AVOIDING INTERFERENCE BETWEEN PUBLIC SAFETY WIRELESS COMMUNICATIONS SYSTEMS AND COMMERCIAL WIRELESS COMMUNICATIONS SYSTEMS AT 800 MHZ

A BEST PRACTICES GUIDE

Note: This Guide was compiled by a working group of subject matter experts from the following organizations: the Association of Public-Safety Communications Officials- International, Inc., the Cellular Telecommunications & Internet Association, Motorola, Inc., Nextel Communications, Inc. and the Public Safety Wireless Network. The authors wish to express their appreciation to the many individuals in these organizations who provided their time and expertise to develop this document.

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I. INTRODUCTION

In April 2000, the Federal Communications Commission ("FCC") brought together representatives of commercial mobile radio service ("CMRS") providers and public safety communications officers to discuss the problem of interference between commercial mobile and public safety radio networks. The FCC stated that it had received an increased number of reports of interference to public safety radio networks in the 800 MHz band apparently resulting from the operations of nearby CMRS systems, even though all providers were operating within the parameters of their FCC licenses. The FCC noted that anecdotal accounts appeared to correlate the increased interference with the recent expansion of 800 MHz CMRS systems – particularly enhanced Specialized Mobile Radio ("SMR") systems and cellular networks – using digital technology and employing more intensive frequency reuse to serve an expanding customer base. It concluded, however, that additional facts and analyses would be needed to conclusively establish the causes of this interference and to identify potential remedies.

The FCC encouraged the meeting participants to develop more definitive information as to the scope and severity of CMRS/public safety interference and to recommend mitigation techniques and solutions. It emphasized that all parties affected by this phenomena -- both commercial and public safety -- must work together and must share responsibility for identifying the causes of such interference, identifying mitigation alternatives, and developing joint planning and technical solutions for preventing interference.

Accordingly, a number of participants agreed to form a working group to accomplish the FCC's charge. The group includes Motorola, Inc. ("Motorola"), a manufacturer of both commercial and public safety radio systems; the Association of Public-Safety Communications Officials-International, Inc. ("APCO"); and Nextel Communications, Inc. ("Nextel"), an SMR provider in the 800 MHz band. The Cellular Telecommunications & Internet Association ("CTIA") also agreed to participate in the working group to represent its cellular and SMR membership as did the Public Safety Wireless Network ("PSWN") representing local, state, and federal government public safety users. These organizations have pooled their knowledge, experience and expertise to develop this "Best Practices Guide" (the "Guide") for parties experiencing commercial/public safety interference.[1]

The Guide provides a broad overview of practices that can be used to identify and alleviate interference between public safety systems and commercial systems. It is intended to improve the ability of both public safety providers and CMRS carriers to identify the radio frequency ("RF") conditions in which public safety radio systems are likely to experience interference from FCC-compliant CMRS operations.[2] The Guide describes the types and causes of such interference. It then provides information that

[1] In addition, APCO has placed on its web site a questionnaire for its members to report incidences of interference to assist in identifying causal conditions and remedial actions.

[2] Public safety system out-of-band emissions also have the potential to interfere with CMRS operations.

may enable the affected parties to reduce or even eliminate such interference. It also offers guidance for future system deployments that can prevent such interference through frequency planning, collocation or strategic location of public safety and CMRS base stations, system design improvements for either CMRS or public safety networks or both, equipment upgrades, frequency swaps and, if necessary, FCC rule changes or waivers.

The developers of this Guide intend that it be used to help prevent or mitigate interference to public safety communications systems that provide critical safety-of-life communications services. The developers believe that the information presented herein will facilitate cooperation by public safety and CMRS operators throughout the country to prevent harmful interference between such spectrum uses. References for more detailed technical information and points of contact are provided at the end of the document.

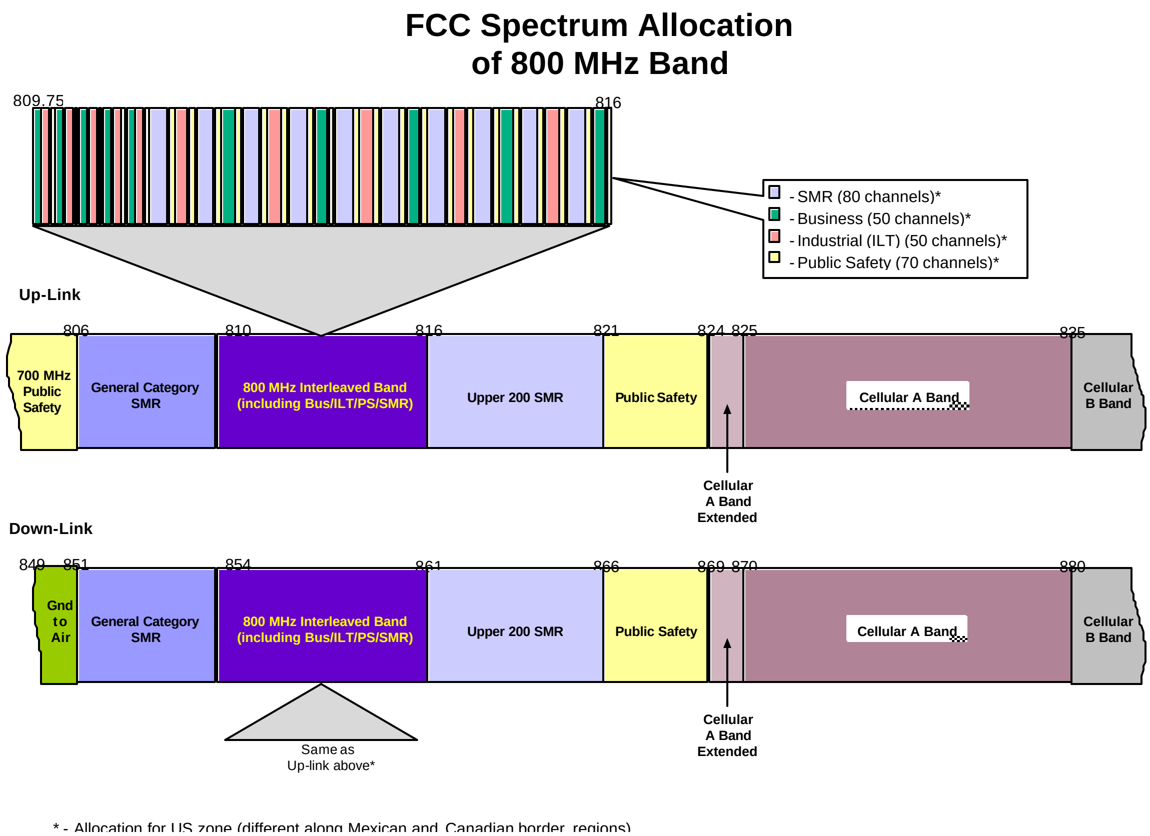
II. BACKGROUND -- 800 MHZ BAND HISTORY

The 800 MHz spectrum band was first made available by the FCC for land mobile communications services in 1974 when it was reallocated from TV Channels 70 to 83 for use by public safety communications systems, private two-way radio, SMR, and cellular systems. As Figure 1 indicates, the FCC allocated 70 channels for public safety mobile communications systems between 809.9625-815.9875/854.9625-860.9875 MHz. These channels are interleaved with 50 channels allocated for private internal-use Business systems and 50 channels for Industrial/Land Transportation private internal-use systems. Some of the public safety channels are also adjacent to commercial SMR channels and some of the Business and Industrial/Land Transportation channels have been converted to SMR use during the past decade.

Subsequently, in 1986, the FCC allocated an additional six MHz of spectrum (821.0-824.0 MHz paired with 866.0-869.0 MHz) for exclusive use by public safety agencies. These channels were allocated for interoperable public safety systems developed through regional planning programs involving both intra- and inter-region frequency coordination efforts. Additionally, some public safety communications systems have been licensed in the 800 MHz General Category frequencies (806-810/851-854 MHz).

Given the then-current state of 800 MHz technology, in which all systems employed similar analog high power, high site system architecture, the FCC had no reason to expect that two-way systems allocated for these different uses would be in any way incompatible and might cause interference to each other. When public safety radio systems initiated 800 MHz service, the FCC had not yet adopted service rules – much less licensed -- cellular mobile radio systems and 800 MHz SMR systems were in their infancy. In short, when the allocations illustrated in Figure 1 were promulgated, neither the FCC, the wireless industry, nor the public safety communications community could have anticipated the revolutionary changes in mobile communications technology that would occur during the 1990s, nor the explosive demand for commercial communications services and increased need for additional public safety communications capacity and capabilities.

Figure 1: FCC Spectrum Allocation in the 800 MHz Band



The advent of cellular mobile communications technology, in which frequencies are intensively reused throughout a system's service area through the construction of multiple, low-power base stations, has enabled the 800 MHz spectrum to be used far more efficiently than ever before to provide value-enhanced services to millions of Americans. Advances in this technology, including the advent of digital communications techniques, have greatly expanded the capacity of cellular and similar frequency-reuse architecture SMR networks thereby making mobile communications affordable and convenient for both businesses and consumers. This has led to explosive demand for cellular and similar commercial wireless services at 800 MHz. At the same time, demand has also increased for public safety communications to support additional mission critical services. This, in turn, has resulted in accelerated deployments to accommodate more users, with more intensive use of the 800 MHz radio spectrum by public safety communications networks.

These deployments of both public safety and commercial wireless systems in recent years have had some unforeseen consequences. Under certain circumstances the mix of public safety and commercial systems on neighboring or adjacent spectrum has resulted in overlapping radio emissions from mobile communications systems designed at different times and for dissimilar operating environments. Public safety radio systems designed for the frequency coordinated, less congested and less intensively used RF environments of ten and 15 years ago, for example, may not be capable of rejecting locally robust commercial transmissions on adjacent frequencies. Similarly, some digital commercial networks, while enabling more efficient spectrum use through division of bandwidth into time slots, may also increase the local noise floor above that in which older public safety equipment was intended to operate, resulting in disrupted communications capability. In addition, both public safety and commercial systems have migrated from systems that primarily use "mobile" in-vehicle devices to systems that increasingly use "portable", hand-held units, thus increasing the mobility of the units and the potential interference effects. The purpose of this document is to help operators identify these circumstances and to proactively as well as reactively obtain assistance in mitigating harmful interference.

III. CONDITIONS EXIST IN WHICH INTERFERENCE CAN OCCUR BETWEEN PUBLIC SAFETY AND COMMERCIAL WIRELESS SYSTEMS

Why do CMRS operations cause interference to public safety radio service in some circumstances, but not in others? The answer lies in certain differences in the design parameters of these systems, which, in certain circumstances, result in conditions conducive to interference. These differences stem from the fact that public safety and commercial wireless systems were developed over time to serve two distinctly different user groups, using system architectures intended to best serve each group.

Public safety systems have traditionally been designed to provide dispatch and coordinating communications to a comparatively small group of users (e.g., police, fire, rescue and medical) over a specified area of jurisdiction or responsibility. Public safety users, typically, are divided into operational/tactical groups of individuals who often have a need to roam throughout the political jurisdiction of the parent governmental entity. Since all members of these operational/tactical groups need to participate in any given communication and since the individual members of the group may be at any location within the operating area, public safety systems are designed to provide radio coverage throughout a large area with little or no frequency reuse. Furthermore, public safety systems must be capable of supporting large increases in capacity resultant from emergency situations (disasters, civil emergencies, large-scale fire, etc.) that may occur at any time and at any place. Based on this, and the fact that public safety agencies typically have limited financial resources, most public safety radio systems use high antenna site base stations and little or no frequency reuse to cost-effectively cover as much area as possible with the fewest sites, thereby holding fixed infrastructure costs to a minimum. This configuration can result in weaker signal strengths in areas distant (e.g., several miles) as opposed to areas closer to the base station. For example, the edge of the service area, other points distant from the base station, and various points within the service area where signals to and from the base station are blocked or otherwise attenuated may receive weaker signal strengths than an area close to the base station or where a signal is not blocked. These weaker signal strengths are acceptable as long as the signal from the base station is sufficiently strong to overcome the thermally generated electrical noise inherent in the public-safety mobile receivers (and, indeed, in all receivers of any type). Systems designed in this fashion, in which the limiting factor is considered to be thermal noise, are considered to be **noise-limited**.

In contrast, CMRS networks are normally designed to provide service to a large user base (i.e., the general public) in a given area. Additionally, the average amount of time the typical CMRS user is actually **using** the spectrum is much longer (because the typical telephone call lasts much longer than the typical public-safety dispatch call). Because the total amount of traffic generated by commercial users far exceeds the capacity of the available spectrum in the system's service area, the radio channels must be reused over and over again throughout the area. This, in turn, requires a CMRS operator to deploy large numbers of base stations throughout its service area with each base station's transmissions covering a very small area, e.g., a radius of only a few hundred feet to a few thousand feet. This "cellular" system architecture enables commercial carriers to deploy networks capable of serving thousands of subscribers using spectrum that previously supported only one call per channel at a time throughout a large service area. As a result, this system design methodology has become the backbone architecture of cellular, Personal Communications Service ("PCS") and enhanced SMR systems throughout the country.

At any given time, the signal from the desired CMRS base station to a mobile or portable unit is **interfered with** by signals from other cellular base stations on the same frequency. Careful system design by the CMRS operator minimizes, but does not eliminate, such interference. This interference, rather than thermal noise as in the case of public-safety radio systems, is the limiting factor on successful operation of a CMRS system. CMRS systems are therefore considered to be **interference-limited** rather than noise-limited.

Inherent in cellular-type architecture is the fact that base station transmissions from a local cell site will be fairly strong at a given receiver location (in order to overcome interference from other CMRS stations on the same frequency farther away). Other receivers in the same location (e.g., public-safety receivers) will be exposed to the same relatively strong signals, particularly in the immediate vicinity of a CMRS base station. This is in contrast to the public safety signal, which, particularly in areas distant from the transmitter site, is designed so that it may be relatively weak, as noted earlier. When these two types of wireless systems are close both geographically and spectrally (i.e., adjacent or near adjacent channels), the potential for interference exists -- especially where the public safety signal is weak due to base station distance or topographic features, relative to a closer commercial base station's signal. Public safety handheld and mobile units may experience one or more of the interference effects described above when numerous commercial antenna sites in a given area (typically in a closely-spaced urban environments) are below 80 feet above ground level – thereby producing a particularly strong signal in the immediate street vicinity – and in fringe coverage/service areas where the strength of public safety transmissions is relatively weak. In such circumstances, public safety receivers may be overpowered in weak signal or "fringe" areas by stronger nearby CMRS signals. This is manifested as interference in the public safety communications system.

Interference to public safety radio transmissions in these circumstances falls into four major categories: intermodulation, receiver overload, transmitter sideband noise, and effects due to the transition from analog to digital modulation, as described below.

A. <u>Intermodulation</u>

Intermodulation occurs due to interaction (mixing) between two or more different carrier frequencies. This mixing can take place internally in a transmitter or receiver or external to both devices. The interaction produces signals at all combinations of the sums and differences of the carrier frequencies. For example, a portable receiver attempting to receive on the frequency 869 MHz could potentially receive intermodulation interference from cellular transmissions occurring at 870 MHz, 871 MHz and 872 MHz (870+871-872 = 869 MHz). As the number of transmitters at a site is increased (which CMRS carriers may do by employing additional frequencies to increase capacity), the probability of creating an "on-frequency intermodulation product" increases accordingly.

As noted above, intermodulation can occur either in the transmitter, receiver, or external to both. However, receiver intermodulation, when it occurs, is typically the predominant effect. A portable receiver experiencing intermodulation interference loses sensitivity when several strong signals mix in the front-end of the receiver, producing a strong intermodulation signal on or near the "receive" frequency. When this occurs, the receiver has a difficult time differentiating between the desired signal and the undesired intermodulation product, resulting in degraded communications capability.

B. <u>Receiver overload</u>

The first stage of a receiver is usually an amplifier. This device amplifies both the desired signal and any other signals close to the same frequency to a level that the rest of the receiver can use. If the signal or signals in the area are strong, they may overload this amplifier. The likelihood of this happening increases as the number of base stations in the area increases and as the signals from those stations become stronger (e.g., as the distance to the base station antenna decreases).

Receiver overload manifests in three ways: receiver blocking, local oscillator interference, and receiver "desense." Receiver blocking occurs when an extremely strong signal or signals blocks out reception of the desired signal. Local oscillator interference occurs when noise from the local oscillator mixes with a strong, nearby undesired signal.[3] This causes the interferer to "mix" and backfill on the desired frequency, producing a noise like component. Receiver "desense" is interference produced by a close, strong signal that reduces the gain of the amplifying stages of the receiver, thereby inhibiting the ability of the desired signal to be received properly. These effects are rare with modern receiver designs, as other effects are more likely to be manifested before true overload occurs. Interference resulting from receiver overload can be reduced through frequency separation and geographic distance separation between the public safety and commercial operations.

C. Transmitter Sideband Noise

Sideband energy is produced by every transmitter, regardless of type, as a necessary product of the process of making it convey information (the **modulation** process). Modulating a transmitter with information (voice, data, etc.) causes it to produce energy on frequencies above and/or below the assigned carrier frequency. The FCC sets strict limits on how much energy can be produced at various frequency spacings away from the assigned carrier frequency; this set of limits is usually represented as a curve and is referred to as "the FCC mask." It should be noted that in order to allow adequate modulation of the transmitter, the "FCC mask" provides limited attenuation of the transmitter sideband noise on the next, second, and third adjacent channels from the assigned channel (see 47 CFR 90.235(b)).

When the desired signal is weak at a user's receiver and there are no intermodulation products on or near the frequency of the desired signal, the user can still experience interference if the energy from the undesired transmitter's sidebands is as strong as or stronger than the desired signal. This can occur even if the undesired transmitter is operating completely within the limits of the FCC mask.

Sideband noise interference typically becomes predominant only when the desired signal is weak and no intermodulation products fall on or near the desired frequency. In other words, if there were no intermodulation interference, then transmitter sideband noise will most likely be the root cause of an interference problem. Sideband noise is an increasingly frequent factor for commercial/public safety interference as additional low power commercial stations are geographically deployed to meet customer demand for coverage and system capacity. In addition, the sideband noise performance of commercial transmitters often assumes that the commercial operator will be adjacent to its own operations in the spectrum, and, therefore, will be able to manage internally its own sideband noise. The sideband characteristics of digital modulation technologies increasingly used in commercial systems contribute to this type of interference, as discussed below.

D. Analog to Digital Transition

Beginning around 1990, the wireless communications industry (both commercial and public-safety) began to shift from using analog modulation to digital modulation techniques. Digital transmission systems typically have greater sideband noise emissions than analog systems. Thus, the potential exists for digital CMRS systems to cause interference to public safety systems designed to be protected only from analog sideband noise emissions generated by other systems. As noted earlier, many public safety communications systems were designed to be noise-limited; that is, they were designed with an expectation that there would be few nearby spectrum users and that internally-generated noise in the mobile receivers would be their limiting factor. Since analog transmission systems were used exclusively in the band at the time, these systems were designed on the basis that co-channel (on-frequency) interference would be the predominant interference mechanism, with preventing or controlling adjacent channel interference of any kind receiving only limited attention. Public safety systems are becoming "interference limited" in the contemporary RF environment, i.e., their operations are susceptible to interference resulting from the unanticipated mix of technologies and modulation schemes in adjacent 800 MHz spectrum.

IV. OPERATIONAL IDENTIFICATION OF INTERFERENCE

The operational appearance of interference to a public safety system may manifest itself in various ways. All of the identified underlying technical causes discussed above tend to result in the loss of received signal by the mobile units. However, due to the location dependent nature of the interference, and the different kinds of technologies employed by public safety agencies, the actual interference may appear to be sporadic. The typically short duration of public safety transmissions further complicates identification.

Interference to conventional operations is usually self apparent, since the mobile subscriber unit uses a dedicated frequency. Loss of coverage is readily apparent and it is often straightforward to identify the specific frequency being interfered within a definite area of operation.

Interference to trunked operations is more difficult to identify. The frequency experiencing the interference may be used in one of two ways. If the frequency in question is a control channel, the result will normally be mobile radios that are entirely incapable of operation within the zone of interference. Since the radios are unable to decode an assignment received on the control channel, they are not available to receive transmissions. If, on the other hand, the frequency happens to be one of the randomly assigned working or traffic channels, the effect of the interference will appear more randomly. Only mobile units randomly assigned to the "problem" channel will experience the interference, thus rendering a repeatable observation difficult.

In these cases, the close cooperation of both public safety and commercial operators is critical to identifying, evaluating and taking steps to mitigate such interference. The next section provides guidance for addressing interference situations and predicting potential interference conditions.

V. MINIMIZING THE PROBLEM: TECHNIQUES FOR BOTH EXISTING SYSTEMS AND NEW SYSTEMS

While the magnitude of the incidents of interference between commercial wireless systems and public safety radio systems is undetermined, the number of reported cases has not been large relative to the number of public safety communications systems. Even so, the resolution of any instance of interference to a public safety system must receive the highest priority.

This section of the Guide addresses alternative measures, which CMRS system operators and public safety communications system managers can take to (1) mitigate such interference in existing deployments; and (2) prevent such interference in new or future CMRS and/or public safety radio installations.

A. <u>Existing Systems</u>

When a public safety agency believes it is experiencing interference of the types described above, it should contact the CMRS carriers operating in the affected area. Attached hereto are contact lists to assist public safety network operators in reaching the general managers or local engineering personnel of these CMRS carriers to initiate evaluation of the interference to identify whether it is resulting from adjacent channel or geographically proximate CMRS operations. The CMRS contributors to this Guide recognize that such interference can affect communications vital to police, fire, rescue and other safety of life services and will endeavor to give such reports their highest priority and immediate attention. Public safety communications officers should assist in this process by working with CMRS operators to help identify the geographic extent of interference, the type of interference and to expeditiously test mitigation techniques.

If CMRS operations are determined to be the source of the reported interference, a number of measures are available to mitigate or eliminate interference in most cases, as described below. Some involve modifications or refinements of the CMRS operations; others involve increasing the robustness of public safety communications transmissions by adding more proximate base stations, increasing power levels or deploying more interference- resistant public safety handheld and mobile receiver units. Assuming that both the public safety and CMRS systems are operating in compliance with their FCC licenses and the FCC's rules, the parties should cooperate to determine the most efficient allocation of costs and resources necessary for interference mitigation, taking into account the costs and benefits of mitigative actions.

1. System Modifications

The most effective actions to address public safety interference will depend on the specifics of each particular situation. Specific factors include the locations of the involved base stations relative to the area in which public safety communications are impaired; the height, power, and other operating parameters of the CMRS base station; the distance from that area to the public safety base station and its signal strength in the affected area; the number of CMRS channels operating in the affected area and whether they are adjacent to the desired public safety channels; the size of the area in which public safety communications are impaired; and the operating specifications and capabilities of the affected public safety handheld and mobile units. Depending on the factors or factors involved in a particular situation, CMRS and public safety agencies should cooperatively evaluate the interference-reducing effectiveness of the following actions, along with any additional burdens they may cause:

- Retune CMRS Channels Further Away From the Public Safety Operator's Channels. Both cellular and enhanced SMR operators in a given location may be able to modify their channel deployment and/or channel reuse plans to increase the separation between CMRS and public safety channels in the affected area. A separation of 1.5 MHz or more between these channels has been effective in alleviating interference.

- Modify CMRS Power Levels, Antenna Height and Antenna Characteristics. Reducing the Effective Radiated Power ("ERP") of the CMRS operations can reduce or eliminate public safety receiver overload interference. In addition, increasing the height of the nearby CMRS antenna site, changing the antenna radiation pattern, employing tighter beam-width antennas, or more gain in conjunction with reduced transmitter power to maintain the same ERP, may reduce undesired signal levels by virtue of the local antenna pattern. It may also be possible to sectorize CMRS antennas away from the affected public safety facilities to reduce the cumulative RF energy in that direction emitted from an omni-directional antenna.

- Assure Proper Operation of Base Station Equipment. Poorly operating or degraded equipment may exacerbate interference. Both CMRS and public safety operators can check their base station equipment to ensure that it is operating within design guidelines.

- Improve the Local Signal Strength of the Public Safety Communications System. In some cases, the alternatives described above may be less effective than desired in eliminating or sufficiently reducing interference. In such cases, the parties should evaluate improving the propagation and/or strength of public safety base station transmissions, particularly in the case of distant single-site systems designed to operate in a low noise, less intensive channel reuse RF environment. The parties should evaluate adding more proximate public safety base stations, increasing ERP, providing better transmission antennae, and replacing existing mobile and handheld units with more interference-resistant equipment. Any such modifications must be done with careful coordination to analyze potential interference effects on other nearby public safety communications systems.

2. Incorporating Filters Into CMRS Transmission Equipment

As discussed previously, site sideband noise is an increasing contributor to interference in some public safety networks. If sideband noise is determined to be a potential issue, additional filtering of the CMRS transmitters to suppress these emissions can be effective in mitigating or reducing interference. Sideband noise has to be filtered out at the interfering source as it appears "on frequency" to affected receivers. There are a variety of filters that CMRS operators can test as to their efficacy in a particular interference scenario.

3. Segregation of Public Safety and CMRS Spectrum Assignments

Another alternative to mitigate interference in a particular case is to attempt to segregate or relocate public safety use away from commercial use in the 800 MHz band. The 800 MHz band continues to experience robust growth. Public safety organizations, commercial wireless carriers and equipment manufacturers should consider whether segregating public safety and commercial channels would be useful, and seek FCC permission to "swap" or reassign channels. In some cases, such frequency swaps can be a "win/win" solution for both public safety and CMRS operators by enabling them to both mitigate interference and make the most efficient and effective use of their spectrum resources. While all of the mitigation measures described above can be effective in reducing interference to public safety operations, they will typically result in sub-optimal use of the licensed spectrum of either the public safety licensee, the CMRS operator, or both. Frequency swaps that enable each party to fully utilize its licensed channels serve the public interest by promoting spectrum efficiency and the widespread availability of both public safety communications and commercial wireless services.

B. New or Expanded Systems

1. Advance Planning

The most critical factor to preventing interference between public safety and CMRS systems is comprehensive advance planning and frequency coordination between commercial providers and public safety communications entities. This applies regardless of whether a CMRS system is first initiating service in an area already served by public safety communications systems, a CMRS provider is expanding the geographic coverage or user capacity of an existing CMRS system, or is adding or transitioning to a digital modulation technology. It also applies whenever a new public safety radio system is being introduced into an area with incumbent CMRS systems, or when a public safety provider introduces a new voice or data upgrade to its previous communications network or transitions to a digital network. In other words, anytime either public safety or CMRS providers in a market introduce new service or significantly modify their communications systems is an opportunity for advance planning and cooperation to prevent or minimize interference.

CMRS carriers introducing service, expanding coverage or making other major modifications should contact the local public safety agency to examine whether their plans potentially represent an interference risk. In particular, CMRS users of channels that are adjacent to channels allocated for public safety use should ascertain whether such public safety channels are assigned for use in the same geographic area as their proposed CMRS operation. This information can be determined from the FCC's Part 90 database (add url), among other sources. For new or expanding public safety systems, the contact lists attached hereto provide a starting point to assist public safety network designers in contacting the local engineering personnel of CMRS carriers in their area to begin examining which channels may potentially represent an interference risk. By assessing intermodulation potential, base station locations and design parameters, adjacent frequency deployments and the relative signal strengths of each system at representative locations, the parties can identify where the probability of interference is greatest and plan around it. This additional planning should minimize the number of situations in which interference is likely. Advance coordination among public safety and CMRS providers also provides a means through which operators can collocate base station sites. This results in the signal strength of both public safety and CMRS transmission being comparable in the vicinity of the site, thereby reducing the likelihood of interference.

2. Public Safety Equipment Should Be Suited to an Intensive RF Environment

Another key method for alleviating potential interference is to minimize the susceptibility of receivers to interference. Public safety users purchasing new equipment for use in high RF environments should ensure that the receivers have high intermodulation specifications. For systems designed exclusively for on street coverage 75 dB minimum is recommended. This can be relaxed somewhat, 70 dB, for systems designed for portable coverage inside large buildings. Additionally, public safety users should avoid using external antennas when operating portable devices in vehicles, especially when these portables have been designed to provide in-building coverage, as this will aggravate potential interference effects.

3. System Design Criteria

In those instances in which public safety systems will operate in high noise levels within the local environment, interference to public safety operations can be minimized or prevented by increasing the signal strength of the desired signal levels above local noise levels. Public safety systems in urban and other intensive RF environments must be designed to a higher degree of robustness than was required before the advent of multiple adjacent and nearby CMRS networks. System designs that produce higher public safety system signal strength levels throughout the service area will create a more robust system resistant to interference from CMRS systems operating in the area, as well as other interference sources (e.g., computing systems in buildings). For example, if a public safety radio system is being designed to provide in-building coverage, it may also provide more robust coverage on the streets and highways.

VI. FURTHER RESOURCES

More information can be found at www.apco911.org including a softcopy of this Best Practices Guide.

Additional technical background can be found at:
http://www.motorola.com/cgiss/NA/contact/Interference%20Technical%20Appendix.pdf

VII. POINTS OF CONTACT

Association of Public-Safety Communications Officials-International, Inc. (APCO)
351 N. Williamson Blvd.
Daytona Beach, FL 32114-1112
Phone: (904) 322-2500
E-mail: apco@apco911.org
Web address: www.apco911.org

Cellular Telecommunications & Internet Association (CTIA)
Contact: Vice President for Industry Operations
Phone: (202) 785-0081
FAX: (202) 887-1629
E-mail: indops@ctia.org
Web site: www.wow-com.com

Motorola, Inc.
Contact: Customer Service Representative at the Motorola System Support Center
Phone: (800)323-9949. Select Option 1 (operating 24 hours a day/7 days a week).
Note: Callers with a maintenance contract should provide their System ID. All other callers should use a System ID INTFR to expedite routing to the appropriate division representative. This method of contact provides the quickest response time.
FAX: (847)725-4073
E-mail: cms072@emailmot.com

Nextel Communications, Inc.
Contact: Senior Engineer RF Operations
Phone: (703) 433-8894
Fax:(703) 433-8484
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Public Safety Program Network (PSWN)
Contact: PSWN Program Manager
Phone: (800) 565-PSWN (7796)
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