands for low latency, high reliability, stringent security, extensive geographic coverage, compatibility with existing protocols and a host of other factors that protect the safety and reliability of the entire electric grid.

- *Reduce Latency: The commercial networks need to meet the very low latency requirements of important Utility applications such as 2-point line differential pilot wire, 3-point line differential pilot wire, and Phase Comparison transmission line protection circuits. Utilities had to build their own networks to ensure they can support the stringent latency specifications of 2 to 8 milliseconds (i.e. less than ½ cycle).*

- *Increase Coverage: Utility crews operate in wide geographical areas many of which are in remote areas far from populations centers. Also, Utility assets such as reclosers, capacitor banks, and regulators are typically distributed in remote areas. The commercial networks are usually concentrated in the highly populated areas, leaving huge coverage gaps in the Utilities' service territory. These coverage gaps often presented safety or operational risks that the utility was not willing to assume.*

- *Enhance Reliability: Telco networks built for the mass consumer market often lack the reliability needed for core Utility applications such as voice dispatch or SCADA. For example, whereas Utility base station sites have several weeks of emergency power backup, Telco cell sites have only hours (or days at most) of power backup. In addition to limited power backups, they have little or no redundancy, reducing the overall reliability.*

- *Guarantee Emergency Availability: Telco networks and services built for, and shared with, the consumer market run into congestion problems during emergencies. This has been demonstrated again and again: during September 11, 2005 Hurricane Katrina, 2009 Hurricane Ike, and the 2007 bridge collapse in Minneapolis. Utilities believe Telco services will not be available when they need them the most, during emergencies. That is one of the primary motivations, for example, why Utilities built their own mobile radio dispatch system to meet both routine and emergency communication needs with a high degree of reliability and emergency availability.*

(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?

As Smart Grid capabilities are rolled out, we expect the communication requirements to evolve in many ways. Traffic in the high-speed backbone will increase dramatically with increased automation, use of video streaming, video surveillance, and mobile dispatch. Significantly more end-points will need network connectivity through the Field Area Network. There will be greater need for inter-Utility *connectivity for wide-area-situational awareness. Cybersecurity requirements will increase both in scope and control standards.*

To build a communication network that can adapt to the evolving needs, we need to select architectures, technologies, and protocols that can scale and are flexible. Examples include: fiber optics and wave division multiplexing for transport, IPV6 for addressing, and MPLS for routing and switching. In addition, we need to implement a distributed architecture models that do not require all data to be brought to a central hub, but allow local decision making based on use cases and predefined criteria.