Northeast Utilities System

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U.S. Department of Energy,
Office of the General Counsel, 1000
Independence Avenue, SW., Room
6A245, Washington, DC 20585

Subject: NBP RFI – Communications Requirements

We are pleased to have been given this opportunity to provide information about our current and projected communications needs. Northeast Utilities recognizes the need to partner with commercial carriers and wireless service providers to help us accomplish our mission; however, the need for privately owned and maintained telecommunications systems for mission critical applications will remain, and our bandwidth requirements in some areas of the spectrum are increasing.

Answers to the communications needs questions are below.

Respectfully Submitted,

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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?

CURRENT STATE

Background Information
Northeast Utilities serves approximately 2 million customers across its territory which spans 3 states (CT, Western MA, and much of NH) and includes rural, urban and suburban population densities.

Land Mobile Radio Systems for Voice and Data Uses
Our land mobile radio systems, for voice use, require coverage in one common band across a whole region, and preferably a whole company. Foliage and mountainous terrain in our New England territories dictate that we utilize frequencies below 450 MHz to provide dependable (> -95 dBm) coverage to approximately 95% our territory. Higher frequencies become too much of a burden on our budget, resources, and rate payers. Today we do not have a sufficient number of channels in one band to build an interoperable land mobile voice network that would enable our crews from one district or company to perform emergency and disaster electrical system restoration without needing to borrow radios from the home group.
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Maintaining a relatively low tower site count and keeping those tower sites under our control is essential for ensuring the reliability of communications and for coordinating a proper triage to respond to outages/generator failures or refueling telecom sites in the worst weather conditions. NERC ERO Reliability Standard Requirements, which are addressed by the Northeast Power Coordinating Council, (NPCC), Directory #8 System Restoration bulletin, call for Transmission Operators (us) to identify tower sites that enable key facilities to come on line in the event of a black-out. These tower sites are now also considered to be key facilities and must be maintained, alarmed and monitored by our technicians, and completely under our control in order to be given the attention we are required to give them.

Distribution Automation

Our tower sites are also being used today for fixed data for distribution automation (DSCADA) and for some AMI pilot projects. The frequency availability from the FCC for this use is extremely poor and we have been forced to share some voice channels with data traffic. The use of 900 MHz bands is not adequate for providing widespread coverage of our rural areas with long feeders in wooded, hilly areas because of the number of intermediate sites required and the latency they add to the communications links. We have an immediate need for frequencies below 500 MHz for data as a primary use for Distribution Automation. In more urban areas, frequencies in the 900 MHz range are used because they are needed, for capacity reasons, to supplement the lower frequency bands for fixed data.

- The Connecticut Light & Power Company, (CL&P), currently has approximately 1866 DSCADA (poletop) remotes on fixed "land mobile" radio systems of various makes and multiple different frequency bands, with data as a secondary use. CL&P also has 42 substations connected by a combination of private and commercial carrier frame relay connections.

- The Western Massachusetts Electric Company, (WMECO), has 49 DSCADA (poletop) remotes, split between the newer trunked 217-219 MHz AMTS (supplemented with NRTC 220-222 MHz spectrum) voice and data network and an old 450 MHz legacy radio system. Four (4) distribution substations are currently connected to the DSCADA host with a combination of private and carrier frame relay connections.

- Public Service Company of New Hampshire, (PSNH), has a total of (140) DSCADA (poletop) remotes using (20) conventional 153 MHz sites, (4) 900 MHz MAS sites, and (1) 217-219 MHz site.

Command Control (Black Start) Voice Radio Network

Transmission Switching Coordinators must maintain communications systems to Black Start Generating Stations and supporting substations that do not rely on the public switched telephone network. Northeast Utilities maintains a system of 37.60 MHz base stations in CT and MA, and 153.515 MHz radios in NH connected to the Transmission Switching Coordinator using Private Operational Fixed (part 101) microwave systems. There are very specific requirements for backup power and system capacity for these key components and we are required to keep maintenance records.

Load Management (VAR control and load shedding)

In MA and CT a simulcast, 154.46375 MHz 6.25 kHz bandwidth channel is shared for paging and load shedding and VAR control. Tower sites are connected with our private microwave systems. In NH load shedding and VAR control are done over the same 153 MHz communications network that is shared with voice traffic.

Private Operational Fixed Systems

Tower sites, some substations, and some office buildings are connected with private, point-to-point licensed (upper and lower 6 GHz and 11 GHz) microwave systems. Some of the paths are very long and require large dishes or space diversity to meet critical infrastructure 99.999% path reliability requirements. In past years we had access to 2 GHz spectrum, but that spectrum was reallocated for commercial use. The 2 GHz spectrum is sorely missed for our longer paths (30 mile range) where fading is having a negative impact on reliability. Our private microwave systems are depended upon to provide reliable backhaul communications during storm events when land lines have proven to be unreliable.

Public Carrier Systems

We have been experiencing more and more problems with our leased telephone lines which use copper based facilities. The last mile telephone carriers have not maintained the copper cable plant due to increased costs and fewer personnel. T1 circuits which were traditionally constructed using 4 wire repeaters have been replaced with 2 wire circuits using ADSL/HDSL type electronics. This change in technology has helped the telcos to reduce engineering and cable maintenance costs but it has reduced circuit reliability and limited our ability to design highly available solutions for electric grid protection & controls systems.

The Internet evolution has caused the telephone carriers to go where the business is and pay less attention to low volume special circuit requirements and designs. Carriers such as Verizon have made a business decision to sell off the wire line business due to declining plain old telephone service, "POTS", revenue. More investment has gone into the cell phone mobile/wireless businesses. Utility real time protection and controls systems require low latency and deterministic communications routes which are not well served by the public internet infrastructure.

Actual statistics from our corporate router network reports availability of service based on privately owned backhaul (both fiber and microwave), leased DSL, and internet T1 services. For the year, May, 2009 to April, 2010 the average availability figures are below. Private services were down 3 times fewer hours than leased services were down over the past year.

% Availability of Router Network Communications, May-09 to Apr-10			
	Private	DSL	Internet T1
May-09	98.807	98.586	99.598
Jun-09	99.607	99.025	99.932
Jul-09	99.903	99.604	98.85
Aug-09	99.895	97.527	94.895
Sep-09	99.963	99.005	95.636
Oct-09	97.141	98.585	99.089
Nov-09	99.998	98.808	99.932
Dec-09	99.771	99.266	99.959
Jan-10	99.847	97.989	98.64
Feb-10	99.608	98.816	99.058
Mar-10	99.976	97.119	98.849
Apr-10	99.961	96.67	98.735
Avg.	99.540	98.417	98.598
Unavail.	0.005	0.016	0.014
Hrs./yr.	40.318	138.700	122.837

Transmission Protection & Control (SCADA and Relaying)

Our Transmission Switching Coordinators, or local control centers (LCCs) - CONVEX and the ESCC – rely heavily on SCADA RTUs for data collection – alarms, device status, analog quantities - and remote control of substation facilities. The Transmission SCADA system is connected through a combination of private and commercial carrier frame relay connections. Approximately 95% of Transmission (69kV and above) substations have some form of SCADA control today. By the end of this year all transmission owned RTUs in MA and CT will utilize digital communication circuits and equipment to communicate with their LCC. A Frame Relay Access Device (FRAD) has replaced an analog modem and T1 or fractional T1 data circuits have replaced tone circuits. Data circuits come in various hardware formats.

The preferred medium is the company-owned fiber optic and/or microwave network. Dedicated, leased lines from the local telecommunications provider are used where no NU-owned facilities exist. Power line carrier is also used in transmission line protective relaying applications. These very reliable somewhat older vintage systems, typically utilizing radio carrier frequencies in the 30kHz to 300kHz range over the transmission line, have the advantage of being NU-wholly owned facilities. They will continue to be employed well into the foreseeable future, and serve a need in areas where fiber is unavailable and third party phone circuits are problematic.

Fiber Optics Networks

NU has been gradually expanding its fiber optic network over the transmission system utilizing optical ground wire (OPGW). By expanding our fiber optic system to as many substations as possible, we can eliminate phone lines, keep systems under our control, and provide opportunities for smart grid concentration points and wireless access points for remote data applications with excellent backhaul capabilities.

NPCC Regulations require that Bulk Power Substations be served by redundant protection systems. These systems must be electrically and physically separated. Communication route diversity is often difficult to obtain. We are leveraging our OPGW fiber for one of the two communication paths. Where fiber is readily available, we use it for other applications such as SCADA and substation site security.

The OPGW and fiber segments are expensive to install and maintain. While fiber works well for point to point applications or data backhaul, it is not anticipated that it can be deployed to each electric system monitoring point. In some cases connections to our private microwave networks are made at the OC-3 level. The majority of our distribution substations will not be connected to the main fiber transmission network and we will need to either lease commercial services or provide our own communications connections.

Advanced Metering Infrastructure

Northeast Utilities doesn't currently have any Advanced Metering Infrastructure ("AMI") in service. NU decided that the technology was still evolving and felt that it would be prudent to hold off until the industry stabilized and standards were in place to ensure some level of interoperability between the different vendors equipment. In the meantime however CL&P decided to run two pilot programs. From a technology perspective both of these pilots are considered a success, but there is still concern in terms of a full statewide deployment because of scalability, maintainability, and handling the various tough-to-reach meters that these pilots didn't focus on.

The first pilot CL&P did used mesh technology and was to gauge the feasibility of covering an area using said technology. The mesh technology uses meter-to-meter communication to get back to collector locations and from these collectors the data is relayed back to the NU network. New Britain and Middletown were the test locations and Trilliant with GE meters were deployed at one location and Itron meters and infrastructure were deployed at the other. Both locations performed well and the targeted number of meters was covered using this approach.

For the second pilot CL&P used Sensus which employs a point-to-multipoint technology whereby the meters talk directly to collector which is located at carefully selected communication tower locations. This technology was also able to communicate with the targeted number of meters, but unlike the first pilot this wasn't a technology pilot. This pilot was used to gauge the customer's response to such a system and how it would affect people's daily usage. Through this pilot CL&P was able to gain a lot of valuable insight into how a system such as this would impact the customers and the grid.

FUTURE STATE

Distribution Automation

- **Connecticut**: Although we have automated many of the reclosers and switches in CT we have a long way to go to finish the build-outs in MA and NH. Our CT sites are overloaded with data and these sites busy out during weather events when they are most needed. We are in the process of trying to offload some of the remote units currently on more congested 450 MHz sites to 900 MHz channels where we have coverage. Our experience has been that no more than 50 units at 4800 bps should be carried by a single 12.5 kHz pair. We will be making use of our 217-219 MHz AMTS spectrum with packet radios as well.

- **Massachusetts**: In MA, where we have a trunked 217 – 222 MHz radio network for voice and data we have had a difficult time making the channel plan work with the geographical border restrictions and inter-site interference. Some sites only have two working channels for both voice and data, and these sites are queuing already. We need spectrum for which data is a primary use in order to enable us to build out packet radio networks to supplement the trunked voice and data network without taking interference from voice users.

- **New Hampshire**: In NH we are planning to make use of the 217 – 222 MHz spectrum to expand DSCADA coverage using packet radios.

Advanced Metering Infrastructure

The extent to which we are able to make use of private wireless networks to support smart metering functions will depend upon the regulatory requirements. Will we need to push load information and reactive pricing information to meters on our networks every 15 minutes? If so, we may have the ability to provide all of the required bandwidth between concentrators and our tower sites, (with some coverage issues), but it is possible that we will not have sufficient capacity to backhaul this data over our existing microwave networks. Getting all of the remote data to our transmission substations that have fiber is probably not realistic. It is possible that we will need to rely on commercial wireless providers to meet our bandwidth needs in the less rural areas. In rural areas we may be better positioned to handle the bandwidth requirements internally.

Plug-in Hybrid Electric Vehicle Charging Stations and Distributed Generation

These functions will fall under the category of AMI and will probably be supported by the same networks.

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(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 current and future needs for security, reliability, coverage and backup power are the same. Some of these requirements have been discussed in answer to the first question. Latency is an important consideration for our transmission protection and controls systems in particular. Transmission protective relaying communications networks have a latency limit of ½ cycle, or 8.5 ms, in either direction from end to end (through all tower or intermediate node sites in between). Our current networks are TDM or SONET-based (not IP-based), and latency is not usually a problem.

Latency is also an issue for our DSCADA communications for several reasons. Poor coverage and busy channels has caused latency to be a problem with some of our DSCADA sites. CT and MA share a host system with timer settings as follows:

Command to live = 29 seconds, this is the maximum time the Command can wait in the DSCADa host to be delivered to the radio system. If the command cannot be delivered into the radio system within 29 seconds the command is discarded.
Control Timeout = 50 seconds, this is the time allotted for a complete control operation. Command sent to RTU and the RTU to respond back to the host. If not complete in 50 seconds the command is "failed"
Response Timeout = 16 seconds, the time the host with wait for an RTU response before failing the RTU

During weather events and peak site use times we have already experienced serious problems with latency on our CT (most completely deployed state) DSCADA system. Having more data channels would ease that congestion.

Security is a major concern for control networks, as it is for networks that carry protected information. Encryption of DSCADA and AMI wireless networks over the air is always done. Separating the wireless networks from the corporate network with a firewall is also standard practice. Availability (reliability) is an important part of security. Maintaining end-to-end control to the extent possible over Transmission SCADA, DSCADA, load management and black start radio networks is a must.

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

The terrain in New England is mountainous in areas. Much of our territory has an abundance of tall pine and oak trees making broad coverage of our wide service territory difficult and expensive on microwave point-to-multipoint frequencies. Frequencies below 500 MHz serve us best, but provide little bandwidth. If we keep our communications requirements simple we can get by, using low speed data.

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

Transmission Automation
The ability to retrieve real time information on the status of transmission systems is vital to the stability of the bulk electrical grid. SCADA systems have been in place for many years; however these systems have not been interoperable with our load management systems or DSCADA networks. New security requirements for access to transmission substations have added to the bandwidth requirements at our bulk substations.

Distribution Automation (DSCADA), PHEV, Distributed Generation
The increase in cogeneration and construction of new solar and wind generating facilities has added to our communications needs by requiring more SCADA controlled switching devices.

Advanced Metering Infrastructure

- Near real-time data communication is expected to be needed for PHEV charging station meters. It is likely but not certain that we will need to lease services to these stations to provide adequate bandwidth.
- Distributed Generation projects require the addition of SCADA-controlled switching equipment and are expected to be supported by our DSCADA radio networks.
- It is unclear how much bandwidth we will be required to support home meters. State regulations will have a big impact on the cost of this service and on our ability to construct and maintain the network.

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

- Conventional and trunked land mobile radio: We will continue to depend on conventional and trunked land mobile radio systems to support black start communications, load management, and truck to truck and dispatch communications.

- Conventional and trunked voice and data radio systems with custom-designed modems: We have worked with three different vendors who designed modems for our DNP3 DSCADA applications. One of those vendors is no longer in business. Another required us to purchase a large number of modems (more than we can use) as part of the agreement for the custom design. The "DSCADA modem over conventional or trunked 12.5 kHz channel" solution will not be viable for advanced metering applications because of the load this application would add to our already heavily loaded networks.

- Packet radio: We will begin to roll out packet radio networks to supplement shared voice and data networks for DSCADA and potentially for AMI use in more sparsely populated areas.

- TDMA Radio: In more urban areas in CT we will be using TDMA radio infrastructure to support DSCADA and possibly AMI applications.

- WiMAX, point-to-multipoint microwave or MAS, LTE or commercial wireless: Some combination of these technologies will probably be selected to support AMI applications. In more rural areas we may be able to use private packet radio networks.
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- Dedicated, leased services will continue to be needed to connect locations that do not have privately owned communications facilities.

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(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?

- Make available more primary data channels below 500 MHz for utility use.
- Give utilities access to the NTIA 1.8 GHz spectrum for either licensed, coordinated point-to-multipoint or point-to-point microwave use to support the needs of the Smart Grid.

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

- Connecting substations, offices and remote tower sites with no privately owned fiber or microwave connections to our private networks
- Company cell phone and Executive Smart Phone plans
- Paging services (NH)
- Some high speed fiber connections between major office buildings
- For PHEV charging stations
- Possibly for some smart meter concentrators

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

- Improved maintenance of copper facilities used for dedicated leased T1's and DS0's connecting our facilities
- Improved responsiveness when we order new services to our substations (some orders have been out for two years and are still not filled!)
- Backup generators with sufficient fuel for 10 days (what we require at our tower sites) at all cell tower sites

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(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?

- Increased dependence on packet radios
- Improved backhaul networks
- Increased congestion on our voice & data networks creating the need for more dedicated primary data channels below 500 MHz
- Possible increase in requests for leased digital wired and wireless commercial services