SURVEY OF UTILITY COMMUNICATIONS CONDUCTED BY THE UTILITIES TELECOM COUNCIL IN PREPARATION FOR THE

FCC's Public Notice Seeking Comment on the Implementation of Smart Grid Technology

REPORT

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I. INTRODUCTION AND BACKGROUND

In response to the release of the FCC's Public Notice Seeking Comment on the Implementation of Smart Grid Technology on September 4, 2009, the Utilities Telecom Council conducted a survey of its core utility electric utility members to gather data on the state of substation communications, the potential cost savings of dedicated spectrum in terms of speeding deployment of smart grids and utility plans for deploying intelligent grid devices.

UTC received 66 total useable responses from our members, who encompass a wide range of different kinds of electric utilities.[1] These companies collectively represent 33.4 million electricity customers, representing 24% of all electricity customers nationwide. Although this represents a substantial sample of utilities, we cannot make any determinations as to the representativeness of the sample.

The following report summarizes the survey's results.

II. THE STATE OF SUBSTATION COMMUNICATIONS

The survey asked the utilities a number of questions regarding what kind of communications capabilities exist for their substations.

Table 1 – Existence of One-Way, Two-Way and Any Communications

Total Distribution Substations	18,530
# with One-Way Communications	1,001
% of total substations	*5%*
# with Two-Way Communications	8,456
% of total substations	46%
# with Any Communications	9,457
% of total substations	51%
# with no communications	9,073
% of total substations	49%

As Table 1 above illustrates, the respondents collectively reported that they have 18,530 distribution substations. Of these, 5% have one-way communications and 46% have two-way communications (note that some substations can have both one-way and two-way communications). In total, the group of respondents reported that 7,455 of their substations have any form of communications, representing only 51% of the total. Therefore, approximately 49% of the total substations are assumed to have no form of communications capabilities.

[1] Companies who responded but were excluded from the analysis include those who have no distribution substations, a main criteria for response, or those who failed to identify themselves.

The respondents were further asked to specify what kinds of two-way communications exist for those substations that have two-way communications. (Note, again, that substations can have or have access to multiple kinds of two-way communications – i.e. a substation may use and have access to both narrowband wireline *and* broadband wireline communications.)

Table 2 – Type of Substation Two-Way Communications

Of those substations with Two-Way Communications how many use or have access to:	
# with narrowband wireless	2,734
% of two-way substations	*32%*
# with broadband wireless	382
% of two-way substations	*5%*
# with narrowband landline	4,039
% of two-way substations	*48%*
# with broadband landline	393
% of two-way substations	*5%*
# with fiber	1,200
% of two-way substations	*14%*
# with other	456
% of two-way substations	*5%*
# with any form of broadband (incl. fiber and other)	2,431
% of two-way substations	*29%*
% of all substations	*13%*

As Table 2 above demonstrates, the vast majority of two-way communications is of the narrowband kind, with narrowband wireline two-way communications dominating the kinds of two-ways communications available to the respondents' substations. In total, at most only 29% of two-way substations use or have access to broadband communications, which translates into, at most, only 13% of all substations.

We asked the respondents to explain in their own words what steps they plan to take to implement two-way communications in those substations that have none. Although the responses varied, the bulk centered on plans to implement two-way wireless technologies, with several respondents raising the need for additional spectrum to do so. The following are selected responses to the question "For those distribution substations that don't have two-way communications, please describe what steps you plan to take to implement two-way communications:"

- "Submitted project request to budgeting to deploy wireless into distribution subs over the next 3 years for metering and distribution SCADA."

- "Install leased lines or [company name removed] Radios. Would prefer licensed spectrum but it is costly."

- "Extending fiber to a distribution substation is the first choice. If it is deemed too expensive the next option is create a private broadband wireless network. The final option is to go to a third party wireless or wireline provider."
- "With AMI installation, fiber and wireless connections will be used to establish two-way communication with all substations."
- "We are studying wireless WiMAX but need access to viable spectrum and a proprietary semi-broadband licensed wireless at 700 Mhz."

Table 3 – Private v. Commercial Network Availability for Two-Way Communications

Of the substations using broadband wireless, how many use or have access to	
Private communications	282
Commercial communications	104
Of the substations using narrowband wireless, how many use or have access to	
Private communications	2,572
Commercial communications	999
Of the substations using narrowband wireline, how many use or have access to	
Private communications	1,245
Commercial communications	3,036
Of the substations using broadband wireline, how many use or have access to	
Private communications	37
Commercial communications	647
Of the substations using fiber, how many use or have access to	
Private communications	1,143
Commercial communications	163
Of the substations using some other form of connectivity, how many use or have access to	
Private communications	267
Commercial communications	526

The survey further sought to quantify the use and availability of commercial communications for the various two-way communications technologies. As Table 3 above illustrates, most utility respondents say that most substations either use or have access to primarily private communications networks, presumably the communications networks that utilities typically build themselves.

For example, when asked "Of the substations using narrowband wireless, how many use or have access to private or commercial communications," the respondents answered that 2,572 use or have access to

private communications, while only 999 use or have access to commercial communications, such as those provided by third party wireless carriers.

This type of preference for or knowledge of private network communication options was typical for each kind of two-way communications, with one notable exception. When asked the same kind of question for narrowband wireline communications options, commercial communications outnumbered private communications by more than two-to-one.

III. THE STATE OF COMMUNICATIONS FOR INTELLIGENT GRID DEVICES

The survey asked the utilities a series of questions about how many intelligent grid devices they plan to deploy and what kinds of communications plans are in place for those deployments.

Table 4 – Intelligent Grid Devices and the Need for Upgraded Communications

How many intelligent grid devices (i.e. beyond the substation) do you plan to deploy for smart grid?	10,161,042
How many grid devices enumerated in 1. above need upgraded communications to support smart grid functions?	7,279,262
% of total devices that need upgraded communications	72%

A. Plans for Upgrading Communications for Intelligent Grid Devices

In total, the respondents say they plan to deploy 10.1 million intelligent devices for smart grid (see Table 4 above). When asked how many of these devices need upgraded communications to support smart grid functions, the utilities said that 7.3 million of these devices need upgraded communications, an aggregate response that represents 72% of the total intelligent grid devices they plan to deploy.

When asked to explain how the communications networks need to be upgraded, the utility respondents offered a variety of different responses, from identifying special upgrade plans to explaining the need for better commercial broadband communications capabilities to articulating how mountainous terrain bars the use of lower cost wireless options. The following are selected open-ended responses:

- "Most points currently have no connectivity. The current solution involves using [vendor name omitted] from the transport to the meter, with cellular backhaul at every transformer. Intermediate points, such as cap banks and line sensors will have cellular modems."
- "Need to get away from 902-928 due to interference issues. Also need more bandwidth for backhaul functions. Coverage and latency are currently both OK."
- "There are no communication networks available. We have some MAS channels, but they can provide only a fraction of the needs."
- "The network will have to be extended to reach devices not at substations. The current main fiber backbone (SONET) will have to be upgraded from OC-48 to OC-192 to handle the additional traffic coming from these grid devices. Latency is also a consideration."
- "We would like to establish higher throughput low latency connectivity to our substations for AMR backhaul and substation connectivity purposes. We are targeting 10MB bandwidth as the base configuration. This would require a significant investment to a completely new infrastructure. Again, our preference is to own making wireless the most cost effective way to accomplish this."

- "Most of these locations don't have a communications medium. We need broadband, wireless to interconnect these smart devices. It is difficult in our mountainous terrain to get adaquate coverage."
- "Currently we are using paging one-way communications to support capacitor controls. We are also using public cellular communications to remotely controlled or monitor switches. All need cost effective, private two-way communications to become effective parts of the emerging SmartGrid at [COMPANY NAME]."

B. Plans for Upgrading Communications for Intelligent Grid Devices

The utilities were further asked how they plan to implement a communications technology to support these intelligent grid devices, with a specific focus on the kind of technology – wireless or landline, broadband or narrowband, and so forth – they plan to use. The following are selected responses to this question.

- "Combination: Fiber, Wi-max, point-point MW."
- "We will be using wireless systems for the great majority of our IG devices. It will not be economically viable to use non wireless technology. The capacity of this wireless system is still to be determines as we are currently in a RFP process looking at wireless systems ranging from 9.6 kbps to over 1 Mbps."
- "Our AMI infrastructure uses licensed 900 MHz radio spectrum. Some small number of smartgrid endpoints will be added to this system. We have not yet developed a comprehensive smartgrid plan. By the nature of the devices, some combination of private and commercial wireless will probably be used."
- "Once we have examined the technology that is available at each location, we will make a decision as to the communications platform at each location. It will probably end up being a mixture of technologies."
- "Power line carrier through the existing TWACS two way communications system."
- "We plan to install fiber in existing conduit system for 80% of the project. The remaining 20% will be installed using underground boring technology."
- "At this time, we do not plan to implement of new communications infrastructure due to economics and lack of business drivers. We have analyzed our options and the path we plan to pursue long-term is wireless broadband."
- "Multiple technologies will be used based on topography, payback, and reliability needs. We do not see a one-size-fits-all solution, but need multiple options to ensure the communications needs are filled with the appropriate device, both in cost and reliability."
- "It will likely be a combination of technologies. We are a utility that has devices in urban and rural environments. Therefore, depending on the location and the type of equipment we could use wireless or landline. There would also be a combination of broadband and narrowband technologies."
- "Wireless to the meter, fiber back to a collection point."

- "Plan to use wireless broadband spectrum."

- "We probably only need narrow band wireless communications. Cost of wireline is prohibitive, especially where it needs to be constructed."
- "Improve broadband to our substations and add broadband connectivity to our substations that currently do not have broadband access. Increase the throughput and bandwidth on the backbone that is used connect our substations. Then determine the method of communicating to smart grid devices."
- "We plan on using a separate ethernet LAN as backhaul from the substations to the central servers. We will use wireless as much a possible to the collection points. The collection points will use licensed MW links for reliability or lease line. The collection point will then be backhauled to the nearest substation."
- "We wish to have a single "Wireless Infrastructure" to support all telecom RF needs."
- "Combination of fiber from the back office to the substations, broadband wireless to mesh collector locations and medium bandwidth wireless from collectors to mesh components."
- "I would use a licensed broadband network, if frequencies were available, in areas that are not accessible with fiber."

C. Intelligent Grid Devices: Private or Commercial?

When asked if they plan to use commercial or private networks or both for the communications functions surrounding intelligent grid devices, the respondents say they plan to use either private networks exclusively or a combination of private and commercial. Respondents cited private networks as the preferred communications option -- several respondents stated that past reliability issues with commercial networks as well as the need to meet NERC cybersecurity and CIP requirements pose problems when it comes to commercial carrier use. The following are some of the open-ended responses to this question:

- "Commercial wireline and fiber companies will be used for leased circuit services to substations and other points. Commercial wireless services will be used for mobile data and to non-critical DA points. Private wireless services are needed for LMR mobile voice and critical DA points. Private broadband wireless is needed for stations where commercial wireline services are not available."
- "Both. We plan to utilize both commercial cellular and a new private radio network to provide the required two way real time communication link to the field devices."
- "Both. We understand the limits of commercial networks and would use when the availability requirements of the specific application allow."
- "Private. Security issues with the data / control is the largest concern."
- "Mostly private, but some commercial. In most locations, the limited commercial offerings are not cost competitive compared to private installations. The service record of the commercial applications in the area (carrier name omitted) is very poor."
- "We use public but have a fundamental principle to move to private communications."
- "Prefer private but based on economics, we will look at public as necessary."

- "The preference is to keep the majority of the communications on a private network. We will only want to use the public network on a limited basis. The private network is preferred from a control and security standpoint. Security is needed primarily to maintain NERC/CIP compliance."
- "Private at this time. But we are only at the initial planning stages, and may have to use a combination of networks. Especially for devices that the private network cannot communicate to."
- "Yes, We plan on using a broadband provider such as cable companies to help in areas we don't have spectrum, fiber, or POTS lines."
- "Undetermined at this point in time until more detailed analysis is performed. Potentially, both depending upon reliability requirements, market offerings and costs."
- "Using some commercial networks now (gprs from collector meters) but view it as temporary until dedicated spectrum is available. 95% of our networks are currently private. "
- "We use both, but for the 25,000 devices that are not on our private network, we need to rely on commercial networks to carry the traffic."
- "Both, but primarily private networks for control (SCADA)"

IV. THE STATE OF COMMUNICATIONS TO THE CUSTOMER PREMISES

The vast majority of electricity customers will need upgraded communications for smart grid, according to the respondents. Of the total 33.8 million electricity customers served by the respondents, 91% will need access to upgraded communications to support smart grid functions. (See Table 5 below.)

Table 5 – Electricity Customer Users and the Need for Upgraded Communications

How many electricity customers do you serve?	33,786,723
% of U.S. customers	*24%*
Of the total customers enumerated in 1. above, how many will need access to upgraded communications to support smart grid functions?	30,762,404
% of electricity customers served	91%

A. Plans for Advanced Metering, Home Area Networking and Demand Response

The respondents were asked a series of open-ended questions regarding plans for advanced metering, home area networking and demand response. In terms of how the networks should be upgraded to accommodate these advanced functions, the utilities offered a wide range of responses, although many stated that they currently lack advanced metering infrastructure and several cited the need for increased broadband wireless functions.

The following are selected responses to the question "Explain how the communications networks need to be upgraded (e.g. throughput/bandwidth, coverage, latency, etc.)" for AMI/HAN/DR.

- "Communications for advanced metering deployments will be coupled at substations wherever possible to leverage broadband communications to various requirements. Security will be maintained with several technologies and all communications will be classified for transport in one of several VLANS: Grid SCADA, SmartGrid, Advanced Meter, and Enterprise."
- "We anticipate implementing an AMI system to all of our customers. We anticipate this will be a wireless mesh system using aggregators to communicate with multiple meters in the neighborhood. These aggregators will need a high capacity real time two way wireless network to provide communications to the central MDMS."
- "A pervasive RF blanket will be deployed to communicate with the meters and then be backhauled through a high speed RF network."
- "Communications for an AMI system can be narrow band. However, if you want to begin some form of DSM/HAN, bandwidth requirements begin to increase. Depending on the communications platform, this could require greater coverage for wireless and minimal latency."
- "The existing Wi-Fi mesh radio network (vendor name omitted) will need 100 additional units to provide signal strength. (Vendor specific information omitted.) The other option is to utilize

meter to meter communications network and use our fiber system to collect and backhaul the data. We hope zigbee becomes a usable technology for the HAN."

- "There is no communications in place today. The AMI will use Power Line Carrier and commercial communications to the 13 substations."
- "Throughput needs to be upgraded. Because we rely on cellular for a portion of this network, coverage will need to be expanded."
- "The coverage of the communications network needs to be expanded. Although the network backbone is adequate to meet the requirements of AMI/HAN/DSM the reach will have to be extended to get information from the meter back to the headend."
- "Initially, we will use leased wireless service with an eventual change to private when that technology and channels exist."
- "We would need more bandwidth to our substations."
- "Throughput and bandwidth will need to be increased. We will need to determine how to communicate to these devices."
- "Must provide enhanced security, reliability, improved bandwidth and performance, increased coverage, low latency, scalability and support for recognized and emerging NIST interoperability standards and frameworks."
- "Spectrum or commercial wireless to collect data on our customers. Although frequency hopping on the unlicensed spectrum is effective for now in avoiding occupied channels, this method will become more challenging as more consumers purchase wireless devices in this spectrum We would prefer to have a licensed method to get this data, giving us a long term reliable communications network."

B. AMI/DSM/HAN: Private or Commercial?

When asked whether they plan to use commercial or private networks or both for these advanced services, most of the utility respondents expressed a preference for private networks, although a number of respondents say they plan to use both commercial and private networks. The following are selected responses to the question "do you plan to use commercial or private networks or both?"

- "We will use both where each communication is appropriate. Commercial wireline is generally appropriate for all types of communications. Commercial wireless is appropriate for data mobility for non-command and control functions. Private communications under [utility name omitted] ownership and control is required for critical command and control functions including mobile voice (dispatch), SCADA to bulk power grid points and to key distribution DA points."
- "Both. We plan to utilize both commercial cellular and a new private radio network to provide the required two way real time communication link to the field devices."
- "Private with commercial to augment as necessary."
- "Private - commercial networks are simply not available in most rural areas. We have to build our own."
- "Plan to use private where possible."

- "We will explore both private and commercial, depending on which is readily available and economical, we will probably have a mixture of both."
- "Our desire is to use our private fiber network to minimize costs."

- "More than likely, private."
- "The preference is to keep the majority of the communications on a private network. We will only want to use the public network on a limited basis. The private network is preferred from a control and security standpoint. Security is needed primarily to maintain NERC/CIP compliance."
- "Initially, we will use leased wireless service with an eventual change to private when that technology and channels exist."
- "[Utility name omitted] currently deploys an Automated Meter Reading (AMR) network comprised of both commercial and private networks. These networks will continue to be used until internal and/or external drivers dictate otherwise."
- "Private. Commercial networks do not have sufficient coverage for our service area."
- "The preference is with private networks, since we control over the maintenance if there is a problem. If there is a problem with a commercial network, all we can do is open a trouble ticket and constantly follow up with escalations. Commercial carriers do not understand the importance of utility operations."

C. Plans for Upgrading Communications for AMI/DSM/HAN

The utilities were asked what kind of technologies they plan to implement to support AMI/HAN/DSM. The bulk of the respondents said they plan to use broadband wireless technology, both licensed and unlicensed, although a few plan to deploy broadband fiber technology and a few plan to use powerline carrier or broadband over powerline technologies. The following are selected responses to the question "*How do you plan to implement a communications technology to support AMI/HAN/DSM (e.g. wireless or landline, broadband or narrowband, or combinations of technologies)?"*

- "The majority of our advanced meters will be communicating via wireless in the unlicensed 900 MHz band to data collectors/take out points. Backhaul of this data will be by a variety of means depending on the location of the collectors. However, private communications is preferred if available for reliability and security."
- "We plan to implement an AMI system in a phased approach. This AMI system will then be used to provide access to the HAN and to support the DSM program. We plan to leverage both commercial cellular services and our private wireless network to provide the needed connectivity to support the AMI/HAN/DSM programs. The bandwidth required for this wireless connectivity is still TBD but is is anticipated it will need to be greater than 256 kpbs."
- "Wireless with landline and wireless backhaul, narrowband but would use broadband for some applications if it were available."
- "AMI using 900 MHz licensed spectrum. HAN has yet to be decided although leaning toward unlicensed wireless from the smart meter."
- "Given the wide rural areas we serve, we must use wireless means. We are pursuing both radio and broadband over powerline options."

- "Wireless back to the core backbone. Prefer licensed but if not available it will be unlicensed."
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- "It will be a combination of technologies. To reach the meters we have looked at RF Mesh technologies and PLC communications to the meter. Since we have a large base of urban and rural customers a combinations of communications technologies and bandwidth capabilites will be used. Fiber and broadband wireless communications will be used for communications between the AMI collection points and the AMI Headend."
- "Plan to install wireless broadband coverage across our service territory."
- "Initially, we will use leased wireless service with an eventual change to private when that technology and channels exist."
- "Combination-fiber, wireless and PLC."
- "We do not know at this time. We only know that we have to do this. We are currently looking at technologies of doing this."
- "Dedicated ethernet LAN and numerous methods for backhaul between collection points and LAN."
- "Existing fiber to Substation, then new spectrum to meter collectors, then new spectrum to meters, then Zigbee in the HAN for DSM devices."
- "We are trying to determine how to upgrade to get communications to do any form of Smart Grid."
- "95% of the Access Points are on the utility private network. Those that aren't are not as reliable, such as those using the commercial wireless networks. We are currently looking at collecting data on capacitor banks, but are forced to look to the commercial wireless carriers as the only method of transporting the traffic back to our Control Center."

V. THE POTENTIAL COST SAVINGS OF DEDICATED SPECTRUM

Given that UTC's members have long advocated the need for additional spectrum to implement advanced, reliable wireless communications, we asked our members to provide us with quantitative and qualitative information on how much more quickly or less expensively utilities might be able to deploy smart grid technology if they have access to dedicated spectrum. We further asked them to supply us with any materials related to DOE smart grid grant applications that might shed light on smart grid deployment technologies and cost structures.

In terms of general descriptions, several respondents said that gaining access to more spectrum would make smart grid deployment easier. The following are selected responses:

- "Smart Grid implementation would essentially explode if we had dedicated, private frequencies."
- "We are still early in our evaluation process of Smart Grid communications technologies. However, interference is a major concern when we look at RF technologies in the unlicensed spectrum band. The very possibility that communications to our substations could be interrupted periodically could force us to eliminate RF as an option. This may cause us to use more expensive landline options (i.e. fiber) for broadband applications. An RF solution allows for quicker deployment and should be less expensive when you factor in installation costs of fiber and BPL equipment. Therefore, dedicated spectrum will have advantages for us in any future deployment of SmartGrid."
- "Currently reviewing proposals for an AMI system. The unknown with them is the available spectrum whether commercial or private. Commercial spectrum is costly and has rising costs. The private spectrum available is not useful for AMI. Dedicated spectrum would solve this problem."
- "Smart grid is more than just communication with substations. We need dedicated spectrum to be able to communicate with distribution automation devices. This means either long haul communications at lower frequencies or spectrum for us to build coverage areas that include ALL of our distribution system."
- "Our problem is not in the substation. It is on the distribution system where we could use dedicated spectrum. We are a three service [Electric, Gas, and Water] utility - the same comment applies to our water and gas distribution systems."