CHAPTER 7:
Why Radio Spectrum Matters to You

What is radio spectrum?

If you asked the average person to define radio spectrum, most would not be able to provide a satisfactory answer, yet it is one of our country's most valuable resources. Radio spectrum transmits electronic signals. More than 98 percent of all public safety agencies use wireless radios as their primary means of communication. Without spectrum, the radios are useless. Originally allocated to voice transmissions, radio spectrum is now also used to transmit video and data. As technology evolves, the growing number of electronic devices require more and more radio spectrum to operate. As a result, spectrum is fast becoming more scarce, more valuable, and more eagerly sought by competing private and governmental interests.

The radio frequency spectrum within the United States extends from 9 KHz [kilohertz] to 300 GHz [gigahertz] and is allocated into more than 450 frequency bands. 900 MHz [megahertz] cellular telephones are licensed to operate in a 900 MHz band and common garage door openers at 40 MHz. The Federal Communications Commission (FCC) regulates the use of frequencies and has allocated certain portions of the spectrum for the specific use of public safety agencies. Initially, almost all public safety communications were confined to the low end of the frequency range, but as technology advanced and improved, transmission at higher frequencies became possible and the FCC assigned frequencies in different bands, offering a temporary solution for congestion and crowding. The result—public safety operates in 10 separate bands, which has added capacity, but which has also caused the fragmentation that characterizes the public safety spectrum today. Imagine dividing the country into many slices and then placing mountains in between those slices. Getting from one slice (frequency band) to another is made more difficult because of those mountains (non-public safety frequency bands). Many of the new digital 800 MHz trunked systems are based on proprietary techniques, so even when operating on the same 800 MHz frequency, communication from one manufacturer's radio cannot be heard by another manufacturer's radio. This resource, that cannot be seen or felt, but without which, lives

Radio Spectrum Issues

VHF (25-50 MHz)
- ➢ Used by many commercial applications resulting in overcrowding
- ➢ No public safety quality radios being produced today

VHF (150-174 MHz)
- ➢ Inadequate capacity in most areas
  - ✔ Extreme overcrowding in metropolitan areas
  - ✔ Fully occupied even in rural areas
- ➢ Inefficient allocation between Federal/Non-Federal use

UHF (450-512 MHz)
- ➢ Extremely crowded in metropolitan areas
- ➢ Heavily occupied in other areas

700 MHz
- ➢ Blocked by TV stations in most metropolitan areas until 12/31/06 OR when 85% of households have DTV
- ➢ Canadian/Mexican border issues
- ➢ Potential for interference from commercial services
- ➢ Equipment cost and tower siting requirements (due to more limited range than UHF/VHF) can be a problem

800 MHz
- ➢ Very limited capacity in most metropolitan areas
- ➢ Facing harmful interference from commercial users
- ➢ Equipment cost and tower siting requirements (due to more limited range than UHF/VHF) can be a problem

could and would be lost, is critical to public safety agencies. It is not just in major disasters such as the World Trade Center terrorist act or the Oklahoma City bombing; it is vital for day-to-day operations—traffic and industrial accidents, police chases, drug busts, or just being able to communicate with one another from different sections of the city or town. Public safety mandates that personnel have access to effective radio spectrum not only to serve the public, but also to ensure their own safety.

What has been done?

Funding problems and concerns are major obstacles to interoperability and can mean the success or failure of the effort.

In 1995, the FCC adopted a plan regarding radio spectrum requirements at that time and through the year 2010. Recognizing that it did not have enough information from the user community to adequately address the problem, the FCC and the National Telecommunications and Information Administration (NTIA) established the Public Safety Wireless Advisory Committee (PSWAC) to evaluate the wireless communications needs of local, State, and Federal public safety agencies through the year 2010 and recommend possible solutions. The membership of the PSWAC encompassed a broad range of local, State, and Federal public safety agencies; public service providers; equipment manufacturers; commercial service providers; and the public at large.

The following year, PSWAC submitted its final report to the FCC and NTIA that sounded the alarm regarding the extent to which the lack of adequate radio spectrum hampered and would continue to hamper public safety mission-critical activities. This hue and cry indicated that an additional 97.5 MHz of radio spectrum is needed by the year 2010 to enable public safety to keep pace with its expanding needs. To date, only 24 MHz has been made available as the result of congressional and FCC actions and, unfortunately, this is not available due to TV incumbency. Even with this allocation, that still leaves a gap of 73.5 MHz of radio spectrum.

Most recently, the FCC has formed a Spectrum Policy Task Force to assist the FCC in identifying and evaluating changes in spectrum policy that will increase the public benefits derived from the use of radio spectrum. The Task Force recently released a report that addresses public safety communications issues, among other issues. A link to that report and FCC website addresses are provided at the end of this guide.

700 MHz and digital television

In 1997, Congress committed 24 MHz of the radio spectrum in the 700 MHz band to public safety; however, the reallocation is tied to the relocation of analog television channels as part of the television industry move to digital television (DTV) and upon the availability of equipment that can use that allocation. All radio equipment operating in this new band will be interoperable with the existing base of 800 MHz band users. Another portion has been allocated for direct licensing to the States. The 700 MHz band is particularly well suited for wide area (county, large city, State) systems that can accommodate all public safety users and are inherently interoperable.

In most major metropolitan areas, some or all of the 700 MHz radio spectrum allocated for public safety is blocked by ongoing television broadcast operations on channels 63, 64, 68, 69 (and to some extent by adjacent channels 62, 65, and 67). Current law permits those TV stations to remain on the air until December 31, 2006, or until 85 percent of households in the relevant market have access to DTV signals, which ever is later. There are about 250 million television sets currently in use in the United States. Only 3.5 million (1.4 percent) are capable of receiving DTV signals directly or through a set-top box and current prices for DTV are not consumer friendly. The ability of public safety to use the 700 MHz radio spectrum is contingent upon how fast the public replaces its analog televisions with DTV.

The timeline established by Congress for broadcasters to relinquish the spectrum is behind schedule and, at the current rate, it is unlikely that transition to DTV will occur by 2006. Milestones were also set, and to date, several have been missed. If the milestones are not met, public safety will be denied access to this valuable radio spectrum for many years. One final caveat—although the 700 MHz and 800 MHz bands are emerging as the primary public safety bands for the State and public safety community, at this time, no mobile, portable, or base station radio equipment operate in the 700 MHz band. Further, no public safety equipment is readily available that can support both bands, and since the 2006 date is somewhat elusive, no public safety agency can logically budget for equipment that uses radio spectrum that is not yet available for them. This inability to plan affects the manufacturers.

They will not fund development of radios when customers do not exist. They will not expend time, effort, and money until the spectrum is available and funds have been budgeted.

What about 800 MHz?

The existing public safety radio spectrum in the 800 MHz band is being used by many State and local governments for current wide-area interoperable radio communications systems; however, the 800 MHz band currently faces growing interference problems from commercial radio operations. The FCC is considering proposals to address that interference problem by clarifying responsibility for correcting interference and to reconfigure the band to reduce the potential for interference. Some of these proposals would also increase the amount of 800 MHz band radio spectrum available for public safety use, which would provide additional capacity for new and existing interoperable radio communication systems.

In addition to the interference problem, there is another problem facing the 800 MHz band. All of the designated public safety channels in the 800 MHz band are already assigned to users in most major metropolitan areas, leaving little or no room for new system development or expansion of existing systems. Radio spectrum in the adjacent 700 MHz band has been allocated for public safety, but as discussed previously, it cannot be used in most heavily populated areas because of ongoing television broadcast operations on the same frequencies.

Standards

Standards are helpful in promoting public safety communications interoperability. The use of standards for equipment and software may alleviate many of the interoperability problems faced today. This is not a new problem—the need for open standards in public safety wireless communications began about 20 years ago. Prior to that time, the technical compatibility of voice communications systems relied on the common use of frequency modulated analog or analog FM, signaling. In effect, this was the standard; however, as manufacturers began making improvements to the functionality and efficiency of their products, they began using signaling protocol that was unique to each manufacturer. They developed proprietary systems that were incompatible with other manufactured systems in the same way that the personal computers of the 1980s could not read each other's data or use each other's software. Due to this incompatibility, representatives of industry and local, State, and Federal public safety

agencies recognized the need to collaboratively develop standards for voice communications.

Through a joint effort of public safety users and multiple radio manufacturers, the ANSI/TIA/EIA-102 Phase I standard, commonly referred to as Project 25, became an example of a standard that can lead to improved interoperability. Project 25 consists of a suite of standards including procedures and specifications that are targeted specifically at mission-critical requirements of public safety. Unlike many other communication standards and technologies, the user needs drove the development of Project 25, which has been endorsed by several public safety organizations and Federal government agencies. Additionally, the FCC has chosen the Project 25 suite of standards for voice and low-moderate speed data interoperability in the new nationwide 700 MHz frequency band, based upon public safety user recommendations.

Making spectrum more efficient

Digital versus analog systems

The 700 MHz band is specifically set aside for modern radio systems with high spectrum efficiency that require digital technology. Digital technology has several advantages over analog. It is much more spectrally efficient, allowing a greater number of users over the same bandwidth. Digital signals have a better voice quality over longer ranges than analog signals. Digital transmissions are computer code, making encryption and increased security an inherent capability. Digital transmissions are easily encrypted by simply encoding and decoding the bits and bytes through software programming in the radio. And finally, data are data—whether voice, text, or full-motion video, it's all ones and zeros. This makes integration of voice and data radio systems easier and allows for the acquisition of one communication system instead of two redundant and highly expensive systems.

Trunked versus conventional systems

Radio systems utilize frequencies through conventional or trunking operations. A conventional system, still the most popular system type in the United States, utilizes a single dedicated frequency or channel for each specific communication requirement. If an agency has three frequencies for its radio system, it might use one channel for all car-to-station trans-

missions, one channel for station-to-car transmissions, and the other for car-to-car transmissions. When an emergency medical technician keys the microphone and transmits on a frequency, everyone else using that channel must wait until he or she is finished before making their own transmission. When no one is talking on a channel, that frequency is sitting idle and not being used.

Trunking is a relatively new radio technology, developed in response to frequency shortages in public safety to increase radio spectrum efficiency. Trunked radio systems provide a relatively efficient system for multiple agencies in a geographic area that can share a radio system. Trunking is a computer-controlled system that uses all the available frequencies in a pool, allocating an open frequency each time someone on the system pushes to talk. Users are programmed into computerized groupings called talk groups, based on the operational criteria of the agency or agencies on the system. Patrol officers in a particular sector could be placed within one talk group, detectives in another, tactical teams in another, and administrative personnel in another. All of the system users utilize the same pool of frequencies. When a user keys the microphone, the system selects an open frequency and puts the user on it. When the user stops transmitting, that frequency immediately becomes available for the system to assign to the next user. In this manner, frequency idle time is drastically reduced, and users within a properly sized talk group spend far less time waiting for a clear talk-path.

Radio technology in use today is limited by geography. Radio communications depend on frequency assignments, which are specific to a geographic area, and on the physical characteristics of power and emissions that are limited to a specific radius around a radio tower. Towers can be interconnected and frequencies reassigned to create a large coverage area, such as a statewide radio system; however, the operations of an extended area system become extremely complex. Before the last few years, statewide systems were rarely constructed for public safety uses. Public safety relied on local conventional radio systems licensed to a single user organization. With the advent of trunked radio systems, carrying very high price tags and requiring complicated frequency coordination, the idea of regional, countywide, and statewide public safety systems with many user agencies is becoming more common.

The availability of adequate radio spectrum and interoperability go hand and hand. Any community, region, or State considering implementing or upgrading radio communication systems must understand the importance of this vital and limited resource.