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4.9 GHz Task Force Report

**Presented to the Federal Communications Commission,
Public Safety and Homeland Security Bureau**

28 September 2015

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Introduction

The 4.9 GHz band represents a valuable, though currently underutilized, resource for public safety communications. As broadband applications begin to play an increasingly essential role in the emergency response landscape it becomes ever more important to identify and fully utilize spectrum that has been reserved for the unique needs of public safety users. In response to requests from the Federal Communications Commission to identify ways to promote the best and most efficient use of this band, APCO convened a 4.9 GHz Task Force consisting of 32 public safety communications practitioners. The goal of this Task Force was to provide recommendations to the Federal Communications Commission, as the agency explores changes to applicable regulations.¹

The Task Force was convened on June 1, 2015, and set out to address the following issues:

1. How 4.9 GHz is being used by public safety for Wi-Fi and other broadband applications;
2. How to increase public safety use of the 4.9 GHz band;
3. How to reduce barriers to public safety's use of the 4.9 GHz band; and
4. How to drive investment in the 4.9 GHz band.

In order to gather as much definitive data as possible upon which to base any recommendations, the Task Force conducted a survey of current 4.9 GHz Band licensees. The survey results, as well as the experiences of the individual Task Force members and other public safety professionals, form the basis of this report.

How 4.9 GHz is being used by public safety for Wi-Fi and other broadband applications

At present, there are a number of local and state government agencies that utilize the 4.9 GHz band in support of their operations. These deployments vary in size and architecture, and offer a variety of tools such as video monitoring, mesh networking, local area networks, and local hotspots. While the potential for multiple uses remains strong, it is also important to note that at present over 90% of the utilization is for point-to-point applications.

The unique broadband capabilities of 4.9 GHz networks have led to increased efficiencies in public safety operations. For example, the 4.9 GHz band supports air-to-ground communications, real-time video streaming, bomb-squad and other special operations, and point to point transport of critical broadband data. 4.9 GHz provides end to end solutions for

¹ APCO participated in the previous NPSTC 4.9 GHz National Plan Recommendations Final Report in 2013 (available at http://www.npstc.org/download.jsp?tableId=37&column=217&id=3222&file=4_9_GHz_National_Plan_Report_13_1024.pdf), and this Task Force's report provides additional recommendations.

public safety. Transport of broadband data in this spectrum affords better information to first responders on the ground, supporting aircraft, telecommunicators, command personnel, and other users and assists all in providing a more coordinated response.

The following are specific examples of how public safety agencies in Washington State and Seattle/King County, Riverside, CA, New York City, and Los Angeles have implemented 4.9 GHz solutions that are critical to public safety operations:

Washington State and Seattle/King County

- Estimated 1,500 vehicles and 1,000 fixed devices connected to wired and wireless network in 2014
- Transit security video, signal priority, vehicle location, passenger information, fare payment, and on-board system management
- Wireless LAN dedicated for public safety and emergency operations
- 4.9 GHz mesh network in downtown Seattle and along shoreline in support of security video and public safety operations
 - Provides multiple interoperable networks for public safety and transportation operations
- 4.9 GHz point-to-multipoint network connects 25 city government sites to the city's internal network and provides voice and data communications to large event command centers
- Washington State Department of Transportation utilizes spectrum for point-to-point, point-to-multipoint, and mesh applications (e.g., providing data connectivity to variable message signs, variable speed limit signs, remote weather information stations, highway advisory radio, and full motion video to Traffic Management Centers and Emergency Operations Centers)
- Fixed 4.9 GHz (e.g., vehicle to infrastructure communications; last mile infrastructure voice/data communications to large impact incident command posts, including in event of fires, shootings, vehicle crashes, landslide responses, flooding, etc.)

Riverside, CA

- Citywide deployment project of 4.9 GHz Wi-Fi wireless broadband Internet access network
- Covers all developed areas of the city's 86 square miles with over 1300 access points using a mesh network topology with six fiber connected backhaul aggregate sites
- The combined 2.4/4.9 GHz access points have efficient range of approximately 1,000 feet depending on topography, and are installed on street lights, traffic signals, and city facilities
- Used to support video surveillance, video to police cars, and broadband connectivity to police stations

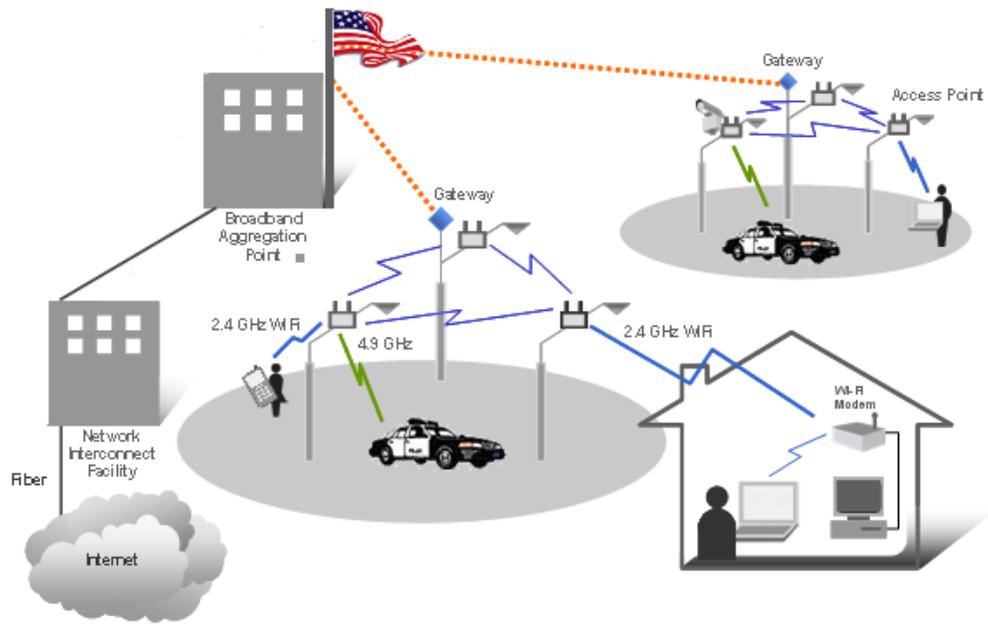


Figure 1 - Riverside 4.9 GHz Deployment Concept



Figure 2 - Residential Access Points

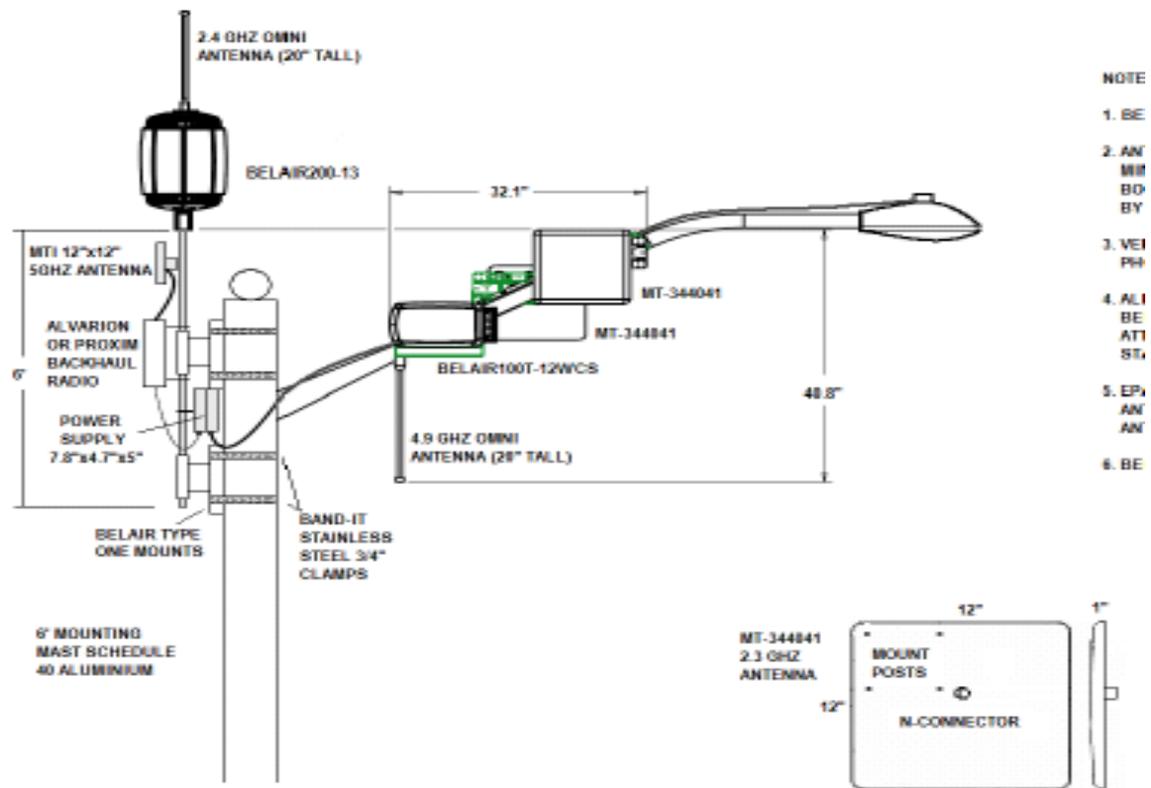


Figure 3 - Configuration Example of Access Points



Figure 4 - Backhaul using 80' Flagpole Antennas

New York City

- 275 public safety transmitter sites within NYC
- NYPD video monitoring operations at numerous locations throughout the city
- NYPD hotspots at critical locations throughout city in support of NYPD patrol mobile data operations
 - Operates in conjunction with NYC wireless network, providing macro network offload
- NYC Department of Information Technology & Communications uses 4.9 GHz for backhaul of land mobile radio networks and mobile deployable assets supporting NYC wireless network and disaster recovery operations
- Port Authority uses 4.9 GHz in support of security operations at facilities including World Trade Center, LaGuardia Airport, and JFK Airport

Los Angeles, CA

- Transmit video images of an incident/event to an agency's central communications center for distribution to personnel involved in allocating critical and limited resources to areas where they are most needed
 - E.g., airborne platforms transmit video images, either to tactical operations on the ground or to the Sheriff's Communications Center for further routing to other departments

Lessons learned from 4.9 GHz deployments:

- 4.9 GHz is a good option for wide-area video surveillance needs – networks generally can support two cameras per access point and ten cameras per square mile
- 4.9 GHz is a good option for video in emergency response vehicles – 1 Mb to the vehicle appears sufficient to transport/download in-car video
- Access points directly connected to fiber at public safety locations (such as precincts) are preferred for large downloads (software updates, etc)
- High foliage areas require higher density of access points
- Siting issues with placement of access points in historical districts can be addressed by placement on power poles and traffic signals in such areas

As illustrated by these actual deployments, public safety is making good use of 4.9 GHz capabilities. However, acceptance and deployment has been slower than anticipated and still remains behind projected, and optimal, numbers. An overview of nationwide licensing for 4.9 GHz, by state, is broken down graphically in the figures below.

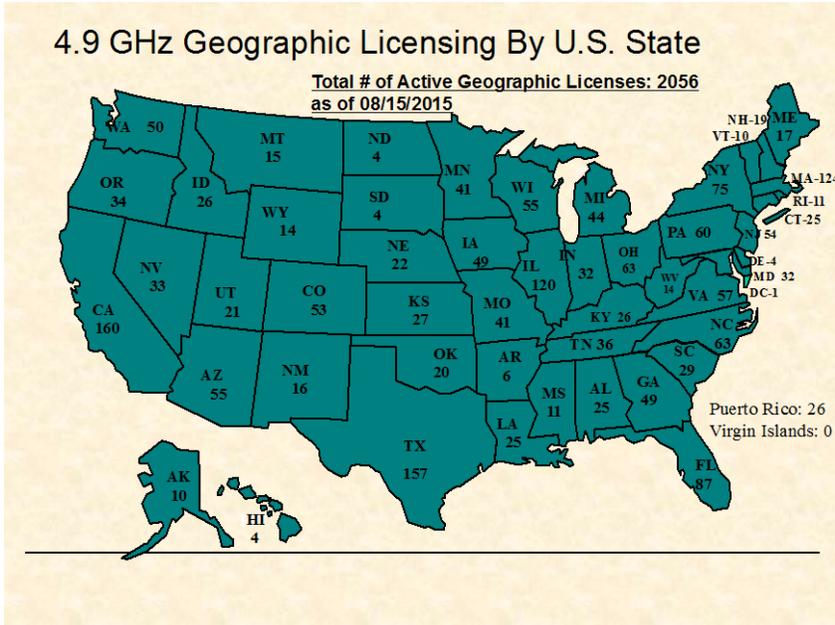


Figure 5 - 4.9 GHz Geographic Licensing (By State)

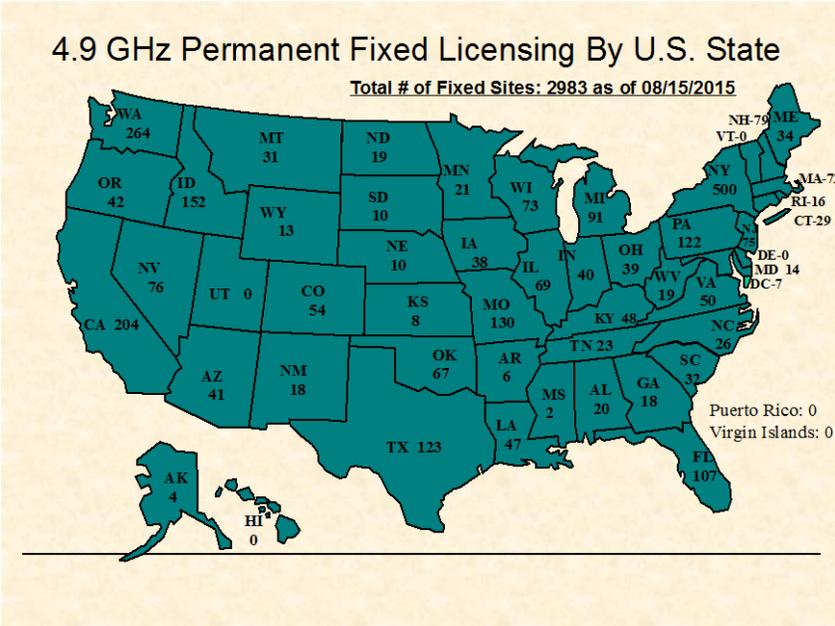


Figure 6 - 4.9 GHz Permanent Fixed Licensing (By State)

Outside of the use cases illustrated above, point-to-point backhaul (generally transporting land mobile radio traffic) currently represents 94.5% of overall usage. This is a critical consideration in both driving future investment in 4.9 GHz and in considering how, and why, public safety

should consider broader use of this spectrum. There needs to be a more compelling value proposition to drive use and investment in expanded deployments and applications, such as WiFi.

As previously noted, the 4.9 GHz band is used for different and varied applications. The National Public Safety Telecommunications Council (NPSTC) formed a planning group that incorporated the experience of the participants and agencies and did a very good job of documenting uses such as hot spots, mesh networks (primarily video surveillance), point-to-point backhaul, and limited use in bomb detection/diffusion robots. However, according to the NPSTC report there is also anecdotal evidence that there is some confusion over the circumstances when a license is needed. The varied uses and regulatory schemes all point to the need to bring more structure to the band.

In addition, according to both vendor and public safety sources contacted by the Task Force, there are serious concerns about licensing, and specifically around coordination, and also issues with the high cost of purchasing, and deploying limited equipment options. These concerns, along with the growing potential of 4.9 GHz systems to complement Next Generation 9-1-1 and FirstNet deployments, are the driving factors in how to increase public safety use of this band, decrease barriers to public safety entry into this space, and increase investment in these life saving technologies.

How to Increase public safety use of the 4.9 GHz Band

The cited examples demonstrate how public safety agencies are benefitting from the broadband applications made possible by the 4.9 GHz band. The importance of the 4.9 GHz band to public safety is likely to grow substantially in the near future. The 4.9 GHz band is unique in offering public safety users agency-specific and localized options for supporting high bandwidth video and data communications. Raising awareness of the value of these deployment alone would spur further use in other jurisdictions. However, the Task Force believes that some specific elements are critical to driving maximum and sustained use. The first of these is proper and structured frequency coordination.

Frequency Coordination

According to the NPSTC Report, “Public Safety agencies have expressed frustration with the 4.9 GHz band because current rules allow geographically based licensing with little documentation on system design and transmitter location. Public Safety agencies contemplating new service in this band cannot determine if other agencies in their area might cause harmful interference today or in the future. While the licensing rules provide for geographical sharing of the band between different agencies, the lack of licensing detail invites the potential for conflict and interference.”

Acknowledging these NPSTC findings, the Task Force reached out to public safety users via a survey to determine what was preventing them from using this band. As the Commission is well aware, a fundamental requirement of any public safety communications network is reliability. The Task Force found that this is especially true for the 4.9 GHz band, given the advantages it offers to transmit large amounts of sensitive data, whether used in a WiFi, hot spot, video, mesh networking, or other configurations. Access to this band must be predictable and dependable.

The results of the Task Force survey indicate that many public safety users and manufacturers choose not to invest in the 4.9 GHz band because it is not coordinated. The current jurisdictional licensing model is viewed within the public safety community as too similar to an unlicensed structure to provide the degree of confidence needed for mission critical communications, including sensitive transmissions.

The Task Force found that new frequency coordination procedures designed to improve usage, performance, and interference protection would encourage public safety entities that have been reluctant in the past to begin utilizing the 4.9 GHz Band. It follows that increased interest in the public safety community would provide incentives for equipment vendors to direct investment into this market.

A few areas in the country have voluntarily adopted an informal coordination process for use of 4.9 GHz systems among departments and jurisdictions, and some regions have developed regional plans for agencies to coordinate use. In these areas where an informal frequency coordination process has been adopted, such as Riverside County, CA and New York City, the 4.9 GHz band is more extensively utilized. Thus, these examples evidence the importance of frequency coordination in driving public safety use.

The Task Force supports the proposed NPSTC approach that would require all applications to go through the frequency coordination process. Further, this should remain limited to public safety coordinators as this band is specific, and critical, to public safety.

Another issue that inhibits wider use of the 4.9 GHz band is blanket geographical licensing for fixed and mobile operations on any channel across the band. Vendors described situations in the field where they have been given a frequency following the local regional plan only to find users already operating on that frequency when there should not be anybody there. This can be avoided by implementing a more comprehensive frequency coordination process. The NPSTC plan proposes, and the Task Force supports, that all fixed locations be identified and licensed for a specific channel or channels with aggregation to no more than two channels (10 MHz of bandwidth per channel).

As noted earlier, point-to-point use for backhaul currently represents nearly 95% of the use of the 4.9 GHz band. Providing public safety with a more efficient process to deploy such links, which are presently more familiar and clearly more common, can help drive adoption of a wider range of broadband-type applications. As mentioned in the NPSTC report, the Task Force

believes that incorporating some elements of the Part 101 rules and adding frequency coordination could be blended with the simplicity of the current rules to achieve better spectrum reuse and still maintain a relatively simple quick process to become operational. This would also ease public safety concerns with regard to efficiency and reliability. The Task Force also recommends that point-to-point links be coordinated by the public safety coordinators.

Air to Ground to Air Applications and Robots

Air to ground/ground to air use in the 4.9 GHz band is not allowed under current rules except by waiver.² Advances in Unmanned Aerial Vehicles (UAV) technologies have led to increased potential for tactical and strategic use of this technology, in an airborne application, by first responders. Again citing to the NPSTC report, “many law enforcement agencies operate helicopters and small airplanes using video cameras. While public safety has shared access to broadcast spectrum used for studio links of video from broadcaster’s aircraft, in major markets this spectrum is hard to use on an ‘immediate need’ basis due to coordination requirements with the broadcasters.” The 4.9 GHz spectrum represents an excellent potential solution for use in an airborne platform. Modification of existing rules, using the guidelines proposed in the NPSTC recommendations, would allow use of the 4.9 GHz band for air to ground communications, would add to the available public safety portofolio, and would assist with increasing public safety use of the spectrum.

Robotic and other specialized uses are an area of growing use for public safety. Law enforcement has been using bomb robots for a number of years and the use is accelerating among agencies. Older robots require two narrowband voice channels plus a wideband video channel to control the robot and feed video back from the robot to the control point. The public safety coordinators frequently have a difficult time finding suitable narrowband voice channels and there is only one 2.4 GHz channel available for the video feed, which is unlicensed and subject to unpredictable interference. Newer robots use the unlicensed bands for both control and video feed. The Task Force recommends following the proposal contained in the NPSTC report with regard to robotic operations to allow for use of 4.9 GHz spectrum on a controlled and limited basis for robotic applications.

² Section 90.1205(c) prohibits the use of the 4.9 GHz band for “aeronautical mobile operations.”

How to reduce barriers to public safety's use of the 4.9 GHz band

Implementing frequency coordination in the 4.9 GHz band, and allowing for airborne and robotics use, will go a long way towards making this spectrum a viable and effective option to satisfy the broadband communications needs of public safety agencies across the country.

However, the public safety user community remains small relative to the greater consumer marketplace. This factor has historically resulted in a limited vendor ecosystem, specialized devices, and higher costs. Public safety agencies also typically have limited financial resources, which often need to be budgeted over time. Thus affordability, featuresets, and equipment options are also important considerations for public safety adoption. Manufacturers need to be able to achieve economies of scale to reduce costs in order to provide a variety of network and device options to public safety users.

Ideally, public safety 4.9 GHz equipment can be developed in such a way that it leverages the much broader consumer marketplace for WiFi and related products and services supporting broadband communications, including 4G (LTE). Technology providers need to be incentivized to develop technology that integrates 4.9 GHz into devices operating in other unlicensed and 4G spectrum to assist in accessing the larger consumer market. This in turn would provide public safety with a dedicated band to support their localized and particular broadband communications needs including during emergencies, potentially decrease costs, lead to commercial off the shelf (COTS) equipment capable of utilizing both the 4.9 GHz band and other unlicensed and LTE bands, and enable handoffs between public safety 4.9 GHz networks and other networks (including commercial wireless services and the FirstNet network).

The commercial development and deployment of dual SIM, Quad chipset handsets is indicative of the ever evolving nature of wireless communications systems, services and equipment. Utilization of this type of technology in North America allows for multiple uses from a single, commercial, off the shelf product. Inclusion of the 4.9 GHz band, along with Band Class 14 (FirstNet) and commercial cellular frequencies, would allow for multiple uses across networks and single devices (access points, handsets, etc.) for both public safety and commercial applications while driving down costs and incentivizing manufacturers and carriers to incorporate these options into their networks and systems.

This is yet another example of how working cooperatively can benefit both public safety users and commercial providers of both equipment and networks. By making devices inclusive of the 4.9 GHz band, the products become less expensive, more widely available, and more attractive to both the manufacturers and public safety. These and other options also relate to both reducing barriers and increasing investment as discussed in the next section.

How to drive investment in the 4.9 GHz band

Provide more options for rural deployments

As already discussed in previous sections, a more structured regulatory environment for the 4.9 GHz band is needed not only to convince public safety users that the spectrum is protected and reliable, but in turn to drive investment by vendors in the products to support this use. But the Task Force also learned after contacting several equipment manufactures that a few minor regulatory changes could also provide more incentives.

All of the current 4.9 GHz vendors contacted, as well as some vendors who do not currently build equipment in the band, stated their desire to resurrect the 40 MHz channel. Many providers of this equipment have 40 MHz products that can only be sold overseas. This should be possible with proper frequency coordination and would be quite useful especially in rural areas that have little or no use of the band. This would support public safety needs for cameras and data intensive applications that require more bandwidth.

Combining flexibility to offer 40 MHz products with a well defined and required coordination process would create a better business case for manufacturers. The more incentives vendors have to invest in a variety of core products of direct interest to public safety users that could lead to positive business results, the more likely they will expand into offering other innovative applications of the types that the Commission, and public safety, also want to see. Furthermore, public safety would then have more leverage to request the products that they need.

Another specific example provided by participants in the Task Force's survey, and of great interest to the Task Force, was the argument for increasing the size of the antennas supporting 4.9 GHz operations. Consider a use case in which a microwave path in place between two distant sites requires more capacity but there are no channels available in the L6 and U6 bands. The distance is too far for frequencies bands 11 GHz and higher. Thus, presently the only solution is to oversubscribe the path, which may result in blocking of public safety communications. Additionally, larger directional antennas (i.e. 4' diameter and above) have more discriminatory "off-path" antenna patterns and FB (Front-to-Back) Ratios which allows the coordinator to assign frequencies closer together and permit more systems to co-exist interference-free within a given frequency band. Furthermore, there are cases where a larger antenna may allow the coordinator to assign a frequency to a system where a smaller antenna may not have an efficient enough antenna pattern. A rule change permitting larger diameter antennas especially in rural areas would offer a possible option. Like the 40 MHz channel option noted above, relatively minor changes can help contribute to increased investment, deployment, and utilization by public safety.

Critical Infrastructure Industries and potential new markets

The work on the NPSTC national plan included a discussion of Critical Infrastructure Industries (CII). While the 4.9 GHz band might well enhance the delivery of services delivered by CII in support of public safety, this band is intended primarily for public safety users and care must be taken to ensure that any use by CII of this band not prohibit or in any way inhibit public safety users. Additionally, as previously recommended, application for use of this spectrum by CII entities should be subject to the same frequency coordination and licensing requirements as any other user in the space and coordinated by public safety coordinators.

In addition, while the Task Force supports limited, and controlled, use of 4.9 GHz by CII entities, it is important to note that per the NPSTC recommendations, “CII would have access to license two (5 MHz wide) channels on a shared co-primary basis with public safety agencies. CII entities may also license the other channels but only with a 30 calendar day notice period.”

While this approach is designed to foster development in the commercial sector, resulting in more cost effective equipment and opportunity for public safety use, it must be carefully monitored to ensure that public safety needs are considered in every potential conflicting filing.

This said, there may exist a tremendous potential to take advantage of logical partnerships to grow 4.9 GHz spectrum use. The Riverside, CA use case described above provided one example of a combination approach, wherein both commercial unlicensed and 4.9 GHz licensed devices are deployed and infrastructure is developed to support both public safety and general public populations. While not necessarily optimal, this would spur deployment as it would still allow vendors to capitalize on multiple markets and would drive down cost to public safety to some degree. The use of multi-band chipsets would allow for deployment of devices and handsets that support any of the broadband solutions that are deployed.

Perhaps even more effective would be a solution that affords priority and preemption for public safety users in a shared environment. As with FirstNet, it is important that any shared space allow for priority traffic should public safety need to use the spectrum. In the 4.9 GHz band, when not in use, the spectrum could be made available to CII entities (and perhaps others) on a broader scale than currently proposed.

While the principles noted in the NPSTC report remain the same, the idea here is that advances in technology may well allow for a broader use of 4.9 GHz spectrum across a larger base of users, while still ensuring that public safety has available spectrum when it is needed. Any CII (or other) applicant would still have to go through the recommended licensing and frequency coordination process. However, due to the critical nature of this spectrum when public safety does need it, this would likely be more than just a “white space” like situation. Not only would priority and preemption be a requirement, some method of determining eligibility, and coordination outside of the traditional frequency coordination model would likely be necessary. To this end, the Task Force recommends a consideration of further efforts focused on how to

build upon the “white space” model and apply it to the 4.9 GHz arena to spur development by increasing the potential customer base, including within the CII segment. At the same time, it is extremely important that the Commission allow for priority use by public safety any time the spectrum is needed. Whether this be by development of software to determine priority and pre-emption, by a new coordination process in conjunction with development efforts by the vendor community, or by some other innovative approach, the opportunity exists to begin development of a “path to deployment.” The Commission should encourage sharing arrangements like this, and cooperative work whenever possible in the interest of promoting the protection of life and property while making maximum use of the band.

This approach is not without its challenges, nor will it be solved in the immediate future. However, if work begins on this effort sooner rather than later, and a solid model can be agreed upon, the likelihood of vendor engagement and public safety participation should both increase. In an age where broadband spectrum applications are becoming a necessity for public safety, it is important to consider options which may have been overlooked in the past. An innovative approach that incorporates essential features such as frequency coordination, with newer spectrum management tools that could expand the user base while preserving reliable access for public safety, may be the most appropriate path for fully unleashing all of the potential of the 4.9 GHz band. The Task Force thus encourages the Commission to consider further study of this option.

Conclusion

The 4.9 GHz band has become an important element of many public safety communications systems. As illustrated in the first section of this report, agencies have implemented some unique programs to utilize this broadband spectrum to its fullest. However, to date adoption by public safety has not lived up to expectations. In order to increase interest on the part of public safety, reduce barriers to the use of this technology, and spur investment in developing equipment and systems, a number of options exist. Adoption and investment can be increased greatly if the FCC requires frequency coordination to ensure the protection from interference that is expected and necessary for mission critical communications. At the same time, the 4.9 GHz marketplace needs to be expanded to take advantage of the economies of scale and innovation present in the greater consumer marketplace for broadband communications.

Reconsideration of existing applications will assist in increasing both investment and use. Incorporating emerging technical capabilities in the form of dual SIM/quad chipsets will aid in bringing down cost, enabling wider deployment, and making 4.9 GHz equipment more cost effective and therefore move available to public safety. Finally, thinking “outside of the box” and considering solutions that mirror a white space approach, but ensure public safety priority

and preemption when needed will also drive investment, reduce barriers, and spur interest from both public safety and the vendor community.

The 4.9 GHz band has already been put to good use in support of public safety missions. By implementing a few key changes, this band can become an essential communications tool and provide greater support to broadband applications throughout the country. Use of 4.9 GHz spectrum and technologies to assist public safety in modernizing their mission toolkit should be encouraged.

The Commission is to be applauded for taking a proactive approach to driving this innovation. This Task Force's recommendations are intended to help drive increased interest in, and use of, this band. While the Task Force provides a set of recommendations, we encourage the FCC to continue their outreach to public safety practitioners, agencies and relevant associations as the agency considers the best path forward for this important resource.