WHITE PAPER

# THE BEGINNING OF THE FUTURE: 4G PUBLIC SAFETY COMMUNICATIONS SYSTEMS

MOTOROLA

As a society, we place many demands on the first responders who safeguard our communities. That means that the mission critical technologies our public safety officials use every day must meet exceedingly high standards as well.

New 4G networks will enable powerful and innovative solutions for better protecting our first responders, providing them with the real-time information, the control, the reliability, the security and the performance that are at the core of mission critical technology.

But as important as 4G technology is in and of itself, it's even more important as a driving force behind something bigger. Something much bigger. As it combines with other new and legacy network elements and applications, 4G is an integral part of an innovative and powerful new network structure that will transform mission critical public safety communications.

How can your public safety organization begin to prepare for the 4G future? A good way to start is by examining three key areas of next-generation networks: applications, infrastructure and devices.

# 4G NETWORKS WILL SUPPORT ADVANCES IN COMMUNICATIONS NOT YET DREAMED ABOUT

**Communications networks have supported the mission critical needs of government and public safety agencies for nearly a century.** When Motorola first began delivering police radios back in 1930, no one could have imagined that first responders would one day use their communications systems to run license plate checks, to file traffic tickets or to monitor high-crime areas from miles away via video surveillance systems.

But that is exactly what they are doing today. In fact, those applications are not only possible but also common in the day-to-day operations of many public safety organizations around the globe. And they are just the tip of the iceberg. With the advent of 4G networks, a plethora of new communications applications will become available for public safety and other government agencies. When added to today's existing narrowband applications, these 4G networks will support advances in communications not yet dreamed about.

Data speeds, currently at dial-up speeds with existing narrowband networks, will reach broadband speeds with 4G. That means the simple text messaging applications in widespread use today will make way for a wide variety of rich media applications, enabling:

### MORE REAL-TIME ACCESS TO INFORMATION

Thanks to the increased bandwidth delivered by 4G networks, it will be easier to extend your office into your vehicle or even onto your belt. Advanced mobile office and new productivity applications will enable content-rich database lookups and remote analytics leading to greater productivity and reduced costs.

### ANYWHERE, ANYTIME CONNECTIONS

Using 4G systems, police officers will have access to high-speed connectivity no matter where they are – whether they are on the street, in the car or at the scene. Officers will be able to count on high-speed broadband data as well as new critical location aware services to keep them connected anywhere, anytime.

### ENHANCED SITUATIONAL AWARENESS

With the advent of 4G in public safety organizations, massive amounts of data can be transmitted to and from the command center or even directly from patrol car to patrol car. This will give first responders rich media information and greatly enhanced collaboration capabilities in addition to the already powerful voice communications they depend on in the field today.

# THE PROMISE OF 4G

**Public safety organizations can do a great deal with today's communications networks.** From basic voice communications and database queries to mobile fingerprint identification, today's narrowband networks are supporting a wide variety of applications that help first responders and other government agencies save lives not to mention do their jobs more efficiently

But tomorrow's 4G broadband communications networks will enable so much more. A database query will no longer deliver just a small paragraph of text-based data. Instead, these queries will deliver information-rich, easy-to-read reports filled with images such as mugshots and even video clips. And this information will arrive immediately. No more waiting three to 10 minutes or more for a simple image to download or for a report filed from the patrol car to upload to the central database. When seconds and minutes count, high-speed broadband communications can truly make a difference.

- Police officers will be able to access video of a crime in progress and check maps while enroute to a scene to determine how best to approach a building unseen, giving them access to life-saving information.
- Instead of a child abduction alert just giving a description of a car, these alerts might include a high-resolution image of the child along with a detailed sketch of the perpetrator. And they can be downloaded not only to first responders but to all municipal employees in just seconds.
- As an alternative to waiting for the individuals involved in an accident to call in to report it, video surveillance cameras might automatically trigger an alarm to alert the command center when an accident occurs. If that accident involves hazardous materials, first responders could also receive detailed instructions on handling that hazardous material on the way to the scene. Meanwhile, municipal authorities could simultaneously be alerted to begin organizing any necessary evacuations of the accident area.

Broadband 4G networks will also enable municipalities to improve workforce productivity and improve community response. The ability to reduce gridlock and improve disaster response will be enabled through dynamic mapping, weather and traffic flow applications.

- Municipal transportation departments can improve road safety through better monitoring of traffic signals and road conditions.
- Safety inspectors can pull up information such as inspection histories and file reports directly from the site instead of waiting until they get back to the office.
- Maintenance workers can make use of high-speed connections to access step-by-step maintenance procedures and file work orders directly from the field reducing overtime costs resulting from filing paperwork at the end of the day. Additionally, staff can be rerouted to address higher priority repair jobs in real-time, thereby increasing efficiency.
- Port authorities can use tracking systems to account for every single item that arrives via the water, thus improving security.

The bottom line is that 4G networks are a new platform on which municipalities and public safety organizations will be able to both utilize the data applications in place today with faster, more responsive performance. This will increase their utility as well as offer access to a whole array of advanced, multimedia applications that take advantage of key enablers including:

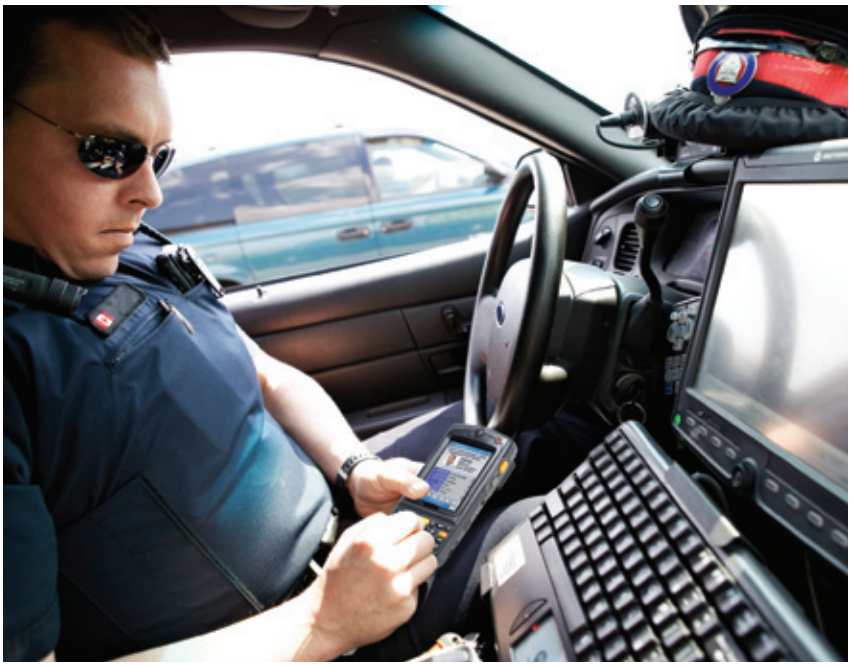
- Bi-directional vehicular video
- Location aware real-time services
- Mobile office, in-field productivity
- Multimedia command and control
- Dynamic mapping, weather and traffic flows
- Content-rich lookups to complex databases

## THE CRITICAL ROLE OF TODAY'S NARROWBAND VOICE AND DATA NETWORKS IN A 4G ENVIRONMENT

Today's mission critical, public safety networks will continue to provide uncompromising services for two-way voice and critical data applications, offering the performance, coverage, reliability and unique call features demanded by public safety. With the introduction of 4G networks, public safety communications systems will have the opportunity to supplement their critical voice and data services with enhanced multimedia applications. By developing strong and meaningful interactions between the narrowband public safety and 4G broadband networks, as well as collaborations between two-way radios and data devices, public safety organizations will have all the assurances of their mission critical voice in times of crisis with all the advantages of cutting edge, multimedia services.

Integrated data services on narrowband public safety networks will provide the most wide-reaching geographic coverage for many years to come and first responders and government agencies will continue to use these networks for many lower data rate applications. Meanwhile, new 4G networks will augment existing narrowband networks to support more bandwidth-intense, rich media applications in concentrated regions.

Even when 4G systems are widely deployed, narrowband systems will continue to play a key role in mission critical communications. Today's mission critical narrowband communications networks have literally hundreds of features that have been built into talk groups for voice, from subsecond push-to-talk response times to direct radio-to-radio communications. Next-generation public safety communication systems will support interoperability between the existing narrowband mission critical voice equipment and broadband equipment to deliver unprecedented functionality to first responders.



In fact, next-generation systems will eventually support communications across multiple access technologies, including 4G, WiFi, cellular and private narrowband networks. This will enable public safety agencies and their municipal counterparts to cost-effectively use multiple networks to obtain more services over a wider range of coverage.

> "It will be many years, if ever, before LMR systems are replaced entirely. Before LMR systems could be supplanted, broadband services would first need to be deployed to the level that provides the same extensive coverage that mission critical voice systems provide, including in-building coverage in many instances. Because coverage area decreases as data rate increases, covering the same area at the same level of reliability with broadband services will require even more sites than the number used today for voice communications."
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> -Harlin McEwen, Public Safety Spectrum Trust, in response to FCC questions on October 1, 2009

# 4G NETWORKS: A LOOK AT THE TECHNOLOGY

**LTE is the primary technology being considered by public safety and government organizations for broadband applications in the foreseeable future.** LTE is a standards-based technology that delivers something that many public safety and governmental organizations have been requesting for years: a cost-effective way to meet their broadband communications needs and one that gives them a greater selection of devices and applications.


Key technology enablers of LTE is its use of Orthogonal Frequency Division Multiplexing (OFDM) air interface, advanced antenna techniques including Multiple-Input Multiple-Output (MIMO) and beamforming, flat all-IP architectures, and a common IP core. Industry forecasts demonstrate strong market adoption rates for LTE leading to the necessary volumes for driving economies of scale. Within a decade, it is anticipated that the majority share of commercial wireless networks will utilize LTE technology platforms.

The LTE technology is available in either paired Frequency Division Duplex (FDD) or unpaired Time Division Duplex (TDD) spectrum configurations. With FDD-based LTE systems, the uplink and the downlink transmit on different frequencies, or paired frequencies. This is the traditional configuration for the cellular industry as well as public safety narrowband technologies and is generally preferred when paired spectrum is available. TDD-based systems commonly referred to as TD-LTE, share the same spectrum for both the downlink and uplink communications. The system can be configured to allocate a preferred amount of channel capacity for downlink and uplink communications.

The United States has allocated 10 MHz of paired spectrum in the 700 MHz band for public safety, allowing a 5 MHz channel. Some commercial mobile carriers have selected FDD-based LTE for 4G services, offering the opportunity for public safety agencies to consider leveraging their LTE devices to roam onto commercial carrier networks. Outside the United States, regulators are considering spectrum allocations for public safety broadband use and will be the determining factor in the technology for satisfying their broadband needs.

## THE BENEFITS OF STANDARDIZATION

The fact that both commercial and private systems will be built using the same technology offers several benefits to public safety and government agencies. LTE will benefit from a rich ecosystem of devices spurred by the standards-based designs, open intellectual property environments, commitments from chipset manufacturers, large communities of developers and interest from consumer electronics manufacturers. Of course, 4G devices supporting critical public safety services will need to support many of the public safety features and design considerations used today, including:

- Interoperability with existing LMR networks
- Direct-mode, device-to-device communications
- High performance battery, radio, antenna and audio
- Ergonomics based on "high velocity human factor" industrial design

It is likely that public safety devices will benefit greatly from the economies of scale supporting certain device components because LTE is anticipated to surpass the critical volumes required to drive down component costs.

Of course, the most acceptable 4G public safety devices will still require further specialization to best serve first responders and withstand the challenging environments they participate in on a daily basis.

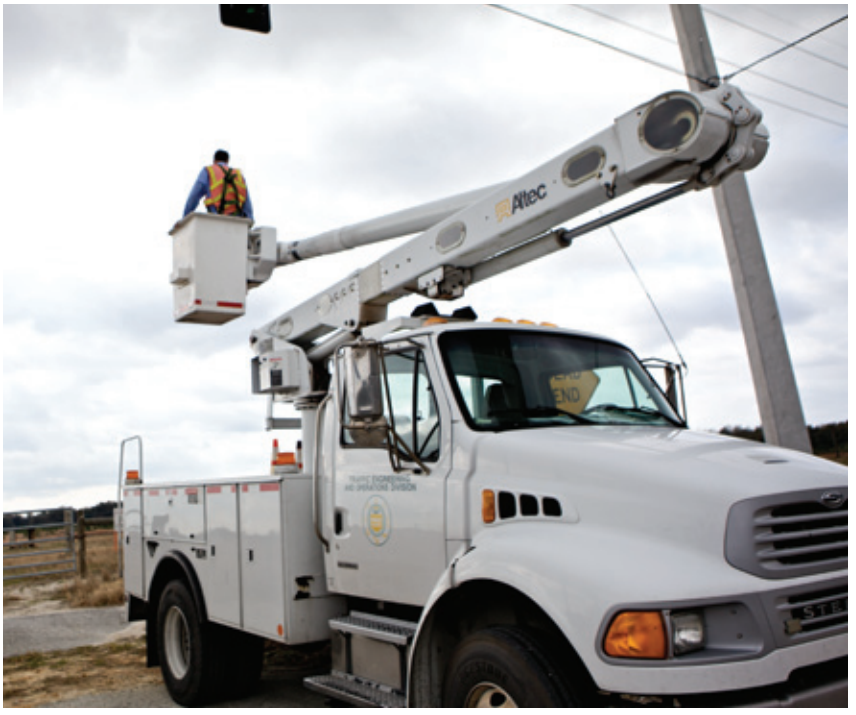
## MEETING THE UNIQUE DEMANDS OF PUBLIC SAFETY

But it is important to remember that the mission critical needs of public safety put unique demands on any communications network. Demands that must be considered in network design. Demands that many commercial networks are not intended to meet.

Today's public safety networks have been built to withstand any emergency, from earthquakes and hurricanes to forest fires and floods. In September of 2008, for example, the public safety network was the only system that continued to operate in the face of Hurricane Ike's 100-mile-an-hour winds and 15-foot flood waters.

Because of public safety's need to support mission critical communications, designing a broadband 4G network for public safety is a lot different than creating one for commercial users. Public safety networks are built for "worst case scenarios," while commercial networks are designed for "best effort." Public safety networks, by necessity, are generally hardened to withstand hurricane force winds. They have back-up generators at almost every tower site. They are built to guarantee a certain level of coverage so that first responders never find themselves without the ability to communicate.

While the usage patterns on commercial networks are typically relatively easy to predict, the same is not true of public safety networks. First responders never know when or where an emergency might occur, so public safety networks must be built to support sudden, unexpected spikes in usage in any portion of the network. In contrast, cellular networks can be designed around expected surges in traffic, like the surge that occurs in Manhattan during rush hour.




"We suffered a lot of losses throughout the area. We lost utilities. We lost electricity. We lost telephones. We lost cell phones," says Fire Chief C.T. Anderson of the Santa Fe Fire Department. "But we were able to continue to operate without any fears because we had our radio system.

# COMING TO A MUNICIPALITY NEAR YOU: A WIDE ARRAY OF 4G DEVICES

Within a few years after both commercial and private 4G networks become commonplace and economies of scale start to kick in, public safety officials and their municipal counterparts are expected to have access to a wide variety of devices, including:

### DATA ADAPTORS

Adaptors that connect using standard data interfaces will bring high-speed 4G broadband connections to existing laptops and computing platforms. These will likely be some of the first devices available to operate on 4G public safety networks.

### RUGGED IN-VEHICLE DEVICES

High-power, in-vehicle 4G modems will offer wide area connections to mobile applications. Integrated WLAN access point functionality will create a "travelling hotspot" within and around the vehicle to allow connection to many WiFi capable devices.

### RUGGED HANDHELDS

Portable data devices with advanced display and interface technologies offering survivability and performance in the most demanding environments will be available to support operations in the field.

### FIXED DEVICES

With 4G, a wider variety of fixed location devices will be available to support sensors and alarms and other "unmanned" devices such as parking meters or video surveillance systems.

## NON-RUGGEDIZED EQUIPMENT COMES AT A COST

When it comes to selecting the right device to operate across their 4G networks, public safety organizations must keep one thing in mind: the latest and greatest 4G commercial devices simply will not meet the unique needs of public safety agencies. No matter how tempting it may be to purchase less costly, non-ruggedized commercial equipment to support public safety communications, that decision could cost municipalities a considerable amount of money in the long run.

In fact, a study by VDC Research Group examined the costs of buying ruggedized public safety equipment over a five-year timeframe. VDC found that buying ruggedized devices delivers a savings of about $2,000 per year per device thanks to reduced equipment failure and downtime – even though it might initially require a larger upfront investment.

# BUILDING THE BUSINESS CASE FOR 4G

**Agencies looking to invest in 4G systems should consider the profile of applications and devices they plan on bringing onto their network, as well as how these services may evolve over time.** A deployment roadmap can then be mapped, also taking into account the investment profile of the agency, the requirements for service control and prioritization and how to best coordinate between public and private network coverage. Agencies building their own private networks will maintain the benefits of service assurance, access to important public safety features and interoperability into their LMR narrowband networks. These agencies may also consider supplementing their coverage perimeters at the early stages of 4G deployment with roaming agreements onto public carrier networks offering expanded coverage while recognizing possible limitations on some public safety features.

## WHY APPLICATIONS MATTER

The deployment plan for a 4G network and the density of the sites required will be determined largely by the profile of applications being considered for the users. Some applications are bandwidth-intensive and require more capacity while others involve real-time transmission and very low network delay. In both cases, the demands on the network increase and must be compensated for in the network design.

For instance, email attachments and content-rich database queries tend to place high throughput demands on the network while other applications, such as location or voice, require very low delay. Real-time video requires both high bandwidth and short delay and is perhaps the most demanding application on a network. To put it another way, supporting demanding applications like video requires the transmission of enormous amounts of data in the same sector or cell. In contrast, if you implement low speed data applications, like text messaging or text-based data queries, the coverage area of your cell sites can be much larger.

That means that municipalities that want to give their first responders guaranteed access to real-time video as they are headed toward a crime scene may need to build more sites than those that want to support applications that are less taxing on the network, such as license plate recognition systems.

## THE ROLE OF DEVICES IN NETWORK DESIGN

The selection of 4G devices will also significantly affect network design. A low-powered portable device used primarily at pedestrian speeds has very different network requirements than a high-powered vehicular modem traveling at 80 mph. In addition, a low-powered portable device may have difficulty maintaining a high quality signal needed to support bandwidth-intensive applications at the edge of a network while a high-powered fixed device may not experience the same difficulty.

As an example, a handheld device with a 250 milliwatt uplink transmitter may experience 300 kbps data speeds – which is still more than 10 times the speeds many first responders can get today. But a vehicle that has a two-watt transmitter with greater receive capability may give you access to multi-megabit connection speeds at the same range.

Important consideration must also be given to the requirements for indoor coverage. A network designed to a more aggressive set of requirements to support in-building needs of course ultimately increases the cost of the network.

## ASKING THE IMPORTANT QUESTIONS

So what does this mean for public safety and governmental agencies looking to build out 4G networks? It means your organization must decide key questions such as:

- What range of applications will be offered?
- What role is intended for video in the downlink or uplink?
- What are the various types of devices being considered?
- What profile mix of users will be on the broadband network?
- How will the network be shared among public safety and public service agencies?
- What level of service guarantees and prioritization is required?

Carefully considering these questions will offer agencies the opportunity to work with experienced 4G and public safety communications providers to develop customized business modeling and network dimensioning scenarios. By working with an experienced provider that understands the trade-offs between coverage, capacity, capability and cost, public safety agencies can make the most informed and advantageous decision to meet their specific needs.

## THE BOTTOM LINE BENEFIT OF "UNMANNED" DEVICES

One key way to offset the costs of future 4G networks is to deploy more "unmanned" devices – such as parking meters, traffic sensors or video surveillance systems. Right now, many cities are already benefitting from these "electronic eyes" which serve as force multipliers and free up invaluable first responder human resources.

The increased bandwidth provided by 4G systems will allow even more of these "unmanned" systems to be deployed. This will enable even greater efficiencies and cost-savings – similar to those provided by these "force multipliers" in use today:

### DECREASED CRIME BY 40 PERCENT

The Los Angeles Police Department decreased crime by 40 percent in just one year in its Jordan Downs public housing development after 10 wireless video cameras were installed that allowed patrolling officers to view suspected criminal activity using laptop computers or handheld devices.

### RECOVERED 275 STOLEN VEHICLES

California's Long Beach Police Department recovered 275 stolen vehicles and made 50 additional arrests in just six months after installing four mobile Automated License Plate Recognition (ALPR) systems – without hiring a single extra officer.

### ELIMINATED VANDALISM

Video surveillance in Sergnano, Italy, allows the town's two-man police force to control 100 percent of their territory without moving from the control room. The result? Vandalism has now been completely eliminated. This saved the town so much money that the system paid for itself within 12 months.

### INCREASED SITUATIONAL AWARENESS

Abu Dhabi's Police Force is streaming live video from officers in the field to command centers to heighten visibility of events as they occur and to enable control room operators to better assist officers in responding to calls and solving crimes.

### FIGHTING CRIME IN 20 DIFFERENT PLACES AT ONCE

In Ripon, Calif., video surveillance cameras allow officers to check 20 different locations simultaneously every day, helping the officers to be significantly more efficient

### FILING CRASH REPORTS IN EIGHT HOURS INSTEAD OF 18 MONTHS

The State of Iowa now completes crash reports in eight hours instead of 18 months after automating its citation process using wireless.

When designing a 4G system, one key thing to remember is that the cost of a 4G network is determined in large part by the way an organization intends to use the network. By loading up on "force multiplier" applications that are less taxing on the network, such as license plate recognition systems, first responders can quickly realize a return on their 4G investments while also exploring new applications where the true payback has yet to be determined, such as sending video to and from the command center.

That's why it critical to have a partner that understands the unique needs of public safety agencies and how to balance those needs against the total cost of ownership when designing and building a 4G broadband wireless network.

# THE EVOLVING INNOVATIONS OF 4G

**The next generation of public safety communications will draw from the resources of all available systems and networks.** Integrating the advantages of real-time information offered by 4G with existing ultra secure and reliable voice communications networks will create new and innovative use cases enabling more effective public safety operations. To realize this vision, standard 4G systems, initially designed to carry commercial carrier services, must be enhanced to meet the demanding needs of public safety and provide peace of mind that 4G services can be safely integrated into daily operations. Important requirements include:

### LMR TO 4G INTEROPERABILITY

Public safety interoperable gateways will bridge together 4G and LMR networks offering a common services engine to mediate across networks and deliver unified services down to collaborative two-way radios and data devices

### MULTI-AGENCY OPERATIONS AND PRIORITIZATION

Multiple agencies sharing common 4G network resources will require platform capabilities to secure and manage individual agency information, access, quality of service (QoS) and prioritization as well as dynamically adjusting QoS and prioritization appropriate to incident response.

### NETWORK AVAILABILITY AND SURVIVABILITY

Hardened public safety 4G systems will self heal and autonomously reconfigure around network failures through Self-Organizing Network (SON) design while interoperability gateways will dynamically steer traffic to the best network based on performance and availability.

### PUBLIC SAFETY SCALED AND SIZED

By leveraging the investments and innovations from public carrier solutions, 4G systems offer the benefits of economies of scale. Even greater cost efficiencies can be realized by scaling system components more appropriately to public safety network sizing and numbers of users.

### DEVICES OPTIMIZED FOR PUBLIC SAFETY

Public safety officials will choose from a portfolio of tiered devices offering the necessary ruggedness and ergonomics for public safety environments. These devices will also support various modes of operation from 3G to 4G and private to public for the most flexible operating models.

### PUBLIC SAFETY APPLICATIONS

Unified applications accessing common services across LMR and 4G systems will optimize public safety workflows from the command center to the edge and allow for real-time, intuitive sharing of rich media content to increase situational awareness and operational efficiency.

The advent of 4G networks will make it possible for law enforcement and government officials to use advancements in video and other technologies to do their jobs better than ever before. In essence, 4G systems will become a new "tool" in their toolbox that will allow them to take their existing productivity-enhancing, crime-fighting and command center communications to a whole new level.

Public safety and government agencies that take the time to plan for 4G today will be the best-positioned to take advantage of the crime-fighting next-generation communications tools that will be available in the future. Using 4G, municipalities can implement new applications to achieve productivity and life-saving enhancements they never even dreamed were possible.

# FINDING THE RIGHT PARTNER: THE MOTOROLA 4G ADVANTAGE

**Motorola is uniquely positioned to help first responders and government officials fully realize the promise of 4G broadband communications.** With more than 75 years of experience in wireless communications, Motorola has earned a solid reputation as the most trusted partner to many public safety and local, state and federal governments. Motorola has built more than 500 standards-based, public safety networks in 90 countries around the globe.

The company's innovation, design and deployment expertise is clearly seen as the industry moves to 4G. Motorola is unquestionably leading the way. As early as 2008, the company demonstrated the world's first public safety 4G applications at 700 MHz.

Given Motorola's industry-leading experience in public safety networks, Motorola is distinctively qualified to introduce 4G networks that meet the demanding needs of public safety communications. The result will be seamlessly integrated 4G systems that easily stand alongside today's mission critical networks and devices and deliver the kind of quality and reliability customers have come to expect. Motorola is truly transforming mission critical public safety communications now… and into the future.

## NEXT GENERATION PUBLIC SAFETY

At the heart of every mission is the ability to communicate in an instant to coordinate response and protect lives. Today, Motorola is putting real-time information in the hands of mission critical users to provide better outcomes. Our powerful combination of next generation technologies is transforming public safety operations by strengthening the mission critical core with broadband connections, rich-media applications, collaborative devices and robust services. It's Technology That's Second Nature. To find out more, visit **www.motorola.com/nextgen**



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