A. The Mixed Licensing of Public Safety, Private and Commercial Systems Throughout the 800 MHz Band is the Fundamental Cause of CMRS – Public Safety Interference

The potential for CMRS – public safety interference in a specific area is, of course, influenced by the particular facts and circumstances of each local situation.[20] As noted above, there are two basic underlying causes of this interference: (1) the interleaved and mixed allocation of public safety, private radio, and CMRS systems at 800 MHz, and (2) the different architectures these systems have come to use. Realigning the 800 MHz band would directly address these two factors and make it possible to rectify CMRS - public safety interference in the 800 MHz band.

Interleaved and Mixed Spectrum Allocations and Licensing. One of the two fundamental causes of CMRS – public safety interference is the shared, mixed and interleaved allocation and licensing of commercial, private and public safety systems throughout the 800 MHz band. Because public safety channels are interleaved among and adjacent to CMRS and B/ILT channels, and because public safety licensees can be found throughout the 806/824 – 851/869 MHz band, public safety radios must be able to transmit and receive on any of these channels so that they can be used on any public safety system.[21] The Land Mobile Radio spectrum allocation is so intermixed that it is technically impractical to build receivers that respond only to those channels licensed to a particular system. Thus, the allocation of spectrum for public safety uses

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[20] In general, the magnitude of the disparity between public safety and commercial signal levels, the number of channels being used by each operator, the height and power of the affected stations, the degree of antenna downtilt and local topographic and propagation characteristics can all affect whether interference occurs. Moreover, some models of public safety receivers exhibit sub-optimal intermodulation, adjacent channel and spurious-response rejection capabilities, thereby increasing the potential for CMRS - public safety interference.

[21] It would be significantly more expensive to build different receivers for the interleaved 70 public safety channels only, or for the NPSPAC channels only, thereby increasing

at different places in the band and the actual licensing of public safety communications systems throughout the 800 MHz band make it impossible to design receivers that will "hear" only public safety transmissions and filter out other systems' signals within the band.[22]

Moreover, equipment designers must also take into account the thermal "drift" of bandpass or preselector filters in response to ambient temperature changes. As the temperature varies, the range of frequencies that pass through the receiver's front end shifts up and down; the filters must therefore pass an even wider range of channels to ensure that the receiver "hears" the desired channels. Most public safety receivers "hear" and respond to RF energy in the adjacent 824/849 – 869/894 MHz cellular band with minimal signal strength attenuation, as well as in the 806/824 – 851/869 MHz land mobile channels. The broad frequency response of public safety receiver equipment permits multiple RF emissions from SMR transmitters, cellular transmitters, or mixtures of both to combine in a public safety receiver and produce interference.

Diverging System Architectures. The Commission's approach of allocating and licensing different services on adjacent, interleaved, and mixed spectrum in the 800 MHz band worked so long as all licensees built systems using the same basic "noise-limited" design architecture: analog, high-site, high power configurations without frequency reuse.[23] Over the past decade,

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infrastructure costs for publicly funded systems. It would also prevent a single system from using both lower 70 and NPSPAC channels, unless the user carried two separate handsets.

[22] Public safety handsets are able to receive and transmit on General Category channels, the lower 80 interleaved SMR channels, and the upper 200 SMR channels as well as the 70 interleaved public safety channels and NPSPAC channels, because public safety systems were licensed in the past on all of these channels.

[23] As discussed above, Public Safety communications systems have traditionally been designed to enable communications at low signal levels (as low as –105 dBm or less) until the desired signal cannot be distinguished from the background thermal noise in the receiver. This design enables public safety agencies to provide coverage throughout their jurisdictions – often large geographic areas -- with one or at most a few base stations (using simulcast rather than frequency reuse design) -- and therefore minimal expenditure of public funds.

however, commercial land mobile systems have transitioned to "interference-limited" system designs featuring multiple, low-power base stations with intensive frequency reuse and mobile hand-off from cell-to-cell throughout a geographic area to serve many times more users with the same quantity of spectrum.[24] At the same time, cellular operators licensed above 869 MHz adjacent to the NPSPAC channels have expanded the capacity and coverage of their "interference-limited" systems. By introducing digital modulation technologies and numerous low sites, these cellular operators more intensively reuse their spectrum to meet the substantial growth in demand for commercial wireless services.

These differing system architectures can result in locally robust CMRS signals being much stronger than distant, less robust, public safety transmissions,[25] particularly within a few hundred meters of the CMRS base station where the commercial signal is strongest.[26] This disparity in signal strength leads to three types of interference:

> (1) *Intermodulation*. Intermodulation ("IM") is the primary interference mechanism involved in CMRS – public safety interference. It occurs when locally stronger CMRS signals, on non-public safety frequencies, combine in the public safety receiver itself to form a new frequency or frequencies, much like combining red and yellow paint produces a new color -- orange.[27]

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[24] Interference-limited systems use multiple, low power base stations and sophisticated frequency coordination to control intrasystem interference while maximizing user capacity.

[25] Signal levels immediately around low-height CMRS sites are typically much stronger (*e.g.*, -25 to -40 dBm) than those from more distant high-height public safety transmitters (*e.g.*, -70 to -100 dBm or less).

[26] In the earlier days of cellular development, this happened infrequently because cellular antennas were located at high enough elevations that the distance to the ground sufficiently attenuated the signals so that they rarely "overpowered" adjacent public safety signals. As cellular use has grown, cellular carriers are building smaller cells with lower sites to maximize frequency reuse; the lower antennas produce a stronger signal at ground level.

[27] As an example, a commercial SMR signal at 864 MHz can combine with a cellular A-band signal at 870 MHz to produce intermodulation products at 858 MHz and at 876 MHz. The 876 MHz product falls in the cellular A-band and therefore is not germane to this discussion; however, the 858 MHz signal falls in the 851-869 MHz band and could be licensed to a public safety system. If the public safety system is operating on 858 MHz, and if the SMR and cellular

(2) *Wideband noise interference.* The large signal strength disparity between typical high-site public safety and low-site commercial systems means that wideband noise produced by the commercial systems, while fully within FCC limits, may still be strong enough to cause interference to the relatively weak signals produced by the public safety radio system, particularly if those signals are close to the thermal noise limit of the public safety receivers.[28]

(3) *Receiver Overload Interference.* If a commercial SMR or cellular operator has a large number of transmitters at a given site (to serve user demand), a public safety radio designed to receive very weak signals may be overloaded by the cumulative energy coming from the nearby site.

It warrants reemphasizing that the incidents of CMRS – public safety interference in the 800 MHz band reported to date have *not* resulted from the failure of any party to comply with Commission rules or the parameters set forth in its license. Rather, such interference results from the normal operation of systems designed and optimized to meet the different needs of public safety and commercial communications systems licensed on adjacent, interleaved and shared channels. "Noise-limited" public safety system designs have been a satisfactory model for public safety deployments given that public safety operators, spending public funds, must cover large geographic areas as economically as possible. CMRS providers, in contrast, have acted rationally in response to marketplace demand by making substantial investments in digital, frequency reuse technologies to meet the dramatically increasing consumer demand for their wireless communications services.[29]

A-band providers are colocated on a tower or building in its service area, the public safety mobile and portable units could experience interference in the immediate vicinity of the colocated CMRS site due to the relatively strong signals from the commercial SMR and cellular A-band operator creating intermodulation interference in the public safety receiver.

[28] Wideband noise interference usually becomes visible only after intermodulation interference is eliminated. It should be noted that commercial SMR and cellular operators are not the only contributors to a higher noise floor. Other RF sources, such as "active" television reception systems, cellular antennae flashing light displays, and computer RF emissions also increase the noise floor and can interfere with public safety communications.

[29] For example, in 1990, 19 MHz of SMR spectrum was exhausted in most major markets despite serving only about one million users. The subsequent evolution of SMRs to digital,

B. 800 MHz Realignment Will Create the Spectrum Allocations Necessary to Mitigate CMRS – Public Safety Interference

The ability of law enforcement, fire departments, and other public safety agencies to communicate effectively and without harmful interference is critical to the safety of life and property and our nation's security. The public safety community and the CMRS industry have worked to address these problems through the Best Practices Guide and Project 39, and these parties should be commended for undertaking these initiatives. These efforts, while a positive step, are nonetheless *ad hoc* and time consuming and impose significant burdens on all parties.

Incident-by-incident, after-the-fact interference remediation will inevitably fail to protect fully the safety of law enforcement personnel, firefighters and other emergency responders, and fail to keep pace with the evolving communications needs of both public safety and commercial communications providers. CMRS – public safety interference is likely to worsen in the coming years unless a long-term solution is adopted. CMRS carriers continue to expand their systems to serve additional users on existing spectrum and to meet the growing demand for competitive commercial wireless communications, including high speed data and other advanced services. Public safety communicators, despite limited funding and network infrastructure, must provide expanded communications coverage – particularly in-building coverage – as well as data and other enhanced capabilities to support life safety services in growing cities and suburbs. These realities will increasingly juxtapose locally robust CMRS deployments with public safety

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cellular-like, frequency reuse technology dramatically increased their capacity enabling the same 19 MHz to support more than eight million users – an eightfold capacity increase over the 1994 industry total. *See Industrial Communications,* October 13, 1989; Implementation of Section 6002(B) of the Omnibus Budget Reconciliation Act of 1993: Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services, *First Report,* 10 FCC Rcd. 8844, 8855-57 ¶¶ 35-39 (1995) (*"First Competition Report"*).

communications systems operating with relatively weak signals – a recipe for increased CMRS - public safety communications interference under the current 800 MHz band plan.

Given these risk factors, the Commission must use its regulatory authority to implement a long-term solution that corrects the underlying cause of 800 MHz CMRS – public safety interference by realigning the 36 MHz of Land Mobile Radio spectrum in the 806/824 – 851/869 MHz band to separate public safety channels and commercial channels into exclusive, contiguous blocks. As discussed further in section VI.B., below, the Commission and the public safety community must consider additional measures to safeguard against CMRS - public safety interference, including a possible guard band and the reduction of public safety receiver sensitivity outside the public safety channel block.

These actions would eliminate the underlying bases for CMRS – public safety interference and provide a near-universal solution. Unless the Commission mandates 800 MHz realignment and the associated interference-prevention measures discussed below, public safety operators will face the ongoing challenge of case-by-case interference identification and analysis, as well as trial and error corrections every time a nearby commercial carrier modifies its inherently dynamic network. Even with close cooperation among all parties, the ongoing burden of this process and continued threat of impaired public safety communications, not to mention the spectral constraints it imposes on commercial carriers, warrants the cost and effort necessary to implement the ubiquitous, permanent solution described herein.

The same considerations that call for a realignment of the 800 MHz Land Mobile Radio band shaped the band plan the FCC adopted for future public safety and CMRS systems that will operate in the 700 MHz band spectrum reallocated from broadcast television service on UHF Channels 60-69. The Balanced Budget Act of 1997 directed the Commission to reallocate 24

MHz of this spectrum for public safety use and 36 MHz of this spectrum for commercial use.[30] Instead of interleaving commercial and public safety channels in this spectrum, the Commission has designated contiguous spectrum blocks (channels 60-62 and 65-67) for exclusive commercial use, and separate contiguous spectrum blocks (channels 63-64 and 68-69) for exclusive public safety use. In addition, the Commission established guard bands in the commercial spectrum immediately adjacent to the public safety bands and prohibited commercial licensees in these bands from employing cellular architectures.[31] The FCC adopted these measures in response to concerns that commercial, interference-limited systems could not co-exist adjacent to noise-limited public safety systems without interference.[32] These same concerns warrant 800 MHz Land Mobile Radio band realignment.

C. The Public Safety Community Needs Additional Spectrum for Communications Services

As part of realigning the 36 MHz of Land Mobile Radio spectrum in the 806/824 – 851/869 MHz band, the Commission should allocate additional spectrum for public safety services by creating a 20 MHz contiguous, primary public safety channel block in the 806/816 – 851/861 MHz band. This proposal would more than double, from 9.5 MHz to 20 MHz, the public safety spectrum at 800 MHz.

There is a pressing need to allocate additional spectrum for public safety communications. In 1996, the Public Safety Wireless Advisory Committee ("PSWAC") issued a report that, among other things, recommended that the FCC allocate 97.5 MHz of additional

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30 47 U.S.C. § 337(a).

31 *See* In the Matter of Service Rules for the 746-764 and 776-794 MHz Bands, and Revisions to Part 27 of the Commission's Rules, *Second Report and Order*, 15 FCC Rcd 5299 (2000).

32 *Id.* at ¶ 12.

spectrum for public safety services to meet the current and foreseeable requirements for wireless communications through the year 2010.[33] The Commission took an important step towards meeting these requirements in 1997 when, as described above, it reallocated 24 MHz of spectrum from television channels 60 – 69 for public safety use in the 700 MHz band and subsequently established a band plan and service rules for that spectrum allocation.[34] Due, however, to current television broadcaster incumbency, public safety communications providers in most parts of the nation cannot yet access this spectrum, and may continue to be foreclosed from deploying service there for many more years.[35] This uncertainty has, in turn, hindered the development of 700 MHz public safety communications equipment. Thus, while 700 MHz may offer a partial long-term solution to the spectrum needs of public safety communications, it does not provide short-term or even medium-term relief.

As noted above, on September 14, 2001, PSWN filed a petition for rulemaking reiterating the urgent need to allocate an additional 71 MHz of spectrum to meet public safety needs, and described the delays encountered in deploying public safety services in the 700 MHz band.[36] PSWN states that, "the greatest spectrum need of public safety wireless communications is for bandwidth to support low-speed data, high-speed data, and video. These capabilities,

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33 PSWAC Final Report, September 11, 1996.

34 *First Report and Order* at ¶ 2, *citing* Report and Order, ET Docket No. 97-157, 12 FCC Rcd 22, 953 (1997).

35 Analog broadcast television stations, including those operating in the 700 MHz band (UHF Channels 60-69) are permitted by statute to continue operations until their markets are converted to digital television, which is not scheduled to occur until at least December 31, 2006. *See* 47 U.S.C. § 337(e). The Commission must extend this date in certain circumstances, including the lack of significant penetration of digital television within a market. *See id.* at § 309(j)(14). *See also In the Matter of Service Rules for the 746-764 and 776-794 MHz Bands, and Revisions to Part 27 of the Commission's Rules*, Order on Reconsideration of the Third Report and Order, WT Docket No. 99-168, FCC 01-258 (released Sept. 17, 2001) (adopting initiatives to expedite the clearance of broadcast television operations in UHF Channels 60-69).

incorporating the latest technologies, would allow local law enforcement, fire, and emergency management service personnel to employ the quickest and most informed approach in performing their duties."[37] The petition also "reassert[ed] the urgent need for additional interoperability spectrum to be allocated for use by public safety agencies in all bands."[38] According to PSWN, such an allocation "is important primarily because of the emergence of new, innovative, life-saving technologies that will likely require greater bandwidth to function optimally."[39]

The compelling necessity of 800 MHz realignment to combat CMRS – public safety interference provides the FCC with a unique opportunity to allocate additional spectrum for public safety communications systems in a band where equipment is already available. Consequently, the Commission should reallocate 10.5 MHz of 800 MHz SMR spectrum for public safety use to be consolidated and realigned on a contiguous basis with the existing 9.5 MHz of public safety spectrum at 800 MHz. Equipment is readily available for public safety use on 800 MHz spectrum,[40] and relocating SMR (and many B/ILT) incumbents from this spectrum can be achieved in a relatively short timeframe – as short as two to three years and certainly before relocation of incumbent broadcasters out of the 700 MHz public safety channels can be

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36 *Supra.* at p. 3 and n. 3.

37 PSWN Petition at 10.

38 *Id.* at 15.

39 *Id.* at 14.

40 Equipment meeting the specialized public safety needs of the APCO 25 standard is already available for 800 MHz use and is well along in development for adjacent 700 MHz channels. In short, expanding the amount of exclusive, contiguous public safety spectrum at 800 MHz adjacent to the new 700 MHz public safety allocation is a far more effective and efficient long term plan than establishing additional public safety spectrum in another band, particularly in the higher bands with propagation characteristics requiring more infrastructure to meet ubiquitous public safety coverage requirements.

completed.[41] This reallocation will help meet the public safety community's urgent need for additional spectrum to accommodate data applications as well as critical interoperability needs. It will also provide public safety communications a larger contiguous block of spectrum in the 800 MHz band that is directly adjacent to the 700 MHz spectrum that has been reallocated for exclusive public safety use. This additional spectrum will provide the basic spectral resource for the development of advanced communications capabilities to support both Homeland Security and "everyday" public safety services in the post-September 11 environment.

VI. PROMOTING PUBLIC SAFETY BY REALIGNING THE 800 MHZ BAND AND ALLOCATING ADDITIONAL SPECTRUM TO PUBLIC SAFETY COMMUNICATIONS

A. The Realignment Plan

This White Paper has described two vital steps to promote public safety communications: mitigating current and future CMRS – public safety interference, and providing public safety licensees with additional, useable spectrum as quickly as possible. To accomplish these steps, the Commission should implement the following spectrum reallocations and redesignations, and the subsequent mandatory relocation and voluntary relocation of various incumbent licensees:[42]

(1) Reallocate the 800 MHz General Category and interleaved SMR, B/ILT and public safety channels, 800 MHz channels 1 – 400 (806/816 – 851/861 MHz), to create a 20 MHz contiguous, primary Public Safety spectrum block.

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[41] This reallocation plan takes into account Nextel's consolidation over the past decade of the majority of commercially-available 800 MHz land mobile radio spectrum. The fact that one CMRS licensee in this band, Nextel, holds many of the EA licenses and site-by-site licenses on the proposed new 20 MHz public safety block at 800 MHz, significantly simplifies the incumbent retuning and relocations necessary to effectuate an 800 MHz Land Mobile Service band realignment.

[42] *See* Exhibit B for a chart depicting the proposed new 800 MHz Land Mobile Radio band plan, and a chart depicting all of the reallocations and redesignations necessary to carry out the proposed realignment.

(2) Reallocate the 6 MHz of public safety NPSPAC channels (821/824 – 866/869) and the adjacent 10 MHz of upper 200 SMR channels (816/821 – 861/866) for advanced technology commercial wireless systems using "interference-limited" multiple low-site, low-power systems architecture. The Commission should license the additional 6 MHz to Nextel in partial exchange for the spectrum it will vacate and swap to help implement 800 MHz realignment; Nextel is already the dominant incumbent licensee on the adjacent 10 MHz.

(3) Reallocate 10 MHz of contiguous spectrum (2020/2025 – 2170/2175) from MSS for exclusive terrestrial advanced commercial mobile communications services. This block is currently not being used by any MSS licensee, but includes non-MSS Broadcast Auxiliary Service incumbents that must be relocated to enable advanced mobile communications services to use this band, as detailed in section VIII.B. below. The Commission should license this 10 MHz to Nextel as part of this proceeding in an even exchange for certain of its licenses totaling 10 MHz of spectrum in the 700, 800 and 900 MHz bands to make the 800 MHz band realignment possible.

(4) Redesignate 4 MHz of the 5 MHz of SMR spectrum at 900 MHz (896/901 – 934-940), currently licensed to Nextel, for traditional (noise-limited) co-primary B/ILT and high-site SMR use.[43]

(5) Redesignate the 50 Business and 50 I/LT channels between 809.75/816 – 854.75/861 MHz from primary B/ILT to primary public safety use as part of the channels 1 – 400 public safety block. Incumbent B/ILT licensees would be permitted to remain on these channels on a secondary, non-interference basis or voluntarily relocate as described below.[44]

(6) Redesignate the 4 MHz of 700 MHz Guard Band spectrum (762/764 – 792/794 MHz) from Guard Band Manager to co-primary B/ILT and high-site, analog SMR use, and modify the current service rules that apply to this spectrum to achieve this objective.

(7) Expedite the current schedule for mandatory retuning of all Broadcast Auxiliary Service incumbents at 2020 - 2025 MHz, and, to the extent necessary, terrestrial Fixed Point-to-Point Microwave systems at 2170 – 2175.

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[43] A total of five MHz of this 10 MHz block is currently allocated for SMR use with the remaining five MHz allocated for B/ILT use. The SMR and B/ILT channels are allocated on an alternating, interleaved basis. Because all licensees will initially be using comparable noise-limited system architecture, this interleaved spectrum does not pose an interference risk. To the extent that these licensees desire to migrate eventually to interference-limited systems, the Frequency Coordinators for 900 MHz can assign these channels to separate such uses.

[44] Any B/ILT licensees remaining on these channels after a voluntary relocation period would have secondary status only, *i.e.*, they may not interfere with public safety communications and must accept any interference resulting from the primary public safety operations.

(8) Require mandatory retuning of all advanced technology (interference-limited) CMRS SMR systems from the new 800 MHz Public Safety Block (800 MHz channels 1 through 400) to the 16 MHz advanced technology block at 800 MHz.

(9) Require mandatory retuning of all public safety licensees in the NPSPAC channels, 821/824 – 866/869 MHz, to the new 806 MHz Public Safety channels through the assistance of a Special Public Safety Frequency Coordinator, as detailed below. This mandatory retuning of public safety systems would be funded in large part by Nextel, any other advanced technology SMR licensee, and the cellular licensees.

(10) Permit voluntary retuning of B/ILT incumbents and noise-limited SMR incumbents to the new 900 MHz B/ILT and traditional SMR spectrum, or to the 700 MHz former guard band channels, with the assistance of Frequency Coordinators on a first-come, first-served basis.[45]

At the end of the relocation period, all users would be grouped together in discrete parts of the band depending on their technology choices. No private radio or commercial licensee would experience a net gain or loss of spectrum, and all licensees would have the opportunity to gain increased spectrum efficiency because of the new contiguous and near-contiguous spectrum grants. To facilitate this realignment plan, the Commission should waive applicable FCC fees associated with the relocation and other license modification applications that would need to be filed by incumbent licensees under this plan.[46]

This 800 MHz realignment plan offers the most expeditious and efficient path to eliminating CMRS – public safety interference. Nextel has evaluated other realignment alternatives, including separating public safety, B/ILT and commercial/advanced SMR licensees into separate blocks within the 800 MHz band; requiring the immediate refitting or replacement of all public safety receivers to achieve higher IM rejection specifications; moving all 800 public

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[45] The Commission should establish a filing window for first-come, first-served incumbent relocation applications to encourage these incumbent licensees to migrate to the largely vacant 900 MHz current SMR spectrum or the 700 MHz spectrum.

[46] *See* 47 U.S.C. § 158(d)(2) (FCC may waive payment of an application fee "for good cause shown, where such action would promote the public interest").

safety systems to 700 MHz or to 900 MHz; requiring CMRS and public safety licensees to mitigate interference on a case-by-case basis much as they have been doing to date; and requiring extensive and careful frequency coordination between CMRS providers and public safety communications systems. None of these alternatives effectively achieves the essential public interest objective of correcting the fundamental cause of CMRS – public safety interference at 800 MHz while making a significant amount of near-term spectrum available for enhanced and expanded public safety communications networks.[47]

B. Additional Measures To Prevent CMRS – Public Safety Interference

The realignment of the 800 MHz Land Mobile Service spectrum band is an essential step toward eliminating harmful CMRS – public safety interference in this band. Realignment alone, however, will not completely eliminate this interference because public safety radios may still respond to RF energy from the adjacent digital SMR and cellular bands. This section discusses a number of potential solutions to this problem. The Commission could by rule adopt any of these specific alternatives or instead authorize public safety frequency coordinators to implement them in whole or in combination as warranted on a regional, metropolitan area, or other geographic basis.

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[47] For example, while it has been possible to undertake "careful frequency coordination" in some cases, it is increasingly difficult to do so in the current environment as the result of two trends. First, local jurisdictions have become increasingly interested in requiring CMRS operators to collocate on the same transmission towers. This collocation has led to increased combinations of signals by commercial operators and thus increased interference to public safety communications. Second, CMRS operators are now deploying automated frequency use algorithms to maximize the moment-by-moment efficiency of their spectrum use. This development makes it more difficult to account for a particular public safety system through frequency coordination, particularly if multiple CMRS systems each employing automated assignment programs need to be coordinated. Given both these trends, frequency coordination is impractical at best when CMRS channel use restrictions are required to avoid IM interference with public safety frequencies, particularly when multiple CMRS carriers are involved.

Improved Receivers. One means of reducing CMRS - public safety interference is to improve public safety receivers. Realigning the 800 MHz band to eliminate interleaved mixed spectrum should enable equipment manufacturers to design narrower band-pass preselector filters and/or receiver signal attenuation characteristics that would in most cases prevent commercial transmissions from forming intermodulation products in public safety receivers. Narrower filters could limit receiver sensitivity to the new public safety channel block; if the receiver did not respond (or had a much smaller response) to signals outside the public-safety band, it would not be susceptible to intermodulation interference. Alternatively, if such filters were too costly, required too much space in the receiver or imposed undesirable performance tradeoffs, manufacturers could couple a somewhat less restrictive preselecter with a fixed or variable attenuator to combat intermodulation. Digital SMR, cellular and PCS receivers already use this type of automatic attenuation capability to control potential intermodulation interference.

Based on analysis of CMRS – public safety interference in several cities as well as current receiver performance specifications and characteristics, it is recommended that the Commission adopt the following performance standards for 800 MHz public safety and CMRS systems to prevent harmful interference between these systems:

- Public-safety mobile or portable receivers should be able to receive the desired public safety signal in the presence of commercial signals having a composite average power of –10 dBm, a peak-to-average ratio of 15 dB, and a noise output that conforms to the FCC requirements for transmitters in the band.

- In accordance with the licensee relocation schedule discussed in section VI.F. below, all public-safety receivers should meet or exceed the following performance standards by the end of the mandatory relocation period specified for a given EA:

Item	Requirement
Intermodulation rejection	75 dB or better
Front-end filtering	The receiver should incorporate filters ahead of the first active stage such that commercial signals outside the public-safety range are attenuated no less than 20 dB more than any attenuation provided to signals in the public-safety range. This filtering should take place under all operating conditions.
Adjacent-channel rejection	75 dB or better
Reference sensitivity	< -112 dBm

Additional CMRS Base Station Filtering. In addition to receiver standards, the Commission should require additional filtering of CMRS base station transmitters to further reduce wideband noise from CMRS transmitters falling in the public-safety band. Specifically, all commercial transmitters in the 851- 894 MHz band could be required to attenuate energy in the public-safety band no less than 85 dB below the desired carrier level.

Guard Band/Advanced Technology Band. In order to allow public-safety receiver preselectors and CMRS base station transmitters to filter out signals not in the appropriate band, some spectrum isolation between CMRS and public-safety systems is necessary. One way to achieve this is for public safety coordinators to implement a guard band on the upper end of the base-to-mobile frequency in the 20 MHz public safety block.[48] Requiring a guard band would be consistent with the band plan adopted by the Commission in allocating spectrum for CMRS and public safety use at 700 MHz. A 2 MHz minimum guard band likely would be required to allow filters in public-safety receivers and CMRS base-station transmitters to function effectively. The Commission should evaluate further whether 2 MHz is sufficient or whether a larger guard band

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[48] A guard band is required on the base-to-mobile link. It is normally not required on the mobile-to-base link because (a) the signal levels from CMRS mobile transmitters are generally significantly smaller than the signal levels from public safety mobile transmitters, and (b) the public-safety base station receivers are generally located where they cannot receive destructive interference from CMRS mobile transmitters.

may be required. The Commission should also consider whether this guard band is best treated as "dead spectrum" or whether public-safety entities should have the flexibility to operate systems in it with the understanding that they must accept any interference they receive from CMRS systems in the adjacent band.

A more spectrally-efficient approach to isolating CMRS and public safety systems may be to establish a high technology public safety spectrum set-aside adjacent to the proposed digital SMR spectrum block. Equipment in this portion of the proposed new public safety block could be required to (a) limit on-street infrastructure signal levels to prevent interference to traditional public-safety designs in the lower part of the public-safety band, and (b) be designed to withstand the relatively strong signals from digital SMR systems in the adjacent spectrum block. For example, a robustly designed, high-site digital public safety system could be a "good neighbor" to both traditional high-site public safety systems and adjacent commercial mobile radio services. Thus, the Commission could achieve the benefits of a guard band without wasting or underutilizing scarce spectrum by establishing a digital technology, high-site channel reserve that could be used by public safety operators for data services, telemetry and perhaps interoperable voice services across political jurisdictions. The Commission should also consider requiring any technology used on these channels to be open and non-proprietary and based on, or compatible with, a commercially available wireless technology. This approach would serve the public interest by spurring development of competitive advanced public safety equipment and infrastructure incorporating interference-resistant protocols.

Stronger Public Safety Signal Strength. Another alternative CMRS – public safety interference safeguard would be to require public safety systems to achieve a more robust signal in the field. As discussed in section V.A. above, typical public safety system design has

emphasized using the least infrastructure possible to control costs while providing usable coverage. This design approach assumes that public safety systems can operate effectively at lower signal levels than are used by commercial wireless networks. It is the disparity in signal strength between public safety and CMRS systems, however, that sets the stage for interference to the less robust public safety transmissions.

One approach to eliminating interference in a realigned 800 MHz band would be to require stronger public safety base-to-mobile signals, *i.e.*, a more robust signal "on the street." By reducing the disparity between CMRS and public safety radio signals, a more robust public safety signal would be more resistant to interference from locally stronger CMRS system base station transmissions. For example, while maintaining a 40 dBu requirement for co-channel protection, the Commission could require new public safety system deployments, and expansion or upgrades of existing systems, to provide a signal strength of no less than 53 dBu in all areas requiring interference protection from nearby CMRS systems. This approach to preventing interference would generally require public safety systems to add additional infrastructure to their networks to provide more consistent and robust signals.

Selecting a Solution. The alternatives described above, individually or in combination, could provide sufficient protection against CMRS – public safety interference under the 800 MHz realigned band plan. The wideband sensitivity of public safety receivers, their resistance to intermodulation, the signal strength of public safety systems, and the types of system designs and interference resistant technologies used adjacent to the public safety block are all interrelated factors that affect how large a guard band is necessary in the public safety block to prevent interference. As part of a rulemaking proceeding to implement the proposed 800 MHz realignment plan, the Commission should consider (a) the numerical standards for the protection

that must be provided to public-safety operations, (b) how compliance is to be measured, and (c) whether to allow the public safety community, through its designated frequency coordinators or some other representative body, to determine what solutions to pursue.

Reduced CMRS Power Levels. One option the Commission should not pursue is to require CMRS operators to reduce their on-street power levels through lowering transmitter power or changing antenna characteristics. In a good-faith effort to combat interference, and as described in the Best Practices Guide, CMRS operators have voluntarily reduced on-street signal strength in some instances. While this helps to control interference in certain circumstances, it requires these CMRS systems to accept degradation of their networks and their ability to serve customers. The public interest would be disserved by requiring CMRS operators to implement this "stopgap" measure on a permanent basis throughout their networks, as to do so would inevitably create coverage "holes," dropped calls, and disrupted service for many existing CMRS users.

In theory, CMRS operators could compensate for reduced on-street signal levels by changing or building out additional CMRS infrastructure to restore the loss in coverage and service. This would, however, impose substantial costs on carriers and their customers, thereby reducing customer access to commercial mobile radio services, particularly for less affluent citizens. It would also be very difficult to obtain the necessary local zoning and permitting approvals for installing larger CMRS antennas and towers, or for the numerous additional base station sites necessary to restore the lost service. Moreover, this approach would do nothing to correct -- and in fact would perpetuate -- the underlying spectral problem of incompatible radio system designs and uses on adjacent, interleaved and mixed 800 MHz spectrum. For these reasons, the Commission should reject any suggestion that CMRS operators employ lower power

levels as a long-term measure to prevent CMRS – public safety interference in the 800 MHz band.

C. Using Mandatory Retuning and Special Frequency Coordinators to Implement the 800 MHz Realignment

Mandatory Retuning. To achieve the public interest benefits of the 800 MHz realignment – *i.e.*, eliminating CMRS – public safety interference and making additional public safety spectrum available expeditiously – the Commission should require incumbent licensees in the targeted frequency blocks, with the exception of B/ILT and traditional SMR licensees, to retune their systems to "relocate" in the proper spectrum block. Relocation must be mandatory because any non-compliant licensee could create renewed interference potential for itself or for other affected licensees, or could block timely completion of the realignment reallocations.

Special Frequency Coordinator. To expedite and simplify retuning, the Commission should certify a special "Public Safety Realignment Frequency Coordinator" (the "Public Safety Special Coordinator") whose responsibility would be to: (1) identify specific channel assignments for public safety licensees relocating from the NPSPAC channels to the new 800 MHz public safety channel block (806/816 – 851-861 MHz); (2) verify that the new assignments will reduce or eliminate the potential for CMRS – public safety interference while ensuring that incumbent licensees receive new licenses that are geographically and spectrally equal to or better than their original licenses; and (3) assist incumbent NPSPAC licensees with carrying out their retuning obligations.

The Public Safety Special Coordinator should be staffed by at least one representative from each of the existing FCC-certified public safety frequency coordinators,[49] as well as

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[49] Nonprofit associations certified by the Commission for frequency coordination include: Association of Public Safety Communications Officials International, Inc. ("APCO"), Association of State Highway and Transportation Officials ("AASHTO"), Forestry Conservation

representation from the existing NPSPAC regional planning committees and the new 700 MHz planning organizations. Using a unified updated licensing database and computerized frequency coordination programs, the Public Safety Special Coordinator would identify and publish new channel locations for all relocating public safety licensees.[50] The Special Coordinator would carry out this process using the regional planning areas as identified for the NPSPAC channels. Individual licensees could review their new assignments and work with the Special Coordinator to undertake any refinements, changes or modifications necessary to account for local propagation anomalies and special terrain factors. The Special Coordinator would also act as a liaison and facilitator with current incumbents on the public safety block to handle the logistics of the retuning, relocations and spectrum swaps that will effectuate the relocation process.

Few if any incumbents on the lower 70 interleaved public safety channels would have to relocate because that spectrum would be within the new 20 MHz public safety block. Relocation may be desirable or necessary in some instances, however, in light of local or regional requirements or other special circumstances. The Commission should permit the Public Safety Special Coordinator to determine whether relocating lower 70-channel public safety incumbents is necessary to make efficient use of the new Public Safety block in a particular planning region and, if so, to identify new assignments within the new 20 MHz public safety spectrum block, and assist in completing such relocation.

Communications Association ("FCCA") and International Municipal Signal Association ("IMSA").

[50] This process may be simplified by simply transferring in its entirety the existing NPSPAC assignments in a regional planning area to a comparable spectrum sub-block in the new 20 MHz public safety channel block. This White Paper recommends that the Commission consult with the public safety community, existing frequency coordinators, and equipment manufacturers to determine the most efficacious way to identify relocation assignments for NPSPAC incumbents.

D. CMRS Licensees Should Fund the Bulk of Public Safety's Retuning Costs

The 800 MHz realignment plan cannot be implemented unless public safety entities have sufficient funds to cover their retuning costs, including applicable engineering, equipment and site costs, base station retuning costs, handset and mobile unit retuning costs, as well as any reasonable additional costs of relocation to fully comparable facilities. In some cases, this may include the costs of new repeaters, antennae and handsets where retuning existing equipment is not practicable or replacement equipment is required to prevent interference. Because public safety communications systems are generally funded by tax revenues, government bonds or other public sources, 800 MHz relocation costs could impose an unexpected and unplanned burden on state and local governments – many of which are already struggling to meet increasing costs for roads, schools, health care and other essential public services and facilities. Thus, if public safety communications providers were required to provide funding for the entire cost of their portion of the 800 MHz realignment, it would be difficult to complete realignment in an acceptable time period. The urgent need to eliminate CMRS – public safety interference and make additional spectrum available for public safety communications systems requires that additional relocation funding resources be made available.

Therefore, the Commission should require commercial SMR providers, including Nextel and SouthernLinc®, and the 800 MHz cellular licensees to make a substantial contribution to the costs of retuning public safety communications systems. These CMRS licensees stand to benefit significantly from realigning the 800 MHz band and concomitantly adopting technical and operational requirements that ultimately will virtually eliminate CMRS – public safety interference. In particular, cellular carriers will be relieved of the burdens of detailed, ongoing coordination requirements, operational limitations and channel use restrictions necessary to

safeguard public safety communications systems from interference. Advanced SMR operators, like Nextel, will be able to consolidate spectrum holdings now mixed and interleaved with public safety and B/ILT systems into contiguous, exclusive channel blocks offering increased user capacity and freedom from the operational limits and ongoing coordination procedures otherwise necessary to mitigate and/or prevent CMRS – public safety interference.[51] Cellular and advanced SMR/CMRS operators will be free to focus on competing with each other for customers, rather than diverting corporate resources to complex multi-carrier coordination efforts to prevent intermodulation products from falling on public safety channels.

Nextel will be the most substantially affected advanced CMRS licensee involved in this project. Nextel is willing to contribute up to $500 million for relocating incumbent public safety communications systems to the new public safety channel block at 806/816 – 851/861.[52] While this may cover a substantial portion of the public safety retuning costs, other commercial SMR providers and cellular licensees, particularly the "A" band carriers, should help fund public safety retuning costs.[53] As described above, cellular licensees are a primary source of CMRS –

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[51] Nextel has expended, on a voluntary basis, significant resources for modified antennas, special combiners, custom-made filters, modified base stations, interference drive testing, signal strength mapping, intermodulation prediction and analysis, and interference monitoring, as well as tens of thousands of man hours in carrying out these activities, to identify the source or sources of CMRS – public safety interference and to develop and implement fixes. AT&T Wireless and other cellular carriers are also incurring similar costs and overhead to mitigate interference on a case-by-case basis.

[52] Nextel would provide this contribution contingent upon the Commission's adoption of a Final Order: (1) creating a new digital advanced SMR channel block as described herein at 816/824 – 861/869 MHz; (2) assigning to Nextel licenses for the 6 MHz of spectrum (the current NPSPAC channels) in the new advanced SMR channel block; and (3) assigning to Nextel nationwide licenses for a contiguous 10 MHz of MSS spectrum at 2.1 MHz reallocated for terrestrial commercial mobile use.

[53] In addition to this contribution to public safety retuning costs, Nextel will also bear the costs of its own relocation out of channels 1– 400 to the new digital SMR spectrum block. Nextel holds many of the EA and site-by-site licenses in this spectrum. Moreover, Nextel will

public safety interference in the 800 MHz band. The realignment plan would relieve their burdens associated with responding to and mitigating the interference incidents that will become increasingly prevalent in the future.

Consequently, *all* cellular and advanced 800 MHz mobile communications providers should make a substantial contribution toward the costs of retuning public safety communications systems from the NPSPAC channels and, where necessary, interleaved lower 70 channels, to the new public safety block.[54] Public safety communications operators would contribute a lesser portion of the costs. This approach will create a public-private partnership effort to eliminate CMRS – public safety interference and make additional spectrum available for public safety communications without damaging the competitiveness of affected CMRS providers.[55]

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have approximately 2 MHz less spectrum at 800 MHz at the completion of retuning and will have to commence construction of a 2.1 MHz network in lieu of its planned developments at 700 MHz and 900 MHz. Accordingly, Nextel will incur more relocation costs than any other licensee under the 800 MHz realignment plan.

[54] B/ILT and traditional SMR licensees will contribute to this effort by paying their own costs of relocation. Many B/ILT users will be able to simply retune their systems to their new allocated frequencies, thus keeping their costs to a minimum. Arguably, however, B/ILT users also will benefit from access to interference-free contiguous spectrum, particularly if they choose to relocate to their new homes at 700 MHz or 900 MHz, and therefore also should contribute to the fund to relocate public safety. In addition, the Commission should support before the Congress an appropriations request to assist public safety communications entities with the costs of retuning to carry out the 800 MHz realignment plan.

[55] Such a public-private partnership would be similar to the many highly successful federal programs that offer matching funds to stimulate state or local government participation in essential programs. For example, the Interstate Highway System was originally conceived as a national defense program to speed the movement of army and other defense forces and material throughout the country; the federal government offered 70 percent funding, provided the states matched it with the remaining 30 percent. *See* Richard F. Weingroff, *Federal-Aid Highway Act of 1956: Creating the Interstate System*, Public Roads On-Line at 9 (1996) <http://www.tfhrc.gov/pubrds/summer96/p96su10.htm>; Financing Federal-Aid Highways, *Appendix G: Federal Share and Availability for Significant Programs* 44 (U.S. Dept. of Transportation Federal Highway Administration, May 1992) (noting that the federal government

In identifying those costs eligible for reimbursement and establishing reimbursement procedures, the Commission should follow the approach it adopted in relocating incumbents from the upper 200 SMR channels at 800 MHz.[56] Costs incurred to retune public safety incumbents from their current channels assignments to their new assignments in the public safety channel block would be eligible for reimbursement. The costs of expanding or improving existing systems, including upgraded equipment (unless retuning the existing equipment is impractical or impossible), or correcting coverage gaps or other system shortcomings would be ineligible for reimbursement.[57]

E. Using Voluntary Retuning and Special Frequency Coordinators for Realignment of B/ILT and Noise-Limited Traditional SMR Licensees

Voluntary Relocation for B/ILT Licensees. The Commission should permit incumbent B/ILT and high-site analog SMR licensees to continue operating on a secondary, non-interference basis in the 800 MHz band, while providing incentives for these licensees to relocate voluntarily to the 700 MHz band or 900 MHz band. This flexible approach would enable such

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currently funds 80 percent of the interstate system). Urban mass transit, hospital construction, irrigation projects, rural electrification and many other governmental programs use this type of shared funding approach. *See, e.g., id.* (mass transit); Center for Public Service, *Government's 50 Greatest Endeavors: Enhancing the Nation's Health Care Infrastructure*, p. 1-2, Nov. 12, 2001 <www.brook.edu/gs/cps/50ge/endeavors/healthcare.htm> (hospital construction); Larry Todd, Bureau of Reclamation, *Statement on S. 2881: Small Reclamation Water Resources Act of 2000*, July 25, 2000 <www.doi.gov/ocl/2000/s2881.htm> (irrigation projects); Office of Industrial Technologies, *NICE*^{3}, Nov. 12, 2001 <www.oit.doe.gov/nice3> (describing the cost-sharing program created by the Department of Energy to promote energy efficiency and stating that non-federal funds must account for at least 50 percent of the total cost of the project).

[56] *See* Amendment of Part 90 of the Commission's Rules to Facilitate Future Development of SMR Systems in the 800 MHz Frequency Band, *First Report and Order, Eighth Report and Order, and Second Further Notice of Proposed Rule Making*, 11 FCC Rcd. 1463, 1510, ¶ 79 (1995), *aff'd by Memorandum Opinion and Order on Reconsideration*, 14 FCC Rcd. 17556, 17577, ¶ 38 (1999).

[57] In most cases replacement equipment will not be necessary because existing public safety system hardware can be returned to the new public safety channel block.