UTC
UTILITIES
TELECOM
COUNCIL

The Utility Spectrum Crisis:
A Critical Need to Enable Smart Grids

Utilities Telecom Council

January 2009

The Utility Spectrum Crisis – A Critical Need to Enable Smart Grids

January 2009

The Utilities Telecom Council is a global organization representing the telecommunications and information technology interests of key critical infrastructure entities, especially utilities. UTC's members serve collectively virtually every community in the United States and several areas around the world. Our ongoing mission is to create a favorable business, regulatory and technical environment in which all members and stakeholders will thrive. We do this through a variety of advocacy, technological, information, and education programs. We invite you to explore our web site at www.utc.org and let us know how we can be of further service to you.

The Utilities Telecom Council represents electric and gas utilities of all ownership types; water companies, energy pipelines, and other critical infrastructure providers, as well as their technology partners—all united in their commitment to ensuring the best, most reliable systems and networks critical to their core business and the customers they serve.

Utilities Telecom Council
1901 Pennsylvania Ave, NW
5th Floor
Washington, DC 20006
202.872.0030

The information contained in this report builds on previous work by UTC's Utility Spectrum Assessment Task Force, UTC member surveys conducted in 2005 and 2007 and other previously published UTC reports.

Table of Contents

Executive Summary

> ***A Spectrum Crisis exists in the utility industry. Without a dedicated allocation of 30MHz of spectrum, enabling smart grids in North America will be, at best, extraordinarily expensive or, at worst, impossible.***

Electric, gas and water utilities and gas pipelines have extensive communications requirements. Expansive, sprawling infrastructure, whether in the form of generating stations, transmission lines, water pumping stations, gas pipelines or electric substations, requires maintenance, remote control and monitoring. Field crews must have effective communications at all times throughout service territories. Individual customer meters must communicate back to the utility. These objectives can be met effectively only through communications systems, and among the most critical components in a utility's communications arsenal are its wireless networks.

As detailed in this report, electric, gas and water utilities in the United States need an estimated 30 MHz of radio spectrum dedicated to their use to meet infrastructure needs and to help ensure reliable service for the next two decades. The most preferred source for this spectrum is the 1800-1830 MHz band, to harmonize with a Canadian allocation for its electric grid and create a communications capability that can support our North American electric system.

This level is an increase from previous estimates based both on a decline in available spectrum over recent years and the much greater capacity demanded for basic system growth and Smart Grids. In 1998, UTC released a research study that detailed the shortage of available, reliable spectrum for utility communication requirements. That report predicted that additional spectrum requirements for utility operations were 1.0 MHz to 6.3 MHz from 2000 to 2010.

The new estimates, however, show dramatically increased additional spectrum requirements if utilities are to keep pace with smart grid technology and other new demands placed on their networks. Utilities need 30MHz of spectrum urgently because:

1. Utilities access to shared spectrum has declined as our need has increased.
2. Demand for critical emergency communications in the face of disasters – both natural and manmade – have stepped up dramatically.
3. Federal requirements to report and monitor the security of critical infrastructure resources.
4. Realization by Congress and other regulators that the electric grid of the future is critical to national security.
5. No other communications technology can cost-effectively support the rapid deployment of smart grids in North America.

Regulatory decisions over the intervening years, however, have resulted not in an increase in spectrum available, but in a net loss of spectrum available for critical infrastructure industries. Utility companies will require advanced wireless technologies to accommodate a variety of energy and water operational advances. For the implementation of Smart Grids and more intelligent utilities, such technologies – and the spectrum on which to run them -- are absolutely essential.

This report updates our 1998 work so that we may highlight the increasingly heavy reliance on spectrum-based systems by utilities and other critical infrastructure providers. In the ten years since the initial version of this report, the U.S. has experienced a dramatic increase in focus on national security, which, combined with devastating natural disasters, warrant another evaluation of the spectrum needs of critical infrastructure industries including energy, water, transportation and petroleum. We seek to present updated arguments for dedicated critical infrastructure industries spectrum, a reasonable estimate of the spectrum required to support the needs of utilities over the next decade and a reaffirmation of Congressional designation of internal critical infrastructure industries networks as “public safety radio services”[1] with an exemption from spectrum auctions to acquire suitable spectrum to serve the public good.

With this report, we recommend the allocation of 30 MHz of radio spectrum for use by critical infrastructure agencies to meet the growing demands of voice communications, mobile data to personnel, fixed data including smart grid and AMI implementation, and vital security monitoring for those providing the most critical services to the public and the U.S. economy.

---

[1] *See* 47 U.S.C. §309(j)(2)(A); H.R. Conf. Rep. No. 105-217, 105th Cong., 1st Sess. at 572 (1997).

I. Introduction and Background

Utilities have traditionally made extensive use of wireless applications; this use is increasing as demand for voice and data communication capabilities increases. These applications include, but are not limited to, traditional dispatch voice operation, telemetry, supervisory control and data acquisition (SCADA), protective relaying, advanced two-way metering, and pump station monitoring. In our 1998 report, we stated that utilities will increasingly depend on wireless communication. This prediction has come true. Recent requirements instituted by the Department of Homeland Security focused on security monitoring of Critical Infrastructure (CI) assets have increased the demand for already-congested available spectrum, with some essential security services, such as video monitoring, consuming massive amounts of bandwidth. Moreover, legislation including the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 coupled with broadening state regulation, compel utilities to install more sophisticated monitoring, control and metering systems. This further increases their need for reliable communications networks and the spectrum on which to operate them.

The purpose of updating this report is to:

1. Reaffirm the need for priority or exclusive access to spectrum below 2 GHz for the support of critical utility communications needs through the year 2020.
2. Develop and present the case for a justifiable amount of spectrum needed by utilities to meet the increasing demand for internal wireless communications.
3. Reaffirm utility and critical infrastructure exemption from spectrum auctions as the required means of acquiring new spectrum and recommend communications policy changes to facilitate access to appropriate spectrum.

About UTC and this report

UTC

UTC was first organized in 1948 as the National Committee on Utilities Radio (NCUR), in order to plan for the use of mobile radio technology in the utility industry. The organization was later renamed Utilities Telecommunications Council (UTC)[2] to reflect the association's broadened scope of activities and interests.

---

[2] UTC's membership consists primarily of publicly held, municipal and cooperative electric, gas and water utilities and gas pipelines, and Federal power authorities. Through affiliated association members, UTC reaches out to

UTC is a non-profit 501(c)(6) "business league" representing the communications interests of entities involved in the generation, transmission or distribution of electricity, natural gas or water and their technology partners. UTC's membership consists of approximately 500 utilities and pipelines, along with approximately 300 associate members, including equipment manufacturers, engineering firms and other stakeholders in the field of CI information and communications technology (ICT). UTC also is a Federal Communications Commission-certified frequency coordinator of Industrial/Business land mobile and telemetry radio channels. Pursuant to agreements with the FCC and the National Telecommunications and Information Administration, UTC maintains the national Power Line Carrier (PLC) database for the coordination of PLC use with licensed government radio services in the 10-490 kHz band and the Access Broadband over Power Line database

This Project

This project was initiated in late 2007 to re-examine our 1998 report on utility spectrum requirements, to review real-world experiences during the intervening years and to determine the amount of new electromagnetic spectrum that utilities and pipelines will need by the year 2020 and beyond. The methodology of this project draws upon a combination of original survey data, projections based on typical utility needs and data from members of UTC Canada our affiliated organization in that country, whose members are examining similar issues with the Canadian government.

To accomplish the project goal, a steering committee was formed between UTC's Technical and Public Policy Divisions. The final committee included representatives from radio equipment manufacturers, consultants and electric, gas and water utilities.

---

other Critical Infrastructure Industries (CII) as defined by the FCC in Section 90.7 of its Rules (47 CFR § 90.7), including petroleum and oil pipeline companies and railroads.

II. Utility Communications Requirement Update

Utilities are facing an increasingly competitive marketplace and growing regulatory pressures, forcing most to adopt "lean and mean" operations. In an ongoing effort to produce ever more reliable services at the lowest possible price, utilities are forced to look for newer, high-technology methods of improving efficiency in all operating areas. At the same time, utility communications networks must withstand man-made and natural disasters, necessitating system design factors above and beyond those of a commercial provider's network. These systems must work "24 X 7, 365," to a "five 9s" standard of reliability (i.e. 99.999%), *especially* during service outages when other, commercial power-dependent systems are down. This high level of reliability, coupled with the specialized applications needed, mean that in the future most utilities will rely as much, if not more, on private, internal networks that can be built and maintained to their standards. Regulatory pressures for greater system intelligence and greater reliability add to the demands.

Spectrum requirements for future years will come from the need both to expand existing systems and to add new wireless applications. Some examples of specific utility uses of wireless technology are highlighted in Appendix A. The industry is faced with new, major challenges that continue to place pressure on already-limited spectrum resources. Three factors contribute to the pressure to find new spectrum resources:

1. Stepped-up demands for critical emergency communications in the face of disasters, both natural and manmade.

2. Federal requirements to report and monitor the security of critical infrastructure resources, which have led to a reliance on wireless communications as an effective, affordable means to meet these standards.

3. Realization by Congress and other regulators that the electric grid of the future is crucial to national security and that the grid of the future must be "smart," with end-to-end, two-way communications that depend to a great extent on wireless technologies.

Allocation of dedicated spectrum for critical infrastructure providers will allow the industries that support nearly all day-to-day operations of the nation to design and build reliable communications systems that are capable of withstanding the challenges facing them. Critical infrastructure entities can no longer be viewed, as they have been in recent years by the Federal Communications Commission, as "commercial" enterprises with the same resources as the nation's public communications carriers to purchase spectrum. These entities are not in the commercial communications business, and they do not build for-profit systems designed to serve high-density populations with consumer-oriented features. Moreover, most utilities are prohibited by either regulation or statute, not to mention insufficient capital, from participating in high-dollar auctions. ***As a matter of national economic and security policy, spectrum and wireless infrastructure used to support the availability of basic necessities like water, gas and electricity must be available at a reasonable cost.***

A. Emergency Communications and Interoperability among First Responders

A utility's ability to rely on communications networks is critical during heavy storms and other serious weather events. In these situations, commercial systems typically cease operation due to lack of commercial power, or become saturated with traffic and, as a result, cannot be relied upon when the need for reliable communications among utility workers is at its peak. Critical users typically lack priority access to the commercial system and even when priority access service is available, it has inherent technical shortcomings. Consequently, utilities have no greater likelihood of gaining access to a crucial communications channel than does the average residential subscriber at a time when entire communities are relying on them for rapid restoration of services. This lack of priority access is simply is not acceptable if utilities are to provide essential services during emergencies.

By designating the internal networks of utilities and other critical infrastructure providers as "public safety radio services," Congress acknowledged that these industries are first responders in the same sense as are police, fire and medical personnel.[3] Often, police and fire professionals cannot adequately respond to a crisis before a gas company shuts down the flow of gas or an electric company makes downed power lines safe, nor can fires be extinguished without adequate water at the locations and times it is needed. The need for disaster-tolerant communications and interoperability can be seen in the aftermath of the hurricane devastations of recent years.

The hurricane season of 2005 resulted in immense damage and tragic loss of life in Florida and along the Gulf Coast of the United States. The responses to storms like Katrina, Rita and Wilma revealed weaknesses in many of our critical infrastructures, including commercial communications networks --some of which are still recovering years later. However, in sharp contrast to much of commercial wireless, landline telephone and other communications networks, most of the private, internal networks (radio, microwave and fiber) of electric, gas and water utilities continued to function throughout and immediately after the storms. In some

---

[3] Following the disastrous hurricanes of 2004 and 2005, after noting the robust performance of their internal networks, the Southern Governors' Association also determined that utilities should be among official public safety entities and recommended that they have access to spectrum. *See,* Resolution, *Expressing a broad set of principles endorsed by the Southern Governors' Association regarding the development of a national interoperable public safety communications network,* Southern Governors' Association, submitted to the FCC May 15, 2007.

cases, utility communications networks provided the only reliable communications among emergency responders and other officials during the first few critical days after the storms.

The reliable performance of these internal systems was neither unexpected nor unusual; utility communications systems are constructed specifically to withstand major disasters. UTC conducted informal polling of its members after such emergencies as a major Northeast ice storm in 1998, the huge electric blackout of August 2003, and the hurricanes of 2004, and likewise found that the internal systems performed reliably.
However, given the magnitude of the hurricane disasters and the resulting national discussions concerning the survivability of communications networks, UTC felt it imperative to undertake a formal survey of Gulf Coast electric, gas and water utilities of all sizes to generate data that would quantify our anecdotal information. Overall findings:

- 86% of impacted critical infrastructure industry (CII) entities responding reported that their communications networks generally survived the hurricanes and continued to operate well throughout restoration efforts, even if on generators
- Private land mobile radio (LMR) networks provided critical communications among crews. However, the huge number of responding entities from around the country taxed capacity or could not operate on local systems, emphasizing the need for CII interoperability through designated common spectrum.
- Utility fiber and microwave systems survived and generally continued to function; however, this was due in part to built-in redundancies, robustness and recovery mechanisms that would be cost-prohibitive for a for-profit network designed to serve the general public. Therefore, CII entities will continue to require private networks to meet mission-critical needs for the foreseeable future, along with the ability to expand them as needed to meet system growth requirements.
- Unfortunately, there was little or no formal coordination with state or local agencies or public safety organizations during or after the storms. Given the opportunities for improved response communications offered by robust CII systems, and the presence of CII personnel “on the ground” in nearly every disaster scenario, this lack of coordination shows that CII MUST be included in emergency response planning at the federal level.

Without exception, survey respondents that maintain land mobile radio (LMR) systems were pleased with their performance during and after the storms. Unlike most commercial wireless systems, these networks are built specifically to weather such disasters and to continue to operate in extended power outages in support of restoration crews carrying out extremely hazardous duties. Where possible, LMR networks also support radios brought in by visiting crews from utilities across the region or from other parts of the country. However, the superior performance of individual systems and the industry in general is offset by the lack of interoperability between systems and the lack of dedicated spectrum to share with other utilities and public safety providers. Valuable time was wasted in restoration efforts where host utilities had no additional capacity or assisting utilities used other frequency bands, because of the need to work around communications difficulties or to use host utility personnel to guide visiting crews without another means of contacting emergency control centers.

LMR is at this time the most critical tool of critical infrastructure communications in emergency situations. It provides for necessary mobility and quality of service as crews travel throughout the damaged service territory. In many cases during events such as Hurricane Katrina, it provides the only means of wireless communications during the first critical days after storm impact. The overall performance of private utility communications systems during catastrophic storms, in comparison with consumer networks, reinforces the industry position that private systems must be maintained and encouraged for emergency response. The emphasis upon reliability for utility operations dictates that critical infrastructure entities not depend upon commercial systems for core communications for the foreseeable future.

However, one downside to the current LMR framework is that responding utilities operate on several different frequency bands: below 100 MHz, 150-512 MHz, 900 MHz and 800 MHz for voice systems alone. This dependence on multiple bands hampers the ability of neighboring utilities to help each other and hamstrings utilities that travel to assist with restoration and recovery efforts. Unlike traditional public safety, energy companies such as electric utilities assume a nationwide response from other entities as part of their emergency response planning. A broad network of mutual assistance agreements and guidelines is in place across the country, and in severe situations such as recent hurricane seasons, other utilities are contacted for equipment and crews. It is not unusual to see crews from 30 or more utilities in convoys of trucks heading for an area under threat of disaster, or immediately after an unexpected disaster strikes. Outside crew convoys, especially from larger utilities, carry their own supplies and stage themselves near the area of disaster impact. In the case of disasters such as hurricanes, they enter the area and begin recovery work as soon as wind levels fall.

Recently, the same nationwide response occurred following Hurricane Ike's devastation from the Gulf through the central United States. Among the utilities responding was Progress Energy:

> On Sept. 13 [2008], strike teams from the Carolinas and Florida headed to Texas to support Entergy and Centerpoint following the damage caused by Hurricane Ike . . . Two portable radio tower teams accompanied the Line & Service strike teams into the field to establish and manage radio communications between crews. These systems, also known as Communications on Wheels (COW), have been used for many years to provide extended radio coverage for the line crews. With the COW systems in place at a central restoration point, radio range is effectively doubled. This allows line crews to work more closely together to restore long feeder lines while improving safety . . . Now safely home, the

> Telecom technicians were among the last of the personnel deployed by Progress Energy to leave Texas.[4]

While most utilities do commendable work with portable resources, assisting utilities should be able to bring their own radios to the area with the knowledge that they will function on the host utility's system. While this was possible in some areas post-Katrina (for example, one utility's new 900 MHz trunked system accommodated assisting crews from two other out-of-state companies), generally host utility personnel carrying local radios must serve as guides and communications links to assisting crews - a waste of personnel and time better spent in recovery efforts. Meanwhile, entities sending crews to assist must obtain emergency Special Temporary Authority from the FCC to use their own portable equipment in areas where they are not licensed to operate. Thus, they can communicate with each other, but not with anyone else. This is hardly an ideal situation. ***In order to take full advantage of the robustness of LMR networks, CII entities should have an allocation of dedicated spectrum on which an open architecture, interoperable system can be built to CII standards.*** Such a system would ensure reliable wireless communication for emergency response, not only to a large number of responding CII personnel, but to other responders as appropriate. The storms of 2005 and 2008, as well as the other disasters of the past and the certainty of more in the future, make a strong case for pursuing this goal.[5]

B. Federal Security Standards and the Use of Wireless Technology

Threats to electric utilities do not just come from potshots at transmission towers or downed lines; some of the greatest vulnerabilities in electric utility networks come within the cyber-based systems that ensure continuous operation and electric reliability. UTC was informed in early 2002 that Al Qaeda operatives had searched Internet sites for US utility Supervisory Control and Data Acquisition (SCADA) frequencies. Moreover, the Department of Homeland Security has identified control system security within critical infrastructure industries as one of its key goals. While the power industry has avoided mandates in the past, the protection of utilities' cyber assets has changed from being taken for granted to being investigated thoroughly, upgraded and tested. More than ever, and likely even more in the future, utilities use a number of different cyber-based systems that are vitally important to their operations and, consequently, to electric system reliability as a whole. Because of this, a typical company that generally deals with core electric issues is now compelled to consider its cyber security vulnerabilities. To address this issue, the North American Electric Reliability Council (NERC),

---

[4] Progress Energy, "People in Progress," October 10, 2008; "Progress Energy IT&T Techs keep restoration crews connected in Texas."

[5] Policymakers also should note that CII does not request government funding in order to build this network; utilities and other users can build and occupy such spectrum as equipment life and budget cycles permit, although the need is widely recognized.

working with industry representatives, has developed and adopted a series of cyber security standards: Critical Infrastructure Protection (CIP) 002-009. The CIP standards now are mandates for those utilities with ties to the bulk power system.

NERC's cyber security standards impact all aspects of utility operations, from human resources, training and hiring practices to information technology system security. One vital aspect of the new standards is the security of networks that monitor and control utility infrastructure. Unfortunately, many highly critical utility control networks currently operate on radio frequency bands that must be considered suspect. Far too many have only secondary (interference-accepting, non-interference causing) status on the 150-512 MHz bands allocated primarily for mobile voice systems. Many more operate on unlicensed spectrum, mostly in the 900 MHz band, sharing it with hundreds of millions of other devices from cordless phones to wireless internet service providers and RFID tags. These are not the best environments for such mission-critical networks.

Two-way, real-time communications among critical utility assets can be accomplished efficiently and economically with wireless technologies. These technologies support machine-to-machine communications that form the backbone of energy distribution. Dedicated, interference-free spectrum is needed to allow utilities to upgrade low-tech systems that have been operating on shared channels for decades. As the land mobile and unlicensed frequency bands become more and more congested, it is only a matter of time before a utility communications system fails due to interference from another authorized user. The result could be power outage or more life- threatening consequences.

C. Implementing the "Smart Grid"

UTC's 2007 report on one aspect of the migration toward the concept of a smart electric grid, ***Advanced Metering Infrastructure (AMI): "Smart" Metering Meets the Smart Grid***, demonstrates that the electric industry faces an enormous challenge modernizing its antiquated architecture. The electric power infrastructure is under pressure: continuing growth in demand, the importance of power quality and reliability in a digital society, aging workforce and assets, physical and cyber security of the electric infrastructure, and environmental and cost pressures are all combining to drive the development of a highly automated power delivery system. For most utilities, the first step in this direction will be the implementation of a system that goes well beyond the traditional view of Automated Meter Reading (AMR) to encompass Advanced Metering Infrastructure (AMI) and AMI's close cousin, Advanced Metering Management (AMM).

For the past twenty years, the industry has focused considerable resources on automated meter reading (AMR), primarily intended to improve the accuracy and cost of monthly revenue reads. Over the past few years, there has been a clear transition from the classic AMR approach to two-way, advanced metering infrastructure (AMI). While receiving reads from the meters is still the largest perceived benefit for the utility, significant benefits can be obtained from the new functionalities provided by technological advance. Today's focus has broadened to a number of related applications leveraging the same technology assets. Dynamic pricing programs, for one, hold great promise for flattening the load curve, but require more sophisticated and granular measurement.[6] From a regulatory standpoint, AMI is popular because of the technology's ability to empower consumers to control their own energy use; for example, setting smart thermostats and appliances to operate during lower-peak periods of less expensive energy.

Communications is the foundation for success of this effort. It is clear that AMI solutions will combine a number of technologies, but wireless communications will be a key aspect. Dedicated spectrum would foster the development of open standard technology that will benefit utilities, their ratepayers and society in general. We must remember that there are portions of the electric distribution network that are over fifty years old. The transition from Automated Meter Reading (AMR) to AMI technology was anticipated in our 1998 report, but the amount of data generated by this means of energy efficiency will require more bandwidth than anticipated previously. Additional two-directional communications capacity, such as among utility assets such as pumping stations, substations, pipelines and transmission lines, will add to the necessary capacity, as will security and control measures such as video cameras at key facilities.

D. Spectrum for the Electric Grid

Finally, we note that the importance of these industries is not going unrecognized elsewhere. UTC Canada, along with the Canadian Electric Association (CEA), has been working with spectrum regulator Industry Canada for spectrum dedicated specifically to enable smart grids. CEA's August 2007 report, ***Federal Policy with respect to Electricity Utility Communications***, provides compelling arguments worth quoting here:

- The energy and utilities sector has been recognized by Public Safety Canada ("PSC") as part of Canada's critical infrastructure — that is, "those physical and information technology facilities, networks, services and assets which, if disrupted or destroyed, would have a serious impact on the health, safety, security or economic well-being of

---

[6] Congress recognized the importance of AMI systems in the Emergency Economic Stabilization Act of 2008, providing for shorter depreciation schedules for utilities implementing metering networks that meet specified, advanced technology criteria. *See,* Emergency Economic Stabilization Act of 2008, Pub. L. No. 110-343, Section 306, enacted October 2008.

Canadians or the effective functioning of governments in Canada."

- Further, it is crucial that policymakers recognize that Utility Communications are the "internal critical infrastructure" of Electricity Utilities. Without dedicated, reliable and efficient internal private communications networks, Electricity Utilities simply cannot operate. Electricity Utilities rely on these internal private networks to ensure the reliable, safe and efficient operation of their power systems, to quickly isolate faults, monitor system stability and status, and to restore power when problems are encountered. Due to the critical nature of Utility Communications, these networks have been deliberately engineered to meet the demanding needs of Electric Utilities. Utility Communications are particularly designed to operate even in the most abnormal circumstances — most importantly, when the power goes out.

Industry Canada is completing a proceeding to allocate 30 MHz of bandwidth below 2 GHz for use to benefit the electric grid.[7] The allocation is part of a frequency band otherwise to be used for next-generation commercial services – and use for the grid is proposed through small changes to the technical rules already in place for the spectrum. The acknowledgment that the electric industry is the foundation for the national economy and warrants a spectrum allocation to ensure the public welfare of Canadian citizens is an example to the FCC and regulators in other countries for similar allocations.

1. 1800 MHz

Harmonization of the Canadian 1800-1830 MHz allocation in the United States would be ideal. While at higher frequencies than traditional land mobile systems, this band is low enough that its propagation characteristics can accommodate voice and data, fixed and mobile applications without prohibitive cost to entities who are not using the spectrum to provide a commercial communications service that will pay back the investment.

In the United States, 1800-1830 MHz is allocated currently for Federal Government use. While it is unclear what agency may be actually using this portion of the band, UTC has been pursuing spectrum sharing talks concerning this spectrum, and believes this should be a textbook example of a successful federal/non-federal sharing arrangement. Utilities build highly robust communications infrastructure that they are willing to share with federal agencies, benefitting both parties. Utilities also understand the special needs of various user groups, and can accommodate them. UTC welcomes assistance with this effort and urges this allocation as the preferred home for a CII/Smart Grid-enabling wireless infrastructure.

Flexibility within the allocation is important: Canada's initial rules do not specify channelization, which allows licensees to determine the appropriate bandwidth for the relevant application to

---

[7] See http://www.ic.gc.ca/epic/site/smt-gst.nsf/en/sf08971e.html for more information on this proceeding.

use the spectrum most efficiently (i.e., more for data transmission, less for voice or low-speed needs) at any given location.

Timing also is critical: utilities are under increasing pressure to implement smarter networks now, and must have spectrum that is appropriate to their needs. A harmonized, nationwide or even international band creates opportunities for high-speed interoperability across IP-based data networks that will help greatly in deploying and improving demand response capabilities, renewable generation sources, and overall reliability and secure control. This goal simply is not possible in today's inadequate and balkanized CII spectrum environment.

2. 14 GHz

In May 2008, UTC, in partnership with Winchester Cator, L.L.C., petitioned the FCC for secondary access to another frequency band as a potential means of alleviating some spectrum pressure. The 14.0-14.5 GHz band is used on a primary basis for the fixed satellite services as well as other satellite operations; however, technical examination revealed potential for additional, terrestrial use. UTC and Winchester Cator proposed access for CII entities only on a secondary, non-interfering basis, with restrictions on power and other parameters to ensure minimum impact on satellite operations.

Such spectrum is quite different from that at 1800 MHz or lower: due to the size of the band and propagation characteristics, transmissions could be wide in bandwidth, but would be significantly shorter in distance traveled. The proposal included a call for a single, nationwide license to a CII entity such as an industry association – this could be UTC, or another – and a "CII Coordinator" with responsibility to manage the spectrum and mitigate any potential interference. The petition remains pending at the FCC.[8]

In spite of strong opposition from the satellite industry, UTC continues to pursue this option: use of the 14 GHz band where possible could permit much-needed short fixed links transmitting high-speed data in routine and emergency situations. However, it must be emphasized that a secondary allocation at such a high frequency cannot meet fully the demands of tomorrow's utilities. America's providers of most-critical services deserve reliable spectrum allocated on a primary basis, with propagation characteristics appropriate to the many applications they must deploy.

---

[8] *See,* FCC RM-11429.

III. Dedicated Spectrum and Private Networks

As mentioned at the beginning of this report, in spite of spectrum needsthat have gone unmet for more than ten years, , the amount of FCC-regulated spectrum available for utility and other critical infrastructure use has declined in the past decade. Unlike traditional public safety agencies, which can point to a total of approximately 80 MHz of spectrum dedicated to their exclusive use, utilities and other critical infrastructure industries such as petroleum and metropolitan transit in fact have *none*.[9] The development of trunking technologies and the release of spectrum in the 800 MHz band provided relief for some utilities in the 1980's, but there has been no allocation of non-public safety spectrum for private wireless networks in nearly 25 years. Losses in the past dozen years include:

- The former Power, Petroleum and other designated frequency pools in the 150-512 MHz band were combined into the larger Industrial/Business pool and left open to all private wireless eligibles, including commercial systems, leading to rapidly increasing congestion and interference.
- Multiple reorganizations and auctions of the 800 MHz PLMR band, including the most recent "rebanding" to reduce interference from one commercial network, have resulted in less spectrum being available to CII entities, tighter packing of systems across the band, and virtually no frequencies left for critically needed expansion of utility networks as energy and water services expand.
- The already-small 900 MHz PLMR band was split between private and commercial networks and the commercial frequencies were auctioned. For the past three years, the FCC further threatened to auction any remaining "white space" on frequencies used by utilities and other critical systems, while the band remained frozen to any new systems.
- Frequencies allocated to the Multiple Address Service in another part of the 900 MHz band – important for utility control networks – were proposed for auction. After concerted action by licensees, the FCC divided the band and auctioned only half the frequencies. Those remaining for private use have been completely licensed and are rarely available anywhere in the country; meanwhile, multiple auctions of the rest of the band have been less successful, with the FCC still retaining many licenses that are going unused.
- Important frequency bands used for fixed service data transmission in the 1.9 GHz, 2.1 GHz and higher bands have been re-allocated over time for yet more commercial wireless networks and satellite services, with utilities and other users required to relocate to higher frequencies with inferior propagation.

---

[9] The exception to this deplorable situation proves the rule: the U.S. railroad industry was granted exclusive use to six pairs of 900 MHz PLMR spectrum of 25 kHz each, a total of 125 kHz (one-eighth of one megahertz). The grant came only after the railroad industry showed that it had been granted access to the same frequencies in Canada.

These trends have resulted in a net loss of spectrum available for critical infrastructure industries. Future applications of wireless technology will rely heavily on the marriage between technology and regulatory flexibility. Utility companies will require advanced wireless technologies to accommodate a variety of energy and water operational advances. However, the necessary changes to federal communications policy that would recognize the importance of critical services and their reliance on private wireless systems remain elusive.

As discussed above, wireless technology has become a backbone for many trends in advanced metering infrastructure (AMI) and “smart grids,” computer aided dispatch, vehicle tracking, telemetry and numerous other core business support mechanisms. It is apparent that regulatory guidelines must continue to allow the utility industry to improve service and operations, increase overall customer satisfaction and compete fairly in a competitive market. It is imperative that utility organizations and regulators encourage the development of spectrally efficient technologies that will allow them to provide the best possible utility service to the public. Even spectrally efficient technologies will, however, continue to require additional spectrum allocations for successful implementation.

In 2000, UTC was instrumental in winning from Congress a mandated study on the current and future spectrum needs of the energy, water and railroad industries. The study was carried out by the National Telecommunications and Information Administration (Department of Commerce) then forwarded to the FCC. On July 30, 2002, the FCC issued a Staff Report on the study. Despite acknowledgment by NTIA of “the vital roles that the railroad, water and energy industries play in the Nation’s critical infrastructure and that the events of September 11th underscored the importance of these industries not only in the daily lives of the public but also in times of disaster response and recovery,” the FCC declined to propose or make any specific spectrum allocations to CII.

Since 2001, the FCC has devoted significant attention to providing spectrum to Public Safety users, including its current work to provide a public/private network in the 700 MHz band to be built by a carrier. While regulators struggle to develop funding mechanisms for Public Safety’s communications needs, UTC calls on the FCC to address the acknowledged needs of utilities and other CII entities, which also play a vital role in Homeland Security through their operation of the infrastructures on which all Americans constantly rely. UTC stresses that the CII community does not seek funding or help in building networks – just the spectrum that is vitally needed to operate them.[10]

---

[10] As stated above, interoperability is a need among utilities, as well; however, our needs are different from those of Public Safety. UTC’s members currently are engaged in defining interoperability for this industry’s purposes, including communications within utilities, among utilities for both voice and telemetry purposes, and between utilities and other responders such as public safety agencies when necessary. Spectrum will be key to this effort.

A. Why Private Systems?

Private communications systems are generally defined as those systems that support a company's internal communications requirements (e.g., directing a group of employees to work assignments in a dispatch radio system). They are to be contrasted with "commercial" wireless systems. Commercial systems are defined as those which:

1.) Provide communications service for a profit;
2.) Are interconnected to the public switched telephone network (PSTN); and
3.) Are offered indiscriminately to the general public.

Utility networks differ from their commercial counterparts in that they meet none of the above criteria and in fact, are built to an entirely different economic model. Four major success factors are used when designing utility networks: coverage, availability, capacity and functionality. All of these have the goals of personnel safety, infrastructure safety and, connected to these, the reliability of the critical service provided.

Coverage is usually specified as a minimum of 90% of the affected service area, based on the utility service area and not on the location of population centers. Crews engaged in hazardous operations need to be able to communicate wherever they may be working, and control networks obviously need to go wherever lines and pipes are located.

Availability needs to be as high as 99.9% or more to provide the ability to survive natural disasters. Built-in redundancy, including power supply, is essential to ensure that the communication network remains functional during and after a major disaster.

Utility networks must have the capacity to handle tremendous increases in traffic generated in response to major storms and disasters, when traffic can increase by 500% and more above normal traffic levels. While some private wireless users are criticized for less than commercial density on their networks, critics are missing the point: these networks are built for the work they must do in emergencies, not for routine adequacy.

Finally, the networks must have the functionality to allow timely, accurate communications. Sub-systems such as status messaging and packet data capability have been proven to provide accurate information transfer and dramatically improved spectral efficiency. Functionality demand will grow as systems enlarge and more intelligence is added.

Private systems are critical to reliable and efficient operation in the energy and water industries, as well as in other CII sectors. Commercial systems can (and do) provide some of a utility's everyday business communications requirements. However, two substantial issues prevent commercial entities from providing all service:

a.) The need for system control, and
b.) Unique design requirements.

Differences in overall design philosophy can be seen in private versus public wireless networks:

Public systems:

- strive for coverage among maximum populations and density to improve profitability
- limit tower site overlap
- emphasize low cost infrastructure implementations
- may or may not utilize the NTIA priority access protocol
- perform system maintenance independent of user's needs/requirements
- limit talk group configurations (tens of participants)

Private systems:

- require geographic coverage regardless of the financial return potential
- design for site overlap redundancy
- emphasize power supply and connectivity redundancy
- deliver highest priority to the owner
- control system maintenance schedules
- allow large talk group configurations (100's of participants)
- provide emergency alert functions

These few differences deliver widely varying results to a CII entity both during routine communications or during and immediately after major storms and disasters. It has been stated that the events in 2004 and 2005 make a profound case for the high reliability of CII private radio systems (the 2008 storm season saw similar performance). Each time hurricanes pounded the Atlantic and Gulf of Mexico shorelines, utilities were able to respond immediately using their private radio systems. Many other private radio systems, including some public safety systems, and virtually all commercial systems could not withstand the damage inflicted. While these failed systems were able to be brought back into service in the hours and days following these major storms, it was by and large the CII radio systems that survived and provided critical communications throughout the events, enabling much faster and safer restoration of basic services to the public than would have been possible without reliable communications.

Perhaps one of best ways to determine the ability of commercial systems to provide CII wireless communications is simply to examine a contract for wireless services from any commercial carrier. The inclusion of a comprehensive force majeure clause should be an indication that the public network operators are not confident in their abilities to provide continuous services during emergency conditions which CII entities face on a regular basis.

CII organizations should closely examine their “worst case” disaster scenarios to determine how their field employees will communicate during a major disaster, when the safety of utility field employees and the public at large is at greatest risk.

Energy utilities face important public safety issues on a daily basis. One large midwestern utility reported in a recent year that it responds to an average of over 285 natural gas leak and carbon monoxide calls *per day*. Because the utility responds to these calls and takes corrective action, a traditional public safety organization will not need to respond to 285 potentially tragic situations. The reporting utility’s figures are not extraordinary; extrapolated across the country, utilities respond to literally tens of thousands of life or death emergencies each day, before any occurrence of a major disaster such as a hurricane, earthquake or ice storm.

One obstacle to necessary clear communications from commercial networks is the fact that most commercial systems depend upon utility-provided commercial power to keep their systems running. If power is interrupted, these communications systems will be interrupted as well,[11] further impeding progress on power restoration. Private communications networks ensure that utility systems are brought back on line in the timeliest manner possible, without the complications caused by interdependencies between commercial power and communications systems.

B. The Need for System Control

Because of the unique nature of electricity, gas and water delivery, reliability and control are of critical importance. To prevent disaster, it is imperative that communications systems remain functional and accessible during storms and other natural events.

---

[11] Standard commercial wireless practice is to provide battery backup to cellsites of 2-4 hours, enabling the site to shut down in a power outage without losing valuable network data. Still pending at this writing is an FCC mandate that wired and wireless networks provide eight hours of power backup at their facilities. While the carriers and their industry association are fighting the mandate furiously in the courts, even eight hours of backup is completely inadequate as a standard for CII: most utility radio base stations are equipped with generators and up to two weeks’ worth of fuel.

During heavy storms and other emergency situations, commercial systems become saturated with traffic and, as a result, experience outage. Because commercial systems provide indiscriminate service to the general public, utilities have the assurance of workable priority access to the system. Consequently, utilities have no greater likelihood of gaining access to a channel than the average subscriber. It is precisely during these emergency situations that utilities require unencumbered, clear radio channels to address downed lines and other power outage problems.

C. Unique Design Requirements

(Service Coverage and Service Availability/Response Time, System Stability)

One serious shortcoming of commercial service providers is that they often do not provide service throughout the utility company's service territory. For example, a cellular operator may deem it unprofitable to deploy sites in remote areas where usage is likely to be light or nonexistent; however, utilities still require reliable wireless service in such areas. Special interfaces must be developed to connect wireless communication networks to a utility's dispatch console systems, mobile data systems, and SCADA systems. Another shortcoming of commercial systems is that they likely are not designed to the high performance standards requirements in the daily operation of a utility system. Often, response times measured in milliseconds (ms) are required to avert catastrophic disasters. For example, high-speed tele-protection systems require response times of 20 ms or less in order to isolate portions of the power grid experiencing electrical faults before the faults can spread to other portions of the electric grid. Many event monitoring systems require a resolution of 1 ms; short-term (or long-term) system outages are not acceptable. Commercial systems, designed for voice traffic, may not be designed to meet the robust standards required by utilities, even if such specialized devices are manufactured for operation on commercial networks.

D. Influence of commercial systems on private needs

As indicated above, utilities use commercial land mobile systems (i.e., cellular, PCS or ESMR) to augment their voice systems in appropriate situations. Commercial data systems are also employed. While these services can supplement a utility's private communications networks, it is highly unlikely that they will be able to serve as an adequate replacement for the utility's private internal system.

The present study of utility spectrum needs has accounted for commercial system usage. As in our 1998 study, it was assumed that approximately 10% of spectrum requirements would be satisfied by commercial systems in the future.

IV. Restructuring of the Electric Utility Industry

Driven largely by industrial customers, electric utility restructuring continues to unfold in a number of states. Restructuring was previously labeled "deregulation," a misnomer because there will still be a great deal of regulation even with restructuring. It is perhaps better labeled "reregulation," since regulation will be redesigned and redistributed, but still pervasive. The need for energy efficiency, coupled with increasing demand for energy, point to new regulatory mandates that, once again, will change how utilities structure themselves to provide the best service. Further changes to the basic framework of the U.S. power infrastructure are coming, as renewable energy generation sources are added to the grid, transmission systems adjust to promote “clean” power over that produced by coal-fired generating plants, and consumers both exercise more power over their energy use and generate power on their own premises.

A. What is restructuring?

Restructuring was essentially the transition from "vertically integrated," monopolistic electric service to competitive service. To discuss restructuring, one must first look at how a traditional utility is structured.

Generally, there are four functional units within an electric utility:

1. Generation
2. Transmission
3. Distribution
4. The Customer Information Unit

The generation unit converts some resource (e.g., oil, coal, nuclear fuel, air flow, water flow, etc.) into electrical energy. Electric power does not generally lend itself to efficient storage, so the amount of generation will be based upon expected demand.

The transmission unit carries the electricity that has been generated to areas where it will be used. Often the source of generation, a dam for example, is far removed from the end user. To effectively carry power long distances, it is necessary to use high-voltage transmission lines. The distribution unit of the utility lowers the transmission voltage to practical usable voltages and delivers the electricity to the end user: homes, businesses and industry

The fourth unit, the customer information unit, is the interface with the customer, providing metering and billing for the use of the electricity. As discussed above, utility involvement with customers is becoming stronger with the advent of smart appliances and smart meters, among other devices that can enable the public to customize various services.

Prior to restructuring, the above operational units often fell within the control of a single utility entity. In a restructured environment, however, some, if not all, of these constituent parts are separated and operated by independent entities. The above model also is limited to investor-owned utilities. Although this is the best known to many consumers, a significant percentage of Americans get energy from their municipalities, and nearly all obtain their water from publicly owned entities. In rural areas, services may come from cooperative utilities that are owned by their customers. While models vary, municipalities and cooperatives generally do not generate the power they distribute, but purchase it at wholesale rates from other utilities.

Additionally, new entities may be created. Around the country, reliability regions now include an Independent System Operator (ISO). This non-profit company is employed as an independent manager of the transmission network to ensure equal access to the transmission grid by all generators. A power exchange (PX) may also be employed to act as a broker for bulk power.

To get a better sense of California's restructuring plan, visit the California Energy Commission's Restructuring Web site: http://www.energy.ca.gov/restructuring. Another comprehensive Web site on restructuring is the U.S. Energy Information Administration's Restructuring site: http://www.eia.doe.gov/cneaf/electricity/page/restructuring/restructure_elect.html. This link provides an interactive diagram that shows the status of this effort in various states as of November 2007.

B. How does Restructuring impact communications?

Communications will be an even more integral part of utility operation after restructuring has taken full effect, as it will still be necessary to reliably control the vast network of deployed electric networks, now owned by different entities. In fact, a greater need for wireless communications may exist due to reduced staff. As the industry becomes decentralized and power sources become increasingly dispersed, precision control systems will become critical. Additionally, automated processes and remote access will become more prevalent. Obviously, such changes also drive a need for interoperability on various levels. This will be practicable only to the extent that communications infrastructure can support these applications.

To survive in a competitive environment, the new utility will need to keep costs to a minimum. As a result, some communications requirements for less critical applications will likely be outsourced. However, the utility will still require extensive private communications systems to support its critical infrastructure.

V. Updated Utilities Spectrum Assessments

In 1998, UTC's *Utility Spectrum Assessment Taskforce* (USAT) report provided an evaluation of the spectrum requirements for utilities based on surveys, interviews and a spectrum needs analysis. UTC's analysis was based on a methodology used by the Public Safety Wireless Advisory Committee (PSWAC) in a similar report published in 1997. The communications requirements for Los Angeles County served as the basis for the study, and the components included voice, narrow bandwidth status messaging, broadband data and video. Estimates of nominal increases in demand for these services through 2010 led to the estimates previously provided:

In 2002, UTC conducted another study in conjunction with then-consultant KPMG that created a model to determine the voice communication requirements of agencies upgrading their land mobile voice communication systems. The Wireless Upgrade Model (WUM) extended the PSWAC model by considering frequency bands and the differences in spectrum requirements for analog, digital and trunking equipment technologies. The WUM tool allows for analysis of specific requirements based on territory square mileage, number of users, frequency band and technology. UTC and KPMG also created generic parameters for small, medium and large utilities in rural, suburban and urban markets.

With this tool, UTC created a matrix that details the spectrum requirements for voice dispatch communications for small, medium and large utilities using a variety of technologies and frequency bands. Other parameters include an assumed 30 minute per day talk time per mobile radio and 12.5 kHz channel spacing for all bands except 800 MHz. If we assume each market has a combination of small, medium and large utility operations comprised of water, gas and electric services, it is conceivable that dispatch communications alone can require between 6 MHz and 15 MHz of spectrum. This makes up the first component of the USAT spectrum recommendation for 10 MHz of spectrum for dispatch communications to support day-to-day operations, emergency response peak communications and utility interoperability in times of natural disaster. As utilities upgrade their land mobile systems to the FCC's requirement to migrate to 12.5 kHz bandwidth, an allocation of 10 MHz of bandwidth for critical infrastructure voice communications will both serve the utilities' needs and free up land mobile spectrum for other users who have been unable to identify suitable spectrum due to congestion.

The second aspect of critical infrastructure spectrum needs is the increased reliance of data services to the vehicles. We describe these applications in Appendix A. While the requirements of data services were anticipated in the 1998 USAT report, recent work with UTC member utilities shows that the FCC's drive to narrow bandwidths in the land mobile bands is hindering the speed at which data can be sent to vehicles. Mobile data applications are becoming increasingly graphics oriented, and the FCC's stated efficiency standard of 4800 bps per 6.25 kHz bandwidth does not allow for the needed throughput. Additionally, already-congested land mobile spectrum simply will not support the need for needed, and reliable, spectrum. Our members are seeking broadband data rates to vehicles, substations and other assets and are focusing on internal systems to support protocols like WIMAX if adequate spectrum is available.

The need for data to the vehicle and facilities can be combined with spectrum anticipated for AMI implementation to allow for combined utility data networks. Recent surveys show that one aspect that hinders AMI deployment is the lack of available spectrum. Utilities are willing to build mesh networks using WiFi and WiMAX systems to support this effort. A spectrum allocation can support both AMI and vehicle data requirements and drive standardization of AMI and data platforms. An allocation of 20 MHz of spectrum will foster this effort.

Finally, we have shown in this report and in others that the security of our nation's utility infrastructure depends on monitoring of assets, and existing, aging infrastructure cannot support this effort. The level of monitoring needed includes video and high data rates to substations and other utility assets. These requirements add to the 10 MHz of spectrum already discussed; in order to support them, an additional 10 MHz of spectrum is essential.

Therefore, the recommendation of this report is that critical infrastructure agencies providing vital services to this nation be allocated 30 MHz of spectrum to support emergency and dispatch voice communications and the extensive data needs of vehicle communications, smart grid implementation, modernization of aging communication assets and security monitoring of critical assets. It is no coincidence that this is the same spectrum request being discussed and finalized by the Canadian government. Utility communication spectrum needs has been a topic of discussion for some time and we hope the US will follow the Canadian lead, especially since the power infrastructure of the United States in general is overseen on a North American basis.

The 1998 USAT report anticipated some of these requirements, though it underestimated the importance of data in the post-9/11 world. With 10 MHz of spectrum for a nationwide voice dispatch allocation and 20 MHz of spectrum for high speed data to support vehicular data needs, AMI and smart grid implementation and security needs, the critical infrastructure industries can commit the funds needed to use new technologies for the benefit of the country as a whole.

VI. Conclusion

Today's utility must design and implement communications networks to meet ever-changing service expectations. Networks must provide coverage, availability, capacity and functionality. In addition to needing access to wireless communications, utilities have a separate requirement: control over the communications system. For a number of reasons, utilities have found that this control can be satisfied only through the use of private radio systems. The transmission and distribution of gas and electricity pose challenging problems. These two commodities, delivered to customers on demand, can be extremely volatile and require "real-time" control to be administered effectively. Water systems also require substantial control; loss of water supply to an urban area, community or to the site of a fire could cause disastrous consequences, and a break in a water main must be addressed in short order. Therefore, while commercial communications systems may meet some of a utility's communications needs, utilities will continue to need internal private systems for the foreseeable future.

Federal and state mandates that utilities migrate to "smart grid" technology will result in a dramatic increase in the amount of data capacity that utilities need to serve their clients and meet federal guidelines for modernization and network security. For these reasons, it is appropriate to update the initial results of the USAT study to include estimates of capacity needed for smart grid initiatives, cyber-security initiatives and lessons learned from recent disasters like the hurricanes in the Gulf region. We have shown that an allocation of 30 MHz for critical infrastructure industries would meet these capacity needs through 2020.

Since 9/11, public safety agencies have seen such an influx of spectrum that they do not have the funds to build a fraction of their allocations. And rather than partner with utilities, also designated as public safety agencies, these entities seek to form a partnership with commercial carriers whose sole interest is acquiring new spectrum to support shareholder interests. In contrast, critical infrastructure has seen a net loss of spectrum. The bands below 800 MHz become increasingly congested. The 700 MHz spectrum is not available to critical infrastructure. The 800 MHz band is embattled with its rebanding effort, and the tiny 900 MHz band is frozen, although the FCC has determined against its auction proposal. . Regulators seem to forget that even public safety's response plans depend on utilities to respond as quickly as police, fire and medical personnel, yet utilities are not provided the spectrum tools necessary to meet these demands.

A spectrum allocation will rectify these increasingly dire issues and allow for utilities to modernize infrastructure. Utilities cannot go to spectrum auctions for relief; the rate base will not support a large, let alone unknown, capital expenditure such as carriers can make; outcomes are questionable; and many utilities are statutorily prohibited from even considering them. Relying on commercial networks in times of crisis does not work when there is no electricity, gas or water to support the emergency needs of first responders, including critical infrastructure.

Appendix A: Utility Wireless Applications

The Utility and Wireless Applications

The following paragraphs will illustrate the focus of the USAT: wireless applications within the utility operations context.

1. Voice

Voice communications continue to play a critical role in everyday utility operations. However, voice requirements will probably not change as dramatically as requirements for data and video communications. Voice requirements will be dominated primarily by forces such as labor force distribution and less so by technology. Various concepts in wireless voice communication are discussed below.

2. Dispatcher to Crews

This is a typical communications path between dispatchers and field personnel. The call types are typically business oriented with emphasis on operating the business in a safe and efficient manner. Dispatch communications is sometimes referred to as a one-on-many type of communication. Like public safety communications, it is this one-on-many function that has not been replicated successfully by any other technology. In the utility business it is quite common to have a need to “broadcast” vital information to every unit in the field. The function of opening and closing switches on electric distribution and transmission systems is so dangerous that an “all units” type of broadcast is essential to keeping field workers safe.

Due to the increasing use of data networks, we cannot lose sight of the need for voice communications. Utility workers must always have the ability to grab a microphone and call for help.

During emergency restoration of energy services, utilities commonly reassign in-house employees from unaffected areas as well as utilize personnel from other utilities and contractors. This results in significantly more workers in the field than on a normal workday. A utility’s workforce can increase many-fold under such conditions, and it is not uncommon for several hundred units to need to be able to hear messages. No public networks have this capability.

3. Crew to Crew

This function relates to the typical communications between field users. These communications are used for the coordination of daily activities to maximize the safety and efficiency of operations and are typically used when two or a limited number of employees are involved in a conversation. Communication across a single job site is an example.

4. Emergency Call

This function is typically initiated from a field user to a dispatcher. As the name implies, the call type is an emergency where loss of life or property is imminent or has already taken place. Utility work is very dangerous work, demanding professionals to bein close proximity to and handle high voltage conductors and high pressure natural gas. A review of the US Bureau of Labor Statistics, Table A-1 Fatal Occupational Injuries by Industry for the past four years that data is available shows that utility worker lost of life increased from 2005 to 2006. When compared to traditional police and fire protection workers, we see that utility workers are at significant risk when doing their jobs.

Table 1. Comparison of Occupational Fatalities[12]

Occupation	2003	2004	2005	2006
Utility Workers	131	51	30	52
Police Protection	126	119	125	110
Fire Protection	38	37	28	42

The ability to instantly alert co-workers and dispatch staff of a life threatening emergency can and has prevented the loss of life.

5. “Talk Around”

In many operations between field users, routing a call through the network or a repeater is not feasible for a variety of reasons. A talk around mode is necessary so that the field users can communicate with each other, within the range of their mobiles and portables, without the assistance of a network or repeater. We see this used frequently on job sites where a wide area communication is not desired or necessary.

6. Interconnect

In nearly all field activities, users need to communicate with people by way of landline telephones. Telephone interconnect is a necessary option for many of the present day radio systems. We can see from the experience of Mississippi Power in responding to Hurricane Katrina that their ability to utilize their interconnect function from their wireless network was compromised by the hurricane-inflicted damage to the PSTN network. However, the ability to communicate to field work crews was maintained.

7. Trunked Operation

Trunked operation involves the dynamic allocation of communication channels. When a channel is requested (via a control channel), a computer searches for an available frequency pair and assigns it to the party requesting it. This eliminates scenarios in which many users are

---

[12] http://stats.bls.gov/iif/oshcfoi1.htm#rates

waiting for a channel while other channels remain idle. This technology is used by the cellular industry.

Traditionally allowed only in the private land mobiles of 220, 800 and900 MHz bands, trunked operation is now permitted on all channels below 512 MHz. While the issue of channel exclusivity must still be reconciled by users seeking to deploy these systems, it is common knowledge that trunked operations provide for efficient use of spectrum. Centralized trunking on the "shared" channels below 512 MHz has been extremely difficult for utilities due to their typically large service areas and the need to clear or obtain trunking concurrence from the multitude of existing licensees already on these shared channels.

8. Mutual Aid/Interoperability

Utilities need to communicate with adjacent utilities or local public safety or civil defense authorities in emergency situations, or with other utility crews brought in to assist with restoration efforts. In the wake of deregulation, the utility industry is becoming increasingly fragmented, and with more parties involved, interoperability will become a critical consideration.

Due to the lack of specific spectrum allocations, utilities have been forced to develop limited workaround processes to address their inability to directly communicate in emergency situations. The 2004 and 2005 hurricane activities in the Gulf region are an example of how and why utilities maintain mutual aid arrangements. Attempting to reconstruct the utility infrastructure on such a massive scale places significant demands on communication networks. Not only must the utility wireless networks survive the initial incident, but they must also have the ability to pass significant increases in internal traffic and to support mutual aid workers.

9. Data: System Monitoring and Control, Reports and Status Messaging

The efficient operation and coordination of plants used to deliver electric power, water, gas and steam is totally dependent on the effective use of data communications. Large transmission and distribution networks that are spread over vast areas require remote administration. Data applications bring necessary control and status information to system operators' fingertips.

As electric loads have increased and generation plants have become increasingly removed from the distribution market, data communications have become paramount to efficient system operations.

10. Telemetry, Protective Relaying

The utility industry relies on data communication systems for the purposes of controlling electrical distribution systems and pipelines which include gas, steam, and water. Electrical distribution systems utilize these data links to trip circuit breakers in the event of a power fault or short circuit. They also utilize these systems to control the amount of load, which the generation facilities have to serve during peak demands. The pipeline systems utilize similar techniques for the purposes of controlling valves to reroute or inhibit the flow of materials in the event of a failure of a section in a pipeline network.

11. SCADA (Supervisory Control and Data Acquisition)

Supervisory Control and Data Acquisition (SCADA) systems are computer-controlled radio communications links that provide for the remote administration of facilities. These systems allow a user to control and monitor equipment without having to deploy staff to the location of the equipment. Additionally, they provide for very fast monitoring: usually the master station can poll all remotes in a matter of seconds. These systems are point-to-multipoint networks usually configured in a “star” architecture. In each area, one “master” station communicates with multiple Remote Terminal Units (RTUs), usually in the 450, 900 0r 1427-1432 MHz bands of the electromagnetic spectrum.

As modern utility systems have increased in complexity, SCADA systems have become critical components of infrastructure. These systems help to automate tasks like opening and closing circuit breakers, monitoring system stability and monitoring alarms for overload conditions. Additionally, they are used for monitoring and controlling pumping stations and other critical components of water networks.

12. Automated Meter Reading

The electric power infrastructure is under pressure. Issues such as continuing growth in demand, the importance of power quality and reliability in a digital society, aging workforce and assets, physical and cyber security of the electric infrastructure, and environmental and cost pressures are all combining to drive the development of a highly automated, responsive and resilient power delivery system. For most utilities, the first step in this direction will be the implementation of a system that goes well beyond the traditional view of Automated Meter Reading (AMR) to encompass Advanced Metering Infrastructure (AMI) and AMI’s close cousin Advanced Metering Management (AMM).

AMI refers to systems that measure, collect and analyze energy usage from advanced utility meters through various communications technologies on request or on a pre-defined schedule. This infrastructure includes hardware, software, communications, customer associated systems and meter data management hardware and software. Related to AMI is Advanced Metering

Management (AMM), which refers to the distribution of meter-obtained data throughout the utility for use in improving the operational efficiencies of various departments. AMR, or “Smart Metering,” was originally promoted as Offsite AMR, Mobile AMR, etc. Since the 1970s, dozens of firms have been launched, investing hundreds of millions of dollars into R&D, technology trials, and small-scale system deployment. A wide range of technologies for enabling AMR have been developed, evaluated, and many have been discarded. For example, AMR was initially implemented over telephone lines; in 1993, few people could have predicted that the percentage of homes with landline telephones in the US would actually decrease.

13. Home Automation

An integral part of the smart grid trend is a data application referred to as home automation. This service allows appliances to be monitored or controlled from a remote location, allowing consumers to turn on lights, sprinklers, air conditioning units, etc. from a remote location or in an automated manner. It also enables a utility to monitor wasteful appliances and to alert consumers on how to better manage electricity consumption.

14. Security

Other common data needs include security system monitoring systems. As with many other entities, security systems are essential to help protect lives and property from destruction or tampering by individuals.

15. Mobile/Personal Data Computer/Terminal Applications

In order to maximize the effectiveness of personnel in the field, mobile office environments utilizing wireless data communications are being developed and deployed. These mobile offices would provide instantaneous voice, data and video access to other utility personnel, various utility data repositories, personnel from other utility related disciplines and commercial networks. Utilities are beginning to incorporate these mobile offices into a paperless environment inclusive of multimedia transfer. There is a need for real-time support of wireless mobile and portable computer systems capable of transmitting and receiving routine data queries and responses, electronic mail, location data and other graphics including equipment schematics along with incident-specific data. There is also a need for communications support of wireless mobile and portable computer systems capable of transmitting and receiving incident specific data and intelligence. Support for these systems should accommodate: the transmission of text, such as electronic mail; secured and unsecured individual and group messaging; multilayered geographic information data (GIS); and real time data, such as automatic vehicle and personnel location, weather and atmospheric conditions, hazardous material or environmental/equipment conditions and incident intelligence received from remote sensors or directly keyed.

The growth in use of mobile data computing is offering today’s utility many advantages. Foremost are productivity increases due to the employee arriving at the job site better informed and prepared to accomplish the needed work. The ability of the employee to access a wide range of resource material from the job site, such as equipment diagnostic materials, wiring diagrams, etc. results in productivity improvements. Automating interfaces to back office systems assists with customer billing, employee timesheets, vehicular use records, materials used replenishment, and a host of other benefits.

This growth is illustrated by the chart below, which documents the annual increases in data traffic seen on a large utility network. The most recent year shows that data traffic has increased to a full third of voice traffic.

For the utility system represented in this chart, it should be noted that of a total fleet of 2700 mobile radios, a total of 850 were equipped with wireless data. Work is underway to equip an additional 600 vehicles with data units. This change can reasonably result in the percentage of data used to continue to increase.

16. Wireless LAN/WAN Connectivity

Typically operating in the unlicensed 2400– 2500 MHz and 5.8 GHz bands as well as the infrared regions of the electromagnetic spectrum, the wireless LAN allows the freedom to roam while maintaining connectivity to a LAN. A transceiver and antenna interface attaches to a personal computer and allows it to connect with a LAN without being attached to a run cable.

17. Remote Device Monitoring

Utilities require the ability to monitor remote device indicators via data transmission. For example, the real-time ability to monitor air quality standards at chemical and nuclear incidents is needed to help establish evacuation plans. Data transmission capabilities must support transmission of wind speed and direction, temperature, and a time and date stamp. The data bank of remote device transmissions must be accessible by remote computer or terminal for incident tracking and decision support by field personnel.

18. Robotics support

In extremely hazardous situations, safe access may only be accomplished with remote equipment supported by robotics, such as with hazardous material containment. The operation of this equipment will be heavily dependent upon wireless data connectivity.

19. Commercial Services

Cellular Digital Packet Data (CDPD) was a commercial service that some utilities used for their data communications needs. This architecture is no longer available as commercial carriers completely embrace digital technology. The utilities that made use of this technology are forced to seek other spectrum solutions for data communications.

20. Status Messaging

Status Messaging systems enhance spectrum efficiency by allowing short, preplanned messaging, typically between field units and a centralized dispatch center. These short bursts of data can deliver a short message quickly and far more efficiently than voice communications.

Typical uses allow a mobile unit operator to relay a need to talk to dispatch by sending a Request to Talk message. This allows dispatch to orderly address all traffic during peak traffic periods. Other messages commonly used include: Request for Work, At Scene, Need Supervisor, and others.

21. Wide Band Data and Static Imaging

a. *Still Photographs*

Utilities require the ability to transmit still photographs on demand to other locations. For example, a worker in the field should be able to transmit a digital image of a critical circuit element, construction detail, or possible safety situation to a remote location upon demand.

b. *GIS/Map Data and Technical Diagrams*

GIS (Geographic Information Systems) are becoming increasingly prevalent in utility operations. GIS systems allow for the accurate combination of general map data with system specific infrastructure. Discrete landmarks can be pulled up from a computer database and displayed graphically on a map on a computer screen. Users can easily see the precise location of transmission towers, transformers, company buildings, etc. on a street map. GPS (Global Positioning System) receivers now facilitate the population of GIS databases by allowing for the quick determination of accurate coordinates for various infrastructures (e.g., transmission towers, radio towers, transformers, etc.). Real time wireless access to this information will be necessary for the utility of the future.

Additionally, electronic documentation and the "Interactive Electronic Technical Manual" will become increasingly pervasive in the future. Real time access to these resources will be necessary and will require wideband channels to accommodate complex diagrams and the accompanying links/text.

22. Video

Utilities are focusing more and more on security issues, both from a local focus as well as from a national perspective. The ability to adequately monitor and safeguard the important infrastructure assets that utilities require will mandate the application of technology solutions such as remote monitored video. Without the spectrum allocations to support such requirements, the utility industry will be hard pressed to meet emerging security requirements and regulations.

Utilities are continuously looking for new techniques to lower customer minutes of power interruption. Storms and natural catastrophes are a major source of distribution and transmission line outages which cause these customer interruptions. Real time video is one such technology that would greatly enhance a utility's ability to expedite damage assessment. During wide spread outages, video cameras mounted on helicopters would provide accurate assessments of damage location and ensure proper crew and vehicle deployment. Utilities currently deploy crews based on limited information, not always understanding the type or extent of the damaged facilities. Real time video feedback to operation centers would help facilitate restoration of power in the shortest time possible.

There is also a strong and developing need for wireless video services to enhance daily operational efficiencies and to deal with emergency conditions where it is important to communicate the complex and often dynamically changing details of the situation to others in the command or worker/supervisory chain. Video systems are very valuable tools when public service entities respond to catastrophic events such as train derailments, tornadoes, hurricanes, or earthquakes. For example, ice storms, such as the one that hit upstate New York in the winter of 1998, caused thousands of lines to go down. Video images of disaster areas sent from the field would have greatly assisted with power restoration efforts.

The basic requirement for video/imagery is immediate, clear wireless transfer for all utility personnel upon all demands, major and minor, created by utility-related field situations and emergencies. Video/imagery capture and display systems must be capable of transceiving specific replications and should accommodate video and imagery from multiple sources, including privately owned and utility controlled. For example, automatic aid agreements with public safety agencies could often require quality video/imagery of incident scenes for utility command personnel, either directly or through retransmission.

As an extension of the data-related security monitoring systems above, video surveillance provides much more information in specific situations than typical alarms can provide. In many cases, the video surveillance would be most effective if made available through a wireless means instead of via wireline.

Multiple departments may need to be able to monitor video transmissions, but the ability to access utility video must be based on a "need to know" or incident management basis. Certain situations may require encryption of the video stream in order to preclude casual monitoring.

a. *Incident Video*

Some incidents, such as repairs to sensitive areas of a nuclear power plant or emergencies, require real-time video. While these incidents may be infrequent in some areas, other areas will have a more frequent demand for real-time video. The capability must exist for both point-to-point and point-to-multipoint use of the video. For example, full motion video must be transmitted from the incident scene to either an incident command post or to a remotely located emergency operations center. Hurricanes, major fires, chemical/nuclear incidents, etc., may require monitoring of the incident from more than one location. A specific need exists for the real time transmission of Haz Mat scenes from the incident location to the incident command post and to remotely-located emergency operations centers.

b. *Surveillance and Monitoring*

Utilities require the ability to transmit video snap shots at the rate of approximately one frame every 5 seconds for surveillance and monitoring purposes. For example, sub-station surveillance and building security would be adequately served by this quality of video transmission.

c. *Aerial Surveillance Video*

Many utilities need to operate surveillance of major transmission lines or emergencies such as natural gas explosions or ruptured water mains and other events from airborne platforms. Also, a need exists for the transmission of video/imagery and multi-spectral toxic cloud replication. Full motion video transmissions from airborne platforms to both command and control locations and supervisors on the ground are required.

d. *Robotics Video*

Electrical safety, hazardous material and explosive conditions frequently benefit from use of robotic devices. Full motion, generally short distance (up to 1000 meters), video transmissions from the robotic device to a local control site is required to support such activities.

The operation of remote equipment supported by robotics in extremely hazardous situations will be heavily dependent upon wireless connectivity and the ability to guide these devices via video support.

e. *Slow-Scan Video*

In many circumstances, the real time nature of full motion video is not required. In these circumstances and in the absence of high bandwidth video channels, slow scan video can be utilized. This form of video involves transmissions where the picture is updated at a much slower rate than that of full motion video.

f. *Worker Safety and Operational Video Transmission*

Utilities would benefit from trucks and other vehicles being equipped with mobile video cameras, with both a local recording and wireless transmission means. High quality video recorded by these cameras would provide evidence usable in civil liability trials and document worker actions in the event professional standards concerns are voiced. The ability to transmit both “slow-scan” and full motion video from mobile video cameras directly to dispatch and other command and control installations is required on demand. Although constant transmission of this data from each individual worker or mobile unit is not often required, the ability to monitor video from a unit is needed on an episodic basis in the event of worker assistance situations and other high risk events, or in operations of high command interest. In addition, the system must support retransmission of full motion video to mobile and remote locations where command and control personnel and other mobile workers can monitor, make decisions and provide assistance based on the video transmission.

Appendix B. Voice Dispatch Spectrum Needs Assessment

Wireless Upgrade Model - Voice Communications Bandwidth Requirements																	
	Bandwidth Provided in MHZ by Frequency Band for Rural Environments																
	Analog Conv				Analog Trunked				Digital Conv				Digital Trunked				Average
	150	450	800	900	150	450	800	900	150	450	800	900	150	450	800	900	
Utility Size																	
Small	0.40	0.45	0.65	0.36	0.20	0.23	0.65	0.36	0.45	0.50	0.70	0.40	0.23	0.25	0.70	0.40	0.43
Medium	2.75	2.50	3.70	2.10	2.20	1.88	3.70	2.10	3.13	3.38	4.05	2.33	1.88	2.03	4.05	1.16	2.68
Large	5.80	6.40	9.70	5.55	4.35	4.80	9.70	2.78	6.40	7.00	10.65	6.10	4.80	5.25	5.33	3.05	6.10
Sum	8.95	9.35	14.05	8.01	6.75	6.90	14.05	5.24	9.98	10.88	15.40	8.83	6.90	7.53	10.08	4.61	9.22

Wireless Upgrade Model - Voice Communications Bandwidth Requirements																	
	Bandwidth Provided in MHZ by Frequency Band for Suburban Environments																
	Analog Conv				Analog Trunked				Digital Conv				Digital Trunked				Average
	150	450	800	900	150	450	800	900	150	450	800	900	150	450	800	900	
Utility Size																	
Small	0.15	0.15	0.25	0.14	0.15	0.15	0.25	0.14	0.15	0.15	0.28	0.15	0.15	0.15	0.28	0.15	0.18
Medium	1.25	1.40	2.30	1.30	1.25	1.40	2.30	2.30	2.03	1.50	2.53	1.43	1.35	1.50	2.53	1.43	1.74
Large	6.60	6.48	9.23	5.18	4.95	5.55	6.15	3.45	7.20	7.00	10.13	5.70	5.40	5.00	6.75	3.80	6.16
Sum	8.00	8.03	11.78	6.61	6.35	7.10	8.70	5.89	9.38	8.65	12.93	7.28	6.90	6.65	9.55	5.38	8.07

Wireless Upgrade Model - Voice Communications Bandwidth Requirements																	
	Bandwidth Provided in MHZ by Frequency Band for Urban Environments																
	Analog Conv				**Analog Trunked**				**Digital Conv**				**Digital Trunked**				**Average**
	150	**450**	**800**	**900**	**150**	**450**	**800**	**900**	**150**	**450**	**800**	**900**	**150**	**450**	**800**	**900**	
Utility Size																	
Small	0.33	0.33	0.40	0.23	0.23	0.23	0.30	0.15	0.35	0.40	0.45	0.23	0.23	0.30	0.30	0.15	0.29
Medium	3.40	3.40	3.70	1.88	2.35	2.35	2.60	1.38	3.70	3.83	4.13	2.06	2.35	2.48	2.75	1.38	2.73
Large	4.20	4.50	5.50	2.75	3.00	3.25	4.00	1.93	4.73	4.95	6.05	3.00	3.15	3.30	3.85	2.10	3.77
Sum	7.93	8.23	9.60	4.85	5.58	5.83	6.90	3.45	8.78	9.18	10.63	5.29	5.73	6.08	6.90	3.63	6.78