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Public Safety Voice Interoperability

Some in Congress and on the House Energy and Commerce Committee are pointing to a March 18, 2011 memo from the Congressional Research Service (CRS)[1] to assert that the Public Safety Community has wasted more than $13 billion in federal grants for radio communications systems since 2001. In reality, the grants have totaled less than $4 billion and they have, in fact, provided for a higher level of Public Safety interoperability than ever before. In order to fully understand the impact of these grants, it is important to understand the many and varied issues that must be addressed if the ultimate goal of nationwide interoperability is to be achieved for both voice and data services for Public Safety.

Interoperability between various Public Safety agencies had been an issue long before it was brought to public attention during 9/11, Katrina, and other disasters. Articles dating back several decades have pointed out both the need and the issues that must be overcome in order to provide the Public Safety community with interoperable voice and data.[2] Indeed, Public Safety and the Big 7 state and local government associations initially secured the 24 MHz derived from digital TV transition in the wake of the communications failures first responders experienced at the site of the domestic terrorist bombing of the Alfred Murrah building in Oklahoma City in 1994. At that site, firefighters and police officers conducting search and rescue could not speak to each other on their radios within different floors of the building and had to resort to talking to dueling command centers set up outside the site, and couriers running back and forth between the two command centers.

Three major factors have significantly hindered Public Safety's efforts to achieve mission-critical voice interoperability:

1) Public Safety's currently allocated spectrum is in small segments spread out over at least seven different portions of the radio spectrum.
2) Because this spectrum has been in use by Public Safety for many years, interoperability must start at the local level, then the regional, state, regional interstate level, and finally at the national level (and at international borders as well).
    a. Most of the money expended to date has resulted in better interoperability on a local, regional, and state level, interstate regional, and on international borders, but because of the lack of enough spectrum in any given FCC allocation, this process is slow, tedious, and expensive.
    b. The Public Safety broadband network will be built on greenfield, that is, unused spectrum. Therefore, it will be possible to design and implement this new network as a fully interoperable network from the beginning, something that has never before been possible for the Public Safety community.

3) Within each portion of the allocated spectrum, different Public Safety departments make use of different types of radios and radio configurations to meet their own individual coverage requirements.

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[1] Congressional Research Service, Memorandum to Congressional Distribution, March 18, 2011 from Linda K. Moore
[2] Volume 1, No. 5, December 1980, Andrew Seybold's Report on Mobile Emergency Communications. A Limited Natural Resource

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The main reason for a lack of Public Safety voice interoperability is the fact that while the FCC has continued to allocate more spectrum over the years for use by the Public Safety community, these new allocations have been in very different portions of the spectrum. Today, Public Safety voice communications are authorized in small segments of the spectrum from 30 MHz up to 800 MHz, and except for the spectrum in the 700 and 800-MHz bands, the Public Safety channels are comingled with channels used by business, taxi services, truckers, paging services, and others. In short, there has never been an allocation of enough spectrum in a common radio band to permit all of the various Public Safety agencies to migrate to a single portion of the spectrum and be able to interoperate between all agencies.

Frequency Band	Type of Radio Channels	Band Shared with other Users?
30-50 MHz shared spectrum (6.3 MHz of spectrum)	Narrowband voice channels	Yes, business, utilities, government others
150-170 MHz shared spectrum (3.6 MHz of spectrum)	Narrowband voice channels	Yes, business, paging, utilities, other
220 MHz channels (only one area of U.S. near Canada)	Narrowband voice channels	No
450-470 MHz shared spectrum (3.7 MHz of spectrum)	Narrowband voice channels	Yes, business, alarm, utilities, paging, local government, others
470-512 MHz (shared TV channels certain areas only)	Narrowband voice channels	Shared with TV station and business radio/wireless mikes
700 MHz narrowband (12 MHz of spectrum)	Narrowband voice/data	No—contiguous spectrum
700 MHz broadband (10 MHz of spectrum)	Broadband data	No—contiguous spectrum
800 MHz narrowband (9.5 MHz of spectrum)	Narrowband voice/data	N0 AFTER rebanding is completed
4.9 GHz broadband (50 MHz of spectrum)	Low-power data	Suited only for local use and does not penetrate buildings

Note: Cleveland, Buffalo, and Detroit are using shared NTIA channels in the 421-430 MHz band
Note: There are a few 220 MHz systems in use in other areas such as Long Beach, CA.

As the chart above illustrates, today's Public Safety mission-critical voice channels are spread across seven vastly different portions of the spectrum. It should be noted that except for the 700 and 800-MHz voice allocations, all of the other portions of spectrum allocated to Public Safety are shared with other services. It should also be noted that a radio system operating on the 30-MHz band, 150 MHz, 450 MHz, or 800 MHz will have different coverage capabilities on each; the higher in the spectrum that you operate a system, the more infrastructure is required to cover the same given geography.

When those outside the Public Safety community look at the spectrum allocations already made, they oftentimes do not take into account that the 4.9-GHz spectrum (50 MHz) is not suited for wide-area broadband service. In reality, it is designated for low-power, local communications just as today's unlicensed Wi-Fi bands are allocated for citizens' use. The average coverage of a single 4.9-GHz access point is 300 feet or less, and in most systems today, this spectrum is used for point-to-point communications for video transmissions from fixed-location cameras, or for on-scene local broadband services. This spectrum is not available or useful for Public Safety as part of the nationwide broadband network that is being planned to provide wide-area coverage across the nation.

Today, in many urban areas there are not enough radio channels in a given portion of the allocated spectrum to meet the requirements of Public Safety. Radio signals do not stop at city, county, or state (or international) boundaries, therefore the channels in use in a given area must be coordinated with adjacent users to prevent or minimize interference between systems. In many areas this means, for example, that the police departments will operate in the 450-MHz portion of the spectrum while fire and emergency medical services (EMS) units will operate in the 150-MHz portion of the spectrum. Providing interoperability between police, EMS, and fire in these areas requires either specialized equipment in the dispatch centers to patch channels together or the installation of two or more radios in each vehicle; which is an expensive and ineffective method of obtaining interoperability between systems.

If Public Safety had been allocated sufficient spectrum in any one of these bands to satisfy the number of radio channels required for true nationwide interoperability, the result would have been twofold:
1) We would, today, have a truly interoperable voice system nationwide.
2) The cost of Public Safety radio equipment would be at least 50% less than what it is today because it could have been built to operate on a single portion of the spectrum, providing[3] economies of scale and reducing per unit price for Public Safety radios. Today, equipment vendors must build radios for a specific portion of the spectrum, and therefore the quantities they produce for each portion of the spectrum are less.

Other Factors Hindering Mission-Critical Voice Interoperability

Because the narrowband voice spectrum is already heavily used, nationwide interoperability cannot be achieved until it is first made available on a local, regional, and then statewide basis. Much of the funding that has been granted to Public Safety since 2001 has in fact resulted in better regional and statewide interoperability. From 2001 until today, the number of new regional and statewide systems constructed and operational has grown rapidly as the various jurisdictions have sought out their own ways of providing mission-critical voice interoperability.

For example, in California, technology advances have provided fire service with the ability to purchase and install radios capable of more than 300 channels in the 150-MHz band. There is a standard plan in place so that most of the fire departments can and do have interoperability not only between city, county, and state fire units, but also with federal government fire units. However, in major cities such as San Diego, Los Angeles, and San Francisco, there are not enough of these channels to provide for day-to-day fire operations, so fire departments are operating on other portions of the spectrum. During major incidents, agencies responding from out of the area are not able to directly communicate with fire equipment from the large cities without either a second radio in each vehicle or some other form of non-automatic channel sharing equipment.

Many regions have built and installed regional radio systems that are used as interagency communications systems during mutual aid situations. Many of these serve as overlay systems since very few have the channel capacity to serve all of the various local entities. This also requires multiple radios in each vehicle. Several states such as Wyoming, Florida, Vermont, Montana and others have recently built or are in the process of building statewide interoperable mission-critical voice systems in

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[3] Tetra radio prices in Europe are approximately 50% of P25 prices in the United States because they are on a common portion of the spectrum and one radio can be built and shipped to all European Countries

order to provide statewide interoperability, but in many cases, these systems augment rather than replace the local systems that are still needed on a daily basis to meet the capacity requirements of each local Public Safety agency.

In a recent memorandum from the Congressional Research Service (CRS)[4] dated March 18, 2011, the data used as a baseline was taken from a survey conducted by the National Emergency Management Association (NEMA).[5] This report was, in fact, based on Emergency Management Association directors' estimates of funds thought at the time to be necessary for states to achieve full statewide interoperability and did not, as portrayed in the CRS report, reflect actual amounts of funding received by the states and local agencies. Further, specific grant programs put requirements on accessing the funds that led to an emphasis on local, regional, and statewide interoperability (as opposed to nationwide), and there were conflicting requirements among and between grant programs causing a lack of greater interoperability.

When working toward the goal of both voice and data interoperability as is the desire of the Public Safety community, it should be stated again that trying to provide interoperable voice services when the agencies are already using spectrum spread out over seven different portions of the spectrum and on which, today, during peak hours, there is already severe network congestion that must be approached from a local, then regional, then statewide basis. However, the opportunity, with the 700-MHz broadband network is to design and implement it on spectrum that is unused, therefore, the network can be constructed from the ground up based on the requirement for nationwide interoperability.

Different Types of Systems

In addition to the shortage of radio channels in any given portion of the allocated Public Safety narrowband spectrum, there is yet another issue that makes mission-critical voice interoperability even more difficult. Namely, over the years, each local city, county, and region has built out different types of radio systems using differing technologies. Therefore, even two agencies in the same geographic area operating within the same portion of the spectrum are not always able to communicate with each other. Mission-critical voice communications systems, today, make use of two very different air interfaces. Many are still using the 30-year-old voice technology referred to as analog or FM voice communications. Newer systems have moved to the digital voice standard known as P25 or APCO project 25, which is a standard for digital voice systems. However, even within these two different types of voice systems, there are many variations of how they are deployed. Small rural areas might use a simple radio base station and radios in vehicles. Larger departments might elect to repeat all of the traffic on a given channel using repeater stations, while others have tied a number of repeaters together in what are called simulcast systems. Still others are grouping between five and twenty radio channels together into what is known as a trunked radio system. Not many of these radio systems are compatible with the other types, and, in many areas, the common way to provide interoperable voice communications is to use unit-to-unit, direct, or off-network voice channels so those on the scene of an incident can communicate with each other (provided they are all operating in the same portion of the spectrum).

The chart below reflects the complexities of working toward the goal of providing full interoperable mission-critical voice communications. As it shows, there are many variables that must be considered,

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[4]Congressional Research Service, Memorandum to Congressional Distribution, March 18, 2011 from Linda K. Moore
[5] Letter from NEMA to CRS: http://www.psafirst.org/uploads/documents/CRS_Letter_FINAL_05_27_11.pdf

and the grants have been provided on a city, county, regional, or state basis with no substantial coordination between grants or agencies receiving the grants. The reality is that the grant funds already provided to Public Safety have advanced the state of interoperability with an emphasis on local-to-statewide interoperability, and so only achieved on a local, regional, and statewide basis.

Possible Combinations of Systems that need to be Interoperable:

Frequency Band	Analog FM	P25 Digital	Base to Mobile	Repeater	Simulcast	Trunked
30-50 MHz	X		X	X	X	
150-174 MHz	X	X	X	X	X	X
220 MHz	X	X		X		X
450-470 MHz	X	X	X	X	X	X
470-512 MHz	X	X	X	X	X	X
700 MHz NB	X	X	X	X	X	X
800 MHz NB	X	X	X	X	X	X

Conclusions

Given (1) the number of different portions of the spectrum in use today for Public Safety mission-critical voice communications, (2) the insufficient amounts of spectrum within each portion of spectrum provided to Public Safety, (3) the multiple types of systems in use within each portion of spectrum and throughout all of the different portions, and (4) the focus on interoperability for mission-critical voice on local, then regional, then statewide, and only recently on a nationwide level, the funds provided to Public Safety have been used wisely and have achieved much improved interoperability within and among voice systems in most localities in the United States.

One reason Public Safety must have enough contiguous spectrum on a nationwide basis for broadband services is to make sure that systems being built adhere to nationwide standards, use the same technology, adhere to the same system design and, therefore, provide for full interoperability from the very beginning. Public Safety can never again be placed in the position it has been in over the last thirty or more years where spectrum is not contiguous, there is not enough to handle the demands in major metropolitan areas, and there is a lack of financial resources to build the nationwide interoperable broadband network that will, for the first time, provide Public Safety with the resources it needs to accomplish the goal of true interoperability while realizing the cost savings of using a worldwide air interface standard (LTE) to provide Public Safety with economies of scale for the first time.

Public Safety needs the D Block spectrum and it needs federal funding in order to accomplish this goal. If enough spectrum is not made available this time, or if funding is lacking, the only option is to duplicate the mistakes that have resulted in the lack of nationwide interoperable voice and the problem and issues described above.

The Public Safety community has neither wasted the grants allocated since 2001, nor wasted any of the valuable and very limited spectrum provided. The Public Safety community has accomplished much with the little it has had to work with over the years. Today, more regions of the country have interoperable mission-critical voice communications than ever before, but full nationwide mission-critical voice

interoperability is not achievable over the course of the next decade or two given the multitude of spectrum allocations, the differences in technologies being deployed, and the lack of a nationwide long-term plan.

We also believe that given enough broadband spectrum (20 MHz) and funding, Public Safety can and will build out a nationwide, mission-critical broadband network that will provide the level of interoperability needed on a daily basis for data and video services. Over time, this network will serve as a model to solve the nationwide voice interoperability issues that remain.

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