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Protecting Public Safety With Better Communications Systems

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Protecting Public Safety With Better Communications Systems

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Modern communications technology allowed people around the world to watch in real time the horrific aftermath of two planes hitting the World Trade Center in New York City. Simultaneously, communications technology was failing to meet the most basic needs of public safety organizations on the scene [1]. The worst failure occurred in the World Trade Center's North Tower. At 9:59AM on September 11, 2001, the first of several announcements was transmitted to emergency responders ordering them to evacuate the North Tower. Police inside the building heard the order on their radios, and most left safely. However, firefighters were using incompatible communications equipment that could not receive the order. People watching television at home knew that the unimaginable had already occurred - that the World Trade Center's South Tower had collapsed - but many firefighters inside the North Tower would never learn of this. When the North tower fell 29 minutes after that first evacuation order, 121 firefighters were still inside. None survived. At the same time, two hundred miles away, more communications failures were making it harder to contain fires at the Pentagon, where another plane had crashed. These failures put more lives at risk.

These communications failures are not the result of simple operator error or a single design flaw. The problems are rooted in the basic technical architecture of the communications infrastructure used for public safety in the US, and the policy that produced that infrastructure. It will take innovation in both technology and policy to address the many problems.

By US tradition, every police department, fire department, and emergency medical service makes its own decisions about its purchases, and this includes communications infrastructure. In many contexts, there are good reasons for a policy that gives local agencies decision-making power, as they understand the local environment better than distant federal bureaucrats. Such a policy presumably worked well when it allowed each community to determine which horse-drawn fire truck would best suit local needs and financial resources. However, this is not an effective way to design and build a functioning communications system. With over fifty thousand independent public safety agencies making decisions based primarily on local factors, the predictable result is a tangle of systems that do not interoperate. All too often, firefighters from adjacent towns cannot communicate with each other, paramedics cannot communicate with firefighters from the same city, and city police cannot communicate with state or federal law enforcement agents. Some of these communications failures put lives at risk, although such incidents are rarely reported in the news, and when they are, the communications system generally does not get its share of the blame.

A policy that yields thousands of non-cooperating designers will produce problems beyond dangerous interoperability failures. The resulting system is also unnecessarily expensive. For example, to overcome potential interoperability problems, some fire trucks today carry five different radios in the hope that at least one will work with all other responders at the next big fire. This is an expensive strategy. Even if all systems are compatible, lack of coordination

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among public safety agencies is costly. Some neighboring towns deploy their own broadcast antennas on separate towers, even though an integrated regional system could be built with far less equipment and fewer towers. Indeed, our research has shown that the number of distinct towers operating for public safety in a US county depends more on the number of independent municipalities within the county's borders than on factors that are technically relevant, such as area and population.

This policy also leads to inefficient use of spectrum, a scarce resource that is as critical as funding. Some public safety agencies experience periods when communications channels become congested, and emergency responders must either wait to contact their dispatchers or interrupt active calls. Either option can be dangerous. Consequently, there have been serious calls to shift spectrum from commercial or other government use to public safety since (at least) 1996 [2], and those calls have only increased since September 11, 2001 (e.g. [3]). Nevertheless, many public safety communications systems are not designed to maximize spectral efficiency, and for good reasons. It is extremely difficult to site towers so as to maximize frequency reuse, to make the best use of trunking technology, or to allocate capacity to those agencies with the greatest need rather than those who apply first, without a coherent regional approach.

Opportunities, and not just problems, should be driving the improvement of communications infrastructure for emergency services. Commercial cellular networks and military systems have been incorporating many non-voice services. The same should occur for public safety. This might allow firefighters to download blueprints of a burning building, police to upload surveillance videos of suspicious activities, and paramedics to transmit a patient's vital statistics to the closest hospital, all in real time [4]. Some current experiments with non-voice services for public safety have proven greatly beneficial simply by allowing police network access so they can do routine paperwork from their car instead of the police station. When they are in their car, they are positioned to respond to emergencies as needed. The value of non-voice services for public safety is likely to be much greater through strategic planning that considers national and regional needs along with local.

Two kinds of policy reform are needed in the US (and perhaps elsewhere). First, more responsibility should be shifted from local governments to state and federal agencies. Information from local agencies is invaluable and they should continue to play an important role, but without State or Federal leadership, local agencies cannot craft a strategy that makes sense throughout a large area and over a long time horizon. This also means that State and Federal agencies must bear a greater share of the cost. Some nations have already been moving in this direction. All nations should be learning from the positive and negative experiences of others..

Second, the US should reevaluate the traditional separation between public safety systems and commercial systems. Many public safety organizations are determined to provide their own communications services, and do not even consider use of commercial services. Admittedly, there is not always an appropriate commercial service available, but this too can be addressed through regional and national coordination. A major cellular carrier may be unwilling to offer a service targeted at public safety at the request of a single city, but the idea becomes more appealing when public safety agencies in many cities would consider subscribing to the same service.

The US (and many other nations) should also reconsider spectrum management policies that force commercial systems and public safety systems to operate in different spectrum bands. Public safety spectrum is lightly used most of the time [5], but when the spectrum is needed, that need may be critically important. Peak demand from cellular customers and peak use from

emergency responders will often occur at different times [6]. By allowing these organizations to share some spectrum, and giving preemptive priority to public safety through some form of secondary market or interruptible access scheme [7, 8, 9], the carriers and the public safety organizations could all see an effective increase in available capacity.

Citizens depend on emergency responders such as firefighters, police, and paramedics for their lives, and emergency responders similarly depend on their communications systems. Such systems enable a more effective response to a wide range of emergencies, from a fire that is consuming a single building to a devastating tsunami that affects multiple nations. It is technically possible to produce systems that are less prone to communications failure, that support new non-voice services, that consume less spectrum, and that cost less. Reaching this potential will require thinking of our public safety communications infrastructure as one large and highly complex system, perhaps with many administrative domains, rather than a collection of thousands of small independent systems. Both engineers and policy-makers should develop a new strategy to improve this infrastructure that incorporates a larger geographic area, a longer time horizon, and both government-run and commercially run systems.

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