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Broadband, Interoperable)
Public Safety Network in the)
700 MHz Band)
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Development of Operational, Technical)
and Spectrum Requirements for)
Meeting Federal, State and Local Public)
Safety Communications Requirements
Through the Year 2010

A New Proposal for a Commercially-Run
Nationwide Broadband System Serving Public
Safety

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1 Introduction

Chairman Martin and the Federal Communications Commission (FCC) deserve great praise. Through this notice of proposed rule making (NPRM) [3], the FCC wisely reiterates [2] its support for the goal of establishing an “integrated nationwide interoperable network capable of delivering broadband communications” [3], and the FCC implicitly acknowledges that US policy-makers must consider new and different approaches to reach that important goal. As I [6-10] and others have been arguing for some time, there are serious deficiencies in the communications systems used by first responders, and instead of merely expending more limited resources on a poor system, we should enact fundamental reform.

The FCC proposes a basic approach that has great promise, but also potential dangers. This paper will discuss issues that deserve serious attention, and it will propose a new policy that is consistent with many aspects of this NPRM, but has extensions and modifications that would increase the chances of success, and eliminate much of the risk.

While the FCC clearly plays a critical role on this issue, no one government agency has the resources and authority needed to make all of the necessary changes. There should be a concerted effort from multiple federal agencies, as well as state and local organizations. By sad necessity, the FCC is proposing in this NPRM to act alone in this NPRM, and that limits the options available. However the FCC has begun an important process, and we can hope that others will follow the FCC’s lead. This paper will also address some of the areas where other federal agencies could make critical contributions, perhaps initiated by an act of Congress or leadership from the Administration.

2 The Model for Success

This NPRM concerns 12 MHz of spectrum intended to improve public safety. Consequently, the goal should be to deploy a system in this band that is so effective that public safety agencies will choose to use it as their primary communications system. Over time, municipal agencies will be able to abandon their current systems and their current technology in favor of the new nationwide system operating in this band. In the process, they will free up valuable spectrum, much of which is being used inefficiently, for other uses. To achieve this, we must accept as constraints that the quality of the nationwide system must be better than today’s public safety systems, and the

total annual cost paid by municipal public safety agencies using the nationwide system must be less than today's total costs [10].

If first responders merely use the systems deployed in this band to supplement their current communications system, the policy should be deemed a failure. This is not to say that supplementing current systems is bad. As I have discussed in greater detail elsewhere [9, 10], first responders in a given location should often have access to multiple wireless systems. In most cases, there would be one *primary* system, which can support mission-critical voice communications that meet public safety's rigorous standards. There may also be one or more *secondary* systems, such as commercial cellular, municipal wifi, or satellite, which need not meet the same requirements for characteristics such as coverage, dependability, and latency, but are very useful nonetheless. There are many advantages to expanding the number of secondary systems available to public safety, including dependability, coverage, and expanded capabilities. This should be done by making commercial spectrum and commercial infrastructure more accessible to public safety, e.g. by giving municipal agencies greater latitude to make use of any commercial services that happen to exist in the area, or by encouraging public safety and commercial carriers to use compatible technologies in near-by spectrum bands [9]. However, for any initiative that consumes the limited spectrum intended to improve today's public safety communications systems, we must demand far more. The FCC must take explicit steps to insure that the systems deployed in this band will be primary systems for public safety.

A variety of approaches have been proposed for the creation of a nationwide public safety communications system that is good enough to be a primary system [9, 10]. Two stand out for attention here. The simplest would be for a government agency such as the National Telecommunications and Information Administration (NTIA), the Department of Homeland Security (DHS), or the Department of Justice (DoJ) to build a nationwide system for emergency responders (and perhaps some other government personnel), as proposed in [8]. This option is roughly consistent with this NPRM; the license would simply be granted to a government agency, and not to a non-profit organization as discussed in the NPRM. However, it may be possible to serve public safety well at much lower costs by allowing emergency responders and commercial users to share the same infrastructure. In effect, a commercial company will get access to valuable spectrum at a reduced cost in return for obligations to serve public safety, and thanks to the efficiencies of sharing, it is possible that everyone benefits from the substantial savings. In this paper, we propose an approach through which the FCC and other agencies should seek ways to exploit the potential

advantages of sharing. This approach is also roughly consistent with the current NPRM, but some changes would be needed.

3 The Fundamental Challenge

As discussed in [9, 10], there are pros and cons to an infrastructure that serves both public safety and commercial users. One big advantage is based on the fact that first responders need significant capacity during large emergencies, but most of the time, their communications needs are small [1]. Thus, if a system is dedicated to first responders exclusively, a great deal of capacity will sit idle much of the time. Sharing would make this capacity available to the public. Commercial carriers would be far more effective at serving the public than government entities, and the potential revenues from serving the public could motivate commercial companies to pay much of the cost of building out an infrastructure that also serves emergency responders.

The biggest disadvantage of a commercial company that serves both groups is that there may be conflicts between protecting public safety and maximizing profit, especially when most of the company's revenues come from commercial users rather than public safety agencies [9, 10]. If there is significant risk that the company will not serve public safety adequately, public safety agencies would be foolish to give up their primary systems, which means the policy will fail.

Why might there be a conflict between serving public safety and maximizing profit? First, the company may choose to serve only the most populous parts of the country, where there are more paying customers. Second, the company may overcharge public safety. This NPRM would allow the company to charge public safety on a fee-per-use basis. Once a public safety agency abandons its existing system and relies on the commercial company for service, there is no limit to what that company could charge; sending firefighters into burning buildings without communications services would not be an option. Moreover, even if the provider offers services to public safety for free, this does not solve the problem. The company may still offer a service that does not meet costly public safety requirements for coverage, dependability, security, or other vital features, and the public safety agency that has adopted this as its primary system would have no recourse. We cannot place an unregulated for-profit monopoly in charge of critical infrastructure.

These potential advantages and risks associated with shared infrastructure have two important implications. First, the FCC and others

must take steps to insure that the licensee of this band will have sufficient incentive to meet the needs of public safety. Second, there is a possibility that it is not possible to craft adequate protections for public safety without discouraging commercial companies from participating. The FCC should therefore maximize advantages to the licensee to the extent possible without harming public safety. Moreover, the FCC make sure that if this turns out to be the case, the spectrum will still be available to be used in another way, like creating a nationwide system run by a federal agency exclusively for emergency responders. In other words, if licenses are offered for systems that serve both public safety and commercial users, then either the systems must be adequate for public safety, or the license should not be assigned at all. This means that a licensee must accept meaningful requirements for build out and other factors.

To summarize, an effective policy must

- guarantee that infrastructure operating in this band covers most of the country, and is of sufficient quality to serve as a primary system for public safety.
- if possible, offer sufficient profit potential to commercial companies who build and operate this infrastructure that they want the opportunity.
- insure that if the two points above are incompatible, no license is issued that allows spectrum to serve both public safety and commercial users.

4 Can a Non-Profit Organization Protect Public Safety?

As the previous section shows, it is not sufficient to state requirements that a licensee must meet initially. If public safety agencies are going to accept the nationwide system as a primary system, they must know that price, coverage, dependability, and security will remain of sufficient quality, even after the initial license expires. Moreover, requirements must change over time. For example, in 20 years, first responders may need access to much higher data rates than they do now, or coverage in areas that are of little importance now. Among other things, updating these requirements over time will require ongoing oversight by some entity that listens to the needs of public safety and seeks only to advance the public interest.

In this NPRM, that entity would be a non-profit organization to which the spectrum license is assigned. In essence, the FCC would be outsourcing the job of managing the spectrum to this non-profit. There are certainly advantages to outsourcing these functions, but there are also serious risks. After all, this organization will oversee the deployment of infrastructure that is worth billions of dollars. Every move it makes will be scrutinized by equipment vendors and potential service providers. Its leadership must be strongly motivated to serve the public interest, while countless Fortune 500 companies try to influence its decisions. Finding an appropriate method to select leaders with this motivation will not be easy. Moreover, decisions of this organization must be transparent to the public, in many of the same ways that the FCC's decisions are transparent. If the organization will have vast management powers, as opposed to an advisory role while authority remains with the FCC, the organization must commit to an appropriate method of filling leadership positions, and transparency, to be eligible for a license. There is no question that a non-profit representing public safety interests could play an important role in this band, but the decision to give this organization broad discretion to manage the band should not be taken lightly.

There is another potential challenge. As discussed in Section 2, infrastructure should only be deployed in this band if it can be deployed throughout much of the country. This is relatively easy to insure if the licensee accepts strong build-out obligations. However, the non-profit organization cannot be sure that such obligations will be met, since it is not putting up the capital to build the system. The situation is not impossible. The non-profit might be given one year to make the spectrum available to one or more carriers who will actually build the infrastructure, and these carriers will agree to a build-out schedule that collectively meets the FCC's

requirements. If the non-profit is not able to do this, then all contracts become null and void, and the non-profit surrenders the license. Once again, it is possible for a non-profit to play this role rather than the FCC, but it is not simple.

The FCC should have a good reason to make this non-profit the licensee. I will propose one such reason in the next section.

5 A New Way to Protect Public Safety

In [9, 10], I suggest a variety of ways to motivate commercial companies to meet the long-term needs of public safety, even when most of their revenues come from commercial customers. The one that would offer public safety the strongest protection would work as follows. A commercial company competes in an auction for a license to operate in the band. The license includes build-out and other requirements to insure the needs of emergency responders are met for the duration of the license. The company is also free to serve the public over the same spectrum and infrastructure. There are limits on the fees that the company can charge to public safety, but no limits on the fees charged to others.

The license is unusually long-term, perhaps twenty years. Several years before the license expires, the non-profit representative of public safety may establish new requirements that will become effective after the license is renewed. If the requirements are too strict, the licensee may worry about long-term profitability. In this case, it simply will not seek renewal, and the license is auctioned again. In this case, when the license expires, the first licensee must surrender the infrastructure to the new licensee. Public safety is never at risk in this approach.

Two issues must be addressed for this approach to work. First, there must be a legal mechanism through which the infrastructure can be reclaimed from the company that first built it. It is not clear to me whether the FCC would have the legal authority to take possession of this property. (This is an area that deserves further investigation.) If not, the non-profit organization proposed by this NPRM could certainly become the legal owner of infrastructure built in this band, as well as the licensee.

The second issue is that commercial companies must have sufficient incentive to build infrastructure knowing there is a chance that they could lose the infrastructure in around twenty years. For this to be true, revenues during those twenty years must cover the cost of building the infrastructure, plus an acceptable rate of return on investment. This is a topic that deserves further analysis, and as described in the next section, an area where Congressional action could be invaluable.

Although the derivation is not yet public, Cyren Call alleges [4] that if 30 MHz were available, revenues would be sufficient to build infrastructure in just 63.5% of the country (and 75% of the continental US). With only 12 MHz, clearly the area covered would be significantly less. If this is truly the best we can expect from sharing, then it might be possible to achieve more without sharing, i.e. by auctioning the majority of the spectrum at 700 MHz

that will become available through the digital TV transition, and using the proceeds of the auction and the remainder of the spectrum at 700 MHz to build a system that serves only emergency responders. However, I remain hopeful that it will be possible to achieve more. Further analysis is needed to answer such questions.

6 Why and How Congress and Federal Agencies Should Act

For sharing between public safety and commercial users to work, there must be sufficient incentive for a commercial carrier to build infrastructure. As discussed above, that may or may not be the case under the conditions discussed in this NPRM. It is possible to vastly improve the terms in several ways, at least with the help of other federal agencies, and perhaps an Act of Congress.

There are a number of simple ways to make this arrangement more attractive to commercial companies. One is to increase the amount of spectrum available, possibly drawing either from the 24 MHz already allocated for public safety or from the spectrum that is currently headed for auction. This additional spectrum would allow carriers to reduce infrastructure costs by building fewer towers in populous areas, or increase revenues by expanding services offered to the public, or a combination of the two.

A second way to turn an unprofitable arrangement into a profitable one is to offer a subsidy to the company that will build infrastructure serving first responders. The initial spectrum auction could provide the perfect opportunity. As an example, consider the case where the FCC has authority to distribute up to one billion dollars, but only if needed. The right to use the spectrum can then be auctioned, where the first bid must be greater than or equal to -1 billion, which means the bidder is willing to meet the build-out obligations for a subsidy of one billion dollars. As the bids increase, bidders are agreeing to accept a smaller subsidy, and when the bids exceed 0, the bidders are willing to pay for the privilege.

A third approach is to give subsidies to municipal public safety agencies that use the new nationwide system. The federal government would cover the costs of transition [10] by paying for the first mobile handsets that operate in this band. This helps the public safety agencies, and the carrier. The sooner these agencies can purchase new handsets, the sooner they will begin to subscribe to services offered over the new nationwide system.

A fourth approach might be to guarantee that revenues from first responders never fall below a given threshold, even in the early years, as long as build-out milestones are met. This insurance policy may cost the federal government nothing, but the revenue certainty is of great benefit to a company that is contemplating a large capital investment.

There is already funding for these purposes, if the federal government chooses to spend it this way. For example, in late 2006, the lame duck Congress instructed NTIA to spend \$1 billion for first responder communications, and it is not yet determined how those funds will be spent. Furthermore, the Departments of Justice, Treasury, and Homeland Security plan to spend \$3 to \$30 billion on a nationwide communications system known as the Integrated Wireless Network (IWN) that will serve first responders, but only the tiny fraction that work for the federal government. As discussed in [9, 10], those funds could instead fund a system that serves all first responders, and this NPRM combined with the policies described above would be an excellent vehicle.

The NPRM asks whether federal users should be allowed to use the nationwide system. Note that allowing those federal employees who would be served by IWN to use the new nationwide system would improve interoperability between federal, state, and local agencies, and it may facilitate a cost-saving reallocation of funds. There are probably other significant opportunities to serve federal agencies and save money as well. This possibility deserves further investigation.

7 The Objectives for a Nationwide System

The objectives stated in this NPRM (Section III A) are all extremely important. As it states, first responders need *nationwide interoperability*, *cost effectiveness*, *robustness* and *efficient spectrum use*. As discussed at length elsewhere [7, 9, 10], all four of these important objectives are best met with a system that is based on a consistent architecture nationwide, and a specific design that is intended to cover a large geographic region. Thus, we must move past the thousands of separate municipal systems of today. The nationwide license proposed here would help.

This NPRM also correctly calls for *broadband* and a *flexible modern architecture*. First responders clearly deserve access to new applications that will require wideband or broadband on the wireless link, and there are great advantages to an IP-based broadband backbone that interconnects both new and legacy wireless systems.

However, I include one more objective on this list: *security* [9, 10]. Particularly in an age of terrorism, communications systems for first responders may become a target. Thus, they probably need stricter security standards than today's commercial systems. Features should be available when needed to protect communications, e.g. encryption, authentication, and

mechanisms that defend against denial of service attacks. Physical security for towers, interconnection points, and other critical components is also important. Thus, those who build infrastructure in the new band should also meet stated security standards.

8 License Requirements

To serve as the primary system for public safety, the nationwide system must meet all objectives as well or better than today's systems do [10]. As discussed above, this includes coverage, nationwide interoperability, dependability/robustness, and security.

Furthermore, the nationwide system should be capable of providing all essential services, including voice. It is reasonable for the NPRM to focus on broadband, because broadband is not yet pervasive, and because a system that can provide broadband service is also capable of providing voice. Still, the FCC should add push-to-talk voice communications as an explicit requirement.

Build-out requirements are also essential. They insure that first responders outside the most populous cities will also benefit from this policy, or if this is not possible, that the spectrum will not be wasted on an ineffective policy.

The nationwide system should be built on a single architecture, with the same radio air interface throughout the nation. However, legacy systems will still exist. These can at least be connected to the same broadband backbone, presumably running IP. This implies that the licensee may be responsible for a wired backbone that even extends to areas in which wireless coverage is not (yet) available. This should be reflected in build-out requirements.

The NPRM does not discuss open standards. In the long run, a system based on open standards will be less costly than one that is built on proprietary or patented technologies. Thus, the licensee should also be dedicated to open standards.

There must also be limits to the fees charged to public safety agencies. As is well argued in the NPRM (Section III B 3), fees will encourage public safety agencies to make efficient use of the available services. However, such efficiencies come when fees are close to the marginal cost of providing a service, and not the most that the market will bear. Moreover, marginal costs are probably small compared to the annualized cost of deploying the

infrastructure, especially in the early years of the system when there are fewer users. At minimum, carriers might be prohibited from charging public safety more than commercial users for a comparable service, and from charging rural public safety agencies more than urban public safety agencies. This has the potential to be effective because the carrier will face competition for commercial services in the urban markets, and this will provide practical limits on prices in those markets. However, some services used by public safety may not be comparable to any services used by the public, so these constraints are probably not sufficient. (Imposing limits on the prices paid by public safety agencies should be one of the responsibilities of a non-profit organization that represents public safety.)

9 Public Safety Sharing Spectrum, Infrastructure, or Both

As discussed above and elsewhere [1, 9, 10], first responders' communications needs are sporadic, and this can make sharing efficient. There are many forms of sharing, a number of which are contemplated in this NPRM, and some are likely to be more important than others.

First, it is possible to share infrastructure, i.e. to run communications systems that serve first responders and the public. Such infrastructure sharing within the spectrum band in question is the very core of this proposal. It should be allowed and encouraged, provided that public safety has preemptible priority available when they need it. (Not all public safety communications require this priority, but it should not be the carrier's job to decide when public safety communications are sufficiently important. Other methods are needed.)

Infrastructure sharing is also possible outside of this band, i.e. existing commercial carriers could provide services to public safety. By nature of this arrangement, the carriers are serving as secondary communications systems rather than primary communications systems. This is a useful practice, but it does not advance the primary objectives that are appropriate for this spectrum. Consequently, such arrangements should certainly be allowed, but they should not be allowed to count towards build-out obligations.

Second, it is possible to share spectrum without sharing infrastructure. This NPRM offers the licensee the capability to operate in other public safety bands as a secondary user. The licensee must give absolute preemptible

priority to the primary systems in the band. There are sharing methods that are technically possible, and there may be regions where this form of sharing would allow the carrier to expand its capacity beyond what is possible in 12 MHz. The carrier will need access to information about current and *future* plans in the band where it has secondary rights, from regional planning committees and other relevant forums.

The NPRM also contemplates allowing the licensee to make the band primarily used for the nationwide networks also available to commercial users, who would then be secondary users. This does nothing to help public safety directly, but has the potential to raise more funds to support infrastructure deployment, which is certainly worthwhile. Caution is required. First and foremost, the licensee should not be allowed to “lease” spectrum in regions where the nationwide system is not offering wireless services to public safety, as this undermines the licensee’s incentives to maximize coverage.

In regions where the nationwide system is serving public safety at an appropriate level, it is reasonable to allow sharing. Indeed, there are reasons to believe that such sharing can sometimes be profitable [5]. Again, public safety must have preemptible priority available when needed. The NPRM suggests that this might be done with cognitive radio, presumably in a decentralized manner. Cognitive radio has tremendous potential, but there are spectrum bands and applications that are more conducive to a sharing scheme based on cognitive radio than this one. In the near term, it is probably easier and safer to implement this preemption function in scenarios where public safety can explicitly signal over a dependable link to the secondary user(s) to cease all transmissions.

10 Summary

The Federal Communications Commission has taken a great step forward with this NPRM, by promoting the goal of a nationwide interoperable communications systems for first responders, and by implicitly acknowledging that we must consider new approaches to fundamental change rather than minor variations on the policies that produced today's problems in the first place.

There are many ways to produce this nationwide network [9, 10], and two are particularly promising. One is for a government agency to take this 12 MHz of public safety spectrum and build a system to serve federal, state, and local emergency responders [8]. Another is to allow and encourage the private sector to build a system that serves both public safety and the public. This latter approach should only be deemed a success if the system can serve as a *primary* system for public safety throughout much of the United States, which means coverage, dependability, security, and cost must be as good or better than existing systems.

There are reasons to hope for substantial savings when first responders and the general public share the same infrastructure. If those savings can be realized, it is possible that the private sector will gladly pay much of the cost of deploying a system that is vastly superior to what public safety has today, in return for access to spectrum. Moreover, consumers could also benefit greatly from this arrangement, as there will be a new commercial broadband system serving the public throughout most of the country. However, this approach also carries a substantial risk that few regions will gain access to a system of sufficient quality for public safety, or that companies may initially offer adequate quality and prices but they will lack incentive to continue their dedication to public safety in the long run. In the worst case, we would see a system emerge that is only of marginal use to public safety, and a precious allocation of prime spectrum will be lost to public safety forever.

A policy of promoting infrastructure-sharing between public safety and commercial users must address three fundamental challenges. It must

- guarantee that infrastructure operating in this band covers most of the country, and is of sufficient quality to serve as a primary system for public safety.
- if possible, offer sufficient profit potential to commercial companies who build and operate this infrastructure that they want the opportunity.
- insure that if the two points above are incompatible, no license is issued that allows spectrum to serve both public safety and commercial users.

The third challenge can be addressed by imposing strong build-out requirements on the licensee, so that if the first two conditions cannot be met, the spectrum will quickly revert back to the FCC. This process becomes more complex and difficult if the FCC outsources much of the task of managing this band to a non-profit organization, but it is certainly not impossible. To assign this nationwide license to a well-intentioned non-profit organization or anyone else without an explicit commitment to serve first responders throughout the vast majority of the country is gambling public safety's most valuable resource on an untested hope.

This paper proposes a new policy to address the first two challenges. A commercial carrier or carriers would get unusually long licenses and broad latitude to serve the public for a profit. They would also be obligated to serve public safety with standards on coverage, dependability, security, and price. Moreover, those standards may change over time. If the company is unwilling or unable to meet those standards, then when the license expires, they may surrender their infrastructure to the next operator.

With or without the policy above, if the profits to be gained from 12 MHz of spectrum are insufficient to cover the build out of infrastructure, then this approach cannot succeed. This paper also suggests ways to make this approach more appealing to commercial companies, although cooperation with other federal agencies is required, and possibly an Act of Congress. In particular, we propose that companies bidding in an auction for the right to build infrastructure in this band should be allowed to bid negative numbers, which represent the smallest subsidy they would accept in return for meeting public safety requirements. We also propose federal subsidies to local public safety agencies so they can quickly migrate to the new nationwide system at little or no cost. It may also be helpful to expand the amount of spectrum beyond 12 MHz. Further analysis is needed on this issue.

The FCC has shown admirable leadership on this issue. We can hope for further action from other federal agencies and the US Congress.

11 References

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- [9] J. M. Peha, "The Need for Fundamental Reform in Public Safety Spectrum and Communications Policy," *New America Foundation Working Paper 15*, Oct. 2006.¹ www.ece.cmu.edu/~peha/safety.html

¹ There is substantial overlap between [9] and [10], because the latter draws on material in the former. There are also some differences. The first paper has more content on proposals to change the bandplan at 700 MHz, and the latter on the need to address some common concerns of local public safety agencies.

- [10] J. M. Peha, "Fundamental Reform in Public Safety Communications Policy," to appear in *Federal Communications Bar Journal*, 2007.¹
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