Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of Improving Public Safety Communications in the 800 MHz Band Consolidating the 900 MHz Industrial/Land Transportation and Business Pool Channels	WT Docket No. 02-55

COMMENTS OF MOTOROLA, INC.

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Summary

Motorola commends the Commission for initiating a rulemaking proceeding to investigate the causes of, and potential remedies for, the interference being experienced by public safety users in the 800 MHz band. Motorola supports the Commission's efforts to devise solutions that will minimize this interference to the maximum extent practicable. Public safety licensees require highly reliable and effective private radio communications systems to meet their critical mission of protecting the general public. At the same time, CMRS licensees need solutions that will minimize instances of interference and thus reduce the need for case-by-case resolutions, which divert carrier resources that could otherwise be used to enhance service to their subscribers.

In these Comments, Motorola identifies the key principles that the Commission should consider in reviewing the proposed solutions. We will also address the practicalities of interference suppression, provide information concerning the realities of rebanding, and summarize our cost estimates for the two rebanding proposals described in the *NPRM.* We have participated in industry discussions regarding many other plans that are under development, and will offer analysis on those once they are officially submitted to the Commission.

It is important to note that rebanding alone is unlikely to provide an adequate solution to the interference being experienced by public safety, business and industrial systems. Additional measures, such as those recommended in the *Best Practices Guide*, will be needed to help mitigate existing interference and to prevent or minimize such interference in new systems. Because the most effective solution to any interference problem is dependent on the specific circumstances involved, there is no one "silver

bullet” solution that can fully resolve the complexities of interference in the 800 MHz band. Motorola is committed to working with the Commission to ensure that public safety agencies have effective and reliable communications capabilities necessary to serve and protect the American public.

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Motorola, Inc. ("Motorola") is pleased to submit these comments in the above captioned proceeding in response to the Commission's recent *Notice of Proposed Rulemaking* ("*NPRM*").[1] As an equipment supplier and technical advisor to public safety, private wireless and commercial licensees in the 700, 800 and 900 MHz bands, we offer our help to create a Commission decision that best serves the public interest and that meets the needs of all wireless users for both short and long term solutions that are appropriately resourced.

I. BACKGROUND

Motorola wishes to express its appreciation to the Commission for initiating this rulemaking proceeding to address the interference experienced by public safety (and private wireless entities) from systems deploying cellular architectures in the 800 MHz

[1] Improving Public Safety Communications in the 800 MHz Band, Consolidating the 900 MHz Industrial/Land Transportation and Business Pool Channels, WT Docket No. 02-55, Notice of Proposed Rule Making, FCC 02-81 (rel. Mar. 15, 2002) ("*NPRM*").

band. The Commission's *NPRM* and Nextel's white paper,[2] which is fully discussed in the *NPRM*, acknowledge that the interference being experienced by public safety from CMRS systems must be eliminated or minimized to the maximum extent possible.[3] Public safety communications have always been of a highly critical nature but recent events have heightened public safety users' need for reliable, dedicated communications systems to meet their mission of protecting the public. At the same time, CMRS licensees need solutions that will minimize interference potential and thus reduce the need for case-by-case interference resolutions, which divert carrier resources that could otherwise be used to enhance service to their customers.

Since September 11th, state and local governments have even greater responsibilities to protect and defend the American public and there is increasing awareness that effective radio communications is one of the most critical tools for enabling public safety to meet these obligations. Public safety organizations must move forward now to expand and improve their mission critical communications systems. However, some public safety agencies are becoming increasingly reluctant to embark on system upgrades if the potential improvements in service may be marginalized by CMRS interference. Moreover, public safety entities are becoming more hesitant to make significant capital investments to upgrade or expand their systems if they will be required to incur the additional expense and inconvenience of retuning their systems as a result of the outcome of this proceeding. Therefore, the FCC must act fast to eliminate these

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[2] Nextel Communications, Inc., Promoting Public Safety Communications – Realigning the 800 MHz Land Mobile Radio Band to Rectify Commercial Mobile Radio – Public Safety Interference and Allocate Additional Spectrum to Meet Critical Public Safety Needs, ET Docket Nos. 00-258 and 95-18, IB Docket No. 99-81, WT Docket No. 99-87, (filed Nov. 21, 2001) ("*Nextel White Paper*").

[3] *See NPRM* ¶ 16; *Nextel White Paper* at 5.

concerns and this uncertainty so that public safety agencies can be relieved of these distractions and move forward on their core obligations.

In these Comments, Motorola will address key principles by which we believe proposed solutions should be judged. We will also address the practicalities of interference suppression, provide information concerning the realities of rebanding, and summarize Motorola's cost estimates for two of the rebanding plans described in the *NPRM*. We have participated in industry discussions regarding many other plans under development, and will offer analysis on those once they are officially submitted to the FCC. Regardless of which of the proposals are considered for reconfiguring the 800 MHz band, it is our belief that rebanding alone will not eliminate completely the interference that CMRS systems are causing to public safety, business and industrial systems. Additional measures, such as those recommended in the *Best Practices Guide*,[4] will be needed to help mitigate existing interference issues and prevent such interference in new systems. Because the most effective actions are dependent on the specifics of each situation, there is no one set of solutions.

II. PRINCIPLES FOR EVALUATING TRANSITION PROPOSALS

Motorola views the following principles as guidelines to evaluate any spectrum transition proposal. We believe the Commission should ensure, to the maximum extent possible, that any plan adopted:

- Enables an effective process to mitigate interference in the short term and eliminate interference to the extent possible over the long term;

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[4] Avoiding Interference Between Public Safety Wireless Communications Systems and Commercial Wireless Communications Systems at 800 MHz – A Best Practices Guide (Dec. 2000) (*hereinafter Best Practices Guide).*

- Provides an environment that strengthens the ability of first responders to upgrade/expand their systems to meet their Homeland Security and interoperability needs;
- Responds to the public safety community's documented need for additional spectrum;
- Ensures that critical infrastructure users also have sufficient spectrum, adjacent to public safety for interoperability required during emergencies;
- Ensures that industrial, business and Specialized Mobile Radio ("SMR") users do not lose spectrum or their primary status as licensees;
- Provides a smooth transition that includes sufficient funding, allows migration with no loss of service, and does not place an undue burden on any 800 MHz licensee.

Clearly, other factors and implications will be considered. However, these core principles should be used to weigh the various recommendations that will be under consideration in this proceeding.

III. RELIABLE DEDICATED PUBLIC SAFETY SPECTRUM AND SYSTEMS ARE ESSENTIAL

In its *NPRM*, the Commission requests comment on how much spectrum public safety requires. The *NPRM* references a 1996 report published by the Public Safety Wireless Advisory Committee ("PSWAC")[5] discussing the spectrum needs of public safety users, but also suggests that the increased number of CMRS systems put in place since the release of the PSWAC report could serve some of the public safety needs.[6] In Motorola's view, the public safety spectrum needs identified in the PSWAC report remain valid today.

[5] The Commission and the National Telecommunications and Information Administration ("NTIA") established the PSWAC to evaluate the wireless communications needs of federal, state, and local public safety agencies through the year 2010 and to recommend possible solutions.

[6] *NPRM* ¶ 29.

The PSWAC Final Report concluded that almost 100 MHz of *additional* mobile spectrum "will be required for Public Safety officials to continue to protect life and property efficiently and effectively in 2010."[7] Notably, this PSWAC finding is based upon support of *mission critical* public safety applications – the report explicitly recognized that CMRS providers can serve a portion of public safety users' non-mission critical communications needs,[8] and took this factor into full account before arriving at its conclusions.[9] Moreover, PSWAC noted that its spectrum projections factored in "aggressive" improvements in spectrum efficiency.[10]

Since the release of the PSWAC report, the Commission has responded by allocating a total of 74 MHz of additional mobile spectrum for public safety use -- 24 MHz at 700 MHz in 1998 and 50 MHz at 4.9 GHz earlier this year.[11] However, the 700 MHz band – which is most analogous to the existing 800 MHz public safety allocations – remains unusable in the largest cities because it is still largely encumbered with television broadcast licensees.[12] Moreover, while Motorola has recently started shipping public

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7 Public Safety Wireless Advisory Committee, Final Report (Sept. 11, 1996) ("*PSWAC Final Report*"), § 4.4.1 at 54.

8 *See id.* § 2.4 at 25.

9 *See id*. § 4.4.6 at 55; *id*. § 4.4.8 at 56 (estimating that 10.6 MHz of public safety spectrum needs can be served by CMRS providers). PSWAC weighed four factors to quantify the amount of spectrum the public safety community will need: the predicted growth in the public safety community (which is driven by growth in the overall U.S. population); changes in services available to public safety users that will allow increased efficiency, advances in radio technologies; and the extent to which public safety services can be provided by CMRS providers.

10 *Id*. § 4.4.10 at 56-57.

11 *See NPRM* ¶ 29. While Motorola views the 4.9 GHz allocation for short-range public safety broadband use as an extremely positive Commission decision in response to the public safety spectrum needs, we note that equipment development awaits further FCC action on technical rules and licensing requirements.

12 Approximately one-half of the 84 cities that have populations exceeding 200,000 have fully encumbered 700 MHz public safety spectrum leaving public safety users unable to access *any* of the 24 MHz of the upper 700 MHz band allocated for their use. Many of these cities are located in or near top metropolitan population centers, such as New York, Los Angeles, Dallas, Boston, and Miami, where the

safety radios that are capable of operation in both the 800 and 700 MHz public safety bands, the vast majority of imbedded 800 MHz public safety equipment is not capable of operation at 700 MHz. Given these factors, coupled with the current regulatory and legislative landscape, the resulting conclusion is that the 700 MHz public safety band can only be a part of a *long-term* solution to resolving the 800 MHz interference phenomena. Further, additional 700 MHz allocations for public safety and private wireless operations could also be a part of a long-term solution for public safety spectrum needs.[13] It is for this reason that Motorola strongly encourages the FCC to work closely with industry and Congress to ensure that no spectrum option for public safety is prematurely foreclosed.

While public safety users make use of CMRS carrier networks principally for administrative and non-mission critical communications, this does not eliminate the need for adequate public safety spectrum allocations. Experiences during the September 11th terrorist attacks confirm PSWAC's conclusion that dedicated public safety systems are essential in times of crisis, and that public safety entities cannot rely upon CMRS systems to serve their mission critical communications needs. The Public Safety Wireless Network ("PSWN")[14] Program recently released a report detailing the public safety

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shortage of public safety spectrum is most acute. Even in those cities where public safety users do have access to this spectrum, only a small portion of the band is now available

13 *See, e.g., Application for Review,* WT Docket No. 99-168, filed by the Cellular Telecommunications and Internet Association, submitted April 24, 2002, at 5 ("Indeed, the [Auction Reform Act of 2002] contains a finding that the 700 MHz band may provide a solution for the interference problems Public Safety communications are experiencing in the 800 MHz band").

14 The PSWN Program is a federally funded initiative operating on behalf of all local, state, and federal public safety agencies. The PSWN Program arose out of Vice President Gore's 1993 National Performance Review initiative on information technology, which called for the nationwide development of interoperable public safety systems at all levels of government. The PSWN was formally created in 1996 by the Federal Law Enforcement Wireless Users Group ("FLEWUG"). The Department of Justice and the Department of Treasury are jointly leading the PSWN Program's efforts to plan and foster interoperability among public safety wireless networks.

response to the attack on the Pentagon.[15] In this report, PSWN points to the successes of the public safety community's private networks, particularly in the first moments following the attack. The PSWN study found that:

> Major incidents, regardless of location, have shown that commercial service networks are not designed to handle the immense volume of calls generated at or near an incident scene. Responders found that the only reliable form of communications were their own private [land mobile radio] systems."[16]

As a result of the lessons learned during the response to the Air Florida crash in 1982, the Washington, D.C. metropolitan area police and fire agencies developed detailed interoperability plans and held regular training sessions on implementing those plans. During the Pentagon incident, the DC area public safety agencies followed a precise Incident Command System and relied heavily on their dedicated private wireless radio system for communications among fifteen different agencies providing first responders to the scene.[17] According to the PSWN Report:

> Arlington County operates an 800 MHz Motorola trunked radio system for police, fire, EMS and local government communications functions. The radio system supports approximately 1,750 mobiles and portable radios. The normal, day-to-day operations load is approximately 45 percent, or 500 radios. Based on interview data, it is estimated that the communications system loading was approximately 80 percent, or 900 radios on the day of the attacks. Multiple out-of-jurisdiction agencies were operating on the Arlington system during the first 8 hours of the incident. Interviews with key agencies revealed that no system busy signals were experienced during the Pentagon response. The Arlington County radio manager noted that priority levels for all emergency services (*e.g.*, fire,

[15] Public Safety Wireless Network Program, Answering the Call: Communications Lessons Learned From the Pentagon Attack (Jan. 2002) ("*PSWN Report*").

[16] *Id*. at 20.

[17] The success of the public safety communications systems at the Pentagon on September 11th resulted from careful advance planning. Well before that date, steps had been taken to (1) secure sufficient dedicated public safety spectrum; (2) fund and deploy a dedicated interoperable system designed specifically to meet public safety users' requirements; (3) pre-establish coordination procedures across multiple departments/jurisdictions; and (4) train responders to use the communications system effectively.

> police, EMS) had been established in advance. Consequently, no unusual system optimization measures were necessary on the day of the incident.[18]

In contrast, the PSWN report shows that the commercial wireless networks were overloaded within moments after the plane crashed into the Pentagon:

> During the height of the Pentagon response, cellular communications in the metropolitan region were ineffective and unresponsive. . . . As a result of the numerous service demands, users, including those in public safety positions, experienced call delays and interrupts, and system busy tones.[19]

This is not surprising as the primary purpose and design of commercial networks differ from that needed for public safety. Public safety systems are designed to spread necessary capacity over geographic requirements whereas commercial systems are designed to focus coverage capacity where people live, work and travel. Commercial systems become increasingly less viable as an adjunct or alternative source of public safety communications as population density decreases. Even where commercial systems have the greatest capacity in city centers, they can be overwhelmed in emergency situations as experienced on September 11th. Furthermore, there are vast areas of the country where little or no commercial wireless service exists. Yet police, fire, emergency medical responders and other critical users must be able to respond to calls for assistance in all locations.

Of course, PCS, cellular, SMR and other commercial networks clearly provide a valuable service and played a huge role during the events of September 11th. Cell phones enabled people to keep track of loved ones that were in harm's way, allowed for the dissemination of intelligence from key observers of the attacks, and helped in the coordination of clean-up activities. These commercial services proved invaluable on that

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18 *PSWN Report* at 9.

19 *Id*. at 11-12.

day and the stress that these systems faced is further proof that the FCC must move quickly to allocate more spectrum for advanced commercial wireless services.[20] However, as the PSWN report details, the commercial networks are not alternatives for mission critical public safety communications.[21] Accordingly, dedicated spectrum and systems designed specifically for public safety needs are the bedrock foundation upon which interoperability planning and training rest. Collectively, those elements form the basis for reliable public safety communications every day and during catastrophic events.

Since September 11th, an Office of Homeland Security has been established and federal agencies, including the FCC, have placed considerable emphasis on Homeland Security issues. As part of this increased focus on Homeland Security, the Commission and NTIA have reaffirmed that the public safety community must have the tools it needs to respond to any future attacks. One of the most critical public safety needs before, during, and immediately after a homeland security threat, or any other life-threatening incident, is reliable communications. As on September 11th, effective and uninterrupted communications among public safety users will play a key role in future emergency response efforts. Moreover, effective communications systems are critical to enable public safety entities to detect and prevent future threats.

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20 *See, e.g., Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems*, ET Docket No. 00-258, *Notice of Proposed Rulemaking*, 16 FCC Rcd 596 (2001).

21 At this time, priority access to the commercial networks does not provide a satisfactory alternative to private land mobile radio ("PLMR") service for public safety users. Although priority access service places designated governmental and public safety users at the head of the queue for access to commercial networks, it does not guarantee that public safety users will not experience busy signals if the available communications paths are already in use. Furthermore, priority access does not address other operational features required by public safety users.

The issue of homeland security is not limited to public safety agencies. Water utilities, power plants, gas pipelines, railroads, and some manufacturing facilities are all critical to our way of life and are all potential targets for terrorist attacks. The PSWAC report concluded that such industries require interoperable radio communications with public safety agencies.[22] Therefore, these industries should also have sufficient spectrum to meet the increasing communications challenges they face as they attempt to meet their obligations to enhance homeland security. Efforts to minimize the 800 MHz interference issue must also consider the spectrum needs of critical infrastructure industries and other industrial operations that have increased security concerns following September 11th.

IV. INTERFERENCE REALITIES

One of the primary purposes of the *NPRM* is to solicit proposals on how best to remedy the interference to 800 MHz public safety systems, consistent with minimum disruption to the existing licensing structure. Dropped calls can be a life threatening issue for users of mission critical private systems. For this reason, public safety and other mission critical systems are designed to provide 95-97 percent coverage reliability. Public safety users need protection from interference zones that essentially reduce this reliability. Although the FCC's primary focus is on interference to public safety systems, the *NPRM* also requests comments on the extent to which Business and Industrial/Land Transportation ("B/ILT") licensees are affected by such interference.

Interference is a very complex issue and it is often caused by numerous factors. Resolving interference cannot be reduced to a "one size fits all" solution; it often requires more than one type of corrective action. In the discussion that follows, Motorola will

22 *See PSWAC Final Report* § 4.1.17 at 33.

address these issues and then will discuss the extent to which the various proposals being submitted to the Commission help resolve these interference problems. Much of the information contained herein is based on the *Best Practices Guide*,[23] developed in December 2000, by public safety, CMRS providers and Motorola to help carriers prevent or mitigate interference to public safety systems.

As further described below, regardless of which of the proposals are considered for reconfiguring the 800 MHz band, *rebanding alone will not likely eliminate the interference that CMRS systems are causing to public safety and B/ILT systems.* The *Best Practices Guide* and its associated technical appendix on interference, identifies and recommends numerous alternative measures that CMRS carriers and public safety, and B/ILT users can take to mitigate existing interference issues and help prevent such interference in new or future CMRS and private systems. Because the most effective actions are dependent on the specifics of each situation, there is no one set of solutions. However, we note that the *Best Practices Guide* recommendations were utilized at this year's Winter Olympic Games in Salt Lake City, Utah, and greatly minimized the instances of interference among the numerous public safety, commercial and private wireless operations needed to support that event.

A. <u>The Root Causes of the Interference</u>

Public safety and private wireless radio systems have distinct operational requirements and priorities. Consequently, they are designed differently than commercial mobile systems. Public safety and private wireless systems are designed primarily to provide group call dispatch communications. These systems use a relatively high

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23 *See* n. 4 *supra*.

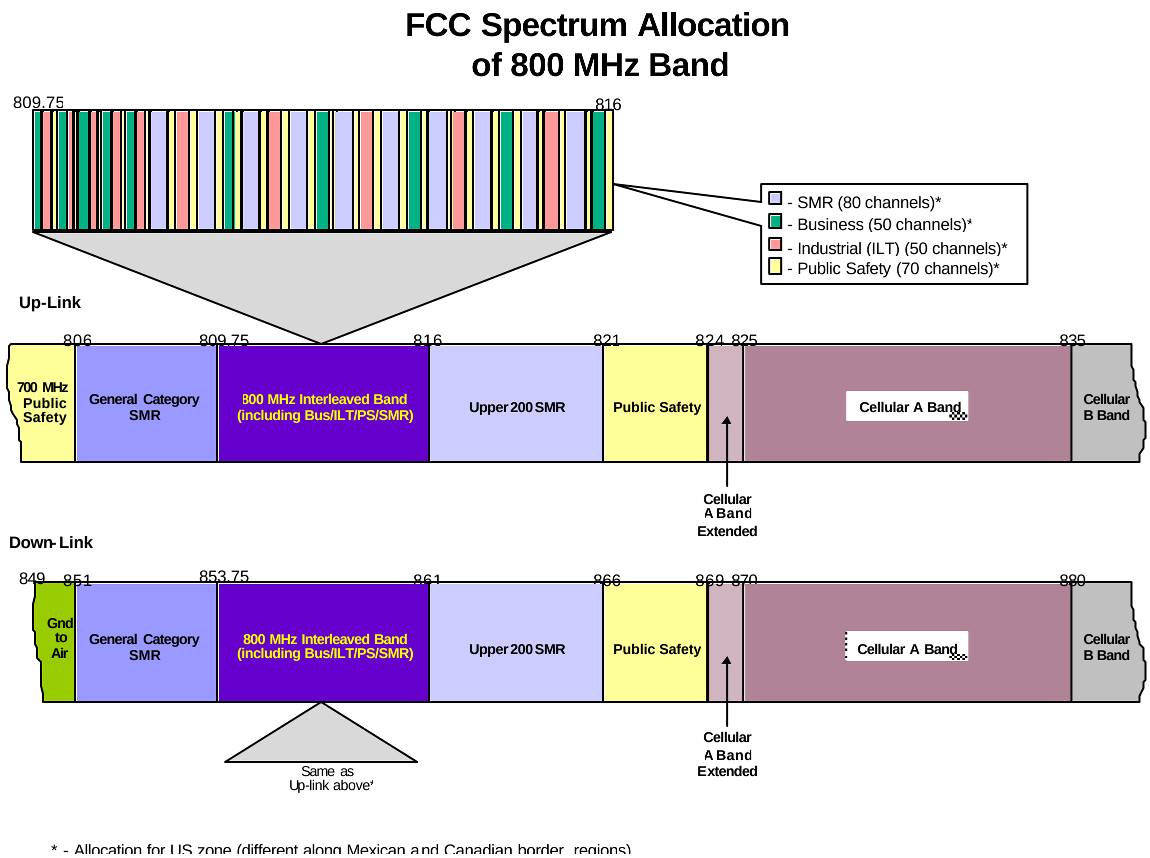
antenna to provide communications capacity evenly over a wide geographic area with the fewest possible number of sites, and thus provide a cost effective and spectrally efficient solution for group call communications. In areas where spectrum is in great demand and where in-building coverage must be provided, some public safety licensees use "simulcast" systems. Simulcast systems are specifically designed to re-use the same channel(s) at multiple sites throughout the service area. This system design provides even greater spectral efficiency for group call requirements.

Public safety and private wireless users generally design their systems to provide coverage throughout their area of jurisdiction or area of business operation. To enhance spectrum efficiency, such users design their systems such that the minimum usable signal level (with some margin) can be received at the edge of the outer boundary of their operational service area. This system design is known as a "noise-limited" system and radios can continue to operate on the system provided that they can overcome the "thermal noise" that is generated.

CMRS systems, in contrast, are designed to provide one-to-one wireless links for the general public, and to support much longer conversations. To maximize capacity where customer demand is greatest, CMRS operators concentrate their capacity in high population areas and reuse the available channels multiple times throughout their overall service area. CMRS systems are also designed to be "interference limited." This means that interference from other CMRS base stations and mobiles is the limiting factor; cellular radios are designed to handover calls to another local cell site before interference degrades the desired signal below an acceptable level. These operational requirements generally dictate that CMRS operators deploy a large number of base stations (cell sites) each covering a very small area, with each local cell transmitting a fairly strong signal to overcome the signals on the same channel from other sites further away. In populated areas, numerous CMRS providers often group their antenna sites in a given area ("co-location") and keep the antenna heights very low. The proliferation of multiple small cells and significant numbers of channels at each cell site combine to increase the number of potential sources of interference.

Advances in cellular and digital SMR technology allowed for intensive frequency reuse throughout the CMRS service area, through the construction of large numbers of low height base stations, transmitting at medium to high powers to provide better portable coverage and to meet their growing customer demand. This constant demand to increase capacity has led CMRS providers to make frequent changes to their frequency plans and site configurations and adopt automated loading systems such as "dynamic channel allocation" features, which continually rearrange channel assignments within a carrier's authorized spectrum. Frequency coordination and interference abatement with the public safety, B/ILT and high site SMR licensees are therefore much more complex and difficult today than when the band was originally envisioned.

In addition to the above design differences between public safety, B/ILT and CMRS systems, there are other contributors to the interference problems in the 800 MHz band. Chief among these is the structure of the 800 MHz band. The Commission originally developed the 800 MHz land mobile band plan to include private systems for public safety, B/ILT and SMR providers. Initially, all of these systems employed similar analog high power, high site system architecture. The frequency allocations for systems used by public safety, B/ILT and SMR licensees were interleaved in the 809.75-816 MHz and 854.75-861 MHz segments of the band, and cellular providers were placed in blocks adjacent to the 800 MHz band (see diagram below). Over the last decade CMRS systems have migrated from analog to digital modulation techniques that typically have greater sideband noise emissions than analog systems.[24]



24 *See Best Practices Guide* at 9-10. Sideband noise interference is discussed in further detail below. *See infra* p. 16. Motorola notes that there is nothing inherent in an Integrated Digital Electronic Network ("iDEN") signature that causes interference as demonstrated by the lack of interference complaints associated with Southern Company's use of the technology in a high transmitter site, wide area environment.

B. <u>Types of Interference</u>

When public safety radios get further away from their own transmitter (weak signal) and within the immediate area of a CMRS transmitter (strong signal), as described above, public safety radios may be overpowered and experience interference. This "near-far" scenario dramatically increases the probability of interference. The resulting interference falls into the following major categories:

- **Intermodulation ("IM"):** This type of interference is caused by the mixing of two or more signals on different carrier frequencies, which causes interference on a third, separate "intermodulated" frequency. This mixing can occur in either the source transmitter or the victim receiver. Typically, this predominant form of interference occurs if an intermodulated frequency is on or near a public safety receiver's assigned frequency. This will cause the receiver to lose sensitivity as it experiences difficulty distinguishing between the desired signal and the undesired intermodulated signal. IM normally arises when one or more CMRS operators have multiple frequency transmitters located on the same site or nearby towers. As the number of CMRS frequencies transmitting from nearby locations increases, so too does the probability of IM interference to public safety and B/ILT licensees operating on nearby frequencies. Also, the wider the frequency spread across the channels at a given CMRS site, the wider the reach (spread) of the resulting intermodulation signals. Today's public safety radios have IM rejection that is typically 70 to 75 dB which, when compared on an equivalent basis, is greater than that for CMRS radios. CMRS systems are able to control intra-system interference by co-location of CMRS antennas and other design mechanisms consistent with their primary business goals and therefore do not normally need such high levels of IM rejection.

- **Transmitter Sideband Noise:** As a result of the modulation process, all radio transmitters produce some energy above and/or below the intended transmission frequency. Close to the channel, this is normally called sideband noise. At separations beyond 150 percent of the channel bandwidth, this energy is normally referred to as out-of-band emissions ("OOBE"). The Commission's rules establish out-of-band emission limits that restrict the amount of energy that a transmitter may produce on the first, second and third adjacent channels to the assigned frequency. This set of limits is referred to as the FCC "mask." Digital systems typically produce greater sideband noise and out of band emissions than analog systems. For both analog and digital systems, this type of interference becomes predominant when no IM occurs.

- **Receiver Overload:** The amplifier in a receiver is designed to amplify the signals in the assigned frequency to a level other components of the receiver can use. When that desired signal or other signals close to that frequency become too strong, they may overload the amplifier. The probability of this type of interference increases as the number of base transmitters in an area increases. Newer receiver designs limit the occurrence of this type of interference.

C. Operational Identification of Interference

As noted above, interference is often the result of multiple conditions and causes. Investigation into complex interference problems may reveal that more than one type of interference problem is present. Further, one interference problem may mask a second or third problem. This may not become known until steps are taken to mitigate the most prevalent cause of the interference.

Interference can also manifest itself in different ways. Interference to analog conventional radios usually results in audible static noises in public safety and B/ILT receivers. For digital receivers, however, there is no audible clue. Instead, the user may interpret the interference as an inherent coverage problem when, in fact, coverage would be sufficient if the interference were not present.

With either analog or digital conventional systems the radios operate on pre-assigned frequencies, assisting the technician to diagnose the interference problem within a defined geographic location. However, interference to trunked radio systems can be more difficult to diagnose for two reasons. First, if the control channel is subject to interference, it impacts the radio's ability to assign traffic channels. Second, if the interference happens on the radio's randomly assigned traffic channel, then only those radios within the interference zone operating on that channel will notice the effect of the interference. Because of the random nature of channel assignments, repeating this interference for testing is much more difficult.

D. The Effect of the Rebanding Proposals on Interference

The *NPRM* seeks comment on two rebanding proposals that have been submitted as potential solutions to the 800 MHz interference problem.[25] Since the FCC issued the *NPRM*, various users and associations that operate in the 800 MHz band have outlined other rebanding proposals. While each of the rebanding proposals will generally offer some potential for reduced interference to public safety users, they will all need to be augmented with other remedies because rebanding alone will not completely eradicate the potential for intermodulation interference to occur throughout the 800 MHz band.

Most rebanding proposals would have a positive impact on interference caused by transmitter sideband noise and out-of-band emissions. Because this form of interference is caused by out-of-band emissions from adjacent and alternate channels, reducing the number of situations where public safety and B/ILT systems operate on channels that are directly adjacent to CMRS channels would greatly reduce the amount of transmitter sideband noise detected by public safety and B/ILT receivers. The currently pending rebanding proposals eliminate interleaved CMRS and PLMR channels and thus significantly reduce the opportunity for this type of interference. To preserve the benefits of any rebanding effort, the FCC should also modify its rules to ensure continued segregation of high-site systems from low-site systems.[26]

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25 *See NPRM* ¶ 20.

26 The current Commission "flexibility" rules allow 800 MHz Business and Industrial pool channels to be converted to CMRS use. Continuing that rule after any rebanding were completed could, in essence, return the band to an interleaved environment.

However, rebanding of the 800 MHz band alone would have less impact on eliminating IM interference. This type of interference is dependent on the combination of frequencies transmitted from the same site or nearby sites by one or more CMRS carriers. Therefore, rebanding would not eliminate the probability of IM interference to public safety and B/ILT users operating on frequencies that fall within the calculated IM frequency spread. The IM frequency spread at any site, *i.e.*, the number of channels above and below the intermodulating CMRS frequencies that may be affected by IM, is mathematically dependent on the lowest and highest frequencies that are being transmitted by one or more CMRS carriers at the site.

As shown in the following diagram, if one or more CMRS carriers on the same site transmit frequencies that are 1 MHz apart from the lowest frequency to the highest (frequency range of 1 MHz), then the chance of IM interference can range up to 2 MHz down from that lowest CMRS frequency and 2 MHz up from the highest. As that CMRS frequency range expands, the IM interference range also expands. If, for example, one or more CMRS carriers co-locate on the same site, that range of CMRS transmission frequencies can become quite large, thereby creating an even larger IM interference range.[27] Since there is a direct relationship of IM to the range of CMRS frequencies being transmitted from the same site, the CMRS carriers need to share site specific frequency data and utilize frequency planning to limit as much as possible the low to high frequency spread among all the carriers transmitting from the same site. In summary, "rebanding" does not eliminate the need for these frequency coordination measures.

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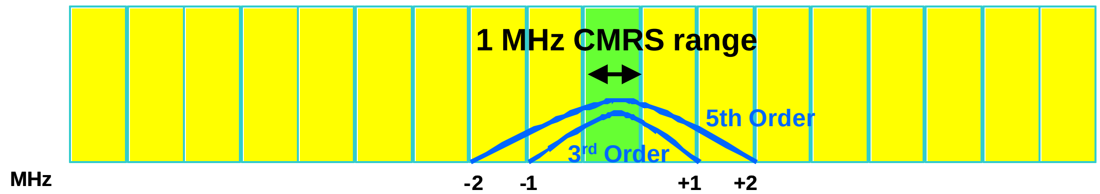
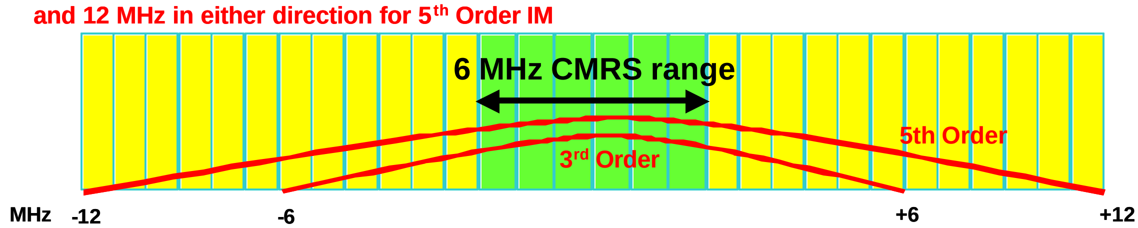
27 There are various "orders" of IM interference, which become much weaker in strength and effect as the order increases in numerical value. The examples shown are based on 5th Order IM and are the more common form of IM interference received by public safety and industrial systems in the 800 MHz band. An even more powerful form of IM interference is 3rd Order IM, which has an interference range that is about one half the frequency range of 5th Order IM as shown below.

Intermodulation Range is Dependent on the CMRS Frequency Range at a Site

Example A:
If low to high CMRS frequency range is 1 MHz,
Intermodulation interference can range another 1 MHz in each direction for 3rd Order IM,
and 2 MHz in either direction for 5th Order IM



Example B:
If low to high CMRS frequency range is 6 MHz,
Intermodulation interference can range another 6 MHz in each direction for 3rd Order IM,
and 12 MHz in either direction for 5th Order IM



In addition to the spread of frequencies at a given CMRS antenna site, the technology of the CMRS signals involved in an IM mix impacts directly the probability and severity of the interference to users in adjacent bands. The bandwidth of an IM product, and the number of frequencies that may be impacted, can be two to three times wider than the bandwidth of the contributing signals. Therefore, wider band signals can spread interference across more channels. Fortunately, wider band signals spread out their transmitted energy across more frequencies, so the interfering power "seen" on any one frequency is generally less than that for narrower signals. In summary, the resulting IM signal from a wider bandwidth CMRS technology will be at a lower power level but will cover a wider range of frequencies compared to an IM signal from a narrower band CMRS technology. Therefore, the IM may occur less often, but when it does, it would impact a greater number of public safety channels and would be difficult to solve solely by frequency planning and coordination.

In Motorola's view, the key is to minimize the potential for "near-far" interference, *i.e.*, to limit situations where the undesired signal is much stronger than the desired signal. Alternatives to accomplish this include CMRS system modifications such as reduced power levels, higher antennas and/or reductions in down-tilting of antenna patterns, and use of auto-tune cavity filters where necessary. Alternatives for public safety and private wireless users include designing systems for portable in-building coverage to deliver greater desired signal and co-locating with CMRS carriers when IM combinations cannot be avoided.[28] Among the most critical factors for minimizing interference is comprehensive planning and frequency coordination between CMRS carriers, public safety licensees, and B/ILT operators.

E. Radio Receiver Performance

The *NPRM* requests comments on receiver standards for intermodulation rejection.[29] Public safety and private wireless receivers are designed to balance three inter-related user criteria – sensitivity, IM rejection, and electrical current drain. IM rejection performance can be improved by reducing the sensitivity of the radio, but since public safety and private wireless systems are designed as "noise-limited" systems, this change would reduce the effective coverage area for each base transmitter. This, in turn, would require PLMR licensees to construct additional base sites, creating additional cost burdens. IM rejection performance could be improved by increasing the electrical

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28 *Best Practices Guide* at 14.

29 *See NPRM* ¶ 73.

current used by several stages of the radio receiver. However, this would significantly increase current drain in the radios and thereby reduce the battery life of the product. Public safety radios are designed so that a single battery will last an entire shift. Reducing battery life would require first responders to carry an extra battery and would risk requiring battery replacement at critical times.

TIA has defined Class A and B specifications for P-25 digital systems.[30] The Class A specifications are targeted for state-of-the-art radio designs and specify -75dB (mobiles) and -70dB (portable) for intermodulation rejection. Motorola 800 MHz radios shipped since the 1990s, as well as its recently introduced 700/800 MHz public safety portable receivers, utilize state-of-the-art receiver designs that meet or exceed TIA's Class A specification. Motorola supports the use of the Class A specification for new public safety and private wireless radios because the Class A specification appropriately balances cost and performance tradeoffs in receiver design. Improved filtering within a handheld receiver beyond this level is not currently viable as it increases the size of the radio and drastically reduces sensitivity to the desired signal.

V. <u>PRACTICALITIES OF REBANDING EQUIPMENT</u>

Retuning public safety, private wireless, and SMR systems is more involved than it may appear on the surface. The purpose of this section is to identify the practicalities associated with retuning existing equipment. The objective is to highlight the necessary procedures and considerations in rebanding the 800 MHz installed base of public safety and private wireless systems. Systems in this band vary substantially in complexity, diversity and size. In addition, system down time is simply unacceptable to mission

[30] ANSI/TIA/EIA-102.CAAB.

critical users. This section outlines a high level approach in order to minimize the time, cost and effort to achieve rebanding.

It is important to understand that not every 800 MHz subscriber unit will be able to be retuned. There are numerous reasons why retuning may not be possible or practicable, including:

- *Memory capacity limitations*: In cases where the new software memory requirements exceeds the memory capacity of a mobile or portable unit, a memory upgrade would be required to support retuning. Motorola believes that some of the NPSPAC compatible subscribers will fall into this situation because of significant differences in the existing and new channel lookup tables. The combination of the following factors must be evaluated to determine whether it is economically feasible to retune the unit: The additional costs to upgrade the subscriber's hardware memory, the product mortality rate associated with a mechanical upgrade (for non-flash memory compatible units) and the potential requirement for further hardware/CPU upgrades to operate with the new program.

- *Lack of availability of test lab diagnostic tools*: Lab test diagnostic tools may no longer be readily available for some older subscriber units that are no longer supported. Rebuilding the test labs to support these older products will, in some cases, be cost prohibitive due to component obsolescence/unavailability.

- *Obsolescence of older subscriber units and retuning/reprogramming components*: Some retuning components and software code, especially on older subscriber units, may not be available or would be cost prohibitive.

- *Complexities arising from system coordination of software releases*: In some cases, coordination of some software releases for retuned subscribers will trigger further retuning and reprogramming requirements to balance the infrastructure equipment. The retuning upgrade may rely on software versions and hardware configurations that are not in the users' original fielded system. The system retuning labor, engineering, new hardware, new software and test costs required for system wide upgrades to support the retuned subscriber units may exceed the cost to replace the entire system.

- *Lack of appropriate documentation*: Some customers may not have the appropriate documentation to support the retuning procedure, especially on the older fielded units.

Motorola cannot over-emphasize that the FCC must carefully consider the logistics of rebanding and retuning before adopting any such proposal. As previously noted, the 800 MHz band is home to a host of public safety and critical infrastructure industry users that cannot afford *any* system down-time for equipment modifications. For example, moving all public safety operations from the "NPSPAC" channels *en masse* will likely require the availability of a commensurate quantity of "green space" spectrum in which to allow for the construction of redundant communications systems. Ensuring public safety users uninterrupted services must be the Commission's highest priority in this proceeding.

In summary, retuning 800 MHz band systems is not just a matter of flash programming subscriber software and retuning base station radios. It requires a multiple step process to ensure that efficient economics, retention and/or improvement of performance, and minimization of service disruption are achieved.

VI. COST ESTIMATES FOR REBANDING

Motorola has carefully considered the costs associated with rebanding the 800 MHz band. Below, Motorola offers its estimates of the cost range involved in moving Public Safety and B/ILT operations as contemplated in the Nextel and NAM/MRFAC proposals set forth in the *NPRM.*[31]. In summary, Motorola's analysis shows the following estimated cost range that may be incurred:

[31] *See NPRM* ¶¶ 21-25. Motorola has not prepared a cost estimate for the Commission's rebanding proposal because it appears to leave the NPSPAC channels sandwiched directly between the SMR and Cellular A bands, providing no possible improvement in interference abatement on those channels.

Nextel Proposal 800MHz Public Safety and ILT/B Cost to Retune and Replace			
Market	Cost Scenario	Probable Cost $ Billions	Risk-Adjusted Cost $ Billions
Public Safety	Retune/Partial Replace Total	1.1	1.5
ILT/IB	Replace Total	1.7	2.4
Both Segments	**Total Cost**	**2.8**	**3.9**

NAM/MRFAC Proposal 800MHz Public Safety and ILT/B Cost to Retune and Replace			
Market	Cost Scenario	Probable Cost $ Billions	Risk-Adjusted Cost $ Billions
Public Safety	Retune/Partial Replace Total	1.1	1.5
ILT/IB	Retune/Partial Replace Total	0.5	0.7
Both Segments	**Total Cost**	**1.6**	**2.2**

A. Methodology and Assumptions Used in the Analysis

This cost analysis assessment represents the estimated expense to the Public Safety and B/ILT 800 MHz user community of rebanding based on the Nextel and NAM/MRFAC proposals. The cost assessment incorporates data derived from the 800 MHz FCC radio frequency license database. In order to provide a cross check reference point of the FCC data analysis results, the FCC results were compared against Motorola's own experience as an equipment vendor in the 800 MHz band.

Motorola's cost estimates rely on the following assumptions:

- Motorola's FCC database analysis results were used to size the market by the number of subscribers and number of sites. Licensee numbers are taken directly from the Initial Regulatory Flexibility Analysis appended to the *NPRM*.

- Estimated equipment life:
  - Portable transceivers: 10 years
  - Mobile transceivers: 15 years
  - Infrastructure equipment: 15 years[32]
- All equipment in the 800 MHz band is affected through either retuning and/or replacement.[33]
- Approximately 30 to 40 percent of the 800 MHz mobiles/portables could not be retuned and would need to be replaced with new equipment.
- A range covering the "probable" and "risk-adjusted" cost estimates has been established to account for potential cost assessment inaccuracies, data omissions and future uncertainties associated with rebanding. Below are several reasons for the cost range:
  - The potential that some systems could be moved more than once, which will depend partially on the implementation plan to be set forth by the regional planning boards. The low end of the cost range assumes only one move per system.
  - The low end of the estimate does not include any risk dollar expenditures.
  - Labor costs may be higher those used to derive the low end of the cost range if labor is outsourced.
  - The FCC database, database interpretation, installed base system statistics and the analysis itself may be inaccurate and could understate the actual installed base.
  - Some users who move operations from 800 MHz to either the 700 or 900 MHz bands may require incremental costs to replicate current system coverage.

The cost estimates are the costs that would be incurred by the purchaser of the equipment under the Nextel and NAM/MRFAC proposals, respectively. In estimating the cost, Motorola used average selling prices for 800 MHz equipment and services related to retuning and/or moving to an alternate band. The equipment cost represents a

[32] Equipment life estimates are based on an estimated average system life for public safety voice and private radio equipment. Actual equipment life may vary by application.

[33] Motorola would be able to derive more precise cost estimates if and when more detailed proposals that identify the percentage of equipment that would need to be retuned or replaced become available.

valuation of the installed base using Motorola 2002 price estimates. The equipment cost does not represent the cost of equipment in the 700 MHz and 900 MHz band, nor is it an offer to sell or price any Motorola equipment or services. The costs identified are indicators of the rough order of magnitude of the costs associated with the replacement and/or retuning of the radio systems. Costs include a budgetary estimate of logistics, retuning services, replacement as applicable, system integration, program management, engineering development required to retune some 800 MHz systems, and testing.

The costs associated with the public safety scenario represent the mix of equipment that can be retuned and/or replaced to be compliant with the new banding proposals. We estimate that approximately 30 to 40 percent of the radio subscribers may need to be replaced because equipment retuning may not be possible or may be cost prohibitive. In the equipment relocation scenario within the 800 MHz band, base stations could be retuned but site work would be needed to adjust or replace filters and antennas as required. The same assumptions and costs apply to both the Nextel and NAM/MRFAC proposals.

The cost estimates for B/ILT vary between the Nextel and NAM/MRFAC proposals. Under the Nextel proposal, B/ILT operations would move to 900 or 700 MHz and therefore would require all new equipment for mobiles/portables, and infrastructure. In contrast, under the NAM/MRFAC proposal, B/ILT operations would stay in the 800 MHz band, minimizing the requirement for new equipment to implement rebanding.

VII. CONCLUSION

Motorola welcomes the NPRM and the Commission's efforts to address the significant interference problem that exists for public safety users in the 800 MHz band. Motorola looks forward to providing additional input on the various rebanding proposals as these proposals take form in the coming months.

Respectfully submitted,

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