700 MHz
Broadband Public Safety Applications
And Spectrum Requirements

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Preface

Since the Public Safety Wireless Advisory Committee (PSWAC) report was released in September 1996, the wireless communications landscape has undergone enormous changes. While it is true that technology has allowed for more efficient use of spectrum resources, it is equally true that public safety's need for spectrum has never been greater. In 1996 there were no broadband wireless networks or applications. Public safety's need for data communications was limited to text in the form of digital dispatch. Even then there was a shortage of spectrum available to public safety. In the interim, public safety wireless networks have continued to fall behind commercial networks in technology and capability.

Today we are at a crossroads. We can either advance public safety communications by consolidating our efforts and resources to create a nationwide public safety broadband interoperable network that supports both data and voice or we can continue to support separate networks on disparate frequency bands using incompatible technologies. We are under no illusion and fully understand that this is a formidable challenge. The vision of a converged public safety data and voice network will not be realized for several years, and then only when public safety is satisfied that broadband mission critical voice is as reliable as existing land mobile mission critical voice networks. Nevertheless, we also understand that if we do not have sufficient spectrum resources, we will never achieve our goal.

Public safety needs additional broadband spectrum that is suitable for both current and future technologies such as streaming video, automated license plate recognition, and biometric technologies including mobile fingerprint and iris identification. The 700 MHz band is ideal for public safety as it provides superior coverage and "in building" performance compared to higher frequency bands. It is imperative that public safety control this spectrum to ensure that the standards established for the Public Safety Nationwide Broadband Wireless Network regarding capacity, interoperability, priority and reliability are maintained at the highest level. Recent incidents have illustrated that commercial wireless services cannot provide the bandwidth and services needed during an emergency.

The existing public safety 700 MHz spectrum allocation is inadequate to support public safety requirements. The D Block spectrum is crucial to the development of the nationwide network because it is adjacent to the existing public safety broadband allocation. Combining the existing public safety 700 MHz spectrum with the D block will simplify network design and deployment, and will reduce handset and mobile device costs. A single wireless broadband network combining the D Block and the adjacent public safety 700 MHz spectrum is the only logical choice to satisfy public safety broadband wireless spectrum requirements. All major national organizations representing police, fire, emergency medical and prominent public safety officials have united in an unprecedented effort to support the reallocation of the 700 MHz D Block spectrum to public safety, and the creation of a truly interoperable public safety wireless broadband network.

Executive Summary

Public safety must plan now for existing and future wireless broadband needs. Many broadband applications are already being used by public safety, often using commercial networks. Public safety envisions utilizing additional broadband applications but requires public safety grade coverage, redundancy and infrastructure hardening conspicuously lacking in commercial wireless networks. This paper lists and describes many public safety wireless broadband applications and their spectrum requirements. As new commercial broadband applications are developed, some of them will undoubtedly benefit public safety agencies.

The currently proposed 700 MHz spectrum allocation is insufficient to support the applications that public safety requires now. The 700 MHz “D block” spectrum scheduled for auction is adjacent to the Public Safety Broadband Licensee (PSBL) 700 MHz Broadband allocation. The adjacent spectrum is critically needed to provide the capacity necessary to support mission critical public safety broadband applications now and in the future. A single wireless broadband network spanning both the D Block and the adjacent public safety 700 MHz spectrum is the only logical choice to support public safety requirements.

Most commercial wireless carriers have committed to deploying a fourth generation wireless technology called Long Term Evolution (LTE). This technology will be deployed worldwide and is supported on the 700MHz band. Once these commercial broadband LTE networks are deployed, public safety will gain access to lower cost infrastructure and mobile devices, and will reap the benefits of ongoing research and development financed by the commercial wireless industry.

The 700 MHz band is ideal for public safety as it provides superior coverage compared to the higher bands in mountainous terrain and within buildings. If the 700 MHz D Block is auctioned to commercial providers, the lack of available spectrum will force public safety to maintain separate wireless networks for data and voice in perpetuity, forcing public safety to financially support two networks and carry two devices.

A 700 MHz public safety nationwide broadband wireless network supporting both data and voice will for the first time establish true interoperability in public safety emergencies requiring a multi jurisdictional response. The September 2009 Draft of the National Broadband Plan lists an eventual converged data and voice network for public safety as a strategic goal[1]. This vision will never be realized without a commitment by the Federal government to allocate the D Block to public safety now. Auctioning the D block is shortsighted and ultimately prevents public safety from attaining its goal of a dedicated, robust and reliable broadband wireless network. We believe that the future cost savings achieved by a converged public safety data and voice network will far

[1] See Draft National Broadband Plan Dated September 29, 2009 Page 9, National Priorities, Public Safety “Interoperable mission critical voice and broadband network”.

outweigh any short term revenue collected from a second auction of the D Block spectrum.

The benefit of allocating the D Block to public safety is very significant while the opportunity cost of reallocating the spectum is very small. The Cellular Telecommunications Industry Association (CTIA) has indicated that approximately 800 MHz. of additional spectrum is needed to enable commercial broadband service[2]. While allocating 10 MHz. of spectrum in the D Block would double the broadband spectrum for public safety, removing it from auction represents a reduction of only 1¼ percent of the spectrum requested for commercial broadband. Dedicating additional spectrum for public safety broadband would benefit the entire population, who are served by dedicated Police Officers, Firefighters and Emergency Medical personnel. We therefore urge Congress to place a priority on public safety by directing the Federal Communications Commission to reallocate the D Block to public safety broadband operations.

Appendix A, attached is an excerpt from New York City's recent Comments filed with the Commission in the Matter of Additional Comment Sought on Public Safety, Homeland Security, and Cyber security Elements of National Broadband Plan -- NBP Public Notice # 8. The excerpt is included at the end of this document to underscore our major points and provide broadband throughput analysis data.

Section One
Public Safety Requires a Robust and Reliable Network

Reducing public safety coverage, reliability or availability requirements in order to attract potential bidders is shortsighted as such a network will not meet public safety's needs. The result will be a false sense of security that will be shattered by catastrophic network failure when the first large scale disaster occurs. All commercial enterprises are motivated by profit, commercial wireless networks are no exception. Their primary responsibility is to their shareholders, not to the welfare of the public.

Public safety's mission is to protect the public, there is no profit motive. Therefore, Public safety communications networks are more akin to military wireless networks rather than commercial wireless networks. The establishment of the Department of Homeland Security and the FCC's recent establishment of the Public Safety and Homeland Security Bureau, as well as the longer established position of Defense Commissioner all serve to underscore the increased threats that public safety agencies must contend with in the post 9/11environment.

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[2] Letter from Christopher Guttman-McCabe, Vice President, Regulatory Affairs, CTIA, to Chairman Julius Genachowski, *et al*, Federal Communications Commission, GN Docket No. 09-51, September 29, 2009 ("CTIA Spectrum Needs").

Reducing the minimum required bid price undercuts the very purpose of the auction. Diluting the network coverage and reliability requirements shortchanges public safety. Rather than taking these steps to attract a potential bidder, we urge Congress and the Commission to cancel the D Block auction and assign the D block directly to public safety. This will insure that public safety has sufficient spectrum to deploy a nationwide interoperable mission critical wireless network that will ultimately support both voice and data, alleviating interoperability issues caused by legacy public safety networks operating on disparate frequency bands and incompatible wireless technology platforms.

Section Two
Benefits to Public Safety

Network Control
If public safety owns and operates its own network or at a minimum holds the spectrum license in a public private joint venture network they can exert greater control over future technical decisions that effect network performance. Additionally, ownership of the network allows public safety to exert influence over the network design and deployment to satisfy the immediate and future needs of the users.

In an emergency it is critical that public safety exert direct control over their critical communications networks. Public safety agencies must be assured that they are afforded the highest priority during emergency situations, even if others are denied service or are otherwise inconvenienced.

The addition the D block licensed to the public safety 700 MHz. allocation will put public safety in a favorable position if a public safety partnership is forged in a particular locality. Other localities may choose to build own and operate their own public safety broadband network. In either case, granting the license for the D Block spectrum through a public safety entity such as the PSBL puts public safety agencies in a better negotiating position if a partnership arrangement is desired. As licensee, public safety will be able to partner with any qualified commercial entity whereas if the D Block is auctioned, public safety can only negotiate with the D Block auction winner.

Guaranteed Access
In order to protect the public and perform their job efficiently and effectively, public safety users require guaranteed access to the communications networks they use. In recent years, public safety users have become increasingly reliant upon commercial networks. During emergencies these networks often fail due to congestion or infrastructure breakdown, since they are not scaled or engineered for emergencies.

On October 11, 2006 New York Yankee pitcher Cory Lidle crashed a small private plane into a 40 story apartment building in Manhattan. Public safety first responders arriving at the scene were unable to use their commercial wireless cell phones due to call blocking resulting from network capacity limitations. All wireless carriers were similarly affected.

Although many of the first responders had "priority access" they were still unable to access the wireless networks in most cases.

Analysis after the event revealed that a large part of the problem was that the commercial wireless networks are simply not scaled and engineered to handle the traffic spikes that result from this type of event. Further analysis revealed that "priority access" was ineffective for two reasons. First, the priority given to public safety is only "top of the queue" priority, rather than preemptive access. Given the location of the incident and the number of news media personnel present, who have learned from experience never to end their call until the incident is over, it is not surprising that few public safety calls were successful. The second factor is that the "access channel" was congested. The network could not recognize the public safety user as a priority user until the call request was recognized by the network. Since the access channel was overwhelmed, the public safety user was competing with all other users for network recognition.

Future Cost Avoidance

Both the NPSTC Statement of Requirements for the National Public Safety Broadband network and the FCC Third Further Notice of Proposed Rulemaking specify a Push to Talk (PTT) voice capability. As LTE technology matures, we are confident that a mission critical voice capability will become a reality. Setting aside sufficient spectrum for this purpose now will create a more definitive market opportunity for technology suppliers to begin early development of products knowing that a true market exists and that development costs can be recovered through sales of equipment and systems.

In the future we envision a single converged voice and data network for public safety. This vision is also expressed as a national strategic goal in the September 2009 Draft of the National Broadband Plan. If a converged public safety voice and data network becomes a reality, public safety agencies will reap significant cost savings since they will only have to support a single wireless communications network and carry a single device for both data and voice.

At the recent GSMA (Groupe Spéciale Mobile Association) Mobile World Congress, the GSMA announced the acceptance by the majority of wireless network operators of a standard for voice over LTE. The technology will be based on IMS (Internet Multimedia Services). The GSMA believes that IMS voice services could become available over LTE as soon as the middle of 2011.

Reliability

Public safety networks are typically equipped with emergency power backup capability. Most critical public safety radio sites are equipped with a minimum of eight hours of backup power. During the Northeast blackout of August 2003 many cell sites in New York City failed within the first few hours and remained inoperative for the duration of the blackout.

Network Restoration
Public safety staff can restore service quicker than commercial entities. Public safety technical staff can more quickly access sites within disaster areas when commercial providers (civilians) are excluded due to security concerns.

Technical Staff
Public safety technical staff will respond in situations that commercial providers will not. Public safety technical staff are credentialed and screened to a higher standard than commercial provider technical staff and their subcontractors. Commercial providers sometimes use third party subcontractors who do not focus on public safety as their primary commitment. often employ transient workers whose commitment to the mission is questionable. Such employees are rarely subjected to extensive background checks prior to employment.

During the Northeast blackout of August 2003 electrical power was out in most of New York City for approximately 25 hours. This exceeded the backup power capacity at many NYPD radio sites. However, NYPD Radio Repair Mechanics and Police Officers were able to keep these sites on the air by replacing discharged backup batteries with freshly charged batteries. These batteries weigh approximately 100 pounds and in some cases had to be hand carried up sixty floors. No commercial wireless network provider made a similar effort to maintain service, nor would we expect them to. They simply waited for commercial power to be restored.

Section Three
Long Term Evolution and Spectrum Efficiency

Long Term Evolution (LTE) has been endorsed by the Public Safety Spectrum Trust (PSST), Association of Police Communications Officials (APCO), National Emergency Number Association (NENA) and the National Public Safety Telecommunications Council (NPSTC) as the preferred technology for 700 MHz. Public Safety Broadband Network. Verizon Wireless, AT&T, and T-Mobile have all publicly stated their intention to deploy LTE in the United States as their fourth generation (4G) wireless network.

LTE standards are governed by the Third Generation Partnership Project (3GPP), an international wireless standards body. LTE is supported by the 3GPP and most commercial wireless carriers, worldwide. LTE supports channel bandwidths from 1.5MHz. up to 20 MHz. wide.

Spectrum efficiency is improved through spectrum aggregation. The larger the channel size the greater the potential for spectral efficiency. Within LTE, a 10MHz. block of contiguous spectrum provides significantly greater spectrum efficiency than two 5MHz. blocks of non contiguous spectrum blocks.

The current allocation for broadband public safety spectrum consists of two 5 MHz. spectrum blocks, one 5MHz. uplink channel and one 5MHz. downlink channel. Although a public safety broadband network could be created using 5MHz. uplink and downlink channels in the existing public safety broadband spectrum and another commercial LTE network could be deployed using the 5MHz. uplink and downlink channels in the adjacent D Block, a better solution is for public safety to be allocated the D Block channels and deploy a network consisting of two 10 MHz. LTE channels, one uplink and one downlink. This solution offers distinct advantages. First, it is more spectrum efficient as it allows higher peak power data rates and higher throughput. Second, it is more economical since the cost to deploy a network consisting of two 10 MHz. channels is approximately the same as the cost to deploy two 5MHz. channels.

The 700 MHz. D Block is the only available spectrum adjacent to the public safety broadband allocation. If the D Block is auctioned rather than being assigned to public safety, state and local governments will pay a much higher price in the future supporting public safety communications than any short term revenue gleaned through a second auction. If a commercial wireless provider chooses a technology other than LTE for the D Block, a guard band will have to be established between the D block and the Public Safety.

LTE supports channel sizes ranging from 1.5MHz up to 20MHz. A network utilizing larger channels in urban environment will provide substantially greater capacity. In rural areas, larger channels will allow for the deployment of a higher site architecture network employing higher power base stations thereby reducing the number of sites required.

Section Four
Convergence of Data and Voice

As time goes on, it will become increasingly more attractive to build converged data and voice networks. This issue was raised during the PSWAC effort in 1996; however it was not technically feasible at that time. The technical environment has changed dramatically since then. A converged data and voice network solution at 700 MHz is now possible if the Federal Government, public safety and the wireless communications industry decides to move in that direction. It will not be possible if the spectrum is not available.

The National Public Safety Telecommunications Council's (NPSTC) Statement of Requirements published in November 2007[3] and the FCC Third Further Notice of Proposed Rulemaking issued in September 2008[4] both specify a commercial grade PTT voice capability as a requirement of the Public Safety 700 MHz. Broadband Network. We are confident that over time a mission critical voice capability will be developed within the LTE framework.

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[3] See NPSTC Public Safety 700MHz Broadband Statement of Requirements pp20-21
[4] See FCC Third Further Notice of Proposed Rulemaking Appendix C, p189(4) and p193 (Table 1)

Federal Agencies are already beginning to use converged voice and data networks for mission critical communications.

> "The vast majority of Federal public safety agencies do not currently use broadband networks to support mission-critical voice communications. The Transportation Security Administration (TSA) of the Department of Homeland Security (DHS) is one exception. TSA uses commercial wireless broadband services in the 800 MHz spectrum for mission critical air to ground communications for Federal law enforcement officers in flight, as that is the only spectrum available for this application. This capability will soon include Voice over Internet Protocol (VoIP)."[5]
>
> "Immigration and Customs Enforcement (ICE), within DHS, is another exception. ICE uses commercial broadband networks for intranet access for laptops and other portable electronic devices, such as Blackberries, and for voice telephony applications. ICE requires exceptionally stringent security to safeguard law enforcement information and therefore allows broadband access only for authorized ICE end user equipment on which the required security controls have been installed and tested. ICE's law enforcement officers have mission-critical requirements for critical demand theater operations. The lack of law enforcement priority on commercial broadband networks also necessarily limits ICE's usage of such systems. Despite such limitations, the Commission should consider whether use of commercial broadband networks, with adequate adoption by public safety agencies, may be a first step in the path to maximized broadband network."[6]

The National Telecommunications and Information Administration (NTIA) shares the view that a converged public safety data and voice communications network will ultimately replace existing narrowband public safety voice networks.

> "As voice and data communications continue to converge, users have a greater expectation for both voice and mobile wireless data capabilities. Broadband systems that can provide reliable, interoperable voice and data systems will likely replace antiquated narrowband voice systems and low data rate networks. If mission critical voice applications are to migrate to broadband, systems will need to have sufficient control channel capability in high congestion areas, especially during special events and large gatherings, to support to support both a significant increase in text messaging and data traffic and call setup capability for national security and emergency preparedness (NS/EP) communications. Legacy voice networks must be effectively leveraged while the migration to broadband evolves." [7]

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[5] See NTIA Executive Branch Views On Public Safety, Homeland Security and Cyber security Elements of a National Broadband Plan, December 2009; Page 4.

[6] See NTIA Executive Branch Views On Public Safety, Homeland Security and Cyber security Elements of a National Broadband Plan, December 2009; Page 4.

[7] See NTIA Executive Branch Views On Public Safety, Homeland Security and Cyber security Elements of a National Broadband Plan, December 2009; Page 11.

Assuming that the 700 MHz. broadband public safety network will be constructed in any event, public safety should seize this opportunity to include mission critical voice as a required network component as soon as the technology permits, thereby solving voice interoperability issues and standardizing public safety communications nationwide. We realize that mission critical voice over broadband is a not available today and that public safety will not accept this technology until it equals or exceeds the capabilities and reliability of existing mission critical public safety land mobile radio networks. However, we also believe that the eventual convergence of broadband data and mission critical voice on a single network is inevitable. The alternative is to support separate public safety networks for data and voice, construct and maintain incompatible mission critical voice networks using dissimilar technologies on disparate frequency bands, and pay premium prices for narrowband user devices. We view this alternative as unacceptable.

The goal of public safety communications planners should be not only consolidation onto an integrated broadband voice and data network[8], but also an orderly migration of existing public safety mission critical voice communications systems, over time, to a common frequency band and technology platform, which will provide inherent interoperability and improved spectrum efficiency while reducing overall costs in the long term. In order to achieve these objectives, Congress should allocate the 700 MHz. D Block directly to public safety and forgo a second auction.

Section Five
The 4.9GHz. Public Safety Spectrum

Some opponents of our effort to assign the 700 MHz D Block to public safety have suggested that the public safety 4.9 GHz channels provide more than enough spectrum for public safety to deploy broadband networks. The deployment of wide area networks using 4.9GHz public safety channels is impractical for several reasons. First, the number of sites required to provide adequate coverage, especially in an urban environment is staggering. The number of sites estimated to cover New York City alone exceeds 13,000. From both a maintenance and infrastructure perspective 4.9GHz is a poor choice. It may be appropriate to use this technology in small areas for special purposes; however the poor propagation characteristics offset any derived benefit. In some localities 4.9 GHz has been used to implement wireless WANs, however this was done out of necessity, since no other spectrum was available. Currently, there are no other options available to public safety for a broadband network deployment. Another very critical issue is the backhaul requirements of a 4.9GHz wide area network; the number of sites required to provide ubiquitous coverage creates a difficult challenge to deliver backhaul infrastructure to the network. The 4.9GHz public safety channels were intended for hotspot or incident scene use only; they were never intended to be used as a wide area

[8] See Draft National Broadband Plan Dated September 29, 2009 Page 9, National Priorities, Public Safety "Interoperable mission critical voice and broadband network". Page 161 Ensuring public safety requires a high quality network; Goal:" Enhances mission critical voice over time"

network solution. 4.9GHz links can be used to transport video for spontaneous or temporary deployment over very short distances.

Public safety emergencies occur in all areas, not merely in pre-defined or anticipated locations. Time is of the essence when lives are at stake. It is far more desirable for public safety first responders to have a wireless network in place that provides adequate broadband coverage in all locations than to call in a special unit to deploy an ad-hoc network. Incidents that unfold quickly or change locations further underscore the need for ubiquitous broadband network coverage rather than relying on ad- hoc networks to be set up and broken down repeatedly. Fixed wireless network assets are a much more permanent, reliable and effective solution for public safety.

The propagation characteristics of 4.9GHz virtually preclude practical wide area network deployment. The range is very limited, typically 100ft.–150ft. Although it is possible to deploy a mesh network to increase the range and circumvent obstructions, this technique severely reduces throughput and adds additional layers of complexity and potential failure. Due to the specifications of the 4.9GHz emission mask, devices deployed on adjacent channels in close proximity may interfere with each other, further reducing throughput.

Connectivity between 4.9GHz devices requires a line of sight path between transmitter and receiver; 4.9GHz signals will not bend around obstructions. These physical channel limitations are especially problematic for deployment in dense urban areas which are the very areas most likely to require the highest data throughput. The inability of 4.9GHz signals to penetrate walls, windows and other common construction materials render them virtually useless indoors.

A wide area 4.9GHz network deployment is inconsistent with the ultimate goal of a constructing a converged nationwide voice and data public safety network utilizing a single user device and operating on a common technology platform. The suggestion that 4.9GHz devices can be deployed over a wide area to provide broadband capability for public safety first responders ignores the coverage limitations of the frequency band. The 4.9GHz public safety channels are more appropriately used as hotspots at known congregation points such as Police Precincts or Firehouses, or at the scene of protracted incidents for the local exchange of broadband data and for Blue Force Tracking purposes.

The majority of public safety broadband applications will require backhaul to remote data bases so that information can be downloaded to public safety responders and to Command and Control facilities so that critical information can be exchanged between headquarters and field units. Ad-hoc 4.9GHz hotspots deployed at incident scenes without the benefit of backhaul do not provide the same level of functionality as access to a permanently installed wireless infrastructure.

Municipal Wi-Fi mesh networks deployed within the last few years by some governmental agencies and private firms have, for the most part, been shut down. This occurred due to the lack of a sound business model, the need to constantly add and relocate access points, the cost of back-haul for these networks and poor in building penetration. The inability of well funded commercial entities to successfully deploy Muni Wi-Fi networks in the lower portion of the spectrum where coverage are better than at 4.9GHz. indicates that this model is not a suitable alternative to the 700 MHz wide-area network planned for public safety.

Section Six
Public Safety Broadband Data Applications

Applications Relevant To All First Responder Agencies

1.) Incident Video

Live incident video has immeasurable benefits to public safety. The ability to stream on-scene video to responding units, operations and communications centers, supervisors and emergency managers can dramatically alter the way public safety responds to major incidents. The ability to share first responder and broadcast video among responding agencies will greatly enhance public safety's ability to manage and contain critical incidents. Integrating Geographic Information System (GIS), sensor and tactical data with video will provide first responders with critical pre-arrival information that will allow a more effective response to critical incidents. Video captured at incident scenes can be wirelessly transmitted to Command and Control facilities or responding mobile units, improving situational awareness and enhancing officer safety.

Incident Video Viewing DL	1150 kbps
Incident Video Viewing UL	28 kbps

2.) Broadband Data Dispatch

Although "digital dispatch" has been available for more than 20 years, its capability has been limited largely to text transmissions by the throughput constraints of current narrowband public safety wireless data networks. A next generation public safety broadband data network will allow broadband data to be transmitted to field units prior to their arrival at the incident location, greatly improving situational awareness.

Advanced consumer wireless features such as photos and video sharing allow citizens to capture incident information and transfer it to public safety dispatch centers. Utilizing a broadband network this information can be wirelessly transmitted to field units responding to an incident. Additionally, this capability will allow dispatchers to attach this information to the incident record, automatically send it to responding units to view or listen to all available data related to the job assignment, including for example an audio file containing the information provided during the 911 call. It will provide critical premises history information such as: prior police response, arrests, weapons, warrants, and crime report histories. This type of information can be critical in determining how the responding officers approach the individuals involved in the incident, or enable them to more effectively conduct their investigation. Broadband data dispatch will reduce radio traffic on voice channels, minimize call backlog, improve response time, improve officer productivity and enhance officer safety.

The NYPD currently responds to an average of 5,000 to 6,000 incidents per day. Over time, the voice component of the public safety dispatch function will decrease, while the broadband data component will increase dramatically. We envision that in the future, pushing broadband data to responding field units will account for 85 to 90 percent of dispatch transactions without the need for voice communications.

Digital Dispatch DL	25 kbps
Digital Dispatch UL	25 kbps
Audio and Video DL	96 kbps
Audio and Video UL	19 kbps

3.) Mobile Incident Command Vehicles

During major incidents and special events, specialty vehicles are dispatched to serve as Mobile Command Posts. These vehicles are typically equipped with multiple communication devices and critical incident management applications and contain radios, cell phones, fax machines and satellite phones. Wireless broadband connectivity will allow two-way transfer of photos, video, and audio clips to and from Headquarters in real time, improving Command and Control and situational awareness for on scene Incident Commanders as well upper echelon command staff not on scene. Additionally, applications that require high bandwidth connectivity can be supported at the incident scene over a single broadband modem.

Incident Video Viewing DL	1150 kbps
Incident Video Viewing UL	28 kbps
Website Viewing DL	90 kbps
Website Viewing UL	25 kbps
Incident Video UL	647 kbps
SFTP Transfer DL	93 kbps
SFTP Transfer UL	92 kbps

4.) Mobile Access to Geographic Information System (GIS)

Mobile units and field commands can download geographic information such as topographical and curb line maps and architectural and computer rendered drawings from government and private municipal data bases. Use of GIS and Computer Aided Drafting and Design (CADD) information will provide invaluable assistance to law enforcement and fire services during routine and major incidents. Incidents such as the Mumbai, India Hotel attack illustrate the need for better tactical information for first responders. This capability replaces the need to carry physical maps that may be out of date. GIS capabilities further provide a means to visually connect different layers of information to improve on-scene situational awareness.

GIS / CADD Request UL	20 kbps
GIS / CADD Request DL	**100 kbps
**file size assumes DWG or similar format and avg sizes	

5.) Blueforce Tracking (BFT)
The location of public safety personnel can be remotely monitored during high risk operations to enhance first responder safety. Fire and police services have been interested in this technology for several years and recent developments in the defense industry now make public safety availability likely in the immediate future. Broadband technology will allow blue force tracking solutions to be available when necessary. Since first responders are typically responding to unplanned incidents there is limited time to deploy ad-hoc or temporary networks for blue force tracking applications. BFT can be used to monitor firefighter and police officer location, and vital signs. Body worn video can be deployed to provide tactical and situational information to field and command personnel.

BFT Data Transfer UL	*25 kbps
BFT Data Transfer DL	*25 kbps
*Assumes polling at 5 second intervals	

6.) Automatic Vehicle Location (AVL)
Real time location and status of public safety agency vehicles can be wirelessly transmitted to the dispatch center, allowing the dispatcher to more effectively deploy the fleet, enhancing command and control and improving efficiency.

Data Transaction UL	40 kbps
Data Transaction DL	**60 kbps
** Estimated average transactions with 5 and 30 sec poll rates	

7.) Supervisory Field Access to **CAD and RMS Data**
Public safety supervisors need the capability to monitor personnel and incident activity Monitoring Computer Aided Dispatch and Records Management Systems wirelessly allows field supervisors enhanced situational awareness and allows field units to react rapidly changing conditions. Although this capability has existed for several years utilizing existing data networks, the functionality has been limited by the lack of sufficient bandwidth. Supervisors are limited to text updates and as more users respond to the incident system response times deteriorate. Users are also limited to text based searches of internal databases and have no access to the internet or web based applications. Broadband connectivity will allow supervisors to search multiple databases simultaneously and receive interactive feedback to allow for further refinement of their search parameters. Secure broadband communications will also allow for access to

external databases that would otherwise be restricted for security reasons. Narrowband or even high capacity channelized data systems do not have the bandwidth to sustain multiple users accessing large amounts of information in a concentrated area. This capability was successfully used in the "Miracle on the Hudson" plane crash in January 2009 when NYPD Special Operations Division (SOD) field supervisors monitored CAD data in real time over the NYCWIN network, thereby eliminating the need for constant dispatcher updates.

Data Transaction UL	20 kbps
Data Transaction DL	**22 kbps
Data Trans. + photo/GIS UL	**40 kbps
** Estimated average transactions based on similar NYCWiN traffic	

8.) Real Time Field Supervision

The capability for Field Supervisors to monitor the location and status of mobile units assigned to them without dispatcher assistance. Utilizing AVL and GIS capabilities, field supervisors can view their area of responsibility and "see" the units on a map. AVL will allow the supervisors to select a unit's icon and instantly see status, assignment, duration of service and other related information.

Data Transaction UL	20 kbps
Data Transaction DL	**25 kbps
** Estimated average transactions with 5 and 30 sec poll rates	

9.) Exchange of Broadband Data in the Field

Mobile units operating in the field can exchange data regarding an incident without dispatcher intervention, decongesting voice channels and allowing dispatchers to process incoming job assignments more efficiently. This data may include photos, video or audio files. This capability aids in the positive field identification of suspects, weapons, stolen items or other evidence. The exchange of data in real time between geographically separated team members improves officer productivity and enhances the investigatory process by enabling crimes to be solved faster and more effectively.

Data Transaction UL	22 kbps
Data Transaction DL	*40 kbps
* Estimated average transactions including audio, video and photos	

10.) Wireless Call Boxes

Emergency (911) call boxes can be installed in any location within the wireless network coverage footprint, regardless of the availability of wire line connectivity.

VOIP Call DL	20 kbps
VOIP Call UL	20 kbps

Police Specific Applications

1.) Mobile Crime Scene Units (Detective Division)

Crime scene investigation involves the gathering of evidence and subsequent analysis by specialists at a centralized location. Specially equipped vans staffed by detectives can respond to a crime scene to gather and analyze evidence. Immediate access to critical information will provide invaluable assistance to investigators and lead to more timely apprehensions. The information must be gathered and analyzed quickly and effectively, in real-time. Broadband connectivity will allow immediate analysis of evidence saving valuable time. Crime scene photos, video, forensic data and other information gathered at the scene can be instantly transmitted to the Real Time Crime Center or crime lab for detailed analysis.

Incident Video Viewing UL	28 kbps
Website Viewing DL	90 kbps
Website Viewing UL	25 kbps
Incident Video UL	647 kbps
SFTP Transfer DL	93 kbps
SFTP Transfer UL	92 kbps
Data Transfer DL	*25 kbps
Data Transfer UL	*20 kbps
* estimates based on current data rates from NYCWiN	

2.) Automated License Plate Recognition (LPR)

Public Safety and government vehicles equipped with Automatic License Plate Recognition systems can scan hundreds of license plates within minutes, sweeping an area for wanted or stolen vehicles with little operator intervention. Additionally, LPR systems can be used to enhance officer safety by transmitting real-time vehicle stop information to the dispatcher and automated database inquiries for car-stops. Broadband connectivity will allow agencies to quickly deploy fixed LPR systems to monitor traffic in and out of a defined area or along major roads for major incidents and temporary security operations.

License Plate Reader UL	256 kbps
License Plate Reader DL	22 kbps
Based on actual data rates from NYCWiN	

3.) Mobile or Handheld Summons Issuance

Traffic Enforcement Agents and police officers can issue summonses using hand held and mobile ticket writers connected to the broadband network. These devices can access DMV, NCIC, NLETS and agency databases in real time, thereby alerting the agent or police officer to a wanted or stolen vehicle, and verify the accuracy of the data entered. Photos and GIS data can be combined with the violation for accuracy and real-time location information. Wanted vehicles can be cross-referenced in real-time with violation information to support detectives during an investigation; an activity that normally would take several days can be accomplished in minutes.

Data Transaction UL	20 kbps
Data Transaction DL	20 kbps
Data Trans. + photo/GIS UL	40 kbps

4.) Chemical, Biological, Radiological, Nuclear and Explosive Detection Devices (CBRNE)

Portable, fixed and deployable sensors designed to detect Nuclear, Biological and Chemical agents can be deployed almost immediately or strategically placed in high threat areas for remote monitoring through the broadband network. Wireless connectivity allows the sensors to be relocated rapidly if necessary without regard to wire line connectivity availability, should the threat location change. The City of New York has been testing devices over the NYCWiN network with great success. In the event of a CBRNE incident the information can be monitored at remote locations reducing risk of further exposure to the threat. The devices can also be deployed at major events such as sporting events, concerts and other large gatherings without consideration for wired data connections.

Data Transaction UL	20 kbps
Data Transaction DL	20 kbps
Data Trans. Alarm UL	**25 kbps
** Includes transfer of spectral image for interpretation	

5.) Real Time Crime Center Wireless Connectivity

The NYPD Real Time Crime Center (RTCC) allows investigators to gather, correlate and analyze data from numerous sources at speeds previously unheard of in law enforcement. The RTCC allows Officers in the field to transmit photos or video directly to the RTCC from handheld devices for analysis. Key components of the RTCC include a data warehouse, data analysis software and a video wall. Using these tools, Police Officers quickly analyze data from numerous data bases and establish relationships that otherwise are not immediately apparent. Prior to the establishment of the Real Time Crime Center, this data is now correlated literally within minutes could have taken days or weeks.

Broadband Wireless connectivity plays an integral role in the operation of the NYPD Real Time Crime Center. The ability to transmit photos and video clips from the field in real time, or from the RTCC to the field, greatly accelerates the investigative process. Currently the NYPD utilizes a commercial wireless provider to supply the broadband wireless connectivity. The implementation of a Public Safety 700 MHz. broadband network would provide a cost savings to the NYPD by eliminating the expense of monthly recurring charges. The 700 MHz. band provides greater in building penetration than the 2.5GHz. NYCWIN network which is used primarily for vehicle based applications. In addition a public safety 700 MHz. broadband wireless network would allow public safety agencies to purchase relatively low cost handheld devices similar to those used in commercial wireless networks.

Data Transaction UL	22 kbps
Data Transaction DL	**160 kbps
Data Trans with photos UL	**80 kbps
** Estimated average transactions	

6.) Transmission of Video from Aviation Units to Terrestrial Mobile Units.
Current technology limits the ability of aviation units (helicopters) to deliver video to multiple terrestrial mobile units. Utilizing wireless broadband connectivity will allow the video feeds transmitted from aviation to be distributed to mobile command posts and responding units. The existing equipment requires the mobile command post to be stationary and erect a receiver directed towards the helicopter. Sufficient bandwidth is required to allow for video distribution to multiple units at the scene, responding to the scene and at remote locations. Broadband wireless connectivity will allow the video to be transmitted to a central repository and re-transmitted to any mobile or fixed unit within the coverage footprint of the broadband wireless network.

Incident Video Viewing DL	1150 kbps
Incident Video Viewing UL	28 kbps

7.) Photo ID
Field Officers can verify the identity of suspects or other individuals being detained, particularly those with common names or without valid identification. This capability enables Officers to detain or release individuals with a much higher degree of accuracy.

Photo ID DL	40 kbps
Photo ID UL	60 kbps

8.) Field Officer Direct Access to Remote Databases
Field Officers can verify the validity of license data without dispatcher intervention. (DMV records, Pistol License data, Peddler Permits etc.)

Data Transactions Text DL	22 kbps
Data Trans. Text + Photo DL	*60 kbps
Data Transaction UL	25 kbps
* estimates based on file sizes from NYPD mobile data photo pilot	

9.) Gunshot Detection

Gunshot detection system have been shown to reduce incidents of gunfire in targeted areas, assist investigators with timely and accurate information and provide invaluable evidence for court cases. The systems rely on strategically placed sensors and some form of line of sight connectivity. In urban areas placement of these sensors can be difficult if not impossible using line of sight communications. Connecting the sensors via broadband affords the user optimal placement options, rapid deployment and critical file transfer capabilities. The incident information and audio files can be instantly sent to the communications center and units in the vicinity to enhance response to gunshot incidents. Additionally, the sensors can be relocated as needed without wire line installation considerations or constraints.

Incident and Audio Transfer UL	*65 kbps
Incident Transfer to Unit DL	80 kbps
Data Transaction Text Only DL	25 kbps
*assumes and average audio file size with 5 seconds of gunshot audio	

10.) Photo and Video Distribution

In an investigation of a crime or missing person the first 30 to 60 minutes are critical to the resolution process. Photos or video of missing or wanted individuals can be distributed to mobile field units in real time improving the likelihood of a successful outcome. (Amber Alert Wanted Persons etc.) The process, if done manually, may take several hours to initiate and distribute the information to the field. Broadband capability will greatly enhance response to these types of incidents.

Video UL from field	*1000 kbps
Photo UL from field	90 kbps
Video DL from Dispatch	*1000 kbps
Photo DL from Dispatch	92 kbps
* Average file sizes – not streaming	

11.) Maritime Surveillance and Monitoring

Port Security is a priority as part of the nation's efforts to protect critical infrastructure and prevent acts of terror. There is the potential for weapons and explosives to enter coastal ports on cargo ships. DHS has stepped up their inspection efforts and port monitoring, however the deployment of a wireless sensor network would greatly enhance the security of our ports. Cargo manifests, ship information and travel itineraries can be made available in real time to Coast Guard and local law enforcement to enhance investigations. Remote sensors can be deployed in strategic locations to assist in early detection of dangerous cargo. These types of systems can only be deployed if sufficient bandwidth is available to allow for exchange of critical information and the monitoring of remote sensors.

Data Transaction UL	20 kbps
Data Transaction DL	120 kbps
Data Trans. Alarm UL	**60 kbps
** Includes transfer of spectral image for interpretation and GIS	

Fire Service Applications

1.) Electronic Command Boards (ECB)

The Fire Department has developed an Electronic Command Board to support fireground operations at the scene of an incident. The ECB allows the Chiefs at the scene of a fire to exchange critical information and provide live updates to the Operations Center. The ECB requires a broadband application to transfer information in a timely fashion. At the scene of many large scale incidents commercial wireless networks are often overloaded and cannot provide the necessary bandwidth for ECB to operate properly. The ECB requires a broadband connection for optimum operation. Fire Chiefs at the incident scene can track responding units and transmit this information to Fire headquarters in real time enhancing Command and Control capabilities.

Data Transaction UL	40 kbps
Data Transaction DL	120 kbps
Data Trans. CADD / GIS	**220-400 kbps
** estimates include transfer of GIS and CADD information	

2.) Wireless Access to Floor Plans, Drawings and 3D Graphical Displays

Responding units and commanders require access to building floor plans, schematic diagrams and 3D Graphical Displays to enhance situational awareness. For Fire Chiefs at the scene of a major incident this capability allows incident commanders to make informed decisions regarding resource deployment thereby enhancing Firefighter and citizen safety. Early transfer of critical information will allow firefighters to approach the incident tactically thereby reducing initial critical response times.

Data file transfer CADD/GIS DL	300 kbps
Incident Video Viewing UL	1100 kbps
Website Viewing DL	120 kbps
Website Viewing UL	40 kbps
SFTP Transfer DL	93 kbps
SFTP Transfer UL	92 kbps

3.) Wireless Access to Building Department Databases

Access included in Building Department records, including the presence and location of potentially hazardous materials within the incident perimeter enhances situational awareness and Firefighter safety.

Data file transfer CADD/GIS DL	500 kbps
Data file transfer CADD/GIS UL	50 kbps

EMS Applications

1.) Automatic Vehicle Location (AVL) Integrated CAD
The location and current status of all ambulances can be wirelessly fed into the EMS Computer Aided Dispatch computer. The EMS CAD computer uses this information to make recommendations to the EMS dispatcher for the next assignment. Implementation of this type of system can result in a significant reduction in response time.

Data Transaction UL	40 kbps
Data Transaction DL	**60 kbps
Data Transaction for Routing	120 kbps
** Estimated average transactions with 5 and 30 sec poll rates	

2.) Patient Tracking
Family members routinely inquire about the location of their sick or injured relatives. Access to a broadband wireless network allows EMS workers to accurately track patients and provide this information to their family members in near real time, increasing productivity and reducing patient tracking errors.

Data Transaction UL	30 kbps
Data Transaction DL	50 kbps

3.) Real Time Transmission of Medical Data
Medical data such as ECGs, photos or videos of injuries and patient history can be wirelessly transmitted to receiving hospitals in advance of a patient's arrival permitting Emergency Room staff to assemble the appropriate personnel and equipment in advance. Advances in mobile telemedicine equipment enhance the initial diagnosis and field treatment of critically injured or sick patients. Information in the form of broadband data can be exchanged between the on board Emergency Medical Technicians and the hospital medical staff to assist in patient treatment during transport. This data may include photos, video, video conferencing and other forms of medical information.

Information Transfer UL	*128 kbps
Monitor status Streaming DL	*200 kbps
Intranet Access UL	*120 kbps
Patient Video UL (1 way)	*647 kbps
Instructional Access DL	*90 kbps
Video Teleconference DL	*900 kbps
Video Teleconference UL	*900 kbps
Data Transfer DL	*25 kbps
Data Transfer UL	*20 kbps
* estimated	

Governmental Non First Responder Agency Applications

The Public Safety Broadband Wireless Network will support QOS and priority. These mechanisms will allow other municipal lower priority users to access network. Allowing non emergency municipal agencies network access improves overall spectrum efficiency. A few examples are listed below:

Sanitation Department Applications

1.) Automatic Vehicle Location (AVL) and Vehicle Monitoring
Real time location and status of Sanitation Department vehicles is wirelessly transmitted to the Sanitation Department dispatch center, allowing the dispatcher to more effectively deploy the vehicle fleet, enhancing command and control. The AVL application also monitors the status and health of the sanitation vehicles by connecting to the ODBCII interface.

Remote vehicle sensors installed in Department of Sanitation vehicles wirelessly transmit vehicle status data to the Department of Sanitation dispatch center. These sensors monitor vehicle health as well as mission status (truck full, sand or salt released, at vehicle location etc.). This data is particularly effective in managing fleet resources during snow removal operations, which are the responsibility of the Sanitation Department in NYC.

Data Transaction UL	40 kbps
Data Transaction DL	60 kbps
Data Transaction for Routing	85 kbps
Supervisory Inquiries UL	60 kbps
Supervisory Inquiries DL	100 kbps
Based on NYCWiN data	

Department of Transportation Applications

1.) Wireless Traffic Signal Control
The Department of Transportation is installing new traffic controllers equipped with broadband wireless modems that communicate with the Traffic Control Center in real time allowing for the wireless control of traffic signals and eliminating the need for wire line backhaul. New traffic signals can be installed in any location within the wireless network footprint without regard for wire line availability, reducing installation time and expense while eliminating recurring (leased wire line) costs. The wireless modems will also allow DOT to implement ITS enhancements such as emergency vehicle priority access, route information and messaging, and traffic management.

Data Transaction UL	40 kbps
Data Transaction DL	**60 kbps
Data Transaction for ITS (future)	120 kbps
** Estimated average transactions	

2.) Traffic Monitoring
Permanent or temporary traffic monitoring cameras can be installed in any location within the footprint of the broadband wireless network without regard for wire line availability, reducing installation time and expense while eliminating recurring costs.

Data Transaction UL	*40 kbps
Data Transaction DL	*60 kbps
* assumes high traffic patterns during peak periods	

Municipal Government and Critical Infrastructure Applications

Sharing the public safety network with other governmental entities on a priority basis enhances and increases public safety agency's return on investment while simultaneously satisfying the original intent of the public safety broadband wireless network to provide ubiquitous national data coverage for first responders. A few examples are cited below.

1.) Wireless Meter Reading
Water, electric and gas meters read remotely taking advantage of the broadband wireless network and/or its backhaul infrastructure to improve accuracy and reduce labor costs.

Data Transaction UL	25 kbps
Data Transaction DL	20 kbps

2.) Wireless Leak Detectors
Water and gas leak detectors connected to the broadband wireless network can be read remotely in real time. These detectors can be installed in any location within the wireless network footprint without regard to wire line availability; reducing installation time and expense and eliminating recurring (leased wire line) costs.

Data Transaction UL	20 kbps
Data Transaction DL	25 kbps

3.) Bus Locator (AVL)
The real time location and status of municipal buses can be wirelessly transmitted to the bus dispatch center, allowing the dispatcher to more effectively deploy the vehicle fleet, enhancing command and control and providing improved service to the public. In addition, it is possible to monitor engine parameters, and emergency requests from the driver in real time, or an alert basis.

Data Transaction UL	**128 kbps
Data Transaction DL	**40 kbps
** Estimated average transactions with 5 and 30 sec poll rates	

Section Seven
Conclusion

Real time access to broadband data improves the efficiency of public safety personnel by giving them the tools they need to perform their job. The delivery of broadband data to field personnel requires access to a wireless broadband network. The FCC has taken the first steps by allocating spectrum in the 700 MHz band to Public Safety for this purpose. Unfortunately, the spectrum allocation will not meet future public safety demands. However, an adjacent spectrum block, the "D Block" has yet to be auctioned. We appeal to Congress to relieve the Commission of their legal obligation to auction the D Block and we implore Congress to direct the Commission to assign the D Block to public safety.

This document has defined some of the broadband applications public safety can benefit from with the assignment of the D block spectrum, and has demonstrated that the current assignment of two 5MHz channels is insufficient for the task. Although technology advancements will improve network capacity (throughput), they will not outpace demand for broadband spectrum. LTE is a very spectrum efficient technology. Improvements in capacity beyond LTE are possible but the physical limit of the radio channel (Shannon Boundary) will limit the magnitude of these improvements.

A unique opportunity exists to change the paradigm of public safety communications where multiple frequency bands and incompatible technologies create obstacles to interoperability and perpetuate inefficiency. We urge Congress to take the first steps to allow public safety to learn from the mistakes of the past and plan for a future in which wireless broadband networks deployed on a common frequency band using a common technology platform provide public safety with the tools they need for the twenty first century.

We endorse the vision of a broadband public safety interoperable data and mission critical voice network listed as a national priority in the September 2009 Draft National Broadband Plan[9], and in NTIA's "Executive Branch Views on Public Safety, Homeland Security and Cyber Security Elements of a National Broadband Plan"[10]. We believe that in order to achieve this vision, Congress should direct the FCC to forgo a second D Block auction and direct the Commission to assign the D block to public safety.

[9] See National Broadband Plan (September 29, 2009 Draft) Pages 9 and 161.
[10] See NTIA Executive Branch Views On Public Safety, Homeland Security and Cyber security Elements of
a National Broadband Plan, December 2009; Page 11.

Respectfully Submitted,
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APPENDIX A

Appendix A is an excerpt from New York City's recent Comments filed with the Commission. It is included here to underscore our major points and provide broadband throughput analysis data.

Current and Anticipated Needs of the Public Safety Community for Mobile Wireless Broadband Networks and Applications.

New York City is closely monitoring the evolution of Long Term Evolution ("LTE") technology as it relates to both mission critical data and voice applications including duplex phone calls, push to talk, instant messaging and broadcast video. Broadband technologies are developing at a rapid pace and the possibility of LTE supporting "push-to-talk" voice communications must be investigated as an alternative to narrowband technology. The lessons to be learned from past experience is that increasing channel size (broad-banding) rather than reducing channel size (narrow-banding) leads to more efficient use of scarce spectral resources. New York City understands that the LTE standards for voice have not been fully developed and that initial forays into broadband voice communications may be a few years away, however the Commission should act now to ensure that sufficient spectrum is available and that public safety standards are developed for this technology to evolve.

Anticipated Broadband Traffic and Capacity Requirements

Using New York City's experience in building the NYC Wireless Network (NYCWiN) as a basis for analysis our team examined the impact that broadband systems may have in the future operations of the public safety. We have collected important data points by gathering application usage from the NYCWiN network in order to provide real-world operational and performance data for the Commission's discussion on broadband usage. First, the NYCWiN 2.5 GHz broadband system provided a basis to characterize the various types of broadband applications that are in use today by the NYC public safety and public sector users. These applications and associated data rates are seen in table 1 below.

Data Rates	Download (Kbps)	Upload (kbps)
Incident Video upload	12	647
AVL Monitoring	51	4
Website Viewing	90	5
SFTP Transfer	93	92
Field Video Viewing	1150	28
Mobile Audio & Video upload	19	96

Table 1 - Typical Data Rates Derived from NYCWiN

The analysis focuses on two very important areas of consideration necessary in understanding the future needs for spectrum for New York City. First we examined the impact of secure broadband applications and the relation to bandwidth to support these applications. As has been discussed throughout the proceeding related to the 700 MHz spectrum, public safety has a critical need to improve daily operations through the use of mobile and fixed applications and technology.

However, it is important to understand the public safety systems must be designed to function outside of the accepted norm for everyday operations to best understand the bandwidth requirements for first responders. As we have seen many times, commercial systems have shown the greatest amount of stress during major City disasters and special events such as:

- September 11th attacks in New York and the Pentagon
- American Airlines Flight 587: 11-12-01
- Staten Island Refinery Explosions: 2-21-03
- Staten Island Ferry Crash: 10-15-03
- Midtown Building Collapse: 7-10-06
- Cory Lidle Plane Crash: 10-11-06
- Midtown Steam Pipe Explosion: 7-18-07
- Multiple Crane Collapses: March and May 2008
- Miracle on the Hudson: 1-15-09
- Helicopter/Plane Crash on the Hudson 8-8-09
- Annual and Special Events (i.e. NY Yankees Parade: 11-6-09)
-

In many of these instances the commercial networks were overloaded with users confined to a small area rendering the networks unusable. In other cases the networks were rendered inoperable due to the lack of sufficient battery back-up or emergency power. These, as well as other real life examples, demonstrate that commercial networks are not designed to function under the stress of critical incidents and when needed the most, cannot perform as required.

We intend to demonstrate, through our analysis, that first responder and public safety services require significantly more bandwidth and capabilities than is presently allocated to public safety in the 10MHz allocation in the 763-768/793-798 MHz band segment. The City also believes that the most effective approach to a broadband public safety network necessitates the allocation of sufficient spectrum to satisfy current and future needs of First Responders.

Normal Operations Scenario

Using real data from our analysis of NYCWiN applications, and using the projected target numbers for the desired adoption of a broadband network by public safety users in New York City; we examined the impact over time for system bandwidth usage as compared to available system capacity. We used models that are similar to in structure those models used by commercial broadband providers in analysis of their capacity needs, but adapted with assumptions appropriate for public safety usage. Using real world experience and our judgment based on our knowledge of the operational goals of Public Safety and other agency plans for broadband we have defined four classes of applications; vehicle MDT installations, Automated License Plate Recognition (ALPR), operational video, and personnel handheld devices. The model assumes a conservative 5% per year increase in the per user bandwidth requirement for both the MDT and handheld users based on current trends in technology growth and additional system capabilities.

Commercial networks generally use a 5% to 10% available user to active user ratio. In simple terms, at 5% usage the assumption is that 1 out of 20 users will be using the system at any one time. For the public safety environment we determined that the commercial carrier formula is not applicable based on a number of factors. We must assume that these devices are used in the day-to-day operations of a majority of system users and are typically reused by each on-duty shift. The number is not likely to be applicable in heavy daytime operation hours for operational vehicles and handheld personal devices. Additionally, the commercial carrier assumption of 5% to 10% of registered users cannot be applied during events such as parades, demonstrations and other large deployments of public safety personnel. As such, a 25% available to active ratio was used for mobile data terminals in vehicles and a 100% ratio was used for machine-to-machine users such as license plate readers.

Normal Operations Model

Using a simple model based on accepted commercial analysis techniques, we examined scenarios that consider the impact of a 12 year program maturation period for a secure broadband network deployed in New York City at 700 MHz. The model network deployment assumes a comparable street-level coverage design to NYCWiN for the 5 boroughs within New York City and uses the known capacity and bandwidth performance of LTE standard equipment as of this writing. The demand model starts with 1,000 vehicle deployments, 40 LPR units, 100 mobile video assets, and 1,000 mobile handheld users. Over the 12 year period the users adopt the network using an "s-curve" model to a final count of 10,000 vehicles, 1,200 LPR units, 2,000 video assets, and 25,000 mobile handheld users. These numbers come from a conservative analysis of anticipated user demand for a secure network of this type by public safety users in New York City, however the potential if expanded beyond local jurisdictions to State and federal entities could easily exceed 100,000 end user devices.

The demand model is then compared against different levels of aggregate capacity that would be available based on different amounts of spectrum. In the case of a 10 MHz spectrum allocation, as illustrated by the graph in Figure 2, the conservative adoption of a 700 MHz network by agencies would result in the UL demand reaching 75% in year 5 and 100% in year 6; while the DL demand reaches 75% in year 7 and 100% in year 9. The model uses very conservative usage assumptions and bandwidth per user requirements and it is anticipated that it is likely these estimates may be low as secure broadband data access becomes an integral part of everyday operations. The commercial industry equivalent to the plausible underestimation of usage comes in the form of the stress placed on commercial carrier networks by smart phones like the I Phone from Apple. These phones have placed significant stress on the capacity of commercial network data services because of the accelerated adoption of new applications and utilization of bandwidth for these new applications.

The 20 MHz LTE analysis uses the same demand assumptions but increases the available aggregate bandwidth as a result of increasing the spectrum available to the Public Safety network from 10 MHz to 20 MHz. The analysis found that the uplink capacity of the network still reaches the 75% at year 8 but never reaches the 100% mark over the 12 year period. The DL system capacity stays below 75% over the entire period of the 12 years, but it does reach a level of >50% as early as 7 years. It is important to note that just a single major incident will require bandwidth well beyond the everyday operational capacity of the network and sufficient reserve bandwidth must be available to ensure proper operational support during a major incident. We have included a parallel analysis of a major incident in figures 3 and 4 on the following pages.

10 MHz LTE Model

Technology	LTE - 10 MHz						
DL Capacity (Mbps)	10						
UL Capacity (Mbps)	3						
Start Year	1						
End Year	12						
User Categories	Initial Number	Final Number	Duty Cycle	DL Data Rate (Mbps)	UL Data Rate (Mbps)	Growth Pattern	Yearly Increase Demand
Vehicles	1000	10000	25%	1	0.25	S-Curve	5%
LPR	40	1200	100%	0.012	0.25	S-Curve	0%
Video Cameras	100	2000	100%	0.012	0.65	S-Curve	0%
Handhelds	1000	25000	5%	1	0.25	S-Curve	5%
# of Sites	200						
Cells/sector	3						

Figure 1 - 10 MHz LTE Model Inputs

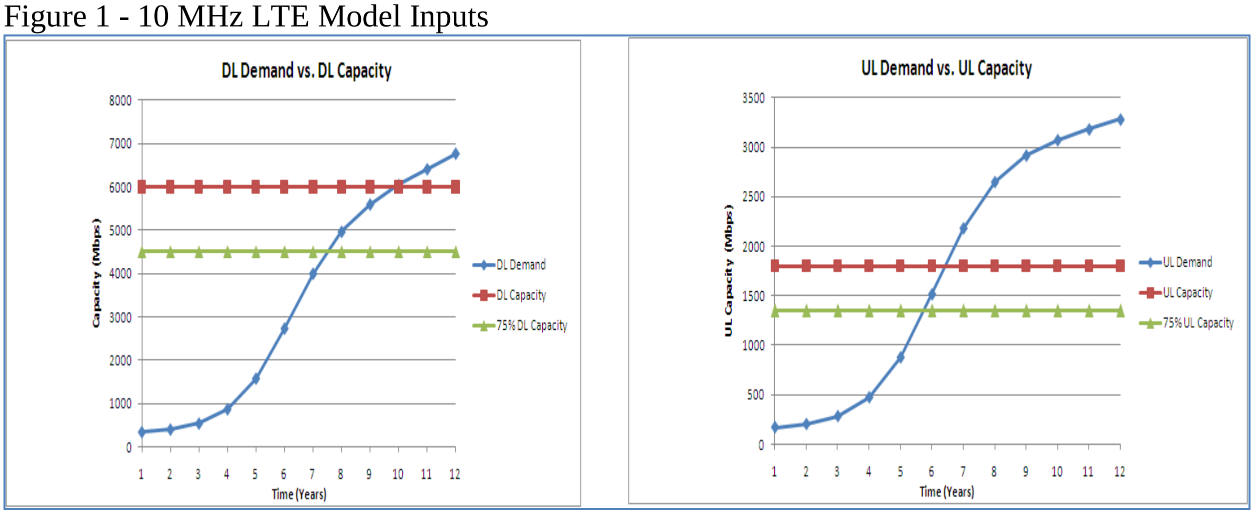

Figure 2 - 10 MHz LTE Capacity Model Graphs

20 MHz LTE

Technology	LTE - 20 MHz						
DL Capacity (Mbps)	21						
UL Capacity (Mbps)	6						
Start Year	1						
End Year	12						
User Categories	Initial Number	Final Number	Duty Cycle	DL Data Rate (Mbps)	UL Data Rate (Mbps)	Growth Pattern	Yearly Increase Demand
Vehicles	1000	10000	25%	1	0.25	S-Curve	5%
LPR	40	1200	100%	0.012	0.25	S-Curve	0%
Video Cameras	100	2000	100%	0.012	0.65	S-Curve	0%
Handhelds	1000	25000	5%	1	0.25	S-Curve	5%
# of Sites	200						
Cells/sector	3						

Figure 3 - 20 MHz LTE Model Inputs

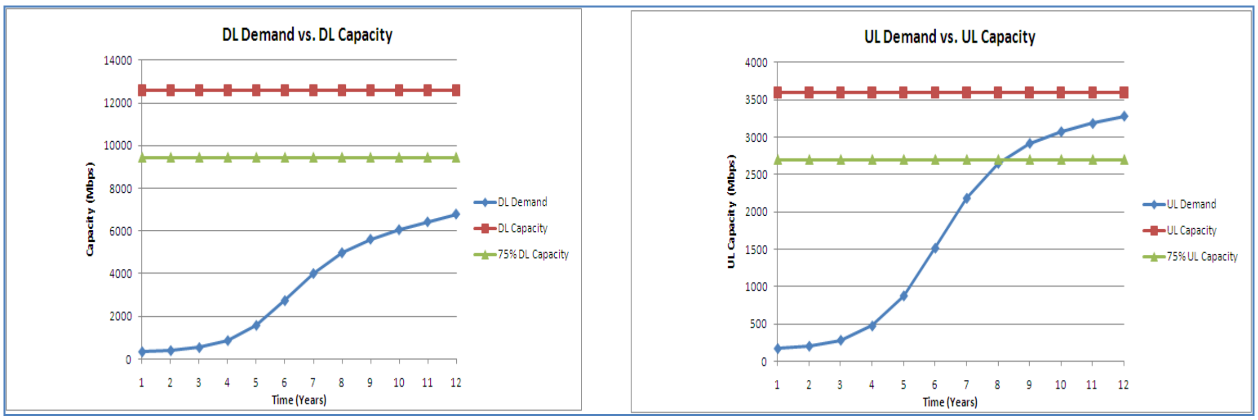

Figure 4 - 20 MHz LTE Capacity Model Graphs

Normal Operations with Voice Application

While the previous section considered only data applications to estimate the total bandwidth demand, in this section we add mobile, enterprise-class Voice as an application and analyzed its impact on overall bandwidth demand. (As standards have yet to be defined for mission critical voice for LTE, we have focused this analysis on non-mission critical use for which reasonable bandwidth estimates can be made) We start with 1000 voice users increasing to 25,000 users at the end of 12 year program maturity period. Voice is a relatively low bandwidth application requiring only about 25 Kbps of bandwidth on both the downlink and the uplink. Current industry estimates of LTE voice capacity are ~160 and ~ 320 simultaneous voice calls in 10 MHz and 20 MHz bandwidth respectively, assuming the entire capacity is dedicated to voice. Under the current assumption of a street-level coverage design of 200, 3-sectored sites, this translates to ~96,000 and ~192,000 total voice users in 10 MHz and 20 MHz bandwidth respectively.

Our assumption of maximum of 25,000 users accounts for only ~26% (~13%) of the total voice capacity if all the 10 MHz (20 MHz) capacity were to be dedicated for voice use. This shows that with the number of assumed voice users, there is still considerable capacity available in the network for other data applications. The charts below show the total demand, including voice, versus available capacity in the network for the two cases of 10 MHz and 20 MHz of bandwidth.

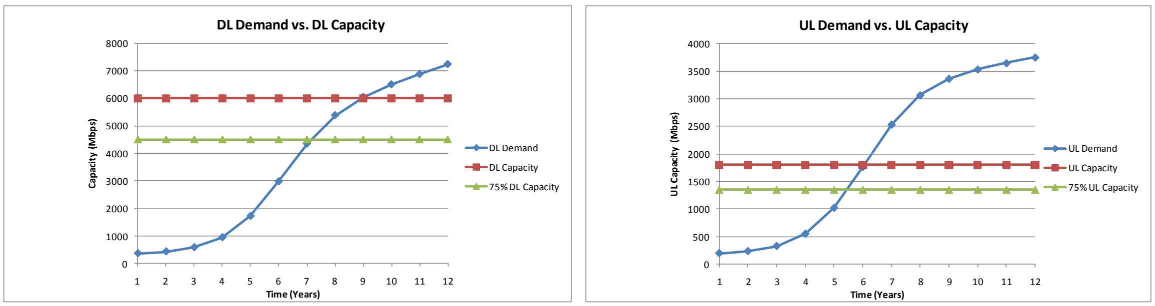

Figure 5- 10 MHz LTE Model Capacity Graphs with Voice

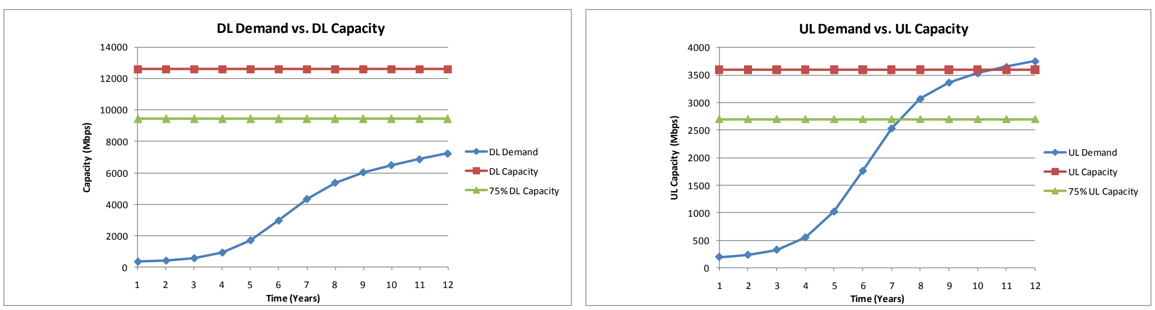

Figure 6- 20 MHz LTE Model Capacity Graphs with Voice

Comparing these charts with the case without voice, we notice a small impact on capacity. For the 10 MHz case, threshold of 75% downlink capacity is exceeded at the end of 7 year instead of 7.5 year without voice, The Tables below illustrates the capacity impact of adding voice for both the 10 MHz and the 20 MHz cases.

75% Capacity Exceeded	With Voice	Without Voice
Downlink	7 years	7.5 years
Uplink	5.5 years	5.8 years

Table 2 - Capacity with and without Voice with 10 MHz LTE Bandwidth

75% Capacity Exceeded	With Voice	Without Voice
Downlink	> 12 years	>12 years
Uplink	7.1 years	8 years

Table 3 - Capacity with and without Voice with 20 MHz LTE Bandwidth

Although the impact of adding voice to the overall capacity is small, this is true only for the number of voice users assumed in this model. If the number of users becomes significantly higher, that would result in a considerable impact on available capacity. Likewise, the model does not take into account the potential impacts on data traffic associated with the yet-to-be-defined implementation of VoIP on LTE. If, for example, the real time nature of VoIP traffic is supported by dedicated channels or bandwidth, the effective bandwidth available to other data traffic could be reduced beyond the linear model assumed in this analysis.

Critical Incident Bandwidth Requirements

While a public safety broadband wireless network provides valuable services to the public safety personnel in the execution of their day-to-day mission operations, it is during an emergency incident brought about by natural or man-made disasters that the potential of a broadband network is truly and fully realized. Public safety networks must be designed and built to meet the most stringent requirements for reliability, availability, quality of service, and security. An important aspect of public safety broadband networks that requires careful consideration is their engineered capacity, and that is strictly a function of the total amount of spectrum available for public safety use. Although the networks can be engineered and hardened to highest standards of reliability and availability, that is meaningful only if there is enough capacity available in the sites serving an incident scene to meet the communication requirements of hundreds, if not thousands, of first responders. A capacity shortfall during a major incident scene would result in blocked and delayed calls, significantly hampering the efforts of public safety personnel to save and protect lives and property. Since an incident can strike without warning at anytime and anywhere in the jurisdictional area of a network, it is imperative that all the sites in the network be provisioned with enough capacity to handle the worst case scenario that would unfold during an emergency situation.

We must assume that a major incident such as the September 11th terrorist attacks on the World Trade Center, if such an incident were to occur again, will require a large and coordinated response by federal, state and local public safety First Responders and support personnel. The purpose of the National Broadband Network is to provide high-speed interoperable data and voice communications for First Responders. The network, under normal circumstances, will be used by the local or regional agencies to conduct day-to-day operations in the conduct of their public safety mission. However, should another terrorist attack of similar proportion occur there will be a large scale response from federal, state and local jurisdictions into the incident area. In the future, when the regional segments of the network are built-out, First Responders and support personnel will be using the network while en-route to the incident and upon arrival at the scene. Because of the dense urban and suburban populations of the greater metropolitan areas there are upwards of 50,000 state and local public safety First Responders in the immediate metropolitan area. In addition, there are many federal agencies that maintain personnel in the area that could potentially respond to a major incident. It is conceivable that the number of active users could increase by approximately 75% if a large response is required.

New York City Critical Incident Response Simulation
In the following section we describe an incident scene in the New York City with the specific objective of estimating how much spectrum is required to adequately meet the communications requirements of First Responder emergency operations.

The incident involves a "dirty bomb" set-off at Pennsylvania Station in Midtown Manhattan. The device was planted in the information and ticket sales area of the Amtrak area and has caused moderate structural damage to the area and has caused secondary damage to the structure above and below Amtrak's Penn Station. The area below the Amtrak section is part of the Long Island Rail Road (LIRR) complex and has damaged passenger corridors and waiting areas. The bomb also damaged the structure above the Amtrak waiting area which is part of the Penn Plaza / Madison Square Garden Complex. Immediately above Penn Station is a large office building that is operating at 75% occupancy.

The "dirty bomb" has released nuclear contaminants throughout the Amtrak and LIRR complexes and into the areas above and below the stations. The bomb also caused fires to break out on all levels including the track levels. The fires are causing a large smoke condition throughout the complex and into the track areas of the LIRR, Amtrak New Jersey Transit, and the New York City Subway. Smoke is also billowing out of the station at the street level exits and blanketing the street area immediately around Penn Station.

Incident Assessment
There are approximately 400 injured passengers on the Amtrak / New Jersey Transit level and 500 injured passengers on the LIRR level, The injuries range from critical and serious near the center of the explosion to minor caused by fleeing passengers and the heavy smoke conditions. There are injuries on three levels of the station and above the station from falling glass and building materials.

The New York City Police Department (NYPD) has initiated a level 4 mobilization setting up command posts in the vicinity of 34th St. and 8th Ave. The FDNY's Command Tactical Vehicle, Mobile Field Communications, and Emergency Medical Field Units are set in the same area. The Office of Emergency Management has set-up their command vehicle on 8th Ave near 34th St. All of the mobile command posts are near each other.

Fire Department of New York City (FDNY) is setting up a hazardous material (HazMat) detoxification / wash-down area on 31st St. and Broadway, while Emergency Medical Services (EMS) has set up their mobile triage vehicles on 31st St. and Broadway.
The Departments of Health and Mental Hygiene and Environmental Protection have responded with their mobile command posts and have placed them in the vicinity of 35th St. and 7th 8th Ave. FDNY will use 34th St. and 8th Avenue for ambulance and bus staging and the NYPD has closed off Broadway, seventh and eighth avenues from 20th St. to 42nd Street.

New York City Transit (NYCT) has been asked to stage busses to begin transporting the injured to area hospitals and has responded with a mobile command center located near the Office of Emergency Management (OEM) command vehicle.

Emergency Response

Because of City's preparedness to handle incidents of this magnitude, there is a swift and coordinated response from a number of different agencies including Police, Fire, Emergency Medical Services, and Office of Emergency Management Services among many others. Each agency, in turn, will respond with several different units trained, equipped, and specialized in handling specific aspects of emergency response. For example, in this particular incident, NYPD will respond with, in addition to patrol vehicles, a number of different specialized units such as Detective Bureau, Intelligence Division, and Mobile Command Posts etc. Table 1 below illustrates the level of effort required to handle a crisis of this magnitude. For each of the major agencies, it lists the different units, the number of units that would be converging at the scene, and typical applications they would be using.

Table 4 - Agency Response

Police Department			
Agency	Qty	Primary Application	Secondary
NYPD Mobile Command Posts Borough and Comm. Div.	2	Requires video from deployed cameras as well as the ability to view video from other sources. Each MCP will deploy a number of wireless cameras and monitor other feeds from other MCPs and agencies. Assume each MCP has 4 cameras	Incident Management, CAD, Internet and mobile data access VoIP Comms
NYPD Emergency Services Command Posts	2	Viewing video from other sources and their own equipment. Assume each vehicle deploys 2 cameras	Incident Management, CAD, Internet and mobile data access VoIP Comms
NYPD TARU Skywatch with 4 cameras each	3	Extensive use of video and specialized equipment.	Incident Management, CAD, Internet and mobile data access VoIP Comms
NYPD CTD Command Vehicle	1	Video feeds, primarily viewing not sending Management of sensors and access to	Incident Management, CAD, Internet

		CTD databases and internet. Access to federal databases and applications. Use of portable sensors for CBRNE	and mobile data access VoIP Comms
NYPD CTD Support vehicles	5	MDSL deployed for mobile detection of CBRNE threats	
Portable Sensors	25	Monitors the levels of toxins and radiation, CBRNE	
Patrol Division Mobile Command and Support Vehicles	3	Video, access to personnel information, databases, CAD, Incident Management	Internet, VoIP Comms, mobile data
NYPD Intel Division Mobile Support Vehicles	2	Access to databases, federal databases, internet, video feeds	Incident Management, CAD, Internet and mobile data access VoIP Comms
NYPD Fleet Services Towing Services	25	AVL	
Fire Department – Includes Emergency Medical			
Agency	Qty	Primary Application	Secondary
FDNY Command Tactical Vehicles	2	Video from CTV and portable cameras, access to FD Operations Center applications, Electronic Command Board, HAZMAT databases	Incident Management, CAD, Internet and mobile data access VoIP Comms
FDNY Field Communications (Includes Command Post)	3	Audio feeds for recording Fireground, video, uplink Fireground to FDOC	Incident Management, CAD, Internet and mobile data access VoIP Comms
FDNY Heavy Rescue	4	Video, Incident Management, CAD	
FDNY Emergency Medical Command Post	1	Video, audio from Fireground	
FDNY Mobile Triage Vehicles	3	Telemetry, video, photos,	Incident Management, CAD, Internet and mobile data access VoIP Comms
FDNY Ambulances	10	AVL, telemetry, CAD, triage applications	Incident Management,

			CAD, Internet and mobile data access
Office of Emergency Management			
Agency	Qty	Primary Application	Secondary
OEM Mobile Operations Center	1	Video, downlink and uplink for 5 cameras	Incident Management, CAD, Internet and mobile data access VoIP Comms
OEM Temporary Field Operations	1	Connectivity to OEM Operations, databases and applications	Incident Management, CAD, Internet and mobile data access VoIP Comms
Other New York City Agencies			
Agency	Qty	Primary Application	Secondary
Department of Environmental Protection Mobile Operations Center	1	Access to applications, sensors, video	
Department of Health	1	Access to applications, sensors, video	
Department of Buildings	1	Access to applications, video	
NYCT	1	Radio communications, applications	
MTA Police Field Communications Emergency Services	3	Video, applications, databases, internet	
AMTRAK Command Post	1	Video, applications, databases, internet	

Bandwidth Requirements Analysis

We used the model of the expected users, command vehicles and associated applications associated with the response to estimate the total bandwidth demands that would be required during the peak response periods following the incident. We have assumed that the incident area is served by a public safety broadband wireless network that is built using fourth generation Long Term Evolution (LTE) technology and operates in the 700 MHz public safety frequency band.

Table 5 below lists the average capacities available from a single LTE sector using 10 and 20 MHz of spectrum.

Spectrum	Downlink Capacity	Uplink Capacity
10 MHz, (5 MHz Downlink, 5 MHz Uplink)	10 Mbps per sector	3 Mbps per sector
20 MHz, (10 MHz Downlink, 10 MHz Uplink)	21 Mbps per sector	6 Mbps per sector

Table 5 - Spectrum versus Capacity

The aggregate bandwidth requirements of the applications used during the incident can be compared against the available capacity. Estimated bandwidth requirements of typical applications used during at an emergency incident are listed in Table 6.

Application	Downlink Data Rates (Kbps)	Uplink Data Rates (Kbps)
Incident Video Upload	12	647
Field Video	1150	28
Data Access	10	100
CAD Dispatch	50 Kbps	50 Kbps
VoIP	25 Kbps	25 Kbps

Table 6 - Application Data Rates

As illustrated in Table 6, video applications are the most demanding in terms of bandwidth usage. However, it is also a critical application for incident management, sending images in real time from the incident scene to the command and control centers enhancing situational awareness and providing a current and consistent operating picture required for effective and coordinated response. An incident scene will typically have a large number of video cameras streaming information back to the command vehicles present at the scene as well as to the central command and control centers. Command staff personnel from each agency will make extensive use of the video feeds to get a real-time view of rapidly and dynamically changing situation at the incident scene to aid them in their decision making process and to coordinate their response with other agencies.

In the incident scene we have depicted there are 38 simultaneous downlink video streams consuming about 44 Mbps of bandwidth at 1.15 Mbps per video stream. These streams are distributed to the various public safety command vehicles present at the scene. This combined with other applications such as database access, file downloads, telemetry, computer aided dispatch, VoIP results in an aggregate sustained downlink bandwidth requirement of about 60 Mbps.

On the uplink, we have assumed that the agencies will deploy twelve portable or vehicle mounted cameras continuously sending real time images from the incident scene. This utilizes about 9 Mbps of bandwidth on the uplink. Another significant consumer of uplink bandwidth is ambulances sending triage images back to the hospitals to inform them in advance of the nature and seriousness of the injuries. We estimate that EMS will utilize about 2 Mbps of uplink bandwidth. Coupled with uplink usage of other applications, aggregate bandwidth used on the uplink is about 16 Mbps.

The aggregate bandwidth demands in above can be compared against the bandwidth that would be available in an incident scene. Available bandwidth is a function of the number of sectors/sites that would be within range of the incident scene and bandwidth available per sector, as shown in Table 5. Table 7 shows the total aggregate demand at the incident scene and the number of sectors of bandwidth that would be required to fulfill that demand.

Spectrum	Downlink Demand	LTE Sectors Required for DL Demand	Uplink Demand	LTE Sectors Required for UL Demand
10 MHz (5 MHz uplink) (5 MHz downlink)	60 Mbps	6	16 Mbps	6
20 MHz (10 MHz uplink) (10 MHz downlink)	60 Mbps	3	16 Mbps	3

Table 7 - Total Incident Scene Demand

The number of sites that would realistically available to support an incident is a function of the network design and the geographic distribution of the users. In the example provided, given the localized nature of the incident coupled with lower site count due to superior propagation characteristics of the 700 MHz frequency band relative to other higher frequencies such as 2.5 GHz and 1.9 GHz, it is likely that the incident scene would be served by only 3 sectors.

For incident scenario presented and the associated site density, 10 MHz of spectrum will fall considerably short of the required bandwidth demand. 20 MHz of spectrum is barely sufficient to meet the projected demand. We realize, however, that the incident we have utilized in our model represents an extreme case but it is entirely within the realm of possible threats for a large metropolitan city like New York. To meet the extraordinary demands that are placed on a network during emergency situations, we strongly believe that 20 MHz of spectrum is needed in order to prevent the network from being saturated and to continue providing reliable service.

Incident Scene Operations

Incident Scene Response Units	Qty	Primary Application	Secondary Application	DL Data Kbps	UL Data Kbps
Mobile Command Posts	2	Receive 4 video feeds	CAD, internet, incident mgmt, VoIP	9700	442
Emergency Service Unit (ESU)	2	Receive 2 video feeds	CAD, internet, incident mgmt, VoIP	5100	442
Technical Advisory Response Unit (TARU)	3	Uploading 4 video streams	CAD, internet, incident mgmt, VoIP	642	8664
Counter Terrorism command vehicle	1	Receiving 2 video feeds	CAD, internet, incident mgmt, VoIP	2550	221
Counter Terrorism support vehicles	5	Monitor CBRNE threats		500	
Portable sensors	25	CBRNE			625
Patrol Division Mobile Command	3	Video, database access, internet	Internet, VoIP, comms, mobile data	4200	663
NYPD Intel Division Mobile support vehicles	2	Video, database access, internet	CAD, internet, incident mgmt, VoIP	2800	442
NYPD Fleet Services Towing Services	25	AVL			625
FDNY Command Tactical Vehicles	2	Video, ECB, HAZMAT database	CAD, internet, incident mgmt, VoIP	5100	442
FDNY Field Communications	3	Video, Audio	CAD, internet, incident mgmt, VoIP	4200	663
FDNY Heavy rescue	4	Video, Incident mgmt, CAD		5600	
FDNY Emergency Medical Command Post	1	Video, audio		1400	
FDNY Mobile Triage Vehicles	3	Telemetry, video, photos	CAD, internet, incident mgmt, VoIP	4200	663
FDNY Ambulances	10	AVL, Telemetry, triage applications	CAD, internet, incident mgmt, VoIP	2500	2210
OEM Mobile operations Center	1	Video downlink, uplink	CAD, internet, incident mgmt, VoIP	2550	947
OEM Temporary Field Operations	1	database access, data apps	CAD, internet, incident mgmt, VoIP	300	221
Department of Environmental Protection applications	1	video , sensors, apps		1400	
Department of Health	1	video , sensors, apps		1400	
Department of Buildings	1	video , apps		1400	
NYCT	1	radio comms, apps		300	
MTA Police Field Communications Emergency services	3	video, database, internet		4200	
AMTRAK Commend Post	1	video, database, internet		1400	
Total in Mbps				**61**	**17**

Table 8 Incident Scene Operations

City's Response to Commission Questions Regarding Operational Requirements

The FCC has suggested three categories of operational conditions relative to demand; critical, medium and low. For the purposes of this filing we will define the three categories as follows:

> Critical – Network usage during a major incident(s) supporting a large scale response to a catastrophic event such as a bombing or natural disaster. This type of incident will initiate responses from local, federal and mutual aid agencies for initial response, rescue and recovery. Using prior incidents as a model the City can expect the number of first responders to grow exponentially as the incident progresses through its various stages and the network utilization to fluctuate between periods of extreme (>75%) utilization, heavy utilization (>50%) and medium utilization (<50%).
>
> Medium – We have assumed that medium usage refers to normal operations during the primary work hours of a public safety agency such as the police department or the fire department. Based on staffing levels the time period for medium usage will span from early morning rush hour for both vehicular traffic and public transportation, through the normal and extended workday, the end of the school day and evening hours until midnight. This period of time from approximately 5:30 AM to 12:00 AM comprises the majority workload of the New York City Police Department. This model also takes into consideration typical tourist and commuter workforce traffic travelling into and out of the City proper. This model will most likely apply to the Fire Department, specifically with regard to Emergency Medical incidents responded to by emergency medical personnel and firefighters.
>
> Low – We assume that the low usage period will consist of the period of time after the evening hours and prior to rush hour when staffing and equipment is deployed at lower levels. Typical public safety models assume that these hours are less busy than other periods and staff accordingly, however the typical per unit workload may remain similar to the workload during busy periods due to reduced staffing.

During critical usage periods we anticipate that the network will first be utilized by First Responders to coordinate multi-agency response to the critical incident and exchange critical information relative to the incident response and operational plans. This may include but not be limited to:

- Incident data from 911 calls and first responders
- Information sharing for HAZMAT and environmental information
- Coordination of response for federal and mutual aid responders
- Video from fixed cameras that are adjacent to the incident
- Maps and GIS data relevant to the area
- Personnel and equipment rosters for logistics
- Building or location information
- Executive / managerial teleconferencing
- Personnel and vehicle tracking

- Incident Management / Situational Awareness
- Mass Notifications
- Traffic Control and Traffic Advisories
- Download and consolidation of surveillance data for forensic analysis

As described earlier we believe that the type of traffic will constantly fluctuate however the usage will remain high during the initial response period. Depending on the severity the initial response may last upwards of 7 to 10 days as the various first responders arrive at the incident scene. The type of network usage will change based on the stage of the incident response. We must assume that the network will be utilized at approximately 75% of capacity for the first stage of response. The network must support the first responders throughout the period of initial response to the incident through the remaining stages of rescue and recovery.

As evidenced during the September 11th terrorist attacks the initial response was tremendous and the logistics aspect was primarily carried out through a manpower intensive effort. Not only were commercial network services overwhelmed at all levels, their infrastructure was severely damaged and ineffective. Public safety responders did not have a broadband wireless networks to supplement the coordination of the massive response effort and relied on inefficient forms of communications for such a complex event.

It must be noted that during this type of incident the City's first responder agencies must also serve the entire City and not just the area of the incident. In a City as large as New York an incident can occur in a small area with a dense population and still only involve a small percentage of the City's area.

For medium theater operations we have assumed the model of normal daily operations of the City's First Responders. In this category public safety will utilize applications designed for routine business processes. The Fire Department's typical usage will consist of dispatch information for fire and medical incidents that will require broadband communications to transfer patient data, location history and HAZMAT information, building plans and maps, driving directions, patient telemetry, AVL and telematics data and other incident related information. Prior to the adoption of NYCWiN none of this information was available to responding units with the exception of on-scene patient telemetry for EMS. As the agencies begin implementing new technology the utilization demand will rise, primarily driven by many factors; new capabilities, features and functions of systems due to the availability of the broadband network and additional bandwidth requirements as more data intensive applications are implemented. For example; the ability to quickly and efficiently transmit patient data, photos and video of patient's injuries, and bio-metric information to a physician and subsequently allow the hospital staff to assist in field treatment via video teleconferencing will provide tremendous benefit to the citizen's of New York City.

The Police Department will soon have the capability to download photos within seconds from their criminal history databases along with other critical information that will support the investigatory process in the field thus saving valuable processing time. The ability to scan bar-coded documents for traffic violations will not only save time and produce more accurate citations, it will also increase officer safety. Automated and bundled transactions will help the officer make sound decisions and alert him/her of potentially dangerous conditions. These capabilities are not available with today's 25 KHz channelized systems. Real-time data collection will create new capabilities for investigators and counter-terrorism personnel by moving data from the field to the data warehouse as fast as it is collected for critical analysis. Scanning a driver's license will provide the officer with the appropriate information within a fraction of the time previously required to type or call in the information request. The database query will return a photo in addition to the standard DMV and warrant information, helping the officer confirm the identity of the person stopped for the violation. These and many more applications will make first responders more productive and effective. But these applications require an appropriate allocation of spectrum and bandwidth to perform as specified under these normal operating conditions.

Low theater operations do not necessarily reduce the bandwidth requirements due to lower staffing or reduced activity. Individual applications will still require sufficient bandwidth to operate efficiently. However, these periods of lower activity offer opportunities for agencies to update their mobile applications and equipment with security patches, new applications and data. The mobile and portable devices and applications should be afforded the same maintenance features benefits derived from a wired network or a commercial cellular network. Updates, new applications and patches should be pushed out from a central source to the edge devices to keep the users and devices in the field, rather than ferrying devices to depots for software updates. Applying the right design parameters to the network and applications will allow for the efficient maintenance of the devices, applications and data ensuring that the mobile workforce is truly mobile.

No matter how carefully bandwidth planning is done on any type of secure public safety wireless network, the network will eventually be placed in a position of stress due to a major incident or an unplanned increase in utilization. There is not enough spectrum available to provide the necessary overhead to assure that bandwidth will be available during critical incidents where users require immediate and high priority access. It must be assumed that utilization will be higher in certain operational scenarios. Once broadband data systems become widely adopted by public safety it is highly probable, based on analogies to commercial systems, public safety networks will be extremely stressed during events similar to September 11th in New York and July 7th in London. During events such as these usage will dramatically increase, and intelligent mechanisms to handle bandwidth must be in place well before the occurrence of a large scale emergency of this type.

In our bandwidth analysis of the incident scene we discussed the various impacts of applications on bandwidth availability during emergencies. It is clear from our analysis that in scenarios where 20 MHz of spectrum is available to public safety the system will be "stressed" during periods where important characteristics of a network need to exist above and beyond what is available commercially. A public safety system must have built-in mechanisms that support Quality of Service (QoS) prioritized by both applications (voice, video, data, etc.) and by the role of the user based on the operational command structure. Next generation wireless technologies such as LTE have included these mechanisms as part of their adopted standards, however the configuration of these controls must be carefully implemented in any network supporting public safety users. It is highly unlikely that commercial carriers will break with their tradition of "best efforts" delivery and offer guaranteed message delivery and bandwidth allocation. Based on the quantity of users they must support it will be difficult to provide priority services to a small number of users when the demand will be so great from the users at large.

New York City is learning valuable lessons from our implementation of the NYCWiN program on how to deploy and operate applications on a broadband network to ensure that the available bandwidth is efficiently and effectively used in high stress utilization conditions. Application planning must include such concepts as intelligent distribution of data based on role, location, and need utilizing prioritized push technologies to control of information flow during peak and stressed network conditions.