# Statement of Requirements for Public Safety Wireless Communications & Interoperability

The SAFECOM Program
Department of Homeland Security

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# Publication Notice

## Abstract

This document contains the assembled requirements for a system of interoperable public safety communications for use across all federal, state, local, and tribal "first responder" communications systems.

## Disclaimer

The U.S. Department of Homeland Security's Science and Technology division serves as the primary research and development arm of the Department, utilizing our nation's scientific and technological resources to provide federal, state and local officials with the technology and capabilities to protect the homeland. Established in 2002 as part of the President's Management Agenda, SAFECOM is the overarching umbrella program within the Federal Government that oversees all initiatives and projects pertaining to public safety communications and interoperability.

## Change Log

| Version | Date | Change(s) |
|---|---|---|
| Version 1.0 | March 10, 2004 | Start |
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## ACKNOWLEDGMENTS

The SAFECOM Program extends its sincere appreciation to the many public safety practitioners, individuals, associations, and government organizations that directly contributed to the creation of the Statement of Requirements for Public Safety Wireless Communications and Interoperability.

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# The SAFECOM Program

## Background on Public Safety Wireless Communications

Inadequate and unreliable wireless communications have been issues plaguing public safety organizations for decades. In many cases, agencies cannot perform their mission- critical duties. These agencies are unable to share vital voice or data information via radio with other jurisdictions in day-to-day operations and in emergency response to incidents including acts of terrorism and natural disasters.

According to a report done by the National Task Force on Interoperability (February 2003), the public safety community has identified the following key issues that hamper public safety wireless communications today:

- Incompatible and aging communications equipment
- Limited and fragmented budget cycles and funding
- Limited and fragmented planning and coordination
- Limited and fragmented radio spectrum
- Limited equipment standards

In short, the Nation is heavily invested in an existing infrastructure that is largely incompatible. The SAFECOM Program was established by the Office of Management & Budget and approved by the President's Management Council to address these public safety communications issues.

## The SAFECOM Program

SAFECOM's mission is to serve as the umbrella program within the federal government to help local, tribal, state, and federal public safety agencies improve public safety response through more effective and efficient interoperable wireless communications. Communications interoperability is the ability of public safety agencies to talk across disciplines and jurisdictions via radio communications systems, exchanging voice and/or data with one another on demand, in real time, when needed.

SAFECOM is the first national program designed by public safety for public safety. As a public safety practitioner driven program, SAFECOM is working with existing federal communications initiatives and key public safety stakeholders to address the need to develop better technologies and processes for the cross-jurisdictional and cross-disciplinary coordination of existing systems and future networks. SAFECOM harnesses diverse federal resources in service of the public safety community. The scope of this community is broad. The customer base includes over 50,000 local and state public safety agencies and organizations. Federal customers include over 100 agencies engaged in public safety disciplines, such as law enforcement, firefighting, public health and disaster recovery.

SAFECOM makes it possible for the public safety community to leverage resources by promoting coordination and cooperation across all levels of government.

## SAFECOM's Near-Term Initiatives

Develop a process to advance standards necessary to improve public safety communications and interoperability.

Integrate coordinated grant guidance across all agencies, providing grants for public safety communications and interoperability.

Provide training and technical assistance for public safety communications and interoperability.

Create a one-stop shop for public safety communications and interoperability.

Research, develop, test, and evaluate existing and emerging technologies for improved public safety communications and interoperability.

## SAFECOM's Long-Term Goals

- Provide policy recommendations.
- Develop a technical foundation for public safety communications and interoperability.
- Coordinate funding assistance for public safety communications and interoperability.
- Create and implement a national training and technical assistance program.

The SAFECOM Program, with its partners, is assuring a safer America through effective public safety communications.

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# Introduction

*"In times of emergencies, the public looks to government, particularly their Public Safety officials, to act swiftly and correctly and do the things which must be done to save lives, help the injured, and restore order. Most disasters occur without warning, but people still expect a rapid and flawless response on the part of government. There is no room for error. Whether a vehicle accident, crime, plane crash, special event, or any other Public Safety activity, one of the major components of responding to and mitigating a disaster is wireless communications. These wireless communications systems are critical to Public Safety agencies' ability to protect lives and property, and the welfare of Public Safety officials."*

This statement comes from the highly regarded Public Safety Wireless Advisory Committee (PSWAC) Final Report, presented to the Chairman of the Federal Communications Commission (FCC) and the Administrator of the National Telecommunications and Information Administration (NTIA) in September 1996[1]. The PSWAC Final Report defined and documented critical public safety wireless communication needs in 1996, and projected anticipated needs through the year 2010. The report focused on the requirements for communications resources and the radio frequency spectrum to support those requirements. While the report mentioned the crucial need to promote interoperability, its emphasis was clearly on the necessity of taking immediate measures to alleviate spectrum shortfalls. Fortunately, for public safety, and for the benefit of all Americans, the report spurred the allocation of precious spectrum for use by public safety practitioners.

Unfortunately, the communication challenges for those working on the front lines in public safety have not been eliminated. In fact, at a time when more attention is being paid to interoperability among different disciplines and jurisdictions within the community, there still exists fundamental communication deficiencies within disciplines and jurisdictions as practitioners strive to perform the most routine and basic elements of their job functions. Agencies must be "operable," meaning they must have sufficient wireless communications to meet their everyday internal requirements before they place value on being "interoperable," meaning being able to work with other agencies.

This document, the Statement of Requirements (SoR) for Public Safety Wireless Communications and Interoperability, is the natural follow-on to the PSWAC Final Report, but differs in three ways. First, this SoR is not keyed to the issue of spectrum allocation, but focused on public safety requirements from a broader perspective. Operational and functional requirements delineated in this SoR are not based on a particular approach or technology.

1. In 1994, the FCC and NTIA established PSWAC to evaluate the wireless communications needs of local, tribal, state, and federal public safety agencies through the year 2010, identify problems, and recommend possible solutions.

Second, this SoR was developed 8 years after the PSWAC Final Report was published. While the Final Report did not explicitly identify specific technological approaches along with the stated requirements, it is important to realize that advances in technology have helped to fashion the way practitioners think about their jobs over the years. Because users expect more from technology today, their needs and desires have been affected, sometimes subtly, by industry advances and solutions that exist in today's commercial and consumer world. Additionally, current technological advances promote futuristic thinking about what the user may be able to expect 15 years from now. That said, the methodologies used, and the general projections made in the PSWAC Final Report remain as valid today as when they were first published. Based on the rapid changes and potential of technology, this SoR addresses current requirements for 2004 and future requirements through 2019.

Third, this SoR emphasizes the "information" aspects of communications, that is, the need for the wireless exchange of data, video, and other non-voice mediums. The need for voice communications was clearly made in the PSWAC Final Report as well as the need for additional bandwidth for other data resources. This SoR defines the information requirements of public safety practitioners more explicitly to guide how practitioners will use information resources in the field in mission-critical situations.

## Scope

In general, this SoR is focused on the functional needs of public safety first responders—Emergency Medical Services (EMS) personnel, firefighters, and law enforcement officers—to communicate and share information as authorized when it is needed, where it is needed, and in a mode or form that allows the practitioners to effectively use it. The communications mode may be voice, data, image, video, or multimedia that includes multiple forms of information.

Because the emphasis of this document is on functional requirements, there has been a conscious effort to avoid specifying not only technologies but business models as well (i.e., whether requirements should be addressed through owned products and systems or via commercial services). Similarly infrastructure is not specified, except to note that consistent with first responder operations, it is assumed that terminal links to and from users are wireless unless stated otherwise.

This SoR has been written to address a number of complementary objectives. First and most importantly, it is rooted in the goal of improving the ability of public safety personnel to communicate among themselves, with the non-public safety agencies and organizations with whom they work, and with the public that they serve. In addition, this document can assist the telecommunication interoperability and information-sharing efforts by and among local, tribal, state, and federal government agencies, and regional entities, by delineating the critical operational functions and interfaces within public safety communications that would benefit from research and development investment and standardization.

This SoR can assist federal programs that work with public safety practitioners to facilitate wireless interoperability at all government levels to develop a comprehensive vision for public safety communications that satisfies the defined needs. This vision would be reinforced by developing federal grant programs that promote government research and development, as well as investment in communications equipment and systems, in a manner consistent with the SoR.

This SoR provides information that can assist the communications industry to prioritize its research and development investment and product and service development strategies so that they are aligned with public safety communications needs.

Finally, this SoR can be used to clearly identify public safety operational issues so that discussions regarding existing and proposed regulations and laws can be dealt with expeditiously by regulatory and legislative bodies.

## SoR Organization

*Section 1.* **Public Safety Requirements and Roles**, defines public safety communication needs and public safety roles and functions.
(*See Section 1. "Public Safety Requirements and Roles" on page 1.*)

*Section 2.* **Communications Services Definition**, defines communications services—interactive and non-interactive voice communications and interactive and non-interactive data communications.
(*See Section 2. "Communications Services Definitions" on page 3.*)

*Section 3.* **Public Safety Wireless Communications Scenarios**, outlines several public safety scenarios based on typical operations to provide a view of future public safety communications.
(*See Section 3. "Public Safety Wireless Communications Scenarios" on page 5.*)

*Section 4.* **Operational Requirements of Public Safety for Wireless Communications and Information Capabilities**, identifies the wireless communications operational needs of public safety.
(*See Section 4. "Operational Requirements of PSWC&I" on page 19.*)

*Section 5.* **Wireless Communications Functional Requirements**, defines the wireless communications functional requirements.
(*See Section 5. "Wireless Communications Functional Requirements" on page 51.*)

*Appendix A.* This contains a **complete glossary** of the terminology and acronyms used in this report.
(*See Appendix A. "Glossary and Acronyms" on page 85.*)

*Appendix B.* This contains the list of **System Capabilities** developed at the SAFECOM-AGILE-NIST [National Institute of Standards and Technology] Summit on Interoperable Communications for Public Safety.
(*See Appendix B. "SAFECOM-AGILE-NIST Summit" on page 91.*)

*Appendix C.* This contains a number of **additional Operational Scenarios**.
(*See Appendix C. "Operational Scenarios" on page 99.*)

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# 1. Public Safety Requirements and Roles

Public safety operations require effective command, control, coordination, communication, and sharing of information with numerous criminal justice and public safety agencies, as well as public utilities, transportation companies, and private industry. Thousands of incidents that require mutual aid and coordinated response occur every day. High-profile incidents, such as bombings or plane crashes, test the ability of public safety service organizations to mount well-coordinated responses. In an era where technology can bring news, current events, and entertainment to the farthest reaches of the world, many law enforcement officers, firefighters, and emergency medical service (EMS) personnel cannot communicate with each other during routine operations let alone during major emergencies, such as the Oklahoma City Bombing.

There are more than 18,000 law enforcement agencies in the United States. Approximately 95 percent of these agencies employ fewer than 100 sworn officers. Additionally, there are over 32,000 fire and EMS agencies across the Nation. Due to the fragmented nature of this community, most public safety communications systems are stovepipe, or individual systems that do not communicate with one another or facilitate interoperability. Just as the public safety community is fragmented, so is radio spectrum. Public safety radio frequencies are distributed across four isolated frequency bands from lowband VHF (25-50 MHz) to 800 MHz (806-869 MHz).

Voice communications are critical, but voice communication requirements are not the only issue. Because of advances in technology, public safety operations are increasingly dependent on the sharing of data, images, and video. New technologies promote the convergence of information and communication systems with the result that mobile units are increasingly being viewed as merely wireless nodes within information networks.

The public safety community requires interoperable communications-the ability to communicate and share information as authorized when it is needed, where it is needed, and in a mode or form that allows the practitioners to effectively use it. Broadly defined, the public safety community performs emergency first response missions to protect and preserve life, property, and natural resources and to serve the public welfare. Public safety support includes those elements of the public safety community whose primary mission might not fall within the classic public safety definition, but whose mission may provide vital support to the general public and/or the public safety official. Law enforcement, fire, and emergency medical services fit the first category, while transportation or public utility workers fit the second.

Table 1. First Responder Roles and Functions

| First Responders | |
|---|---|
| **Community Element** | **Functions** |
| Emergency Medical Services | Public protection, public health, emergency medication/ medical services |
| Fire Services (fire marshal, volunteer and professional fire protection districts, etc.) | Public protection, protection of property, identification of hazardous situations |
| Law Enforcement (identification services, laboratory, operations, juvenile department, etc.) | Public protection, law enforcement, identification, investigation/evidence gathering, arrest, filing of charges |

Table 2. Supplemental Responders Roles and Functions

| Supplemental Responders | |
|---|---|
| **Community Element** | **Functions** |
| Emergency Management | Public protection, central command and control of public safety agencies during emergencies |
| Environmental Health/Hazardous Materials specialists - environmental health personnel | |
| Homeland Security and Defense units | |
| Search and Rescue teams | |
| Transportation personnel | |

Table 3. Related Agencies Roles and Functions

| Agencies Related to Public Safety | |
|---|---|
| **Community Element** | **Functions** |
| Corrections (institution, community corrections, jails, juvenile corrections, etc.) | Inmate welfare, rehabilitation, incarceration, timeliness |
| Courts (court administrations, judges, bailiffs, court recorders, municipal courts, etc.) | Evidence evaluation, fairness, impartiality, timeliness |
| Defense (public defenders, private attorneys, etc.) | Evidence review, response to charges, suspect's rights, bail recommendation, timeliness, trial preparation |
| Probation and Parole (parole board, probation officers, etc.) | Reintegration, victim notification, oversight, timeliness |
| Prosecution (district attorneys, etc.) | Evidence review, prosecution decision, suspect's rights, bail recommendations, trial preparation |

# 2. Communications Services Definitions

This section defines what communications services are required by public safety agencies. Because voice services are the most important for mission-critical operations, it is listed by itself; all other forms of communications are considered as data. In general, data communications will have a lower priority than voice communications.

While this section discusses the communications services that are identified as required by today's environment, the demands of tomorrow's first responders may change regarding communications. Thus this SoR is a living document to define those services as they change or become new requirements for public safety agencies to carry out their missions.

**Interactive voice communications** between public safety practitioners and their supervisors, dispatchers, members of the task force, etc., require immediate and high quality response, with much higher performance demands than those required by commercial users of wireless communications. Commands, instructions, advice, and information are exchanged that often result in life and death situations for public safety practitioners, as well as for the public.

**Non-interactive voice communications** are those that occur when a dispatcher or supervisor alerts members of a group about emergency situations and/or to share information. In many cases, the non-interactive voice communications have the same mission-critical needs as the interactive service.

Data communications are becoming increasingly important to public safety practitioners to provide the information needed to carry out their missions. **Interactive data communications** will provide practitioners with maps, floor plans, video scenes, etc. In the context of the type of communications, interactive means that there is a query made and a response provided. The query and response need not be initiated by a practitioner and can include automated queries/responses. Commanders, supervisors, medical staff, etc., can make more intelligent decisions more efficiently with data from field personnel. Similarly, personnel entering a burning building armed with information about the building, such as contents, locations of stairwells, hallways, etc., can also perform their duties more efficiently.

Finally, **non-interactive data communications** are a one-way stream of data, such as the monitoring of firefighter biometrics and location, which greatly increases the safety of the practitioners. This form of communications also makes the command and control requirements easier when the commander is aware of the condition and location of the on-scene personnel.

These types of communications are described in greater detail in Section 3 (*Public Safety Wireless Communications Scenarios on page 5*), through examples presented by typical public safety scenarios. The scenarios in the Appendix (*See Appendix C. "Operational Scenarios" on page 99.*) provide more detail about the communications operational needs of public safety in the three areas of interagency interoperability: day-to-day, task force, and mutual aid.

# 3. Public Safety Wireless Communications Scenarios

## 3.1 Introduction

This section includes several scenarios of typical public safety operations to provide a view of future public safety communications. These scenarios describe credible, realistic incidents, activities, and responses that involve public safety agencies and personnel. While these scenarios do not cover all possible activities and situations, this collection provides a comprehensive vision of the future of public safety communications. Additional scenarios that depict increasingly complex events and their associated communications requirements are included in the Appendix ( *See Appendix C. “Operational Scenarios” on page 99.*). These scenarios provide descriptions of the voice and data communications used in routine, day-to-day operations and include a traffic stop, a structure fire, and a medical emergency. In the Appendix, two scenarios-a pre-planned event, represented by a college football game, and a terrorist car bomb-reflect the interaction of multiple services in a local area, and, finally, two scenarios-a hurricane and an earthquake-represent large-scale regional events.

There are several common elements in the following scenarios defined below.

a. **Public Safety Communications Devices** - Public safety personnel in these scenarios communicate using a device that is portable (handheld or wearable), unless specifically noted for Command Post or other in-vehicle use. Throughout this document, these devices will be referred to as Public Safety Communications Devices (PSCD). These devices perform the communications functionality as defined in the scenario. Because the emphasis of these scenarios is on communications capabilities, other important considerations for technology development, such as form (e.g., how text data is input to the device via keyboard, stylus, or spoken language) are not discussed. The scenarios also do not distinguish as to whether a public safety individual is carrying one or more such devices; however, it is noted that minimizing the number of separate devices required to provide the described functionality is preferred, consistent with other requirements, such as affordability and maintainability.

b. **Public Safety Communications User Group** - Public safety personnel and resources that are recognized by the system to share communications and information. This implies that traffic related to this user group only traverses the portion of the network necessary to reach all members of particular user group. Each user group can be a permanent unit or a temporary unit created by an authorized user for a particular task.

c. **System of Systems** - The communications devices are associated with systems or networks that range in size from small to large. Whether large or small, the systems work with each other to pass information and communications back and forth seamlessly. In other words, all systems together become a system of systems.

d. **Personal Area Network (PAN)** - On the small scale, the communications device interacts with other devices that belong with the public safety individual. A first responder is equipped with wireless devices used to monitor the first responder's physical location, pulse rate, breathing rate, oxygen tank status, as well as devices for hazardous gas detection and voice communications. The devices are all linked wirelessly on a personal area network (PAN) controlled by the first responder's communications device.

e. **Incident Area Network (IAN)** - An incident area network (IAN) is a network created for a specific incident. This network is temporary in nature.

f. **Jurisdiction Area Network (JAN)** - The JAN is the main communications network for first responders. It is responsible for all non-IAN voice and data traffic. It handles any IAN traffic that needs access to the general network, as well as providing the connectivity to the EAN.

g. **Extended Area Network (EAN)** - The city systems are in turn linked with county, regional, state, and national systems or extended area networks (EAN).

h. **Permanent and Temporary Networks** - JANs and EANs are networks that exist at all times whereas the IANs are created on temporary basis to serve a particular purpose, such as an incident and then are dissolved. The nature of the IAN is such that it may not reach all areas of an incident. In such cases, the user would either connect to the JAN, or create a temporary network to extend the IAN to the area not covered.

i. **Public Safety Communications User Registration and Authorization** - The PAN is created every time a public safety individual begins a work shift and turns on his communications device. The individual needs to provide a positive identification, such as through a biometric scan, to his communications device, which then registers the individual on the network. From that moment on, all voice or data communications from that communications device are associated with only that individual. All the pieces of equipment that can monitor the environment, monitor the health of the individual, locate his exact position, etc. register with the individual's identification on the systems so that every time a monitor provides a measurement, the measured value is associated with that public safety individual. Each individual also has privileges, permissions, and authorities to communicate with others and to access databases and systems to complete the individual's work assignments. The systems will allow communications and system access based upon the user's profile and authorizations.

j. **Temporary Network Creation and Growth** - An emergency event or incident can happen anywhere, and those responding to the incident must have communications on-scene as well as away from the scene for command, control, and information to complete their missions. As public safety individuals and resources, such as ambulances and fire engines, come into an incident, the incident communications system or IAN will automatically recognize the new entry, register and authorize the resource, and allow an authorized user to assign the resource to user groups for communications and information exchange. Additionally, in the absence of a network, such as an IAN or JAN, the communications system is designed to allow continued operation in the absence of this infrastructure.

The following scenarios include three that relate future communications capabilities for the first responder disciplines and one that describes future command, control, communications, and information sharing for a large incident.

## 3.2 EMS-Heart Attack Scenario

### 3.2.1 Initial Work Shift Tasks

1. At 3:00 p.m., two paramedics report for their shift with the Brookside ambulance service. After being assigned to ambulance A-34 and receiving the day's situation updates from the shift supervisor, they go to their ambulance and begin their system initialization tasks. Both paramedics turn on the Public Safety Communications Devices (PSCDs) that are integrated with the medical equipment and the ambulance's wireless incident area network (IAN), which allows them to have contact with the network when they operate outside the ambulance. At power up, all medical devices, including the video cameras, go through their self tests and report their status to the local command and control system on board the ambulance; the PSCDs go through their network registrations and the ambulance wireless network links to the hospital network to register and download the latest information from the county public health center, emergency procedures from sources, such as the poison center and instructional aids with the latest EMS training packages.

2. Both paramedics must go through a biometric identity check with their PSCDs. After authenticating each paramedic, the ambulance system sets up the profiles of the two paramedics on the medical equipment and the PSCDs, establishes the level of authorized data access for each paramedic across available databases, and initiates personal tracking of each paramedic so that a record can be made of all instructions given to each paramedic, and the treatment each paramedic provides.

3. Before formally alerting dispatch that A-34 is in an active status and available for calls, one paramedic goes through a training exercise (using a life-like mannequin) that simulates a situation in which parents have reported their child has stopped breathing. The other paramedic runs the “Required Inventory” program that identifies all the medical supplies needed on board, locates the inventory present via radio frequency identification (RF ID) tags, and restocks the supplies that the system identifies as insufficient.

4. At 3:25 p.m., A-34 reports to the dispatcher via its on-board data system that it is active and available for calls, and follows up with a radio voice call corroborating the same message. The dispatcher acknowledges that A-34 is active and that dispatch is properly receiving location data from the unit. He assigns the unit to patrol a prescribed grid in the Brookside area.

### 3.2.2 EMS Response to Heart Attack Call

1. At 4:19 p.m., the Brookside Public Safety Answering Point (PSAP) receives a 9-1-1 call from the relative of a man who has returned home from playing tennis and is reporting chest pains. From the PSAP’s computer aided dispatch (CAD) display, the dispatcher knows that the A-17 team is available and is close to the address but will require 7 minutes to reach the address because of heavy rush hour traffic near several factories. The CAD shows that A-34 is farther away from the address, but has little traffic in its path, and is therefore only 4 minutes away. The dispatcher notifies A-34 and simultaneously sends a digital message

providing the patient's name and address. A-34 leaves its location and the ambulance driver notifies the dispatcher who in turn relays the information to the relative stating that paramedics are on their way.

2. The ambulance driver views the patient's address on the cab monitor display, which also maps the route for the driver; a computer-activated voice directs the driver to the appropriate lanes and where to turn. As the ambulance approaches traffic lights along the route, the on-board signaling system adjusts the traffic light sequence to allow the ambulance to travel through quickly and the on-board system also interrogates the county's transportation system for road closures, blockages, train conflicts, or slow traffic conditions to route the ambulance around impediments and provide the fastest route to the patient. At the same time, the geo-location system provides information on the ambulance location and progress on the dispatcher's CAD display.

3. A-34 arrives at the patient's house at 4:23 p.m. and the paramedics enter the home to find the patient barely conscious on the living room couch. While one paramedic begins a preliminary medical assessment, the second paramedic acquires personal information about the patient through the other person present. The patient's information is entered by the attending paramedic who uses the ambulance's on-board facilities to capture the data-patient's name, address, gender, age, etc., through a voice recognition system. One paramedic checks the most recent list of available hospitals and confirms that the Brookside Hospital's Emergency Room (ER) will be able to accept the patient. The paramedics discover the patient is wearing a medic alert RF ID bracelet; the paramedics scan the RF ID tag and find that the patient has a severe allergy to penicillin-based medicines.

4. The paramedics attach a wireless 12-lead electrocardiogram (EKG) unit to the patient and the unit begins transferring its digital information to the PSCD. The Brookside Hospital's ER staff pulls the EKG information from A-34's database. The staff route the information directly to the hospital's emergency physician, who views information from all 12 leads of the EKG simultaneously, zeroing in and enlarging the waveforms for specific leads as required.

5. The cardiologist quickly determines the patient needs a cardiac catheterization and orders the paramedic team to bring the patient directly to the hospital's catheterization lab. The same order activates the hospital's teams to staff the lab and prepare for the patient's arrival.

6. The patient is transported from the house to the ambulance with all medical monitors wirelessly attached to him, including the EKG unit, a respirator monitor, and a blood pressure monitor. The attending paramedic rides in the ambulance's patient module and communicates to the driver via their hands-free PSCDs. As the ambulance approaches the hospital, the catheterization lab staff retrieves the patient's information and vital statistics from the ambulance's database.

7. When the ambulance arrives at the hospital from the house 19 minutes later, the catheterization lab is ready for the patient. After another 33 minutes, the cardiologist and the catheterization lab team successfully establish good blood flow to the affected coronary artery.

### 3.2.3 EMS Communications Summary

Throughout the scenario, the ambulance, the paramedic team, and the patient are tracked by the network providing geo-location information in real time. All patient information and vitals are recorded through wireless monitors and voice recognition systems with no reliance on paper reports and notes. All EMS hospital staff orders as well as paramedic treatments are recorded by the hospital and ambulance databases. All monitors and devices used with the patient are wireless to allow easy patient transport and mobility. All conversations between dispatcher and paramedics and between paramedics and hospital staff are conference call, simultaneous discussions.

## 3.3 Fire-Residential Fire Scenario

### 3.3.1 Initial Work Shift Tasks

1. Three firefighters begin their shift at the Brookside Fire District Station BFD-7. After completing their administrative check-in, they complete their biometric identity check with their Public Safety Communications Devices (PSCD). After authenticating each firefighter, the system sets up their profiles on their PSCDs and the network, establishes the level of data access that each is authorized to have across available databases, and initiates personal tracking of each firefighter so that a record can be made of all instructions that are given to each, and the actions and responses provided by each firefighter. The firefighters initiate the equipment self-tests of the vests they will wear during a fire situation. The vests measure each firefighter's pulse rate, breathing rate, body temperature, outside temperature, and three-axis gyro and accelerometer data. Each vest also provides geo-location information for each firefighter and measures the available air supply in the firefighter's oxygen tank. The vests have a self-contained wireless personal area network (PAN) that interrogates each of the sensors and monitors. The vests code their information with the firefighter's ID and then conduct their registration/authorization steps and report their status to the wireless network.

2. The firefighters begin their check-out of the fire equipment, the fire engine, E7, and fire ladder, L7, at the station. Each apparatus has sensors to measure water pressure, water flow, water supply, fuel supply, and geo-location. Each apparatus also has its own PAN for interrogating all apparatus monitors. The apparatus codes the apparatus ID with the measured values and geo-location information for routing to the network. After successfully completing all the self tests, the firefighters provide a digital status to the network that they have completed all initial set-ups and they are ready. The fire station network reports to the dispatcher, via the station's and on-board data systems, which personnel and equipment are active and available for calls. The station battalion chief follows up with a PSCD voice call with the same message. The dispatcher acknowledges that BFD-7 is active and that dispatch's Geographical Information System (GIS)/CAD systems are properly receiving location and status data from the units.

### 3.3.2 Fire Response to a Residential Fire Call

1. At 3:17 a.m., the Brookside PSAP receives a 9-1-1 call from a cab driver that the apartment building at 725 Pine is smoking and appears to be on fire. From the CAD display, the dispatcher finds that the BFD-7 station is available and close to the address. The dispatcher notifies BFD-7 to send E7 and L7, and to send BFD-7 battalion chief as the fire's incident commander (IC). As E7 is leaving the fire station, firefighter F788 jumps onto the back of the vehicle. The vehicle registers that F788 has become part of the E7 crew for accountability and tracking. The dispatcher simultaneously sends a digital message providing the apartment building's address. The dispatcher notifies another Brookside Fire Department, BFD-12, to also send an engine to the fire. By 3:19 a.m., E7, L7, and the incident commander leave BFD-7 and report their status to the dispatcher. As the incident commander's command vehicle leaves the station, a nearby wireless PSCD sends the apartment's building plans and the locations of nearby fire hydrants, the building's water connections, the elevator, and the stairwells to the command vehicle's GIS. The dispatcher sends a reverse 9-1-1 call message to all residents of the building, which has eight apartments on each of three floors. The nearest ambulance is alerted by the dispatcher to proceed to the scene. The local utility is alerted to stand-by for communications with the IC at 725 Pine.

2. The E7, L7, and IC drivers view the apartment's address on the cab monitor displays, which also maps the route for the drivers; a computer-activated voice tells the drivers what lane to be in and which turns to make. As the fire vehicles approach traffic lights along the route, the on-board signaling system changes the lights to the emergency vehicles' favor and the geo-location system provides the vehicles' location and progress on the dispatcher's CAD display. The on-board system also interrogates the county's transportation system for road closures, blockages, train conflicts, or slow traffic conditions to route the vehicles around impediments and provide the fastest route to the fire.

3. The IC arrives on scene at 3:22 a.m., assesses the situation, noting that smoke and fire are visible, and alerts dispatch that 725 Pine is a working fire. The IC directs the local utility to shut off the gas to 725 Pine. As L7 and E7 arrive and get into position, all fire personnel and equipment are shown on the IC's GIS display. The system automatically sets up the tactical communications channels for the IC and the fire crews. The fire crews are able to talk continuously with each other, reporting conditions and warning of hazards. Because the apartment building is not large enough to require a built-in wireless incident area network (IAN) for emergency services, the first fire crew into the apartment drops self-organizing wireless IAN pods on each of the floors at they progress through the building. Soon E12 and the assigned EMS unit arrive on site. The new personnel and equipment are automatically registered with the IC command post network and their PSCDs are automatically reprogrammed to operate on the incident's PSCD radio channels and protocols.

4. Several families have already evacuated the building. As firefighters ask for their names and apartment numbers, they use the voice recognition capabilities of their PSCDs to capture the information, applying an RF ID wrist strap to each resident to track their status and location. Other firefighters enter the building to guide survivors out and to rescue those who are trapped. The IR cameras on the firefighter's helmets provide the IC a view of fire conditions within the building and where the hot spots are located. Additionally, the firefighters monitor the temperature of the surrounding air in their location; this

information is directly available to the firefighter, as well as the IC and EMS unit on-scene. Other passive sensors, such as hazardous gas detectors, are also operating in the firefighter's PAN. With the IC's guidance, the firefighters search each apartment for survivors and the source of the fire. The IC is able to monitor the location of each firefighter and is aware of which apartments have been searched by the information provided on the GIS displays.

5. The EMS unit outside the apartment monitors the vital signs of all the firefighters in and around the fire scene. The unit alerts the IC that firefighter F725 is showing signs of distress and the IC orders F725 and his partner F734 out of the building for a check-up with the EMS team.

6. Firefighter F765 pushes his emergency button when he becomes disoriented in the smoke. The IC immediately directs firefighter F788 to his aid by providing F765's location relative to F788.

7. While the firefighters check every apartment for victims, the main fire is discovered in a second floor apartment kitchen where an electric range is burning. Two adults and two children are discovered in the apartment suffering from smoke inhalation. RF IDs are attached to their arms and each is given an oxygen tank and mask to help their breathing. They are carried outside the building where the EMS unit is ready to take over medical aid.

8. While the firefighters put out the fire in apartment 202, the IC checks the GIS display, which shows where the fire personnel are and where all the survivors and rescued individuals live in the apartment building. Two top-floor apartments have not been searched and the IC moves fire personnel to those apartments. The apartment database indicates an invalid may be living in apartment 321. The firefighters break down the doors of both apartments and in 321 find a bedridden individual, who is in good condition, and a pet dog in the other apartment. Both are outfitted with RF ID devices and taken from the building.

9. The fire is brought under control. The IC releases E12 and the IC network controller reconfigures E12's PSCDs for return to the fire station. E7 and L7 wrap their fire operations and A34 has to transport one fire victim to the hospital. The IC releases all remaining equipment and gives control to dispatch.

### 3.3.3 Fire Communications Summary

Throughout the scenario, the fire personnel and equipment, EMS support personnel, and the fire victims are tracked by the network providing geo-location information in real time, providing the Incident Commander with current accountability of public safety personnel and of the fire's victims. All victim information and vitals are recorded through wireless monitors and voice recognition systems with no reliance on paper reports and notes. All fire personnel and equipment have monitors to measure vital conditions and status that are reported by the wireless PAN and IAN systems to the IC's GIS. The GIS also has access to city building department databases, which are searched and queried for building information and plans, fire hydrant locations, etc.

## 3.4 Law Enforcement-Traffic Stop Scenario

### 3.4.1 Initial Work Shift Tasks

1. A police officer enters his 10-hour shift at the Brookside jurisdiction. After completing his administrative check-in, the officer takes his duty equipment to the squad car assigned to him for the shift. In the vehicle, the officer initiates his biometric identity check with his Public Safety Communications Device (PSCD). After authenticating the officer, the system sets up a profile of the officer on the PSCD and the network, establishes the level of data access the officer is authorized to have across available databases, and initiates tracking of the officer's activities. The officer initiates the equipment self tests of the devices he will be using within the vehicle. The data terminals, status monitors, video cameras, displays, three-dimensional location sensor, etc., are integrated into a wireless personal area network (PAN). All of the devices code their information with the officer's ID and then conduct their registration/authorization steps and report their status to the wireless network. Each device will be associated with the officer and will provide the officer with capabilities based upon the officer's profile. When the officer starts the vehicle, a wireless hub recognizes the officer's PAN and uploads the pertinent database files, the latest law enforcement alerts, and the current road and weather conditions to the PAN.

2. After successfully completing all the self tests and receiving all the updates from the wireless hub, the officer provides a digital status to the network indicating that he has completed all initial set-ups and is ready. The Police Center network reports to the dispatcher, via the center's and on-vehicle data systems, which personnel and equipment are active and available for calls. The officer follows up with a PSCD voice call with the same message. The dispatcher acknowledges that the officer is active and that dispatch's GIS and CAD systems are properly receiving location and status data from the officer's vehicle and monitor units.

### 3.4.2 Law Enforcement Response to a High-Risk Traffic Stop

1. While on routine traffic patrol, the officer observes a car that runs through a red light at an intersection. The officer presses the “Vehicle Stop” button on his vehicle's PSCD. The PSCD issues a message to dispatch, noting the operation underway, the officer's ID, and the location information of the officer's car. As the officer drives his squad car, the license number of the vehicle is captured by license plate recognition software and queried back to the Motor Vehicle Department. The video camera on the officer's vehicle dashboard begins recording video of the vehicle stop onto a RAM buffer video storage device on the vehicle's network; the video can be accessed at any time, on-demand, by the dispatcher and other authorized viewers. Other units in the area are alerted to the vehicle stop.

2. Shortly, the State Motor Vehicle Registration, Stolen Vehicle, and Wants/Warrants systems return their information to the officer's PSCD. The officer also receives a picture of and information about the registered owner; the information indicates (both on the PSCD screen and with an audio signal) that there are no Wants/Warrants.

3. The vehicle pulls over and stops. The video feed will be available to dispatchers and supervisors on demand, or automatically displayed in the case of an emergency. When the officer leaves his squad car, he has access to all of his communications and data devices as the devices continue to communicate between his PAN and the vehicle's network. The officer approaches the car and notes that there is a single occupant, the driver. The officer requests the driver's license and registration, but the driver does not provide documentation.

4. While obtaining the information from the driver, the officer observes what he believes to be the remains of marijuana cigarettes in the ashtray. The officer decides to search the suspect's vehicle and contacts dispatch to request a backup unit. The dispatcher enters the "Dispatch backup" command for the incident on her dispatch terminal and the CAD system recommends the dispatch of the closest unit based upon automatic vehicle location (AVL) information provided by the vehicles on patrol and known road and traffic conditions. The dispatcher glances at the console map to confirm the recommendation and presses the key to confirm the CAD recommendation. The dispatch of the backup unit is transmitted electronically to terminals in that vehicle, as well as to other nearby units and the area supervisor's car for informational purposes. A user group is created on the network between the original and backup officer to share information. The backup officer acknowledges dispatch and asks the on-scene officer to confirm location and circumstances.

5. The supervisor brings up the real-time video of the event in her vehicle and briefly observes the situation. All appears under control and she releases the video link. The backup unit arrives on-scene. The responding officer orders the suspect to get out of his car. The backup officer watches the driver while the original officer searches the car. The original officer finds a number of bags of a white substance that appears to be cocaine. The original officer then places the driver under arrest and restrains him with handcuffs equipped with an RF ID tag. The RF ID tag is later loaded with the officer's identity code, the nature of the crime, and a case number. The original officer radios dispatch to request a transport vehicle. The unit is dispatched and is linked to the original officer to communicate and obtain information as needed.

6. After the arrest, the officer takes the driver's biometric sample with his PSCD. The PSCD submits the scan data to the biometric ID database for identification. Soon after, the PSCD returns an image, name, date of birth, and physical characteristics of the individual from the biometric sample that matches the name and DOB of one of the aliases returned by the license plate check, and matches the driver's license picture. This indicates that the driver is the registered owner of the vehicle. The officer queries the criminal history database for information about the driver and receives a response that the individual has previously been arrested for drug possession.

7. When the transport unit arrives on scene, its PAN and vehicle network is automatically linked with the original officer's network. Based on the incident and location, the system establishes a single user group so that the officers can exchange appropriate case information. The transport unit takes control of the arrested driver and transports him to the jail. The backup unit departs the scene and resumes patrol.

8. The original officer takes photo images of the suspect's car and the suspected drugs and collects the evidence. He conducts field tests of the substances and confirms that the suspected drugs are cocaine. He places RF ID tags on all evidence bags.

9. The original officer radios dispatch to request a tow truck to impound the vehicle. Dispatch notifies the tow company and the original officer communicates directly with the tow truck operator to confirm location and status. While waiting for the tow truck, the original officer completes preliminary suspect and vehicle information on the crime to automatically populate the electronic Tow Report and Inventory Form and the Jail Booking Form. This information is transmitted electronically to the Sheriff's Central Records System.

10. The transport officers arrive at the jail located in Central City. The officers bring the suspect in for booking. The booking officer queries the suspect's RF ID tag on the handcuffs to begin the booking record, which is automatically populated from the information previously sent to the Central Records System. Information on the handcuff RF ID tag is cloned to a wristband that is then affixed to the suspect after the handcuffs are removed.

11. As the tow truck arrives, the truck's network is recognized on the incident area network (IAN) at the scene. The tow truck and driver are registered and authorized to exchange information on the network. The tow truck company information automatically populates the tow report. The tow truck driver reviews the tow report with the associated officer code and case number and adds his electronic signature. The officer then continues to work on the arrest report, adding a narrative section describing the events, along with descriptions of the confiscated property and associated arrest information. The officer also updates the State Motor Vehicle database to show the vehicle status as “towed/stored.”

12. The officer completes the arrest report in electronic form. The report is transmitted to the officer's supervisor. The supervisor notes one deficiency in the report and she issues it back to the officer. The officer corrects the report and re-transmits it to the supervisor. She electronically signs off on the report and forwards it to the Central Records System and to the District Attorney's office.

13. The officer clears the incident on his PSCD, which automatically shuts off the video camera, and resumes patrol.

### 3.4.3 Law Enforcement Communications Summary

Throughout the scenario, the law enforcement personnel and equipment as well as the arrested suspect are tracked by the network providing geo-location information in real time to provide the field supervisor as well as dispatch with current accountability of all personnel. All suspect information and evidence are recorded through wireless monitors and voice recognition systems with no reliance on paper reports and notes. All information is tagged with the original officer's identity code. All evidence is tracked with RF IDs to provide an audit trail. All law enforcement personnel and equipment have monitors to measure vital conditions and status that are reported by the wireless PAN and IAN systems to the IC's GIS. National and state criminal justice records and state civilian records are searched and queried for information relating to the traffic stop, etc.

## 3.5 Multi-Discipline/Multi-Jurisdiction-Explosion Scenario

This scenario focuses on the command and control, asset status and tracking, and major communications interoperability aspects of an incident involving first responders. The scenario occurs from the perspective of the Incident Commander and Emergency Commander, and does not include first person, first responder perspectives. The communications capabilities described in the three first responder scenarios are implied (but not described) in this scenario. The italicized text indicates actions or responses of the Emergency Manager.

### 3.5.1 Explosion

1. A large explosion occurs at a chemical plant in Barberville, a suburb of Brookside. There is the potential for hazardous chemical leaks as well as toxic smoke from the chemicals burning.

2. Incident Command (IC) arrives on-scene and assesses the situation. After briefly surveying the area, the IC team initiates their mobile command center and begins to receive information from the temporary network created by the on-site first responder vehicles and personnel.

3. The Emergency Manager (EM) is alerted that a major incident has occurred and brings up the command terminal in the Emergency Operations Center (EOC) to monitor the regional situation. All of the region's assets are available for query by the EM.

4. The mobile command center's display registers all of the assets that are currently on-scene, including EMS, Law Enforcement (LE), and Fire. The status of each asset is also available, but is displayed on demand.

5. IC shifts the display to a GIS overlay of the explosion, with the location of all assets shown. Areas are marked to display casualties, fires, evidence, the incident perimeter, etc. The information for the GIS displays comes from a site survey already underway by LE, Fire, and EMS personnel.

6. Information is available on the EM's system as the information is gathered by IC. This information is shown both in a GIS-map format as well as a textual set of data. On demand, the EM can call up the information on the incident as if the EM were on site in the capacity of IC.

7. As new units arrive on-scene, they are authenticated into the incident and added to the list of assets available to IC.

8. The on-scene Fire Branch monitors the status, location, and current duties of the Fire assets on their command screen, and reassigns them as necessary. Any data that is pertinent to the other Branches and IC is automatically forwarded onto their command systems. This same situation is repeated for both the LE Branch as well as the EMS Branch.

9. After completing all of the pre-defined tasks for this particular type of incident, IC begins coordinating with the LE, EMS, and Fire command posts. As IC begins directing the assets in the field, the Fire Branch informs IC that the incident is too large to be handled by the assets on hand. IC then puts in a request to the EM for the acquisition of more fire units.

10. As the request for more fire assets comes into the EM, the EM initiates the Mutual Aid agreements in place, and units are dispatched from the Brookside Metro area to Barberville.

11. The EMS Branch sets up a triage/treatment area and begins to direct the resources available to identify and handle casualties. The location of the triage/treatment area is disseminated to all first responders on-scene, and the area medical facilities are alerted as to the status of the triage/treatment area.

12. The Fire Branch is notified of an emergency on their command screen as one of the firefighters in the field has a passive sensor triggered by the detection of a hazardous chemical. The sensor determines that the hazardous chemical would not be ignited by a radio transmission, allowing the network to notify all first responders within 100 feet of the particular firefighter along with LE, EMS, and IC. The Fire Branch designates this area as a Hot Zone that alerts any personnel entering the designated area as to its status.

13. Because of the potential for the release of hazardous chemicals, the EM directs all available Hazardous Materials (HazMat) teams to the location, and puts these assets under the control of IC.

14. IC sets up a secondary perimeter five blocks back from the incident.

15. The EM notes the perimeter change and initiates a Reverse 9-1-1 warning call that is sent to all fixed and cellular telephones inside the secondary perimeter. This call instructs the people inside the perimeter to find shelter in the area quickly and to close off all outside ventilation.

16. The LE Branch is directed by IC to coordinate with the Department of Transportation (DOT) to configure traffic management assets, such as traffic lights and electronic signs, to divert traffic away from the incident.

17. The LE Branch has enough assets to establish a perimeter, but needs more assets to maintain the security of the incident. IC puts in a request for LE assets to the EM.

18. The EM begins to coordinate with the public utilities and other pertinent private organizations for the appropriate responses, such as shutting down gas lines to the area, and dispatching electrical crews to handle situations, such as downed power lines. The EM also directs additional LE assets into the area upon receiving the request from IC.

19. Upon further investigation by LE and Fire assets, IC determines that this explosion was not an accident, directs LE to treat the area as a crime scene, and assigns Detectives to begin an investigation of the crime scene in coordination with Fire Investigators. This information is also available to the EM.

20. After determining that the probable cause of the situation is a bomb, IC directs the LE Branch to begin directing traffic away from the scene and to initiate a secondary explosive device search by the Explosive Ordinance Disposal (EOD) team.

21. The EMS Branch continues to coordinate the efforts of EMS assets. As casualty information comes onto the command screen via the RF ID tags used by personnel in the field, the most critical cases are selected for transport to the nearest available hospitals. The EMS Branch believes that the on-scene casualties will overburden the medical facilities selected to handle them. The transportation officer is directed to query the local medical facilities as to their status, and their capacity for casualties and what types of casualties can be taken. Casualty statistics are available on demand by IC and the EM. Additionally, the local medical centers coordinate among themselves regarding resource availability.

22. The EM begins to monitor the status of the casualties, as well as the status of the responding medical facilities. Seeing the casualties from the incident will overburden the nearby facilities, the EM puts a neighboring medical facility on alert for incoming casualties. The EM also directs additional EMS crews to respond to the incident.

23. As EMS assets arrive on-scene, the assets are registered and their capabilities are authorized for placement into the EMS asset pool for assignments given by the EMS Branch.

24. The Unit Commander of the EOD team notifies the LE Branch that no secondary devices have been found. The LE Branch pushes this information to IC. IC then automatically forwards this information to the EM.

25. The Fire Branch alerts IC that all of the fires have been identified and are marginally contained. Additionally, the hazardous chemical spill has been contained and eliminated by the HazMat teams dispatched by the EM. All but one HazMat team is released back into the asset pool.

26. The Fire Branch alerts IC that all of the fires have been eliminated, and that all but one Fire Crew has been released back into the asset pool.

27. The EMS Branch alerts IC that all of the casualties have been evacuated to appropriate medical facilities. The coroner has been contacted to begin removal of the corpses.

### 3.5.2 Multi-Discipline/Multi-Jurisdiction Communications Summary

The abstracted view of Incident Command is very different than that of a first responder reacting to a situation in the field. As such, their communications needs and capabilities are tailored to meet those differences. While the communications and actions depicted in the scenario are oversimplified versions of what would actually have occurred in real life, what has been captured is the general nature of the communications, the command and control functionality, and examples of access to a wide variety of information on an on-demand basis. The command and control of Incident Command on-scene and the Emergency Manager provides for the safety and accountability of all the assets at the incident and provides information on additional resources that could be brought to the incident. The networks for communications and information exchange are created on an ad hoc and/or temporary basis at the scenes. They overlay on one another to provide interoperability and integrate with the larger jurisdiction area networks to form a system of systems for command and control.

# 4. Operational Requirements of PSWC&I

Practitioners in public safety agencies rarely need to talk only among themselves in the course of their missions. There are multiple levels of interaction that occur among public safety disciplines and jurisdictions. This section defines the levels of intra-agency "operability" and interagency "interoperability" that occur for each major public safety discipline.

Public safety communications are defined in the area of operability and three areas of interoperability (Day-to-Day, Task Force, and Mutual Aid) based upon their internal and external interactions.

***Note!*** ***It is critical that the reader not confuse these three communications-based definitions (from the PSWAC Final Report) with the common operational use of the same terms. For example, agencies also use "Task Force" to refer to functions that occur within an agency, and the term "Mutual Aid" is commonly used operationally to reference all types of interoperability. For the purpose of this report, the term "Mutual Aid" in its communications context is used to describe events of such magnitude that a state's mutual aid pact is activated.***

The following subsections first define the operations of public safety agencies with general requirements associated with those operations and, second, describe specific operations for each of the first responder groups with their specific communications requirements. All of these services are provided by first responders at the local, county, state, and tribal levels. The federal government has few first responder organizations, primarily providing such services on large federal properties, such as National Forests and Parks and on military bases.

## 4.1 Public Safety Operations Background

### 4.1.1 Disciplines

Previous sections of the SoR have referred to public safety agencies and the supplemental agencies that provide support, such as departments of transportation, or related agencies that provide complementary functions, such as judicial systems. In this section, the discussion will concentrate on the public safety first responders:

- Structure Fire and Wildfire Suppression Services
- Emergency Medical Services (EMS) The components of the EMS system include the following:
  - First responders (people and agencies that provide non-transporting first aid care before the ambulance arrives on-scene).
  - Ambulance services (basic and advanced life support, etc.).
  - Specialty transport services (helicopter, boat, snowmobile, etc.).
  - Hospitals (emergency, intensive, cardiac, neonatal care units, etc.).
  - Specialty centers (trauma, burn, cardiac, drug units, etc.).
  - This section will refer to EMS personnel including paramedics and emergency

medical technicians (EMTs) who are on-scene at the incident
- Law Enforcement Services

The SoR concentrates on first responders' operational needs for communications because their performance requirements exceed those of all other agencies for most performance metrics, such as ease of operation, reliability, respirability, scalability, ability to operate in harsh environments, etc.

### 4.1.2 Jurisdictions

As noted earlier, public safety first responders are either found in all jurisdictions or operate with others in all jurisdictions.

- Local/Regional
- State
- Tribal
- Federal

Public safety agencies interact with one another by discipline as well as by jurisdictions. Communications systems must be able to cut across all levels of interaction just as the practitioners of the agencies cut across all levels.

### 4.1.3 Hierarchy and Modes of Operations

The hierarchy levels of communications include:

a. Intra-agency:

- Single Discipline/Single Jurisdiction

b. Interagency:

- Single Discipline/Multiple Jurisdictions
- Multiple Disciplines/Single Jurisdiction
- Multiple Disciplines/Multiple Jurisdictions

The hierarchical levels define increasingly complex communications interactions and administration as the hierarchy moves from the single discipline/single jurisdiction situation to the multiple disciplines/multiple jurisdictions events. The level or hierarchy of the communications operations interaction should not cause confusion and frustration for the first responder. The first responder must be able to respond and react to each level without regard to the communications requirements and the communications functionality must be invisible to the user.

There are many modes of public safety operations and an equal number of ways to classify them. The PSWAC Final Report defined the interagency modes based upon the needs for “communications interoperability,” according to characteristics that clearly define each of the three modes. In the following, the PSWAC modes are identified as well as agency internal modes that are common to public safety.

#### 4.1.3.1 Modes of Routine Intra-agency Operability:

1. Normal operations within a discipline.
2. Communications that are rehearsed and practiced every day.
3. Day-to-day patrols/duties and responses to dispatches from emergency call centers.
4. Task force operations within a discipline/agency for a specific mission.

#### 4.1.3.2 Modes of Interagency Interoperability:

1. Day-to-Day:
    - Communications that are rehearsed and practiced every day.
    - Routine operations with neighboring agencies to provide support or backup.
    - It is estimated that this form of interoperability makes up 90 percent of an individual first responder's multi-agency activities.
2. Task Force:
    - Cooperative effort among mixed yet specific agencies/disciplines.
    - Extensive preopening with practice.
    - Operations that are planned/scheduled and proactive.
    - Operations that have a common goal, common leader, and common communications.
3. Mutual Aid:
    - Major event that causes a large number of agencies to respond and requires considerable coordination.
    - Major event that requires response from multiple jurisdictions from the local level to the state and national level.
    - Communications that operate under a state or regional mutual aid pact.
    - Operations that are usually not planned or rehearsed, but are reactive to the situation.

#### 4.1.3.3 Overlap and Modes

While there is much overlap of the modes of operation, it is useful to divide the discussion among the four modes. The operability and day-to-day interoperability modes fit a general normal structure for public safety personnel and should not tax their ability to deal with communications processes and procedures. Many of these operations may be strictly within the discipline or agency with no communications interoperability requirements with other disciplines or agencies at all. However, as described in the PSWAC Final Report, day-to-day operations can routinely include the need for city law enforcement personnel to communicate with county law enforcement personnel and vice versa. This ability to communicate minimizes the need for dispatcher-to-dispatcher interaction in the exchange of information among units in the field. Day-to-day operations can also include intra-agency task force operations to carry out a specific mission, such as a DUI (Driving Under the Influence) checkpoint where the communications are within the agency and do not require interoperability with other agencies. Also on a day-to-day basis, an agency, such as one fire district, can routinely back up another, while one agency covers an emergency. This form of interoperability (often called “mutual aid” from an operational perspective) is different than the mutual aid interoperability discussed below. Because these first two modes fit within the normal operating patterns of agencies, they are included together in each of the three first responder discipline-based discussions below.

The task force mode defines a cooperative effort between specific agencies with extensive pre-planning and practice of the operation. As the PSWAC Final Report indicates, the communications tend to be at close range and the traffic requires rapid or immediate response times. In today's environment, task forces, such as a terrorism task force, may cover a broad regional area and not operate exclusively at close range. These operations present additional challenges.

The mutual aid mode describes those major events with large numbers of agencies involved, including agencies from remote locations. Their communications are not usually well planned or rehearsed. The communications must allow the individual agencies to carry out their missions at the event, but follow the command and control structure appropriate to coordinate the many agencies involved with the event.

While the PSWAC Final Report defined these modes of operation to stress the need for communications interoperability among the first responders, the majority (as much as 90 percent) of the communications usage falls under the day-to-day operations mode. Thus, the communications systems must support the day-to-day operations with all the performance features that may be required to support the other modes of operation. Unless the systems provide the first responders with seamless functionality regardless of the mode of operation, the first responders will not use their systems efficiently or effectively, especially when they need to operate in the task force and mutual aid modes.

### 4.1.4 Security

In much of the following discussion, the need for security in communications and information sharing is specified.

As a general specification, the principles of security for public safety communications and information sharing include the following requirements.

a. Access control

Both the public safety users as well as the public safety user's device(s) must be authenticated before they are given access to network resources, and the communication networks must ensure users do not exceed their allowed authorities

b. Data integrity

The communication networks must not allow unauthorized interception/ modification of communications or information; they must not allow communications replay attacks; and, they must have non-repudiation capabilities to ensure evidence in the event of a dispute.

c. Privacy

The communications systems must allow only intended and authorized recipients to hear/see/read information as well as follow national and state policies (e.g., Health Insurance Portability and Accountability Act-HIPAA).

Although security is identified as a separate topic for discussion, it must be fully integrated in the development and implementation of the communications systems. Security cannot be added on after the fact or as a last resort.

#### 4.1.4.1 Attack detection and prevention

The communications networks must be resistant to jamming; they must be capable of passive/ active attack monitoring and defense deployment; they must be able to geo-locate the source of an attack; and, they must be capable of monitoring of all functional aspects by authorized users/ devices.

### 4.1.5 Command and Control

Public safety operations follow a command and control hierarchy that allows public safety personnel to work seamlessly on situations that may begin small, but can evolve into large incidents, requiring many resources and assistance from numerous jurisdictions. As an incident grows in magnitude, the incident commander has to know what resources and capabilities are becoming available for use. Each of the first responder disciplines may have their own branch commander at a large incident, and these branch commanders must be able to coordinate, communicate, and share information with the overall incident commander.

The communications systems that support these operations must also be capable of the same command and control features.

a. Incident command structure

the communications systems must support the agency's incident command policies.

b. System administration of users

the communications systems must allow authorized system administrators, as well as incident and branch commanders, to establish user profiles for network access and usage, depending upon the role that the public safety user is asked to satisfy during an incident.

c. User identification and location

the communications systems must provide user identification to others during communications and, when required, must provide user geo-location information to incident commanders and other authorized resources.

Finally, the system must allow communications and information sharing between incident command and/or unified command operations with an Emergency Operations Center (EOC). In some instances, access on-demand is required by the EOC to Geographic Information System (GIS)-based displays, video, and communications as they are happening at the incident.

### 4.1.6 System of Systems

The communications systems must be integrated with the public safety user's operations. For example, as a police officer leaves a squad car to respond to a traffic stop or to investigate a domestic dispute, the critical communications capabilities-whether voice or data-must remain with the officer. As a firefighter enters a burning building, the biometric monitoring devices, the equipment status devices, and the firefighter's location device must indicate to the incident commander the firefighter's status and location at all times. These wireless devices used by law enforcement personnel, by firefighters, and by EMS personnel must work in a variety of networks. Together, they will form the system of systems, with the following components.

a. Personal Area Network (PAN)

On the small scale, the communications device interacts with other devices that belong with the public safety individual. A first responder is equipped with wireless devices used to monitor the first responder's physical location, pulse rate, breathing rate, oxygen tank status, as well as devices for hazardous gas detection and voice communications. The devices are all linked wirelessly on a personal area network (PAN) controlled by the first responder's communications device.

b. Incident Area Network (IAN)

An incident area network (IAN) is a network created for a specific incident. This network is temporary in nature.

c. Jurisdiction Area Network (JAN)

The JAN is the main communications network for first responders. It is responsible for all non-IAN voice and data traffic. It handles any IAN traffic that needs access to the general network, as well as providing the connectivity to the EAN.

d. Extended Area Network (EAN)

The city systems are in turn linked with county, regional, state, and national systems or extended area networks (EAN).

Because public safety operations are usually conducted in the field and emergency operations must take place in the vicinity of the emergency, the networks must allow for mobile members, or the networks themselves must be mobile and temporary in nature. They must be dynamic and scalable to allow new resources to come on to a temporary network, and they must allow temporary networks to integrate with larger temporary or fixed networks.

### 4.1.7 Communications Needs for Public Safety Operations

The following subsections describe the activities of public safety agencies and how wireless communications and information resources are needed to support those activities. This section is similar to the scenario section, but it further identifies how communications and information will be used by the first responders during intra- and inter-jurisdictional operations.

The modes of communications are divided into four categories.

- Voice communications-interactive.
- Voice communications-non-interactive.
- Data communications-interactive.
- Data communications-non-interactive.

For each of the modes of operational communication and for each of the categories of public safety first responders, the following subsections describe the operational uses of communications and information in the context of the following parameters. The communications occur:

- with whom
- for what purpose
- with what special considerations, needs, and requirements (time limits, encryption, access to sensitive information, etc.)

In the following discussions, all intra- or inter-agency communication and information sharing are assumed to be allowed only when the users are authorized by their agencies.

## 4.2 Structure Fire and Wildfire Suppression Services

### 4.2.1 Routine Operability and Day-to-Day Interoperability

These activities are centered on response to building fires and wildfires, specialty fires, such as at airports, search and rescue missions, emergency calls (9-1-1), traffic accidents, water recreation accidents, hazardous materials incidents, medical emergencies, and other emergency events. In larger cities, fire suppression services are provided by full-time municipal government employees, who also may provide emergency medical assistance and other related services. In other more rural settings, fire suppression services are often provided by organized and trained volunteers. States have Divisions of Natural Resources or State Forestry Departments with teams experienced to fight wildfires within the state. Federal land management agencies, such as the Department of Interior's Park Service and Bureau of Land Management or the Department of Agriculture's Forest Service, have wildfire suppression programs and personnel.

The majority of fire operations are within the routine operability and day-to-day interoperability categories. Fire departments often use interoperability on a day-to-day basis. For example, when a particular fire station responds to a structure fire, a neighboring fire station essentially increases its response area by covering for the first fire station, which is responding to the structure fire.

### 4.2.2 Task Force

Routine fire suppression scenarios often meet the definition of task force operations. With sporting events and other large public gatherings that can be planned in advance, fire response teams will be coordinated. They may have staged equipment and other resources at the event that need to communicate with a local command post. This section assumes the same operational needs as day-to-day operations, though they may need to be expanded in scope for these larger events.

### 4.2.3 Mutual Aid

Mutual aid for the fire services can occur in a wide range of situations, including extreme weather conditions, such as hurricane, flooding, and tornadoes, earthquakes, major explosion (terrorist or accidental), plane crash, major fires, riots, etc.

Mutual aid operations are characterized by a large number of neighboring agencies, personnel, and equipment brought in to assist the affected jurisdiction. These include agencies from neighboring regions, neighboring states, federal agencies, and occasionally agencies from outside of the United States. Communications with all of these additional personnel and a temporary command structure will be required, via existing infrastructure (if still operational) and extra temporary infrastructure brought in for the duration of the emergency. Contacts may include law enforcement, traffic control, Fire, EMS, hazardous materials units, urban search and rescue, military, National Guard, relief agencies, weather information, temporary housing and food organizations, volunteers, etc., depending on the scale and type of the event.

The mutual aid communications functions needed for firefighting are similar in nature to everyday operations except for the greatly increased scale of the effort, shortages of equipment, personnel, and water. In large-scale disasters, there is often greater uncertainty about the location and condition of victims, while contending with multiple fires, water shortages, rescue operations, police actions, overloaded communications and transportation resources and other serious and dangerous distractions that accompany these events.

During these events, firefighting operations must continue at a high level of efficiency, with intensive dependence on large numbers of extra workers from neighboring agencies and jurisdictions.

Also falling into the category of mutual aid are extremely large planned events, such as political conventions, the Olympics, and international meetings where a host state's mutual aid pact is activated in advance. In such events, as with smaller task force-based events, fire suppression response will be coordinated. It is anticipated that large amounts of resources will be staged nearby to support these events, including potential disruption and civil unrest that might occur in conjunction with the event. The provision of day-to-day level services will be expected by the public throughout the event, while the host agency continues to provide the same level of services to the remainder of its jurisdiction.

#### 4.2.4 Voice Communications-Interactive

Table 4. Fire Voice Communication Interactive

| The communication occurs: | |
|---|---|
| **with whom** | Public Safety Answering Point (PSAP), public safety communication center (9-1-1 center), supervising officers and incident commanders, other firefighters at scene, police and other emergency workers on selected user groups, and selected user groups in neighboring areas, agencies to control traffic and crowds, coordination with local hospitals, emergency rooms, and doctors. Dispatcher and supervising officers, incident command officers and other participants, or any other persons on a person-to-person basis, including Public Switched Telephone Network (PSTN) when authorized. |
| **for what purpose** | These voice calls are to receive instructions from the dispatcher and to coordinate with the incident commander, coordinate efforts with local and neighboring fire departments or natural resource management agencies for additional assistance and equipment, coordinate with local and neighboring police and other agencies for traffic and crowd control, for information on building ownership/ contents/ personnel, obtaining detailed medical advice on treatment of victims and instructions for transportation, etc. |
| **with what special constraints** | Many of these calls are very high priority, are mission critical, and may need to be secured to protect privacy and maintain chain-of-command authority. |

### 4.2.5 Voice Communications-Non-interactive

Table 5. Fire Voice Communication Non-interactive

| The communication occurs: | |
|---|---|
| **with whom** | Dispatchers, via voice pagers, or other fire officials in local and neighboring agencies using paging receivers. Incident commanders and supervisors via radios. |
| **for what purpose** | Voice paging is used to alert volunteer fire personnel concerning an immediate need for their services. These voice calls are to transmit instructions from dispatcher and to coordinate with the incident commander. |
| **with what special constraints** | Many of these calls are very high priority and need to be secured to protect privacy and maintain chain-of-command authority. |

### 4.2.6 Data Communications-Interactive

#### 4.2.6.1 Accountability Communications

Table 6. Fire Data Communication Interactive 1

| The communication occurs: | |
|---|---|
| **with whom** | Firefighters share a unique responsibility to each other and to those under their command to provide immediate aid relative to a firefighting activity. |
| **for what purpose** | These communications are for firefighter safety and accountability. The goal is to know where every firefighter is located, to know the firefighter's health and condition, and to have the ability to remove the firefighter from life-threatening situations. Also all firefighting equipment needs to be located and tracked through an Automatic Vehicle Location (AVL). The data must be continuously updated on the Incident Commander's GIS and the dispatcher's CAD displays to indicate the location and health of all firefighter assets. |
| **with what special constraints** | This data must be current, accurate, time sensitive, and have a high priority. The data would include the firefighter's three-dimensional location with high resolution; the firefighter's biometrics such as heart rate, temperature, respiratory rate, and blood pressure; and the firefighter's equipment status, such as an oxygen tank remaining supply. The data must be able to be used to notify nearby firefighters of the location of the firefighter seeking aid and to “vector” the rescuing firefighter to the firefighter requiring aid. |

#### 4.2.6.2 Text messages

Table 7. Fire Data Communication Interactive 2

| The communication occurs: | |
|---|---|
| with whom | Exchange information among firefighters and others via interactive messaging. Exchange information with systems that may include data repositories, databases and active files on a wide range of public safety activities from local and neighboring jurisdictions and agencies. These exchanges will require immediate responses from the other individuals or the data systems. |
| for what purpose | Text data communication is used for access to current and archived computerized information, e.g., information about contents, uses, ownership of buildings; medical records of patients, etc., and for printing backup of incident-related communications sent earlier via a voice call. In addition, data communications are used to file reports remotely and electronically (using office-in-a-vehicle capabilities), so that they are rapidly available to local and neighboring public safety officials. |
| with what special constraints | Much of this data is very high priority and needs to be secured to protect privacy and maintain chain-of-command authority. |

#### 4.2.6.3 Image communications

Table 8. Fire Data Communication Interactive 3

| The communication occurs: | |
|---|---|
| with whom | To communicate with local, state, and national databases, various local and neighboring public safety personnel working on the incident, dispatchers, and command officers. Databases include archived maps, photographs, building drawings, etc. and active files on a wide range of public safety activities from local and neighboring jurisdictions and agencies. |
| for what purpose | The images are transferred for a wide range of purposes to assist firefighters on the scene or to aid the incident commanders with visual information. Maps and drawings of buildings, roads, utilities, hazardous locations, hydrants, and terrain serve a wide range of planning, firefighting, traffic control, and search functions. Current pictures taken at a fire scene (ground level and aerial) are useful immediately for tactical firefighting decisions; pictures of victims are needed to help doctors at distant sites recommend best medical response to injuries. |
| with what special constraints | These communications require rapid response and thus are considered interactive. These images are high priority and require rapid transmission. Encryption will be needed to preserve privacy and prevent the release of critical data. |

#### 4.2.6.4 Video communications

Table 9. Fire Data Communication Interactive 4

| The communication occurs: | |
|---|---|
| with whom | To send video images between fire personnel in the field and remote dispatchers or incident commanders, and medical doctors. Video images are also used to control robotic devices to observe inside burning buildings, collapsed structures, underwater rescues and recoveries, etc. |
| for what purpose | Video pictures (ground based and aerial) taken at the scene of a fire or other emergency sites are extremely useful for immediate tactical firefighting response, to coordinate rescue efforts, to help distant medical personnel evaluate patient condition and treatment, etc. These video pictures can also include specialized non-visual imaging to warn of spreading fire, chemical hazards, etc. Robotics video is needed at the site to aid in controlling robotics devices, but is also useful for tactical direction by the incident commander. |
| with what special constraints | Real-time video is extremely valuable in numerous firefighting and medical situations, both locally and remotely, even though it may require substantial resources to transport it from the scene to observers. Many situations will require very high resolution to provide the observer clear video pictures. Some of this video should be encrypted. |

### 4.2.7 Data Communications-Non-interactive

#### 4.2.7.1 Text messages

Table 10. Fire Data Communication Non-interactive 1

| The communication occurs: | |
|---|---|
| with whom | To send each firefighter's personal biometrics (heart rate, breathing rate, body temperature, etc.), from the fire scene, resources status (oxygen tank, water pressure, battery capacity, etc.) and physical location to the Fire Department (FD) command post. To send large equipment resource status (tanker water pressure, location, etc.) to the FD command post. To send warning pages to firefighters to indicate hazardous conditions. |
| for what purpose | The fire scene personnel and equipment status allow the FD command post to track and control all resources. |
| with what special constraints | Much of this data is very high priority and the data would be polled from the field units or the field units would need to “push” the information to the command post about every second from personnel and about every 30 seconds from large equipment resources. |

#### 4.2.7.2 Image communications

Table 11. Fire Data Communication Non-interactive 2

| The communication occurs: | |
|---|---|
| with whom | To communicate with the incident command post. At the fire scene, head mounted infrared (IR) cameras on the firefighters send images to the FD command post. Firefighters also receive images from the command post. |
| for what purpose | The images are transferred for a wide range of purposes to assist firefighters on the scene or to aid the incident commanders with visual information. IR images allow the FD command post to track the development and suppression of the fires by mapping the IR hot spots. Maps and drawings of buildings with room locations as presented on a firefighter's heads-up display assist in fire suppression and search and rescue functions. |
| with what special constraints | These images are high priority and require rapid transmission. |

#### 4.2.7.3 Video communications

Table 12. Fire Data Communication Non-interactive 3

| The communication occurs: | |
|---|---|
| with whom | To send video images from fixed locations in the field to incident commanders. |
| for what purpose | Video pictures (ground based and aerial) taken at the scene of a fire or other emergency sites are used to monitor situations without requiring fire personnel to be on-scene observers. By using video as well as infrared (IR) images, weather data, wind speed, etc., all chained to a GIS application, the incident commander has a highly useful tool to predict fire behavior and progress. |
| with what special constraints | Usually, high-resolution video images are not needed for monitoring purposes. |

## 4.3 Emergency Medical Services

### 4.3.1 Routine Operability and Day-to-Day Interoperability

These activities are centered on response to emergency calls (9-1-1) for medical emergencies, traffic accidents, water recreation accidents, building fires, hazardous materials incidents, and other events. Although the services provided are similar in various areas, the administrative arrangements to provide these services may differ substantially. In many cities, EMS services are provided as part of municipal government, usually as part of the EMS/FD activities. In other cities, private ambulance companies, hospital-based ambulance services, volunteer EMT-ambulance services (making up as much as 60 percent of some state's providers), and other agencies perform more of the EMS functions. The basic services include patient stabilization from medical emergencies, such as cardiac and respiratory events, motor vehicle and other trauma, often in concert with extrication by fire and/or search and rescue teams. It also usually includes transport of the victim/patient to more intensive care in hospital/emergency room facilities or to medical specialty centers (trauma, burn, cardiac, etc.). Every day mutual aid operations occur when one hospital provides resources to another hospital for EMS purposes.

These day-to-day incidents, along with inter-facility emergency and non-emergency transports, form the bulk of the operations performed by EMS personnel. An expanded role of EMS for the future[1] may provide more requirements for assistance to physicians and hospitals with routine patient care; these additional operations may impact communications.

### 4.3.2 Task Force

EMS scenarios usually consist of a series of high-priority incidents involving task force operations, working with other first responder agencies. With sporting events and other large public gatherings that can be planned in advance, EMS teams will be coordinated. They may have an emergency clinic at the event and the clinic may need to communicate with hospitals and ambulances. This section assumes the same operational needs as day-to-day operations, though they may need to be expanded in scope and/or targeted to specific areas for these larger events.

### 4.3.3 Mutual Aid

Mutual aid for the emergency medical services can occur in a wide range of situations, including extreme weather conditions, such as hurricanes, flooding, and tornadoes, earthquake, major explosions (terrorist or accidental), multi-vehicle car crash, plane crash, major fires, and riots.

Also falling into the category of mutual aid are extremely large planned events, such as political conventions, the Olympics, and international meetings where a host state's mutual aid pact is activated in advance. In such events, as with smaller task force-based events, EMS teams will be coordinated. There will be emergency clinics at the event and these clinics will need to communicate with hospitals and ambulances. It is anticipated that large amounts of resources will be staged nearby to support these events, including potential disruption and civil unrest that might occur in conjunction with the event. The provision of day-to-day level services will be expected by the public throughout the event, while the host agency continues to provide the same level of services to the remainder of its jurisdiction.

1. From the 1996 National Highway Traffic Safety Administration's EMS Agenda for the Future (*http://www.nhtsa.dot.gov/people/injury/ems/agenda/emsman.html*) is the vision statement: “Emergency medical services (EMS) of the future will be community-based health management that is fully integrated with the overall health care system. It will have the ability to identify and modify illness and injury risks, provide acute illness and injury care and follow-up, and contribute to treatment of chronic conditions and community health monitoring. This new entity will be developed from redistribution of existing health care resources and will be integrated with other health care providers and public health and public safety agencies. It will improve community health and result in more appropriate use of acute health care resources. EMS will remain the public's emergency medical safety net.”

Mutual aid operations are characterized by a large number of neighboring agencies, personnel, and equipment brought in to assist the affected jurisdiction. These include agencies from neighboring regions, neighboring states, and national agencies. Communications with all of these additional personnel and a temporary command structure will be required, via existing infrastructure (if still operational) and extra temporary infrastructure brought in for the duration of the emergency. Contacts may include law enforcement, traffic control, Fire, EMS, hazardous materials units, urban search and rescue, military, National Guard, relief agencies, weather information, temporary housing and food organizations, volunteers, etc., depending on the scale and type of the event. As the scale of the event increases in magnitude, the communications and control must be handed off from the local dispatcher and PSAP to a county dispatcher and Emergency Operations Center (EOC) or to a state EOC.

The communications functions needed for EMS functions at large disasters are similar in nature to everyday EMS operations except for the greatly increased scale of the efforts. There may be a requirement to communicate with Disaster Medical Assistance Teams (DMATs), or to request resources from the Strategic National Stockpiles (SNSs) for pharmaceuticals and medical supplies. In large-scale disasters, there will often be greater uncertainty about the location and identity of victims, more intense pressure to provide adequate medical treatment with overworked and overloaded treatment providers and facilities. There may be a need to transport large numbers of patients to many hospitals, including the movement of less injured patients to more remote hospitals or temporary facilities. There will be a need to solve immediate life-threatening medical problems while contending with fire, water, rescue operations, police actions, overloaded communications and transportation resources, and other serious and dangerous distractions that accompany these events.

During these events, EMS operations must continue at a high level of efficiency, with intensive dependence on large numbers of extra workers from neighboring agencies and jurisdictions.

Two notable exceptions to the day-to-day mode of operations will be the need to provide remote medical staging and to engage more levels of medical services, such as the county or state public health agencies.

At a large incident, the medical branch commander will need to do the following: Provide staging of paramedics, emergency medical technicians, supplies, and ambulances at a site remote from the incident scene; request resources; know who is available; know the resources estimated time of arrival (if they are not at the staging site); know their capabilities; and know what hospitals and health centers are available to receive patients.

Some large incidents deal with toxic spills, weapons of mass destruction, etc., that can affect more of the public beyond those who may be close to the incident site. In those incidents, the medical branch commander will need the ability to communicate with public health officials to help plan the evacuation of citizens, to coordinate public responses and preparations, etc.

### 4.3.4 Voice Communications-Interactive

Table 13. EMS Voice Communication Interactive

| The communication occurs: | |
|---|---|
| with whom | 9-1-1 dispatchers; local hospitals, emergency rooms, and doctors; incident command officers for fires, special police operations, traffic accidents, boating and aircraft accidents; other emergency workers on selected user groups; special service providers (other specialty transportation providers, search and rescue teams, and extrication teams); traffic and crowd control; and utility and public service providers. Also with dispatchers, supervising officers, selected user groups, and hospitals in neighboring areas and jurisdictions, and other individuals (such as a patient's personal physician) on a person-to-person basis via the PSTN. To talk between the cab of an ambulance (also aircraft cockpit, snowmobile, etc.) and the patient care compartment of ambulance (also aircraft patient area, snowmobile sled, etc.). To talk with life line electronic medical emergency service providers and automatic crash notification service providers. |
| for what purpose | These voice calls would be used to receive instructions and assignments from the dispatcher; coordinate with the incident commander; inform the dispatcher of progress; ask other EMS providers or other agencies for help or information; to obtain medical directions and consultations with physicians and emergency medical centers; to inform receiving facilities of patient's conditions and needs; to consult with supervising physicians for patient diagnosis and treatment for non-emergent conditions where EMS provides routine community health care services; and to consult with the patient's own physician. Communications can be to multiple jurisdictions, especially during the transport of patients to distant facilities. Communications could be between emergency medical dispatch personnel and patients or those who have called 9-1-1 to provide pre-arrival aid instructions, such as bleeding control and cardiopulmonary resuscitation (CPR), and to determine the level of EMS responders required, based upon the patient's needs. |
| | Communications between the ambulance driver and the patient attendant has to be via wireless head phone capability to allow hands-free operation as well as private communications between driver and attendant without the patient and/or the family listening to both sides of conversation. Communications between EMS and fire rescue units for extrication, lifting patients, and locating emergency scenes. Communications between EMS and law enforcement ensuring scenes are safe for EMS personnel, protecting response crews in violent areas, etc. These communications are considered routine. |
| with what special constraints | Many of these calls are very high priority. Most of these calls need to be encrypted, especially those discussions between EMS incident personnel and the hospitals/medical emergency centers. Because physicians need to know the identity of EMS incident personnel before they issue medical directions and procedures, the voice communications system needs to authenticate and authorize the personnel for the physicians and provide the field personnel's identity to the physicians. Full-duplex with three or more people (physicians, paramedics, EMTs, etc.) with conference call-like features will be required in some cases. EMS field personnel require communications directly with hospitals and physicians and not through dispatchers. |

### 4.3.5 Voice Communications-Non-interactive

Table 14. EMS Voice Communication Non-interactive

| The communication occurs: | |
|---|---|
| **with whom** | Incident commanders and supervisors for alerts and advisories via radios; dispatch for voice paging; automated status systems. |
| **for what purpose** | These voice calls are to transmit instructions from the dispatcher and to coordinate with the incident commander; and for automated weather notifications, fire conditions, water and sea states. |
| **with what special constraints** | Many of these calls are very high priority and need to be secured to protect privacy and maintain chain-of-command authority. |

### 4.3.6 Data Communications-Interactive

#### 4.3.6.1 Text messages

Table 15. EMS Data Communication Interactive 1

| The communication occurs: | |
|---|---|
| with whom | Local and neighboring agencies, using directed text messages, and local and neighboring EMS agencies. To communicate patient medical telemetry to local hospitals/emergency treatment centers. Patient vital statistics collected by EMS personnel at the incident with voice-activated recorders. Status of EMT skills/knowledge/licensing levels and drugs/equipment and other resources on-board the ambulance for medical direction physicians to access in order to provide appropriate medical orders. Accurate location information is needed to guide EMS resources to the patient location. Also AVL information along with vehicle and crew status is needed by dispatchers and incident managers for closest ambulance availability, etc. Information on assignment of patients to hospitals. |
| for what purpose | Text data communications are used to access current and archived computerized information, to establish the identity and medical background of patients, to communicate with responsible medical and incident personnel. To provide immediate transport of diagnostic patient medical telemetry to doctors at emergency treatment facilities and EMS command post supervisors. To provide EMS personnel with data on special hazards (toxic materials, etc.) at a site that may affect the diagnosis and treatment of patients. Although the transmission of real-time vital statistics from an incident or from an ambulance to the hospitals is not currently used (or little used) by EMS personnel, the capability may be useful in the future, especially for high-risk patients. The service would need to be controlled on-command/on-demand by the hospital physicians. To allow EMS personnel to collect a patient's vital statistics and to record the information using “hands-free” voice recognition data entry; for example, an EMS person's statement of “Enter patient's blood pressure of 136 over 95" would be recorded as “BP: 136/95.” To allow information flow between EMS field personnel and hospitals to be digitally transmitted and recorded; for example, patient information and vitals would be transmitted to the hospital and available to the physicians without needing to write the information provided, following the “enter once, use often” philosophy. To allow patient monitors to have wireless connections between the patient and the monitors, such as EKGs, stethoscopes, blood pressure monitors, which allows for easier transport of the patient with all monitors still functioning. |
| with what special constraints | Much of this information needs to be secured to protect privacy concerns and chain-of-command for lifesaving procedures. |

#### 4.3.6.2 Image communications

Table 16. EMS Data Communication Interactive 2

| The communication occurs: | |
|---|---|
| with whom | Various public safety officials in the field, dispatchers, and command officers, and local and neighboring databases. Databases include archived photographs, building drawings, road and terrain maps, etc., and active files on a wide range of public safety activities from local and neighboring jurisdictions and agencies. |
| for what purpose | The images are transferred for a variety of purposes, including identifying patients. Maps and drawings of buildings, roads, and geographic areas serve a wide range of planning functions, including location, rescue, and transportation of patients, traffic control, and search functions. Pictures of victims and injuries at distant sites are helpful to doctors, enabling them to recommend best medical responses, and to law enforcement officials, enabling them to identify victims. Images of a car accident, for example, are useful to physicians identifying the forces applied to victims within the car during the crash. |
| with what special constraints | These images are high priority, require rapid transmission, and may need security. |

#### 4.3.6.3 Video communications

Table 17. EMS Data Communication Interactive 3

| The communication occurs: | |
|---|---|
| with whom | To send video images between EMS workers in the field and remote dispatchers or incident commanders, and medical doctors. Although video communications services are not currently used (or little used) by EMS personnel, the capability may be useful in the future. The service would need to be controlled on command by the hospital physicians. |
| for what purpose | Video pictures (ground based and aerial) taken at the scene of a fire or other emergency sites may be useful to help distant medical personnel evaluate patient condition and treatment, etc. Telemedicine techniques require high-resolution video images to allow viewing a patient's burns, skin and bone details, etc. |
| with what special constraints | Real-time video may be valuable for the correct diagnosis and treatment in some emergency situations, but has tremendous potential for application of routine community health services, particularly in remote, rural areas where EMS personnel provide such services. The options for treatment in pre-hospital emergency setting do not depend on remote physician's viewing of the patient. Some of this video should be encrypted. Additional legal requirements may not allow compression techniques to be used with telemedicine video communications. |

### 4.3.7 Data Communications-Non-interactive

#### 4.3.7.1 Text messages

Table 18. EMS Data Communication Non-interactive 1

| The communication occurs: | |
|---|---|
| **with whom** | To communicate with local and neighboring agencies using e-mail connections, web browsers, etc. To monitor incident personnel's biometric status; traffic status monitors, traffic control devices, and road conditions; hospital and health center status monitors; patient-history smart cards as carried by patient; and state public health services and Health Alert Network services. |
| **for what purpose** | Text data communications are used to access current and archived computerized information, to establish the identity and medical background of patients, to communicate with responsible medical and incident personnel. To provide EMS personnel with data on special hazards (toxic materials, etc.) at the site that may affect the diagnosis and treatment of patients. To provide EMS personnel with the medical history and records from a patient's portable medical records devices. To provide EMS personnel on scene with the real-time biometric status of fire fighters, search and rescue team members, and others on scene who are operating under hazardous conditions and whose vital statistics are to be monitored. To provide EMS ambulance personnel with real-time traffic status (such as, Intelligent Transportation System (ITS) information) for traffic congestion updates and to provide drivers with the capability to control traffic lights during an emergency. To provide EMS ambulance personnel with hospital updates on diversion status, capability status, and resource availability (such as, ER, cardiac care, etc.). To display the medical history of patient from the patient's smart card that would contain information about allergies, prescription drug usage, heart pacemaker, etc. |
| **with what special constraints** | Much of this information needs to be secured to protect privacy concerns and chain-of-command for lifesaving procedures. Communications must include the ability to access state public health information services as well as the Centers for Disease Control and Prevention (CDC) Health Alert Network and need to ensure that EMS systems and public health systems are not “stove-piped” solutions. |

#### 4.3.7.2 Image communications

There are few “non-interactive” image communications needed by the EMS incident field personnel, but pictures of buildings to which EMS may be dispatched would be useful for location identification.

#### 4.3.7.3 Video communications

There are no “non-interactive” video communications needed by the EMS incident field personnel.

## 4.4 Law Enforcement

### 4.4.1 Routine Operability and Day-to-Day Interoperability

Day-to-day activities are in the class of general/routine law enforcement services, such as traffic law and motor vehicle enforcement, crime prevention efforts, patrol operations, search and rescue operations, domestic disturbances, arrest warrant executions, investigative operations, court security, administrative communications, and information exchange.

#### 4.4.1.1 Local law enforcement agencies:

These activities take place in office, patrol car, and pedestrian environments, and within building structures. The area of operation is usually within the agency's jurisdictional boundaries and usually within the nominal communications range of the local radio infrastructure. Operations may extend to the remote edges of the jurisdiction and to in-building situations, as well as to irregular operations into neighboring jurisdictions. The routine operations also include those that bring together law enforcement officials from more than one agency and may involve other public safety providers, such as Fire and EMS units. Examples would include: a multiple car accident with injuries and possible deaths on an interstate highway in an urban area requiring state patrol, local police, fire, and EMS response; a burglary in progress and suspect pursuit across several jurisdictions; and a search and rescue of a private plane crash on remote mountainside.

#### 4.4.1.2 Tribal law enforcement agencies:

Tribally operated law enforcement agencies operate in a variety of environments from large land area law enforcement (e.g., the Navajo Nation law enforcement department covers 22,000 square miles in three states) to urban city enforcement (such as the Reno, Nevada, Police Department). Most of these activities are similar to those of county law enforcement.

#### 4.4.1.3 Statewide law enforcement agencies:

Most of these activities are centered on patrol car monitoring of vehicles on major state highways, though responsibilities are statewide. Some states have state police functions that mimic local law enforcement tasks but occur on a statewide level.

#### 4.4.1.4 Federal law enforcement agencies:

Federal activities take place in airports, in seaports, at border crossings, along borders, in federal courts and prisons, in office and pedestrian environments, and in rural and urban areas. Federal agencies require that most voice communications use Type 1 National Security Agency (NSA)-approved encryption, end-to-end. To support the federal agencies' missions, communications is needed along all borders, along major highways, and citywide in major metropolitan areas.

### 4.4.2 Task Force

Task force operations are those that bring together law enforcement officials from more than one agency and may involve other public safety providers, such as fire and EMS units. Examples would include an arson task force formed to review the causes of a suspicious fire; a joint drug/alcohol/ firearm enforcement operation of local police, county sheriff, and federal agents; and a terrorism task force in continuous operation with multiple local, state, and federal law enforcement agencies. Such operations may include the use of covert communications placed on a decoy officer or on an officer who has infiltrated a criminal group.

With sporting events and other large public gatherings that can be planned in advance, a coordinated law enforcement response is also required. Field units will typically communicate with command posts established at the site of these events. For this latter class of planned events, this section assumes the same operational needs as day-to-day operations, though they will be expanded in scope.

#### 4.4.2.1 Local law enforcement agencies:

Task force situations include officers in patrol cars or on foot. These may involve rapidly changing locations outside of nominal local infrastructure communications, including remote locations where no infrastructure communications is available, areas where in-building communications is required, and areas where communications is available only from neighboring infrastructures.

#### 4.4.2.2 Tribal law enforcement agencies:

Operations include tribal law enforcement officers in mobile units, in rural areas, on the street in urban areas, and within buildings. Many situations involve rapid changes in the scene of the operation, where communications may be limited or non-existent from the infrastructure.

#### 4.4.2.3 Statewide law enforcement agencies:

Most situations will involve officers in patrol cars or mobile units. These may involve rapidly changing locations, including remote locations where no infrastructure communications is available, areas where in-building communications is limited, and areas where additional communications is available from neighboring city or county infrastructures.

#### 4.4.2.4 Federal law enforcement agencies:

Task force situations include agents in mobile units or on foot. The situations may involve rapidly changing locations as the cause and effects of the incident change. Communications may be needed outside of the agency's nominal infrastructure communications area, including remote and in-building locations, where direct unit-to-unit radio communications is required.

### 4.4.3 Mutual Aid

Most situations will involve law enforcement officials in office, car, pedestrian, airborne, or search/rescue environments. Mutual aid operations can occur in a wide range of situations, including weather-related (hurricane, flooding, tornadoes), natural causes (earthquake), major explosions (terrorist or accidental), transportation incidents (commercial plane crash), major fire, riot, etc. These large-scale disaster events are not planned. Disaster events are those that stress communications capabilities the most and will be discussed in the following sections.

Large-scale disasters requiring mutual aid are characterized by a large number of external agencies and personnel brought in to assist. These include agencies from neighboring regions, neighboring states, national organizations, and federal agencies. Communications among all of these additional personnel and with a temporary command structure will be required, via existing infrastructure (if still operational) and extra temporary infrastructure brought in for the duration of the emergency. Contacts may include law enforcement, traffic control, Fire, EMS, emergency management, hazardous materials units, urban search and rescue, military, National Guard, utility and transportation companies, relief agencies, weather information, temporary housing and food, volunteers, etc., depending on the scale and type of the disaster.

Also falling into the category of mutual aid are extremely large planned events, such as political conventions, the Olympics, and international meetings where a host state's mutual aid pact is activated in advance. In such events, all response teams will be coordinated. Numbers of special units, such as SWAT and Bomb Disposal teams, will be staged and must be coordinated. It is anticipated that large amounts of resources will be staged nearby to support these events, including potential disruption and civil unrest that might occur in conjunction with the event. The provision of day-to-day level services will be expected by the public throughout the event, while the host agency continues to provide the same level of services to the remainder of its jurisdiction.

### 4.4.4 Voice Communications-Interactive

#### 4.4.4.1 Routine operability and day-to-day interoperability operations

Table 19. Law Enforcement Voice Communication Interactive 1

| The communication occurs: | | |
|---|---|---|
| with whom | Local law enforcement agencies: | Coordinate with other officers on selected user groups from within agency, selected user groups in neighboring areas, selected user groups in neighboring agencies, connect to incident dispatch, dispatcher and supervising officers, special task force command officers and other activity participants, or any other persons on a person-to-person basis. |
| | Tribal law enforcement agencies: | As criminal jurisdiction over offenses occurring within tribal territories depends upon the particular offense, the offender, the victim, and the location of the offense, the prevailing jurisdiction may be tribal, state, or federal. |
| | Statewide law enforcement agencies: | Talk with other officers on selected user groups across the state, and selected user groups in overlapping areas, particularly counties and cities. Connect with the dispatcher and supervising officers, special task force command officers and other participants, or any other persons on a person-to-person basis. |
| | Federal law enforcement agencies: | Talk with other agents on selected user groups within the agency, with agents of other agencies, and with law enforcement personnel from local, state, and international law enforcement agencies. |
| for what purpose | These voice calls would be for the routine purposes of receiving instructions and assignments from the dispatcher, informing the dispatcher of progress, assisting agents/officers on task force operations and incidents, asking other agents/officers for help or information, keeping current on incidents in neighboring (city and county) areas, and responding to requests for assistance, etc. They would also be to coordinate with assignment dispatch and incident dispatch for determination of availability, assign calls, route, and disposition. CAD is used to assign resources in some locations. | |
| with what special constraints | Law enforcement administrators need to be able to set access and usage priorities for all users and to control usage so that only authorized individuals are allowed to talk to one another. Some of the communications, especially those of federal agents, need to be encrypted for privacy and tactical situations. An “emergency” button on the radio provides for high-priority treatment of emergency calls. | |

#### 4.4.4.2 Task force interoperability

Table 20. Law Enforcement Voice Communication Interactive 2

| The communication occurs: | |
|---|---|
| **with whom** | Other agents/officers or dispatchers involved with the task force incident. These contacts may be from user groups from within the agency, selected user groups in neighboring agencies operating inside or outside the range of their infrastructure, PSTN, dispatcher and supervising officers, incident task force command officers and other participants, or other individuals on a person-to-person basis. Contacts may include federal agents, state officers and tribal/local city/county law enforcement, traffic control, Fire, EMS, hazardous materials units, special operations, etc. |
| **for what purpose** | Communicate immediate intelligence and coordination with respect to an incident in progress. These may involve agent/officer safety and safety of the public. |
| **with what special constraints** | These communications must be available with high reliability, rapid (apparently instantaneous) response times, and may need to be encrypted. |

#### 4.4.4.3 Mutual aid interoperability

Table 21. Law Enforcement Voice Communication Interactive 3

| The communication occurs: | |
|---|---|
| **with whom** | Among agents and officers from various agencies at the incident scene, between the agents and officers with their supervisors, and between the supervisors and the incident commander. |
| **for what purpose** | Communications will be needed to coordinate the activities of large numbers of external workers and local workers, and possibly to re-establish civilian order and safety, at a time when the local infrastructure may or may not be operational. |
| **with what special constraints** | This may require establishing communications with a large number of local, state, and national agencies and personnel who have been rapidly moved into the disaster area, with many critical missions that must be performed as soon as possible. Local communications infrastructures (including local phone service and local law enforcement radio infrastructure) may or may not be operational, with the result that direct unit to unit communications may play a critical role. In other situations, there may be no initial infrastructure, such as a wildfire incident, etc. It is desirable to capture a record of communications when the infrastructure is not available so temporary communications systems may need to be set up to partially replace non-functioning local systems, as well as providing communications for a large number of additional workers. Some of these communications should be encrypted. The incident administrators need the ability to rapidly establish user groups with priorities, to validate the users attempting to use the system, to create temporary networks on the fly, and to provide authorizations as to whom the users may have communications with. The users need to have access to communications that are seamless and transparent in accordance with their public safety roles and responsibilities. |

### 4.4.5 Voice Communications-Non-interactive

Table 22. Law Enforcement Voice Communication Non-interactive

| The communication occurs: | |
|---|---|
| **with whom** | All law enforcement agencies may use voice paging and alerting between dispatchers and officers/agents, from dispatchers and task force commanders to task force members, and from dispatchers and mutual aid incident commanders to mutual aid members. |
| **for what purpose** | These voice calls would inform the officer/agent of a request for assistance or service, of administrative information, or of other routine matters; provide paging and alerting of task force or mutual aid operations. |
| **with what special constraints** | Law enforcement administrators need to be able to set access and usage priorities for the non-interactive communications to ensure priority calls receive proper treatment. Some of the communications, especially those of federal agents, need to be encrypted for privacy and tactical situations. These communications must be available with high reliability and rapid (apparently instantaneous) response times. |

### 4.4.6 Data Communications-Interactive

#### 4.4.6.1 Text messages

Table 23. Law Enforcement Data Communication Interactive 1

| The communication occurs: | |
|---|---|
| **with whom** | Other agents/officers in local and neighboring agencies using directed text messages, and access to local, state, and national databases. These include databases and active files on a wide range of public safety activities from local and state agencies, and other state or federal information sources. Examples of federal databases include the Federal Bureau of Investigation's (FBI) National Crime Information Center (NCIC) and the Integrated Automated Fingerprint Identification System (IAFIS), the U.S. Immigration and Customs Enforcement Automated Biometric Identification System (IDENT), Joint Automated Booking System (JABS), etc. Communications with other components of the criminal justice system, such as corrections facilities, judges, prosecutors, and defense. |
| **for what purpose** | Text data communications are used for a wide range of functions to access current and archived computerized information on vehicle license plates and driver's licenses, printed updates and supplements to current duty assignments or situations, wants and warrants, stolen properties and vehicles, additional background and criminal histories on particular subjects, etc. Data communications (agent/office-in-a-vehicle capabilities) are used to file reports and traffic citations remotely and electronically, making them rapidly and efficiently available to local and neighboring public safety officials and/or state public safety officials. |
| | For a mutual aid operation, text data communications may be needed as a general organizational tool to coordinate the activities of large numbers of external workers and local workers; to help re-impose organization on a chaotic situation; and to organize, catalog, and disseminate a large number of known facts about the current emergency (lists of survivors and missing, lists of damaged infrastructure, lists of needed supplies, etc.). Printed and recorded digital information is particularly valuable to help clarify the confusion immediately following a disaster. |
| **with what special constraints** | Much of this data needs to be encrypted to protect privacy concerns and ongoing criminal investigations. Access to much of this information will be restricted to certain individuals and purposes; the individuals as well as the information will have to be authenticated and tracked. |
| | For a mutual aid operation, it is necessary to establish communications quickly with a large number of local, state, and national agencies and personnel who have been rapidly moved into the disaster area, with many critical missions that must be performed as soon as possible. Local communications infrastructures (including local phone service and local law enforcement radio infrastructure) may or may not be operational, so temporary communications systems may need to be set up to partially replace non-functioning local systems, as well as providing communications for many additional workers. Some of these communications should be encrypted. |

#### 4.4.6.2 Image communications

Table 24. Law Enforcement Data Communication Interactive 2

| The communication occurs: | |
|---|---|
| with whom | Communicate with local, state, and national databases, various public safety agents/officers in the field, dispatchers, and command officers. Databases include archival databases and active files on a wide range of public safety activities from local and neighboring jurisdictions and agencies, as authorized and required. |
| for what purpose | The images are transferred for a wide range of purposes, including persons, vehicles, or things that are either being searched for, or which have been found and are in need of identification. Fingerprints taken in the field can be sent in for rapid identification. Maps and drawings of buildings, roads, and geographic areas serve a wide range of planning, investigative, traffic control, and search functions. Pictures taken at a scene are useful immediately as planning and tactical tools, identification of suspects by witnesses, and are useful later as evidence and for investigation purposes. |
| with what special constraints | Encryption will be needed to preserve privacy and to prevent the release of critical data. Access to this information will be restricted to certain individuals and purposes, i.e., authenticated and tracked. Some time-critical information will need to be delivered in a short time. Other information will be requested only by individuals, but again the information will be needed in a short time to be effective. |

#### 4.4.6.3 Video communications

Table 25. Law Enforcement Data Communication Interactive 3

| The communication occurs: | |
|---|---|
| **with whom** | To send video on demand between various public safety agents/officers in the field, dispatchers, and command officers, or store and forward on demand and transmit in real time video in agent's vehicle or officer's patrol car. Include air support downlink from helicopter, other specialized usages, such as underwater, etc. Send to dispatch or incident commander from private, non-public safety sources, such as schools, banks, etc. Officers, dispatch, or incident commander can access video from private, non-public safety sources, such as schools, banks, area surveillance cameras, news cameras, traffic cameras, etc. |
| **for what purpose** | Video pictures taken at the scene of a stakeout, a traffic stop, or an arrest, or obtained from surveillance cameras are useful as evidence, for further investigation purposes, to document officer conduct, and to send assistance in the case of trouble. These recordings may be recorded for later viewing, or sent directly to a dispatcher or investigator. Video from cameras located to monitor traffic flow provide situation information. |
| | For a mutual aid operation, there will be a requirement to rapidly assess damage caused by the disaster, sending on-site views to recovery coordination officials at remote command posts. Real-time video will also be used by robotics operators and search and rescue teams, where the situation is too risky to allow personnel to go, and to rapidly assess the current situation. |
| **with what special constraints** | Real time needed, if the video is used to provide agent/officer assistance. If the video is used for the surveillance of a large building or field, for example, the required resolution may not be sufficient to determine details of the people or objects in the frames. If the video is used during traffic stops or drug raids, for example, the resolution should be detailed enough to read license plates and to determine an individual's characteristics. |

### 4.4.7 Data Communications-Non-interactive

#### 4.4.7.1 Text messages

Table 26. Law Enforcement Data Communication Non-interactive 1

| The communication occurs: | |
|---|---|
| **with whom** | Dispatchers and supervisors via short messages; other agents/officers in local and neighboring agencies using e-mail connections; databases using web browsers. To communicate with status monitors or by telemetry from task force site monitors to the commander or other central location. Communicate by telemetry from task force site monitors to commander or other central location. Communicate with incident command at major events, including locations and status information. |
| **for what purpose** | Text data communications are used to provide continuous location and status information on vehicles and personnel; e-mail messages are used to exchange files, discussions, strategies, etc.; databases are used to locate information as well as to provide reports, modify or add entries, etc. Text data might be used to rapidly distribute detailed background information, resource and personnel information, or planning information among a number of incident participants, where the participants are not required to respond to the communications. Status monitors include up-to-date reports on traffic congestion, weather forecasts, fire and water states, etc. Telemetry data might include weather and environmental (toxic gas content, etc.) information. Reports may be used to support law enforcement interaction with other components of the criminal justice system, such as booking a suspect into a jail, obtaining a search warrant, etc. Status monitors include up-to-date reports on traffic congestion, weather forecasts, fire and water states, etc. Input to traffic control systems and Intelligent Transportation Systems (such as variable message displays). |
| **with what special constraints** | Much of this data needs to be encrypted to protect privacy concerns and ongoing criminal investigations. |

#### 4.4.7.2 Image communications

Table 27. Law Enforcement Data Communication Non-interactive 2

| The communication occurs: | |
|---|---|
| **with whom** | Disseminate images from a dispatcher to a large group of agents, patrol officers, and law enforcement personnel and vice versa (e.g., the picture of a missing child can be transmitted). |
| **for what purpose** | The images of missing children, mugshots of wanted individuals, etc., are transferred to field personnel to ensure many individuals are able to watch for and recognize missing or wanted people. |
| **with what special constraints** | Encryption will be needed to preserve privacy and prevent the release of critical data. Access to this information will be restricted to certain individuals and purposes, i.e., authenticated and tracked. Some time-critical information, such as an image of an abducted child, will need to be delivered in a short time to all law enforcement personnel. |

#### 4.4.7.3 Video communications

Table 28. Law Enforcement Data Communication Non-interactive 3

| The communication occurs: | |
|---|---|
| **with whom** | Send video from field sites to central location, to dispatcher, or to investigator. |
| **for what purpose** | Video pictures taken at the scene of a stakeout or monitoring location where the field of view and subject is fixed. |
| **with what special constraints** | Real-time review of the video pictures may not be required and the video may be used to archival or evidentiary purposes. If the video is used for surveillance of a large building or field, for example, the required resolution may be low. If the video is for a stakeout to observe who enters or leaves a building, for example, the required resolution may be high. Video must be of good enough quality to generate a still picture. |

# 5. Wireless Communications Functional Requirements

The following subsections describe the functional or qualitative requirements of the wireless system with the features of each requirement presented in a table format immediately following the subsection heading. Where appropriate, quantitative requirements have been added to supplement the associated qualitative requirement. Each of the functional requirements is important; therefore, the order in which they are presented does not imply priority.

These requirements are intended to be "blue sky" in nature and are not limited to current implementations or technologies; however, performance in the current environment is sometimes referenced as a baseline requirement for specific sections.

Not all capabilities defined for "a system" are required for all devices. For example, some capabilities by their very nature may be applicable only to fixed infrastructure or to mobile/portable subscriber equipment. In some cases, equipment may support specialized applications designed for non-network use or for specialized networks.

The format of this section follows the general outline listed below.

1. Services ( **See section 5.1 "Services" on page 53.**)

This section defines the types of services that will be required for public safety communications. There are two main categories of services: voice and data. Voice is broken out as a separate service from data due to its key role in first responder responsibilities. Voice is the primary means of communication for public safety, and is treated with the highest regard in the definition of its requirements. Voice is treated separately regardless of the transport method, including a convergent network carrying both voice and data.

- Voice
- Data

2. Required Features ( **See section 5.2 "Required features" on page 60.**)

This section defines the required set of features that must be available in a public safety communications solution. These features range from defining the requirements for securing the communications network to the command and control features for maintenance and operation of the network.

- Mobility
- Security for voice and data
- Call Types
- Scalability
- Command and Control, Maintenance, and Operations
- COTS-based products
- Standards-based design

- Backwards compatibility
- Migration path for legacy systems
- Spectrum and network efficiency
- Ergonomic and environmental
- Extensibility
- Modularity

**3.** Performance ( **See section 5.3 “Performance” on page 79.**)

The performance of the public safety communications system needs to be defined to a specific set of values, down to the amount of bandwidth required for each application/service. This section defines the performance received within the scope of the system, but does not supply hard numbers due to the assumptions that would be required and the solution alternatives that proposing numbers in this section would eliminate. The following five subsections define the areas in which the performance of the system will be measured and provide specific pieces of functionality that are required to be measured. These sections also define the method that will be used to measure the particular parameter in question.

- Quality of Service
- Availability
- Reliability
- Survivability
- Restorability

## 5.1 Services

This section defines the types of services that will be required for public safety communications. There are two main categories of services: voice and data. Voice is broken out as a separate service from data due to its key role in first responder responsibilities. Voice is the primary means of communication for public safety and is treated with the highest regard in the definition of its requirements. Voice is treated separately regardless of the transport method, including a convergent network carrying both voice and data.

### 5.1.1 Voice

#### 5.1.1.1 Interactive

**Matrix 1.** Interactive Voice Service Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.1.1.1 | 1 | The system must support voice communications where two or more participants/units are involved in an interactive session. | NA |
| | 2 | The system must support interactive multicast voice. | Multicast occurs when one device sends data across the network to multiple devices; however, depending on the multicast protocol, only nodes that are on the path from the originating device to the receiving device receive and forward the data. |
| | 3 | Caller ID must be embedded in the voice frames. | Information regarding the identity of a voice caller will be embedded in voice frames that are transmitted at an appropriate interval. |
| | 4 | The system must support the capability to interface with the Public Switched Telephone Network (PSTN), cellular, or their equivalent. | Includes but is not limited to Plain Old Telephone System (POTS), cellular, etc. |

#### 5.1.1.2 Non-Interactive

**Matrix 2.** Non-interactive Voice Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.1.1.2 | 1 | The system must support voice paging. | NA |
| | 2 | The system must support non-interactive multicast voice. | This requirement is similar to Section 5.1.1.1 Requirement 2; however, the data stream is one-way. This capability could be used for emergency notifications and staff callbacks. |

### 5.1.2 Data

#### 5.1.2.1 Interactive

**Matrix 3.** Interactive Data Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.1.2.1 | 1 | The system must support instant messaging. | NA |
| | 2 | The system must support video conferencing. | NA |
| | 3 | The system must support biometric identification techniques. | This requirement is provided in the context of the ability to identify a user through an appropriate device. Users in this context can be both first responders and non-first responders in the case of a suspect in a crime. Not all devices must be capable of this feature, but the network must support queries of this nature. |
| | 4 | The system must support real-time voice commands. | Real time in this context implies 200ms or less from spoken command to action being taken. |
| | 5 | The system must support voice language translation techniques. | If a member of the public is speaking in a foreign language, the first responders' communications device must support a best effort translation of the language. Additionally, this requirement implies that the first responder then be able to use the device to communicate back to the member of the public. This is not meant to be used for critical communications. |
| | 6 | The system must support interactive multicast data transfer. | See Section 5.1.1.1 Requirement 2 for the definition of multicast. |
| | 7 | The system must support near real-time satellite imaging of various kinds, i.e., infrared. | Near real time in this context implies 1 minute or less from query to response. |
| | 8 | The system must support interfacing with public utilities information, such as the power grid, natural gas distribution systems, etc. | The system must be capable of making queries to public utilities to obtain the most current and accurate information possible and made accessible by the public utility system operators. |

**Matrix 3.** Interactive Data Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.1.2.1 | 9 | The system must be capable of submitting automated database queries. | This type of requirement implies no human interaction or human impetus in the start of an automated query; e.g., license plate recognition software must be able to automatically query a database using the parsed information from the input data source. |
| | 10 | The system must support database queries from any authorized object on the network from any location. | Criminal database queries, such as criminal records, National Crime Information Center (NCIC), arrest reports, incident reports, and other information maintained by state and local agencies. |
| | 11 | The system must support status queries regarding an object participating in the network in real time. | An object can be a first responder, a communications device, a vehicle, a passive sensor, Radio Frequency Identification (RF ID) tags, smart cards, etc. |
| | 12 | The system must be capable of supporting web-based applications. | NA |
| | 13 | The system must support the capability to interface with non-public safety data networks, including the Internet, in a secure manner. | NA |
| | 14 | The system must support communications between any two or more objects/devices on the network. | See Section 5.1.2.2 Requirement 10, for a definition of an object. |
| | 15 | The system must provide human performance support systems (e.g., online help functions, operator and maintenance training, etc.). | NA |
| | 16 | The system must support TTY/TDD devices. | NA |
| | 17 | The system must support real-time command and control functionality with remote devices. | Command and control functionality must not be limited to fixed assets, but instead allow for mobile assets to maintain the same level of functionality as the fixed assets. |
| | 18 | The system must be able to support continuous, interactive streams of data. | For example, if a first responder requests periodic status reports from a sensor on the network or a live video feed from a first responder vehicle, etc. |

**Matrix 3.** Interactive Data Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.1.2.1 | 19 | The system must be capable of capturing data entered into the system in any manner, into the appropriate reporting formats. | For example, if an officer arrests a suspect for Driving Under the Influence (DUI), when the transporting unit arrives at the jail, the booking officer automatically has access to the data entered into the system by the arresting officer. |

### 5.1.2.2 Non-interactive

**Matrix 4.** Non-interactive Data Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.1.2.2 | 1 | The system must support bulk file transfer (including images, GIS overlays, building floor plans, etc.). | This type of data transfer includes transmission from and to vehicles, communications devices, etc. |
| | 2 | The system must support email. | NA |
| | 3 | The system must support passive video transmission. | NA |
| | 4 | The system must be capable of storing an appropriate amount of data locally prior to any outside transmission, if any. | The local communications device must be capable of storing levels appropriate for portable, mobile, etc. |
| | 5 | The system must be capable of transmitting three-dimension geo-location information per object. | An object can be a vehicle, person, etc. |
| | 6 | The system must support non-interactive multicast data transfer. | For example, an incident commander could send a text-based status update to all of their personnel in the field at a given incident. |
| | 7 | The system must be capable of accessing real-time weather information available on request or pushed to specified users for critical weather changes. | Real time in this context implies 30 seconds or less from query to response. Weather information can take the form of a forecast, current weather at a given site, network sensors, etc. |
| | 8 | The system must be capable of pushing data to objects without having received a request from the object, based on policy that allows authorized users to define the criteria under which data is transmitted automatically. | The policy surrounding this requirement will be defined by each agency. |
| | 9 | The information received in database queries must be available upon request to someone outside the incident, e.g., a dispatcher or supervisor. | If an officer is involved in a traffic stop, a dispatcher can query the status of the incident, i.e., downloading a live video feed from the police car. |
| | 10 | An object on the network must be capable of initiating an automated transmission to other objects based on geo-location information (location of the transmitting object, the receiving object, or both). | NA |

**Matrix 4.** Non-interactive Data Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.1.2.2 | 11 | The system must be capable of supporting a variety of passive/active sensors on the network that transmit data at periodic/non-periodic intervals. Information must be available on request or pushed to specified users for critical data. | One example of these types of sensors is a chemical sniffer, which is capable of detecting anomalies in the air at a given location. |
| | 12 | The system must be capable of supporting real-time transmission of vital statistics of an object on the network, e.g., the heart rate of an officer, the oxygen level of the tank for a given firefighter. | Real time in this context implies a maximum or 100ms or less between transmission and reception of data. |
| | 13 | The system must support the creation and implementation of automated communications triggers, e.g., if a bulletproof vest detects a bullet impact, it notifies the appropriate objects. | Using the same example, the officer could have a response to a bullet impact on his vest preprogrammed such that if the vest detects an impact, it sends a message to the appropriate parties without the officer needing to initiate it. |
| | 14 | The system must be capable of interfacing with and/or controlling traffic control systems and the Intelligent Transportation System (ITS). | NA |
| | 15 | The system must support the administrator defined use of digital signatures. | NA |

# 5.2 Required features

This section defines the required set of features that must be available in a public safety communications solution. These features range from defining the requirements for securing the communications network to the command and control features for maintenance and operation of the network.

## 5.2.1 Mobility

### 5.2.1.1 User Motion

**Matrix 5.** Mobility Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.1.1 | 1 | The public safety user/device must be able to have constant communications while traveling at a reasonable speed. | A reasonable speed in this context implies speeds up to and including aircraft, such as helicopters or small propeller-driven planes. |
| | 2 | The public safety user/device must be able to interface with communications systems across multiple jurisdictions while maintaining constant communications and full user functionality. | This requirement includes the ability to roam from jurisdiction to jurisdiction, and maintain communications with user/devices in any jurisdiction as defined by policy. |

#### 5.2.1.2 User Location

**Matrix 6.** Mobility Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.1.2 | 1 | The public safety users' three dimension geo-location must be determinable to some resolution based solely on functionality provided through the communications systems. | The baseline resolution implied in this requirement is accuracy to within 1 meter. |
| | 2 | The public safety user/device must be able to communicate regardless of location: city street, highway, parking garage, high-rise, airport, air/waterborne, etc. | The device must be capable of operating in such a hostile environment and still maintain a minimum level of connectivity to the network, i.e., perhaps increasing the transmission power level until connectivity is reached. |
| | 3 | The system must be able to analyze received signal(s) to derive user location when no location data is available within the transmission content. | If a transmission is received by the network, but the message location contents are unreadable, the system must be capable of determining, within reason, the last known location of the originator of that transmission. |
| | 4 | The system must have a definable period in which asset status and location information must be sent as defined by an administrator. | NA |
| | 5 | The system must have the ability to query asset tracking information from any point on the network at any time. | NA |
| | 6 | The system must automatically create an alert for any asset that fails to respond to two or more consecutive asset tracking requests. | This system must be capable of creating the alert within 2 seconds of detecting a failure. |

### 5.2.2 Security (voice and data)

#### 5.2.2.1 Access control

**Matrix 7.** Security Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.2.1 | 1 | The public safety user/device must be authenticated before use of network resources. | This requirement must work in conjunction with Section 5.3.4 Requirement 3. |
| | 2 | The public safety user/device must be authorized to use specific network resources. | This requirement must work in conjunction with Section 5.3.4 Requirement 3. |
| | 3 | The public safety user/device must be able to be authenticated/authorized anywhere on the network. | This requirement implies that a user be able to authenticate/authorize at any geographic location that is supported by a network adhering to this body of requirements. This does not imply that any user be able to access services outside their normal geographic location without proper authorization. |
| | 4 | The public safety users'/devices' authorization must be tied to a role-based access control method. | Roles will be created which predetermine a user's level of access to services; i.e., a dog catcher is not entitled to the same level of services as an incident commander. |

### 5.2.2.2 Integrity

**Matrix 8.** Security Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.2.2 | 1 | The communication system must be immune to attacks against the integrity of communications traffic. | NA |
| | 2 | The communication system must have non-repudiation. | The level of non-repudiation must be at least sufficient for transmissions to be entered into court proceedings as evidence. |
| | 3 | The system must conform to the current Federal Information Processing Standards (FIPS) publication for data integrity or its current equivalent. | For example, this currently implies Advanced Encryption System (AES) encryption for data integrity. |
| | 4 | The system must allow the administrator to implement policies as to the appropriate level of information protection. | This level is set by the administrator and can be attached to the transmission type, the device type, etc., at the discretion of the administrator. One policy definition is the extent to which users have control over the level of information protection directly. |
| | 5 | The system must provide safeguards to detect and prevent unauthorized access, reading, and modification or destruction of data. | NA |
| | 6 | The system must be capable of meeting each requirement in this document in the face of a denial of service attack, whether distributed or not. | NA |

#### 5.2.2.3 Monitoring

**Matrix 9.** Security Feature Requirements 3

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.2.3 | 1 | The communication system must be able to be monitored by authorized/authenticated users/devices in every aspect of its functionality anywhere on the network. | NA |
| | 2 | The system must maintain and protect the audit trail from modification, unauthorized access, and destruction. | NA |
| | 3 | The audit trail must provide sufficient detail to reconstruct events in determining the cause and magnitude of compromise should such a security violation/system failure occur. | Information, such as login attempts, logs of attacks represented in Section 5.2.2.2 , and other anomalies in the network traffic and system usage will be used to analyze an event. |
| | 4 | The system must provide the capability to validate the correct operation of system security services and properties. | NA |

#### 5.2.2.4 Privacy

**Matrix 10.** Security Feature Requirements 4

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.2.4 | 1 | The communication system must only allow intended and authorized recipients to hear/see/read/modify information. | NA |
| | 2 | The communication system must be immune to traffic flow monitoring analysis from unauthorized users/ devices. | Attackers will be incapable of doing traffic flow analysis. Examples of traffic flow analysis include the incident when several thousand pizzas were ordered at the Pentagon prior to the start of the Iraq war, or individuals listening to an encrypted channel who could detect impending law enforcement action by increased traffic levels even if they couldn't hear actual transmissions. |
| | 3 | The communication system must be capable of supporting low probability of detection techniques as well as low probability of interception. | For example, covert operations. |

#### 5.2.2.5 Attack Detection and Prevention

**Matrix 11.** Security Feature Requirements 4

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.2.5 | 1 | The communication system must be resistant to jamming where possible. | NA |
| | 2 | The communication system must be capable of passive/ active attack monitoring and defense deployment. | NA |
| | 3 | The communication system must be able to geo-locate the source of an attack. | NA |
| | 4 | The communication system must be able to geo-locate the source of jamming. | NA |

### 5.2.3 Call types

#### 5.2.3.1 Individual communications streams

**Matrix 12.** Call Types Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.3.1 | 1 | The communication system must support full-duplex user/device to user/device communications. | NA |
| | 2 | The communication system must be capable of supporting peer-to-peer applications. | For example, if the communications infrastructure in a given area is damaged, first responders within transmission distance of each other would be able to maintain communications with each other as necessary in the absence of that infrastructure. |

#### 5.2.3.2 Multicast communications streams

**Matrix 13.** Call Types Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.3.2 | 1 | The system must be able to support one-to-many (multicast) communications without saturating the network as with broadcast traffic. | Broadcast, in this context, implies that information passes through every node within a network, regardless of whether a particular nodes' participation is required, to ensure that the information reaches the final destination(s). |

#### 5.2.3.3 Group communications streams (an extension of multicast communications streams)

**Matrix 14.** Call Types Feature Requirements 3

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.3.3 | 1 | The system must be able to support many-to-many (multi-multicast) communications without needing to broadcast traffic. | See the explanation for Section 5.2.3.2 Requirement 1. |

### 5.2.4 Scalability

#### 5.2.4.1 Vertical Scaling (number of users)

**Matrix 15.** Scalability Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.4.1 | 1 | The communication system must be capable of dynamic scaling to accommodate a growing number of users on a constrained network. | The system must be capable of scaling to accommodate any reasonable number of users simultaneously accessing the system with no noticeable performance degradation. |

#### 5.2.4.2 Horizontal Scaling (coverage area)

**Matrix 16.** Scalability Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.4.2 | 1 | The communication system must be able to scale in terms of coverage area in a very cost-efficient manner while still maintaining high availability and reliability, as well as vertical scalability. | Adding more coverage area through a new base station or repeater will be affordable as determined by the first responder community, and will not decrease the performance of the network regardless of the density of such infrastructure devices. |

## 5.2.5 Command and Control, Maintenance, and Operations

### 5.2.5.1 Maintenance and Operations

**Matrix 17.** CCMO Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.5.1 | 1 | The agency and system administrators must be able to control and configure the user groups within the agencies' responsibility. | NA |
| | 2 | The agency and system administrators must be able to control and configure the attributes of the members of user groups with characteristics like telephone interconnect abilities, priorities, and roaming. | NA |
| | 3 | User groups must be organized and classified as to use. | NA |
| | 4 | User groups must be assignable by function. | NA |
| | 5 | The agency and system administrators must be able to establish user groups for specific agency and jurisdictional needs. | NA |
| | 6 | The agency and system administrators must be able to manage the user group members quickly and easily. | NA |
| | 7 | The agency and system must be able to disable users/ devices over the air. | NA |
| | 8 | Devices on the network must be reprogrammable over the air in a reasonable amount of time. Multiple device reprogramming can occur simultaneously. | A baseline value for on-air reprogramming time is less than 2 minutes from start to finish. This is not meant to imply serial reprogramming. |
| | 9 | Routine maintenance must be performed without any noticeable degradation on the system. | Such maintenance will consist of replacing failed objects, performance testing, etc. |
| | 10 | User configurations must be transferable between radios. | This includes full/partial radio cloning. |
| | 11 | Devices must be capable of storing and maintaining configurations of user-selectable parameters. | NA |

**Matrix 17.** CCMO Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.5.1 | 12 | The system must support the ability to drop in infrastructure and go operational with little to no configuration or setup. | The setup and configuration time of drop-in infrastructure must be less than 10 minutes. A drop-in configuration is a device that is portable and is capable of being run off of a generator or other portable power supply. |
| | 13 | The system must have a minimum defined period in which, through monitoring and self tests, hardware or software component failures are detected and reported. | The system will detect and report errors within 500ms of a detectable failure. |
| | 14 | The self tests and diagnostics that the system performs must not cause any failure or degradation of any system function as defined in the performance section. | NA |
| | 15 | The system must be able to operate through power fluctuations. | NA |
| | 16 | The system must be able to operate through commercial power losses up to a defined period of time. | The system must be capable of continuous, uninterrupted service for a minimum of 4 hours of power loss. |
| | 17 | The system must be capable of operating 24 hours a day, 7 days a week. | NA |
| | 18 | The system must support separate operator and administrator functions. | NA |
| | 19 | The system must support separate system security officer and auditor roles. | NA |
| | 20 | The system must enforce individual accountability by providing the capability to uniquely identify each system operator and administrator. | NA |

### 5.2.5.2 Command and Control Provisioning

**Matrix 18.** CCMO Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.5.2 | 1 | Communications system operations must be transparent and seamless to the users. | Background information, such as routing information and other maintenance/operational data, will be transparent to the user. For example, if a user attempts a call and the route to the destination is out of date, it will be recalculated dynamically while being transparent to the user. |
| | 2 | The users must be provided with the capability of quickly and easily establishing and maintaining jurisdiction-wide dispatch communications and on-scene voice and data networks for command and control. | NA |
| | 3 | User authentication and authorization on the system must be effortless and rapid. | The baseline value for authentication/authorization is 500ms or less from initial authentication/authorization request. The authentication can include both authentication into a particular device, as well as authentication into the network. Effortless implies little to no interaction with the user. |
| | 4 | Public safety practitioners must have interoperable communications regardless of technologies, infrastructures, and frequency bands. | NA |
| | 5 | Public safety agencies need the ability to establish specific user groups for networks for mutual aid. | A user group is a dynamically selectable set of users that require intercommunication capabilities for a temporary duration. |
| | 6 | Subscriber units and console units must be capable of displaying and sending identification information. | NA |
| | 7 | The communications system must be administered from both a fixed location as well as from a mobile command center with no loss of functionality. | This means that an administrator will have the same capabilities in administering the system from a desk at the headquarters as from a communications device, such as a laptop in the field. |
| | 8 | The incident commander must be able to query in real time, the status of all assets involved in the situation. This includes personnel, equipment, vehicles, etc. | Real time in this context implies a maximum query/response time of 500ms. Status types could be as general as location or as granular as heartbeat information. |

**Matrix 18.** CCMO Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.5.2 | 9 | The command center must be able to interface with the public for information purposes. | An example is maintenance of the IAmAlive service or the ability to create and maintain a live website with information pertinent to the general public with regard to a particular incident. |
| | 10 | The system must have the capability to automatically determine, on a periodic or on-demand basis, what assets are operating within a specific geographic area, the location of these assets, and the operational status of these assets. | NA |
| | 11 | The administrator must have the ability to disable automatic asset status reporting to prevent unwanted transmissions and to maintain emission control. | NA |
| | 12 | The system must provide the ability to archive any aspect of pertinent data traversing the network. | Archiving in terms of content captured must be policy based. |
| | 13 | An authorized communications systems administrator can change authorizations for membership in a user group in real time. | NA |
| | 14 | An authorized user can change the operating parameters of a user group (e.g., operating frequencies, power output, level and type of encryption used for transmissions, waveforms, members involved, late entry requirements, etc.) | NA |
| | 15 | User group membership can include users from different agencies, jurisdictions, services, etc. | NA |
| | 16 | User group membership can include users interfacing from the commercial PSTN or other such telecommunications systems. | NA |
| | 17 | User groups can be pre-defined by an authorized communications systems administrator. | NA |

**Matrix 18.** CCMO Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.5.2 | 18 | Administrator capabilities will include broad policy definitions that will encompass most of the feature/functionality aspects of the system. | NA |

### 5.2.5.3 Communications Prioritization

**Matrix 19.** CCMO Feature Requirements 3

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.5.3 | 1 | There must be some appropriate number of priority levels available to the communications system. | The system will support a minimum of 256 distinct priority levels. |
| | 2 | The communications system must be capable of handling (with better than best-effort performance) all top priority traffic on a network simultaneously (including during a crisis or emergency). | NA |
| | 3 | Pre-emption of network traffic is required as a feature, based on priority. | NA |
| | 4 | The system will provide capabilities to automatically reduce bandwidth requirements based on predefined criteria when the system approaches capacity. | For example, bandwidth can be traded for quality, i.e., if there are several video transmissions with the same priority resulting in more bandwidth consumption than bandwidth available, the system should respond by using dynamically adjustable compression techniques, frame transmission rate, etc. |
| | 5 | An authorized user will be able to designate/modify priorities in real-time. This capability will be available from anywhere on the network. | NA |

### 5.2.6 COTS-based products

**Matrix 20.** COTS Feature Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.6 | 1 | COTS-based products must be leveraged or used wherever possible. | NA |

### 5.2.7 Standards-based design

**Matrix 21.** Standards Feature Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.7 | 1 | The communications system must be based on standards and must not contain Intellectual Property Rights (IPR) that is not in the public domain or licensed at a first responder determined fair and reasonable cost. | This system will not contain proprietary objects of any kind (code, protocols, devices, etc.) that does not meet a first responder definition of fair and reasonable cost. |
| | 2 | Standards should be those that provide or take advantage of the broadest possible market base while meeting the public safety requirements. | NA |

### 5.2.8 Backwards compatibility

**Matrix 22.** Backwards Compatibility Feature Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.8 | 1 | The system must provide as much backwards compatibility with prior implementations as is cost effective and feasibly efficient. | The system designed to meet the requirements set forth in this document must be backwards compatible with prior implementations of public safety communications system (i.e., P25) but not at the cost of not meeting each requirement stated in this document. |

### 5.2.9 Migration path for legacy systems

**Matrix 23.** Legacy Migration Feature Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.9 | 1 | A well-defined migration path must be created for legacy systems to migrate towards the communications system defined here in a cost-effective manner. | NA |

## 5.2.10 Spectrum and network efficiency

### 5.2.10.1 Allow for greater extensibility and scalability

**Matrix 24.** Spectrum Efficiency Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.10.1 | 1 | The Radio Frequency (RF) system must be spectrally efficient to a minimum quantifiable degree. | TBD |
| | 2 | The goodput (information to overhead ratio) of the network must be specified to a minimum quantifiable degree. | TBD |

### 5.2.11 Ergonometric and Environmental

#### 5.2.11.1 Products Suit the Environment and the User

**Matrix 25.** Ergonometric Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.11.1 | 1 | Hands-free operation must be made available for the appropriate applications. | NA |
| | 2 | A maximum weight limit for all equipment carried by practitioners must be defined. | 1. Fire limit - TBD lbs.<br>2. Law enforcement limit - TBD lbs.<br>3. EMS limit - TBD lbs. |
| | 3 | The shape of the practitioners' equipment must be appropriate to the application in which it is used. | NA |
| | 4 | The equipment must be durable to a specified set of standards. | NA |
| | 5 | Usability aspects of the equipment, such as button size and screen size, must be based on a set of specified standards. | NA |
| | 6 | The system must not introduce undue operator fatigue during continuous usage over a 12-hour period every 24 hours, as evidenced by compliance with applicable design criteria of MIL-STD-1472E or its current equivalent. | NA |
| | 7 | Users must be able to operate the system when wearing personal environmental protection equipment, such as foul-weather gear, survival suits, battle dress, etc. | NA |
| | 8 | The system must accommodate a 5th percentile female to a 95th percentile male as described in ASTM F 1166-95a or its current equivalent. | NA |
| | 9 | Devices on the system must support a minimum acceptable battery life. | 1. Fire minimum battery life - TBD hours<br>2. Law minimum enforcement battery life - TBD hours<br>3. EMS minimum battery life - TBD hours |

**Matrix 25.** Ergonometric Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.11.1 | 10 | Devices must conform to a safety standard. | For example, intrinsically safe for hazardous environments. |

### 5.2.12 Extensibility

#### 5.2.12.1 System-wide revision and enhancement

**Matrix 26.** Extensibility Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.12.1 | 1 | The system must be extensible with respect to performance enhancements and feature/functionality improvements through routine maintenance cycles. | NA |
| | 2 | The equipment must be extensible through physical add-on components through a standardized interface. | NA |

### 5.2.13 Modularity

#### 5.2.13.1 Component feature add on

**Matrix 27.** Modularity Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.2.13.1 | 1 | The system must be extensible with respect to feature/ functionality additions through routine maintenance cycles. | NA |

## 5.3 Performance

The performance of the public safety communications system needs to be defined to a specific set of values, down to the amount of bandwidth required for each application/service. This section defines the performance received within the scope of the system, but does not supply hard numbers due to the assumptions that would be required and the solution alternatives that proposing numbers in this section would eliminate. The following five subsections define the areas in which the performance of the system will be measured and provide specific pieces of functionality that are required to be measured. These sections also define the method that will be used to measure the particular parameter in question.

### 5.3.1 Quality of Service

#### 5.3.1.1 Voice

**Matrix 28.** QOS Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.1.1 | 1 | The communications and messages must be clear and understandable. | Techniques, such as voice activity detection and echo cancellation, must be used to maintain the integrity and quality level of the voice stream. |
| | 2 | The speaker's voice must be recognizable and identifiable. | TBD |
| | 3 | The number of required transmission repeats due to added system distortion of the originator's voice are few. | As opposed to packet re-transmission, in a data context, due to system noise or packet errors. |
| | 4 | The delay between mouth to ear is small if not negligible. | The maximum acceptable mouth to ear delay will be 200ms. This is an end-to-end delay, from the transmitting party speaking the message to the receiving party hearing the message. |
| | 5 | The delay for call setup time is short. | The maximum call setup time will be 250ms. |
| | 6 | The tone of the speaker's voice must be recognizable. | A listener must be able to detect the level of anxiety in the speaker's voice. |
| | 7 | Background sounds, such as glass breaking or gunshots, must be identifiable while removing unwanted background sounds. | These types of “non-voice” sounds must be capable of being captured and transmitted at the discretion of the system administrator. |

### 5.3.1.2 Data

**Matrix 29.** QOS Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.1.2 | 1 | Deployable communications networks and network connections must be established quickly. | On-scene data communications must be available within 200ms of the first arrival of a public safety vehicle to the scene. |
| | 2 | The system should recognize units/devices as they enter the on-scene location. | NA |
| | 3 | The controllers must authenticate and authorize the units/devices with little or no interaction by practitioners. | NA |
| | 4 | The controllers must authenticate the users for access control and data auditing. | The controller in this context can be manual administration or automated through a pre-programmed mechanism. |
| | 5 | The network must allow priorities based upon the user and service/application required. | NA |
| | 6 | Video captured on any device must be capable of rendering still images of acceptable quality. | NA |
| | 7 | The system must be capable of recognizing units/devices within a specified/defined geographic area. | For example, an incident commander designates that anyone who enters a defined area will be automatically sent a message pertaining to that area. |

### 5.3.2 Availability

#### 5.3.2.1 Resilience to hostile RF environments

**Matrix 30.** Availability Feature Requirements 1

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.2.1 | 1 | The communications system must be able to continue to operate within the parameters set forth in Section 5.3.1 in harsh/hostile RF environments. | The communications system must be capable of operating in an environment where the received signal level is less than -150dBm. |

#### 5.3.2.2 Temporal availability

**Matrix 31.** Availability Feature Requirements 2

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.2.2 | 1 | Define temporal availability within the context of the public safety communications system. | TBD |
| | 2 | Define a method to measure temporal availability. | TBD |

#### 5.3.2.3 Spatial Availability

**Matrix 32.** Availability Feature Requirements 3

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.2.3 | 1 | Define spatial availability within the context of the public safety communications infrastructure. | TBD |
| | 2 | Define the method to measure spatial availability. | TBD |

#### 5.3.2.4 Administrative Logging requirements

**Matrix 33.** Availability Feature Requirements 4

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.2.4 | 1 | The communications system must be able to log device failure, including details, such as model, serial number, hardware and software version, etc. | NA |
| | 2 | The communications system must be able to log the time an outage started. | NA |
| | 3 | The communications system or system administrator must be able to log the time an outage was recognized. | NA |
| | 4 | The communications system must be able to log the time the cause was diagnosed. | NA |
| | 5 | The communications system must be able to log the time the solution was implemented. | NA |
| | 6 | The communications system must be able to log the time the system was restored to full functionality. | NA |
| | 7 | The communications system must be able to determine whether the failure was partial or full. | NA |
| | 8 | The communications system must be capable of maintaining a record of communications events both locally when access to the wide area is not possible and on the wide area network when available. | NA |

### 5.3.3 Reliability

**Matrix 34.** Reliability Feature Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.3 | 1 | The dependability of the system will be defined as the percent of packets delivered within a required limit of time on the first try. | NA |
| | 2 | Define the minimum dependability within the context of the public safety communications system. | The minimum dependability of the system will be 99.999 percent. |

### 5.3.4 Survivability

**Matrix 35.** Survivability Feature Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.4 | 1 | The system architecture will be such that there are no single points of failure. | NA |
| | 2 | The system will be capable of detecting link/device failures and other network performance issues and reconfiguring communications paths to maintain performance. | NA |
| | 3 | If there is no infrastructure available, the communications objects that arrive on an incident must be capable of automatically setting up and configuring an ad hoc communications network. | This requirement implies that in the absence of infrastructure, communications devices will be capable of "becoming" the infrastructure in an ad hoc fashion. This will enable first responders to communicate in the absence of traditional fixed infrastructure. |
| | 4 | Some form of self healing will be available in the network. | For example, given a situation where traffic is flowing through a particular tower due to it being part of the "best path" to a destination, and that tower fails, the network will retain the knowledge of devices using that tower persistent until a new route is discovered from source to destination. |

### 5.3.5 Restorability

**Matrix 36.** Restorability Feature Requirements

| SoR Section | Requirement # | Qualitative Requirement Description | Additional Information |
|---|---|---|---|
| Section 5.3.5 | 1 | The system will have a maximum amount of time required for restoration or replacement of critical components of communications system infrastructure. | The maximum amount of time required for restoration or replacement will be 4 hours or less from failure detection. |
| | 2 | A local parts depot will be setup and managed where reasonable to decrease the overall mean time to repair. | TBD |

# Appendix A. Glossary and Acronyms

**ACN**-Automatic Call Notification

**ACS**-American College of Surgeons

**ATF**-Bureau of Alcohol, Tobacco and Firearms

**AVL**-Automatic Vehicle Location

**Access control**: Both the public safety users as well as the public safety user's device(s) must be authenticated before they are given access to network resources.

**Attack detection and prevention**: The communications networks must be resistant to jamming; they must be capable of passive/active attack monitoring and defense deployment; they must be able to geo-locate the source of an attack; and, they must be capable of monitoring of all functional aspects by authorized users/devices

**Authorization**: Once a user has been granted access to the system, the services and information that the user has access to will be determined by that users' authorization level.

**CAD**-Computer Aided Dispatch

**CBR&E**-Chemical, Biological, Radiological, and Explosive

**CERT**-Community Emergency Response Teams: Trained civilian volunteer auxiliary responders that assist victims and provide support for professional responders during a major disaster.

**DFFP**-Department of Forestry and Fire Protection

**DMAT**-Disaster Medical Assistance Teams: A mobile medical field unit staffed and equipped to treat large numbers of injured.

**DOT** - Department of Transportation

**Data security**: The communication networks must not allow unauthorized interception of communications or information; they must not allow communications replay attacks; and, they must have non-repudiation capabilities to ensure evidence in the event of a dispute.

**Day-to-day**: Routine or day-to-day operations fit a general normal structure for the public safety personnel and should not tax their ability to deal with communications processes and procedures. Many of these operations may be strictly within the discipline or agency with no communications interoperability requirements with other disciplines or agencies at all. However, as described in the PSWAC Final Report, day-to-day operations can include the need for city law enforcement personnel to communicate with their county law enforcement personnel and vice versa. The ability to communicate minimizes the need for dispatcher-to-dispatcher interaction in the exchange of information among units in the field. Day-to-day operations can also include task force operations to carry out a specific mission, such as a DUI (Driving Under the Influence) stake-out, where the communications are within the agency and do not require interoperability with other agencies. Also on a day-to-day basis, an agency (such as one fire district) can provide mutual aid to another agency (a second fire district) while the first agency covers an emergency. This form of mutual aid is different than the mutual aid interoperability discussed below.

**EMS2**-Emergency Medical Services Event Management System: A database containing information on the real-time status of emergency medical personnel, resources, hospitals, and patients that is accessible by command personnel, authorized responders, health care facilities, and so on.

**EMT-P-**Emergency Medical Technician-Paramedic

**EOC**-Emergency Operations Center

**Extended Area Network (EAN)**: Jurisdiction Area Networks that are linked with county, regional, state, and national systems or extended area networks (EAN).

**FBI-**Federal Bureau of Investigation

**FEMA-**Federal Emergency Management Agency

**GPS**-Global Positioning System

**HAZMAT** - Hazardous Materials

**HIPAA**-Health Insurance Portability and Accountability Act

**IAFIS**-Integrated Automated Fingerprint Identification System

**IC** - Incident Command or Incident Commander

**IDENT**-Immigration and Customs Enforcement Automated Biometric Identification System

**IR-Infrared**

**IST-Incident Support Team**: Provides support to US&R teams with tasking, material, and coordination. US&R teams are task forces equipped with the necessary tools and equipment and the required skills and techniques for the search, rescue, and medical care of victims of structural collapse.

**ITS**-Intelligent Transportation System

**Incident Area Network (IAN)**: An incident area network (IAN) is a network created for a specific incident. This network is temporary in nature.

**Incident command structure**: The communications systems must support the agency's incident command policies.

**Interactive data communications**: These communications will provide practitioners with maps, floor plans, video scenes, etc., during an emergency. In the context of the type of communications, interactive means that there is a query made and a response provided. The query and response need not be initiated by a practitioner and can include automated queries/responses. Commanders, supervisors, medical staff, etc., can make more intelligent decisions more efficiently with data from field personnel. Similarly, personnel entering a burning building armed with information about the building, such as contents, locations of stairwells, hallways, etc., can also perform their duties better.

**Interactive voice communications**: Communications between public safety practitioners and their supervisors, dispatchers, members of the task force, etc., that require immediate and high quality response, with much higher performance demands than those required by commercial users of wireless communications. Commands, instructions, advice, and information are exchanged that often result in life and health situations for public safety practitioners, as well as for the public.

**JABS**-Joint Automated Booking System

**JIC**-Joint Information Center

**Jurisdiction Area Network (JAN)**: The JAN is the main communications network for first responders. It is responsible for all non-IAN voice and data traffic. It handles any IAN traffic that needs access to the general network, as well as providing the connectivity to the EAN.

**LAN**-local area network

**MCC** - Mobile Commander Center

**MCT**-Mobile Computing Terminal

**MSO**-Mobile Switching Office

**Multicast**: Occurs when one device sends data across the network to multiple devices; however, depending on the multicast protocol, only nodes that are on the path from the originating device to the receiving device receive and forward the data.

**Mutual aid**: This mode describes those major events with large numbers of agencies involved, including agencies from remote locations. Their communications are not usually well planned or rehearsed. The communications must allow the individual agencies carry out their missions at the event, but follow the command and control structure appropriate to coordinate the many agencies involved with the event.

**NAWAS**-National Warning System

**NCIC**-National Crime Information Center

**NIMS**-National Incident Management System

**NIRSC**-National Incident Radio Support Cache

**NPSTC**-National Public Safety Telecommunications Council

**Non-interactive data communications**: A one-way stream of data, such as the monitoring of firefighter biometrics and location, which greatly increases the safety of the practitioners. This form of communications also makes the command and control requirements easier when the commander is aware of the condition and location of the on-scene personnel.

**Non-interactive voice communications**: These communications occur when a dispatcher or supervisor alerts members of a group about emergency situations and/or to share information. In many cases, the non-interactive voice communications have the same mission-critical needs as the interactive service.

**OEM**-Office of Emergency Management

**PIO** - Public Information Officer

**PSAP**-Public Safety Answering Point: The answering center for 9-1-1 calls.

**PSCD**-Public Safety Communications Devices: A term developed for the public safety operational scenarios, the PSCD is a portable (handheld or wearable) wireless communications device.

**PSTN**-Public Switched Telephone Network: The public telephone system.

**PSWAC**-Public Safety Wireless Advisory Committee

**Personal Area Network (PAN)**: A first responder is equipped with wireless devices used to monitor the first responder's physical location, pulse rate, breathing rate, oxygen tank status, as well as devices for hazardous gases detection and voice communications. The devices are all linked wirelessly on a personal area network (PAN) controlled by the first responder's communications device.

**Privacy**: The communications systems must allow only intended and authorized recipients to hear/ see/read/modify information as well as follow national and state policies (e.g., Health Insurance Portability and Accountability Act-HIPAA).

**RACES**-Radio Amateur Civil Emergency Service

**Reverse 9-1-1**: REVERSE 911 ® is a Microsoft Windows ® -based program that uses a patented combination of database and GIS technologies that can target a precise geographic area and saturate it with thousands of calls per hour. The software can also create a list of individuals with common characteristics (such as a Neighborhood Crime Watch group or emergency personnel) and contact them rapidly whenever necessary.

**SNS**-Strategic National Stockpiles

**System administration of users**: The communications systems must allow authorized system administrators as well as incident and branch commanders to establish user profiles for network access and usage, depending upon the role that the public safety user is asked to satisfy during an incident.

**Task force**: This mode defines a cooperative effort between specific agencies with extensive pre-planning and practice of the operation. As the PSWAC Final Report indicates, the communications tends to be at close range and the traffic requires rapid or immediate response times. In today's environment, task forces, such as a terrorism task force, may cover a broad regional area and not operate exclusively at close range. These operations present additional challenges.

**Temporary network**: JANs and EANs are networks that exist at all times whereas the IANs are created on temporary basis to serve a particular purpose, such as an incident and then are dissolved. The nature of the IAN is such that it may not reach all areas of an incident. In such cases, the user would either connect to the JAN, or create a temporary network to extend the IAN to the area not covered.

**US&R-Urban Search and Rescue**: A task force equipped with necessary tools and equipment and the required skills and techniques for the search, rescue, and medical care of victims of structural collapse.

**User/User group**: Public safety personnel and resources that are recognized by the system to share communications and information. This implies that traffic related to this user group only traverses the portion of the network necessary to reach all members of particular user group. Each user group can be a permanent unit or a temporary unit created by an authorized user for a particular task.

***User identification and location***: The communications systems must provide user identification to others during communications and when required, must provide user geo-location information to incident commanders and other authorized resources.

# Appendix B. SAFECOM-AGILE-NIST Summit

**SAFECOM-AGILE-NIST - Summit on Interoperable Communications for Public Safety**

The Summit on Interoperable Communications for Public Safety, held at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland, on June 26 and 27, 2003, was a joint effort between NIST, the Department of Homeland Security's Science and Technology (S&T) Directorate, the SAFECOM Program, and the National Institute of Justice's AGILE Program. The summit brought together a variety of programs that were created to assist public safety practitioners, including the first responders.

This summit was restricted to federal agencies and national, state, and local organizations with responsibility for first responder communications.

The summit was the initial step in familiarizing key interoperability players with the work being done by others so that mutually beneficial coordination and collaboration among the various technical programs could be established. The summit also provided insight into where additional federal resources might be warranted and has helped stakeholders maximize the limited resources that are available across all government levels by leveraging program successes and developing standards, approaches, products, and services for the benefit of all.

The information resulting from the summit may prove to be significant in helping to formulate a coordinated approach or approaches toward nationwide communications interoperability. Some of the information developed by the summit participants included a list of system capabilities that were considered essential by the participants for wireless voice, wireless data, and information systems. The List of System Capabilities follows.

# Appendix B.1 Wireless Voice Capabilities

1. Communications Regardless of Technologies, Infrastructures, and Frequency Bands

Ability for users to transparently communicate, as authorized, among multiple agencies/ jurisdictions some of which may use different technologies, infrastructures and/or frequency bands regardless of system. Includes the transitioning between commercial systems and private LMR systems.

2. Communication with Own Jurisdiction

Ability to communicate with members of own agency/jurisdiction while using the infrastructure of another agency/jurisdiction.

3. Communication with Other Jurisdictions

Ability to communicate with other agencies/jurisdictions using the infrastructure of that agency/ jurisdiction.

4. One-to-One Communications

Ability for users to transparently communicate, as authorized, with members of other agencies/ jurisdictions on a unit-to-unit (one-to-one) basis.

5. One-to-Many Communications

Ability for users to transparently communicate, as authorized, with members of other agencies/ jurisdictions on a unit-to-group (one-to-many) basis.

6. Communications Outside Wireless Infrastructure Coverage

Provide direct communications (talk around) between user radios where wireless infrastructure is unable to support communications (such in some rural areas, underground parking garages, tunnels, and inside some buildings).

7. Jurisdictional Signal Coverage

Provide jurisdictional-wide signal coverage to system users; optionally, provide ways to enhance or improve jurisdictional coverage into rural areas, underground parking garages, tunnels, and inside buildings that are usually not sufficiently covered.

8. Identification and Authorization

Ability to initiate wireless voice communications by requiring the user to enter (on his/her radio) a user identification that authenticates and validates the user and loads the user's profile. This profile defines talk groups for the user and completes all radio network administration for the user's voice communications with other members of the user's agency/jurisdiction and with other agencies/jurisdictions, as authorized.

9. Priority Levels for Access and System Use

Ability of the agency/jurisdiction to administer the priority for voice communications of particular users and particular public safety applications (such as task force operations, incidents, etc.).

10. Emergency Voice Communication

Ability to communicate an emergency voice message (e.g. after pressing a panic button) that has priority over other voice communications.

11. Emergency Signal

Ability to broadcast an emergency signal (e.g. via a panic button) that has priority over other communications.

12. Secure Communications

Ability to have secure (encrypted) voice communications to fit users' environment and which satisfies applicable laws, regulations, policies of the agencies and jurisdictions of the users.

13. System Administration

Ability to effectively initiate and sustain flexible and dynamic system administration for purposes of multi-agency interoperability, including administration of talk groups, encryption key management, emergency alerts, networks, and channels for mutual aid.

14. Remotely Re-Program User Radios

Ability to remotely (over-the-air) re-program a radio's parameters (i.e., frequency channels, talk groups, squelch control, encryption keys, etc.) and/or modify functionality (e.g., encryption algorithms, waveforms, etc.)

15. Resilient Operations

Ability to sustain resilient operations including tolerance to individual system failures, redundant coverage from adjacent sites, resistance to impact of catastrophic events, etc.

16. Reliable System Performance

Ability to maintain reliable system performance over disparate interconnected systems.

## Appendix B.2 Wireless Data Capabilities

17. On-scene Wireless Data Networks

Ability to quickly and transparently establish and maintain on-scene wireless data networks (e.g., on-scene to include in-building).

18. On-scene Exchange of Data

Ability of on-scene personnel to transparently exchange data.

19. High-Speed Data Transfer

Capability of high-speed data transfer with ability to sustain performance at network interconnections.

20. Communication with Own Jurisdiction

Ability to exchange data with members of own agency/jurisdiction while using the infrastructure of another agency/jurisdiction.

21. Communication with Other Jurisdictions

Ability to exchange data with members of other agencies/jurisdictions using the infrastructure of that agency/jurisdiction.

22. Sensor Networks

Ability to exchange data involving sensors (e.g., biometric, environmental, personnel location).

23. Identification and Authorization

Ability to initiate wireless data communications by requiring the user to enter (on his/her terminal/radio) a user identification that authenticates and validates the user and loads the user's profile. This profile defines data resource capabilities for the user and completes all radio network administration for the user’s data communications with other members of the user’s agency/jurisdiction and with other agencies/jurisdictions, as previously authorized.

24. System Administration

Flexible and dynamic system administration (includes administration of wireless data networks, adding users, giving permissions).

25. Data Security

Ability to ensure secure exchange of information.

26. Information Protection

Ability to protect information according to applicable laws and statutes.

27. Resilient Operations

Ability to sustain resilient operations including tolerance to individual system failures, redundant coverage from adjacent sites, resistance to impact of catastrophic events, etc.

28. Reliable System Performance

Ability to maintain reliable system performance over disparate interconnected systems.

# Appendix B.3 Information Systems Capabilities

29. Rapid Information Source Access

Ability to provide the exchange of information in a timely fashion to support critical decision points from both field and base locations, including but not limited to information regarding identification (photos, fingerprints, etc.) and activity (criminal history, wants/warrants, reporting/contact history, CAD info, building diagrams, building sensors, transportation info, etc.).

30. Query/Access Multiple Data Sources with One Request

Ability to query/access multiple data sources using one request that is routed to multiple entities simultaneously.

31. "Enter Once – Reuse Forever" Approach to Data Gathering

Ability to enter validated information once, then share and reuse that information among authorized entities.

32. Data Exchange with Computer-Aided Dispatch

Ability to exchange information with Computer-Aided Dispatch (CAD) and Record Management Systems (RMS).

33. Data Access to Logistical Resource Information

Capability to obtain logistical resource information on all personnel and equipment responding to an incident.

34. Emergency Notifications

Ability to broadcast critical information by means such as text messaging to multiple organizations

35. Formatting

Ability to effectively and efficiently exchange data between agencies/jurisdictions (e.g., by employing common data representation structures and exchange formats and protocols).

36. Open Source Formatting

Ability to effectively and efficiently exchange data between agencies/jurisdictions, e.g., by encouraging open source format.

37. Data Security

Capability of maintaining the security requirements of any entity within a broader security framework.

38. Field Image Capture and Distribution

Capability of field image capture and distribution

39. Data Access to Background Information Sources

Ability to access information related to hazardous materials, water sources, floor and building plans, fire pre-plans, utility maps, weather forecasts, topographic terrain, transportation, and other background data to support public safety incident management.

40. Data Access to Medical Information

Ability to manage medical information.

41. Data Access to Legal Information

Ability to access legal information such as investigation/litigation records, court scheduling records, disposition data and charge data.

# Appendix C. Operational Scenarios

This section includes operational scenarios that have been outlined to provide a view of future public safety communications. These scenarios describe credible, realistic incidents, activities, and responses that involve public safety agencies and personnel. While recognizing that these scenarios do not cover the infinite number of possible activities and situations, this collection provides a comprehensive vision of the future of public safety communications.

The scenarios in this section are designed to demonstrate increasingly complex situations. The first three scenarios include detailed descriptions of the voice and data communications used in fundamental, daily operations. These scenarios include:

- A traffic stop (law enforcement)
  ( *See Appendix C.1 "Scenario: Traffic Stop" on page 100.*)
- A house fire (fire)
  ( *See Appendix C.2 "Scenario: House Fire" on page 105.*)
- Emergency medical situations (EMS)
  ( *See Appendix C.3 "Scenario: Emergency Medical Services" on page 111.*)

The next two scenarios reflect the interaction of multiple services in a local area:

- A pre-planned event (college football game)
  ( *See Appendix C.4 "Scenario: College Football Game" on page 122.*)
- A terrorist car bomb
  ( *See Appendix C.5 "Scenario: Terrorist Car Bomb" on page 129.*)

The final two scenarios represent large-scale regional events:

- A hurricane
  ( *See Appendix C.6 "Scenario: Hurricane" on page 149.*)
- An earthquake
  ( *See Appendix C.7 "Scenario: Earthquake" on page 152.*)

As the scenarios become more complex, details are assumed and not explicitly defined in the scenario. Each scenario begins with an Outline of the hypothetical event, followed by the Narrative, which explains in detail the events of the scenario in chronological order with time stamps. The focus is on those aspects of the scenarios that impact communications, activities that do not impact communications are not described or described only briefly. The Narrative is followed by a Transmission History Table, which describes step-by-step the communication events that occur during the scenario. The level of detail included in the Transmission History Table varies, based on the level of detail of the scenario itself, but it generally includes a list of all of the types of communications occurring during the scenario. In many cases, the information in the Transmission Tables describes the creation or dissolution of a user group. While active, there are numerous individual transmissions that are not enumerated; rather, a relative measure of the amount of traffic is provided-from low to very high-to indicate the relative loading the transmissions place on the communications infrastructure.

# Appendix C.1 Scenario: Traffic Stop

## Appendix C.1.1 Outline

1. Scenario initiation: Officer spots traffic violation.
2. Officer runs plates and pulls car over; officer receives owner info and picture.
3. Officer requests license & registration; driver does not provide. Officer matches info provided by driver to alias returned by license plate check.
4. Officer spots evidence of drugs, requests assistance.
5. Officer searches vehicles, finds drugs, places driver under arrest
6. Officer takes a field one-print fingerprint.
7. Transport unit transports driver to the jail.
8. Officer completes preliminary form suspect and vehicle information.
9. Suspect booked into jail.
10. Tow truck removes vehicle, officer completes report and updates the state motor vehicle database to update vehicle status as “towed/stored”.
11. Officer completes arrest forms.
12. Officer closes incident, resumes patrol.

## Appendix C.1.2 Narrative

This scenario includes a “simple” activity, in which an officer on routine patrol observes a traffic violation, pulls the car over, and observes drugs in the vehicle, resulting in an arrest. Throughout this scenario only the voice communications relevant to the scenario are identified; however, the officers involved in this scenario are listening to voice communications involving other officers responding to other incidents.

11:00 PM

1. An officer with the Liberty County Sheriff's Department is on routine traffic patrol (single officer in the car) one evening when he observes a car that runs through a red light at the intersection of Routes 19 and 52. The officer presses the “Vehicle Stop” button on his vehicle's computing device[1], which sends a message to dispatch; the location information of the officer's car is also transmitted. The video camera on the officer's dashboard, which is continually recording to a temporary buffer, stores the current buffer of data and begins recording video captured by the camera onto a storage device in the vehicle. Pressing the “Vehicle Stop” button also results in the auto-capturing of the license number of the vehicle being stopped from a frame taken from the video camera on the officer's dashboard. The license plate number is entered into a query that is automatically sent to obtain vehicle registration, stolen vehicle, and wants/warrants information. The dispatcher “voices back” the vehicle stop for other units in the area, and the in-vehicle display for all units on patrol shows a traffic stop icon at that location on a geographic information display.

2. The vehicle pulls over and stops. Before leaving his vehicle, the State Motor Vehicle Registration, Stolen Vehicle, and Wants/Warrants systems return their information to the officer's computing device; the return information provides information about and picture of the registered owner, which indicates (both on the computing device screen and with an audio signal) that there are no Wants/Warrants.

11:05 PM

3. The officer then switches the camera to begin transmitting real-time video to dispatch in addition to recording the video in the car. (The dispatcher brings up a display in a portion of her console and glances occasionally at it while continuing to perform her duties.) The officer approaches the car and notes that there is a single occupant, the driver. The officer requests driver's license and registration, but the driver does not provide documentation. However, the officer notes that the name and DOB given by the driver matches one of the aliases returned by the license plate check, and the driver's license picture associated with the registered owner resembles that of the driver of the vehicle. The officer queries the criminal history database for information about the driver and receives a response that the individual has previously been arrested for drug possession.

11:10 PM

4. While obtaining the information from the driver, the officer observes what he believes to be the remains of marijuana cigarettes in the ashtray. The officer then contacts dispatch to request a backup unit. The dispatcher enters the “dispatch backup” command for the incident on her dispatch terminal and the Computer Assisted Dispatch (CAD) system recommends the dispatch of the closest unit based upon automated vehicle location (AVL) information provided by the vehicles on patrol and known road and traffic conditions. The dispatcher glances at the console map to confirm the recommendation and presses the key to confirm the CAD recommendation. The dispatch of the backup unit is transmitted

[1]. This scenario assumes that the officer has some type of portable computing device that can be carried with him outside of the patrol car. Such a device could be sufficiently powerful to encompass the functionality of today's mobile computers or a combination of a small portable device that can be synchronized with a more powerful computing device in the patrol car. In the latter case, any critical data is routed to both the in-car and the portable device.

electronically to terminals in that vehicle, as well as to other nearby units and the area supervisor's car for informational purposes. The backup officer acknowledges and a voice link is established to the on-scene officer to confirm location and circumstances as needed.

11:15 PM

5. The supervisor brings up the real-time video of the event and briefly observes the situation; once satisfied that the situation is under control and being properly handled, the supervisor terminates the video and continues previous tasks. The backup unit arrives on scene. The driver gets out of the car. The backup officer watches the driver while the responding officer searches the car. The original officer finds a number of bags of a white substance that appears to be cocaine. The original officer then places the driver under arrest and restrains him with handcuffs equipped with an RF ID tag. The RF ID tag is later loaded with the officer's identity code, the nature of the crime, and a case number. The original officer radios dispatch to request a transport vehicle. The unit is dispatched and is linked to the original officer to communicate and obtain information as needed.

6. The original officer takes a fingerprint of the driver[1] and forwards it to the state database. There is a match on the database and the information provided from the name/DOB check is confirmed.

11:25 PM

7. The transport unit arrives. The transport unit computing device downloads relevant case information from the original officer's computing device for the transport officer's report and the car driver is transported to the jail. The backup unit departs the scene and resumes patrol.

8. The original officer radios dispatch to request a tow truck to tow the vehicle to be impounded. The original officer takes photo images of the suspect's car and the suspected drugs, and collects the evidence. He conducts field tests of the substances and confirms that the suspected drugs are cocaine. He places RF ID tags on all evidence bags. The original officer completes preliminary suspect and vehicle information on the crime to automatically populate a Tow Report and Inventory forms and the jail booking form. This information is transmitted electronically to the Sheriff's Central Records System.

11:40 PM

9. The transport officers arrive at the jail located in Central City. The officers bring the suspect in for booking. The booking officer queries the suspects RF ID tag on the handcuffs to begin the booking record, which is automatically populated from the information previously sent to the Central Records System. Information on the handcuff RF ID tag is cloned to a wrist band that is then affixed to the suspect after the handcuffs are removed.

11:55 PM

[1]. This scenario assumes that fingerprints are still the preferred biometric identifier. Other identifiers could be used if and when the technology matures for them to be used routinely for identification

10. The tow truck arrives at the scene and devices are authenticated, and the Tow Report is transmitted electronically to the tow truck driver. The tow truck driver reviews the Tow Report with the associated officer code and case number and adds his electronic signature. The officer then continues to work on the arrest report, adding a narrative section describing the events, along with descriptions of the confiscated property, and associated arrest information. The officer also updates the state motor vehicle database to update vehicle status as “towed/stored”.

12:45 AM

11. The officer completes the arrest report in electronic form. The report is transmitted to the shift supervisor located at the Sheriff's Department headquarters. The supervisor notes one deficiency in the report and transmits it back to the officer. The officer corrects the report and transmits it back to the supervisor. The supervisor electronically signs off on the report and forwards it to records and to the District Attorney's office.

1:00 AM

12. The officer clears the incident on his computing device, which automatically shuts off the video camera, and resumes patrol.

## Appendix C.1.3 Transmission History

There are several specific transmissions in the following table, such as acknowledgements and notifications that are assumed in the narrative section. Security Indicates whether the transmission is secured (S) or unsecured (U).

| Time | ID | Dispatch | Police | Xmission Type | Security |
|---|---|---|---|---|---|
| 23:00 | | | AVL (continuous) | Binary | S |
| 23:00 | a1 | Acknowledge & voice over to other units | Notify dispatch following vehicle | Binary | Bin. S Voice: U |
| 23:00 | a2 | | Automatic query for registration information, stolen vehicle, wants/warrants | Binary | U |
| 23:00 | b1 | License plate/stolen vehicle/ wants and warrants checks, license picture of registered owner | | Binary and image | S |
| 23:05 | c1 | | Camera turned on | Streaming video | S |
| 23:05 | c2 | Previous arrest info | Criminal history check | Binary | S |
| 23:10 | d1 | Acknowledge | Requests assistance from dispatch | Voice | U |

| Time | ID | Dispatch | Police | Xmission Type | Security |
|---|---|---|---|---|---|
| 23:10 | d2 | Dispatches backup | | Binary | U |
| 23:10 | d3 | | Backup acknowledges, continuing conversation with officer on scene | Voice | U |
| 23:15 | e1 | | Supervisor views video | Video | S |
| 23:15 | e2 | Acknowledge | Officer requests transport unit from dispatch | Voice | U |
| 23:15 | e3 | Dispatches transport | | Binary | U |
| 23:15 | e6 | | Transport acknowledges, continuing conversation with officers on scene | Voice | U |
| 23:15 | f1 | | Biometric transmitted | Binary | S |
| 23:25 | f2 | | Receive confirmation on suspect identity | Binary | S |
| 23:25 | g1 | Acknowledge | Transport notifies dispatch with status upon arriving at scene | Binary or Voice | U |
| 23:25 | g2 | | Transport officer's computing device downloads case information from original officer's computing device and handcuff RF ID tag | Binary | S |
| 23:25 | g3 | Acknowledge | Backup radios dispatch that he is resuming patrol | Voice | U |
| 23:25 | h1 | | Completes preliminary suspect and vehicle information and sends to Sheriff's Dept. Records System | Binary | S |
| 23:40 | i1 | | Booking officer at jail requests arrest report information from suspect's RF ID tag and Central Records System | Binary | S |
| 23:55 | j1 | | Tow Report transmitted to tow truck. | Binary | S |
| 23:55 | j2 | | Tow truck operator's electronic signature attached to electronic copy of report on original officer's computing device | Binary | S |
| 23:55 | j3 | | Transmit tow report | Binary | S |
| 23:55 | j4 | | Update motor vehicle database | Binary | S |

| Time | ID | Dispatch | Police | Xmission Type | Security |
|---|---|---|---|---|---|
| 12:45 | k1 | | Officer transmits report to supervisor | Binary | S |
| 12:50 | k2 | | Supervisor returns report to address deficiency | Binary | S |
| 12:55 | k3 | | Officer transmits report to supervisor | Binary | S |
| 1:00 | l1 | Acknowledge | Officer notifies dispatch that incident closed | Binary or Voice | U |

Table 29. Transmission History Traffic Stop Scenario

## Appendix C.2 Scenario: House Fire

### Appendix C.2.1 Outline

1. Scenario initiation: A call to 911 from woman claiming her house is on fire.
2. Dispatch assigns units to house fire
3. Several units respond
4. CAD System recommends additional units
5. Dispatch pages units
6. Police are Dispatched
7. Additional unit respond
8. 1st unit enters neighborhood
9. Dispatch arrives and describes scene
10. Power Company vehicle is requested
11. Additional Units arrive and are assigned
12. Gas Company vehicle is requested
13. Unit arrives and is tasked with stageing fire
14. Power cutoff being confirmed
15. Another Unit arrives

16. People out of structure confirmation
17. Units begin fighting fire
18. Additional units arrive
19. Water problems
20. Command tells people to get out of structure
21. Units fighting fire from rear
22. Water department is requested
23. Fighting Fire on 2nd floor
24. House is surrounded and being fought
25. Water challenges
26. Ladder Pipe knocking down fire and re-entry is considered
27. Roof and Ladder Pipe Status
28. Air challenges addressed
29. Visual requested by Command
30. Ladder pipe has been effective and people are going to be re-entering
31. Unit enters from front
32. Unit enters from rear
33. Fan requested to blow out smoke
34. 4 units in house but staying away from structural hazards
35. Getting personal Items for family

## Appendix C.2.2 Narrative

This scenario includes a 2 story house fire. Multiple units are involved and several challenges are addressed.

00:12:11

1. A woman calls 911 screaming that her house is on fire. All occupants are out of the residence. Dispatch captures the information in Computer Assisted Dispatch (CAD) system.

00:12:24

2. Dispatch types in the address of the residence and it provides a list of units that are in the vicinity including their location and travel distances. The systems assigns several units to the house fire including: 3 engines (E46, E43, E38), 2 battalion commanders (BC7, BC281), 1 ladder truck (L43), 1 Rescue/Ambulance Vehicle (R43). The system also displays capabilities of each unit.

00:12:52

3. Fire engines (E38 and E46) as well as Battalion commander (BC7) respond that they are in route with lights and siren via their communication device. The roster of people with the unit is automatically transmitted.

00:13:17

4. The CAD system recommends the dispatch of additional units including: Fire Engine (E284), Utility truck (U29), Alternate Response Vehicle (AR12), Rehab Vehicle (RH3) and notifies them.

5. Dispatch pages all units that have not responded as well as a Public Information Officer.

00:13:22

6. A police unit (PHXP2) is dispatched via the Computer Assisted Dispatch (CAD) system.

00:13:34

7. Latter truck (L43), Fire engine (E43) Utility vehicle (U29) and Battalion commander (BC281) responds in route with lights and siren as well as a Rescue/Ambulance Vehicle (R43) Rehab Vehicle (RH3) and a responds in route. Alternate Response Vehicle (AR12) responds in route their communication device. The roster of people with the unit is automatically transmitted.

00:21:25

8. Having been guided to the scene by GPS, Fire Engine (E46) broadcasts that they have entered into the gated community of the house and confirms their status via their communication device.

00:21:54

9. Battalion Commander (BC7) broadcasts via radio that they are On-Scene and confirms their status via their communication device. The Battalion Commander also provides additional scene information including video. It is a large 2-story house with fire on the 1st floor. Being the first officer on scene, the Battalion Commander assumes the role of Incident Commander.

00:21:54

10. Dispatch requests power company vehicle as a result of a recommendation by the CAD System

00:22:00

11. Ladder Truck (L3) and Rescue/Ambulance Vehicle (R43) broadcasts that they are On Scene and confirms their status via their communication device. Battalion commander (BC7) tells L43 to make sure everyone is out and then get water source. L43 locates hydrants via electronic map on communication device.

00:22:33

12. Dispatch requests gas company vehicle as a result of a recommendation by the CAD System

00:23:21

13. Fire Engine (E43) broadcasts that they are staged a block away and confirms their status with their communication device. The roster of people with the unit is automatically transmitted and they are linked into the incident. Upon looking at the capabilities of E43 via the Portable Command Unit, Command tells them to use to come on-scene so they can "Stang this thing".

00:23:47

14. Stang gun operation delayed while checking for power. Status is being conveyed via the Power Company's communication device that is now linked into the incident.

00:23:59

15. Fire Engine (E284) broadcasts that they are staged a block away and confirms their status with their communication device. The roster of people with the unit is automatically transmitted and they are linked into the incident.

00:24:06

16. Command looks to make sure that all people are out of structure via their electronic locators. Defensive fire.

00:25:59

17. Command tells Engine (E43) there is no room for 2nd supply line. Ladder Truck (L43) broadcasts that they have water and Command looks for their position. He sees that they are in the rear of the house. Command asks (E43) to knock down most of fire in Garage and then make way to rear.

00:28:00

18. Battalion commander (BC281), Rescue/Ambulance Vehicle (R38), and Fire Engine (E38) broadcasts that they are staged a block away and confirms their status with their communication device. The roster of people with the units are automatically transmitted and they are linked into the incident. Pumper (P43) is hooking up to the hydrant.

00:29:00

19. Instructions given to vent from rear. Engine (E43) asks for line change. Pumper (P38) broadcasts via their communication device JNM that they are working on changing line and getting hydrant pumped. Ladder (L43) repeats urgent request for water to the rear of house or house could be lost.

00:32:00

20. Command tells responders to stay out of structure until they get water and stay defensive. An electronic page goes out to all incident responders telling them to pull out, account for their group, and to go defensive.

00:34:40

21. Command directs Pumper (P38) to get hydrant pumped and for Ladder Truck (L43) to get water to their ladder and get it up and working. Engine (E38) is unable to vent from their position and are directed via portable communication device to relieve Ladder (L43) in the rear where they can get more water.

00:35:00

22. The water department is notified and a technician is assigned to the scene by dispatch. They acknowledge via their communication device.

00:36:00

23. Engine (E38) is relieving Ladder Truck (L43). Ladder Truck (L43) has its ladder up and is getting its water pipe going. Fire has become heavy on the second floor. Engine (E46) is in front of the house working toward the garage.

00:38:00

24. Engine (E43) is ready for reassignment. House is now surrounded. Ladder Pipe and multi hand lines are in operation. The Ladder Pipe is providing a heavy amount of water to the second floor.

00:39:00

25. Engine (E43) tells Pumper (P43) they are low on pressure. Utility Truck (U29) is now On Scene and confirms their status with their communication device. The roster of people with the unit is automatically transmitted and they are linked into the incident

00:44:00

26. Command tells safety that Ladder Pipe is knocking down the fire well and needs for safety to check on unit positions and determine if re-entry is safe.Command also asks Rescue (R43) to confirm that they have a hand line in their possession. Safety notices on their Communication Device that many of the responders are running low on air. Command asks all units to check their air and rotate crews as much as possible in case they are able to re-enter. Command asks Ladder (L43) to report on roof, look for sagging and video if possible.

00:45:00

27. Ladder Truck (L43) broadcasts that the roof is intact and Ladder Pipe is still operational. Command observes first hand via video.

00:50:00

28. Some crews state they are low on air. Command requests Utility Vehicle to come in closer and take care of the air. (AR12) arrives and confirms their status with their communication device. The roster of people with the unit is automatically transmitted and they are linked into the incident.

29. Command sees only smoke from Engine (E38)s Video and IR Camera. Command asks Engine (E38) for a confirmation.

00:54:00

30. Engine (E38) reports that there is nothing but smoke. Ladder Pipe is going all the way through the house now and spraying responders through the other side. If that line is shut down they can make their way inside. R38 is requested to come up and relieve crews with a hand lines via their Communication Device.

00:57:00

31. Engine (E284) is making entry in the front and up the stairs and hitting hot spots. Their location is being tracked by the GPS and they are using IR to look for hot spots.

32. From the Command Panel the Commander sees that Engine (E43) company is going through front door and that (R38) is in rear with hand line waiting for Engine (E38). Once they hear from Engine (E38) they will work in from rear checking for hot spots.

00:58:00

33. Command request Ladder (L43), Truck (T43), to get fan and blow the house out.

01:09:00

34. Four Companies are now in the house but staying off the second floor because of potential structure problems. Command has also told them to stay out of the Garage area also because the roof is burned through. Their location and biometrics are being tracked. They are firetaping garage.

01:27:00

35. Companies are exiting. Command asks Engine (E284), who are in the bedroom area, to find some clothes and see if they see a purse and some glasses in a jewelry box for the owners.

## Appendix C.3 Scenario: Emergency Medical Services

### Appendix C.3.1 Outline

a. Two person team (EMT-P and EMT) begins shift with EMS service in the village of Bayport.

b. Crew follows up requests for non-emergency service calls.

c. EMT-P conducts home check of post-operative patient while EMT conducts free blood pressure screening at local coffee shop.

d. EMT-P responds to request to check monitoring equipment in use by patient in area that appears to be malfunctioning.

e. EMT returns to health clinic and assists Physician's Assistant in seeing patients.

f. A car accident signals an Automatic Call Notification (ACN) center which alerts the EMS dispatcher who dispatches the ambulance to the scene. Based on ACN information, hospitals are alerted, second ambulance and extrication equipment are dispatched.

g. First ambulance arrives on scene, determines that single car crash was likely caused by driver suffering a heart attack; passenger has open skull injury. Medevac helicopter dispatched to scene.

h. Second ambulance and extrication equipment arrive on scene.

i. Driver removed from vehicle placed in first ambulance and transported to hospital with cardiac catheterization facility.

j. Passenger removed from vehicle and placed in ambulance, transported to helicopter which transports her to specialized Trauma Center.

k. Helicopter arrives at hospital.

### Appendix C.3.2 Narrative

This scenario takes place in late autumn on Masland Island, a coastal island in Liberty County. The island includes a State Park with public beaches, along with a mix of seasonal and year-round residences. The Central City Hospital runs a health clinic in Bayport, staffed by a Physicians' Assistant. The Bayport Ambulance service staff support the physician's assistant when not on call. Also key in this scenario: the Faith Hospital, which is located in Central City, approximately 40 miles from Bayport, has a regional Cardiac Care Center and has a cardiac catheterization laboratory, and Central City Hospital which has an ACS level 1 trauma center. Central City Hospital also operates a medevac helicopter service called Med Flight-1.

Much of the information on the real-time status of responders is maintained in a database referred to as the Emergency Medical Services Event Management System (EMSEMS, or EMS2). This system receives all data on EMS-relevant events in a geographic area. All EMS service providers (non-transporting first responder units and ambulance services), hospital ERs, trauma center coordinating staffs, specialty service responders (e.g., helicopter EMS, extrication and other rescue services) have EMS2 monitors which include a large map of their service area. EMS services, hospitals and other resources are represented on the map, as are locations and status of EMS calls. By selecting an icon, one can see the status of resources (e.g. level of providers on an ambulance) and of events (e.g., location of ambulance call, patient information as available, destination).

6:00 AM

1. The two person crew (one EMT-Paramedic and one EMT) come on-duty for their 12 hour shift. They begin by conducting vehicle and equipment checks. Once checks are completed, they enter “available for call” into the EMS2 while in the ambulance.

6:30 AM

2. The crew checks the Patient Scheduling Status on EMS2. There are two requests. The first, Dr. Smith, a surgeon in Central City, has requested a home check of a 75 year old female post-op patient who has had a wound infection. Dr. Smith has requested a video feed showing the wound, and blood draws to be picked up later at the clinic to be brought to the Central City Hospital Laboratory. The EMT-P calls the patient to set up the visit and then contacts Dr. Smith to confirm the visit, and then travels to the house in a Bayport EMS “interceptor” vehicle (a non-transporting four wheel drive utility vehicle with lights and siren). Meanwhile the EMT drives the ambulance to a local coffee shop and conducts a scheduled free blood pressure screenings. The nature of the calls/status of the crew (non-emergency calls) are updated in the EMS2

7:00 AM

3. The EMT-P arrives at the patient's home, contacts Dr. Smith, and sets up the camera to provide the video feed to show the wound. Dr. Smith, the patient, and the EMT-P converse briefly on the patient's condition, the EMT-P rebandages the wound per Dr. Smith's direction and draws the blood samples.

7:45 AM

4. The EMT-P travels to the home of a 60 year old male patient who is bedridden with a cold, but whose cardiologist at Faith Hospital has had him on a Holter monitor which is now failing to send signals. Again the EMT-P updates status on the EMS2 to indicate that he is responding to the entry in the Patient Scheduling Status, which automatically sends an notification to the cardiologist of the patient’s condition.

8:30 AM

5. The EMT returns to the health clinic and begin to assist the physician's assistant in seeing patients

8:40 AM

6. County dispatch receives a call from an Automatic Crash Notification call center of an airbag deployment on Rte 1-A 12 miles southwest of Bayport in Robert Hayward State Park. The ACN operator is unable to establish contact with the occupants. The ACN data feed indicates a 50 MPH head-on collision and roll-over, with two occupants. There is a belted driver who remained in front seat and a passenger now in the back seat. There is 12" engine incursion into the front area, and the roof is compressed 9" with possible entrapment. The county dispatcher views a display of the location and status of ambulances in the area from the EMS2 and the location of the crash site; the computer system assists by calculating estimated traversal times for the various ambulances based on current ambulance status, distance to crash site, road types, road conditions, and traffic conditions. (Road and traffic information is also downloaded to the dispatched ambulance.) Based on this information the Bayport ambulance crew is dispatched. Police and a wrecker are also dispatched.

7. The EMT-P and EMT agree on a meeting point. County dispatch dispatches a second Bayport ambulance, as well as fire department extrication and manpower service. The Bayport ambulance crew requests dispatch to contact Fisherville Hospital (which is the closest to the crash site and Bayport's local medical direction facility) and also to put the Med Flight-1 helicopter and Central City Hospital Trauma Center on alert.

8. The EMT-P calls up the EMS2 and verifies the crash site on the map display on the computing device in the ambulance, which also maps the route for the driver; a computer-activated voice tells the driver what lane to be in and which turns to make. As the ambulance approaches traffic lights along the route, the on-board signaling system changes the lights to the ambulance's favor. The on-board system also interrogates the county's transportation system for updates on road closures, blockages, train conflicts, or slow traffic conditions to route the ambulance around impediments and provide the fastest route to the crash site.The EMT-P requests additional information on the crash to verify the ACN data and identifies a helicopter landing site in Robert Hayward State Park which is a mile from the crash scene. The EMS2 personnel information shows the status of the backup ambulance, which has an EMT-level crew on board and that a Fisherville volunteer EMT-Intermediate residing near the crash scene hears the radio traffic and is also responding.

9. At Central City Hospital Trauma Center, the Med Flight-1 crew and lead trauma nurse check their EMS2 screen. The Bayport crash is indicated, but there is no information yet reflecting patients' destinations. They check ACN data and elect to start the helicopter. The EMS2 also shows another vehicle crash in town with one of four patients coming to the Trauma Center with an isolated long bone fracture. The EMS2 shows two other ambulance calls in the area (a workplace accident and an overdose), both of which indicate the Central City Hospital Trauma Center ER as their destination. Since these calls (along with the patients already in the ER) will occupy currently available staff, the secondary trauma team is paged and put on 15 minute alert. Each team member confirms receipt of the page and the information is entered automatically into the EMS2.

10. The triage nurse at Fisherville Hospital checks the EMS2 in response to an audible alarm and notices the Bayport crash just as the ER secretary tells her of the call from Bayport EMS alerting them. She accesses information concerning the Bayport EMS ambulance and notes that two ambulances are responding, with one 10 minutes and one 15 minutes from the scene. She also accesses the Central City Hospital Trauma Center status and notes that the secondary Trauma Team has been put on alert and the Med Flight-1 helicopter is prepared to head to the Bayport scene. She accesses personnel information on the EMS2 that shows that the ED physician at the Fisherville Hospital is in the sleep room. She selects automatic notification of the ED physician who responds (and the information is entered into the EMS2).

11. En route, the ambulance, now with both crew members, notifies dispatch of extremely icy road conditions and puts this information into the EMS2. The second ambulance and responding fire vehicle crews hear their EMS2 alert and see the road condition warning flash. Roads crews are dispatched to sand. The volunteer EMT responding in his own vehicle receives a verbal warning from dispatch on their communications devices.

9:00 AM

12. The Bayport ambulance arrives with the EMT-P and EMT partners. The EMT-P establishes the safety of the scene by turning off the ignition, disconnecting the battery, and ensuring that there is no leaking gasoline. Meanwhile the EMT begins entering information into the EMS2. The EMT-P examines the patients and verifies a single vehicle crash into a tree with roll-over. There are two patients, male (the driver) and female approximately 50 years old. The male patient is semi-coherently responding to voice, has no visible injuries, and is complaining of chest and shoulder pain. The EMT-P determines that there is no tenderness to touch in the chest area and suspects cardiac pain. The female patient is trapped in the back seat with doors pinned by a collapsed roof, is unresponsive but is breathing, and appears to have an open head injury with possible skull fracture. The EMT-P requests dispatch to alert the Central City Hospital Trauma Center and to request the Med Flight-1 helicopter. The Central City Hospital secondary trauma team is ordered to come into the Trauma Center.

13. A communications net is established linking the EMT, EMT-P, and the Fisherville ED physician. The physician reads EMS2’†s Cardiac Care Center and the Central City Trauma Center ER physician, who are added to the temporary communications net. The EMT-P does a pulse oximetry and capnograph readings, places the patient on oxygen, determines history, administers aspirin, then immobilizes and moves the patient to the ambulance. The EMT-P then starts an IV, does a 12-lead EKG, and administers Nitroglycerin. The patient also indicates that he is carrying a personal medical data medallion; the EMT-P reads the information into the computing device in the ambulance. The medallion includes allergy information, medication information, and a baseline EKG. The pulse ox shows below normal blood oxygen concentration with and without oxygen being administered. The 12-lead EKG clearly indicates that the patient has suffered a heart attack. The Faith Hospital cardiologist issues immediate alert to the cardiac catheterization team. To confirm the absence of any severe injuries, the Central City Trauma Center physician orders the EMT-P to perform a portable body scan, which is sent to a radiologist at the Central City Hospital Trauma Center who verifies the absence of traumatic injury. Based on consultation between the EMT-P, the Fisherville Hospital ED physician, the Faith Hospital cardiologist, and the Central City Hospital Trauma Center physician, the decision is made to administer

a fast-acting "clot buster" medication in the ambulance, to bypass Fisherville Hospital, and transport the patient by ground to the Faith Hospital for cardiac catheterization. This information is entered into the EMS2.

14. The volunteer EMT-intermediate arrives (via private vehicle).

9:10 AM

15. The second ambulance (Bayport EMS with EMT crew) and fire department heavy rescue vehicle arrive. EMS2 indicates helicopter is on ground at landing site. Doorposts are cut and roof is removed.

9:20 AM

16. The first ambulance (with EMT-P) heads to Faith Hospital, 40 miles away. The EMT-P and Faith Hospital cardiologist are removed from the existing temporary communications net but linked via a separate temporary net. Repeat 12 lead EKG (periodically transmitted to hospital) are performed to monitor progression of the heart attack and "clot busting" treatment. Medications administered en route seem to have improved oxygenation of the heart muscle and have stopped the progress of the heart attack.

9:30 AM

17. The female patient is collared, boarded and removed from the car to the second ambulance. The EMT-Intermediate accompanies the patient and EMT crew to the landing site. The patient receives an IV and breathing tube en route to the helicopter landing area.

18. The volunteer EMT-I is added to the temporary communications net with the Central City Hospital trauma surgeon.

19. The EMS2 now shows two ambulances and two patients, one coded as cardiac transfer to Faith Hospital and one coded as destination helicopter landing pad for transfer to trauma center. A body scan is ordered en route to the helicopter and transmitted to the Central City Hospital Trauma Center. Based on consultation among the EMT-I, the Fisherville Hospital ED physician, and the Central City trauma surgeon, the decision is confirmed to transport to the Central City Hospital Trauma Center.

20. The Med Flight-1 helicopter lifts off.

9:50 AM

21. The Med Flight-1 helicopter is greeted by the Trauma Team at Central City Hospital, including a neurosurgeon prepared deal with a swelling brain shown on body scan and a trauma surgeon and orthopedic surgeon ready to deal with a pelvic fracture that has caused significant bleeding into the pelvis, also as indicated on body scan. Status is updated on the EMS2.

22. Approximately 20 minutes later, the male patient arrives at Faith Hospital and is immediately wheeled into the catheterization lab where it is determined that despite improvement from the medications administered emergency angioplasty is still required and so is performed and a stent placed. This improves blood flow and oxygenation of the heart muscle and leaving the patient with minimal damage.

## Appendix C.3.3 Transmission History

There are several specific transmissions in the following table, such as acknowledgements and notifications that are assumed in the narrative section. Security Indicates whether the transmission is secured (S) or unsecured (U).

| Time | ID | Dispatch/ EMD2 DB | EMS | Other | Xmsn Type | Security |
|---|---|---|---|---|---|---|
| | | | AVL (continuous) | | Binary | S |
| 6:00 | a1 | | Devices register with EMS/hospital net-works | | Binary | U |
| 6:00 | a2 | | Biometric authenti-cation information transmitted for user authentication | | Binary | U |
| 6:00 | a3 | Updates, alerts, etc. downloaded to ambulance | | | Binary, Image & Voice | U |
| 6:20 | a4 | | Enter “Available for call | “ | Binary | U |
| 6:30 | b1 | Scheduled requests | Query Patient Sched-uling Status | | Binary | S |
| 6:35 | b2 | | Calls patient for home visit | | Voice/PSTN | S |
| 6:35 | b3 | | Confirms visit with Dr. | | Voice | S |
| 6:35 | b4 | | EMT-P updates sta-tus to en-route in EMS2 | | Binary | U |
| 6:35 | b5 | | EMT updates status to en-route to restau-rant | | Binary | U |
| 6:45 | b6 | | EMT arrives at res-taurant, updates sta-tus | | Binary | U |
| 7:00 | c1 | | EMT-P arrives at patient's home, updates status | | Binary | U |

| Time | ID | Dispatch/ EMD2 DB | EMS | Other | Xmsn Type | Security |
|---|---|---|---|---|---|---|
| 7:05 | c2 | | Temporary net set up with patient and surgeon | | Voice | S |
| 7:05 | c3 | | Video of wound sent to Dr. | | Video | S |
| 7:15 | c4 | | Temporary net with patient and Dr. dissolved | | | |
| 7:30 | c5 | Notification to cardiologist | EMT-P leaves patient's house, updates status | | Binary | U |
| 7:45 | d1 | | EMT-P arrives at patient's home, updates status | | Binary | U |
| 7:50 | d2 | | Temporary net set up with patient and cardiologist | | Voice | S |
| 8:00 | d3 | | 12 lead EKG data sent to cardiologist | | Binary | S |
| 8:10 | d4 | | Temporary net with patient and Dr. dissolved | | | |
| 8:15 | d5 | | EMT-P leaves patient's house, updates status | | Binary | U |
| 8:15 | d6 | | EMT leaves restaurant, updates status | | Binary | U |
| 8:30 | e1 | | EMT-P and EMT both arrive back at clinic, update status | | Binary | U |
| 8:40 | f1 | | ACN notifies dispatch of accident | | Voice | S |
| 8:40 | f2 | Dispatch Fire and Police | Acknowledge | | Voice | U |
| 8:40 | f3 | | | Fire and PD update status information in EMS2 | Binary | U |
| 8:40 | f4 | Dispatch second ambulance | Acknowledge | | Voice | U |
| 8:40 | f5 | | Second ambulance updates status information in EMS2 | | Binary | U |

| Time | ID | Dispatch/ EMD2 DB | EMS | Other | Xmsn Type | Security |
|---|---|---|---|---|---|---|
| 8:40 | f6 | | Volunteer EMT-I hears dispatch, responds, enters info in EMS2 | | Binary | U |
| 8:40 | f7 | | Request dispatch notify Fisherville Hospital (FH), Central City Hospital Trauma Center (CCHTC), Med-Flight 1 (M-F1), and Faith Hospital Cardiac Care Unit (FHCCU) | | Voice | U |
| 8:40 | f8 | Notify Fisherville Hospital FH, CCHTC, M-F1, and FHCCU | | | Voice | U |
| 8:40 | f9 | | Ambulance signals traffic control to set traffic signals | | Binary | S |
| 8:40 | f10 | | Ambulance queries transportation information for traffic and road conditions | | Binary | U |
| 8:40 | f11 | | EMT-P retrieves crash site data, responder status from EMS2 | | Binary | S |
| 8:40 | f12 | | CCHTC accesses info from EMS2 | | Binary | S |
| 8:40 | f13 | | Secondary trauma team paged/acknowledge | | Binary | U |
| 8:40 | f14 | | FH triage nurse accesses info from EMS2 | | Binary | S |
| 8:40 | f15 | | FH triage nurse notifies ED physician | | Binary | U |
| 8:50 | f16 | | EMT-P notifies dispatch of icy roads, enter data into EMS2 | | Voice & Bin | U |
| 8:50 | f17 | Broadcast road condition alert | | | Voice | U |

| Time | ID | Dispatch/ EMD2 DB | EMS | Other | Xmsn Type | Security |
|---|---|---|---|---|---|---|
| 8:50 | f18 | Notify DPW | | | Voice | U |
| 9:00 | g1 | | EMT arrives on accident scene, updates status in EMS2 | | Binary | U |
| 9:00 | g2 | Acknowledge | EMT-P requests notification to CCHTC, FHCCC, M-F1 | | Voice | U |
| 9:00 | g3 | Notify CCHTC, FHCCC, M-F1 | | | Voice | U |
| 9:00 | g4 | | CCHTC notifies secondary trauma team to come to hospital | | Binary | U |
| 9:00 | g5 | | Temporary net links EMT-P, EMT, Fishersville ED | | Voice | S |
| 9:05 | g6 | | CCHTC and FHCCC physicians added to temporary net | | Voice | S |
| 9:05 | g7 | | FHCCC cardiologist downloads patient medical data from ambulance | | Binary | S |
| 9:05 | g8 | | Body scan transmitted to Fishersville & CCHTC | | Video | S |
| 9:05 | g9 | | FHCCC notifies cardiac cath team to come to hospital/ acknowledge | | Binary | U |
| 9:05 | g10 | | Volunteer EMT-I arrives at accident scene, updates status on EMS2, added to temporary net | | Voice & Binary | U |
| 9:10 | h1 | | 2nd ambulance arrives, enters status update in EMS2 | Fire Rescue arrives, updates status in EMS2 | Binary | U |
| 9:10 | h2 | | Med Flight helicopter lands, updates status in EMS2 | | Binary | U |

| Time | ID | Dispatch/ EMD2 DB | EMS | Other | Xmsn Type | Security |
|---|---|---|---|---|---|---|
| 9:20 | i1 | | 1st ambulance leaves for Faith Hospital Cardiac Care (update EMS2) | | Binary | U |
| 9:20 | i2 | | Temporary net split into two: EMT & Fisherville & Trauma Ctr & volunteer EMT-I, EMT-P and cardiologist at Faith | | Voice | U |
| 9:20 | i3 | | FHCCC cardiologist continues periodic downloads of patient medical data from ambulance | | Binary | S |
| 9:30 | j1 | | 2nd ambulance departs for helicop-ter (update EMS2) | | Binary | U |
| 9:35 | j2 | | Body scan transmit-ted from helicopter to CCHTC | | Video | S |
| 9:40 | j3 | | Medi Flight 1 takes off (updates EMS2) | | Binary | U |
| 9:50 | k4 | | Med-Flight arrives at CCHTC (update EMS2) | | Binary | U |
| 10:10 | k5 | | 2nd ambulance arrives at Faith (update EMS2) | | Binary | U |

Table 30. Transmission History of Emergency Medical Services Scenario

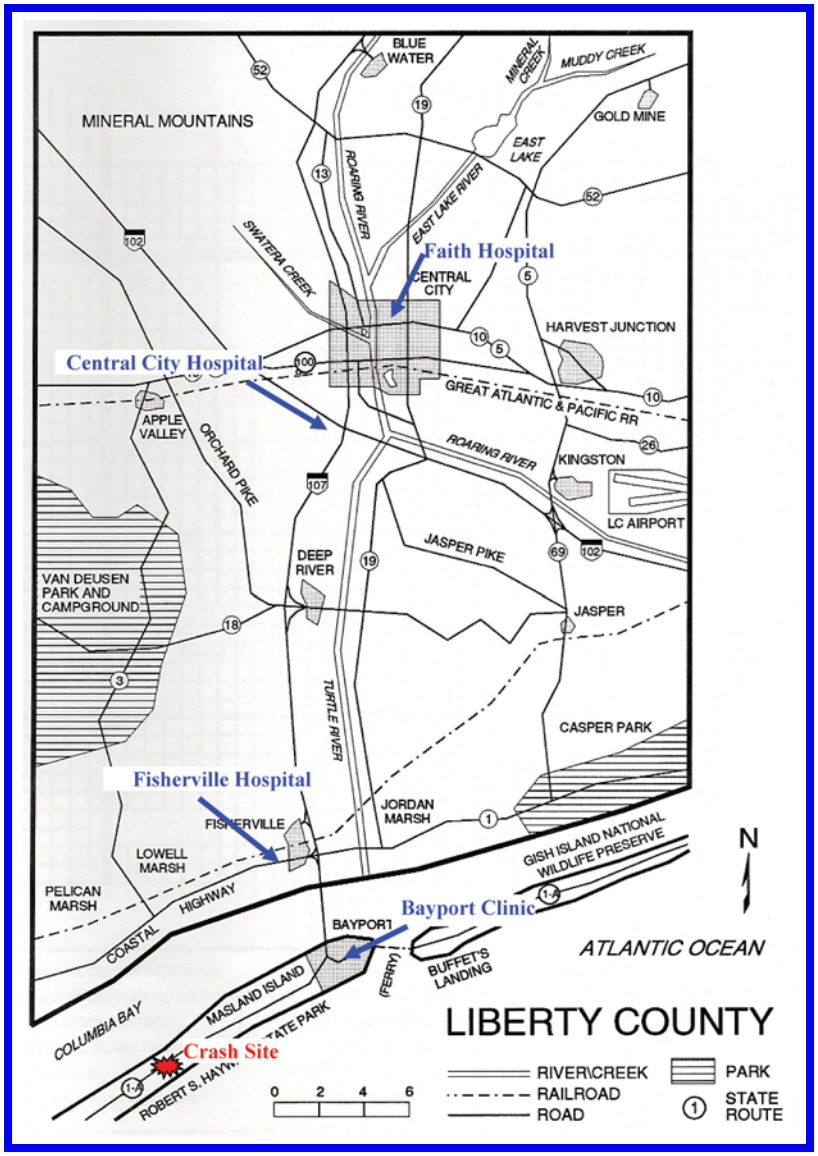


Figure 1 Map of Emergency Medical Services Scenario

# Appendix C.4 Scenario: College Football Game

## Appendix C.4.1 Outline

Pre-planning.

1. Columbia State Police provide escort for Metropolis football team from their hotel in Harvest Junction.

2. Initial traffic detail deployed.

3. Columbia State Police escort meets Central City Police Department escort at city line.

4. Traffic backs up off I-107 due to disabled vehicle, alternative routing established.

5. Traffic detail notices a car fire; fire department responds.

6. Rain begins to freeze in some areas, so DPW is notified and adjusts their priorities to salt areas where traffic is most affected first.

7. Private citizen calls 911 with parking complaint; unit sent to investigate and calls for tow truck.

8. Patient with chest pains removed from stadium.

9. Officers apprehend a suspect that has broken into a car parked in the parking lot.

10. A12 year old boy is separated from family taking a shuttle bus back to a satellite parking area; police find him in a different parking lot.

11. Traffic detail completed.

## Appendix C.4.2 Narrative

This scenario outlines the activities associated with a college football game between Columbia State University and their archrival, Metropolis University, taking place at McDonald Stadium on the campus of Columbia State University in Central City on a gray, chilly November evening.

Several Days Prior

1. The Central City PD officer assigned to coordinate the traffic detail contacts the Columbia State University (CSU) Parking Bureau to coordinate placement of “no Parking” barrels and other details of the upcoming game. The officer also contacts a towing company to provide a tow truck at the Command Center during the game, and also contacts the Central City Public Works Dept. to inform them of the anticipated traffic during the game day.

3:45 PM

2. The Columbia State Police begin escorting the Metropolis University football team from the Holiday Inn in Harvest Junction to McDonald Stadium. CSP provide escort to the Central City line.

4:00 PM

3. The Command Post at McDonald Stadium is activated and the officers assigned to traffic detail are assigned to their posts. At key intersections, the officers park their cars to allow cameras in the cars to take video of the traffic situation (which is made available to Incident Command upon request). Officers on traffic detail are placed in a user group with the command post. Officers inside the stadium are part of a separate user group with the Command Post as well. The location assignments of the officers are displayed as an overlay on a map display in the Command Center.

4:15 PM

4. The CSP escort approaches the City Line. A user group linking the CSP escort and CCPD escort is established when the CSP escort is about five minutes from the handoff point. After the CCPD begins the escort, this user group is dissolved.

5:30 PM

5. Officers on traffic detail at two interchanges along I-107 begin to report in that traffic is backing up along I-107. The commander of the traffic detail checks a monitor in the Command Post, and brings up a video display from each of the police cars deployed along the interstate. She also hears a dispatch from the 911 Center that there is a disabled vehicle on I-107. She brings up a video feed from a news station traffic cam mounted on the Highland Park Building and queries real-time information from the Dept. of Transportation sensor grid to confirm the location of traffic tie-up and the traffic patterns on side streets. This information is displayed as an overlay to a map display. She creates a temporary net to link the officers on traffic detail in the affected area, and officers begin to route traffic heading for the game to exit the interstate further north. The Traffic Detail Commander also sends a message to update Variable Message Signs along the interstate inform motorists of the detour, and sends a message to the DoT Traffic Control Center to change the traffic signal pattern along the alternative route. The Commander then periodically brings up the various feeds to monitor how well the rerouting is working.

6:15 PM

6. Officers directing traffic into a parking lot notice flames inside a parked car. They contact the traffic detail commander who contacts the 911 center. A user group is established between the responding fire truck and the traffic detail officers in that parking lot. The traffic detail commander also reassigns some traffic detail officers in the area to assist in clearing a path for the fire truck to reach the vehicle in the parking lot. The fire is quickly extinguished. The traffic detail commander contacts University Security inside the stadium to page for the car's owner.

6:30 PM

7. A light mist begins falling and freezing on the road surface. Cars using the alternate routing from I-107 must go up a steep hill to get to McDonald Stadium, and cars are beginning to slide. A traffic detail officer reports the conditions to the traffic detail commander, who contacts the Dept. of Public Works, who reassign a salt truck to the area. A user group is set up between the traffic detail officer and the salt truck operator to allow the officer to hold up traffic and allow the truck operator to salt the hill.

7:00 PM

8. The 911 Center receives a call that a car is blocking a private driveway near the stadium. The dispatcher informs the traffic detail commander, who dispatches a unit to handle the parking complaint. The officer runs a plate check to identify the owner; this information is automatically put into the towing report. The officer then contacts the Impound Post which dispatches an on-call tow truck to tow the car.

7:15 PM

9. A woman approaches an officer inside the stadium and tells him that her husband is having chest pains. The officer contacts emergency medical personnel via his PSCD inside the stadium. Medical personnel come to the section where the man is sitting; they quickly conclude the man's symptoms warrant further attention and contact the on-duty physician at the stadium medical station, via PSCD. The physician directs the medical personnel to move the man to the medical station, where an ambulance is located. There the physician concludes that the man should be transported to the Cardiac Care Center at Faith Hospital. The physician contacts the Hospital to notify them of the incoming patient. The patient is then placed in the ambulance and transported to the Faith Hospital Cardiac Care Center (following similar procedures as described in the EMS scenario.) As the ambulance leaves the stadium, the Commander informs the traffic detail officers outside the stadium who direct traffic to allow the ambulance quick departure to the hospital.

8:15 PM

10. Officers sitting in their patrol cars periodically download real-time video from surveillance camera deployed around the parking lots. One officer observes a young male pulling something through the window of a car and then running away. This information is broadcast to the traffic detail users group, and officers on the far side of the lot chase and catch the suspect. The arresting officer requests a transport vehicle to take the suspect to the city jail and completes an arrest report (similar to the procedures described in the Traffic Stop scenario).

10:00 PM

11. As the game ends, City Transit busses, which are connected to a user group for all traffic units, shuttle people back to satellite parking areas. As one family arrives at the satellite parking area, they inform a traffic detail officer that they have been separated from their 12 year old son. The traffic detail officer obtains a photograph of the boy from the mother and captures the image electronically (via scanner or camera). The officer broadcasts the information to the traffic detail officers and the transit bus drivers and forwards the picture of the boy to the traffic detail officers and transit busses on the users group. One bus driver indicates that he had a passenger that may have fit that description who left his bus at a particular lot. The traffic detail officers at that lot identify the boy in the crowd from his picture and reunite him with his family. The busses are removed from the traffic users group.

11:30 PM

12. The Metropolis University team is escorted from the stadium. Shortly thereafter the traffic detail is completed and the user groups are dissolved. And Columbia State wins, 27-21.

## Appendix C.4.3 Transmission History

There are several specific transmissions in the following table, such as acknowledgements and notifications that are assumed in the narrative section. Security Indicates whether the transmission is secured (S) or unsecured (U). Many of the transmissions described in the narrative occur over the identified user group. In addition, there are “routine” communications on this net that are not identified explicitly in this table. In some cases, specific transmissions are identified here to help illustrate the logical flow of events,

| Time | ID | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|
| 16:00 | c1 | User group established among officers assigned to traffic detail and the Event Command Post | | Voice/Low | U |
| 16:00 | c2 | User group established among officers assigned to stadium detail University Security, on-site medical personnel, and the Event Command Post | | Voice/Low | U |
| 16:00 | c3 | Location of traffic detail cars sent to Event Command Post and displayed on map | | Binary/Continuous | U |
| 16:15 | d1 | User group established between Columbia State Police and Central City PD escorts | | Voice/Medium | U |
| 16:20 | d2 | User group dissolved between Columbia State Police and Central City PD escorts | | | |
| 17:30 | e1 | Traffic detail commander downloads video from cameras of police cars at intersections | | Video | U |
| 17:30 | e2 | Traffic detail commander downloads video from news station traffic cam | | Video | U |

| Time | ID | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|
| 17:30 | e3 | Traffic detail commander downloads data from Dept. of Transportation sensors | | Binary | U |
| 17:30 | e4 | User group established among Event Command Post and traffic detail officers in areas where traffic is backed up | | Voice/Medium | U |
| 17:30 | e5 | Traffic detail commander sends messages to Dept of Transportation to update VMS and traffic signal pattern to accommodate re-routed traffic | | Binary | U |
| 18:15 | f1 | Traffic detail commander contacts 911 Center re care fire | 911 dispatches fire truck | Voice | U |
| 18:15 | f2 | User group established between traffic detail and responding fire truck | | Voice/Medium | U |
| 18:25 | f3 | Fire truck arrives on-scene, extinguishes fire, User group dissolved | | Voice | U |
| 18:30 | g1 | Traffic detail commander contacts DPW regarding hazardous road situation | | Voice | U |
| 18:30 | g2 | User group set up linking traffic detail officers and DPW truck; net dissolved when truck arrives in area a few minutes later | | Voice | U |
| 19:00 | h1 | | Citizen call comes into 911 center complaining of illegally parked car blocking driveway; dispatch notifies Event Command Post | Voice | U |
| 19:00 | h2 | Event Commander assigns traffic detail unit to handle complaint | | Voice | U |
| 19:05 | h3 | Traffic detail officer runs license plate check to id owner | | Binary | S |

| Time | ID | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|
| 19:05 | h4 | Officer contacts Impound Post | | Voice | U |
| 19:05 | h5 | Impound Post notifies on-call tow truck | | Voice | U |
| 19:05 | h6 | Officer generates Towing report and submits to supervisor | | Binary | S |
| 19:15 | i1 | Officer communicates with EMS in stadium regarding potential heart attack victim. | | Voice | U |
| 19:20 | i2 | | Medical personnel contact the on-duty physician at the stadium medical station | Voice | U |
| 19:25 | i3 | | Physician contacts Cardiac Care Center and updates patient status in EMS2 | Voice & Binary | U |
| 19:30 | i4 | Event commander notifies traffic detail that ambulance leaving stadium; traffic detail directs traffic accordingly. | | Voice | U |
| 20:15 | j1 | Officer downloads video from surveillance camera | | Video | U |
| 20:15 | j2 | Officer broadcasts alert to traffic detail net. | | Voice | U |
| 22:00 | k1 | Parents inform traffic detail officer that child is missing; officer captures image of child and sends to other traffic detail officers. | | Image | S |
| 22:00 | k2 | Temporary net linking traffic detail officers and shuttle bus drivers set up and information about missing boy is broadcast. | | Voice | U |
| 22:00 | k3 | Bus driver responds on temporary net about passenger who might fit description. | | Voice | U |
| 22:10 | k4 | Traffic detail officer in identified parking area locates boy based on photograph and bus driver information, temporary net dissolved. | | Voice | U |

| Time | ID | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|
| 23:30 | l1 | Detail completed and all temporary nets dissolved. | | | |

Table 31. Transmission History College Football Game Scenario

## Appendix C.5 Scenario: Terrorist Car Bomb

### Appendix C.5.1 Outline

1. An explosion occurs on a downtown street. Numerous calls are received by the PSAP. Police, fire and EMS dispatched to scene.

2. Police arrive on scene, and Incident Command established. A process is initiated to automatically update the roster of on-scene responders using geolocation capabilities with the communications devices and a means for responders to “log in”. The police arriving on the scene establish a perimeter by blocking intersections and clear the area of non-responder individuals and witnesses.

3. EOD unit arrives at the scene and performs a CBR&E sweep of area. Ambulances and fire trucks arrive.

4. Incident Command structure evolves to a Unified Command structure, including Joint Information Center.

5. Mass casualty alert issued, and additional ambulances are dispatched.

6. EOD completes sweep.

7. Fire units begin attacking the fires

8. EMS triage officers begin tagging bodies.

9. Police begin interviewing witnesses that have been moved into a witness area. Investigation begins, conclusion reached that explosion caused by car bomb; surveillance video identifies vehicle.

10. EOC becomes active, contacts Public Works and Utilities.

11. Ambulances begin transporting patients to hospitals.

12. State troopers assigned to secure other areas in city.

13. Additional law enforcement support arrives, and police begin to evacuate other buildings in area. Perimeter control user group divided.

14. Police and firefighters assist people evacuating buildings.

15. ’ user group suffers performance problems; Comm Officer assigns different frequencies to net.

16. Investigators identify high probably that bomb was planted by terrorist group and identify suspects.

17. APB on suspected perpetrators issued, roadblocks set up. Investigators broadcast picture of suspects to officers in region and to transportation sites.

18. Ambulances complete transport of victims to hospitals.

19. Officers identify and apprehend suspect at airport, obtain warrants for suspected accomplices.

20. Electronic case file prepared and warrants requested from judge.

21. Building evacuations are completed. Police officers from outside agencies are released.

22. Evidence technicians begin collecting evidence at the site.

23. Fire in the 1st National Bank building is extinguished, fire trucks return to station.

24. Law enforcement command moved to vacant storefront as investigation continues.

## Appendix C.5.2 Narrative

Electronic communications between all of the personnel involved in this incident is authenticated. For local on-duty personnel, this authentication takes place when each radio or computing terminal is initially logged on. For personnel responding from other local, state and Federal jurisdictions, the authentication takes place at the time the unit initially joins the incident, and as different databases are queried or additional communications links established. Responders equipped with radios that do not support automatic authentication and registration report to the staging area. Information on the real-time status of emergency medical personnel, resources, hospitals, and patients is contained in a database accessible by command personnel, authorized responders, health care facilities, and so on. The database is referred to as the Emergency Medical Services Event Management System, or EMSEMS, (or EMS2). This concept is introduced in the Emergency Management Services scenario.

5:00 PM

1. An explosion rocks the downtown area of Central City just as rush hour is beginning. The explosion is on Y Street near 20th Street, outside the 1st National Bank Building. The explosion destroys several cars in the immediate vicinity, blows out the glass doors of the

bank building, and starts fires in the bank lobby. Numerous calls are immediately placed to the 9-1-1 Center. A number of the calls come from wireless devices; location information accompanying the calls allows the dispatchers to quickly identify the area affected by the incident. There are over 50 victims in the street and in the entryway to the bank, fires have ignited, and there may be structural damage to the bank building. The dispatcher initiates first response of the Central City Police Department (CCPD), Central City Fire Department (CCFD), and EMS Central City, a contract EMS service. In addition, dispatch requests the EMS Mass Casualty Supplies that are cooperatively stored at Fire Station #2, be brought to the scene. Dispatch also contacts the Liberty County Emergency Manager, who authorizes activation of the emergency notification network to alert the county emergency management team.

5:05 PM

2. Within minutes, the first law enforcement personnel arrive on the scene. Since Police Headquarters is located on X Street and 20th, a number of police officers who heard the explosion, including the Assistant Chief of Police, run to the scene. The Assistant Chief assumes Incident Command (IC) for the initial response. He observes the scene and identifies the possibility that the explosion was caused by a car bomb. He immediately requests dispatch of an Explosive Ordnance Disposal (EOD) team. A roster of officers on the scene is quickly compiled by electronically querying PSCDs for GPS coordinates. The Incident Commander then organizes several teams to clear the area of bystanders and establish an outer perimeter that extends two blocks in each direction from the bomb scene. Entry through the outer perimeter is permitted only for authorized first responder personnel, and only once the Safety Officer confirms that the area is safe. As additional law enforcement officers approach the area, their identification infor's computing device; where feasible he assigns tasks to officers responding to the incident; auto'—one is set up for officer working the outer perimeter, one for officers clearing the immediate area.

3. An inner perimeter around the immediate blast damage area is established. The Ins Office (LCSO) and the Columbia State Police (CSP). The CSP helicopter with its stabilized platform video camera is also requested.

4. Shortly thereafter the first ambulances and fire trucks arrive at the outer perimeter. The first EMT-P on the scene assumes the role of Medical Scene Commander. However, entry into the inner perimeter is delayed until the area is determined to be safe.

5:15 PM

5. The police officers on the scene continue to clear the area of bystanders, "walking wounded", people attempting to evacuate the area, and anyone other than authorized responders and victims that cannot move. Witnesses are moved to an area for later interviews. They clear a corridor to allow the arriving EOD team to conduct a Chemical, Biological, Radiological, and Explosive (CBR&E) sweep of the area[1]. While the CBR&E sweep is underway, and video from a camera mounted on one of the police cars that is responding to the explosion is transmitted to the dispatch center and supervisory offices in

1. The topic of secondary explosive devices will be addressed in subsequent versions of the SoR. For more information, refer to the National Institute of Justice (NIJ) 2002 Guide for Explosion and Bombing Scene Investigation.

the fire and police departments. The video is also transmitted to the fire battalion chief who is being driven to the scene. EMTs arriving on the scene begin assisting injured people who are able to walk from the scene and reach the perimeter.

5:20 PM

6. When the Fire Battalion Chief arrives, a Unified Command Structure is estabs computing device, showing users assigned to the nets, loading, and so on.

7. The Medical Scene Commander requests EMS dispatch to initiate a mass-casualty alert to all area hospitals. Hospitals page on-call emergency room staff in anticipation of the need to treat a significant number of casualties. Additional ambulances are requested by the EMS dispatch from the Harvest Junction and Apple Valley ambulance companies, and Paramedic supervisors are requested to respond. As ambulances are dispatched, there status is updated in the EMS2. The Medical Scene Commander selects triage/treatment, transport, and logistics (equipment storage) areas and identifies them on a map display; this location information is transmitted to the computing devices in other emergency medical vehicles. The Medical Scene Commander begins querying the EMS2 to identify inventory of bed spaces at hospitals in the region, etc. Hospital administrators begin evaluating patients to determine if some can be released or moved to increase capacity for accommodating patients from the explosion.

8. As responders are dispatched and/or arrive on the scene, the EMS2 is updated. Their communications devices provide identifying information and geographic location. Identifying information includes name and agency as well as qualifications and skill sets. This data is available to the Unified Command, and hospitals as required. Authentication of personnel from outside agencies is processed through a national database of qualified first responders.

5:25 PM

9. The EOD unit samples for any CBR release, and concludes that the device was a conventional explosive. Because of the initial explosion, the EOD unit is unable to conclusively check for a secondary explosive device using chemical sensors or canine units. The EOD personnel do not observe anything particularly unusual that would indicate a secondary device. The EOD unit commander communicates status to the Safety Officer, who informs the Incident Commander that responders may enter the inner perimeter. The Incident Commander broadcasts that responders can enter the inner perimeter but to be on the lookout for anything that could indicate the presence of a secondary explosive device.

10. Fire units begin attacking the burning cars as well as the lobby of the 1st National Bank building. The battalion chief quickly reviews the building plans and develops the approach for moving people out of the building, including those on upper floors. Firefighters also work their way to a stairwell where they can move to upper floors to aid in evacuation of the building. The firefighters deploy a series of short range high bandwidth devices in an ad hoc network to transmit firefighter vital signs and video from helmet mounted cameras back to the Fire Command.

11. EMS triage officers begin to attend to the victims in the area around the explosion, tagging people with transmitter tags. These tags have unique identifiers that include the color coding (red, yellow, green, black) and an embedded GPS receiver. A timestamped location of these victims is periodically transmitted to update the EMS2s language (while continuing to perform the primary communications functions of the PSCD.)

12. Those individuals in's tag and enter patient information (e.g., name, address, and so on) and condition into the EMS2. The Medical Transportation Officer assigns patient transport based on status of hospital capacities, services available and patient transports. As each assignment is made, the information is updated in the EMS2.

13. A Joint Information Center is also established and the Information Officer begins to coordinate with media as they begin arriving on the scene.

5: 30 PM

14. Investigators arrive on the scene and begin interviewing witnesses. Investigators download stored video from the bank's surveillance cameras. The investigators rerun the video on a computer terminal and are able to reconstruct events occurring during the 30 minute period prior to the explosion. A late model sports car is seen being parked next to the bank; it is apparently the source of the explosion. The investigators are able to identify the last three characters of the license plate. A wild-card query of that license plate with model information on the car is then run against local and state registration and stolen vehicle databases, and the NCIC stolen vehicle database. A matching vehicle is reported stolen in Metropolis in the northern part of the state. At this point the FBI Special Agent in Charge (SAC) for the Liberty County area is en route to the incident scene from his Central City office, along with other Federal agents in the area. The SAC is linked into the investigators' conversation. The investigators download the stolen auto report from the Metropolis Police Department (MPD) and then contact the MPD investigator assigned to the case. The MPD investigator provides information on the primary suspect in the case, a student at the university identified by an eyewitness who placed the student with the stolen vehicle. A check by the FBI SAC confirms that this student is a known member of a foreign militant group; he requests alerting of the Central City and Metropolis Joint Terrorism Task Forces (JTTF).

5:35 PM

15. At this point command staff from CCPD begins initial staffing of the Emergency Operations Center (EOC), providing minimal coordination of resource management and interface to public and private organizations. The Central City Dept. of Public Works Street Maintenance Division is contacted to change traffic signals to steer traffic away from the area of the explosion and the key routes to the hospitals. Utilities are then contacted to shut off gas and electricity in affected area, and to monitor data for any signs of damage that may have occurred to subterranean utilities running underground beneath the seat of the explosion.

16. As ambulances begin removing injured victims from the area, police provide passage through the perimeter and provide traffic corridors to hospitals. The Transportation Officer notifies hospitals as ambulances depart for the hospitals; ambulance and patient status is

updated in the EMS2. At Central City Hospital, the ED doctor accesses the information in the EMS2's vital signs and EKG monitor through EMS2 on a continuous basis until the patient arrives the ER.

17. CSP units are assigned to secure other key sites in Central City and other cities in the state.

5:45 PM

18. Liberty County Sheriff's Deputies and Columbia State Police begin arriving on the scene. The CSP helicopter video system is linked to the Command Post and the EOC and a general sweep of the area is initiated, allowing Command staff to get an overall view of the incident scene; the video is also recorded for later use. The additional law enforcement officers take over perimeter control, freeing up Central City Police to control traffic along corridors to be used by ambulances transporting victims to hospitals, and to assist in the orderly evacuation of the other buildings on the street.

19. As more officers are assigned to perimeter control, the loading for that user group approaches 100%. The Communications Officer brings up a display of the user group assignments and informs the Incident Commander of the problem. The Incident Commander decides to break the perimeter control unit into two operating units, one for the east perimeter and one for the west perimeter. The change in operations is broadcast to the perimeter control user group. The Communications Officer splits the perimeter control user group into two separate user groups. The revised parameters of the PSCDs (such as operating frequencies) based on user group are automatically transmitted to the PSCDs assigned to that user group.

6:00 PM

20. CCPD officers assist in the evacuation of the buildings on either side of Y Street. Where feasible, they direct foot traffic to side and rear entrances to avoid crowding the area around the explosion scene. Officers identify persons with medical situations-one person apparently suffering a heart attack, sixteen with non-life threatening cuts from flying glass. The CCPD officer notifies the police lead for evacuation, who requests assistance from the medical scene commander, who directs triage officers to provide assistance. The 3-D geolocation information of the police officer requesting assistance is displayed on the triage officer's computing device. The officer moves to the location and moves patients to the triage/treatment area where they are attended to by EMS personnel.

21. EMS units are able to get to bodies that are trapped or near the previously-burning vehicles. The triage officer tags nine victims dead at the scene. Firefighters reach one badly injured victim who was apparently near the lobby windows when the explosion occurred. EMS personnel and firefighters enter the building and bring the victim back to the treatment/ triage area to attend to the patients.

6:15 PM

22. Firefighters report poor performance on their network to the Fire Battalion Chief at the Unified Command. The Fire Battalion Chief directs the Communications Officer to identify a solution. The Communications Officer assigns different frequencies for the net. The new performance parameters are then downloaded to the communications devices of all of the users on that temporary net.

23. The Investigation continues. The MPD investigator identifies three people that she was preparing to interview as part of the stolen auto investigation. The first is a professor at Metropolis University; a conference call is setup involving the MPD and CCPD investigators, the FBI, and the professor. The professor also states that the student has been in class during the time period up to and including the explosion. Investigators query all Arrest, Incident, and Citizen Stop reports from the databases of all agencies within the state that con's associates identified by the professor. Members of the Me' network, and identify the associate as under investigation for being a member of a terrorist cell located in Metropolis.

24. The investigators access the JTTF database, obtaining a vehicle description and photograph of the second individual. This information is broadcast to all law enforcement agencies in the region, and to handheld computing devices being carried by officers and agents working around the incident scene. An All Points Bulletin is issued to CCPD, Liberty County Sheriff's deputies, surrounding county sheriff's departments, and the Columbia State Police. The CSP set up roadblocks at locations around the perimeter of the city. The Transportation Security Administration is notified at the airport, and the Coast Guard is notified to watch areas such as the marina at Bayport. FBI agents in Metropolis are also dispatched to the residences of the associate and other members of the cell.

6:40 PM

25. The last of the victims is transported to hospitals. Local ambulances are staged away from the scene, and other ambulances return to their home bases.

26. A CCPD officer patrolling the airport identifies the accomplice's vehicle parked in the parking garage and notifies the CCPD dispatch who notifies TSA. A user group is set up including CCPD and TSA officers. The airport management is notified and the airport closed down. County Sheriff deputies, CSP, and FBI agents arriving on the scene are added into the user group. After a 20-minute search, the suspect is located and immediately taken into custody.

7:00 PM

27. An electronic case file is begun collaboratively by the FBI, CCPD investigators, and MPD investigators, including an electronic request for warrants on the members of the terrorist cell under investigation; the warrant requests are sent to a judge who electronic signs them. FBI agents working in conjunction with Metropolis PD officers then execute the warrants.

28. Evacuation of the buildings is completed. CCPD officers involved in the evacuation are reassigned to inner perimeter control to protect the scene for evidence. Liberty County Sheriff's Deputies and Columbia State Police personnel are reassigned to the outer perimeter, and excess personnel are released.

7:15 PM

29. ATF, local and FBI evidence technicians begin to work at the site to collect evidence, reconstruct the blast, etc.

8:25 PM

30. The fire commander verifies that the fires in the 1st National bank Building are out. Firefighters remove the short-range network that was deployed in the building. All but one fire truck are released from the scene and return to firehouses.

9:00 PM

31. Final fire truck leaves scene, fire command post is removed. The law enforcement command is moved into a vacant storefront office and investigators begin the task of locating all bomb-related debris. The inner perimeter is expanded to include all of this debris. Bomb scene investigators begin the arduous effort of marking, photographing and collection of all evidence debris that will consume most of the next 24 hours.

## Appendix C.5.3 Transmission History

Security Indicates whether the transmission is secured (S) or unsecured (U).

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:00 | a1 | Receives numerous calls; geolocation information including from cell phones indicates area of impact | | | | | | Voice | U |
| 17:00 | a2 | Dispatches Fire | | | Acknowledge | | | Voice or Binary | U |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:00 | a3 | Dispatches LE | | | | Acknowl-edge | | Voice or Binary | U |
| 17:00 | a4 | Dis-patches EMS | | Acknowl-edge | | | | Voice or Binary | U |
| 17:00 | a5 | Emergency notification to key staff | Acknowl-edge | | | | | Voice and Binary | U |
| 17:05 | b1 | Dispatches Explosive Ordnance Disposal item | | | | LE notifies dispatch possible car bomb | EOD acknowl-edges | Voice and Binary | U |
| 17:05 | b2 | | | | | Police per-sonnel from HQ arrive on-scene; IC begins compiling roster of on-scene responders from geolo-cation informa-tion of responders | | Binary | S |
| 17:05 | b3 | | | | | LE officers arriving on the scene send authentica-tion infor-mation and are regis-tered in the on-scene responder database | | Binary | S |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:05 | b4 | | | | | Officers as-signed to perimeter control receive auto-mated notifica-tions | | Binary | U |
| 17:05 | b5 | | | | | User group established for outer perimeter control | | Voice/High | U |
| 17:05 | b6 | | | | | User group established for officers clearing area | | Voice/High | U |
| 17:05 | b7 | | User group established linking IC and EOC (command net) | | | | | Voice & Data/High | S |
| 17:05 | b8 | CCPD dis-patch to LCSO and CSP dis-patch for additional units | | | | CCPD IC requests additional LE support | | | |
| 17:10 | c1 | | | | Download building plans and site in-for-mation | | | Binary & Image | U |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:10 | c2 | Video received from on-scene police car | Video received from on-scene police car | | Video received by battalion chief being driven to scene | Police car arrives on scene, begins transmitting video from car-mounted camera | | Video | U |
| 17:20 | d1 | | | | | Comm Tech Officer accesses information from all responders' communications devices | | Binary | S |
| 17:20 | e1 | Issues Mass Casualty alert | | Requests dispatch issue Mass Casualty alert | | | | Voice or Binary | U |
| 17:20 | e2 | | | | | | Hospitals page on-call staff | Binary | U |
| 17:20 | e3 | Additional ambulances dispatched from other jurisdictions | | Acknowledge | | | | Voice or Binary | U |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:20 | e4 | | | Medical Scene Commander identifies triage, treatment, logistics, transport areas, map overlay sent to responding vehicles | | | | Binary (geospatial) | U |
| 17:20 | e5 | | | EMS responder status updated in EMS2 | | | | Binary | U |
| 17:20 | e6 | | | User group established for responding EMS personnel | | | | Voice | U |
| 17:20 | e7 | | | Medical Scene Commander queries EMS2 to inventory bed space, etc. | | | | Binary | U |
| 17:25 | f1 | | | | EOD notifies Safety Officer that area is clear | | | Voice | U |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:25 | f2 | | | | Incident Com-mander broadcast announce-ment that responders can enter inner perimeter | | | Voice | U |
| 17:25 | g1 | | | | User group established for fire units on scene | | | Voice/ medium | U |
| 17:25 | g2 | | | | As fire units arrive on scene, authoriza-tion infor-mation is transmitted to update the roster of on-scene responders | | | Binary | S |
| 17:25 | g3 | | | | Fire unit de-ploys net for video and “biometry” from inbuilding to fire com-mand | | | Binary | S |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:25 | h1 | | | EMS triage units begin tagging victims with RFID tags which transmit location and status information to Medical Scene Commander | | | | Binary | S |
| 17:25 | h2 | | | Medical information entered into EMS2 for victims, including information on tags | | | As patients are assigned to different hospitals, medical staff at hospitals can download information as needed from EMS2 | Binary | S |
| 17:25 | i1 | | | | | User group established for investigators | | Voice & Binary & Image & Video/ Medium | S |
| 17:25 | i2 | | | | | Investigators download stored surveillance video from bank | | Video | S |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:25 | i3 | | | | | Query on partial license number and car model info | | Binary | S |
| 17:25 | i4 | | | | | FBI added to investi-gators' net | | Voice & Binary & Image & Video | S |
| 17:25 | i5 | | | | | Download Incident Re-port on stolen car | | Binary | S |
| 17:25 | i6 | | | | | MPD inves-tigator added to investiga-tor's net | | Voice & Binary & Image & Video | S |
| 17:35 | j1 | | Contact utilities and Public Works | | | | | Voice | U |
| 17:35 | k1 | | | Central City Hospi-tal ED access info in EMS2, downloads patient vital informa-tion from enroute ambulance | | | | Binary | S |
| 17:35 | l1 | | | | | CSP dis-patched to protect other sites | | Voice | U |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:45 | m1 | | | | | CSP helicopter downloads video to EOC, Unified Command | | Video | S |
| 17:45 | m2 | | | | | CSP and Sheriff's deputies arriving on-scene are added to various User groups | | Voice | U |
| 17:45 | m3 | | | | | User group established for officers working traffic detail for EMS ingress/ egress | | Voice/ Medium | U |
| 17:45 | m4 | | | | | Incident Commander notifies officers on perimeter control User group that net will be split | | Voice | U |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 17:45 | m5 | | | | | Comm Officer downloads new parameters to split existing User group for perimeter control into two nets | | Binary | S |
| 17:45 | m6 | | | | | Automatic acknowledge from radios receiving parameter changes sent to Comm Officer | | Binary | S |
| 18:00 | n1 | | | | | Police officers assisting evacuation request medical assistance for victims | | Voice | U |
| 18:00 | n2 | | | | | Police team leader for evacuation request assistance from Medical Scene Commander | | Voice | U |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 18:00 | n3 | | | Medical Scene Commander directs triage officers to assist police | | | | Voice & Binary (location information) | U |
| 18:15 | o1 | | | | Firefighters report communications problems on their user group | | | Voice | U |
| 18:05 | o2 | | | | Comm Officer downloads new frequencies for PSCDs on user group | | | Binary | S |
| 18:05 | o3 | | | | Automatic acknowledge received from radios to confirm download | | | Binary | S |
| 18:05 | o4 | | | | Firefighters confirm improved performance | | | Voice | U |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 18:15 | p1 | | | | | Professor on commercial phone service added to investigator net | | Voice | S |
| 18:15 | p2 | | | | | Investigators query records for all agencies in state | | Binary | S |
| 18:15 | p3 | | | | | JTTF members added to investigator's net | | Voice & Binary & Image & Video | S |
| 18:15 | p4 | | | | | Investigators query JTTF database and obtain pictures of suspects | | Binary & Image | S |
| 18:15 | q1 | | | | | APB, including suspect's pictures, issued | | Binary & Image | S |
| 18:40 | r1 | | | User group for EMS responders dissolved | | | | | |
| 18:40 | s1 | | | | | CCPD officers identified suspect's car parked at airport | | Voice | S |

| Time | ID | PSAP | EOC | EMS | Fire | LE | Other | Transmission Type and Net Utilization | Security |
|---|---|---|---|---|---|---|---|---|---|
| 18:40 | s2 | | | | | Units assigned to airport, User group set up with CCPD, CSP, FBI, TSA agents | | Voice | S |
| 19:00 | t1 | | | | | Agents compile electronic case file and forward to judge | | Voice & Binary & Image & Video | S |
| 19:00 | t2 | | | | | Judge signs search warrants for execution | | Binary | S |
| 19:00 | u1 | | | | | LCSO and CSP person-nel removed from net as they are released | | | |
| 20:25 | w1 | | | | Short range user group for fire units dissolved | | | | |
| 21:00 | x1 | | | | User group for fire units dissolved | | | | |

Table 32. Transmission History Terrorist Car Bomb Scenario

# Appendix C.6 Scenario: Hurricane

## Appendix C.6.1 Narrative

*This scenario is directly derived from Hurricane Scenario from the July 2002 version of NIMS. It was chosen so that interoperable communications can begin working toward consistency with the current version of NIMS. Some information was eliminated and some added only so that the communication aspects of the scenario would be the primary focus and it would remain brief. Deletions do not reflect a difference of opinion on any aspects of the original scenario.*

## Appendix C.6.2 Hurricane Scenario

1. The National Hurricane Center is forecasting a very active hurricane season, with the potential for a significantly above normal number of hurricanes to develop. A few months following the hurricane prediction, the hurricane forecast center issues a warning that a rapidly developing storm could directly impact the East Coast. The storm has the indications that it could strengthen to a Category 5 hurricane.

2. Within days of the initial spawning of the hurricane, a slow-moving Category-5 hurricane churns ashore with the eye passing close to a large southern city. The forecast calls for a turn to the northeast where it could regain strength over open water again and make a second landfall further north where the scenario takes place.

3. During the first landfall, the hurricane spawns heavy winds and rains, causing widespread wind and surge damage and flooding. Tens of thousands are forced to evacuate their homes, with damages to property and infrastructure forcing a delay in their return. Looting is reported to have occurred along empty coastal areas evacuated but not as affected by the storm. Flooding closes down several key highways and access to and from the damage area is problematic.

4. As the threat of an imminent incident gets closer, the local, state, and regional EOCs rapidly gear up to prepare for (e.g., pre-evacuate special needs populations, direct citizens to begin boarding up windows, etc.) and respond to incidents that the hurricane might spawn. The planning and preparedness actions that have occurred in the PPC prior to an incident transition into the execution of response plans within the EOCs.

5. Within 12 hours of landfall, a large fire starts in a warehouse district along the intercoastal waterway (close to the ocean). The fire department responds establishing a Unified Command with several engine companies being required to fight the fire as well as a Fireboat company. The Unified Command works with the local EOC who coordinates other efforts undergoing hurricane preparations. The local EOC coordinates with the State and regional EOCs to ensure the correct info is passed regarding the extent of the fires and that the Unified Command receives information about the Hurricane. The Unified Command has access to browse extensive weather related information via their Command Unit as well as receive special advisories and forecasting support from the EOC. The Command Unit is able to view the fire from several perspectives including the trucks, several firefighters helmets, from the fireboat and from a dock camera. The EOC also has

the ability to watch live video from the fire scene. Evacuations are ordered in anticipation of the hurricane, but some of the resources normally used to facilitate the evacuation are tied up in the fighting of the warehouse fire including police units.

6. The oncoming hurricane requires tremendous inter-state cooperation as large areas are ordered to be evacuated. The evacuations involve Local and State law enforcement as well the highway department. The highway department is communicating hotspots directly to law enforcement assigned to the evacuation and law enforcement is providing feedback and video back to the highway department so they can make better routing decisions. The extensiveness of the evacuations are problematic as they tie up major routes and coordination with police, fire, and EMS units become strained. The ongoing fire has pulled significant police and fire resources away from the evacuation priority exceeding the existing mutual aid resources, requiring the Local EOC to look to other inland jurisdictions for support. The Local EOC begins coordination of resources and establishing public information announcements to ensure the public understands the gravity of the situation. The Public Information Officer (PIO) in the EOC is communicating directly to a fire department PIO in the Unified Command at the fire scene. The Fireboat company from discussions with the Incident Commander, the Coast Guard, and the EOC has been released from the warehouse fire to take cover and prepare for the hurricane's landfall.

7. As the hurricane gets closer, and forecasts are more positive of its intensity and land fall within 30 miles of the city, the Local EOC recognizes that mutual aid resources and capabilities will be overwhelmed by the threatened level of potential damage, and requests assistance from the state in evacuation and pre-staging response equipment in anticipation of the hurricane's effects. State Police from outside jurisdictions are pulled in to help in the evacuation. Because of the challenges from traffic they used video, electronic maps, and other real time traffic data to navigate to the affected areas. As they arrive on scene they are plugged into the existing command structure so that they can be effectively used as well as provided with current weather and situational information. They can also be accounted and planned for as the storm approaches.

8. A category 5 hurricane affecting potentially several large metropolitan areas would require activation of, at a minimum, state EOCs of the affected areas, as well drive increased staffing at Regional and National EOCs to support State and local planning and preparedness. The local EOCs would work closely with the State EOCs to coordinate resources. The Regional EOC would be reviewing the situation to ensure proper federal assistance was being offered and provided in a timely manner.

9. The fire at the local warehouse district continues to be fought but the winds have whipped the fire out of control and it has jumped to an adjacent warehouse complex. The Incident Command (IC) has requested additional resources, and a separate IC has been set up to fight the second fire. The operations as well as the communications have been segmented into the two commands. An Area Command, run by the local fire department, is headed by the local Fire Chief, who is allocating now scarce firefighting resources has direct access to both. The Local EOC is coordinating the evacuation, made more difficult by the shutdown of a bridge within the vicinity of the warehouse fire and by the shortage of public resources to run the evacuation. The Local EOC requests assistance from the State EOC for National Guard assistance to facilitate the evacuation. The National Guard is able to come on site and communicate both with the EOC and existing Local Incident Commanders.

10. The hurricane landfall is imminent amidst the confusion of the ongoing warehouse fire. Using the real time weather information and the advisories from the EOC, the fire chief makes the decision to abandon the fire in the interest of the safety of the firefighters, and orders the firefighters to move inland out of the danger of the predicted storm surge. Due to the rapid development of the storm, roads are still at a virtual standstill with thousands of evacuees headed inland.

11. As the slow-moving hurricane hits with 145 m.p.h. winds, the initial devastation is immense. The eye remains a half-mile offshore as the storm parallels the coast. While the ensuing heavy rains douse the warehouse fire, the storm surge, winds and rain are combining to seriously impact the areas ability to respond effectively. The response community is essentially in a survival mode as winds continue to batter the area.

12. After landfall of the hurricane, the local first responders become victims themselves. Several Fire stations receive damage as well as a large number of patrol cars. The communication infrastructure has been significantly damaged. The Cellular network is down and the landlines have exceeded capacity and have received some damage as well. With several towers damaged. individual communications devices must rely on the close proximity of a response vehicle, which act as a high power access point/repeater to the surviving tower infrastructure. As first responder resources arrive from outside of the typical regional response area, they must also be able to integrate into the existing Commands with their communication devices.

13. The evacuation was so extensive and the storm so strong that vehicles were caught trying to evacuate during the storm and many deaths and injuries have been reported along the highways. Because of the fallen trees it could be days before some areas are reached. Many small communities have lost both landline communications as well as official radio communications because of extensive damage. Amateur radio operators are relaying some status information to the Area EOCs. Hospitals are full and Disaster Medical Assistance Team (DMAT) and Disaster Mortuary Operational Response Team (DMORT) team will be arriving and will need to communicate to the hospitals as they set up field sites. Search & Rescue teams have been activated and will be arriving. Amateur Radio will provide the communication for many of these groups.

14. The forecast is for the storm to move further offshore, regain strength, and hit further north with the same relative intensity. The storm has rapidly taken on the gravity of a national incident as the damage is widespread and the storm has only begun to makes its ultimate affects known.

15. All affected state EOCs would be coordinating with regional EOCs in each potential major disaster area to work with local response organizations. At the regional level they will be closely coordinating with each of the local federal incident manager officials (FIMOs) to coordinate resources. The immediate need for National Guard resources is apparent at several locations, and requests are working through several state governor offices, through the State EOCs to deploy those assets.

16. Reports begin to come in regarding looting in some counties that were evacuated but slightly further south, out of the main fury of the storm. National Guard assets have been requested to patrol those areas that have been evacuated, but the requirement is outstripping available State Guard assets. As National Guard units arrive they find it necessary to

communicate with local responders more than usual because of the variety of support that they must provide because of the extensive damage to the area and disruption of first responder infrastructure. The Bureau of Prisons has been asked to bring in some low risk prisoners to aid in the cleanup. They must also integrate into the existing command and communication structure. The number of responders and variety of response activities require existing systems to be flexible as the incidents grow and shrink and as massive resources are redeployed on a very frequent basis. There is a need to track these resources both within the incident and between incidents for safety and accountability.

17. Because of the extensive damage, outside resources will be deployed for an extended amount of time in the effected communities.

## Appendix C.7 Scenario: Earthquake

### Appendix C.7.1 Outline

1. Scenario Initiation: A 7.2 magnitude earthquake hits Central City.
2. State Warning Center begins automated notifications.
3. PSAP receives continuous calls.
4. PSAP dispatches first responders and alerts Emergency Management; helicopters requested.
5. Emergency Operation Center is Activated.
6. Fire and EMS arrive at scenes.
7. RACES begins providing communications support.
8. Mayor notifies Governor.
9. Unified Command is formed onsite.
10. US&R and CERTs requested.
11. Central City requests County/State resources, State Mutual Aid System activated.
12. RACES assist outlying areas to report damages.
13. Staging areas defined.
14. Governor activates National Guard and requests Federal assistance.
15. Conference call to identify additional resources requirements.
16. Joint Information Center formed.

17. State US&R arrive.
18. CERT Communication Team sets-up.
19. Red Cross establishes shelters, public bus systems are commandeered for disaster support.
20. DMAT team arrives, coroner establishes body collection and processing center.
21. CERT Team provide information.
22. Structural specialists survey garage.
23. Structural specialists warn of potential building collapse.
24. Search team looks for victims.
25. Gas Main broken and area cordoned off.
26. Search Teams enter building; DMAT consults with other medical specialists
27. Operational Period ends IC Rotates team.
28. National Guard units begin arriving.
29. A Federal Urban search & Rescue Team arrives.

## Appendix C.7.2 Narrative

Santa Luisa County encompasses an area of about 2,800 square miles, bisected by the Santa Luisa Mountains. The County has a population of approximately 450,000. There are 4 incorporated cities (Central City, Fernwood, and Otsego on the southeast side of the mountains, and Cooney on the North side of the mountains). There are two airports - Cooney Regional Airport (the former Cooney Air Force Base), and Santa Luisa Airport at Otsego. It is a Summer weekday. At 9:00 a.m. the temperature at Santa Luisa airport was already 80 degrees with a calm wind.

An earthquake of magnitude 7.2 hits the Central City area at 9:02 a.m. at the end of “rush hour.” Damage to buildings and infrastructure is severe. Utilities are disrupted throughout the city and outlying area. The Cooney Canyon Nuclear Power Plant, located 11 miles outside of Cooney, suffers moderate damage requiring an emergency shutdown of the plant, and the declaration of a Site Area Emergency. Damaged power lines ignite a number of brush fires in the mountains between the CCNPP and Central City. Ruptured Natural Gas lines find ignition sources, and a number of residential structure fires result. Ground-based communications (wire and fiber) to the outside world is temporarily disrupted and lines within the city, where operational, are immediately overloaded by telephones that were knocked off-hook by the shaking and by residents attempting to make calls; delay to getting dial-tone is initially many minutes due to this overload. While the 9-1-1 system remains fully operational from the TelCo tandem switch into the PSAPs, many subscriber cables have been damaged and the system suffers overall from the overload. The 9-1-1 system will be severely taxed for the first 12 hours with only about 1 of 100 callers able to connect to the Central City PSAP.

The cellular system remains minimally operational though the disruption to long distance service generally prohibits calls to outside of the city. The disruption to ground-based circuits leaves many tower sites isolated and out of service. Mobile-to-mobile calls within each cellular system function properly within areas served by operational towers, though circuits quickly overload from heavy traffic. Cellular 9-1-1 trunks linking the Mobile Switching Office (MSO) to the PSAP remain operational and cellular 9-1-1 calls are a significant source of information reaching the PSAP from public callers, particularly at the scenes of some of the major damage. As the incident proceeds, additional cell sites drop off the air as the site battery systems deplete due to the loss of commercial power.

The countywide microwave system, designed to withstand an event of this magnitude and linking all trunked public safety radio sites throughout Santa Luisa County remains fully operational, including the dedicated PABX switch that links all of the 9-1-1 PSAPs and Public Safety Dispatch Centers. The trunked radio system remains operational as does communications with all subscriber units (mobiles/portables) not damaged by the event. Additionally, as the county seat, the Santa Luisa County Emergency Operations Center (EOC) has a ground station that is part of a statewide non-terrestrial (satellite-based) network operated by the Governor’s Office of Emergency Management (OEM). This system provides a T-1 equivalent data circuit to Santa Luisa County that can be used for voice telephony, FAX, data, or video conferencing circuits; all are routed through a dedicated switch at the State EOC backed up by a redundant switch at the Alternate State EOC.

City, county and state EOCs are equipped with integrated situational information systems designed to provide eagle eye views of the overall incident as appropriate for that level of management, with the ability to drill down on any specific event/location to show details of the response to, and management of, that event/location. This information can be shared in real-time with field command posts, as well as with responding state and Federal resource, Through this integrated system, information can be retrieved from, and pushed to, field units. This information system also gives resource managers the ability to monitor, query and control resources at staging areas, as well as individual assets, in real-time.

***Note!*** ***Electronic communications between all of the personnel involved in this incident is authenticated. For local on-duty personnel, this authentication takes place when each radio or computing terminal is initially logged on. For personnel responding from other local, state and Federal jurisdictions, the authentication takes place at the time the unit initially joins the incident, and as different databases are queried or additional communications links established. Authentication of personnel from outside agencies is processed through a regional database***

This scenario depicts the first 12 hours of Federal, state, county and local public safety operations in response to this event.

9:02 AM

1. The local 9-1-1 PSAP immediately initiates internal operational and safety checks, noting it is operating on generator power with about 8 hours of fuel. As part of this effort, firefighters and building inspection personnel are dispatched to the PSAP. As the safety checks proceed, investigators use Personal Wireless Devices (PWDs) to annotate areas of concern on building layout diagrams.

2. The nature of the event automatically activates the city Emergency Operations Center (EOC) located in the Police Department immediately adjacent to, but separate from, the city PSAP per the city's All-Hazard Emergency Management Plan (EMP). The County EOC, located across the street from the city EOC, is automatically activated. The Regional Hospital Patient Management System is automatically activated, and communications links between hospitals are tested to insure operability.

3. City and county public safety management personnel, many of whom were already at work, and other key city/county staff and volunteers who are assigned to these EOCs begin making their way to the centers. Staff includes members of the Public Works Departments and local public utility representatives who will track much of the disruption to gas, electricity, sewer and water systems using a real-time GIS-based system in the city and county EOCs. The nature of the event also causes automatic call-back of all off-duty city and county personnel. Call back confirmations are made via voice radio and/or PWDs as off-duty personnel begin responding. However, disruption to roads and the light rail system will delay many of these persons from reaching the EOCs for several hours.

4. In Capital City, an automated sensor system has detected the seismic event. The preliminary calculated magnitude of 7.0 causes a number of immediate and automated actions at the State Warning Center operated by the OEM. Actions are based upon a series of preprogrammed instructions for this type of event:

- With a single "approval" entry to the OEM's Computer Assisted Dispatch (CAD) system, the State EOC is automatically activated, with computer generated text paging alerts being transmitted across the state to state personnel via a number of commercial paging services. Automatic alerts are also sent to county and local officials and staff/ volunteers within a 100 mile radius of the calculated epicenter of the earthquake. The transmission of these notifications activates the State Mutual Aid System. Notification confirmations are made via telephone, voice radio and/or PWDs as personnel begin responding.

- The State Warning Center operator immediately contacts the Control Terminal for the National Warning System (NAWAS) headquartered at the Federal Emergency Management Agency's (FEMA) Operations Center outside of Washington, DC. NAWAS is a wire-based tie line system linking all 50 states and major federal government facilities, including the Department of Defense. This alert is heard simultaneously by all of these facilities, many of whom initiate a preplanned call-up of personnel. Two centers monitoring this initial alert are the region and national headquarters for FEMA. This alert begins a sequenced notification process to disaster personnel across the country who may be needed.

- The State Warning Center operator then notifies by telephone the governor's staff, key legislators, and directors of all state public safety, resource and transportation agencies.

9:10 AM

5. The local 9-1-1 PSAP center responds to continuous emergency calls originating from cellular handsets and the few operating wireline telephones in the city. Observers state that 10-story and a 14-story office building have collapsed, a Federal building is near collapse, and many other buildings have sustained damage but appear to be structurally sound. Many people are reported injured. The strong odor of natural gas in the downtown area indicating the possibility of a gas explosion is also reported. Reports of smoke in residential areas are received from citizens.

6. The PSAP dispatchers initiate first response to the various scenes by alerting the nearest available PD, FD, and EMS units. FD units, following the CCFD's established Seismic Event Response procedure, report the locations of structure fires on their PWDs as they survey their initial response districts. The city's Mobile Command Center (MCC) is readied for deployment. The Emergency Manager also requests that State Police helicopters be deployed to provide airborne video of the area; the helicopter is also equipped with a forward-looking infrared (FLIR) enabling it to scan for hotspots indicating surface fires. The county PSAP, operated by the Santa Louisa Sheriff's Department (SLSD) Dispatch, receives a call from the State Warning Center via the satellite telephone to obtain a preliminary damage assessment for forwarding to state and federal agencies.

9:15 AM

7. The Emergency Manager, mayor and key city staff arrive at, and activate the EOC to provide support to the Incident Commander (IC) and to coordinate the City's resources. Simultaneously, the County's Emergency Manager, County Executive, and key staff activate the County EOC to coordinate the response in the unincorporated areas to the CCNPP Site Area Emergency, and to coordinate information flow and resource allocation to the incorporated jurisdictions within Santa Luisa County.

9:20 AM

8. Hampered by disrupted roadways and debris, EMS, fire and police units respond to the various scenes. Injured persons who can be self-extricated, or easily extricated, are removed from the rubble and collected for transport to treatment centers. Assistance is offered to public safety personnel by many citizens who are now stranded at work sites. All patient names, medical conditions, receiving hospitals, etc. are entered into the EMS units' PWDs to track the earthquake victims. Additionally, "captured public safety resources" - public safety personnel who work in other jurisdictions but can not physically get there due to the damage - begin to check in at local fire houses and at CCPD. Those who have their PWDs with them are able to log into the local interoperability network and alert the EOC to their presence in Central City. The regional authentication database, housed at SLSD, provides authentication and privilege information as these personnel log into the system, and their location and personal information are added to the Available Personnel roster maintained by the Logistics Section at the City EOC; a similar process takes place within the County EOC for captured resources outside of the city, but within Santa Louisa County.

9. Preassigned members of the Amateur Radio community begin arriving at the EOCs and manning the amateur radio units located there. These units of the Radio Amateur Civil Emergency Service (RACES) provide logistics support to outlaying agencies as well as communications support between the EOC and each of Central City FDs stations which have been designated as neighborhood emergency centers.

9:30 AM

10. Communications is established between the city and county EOCs, and with the State Warning Center via the satellite system. The Governor, county manager, mayor and city/county emergency management directors are partied into a conference call via the VSAT system. Based upon preliminary reports, the governor directs his staff to begin preparing a disaster declaration. Critical response information is passed to responding mutual aid personnel as they log into their local networks, and as they progress toward the scene through authenticated shared network access.

11. Field supervisors from CCPD begin arriving on scene at the major incidents, and assume the roles of local Incident Commanders. The assistant fire and police chiefs accompany the MCC to the field and assume overall IC responsibilities in a Unified Command structure, coordinating each of the individual sites. The ICs and Communications Unit Leader, based upon information being received from the field, set up the MCC in a central location to the major downtown high-rise collapses. In the MCC, the IC uses the PWD to talk with the gas utility administrator and request the gas mains to city center shut off. The IC requests that the DoT administrator and Public Works redirect traffic from city center and begin setting up an incident perimeter barrier that covers a 16-block area that allows only Public Safety traffic to enter. DoT uses the ITS system to reconfigure traffic signal lights (where

connectivity and electrical power permit) and also initiate warning messages to vehicle mounted displays and Variable Message Signs along major roadways in surrounding areas warning motorists to stay out of the incident zone. The IC makes additional resource requests to the EOC.

12. Two State Police helicopters arrive in the area and their video systems and FLIRs are linked to the MCC and the EOC and a general sweep of the area is initiated, allowing Command staff to get an overall view of the area; the video is also recorded for later use.

13. The local jurisdiction's rescue and medical units are quickly being overwhelmed. The Operations Section Chief requests assistance from several specialized Urban Search and Rescue (US&R[1]) teams as well as Community Emergency Response Teams (CERT[2]).

14. Central City contacts the County EOC to request assistance from the County and State, including additional Fire suppression resources, US&R Task Forces, communications and logistics support. This request constitutes the formal activation of the State Mutual Aid System. One of the local US&R teams from the State Department of Forestry and Fire Protection (DFFP) is dispatched from Otsego and assigned to the search and rescue of victims in the two partially collapsed buildings. A Disaster Medical Assistance Team (DMAT[3]) from Capital City has been activated by the state and a US&R Incident Support Team (IST[4]) is also deployed into the area. The state also dispatches an OEM Communications Coordinator to the MCC to assess communications system integrity and to coordinate DMAT and US&R communications resources. In anticipation of need, the OEM Communications Coordinator requests a State OEM ICS Type 1 Communications unit and a trailer-mounted high capacity satellite terminal be deployed to Central City.

15. Amateur Radio operators communicating through the RACES Communications Unit at the county EOC have been reporting the vegetation fires, damage to county roads and bridges, and rural residential damage in the County. The cities of Cooney, Fernwood, and Otsego report to the Santa Luisa County EOC via Amateur Radio and the County microwave voice and data network on conditions in their jurisdictions, and start requesting Fire, EMS, and public works resources.

10:45 AM

16. Based upon GPS information coming from the field, the Logistics Section Chief uses the PWDs city-map monitor that shows the locations of the reported damage and displays command post and critical information for EMS, FD, PD and PW staff in the Operations Section, allowing the most appropriate selection of staging areas. This information is simultaneously transmitted to displays in the MCC.

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1. A Urban Search and Rescue (US&R) team is a task force, complete with necessary tools and equipment, and required skills and techniques for the search, rescue, and medical care of victims of structural collapse.
2. Community Emergency Response Teams (CERT) are trained civilian volunteer auxiliary responders that assist victims and provide support for professional responders during a major disaster.
3. A Disaster Medical Assistance Team (DMAT) is a mobile medical field unit staffed and equipped to treat large numbers of injured.
4. The Incident Support Team (IST) supports US&R teams with tasking, material, and coordination.

17. The Governor activates National Guard units. The Governor requests Federal assistance including National US&R teams and a Mobile Emergency Response System (MERS) unit be sent to Central City.

11:00 AM

18. Using their PWDs and the satellite network, a conference call takes place between the Logistics Chiefs at the MCC, in the Central City EOC, Santa Luisa County EOC, State EOC, and the US&R IST; and with the on-scene OEM Communications Coordinator. Decisions are made to establish a resource Mobilization Center at the Santa Luisa County Fairgrounds; to co-locate the IST at the Mobilization Center, and to establish a unified communications resource coordination point. The OEM Communications Coordinator is designated to serve as the Area Communications Coordinator. Using the vehicle-mounted satellite terminal in the Center City MCC, the OEM Communications Coordinator contacts the State EOC with a request for a DFFP Communications Unit Leader, and a Communications Coordinator from the National Incident Radio Support Cache (NIRSC) to assist with the unified resource coordination. The OEM Coordinator then orders the OEM transportable satellite unit and the Type 1 Communications Unit be set up at the Fairgrounds; and requests two caches (56 units) of OEM-owned PWDs be staged at the Mobilization Center for potential use. A request for fuel trucks to support city/county facilities, particularly the EOCs, is issued.

11:30 AM

19. As reporting teams from the local and regional media arrive on the scene, the Central City Public Information Officer (PIO) forms a Joint Information Center (JIC) in a building adjacent to the EOC and uses PWDs to produce maps directing the placement of camera teams away from areas requiring unrestricted emergency access. The JIC will also provide press releases with supporting video and still imagery that will be made directly available to media data feeds using the capabilities of their PWDs. The JIC will distribute information to the public regarding the location of food, potable water, shelter, and operational waste disposal facilities.

20. Upon arrival at the collapsed building, the DFFP Urban Search & Rescue unit sets up a base of operations at a safe distance from the building as directed by the Staging Manager. Using their PWDs, they begin surveying for structural integrity and for likely victim locations. Their PWDs set up a wireless mobile Adhoc network that links with the MCC database and obtain blueprints & building drawings. The node allows various voice, video, and data to be transmitted to similarly equipped units, including the IST and the DMAT. It also provides 3-dimensional location information for all PWD-equipped personnel that is plotted into a GIS-based tracking system. As units survey the scene, they are able to overlay major structural displacements into the pre-event GIS database to allow improved structural analysis and determination of potential victim locations.

21. A CERT Communication unit (Amateur Radio) sets up in close proximity to the MCC and, working through the liaison officer, verifies a process to pass intelligence and logistics information from CERT to the US&R. Branch.

22. Red Cross has set up a Command Post next to the MCC, and has activated shelters in several local schools. They are capturing the names of every person showing up to the shelters on their PWD and relaying it to a central database that can be accessed by other parties. This information is available to the Red Cross representative in the EOC, as well as to key city officials. City public buses and public school buses, both of whom operate on the public safety trunked radio system, are alerted and organized to support transport of victims and the public to treatment facilities or shelters.

2:00 PM

23. The Disaster Medical Assistance Team (DMAT) from Capital City has arrived and is setting up its unit. When set-up, all patient names, medical conditions, etc. will be entered into PWDs to track the earthquake victims. The SLSD Coroner's Unit begins setting up a central Disaster Mortuary (DMORT) center for processing the dead, including collection of names and identifying information, as well as for the long-term storage of bodies. As bodies are brought to the collection point, critical data including the location where they were found is stored in a special central database.

24. CERT teams are becoming more organized as they search though residential areas for trapped victims. As they come across larger or more questionable structures they request assistance from a US&R team as well as provide damage information through the CERT Communications Unit. PWDs are linked to the city GIS system to log activities of these teams.

4:00 PM

25. Structural specialists begin the structural survey of the parking garage, using handheld PWDs to sketch the structure perimeter, noting entrances and areas of structural concern. The survey data is wirelessly sent to the US&R's node where it is coordinated with pre-event GIS information. At the same time, a group of structural engineers begin looking over the drawing and blueprints for the buildings. Data collected indicates that the larger building is on the verge of collapse within the next 24 hours. This information is relayed to all public safety units via the PWDs and to the command post established at the park. This information is then transmitted to the IC who can make entry plans from this data. Using this data, Incident Command establishes the hazard zone for tracking entry into the garage and the collapsing building. At the same time, the data is relayed from the MCC through the satellite network to the IST at the Mobilization Center to assist in their long range planning.

26. The structural specialists find that one outside wall of the parking garage has fallen away and the concrete T-bars of the parking garage have detached from the outside wall, collapsing. The engineering team at the Federal building found that a gas main on the north side of the building was ruptured, with leaking/trapped gas posing an explosion hazard. The gas utility representative in the EOC is requested to ensure that gas mains are off and, where the gas valve control system may have failed, dispatch personnel to manually check and secure valves. The police are directed to cordon off a four-block-square area and begin necessary evacuations. The structural specialists set up two theodolites[1] to monitor any movement of the federal building. These units contain video cameras that transmit images

[1] A theodolite is a surveying instrument that may be used to measure and monitor movement of an object

via an integrated broadband transmitter to the base of operations, where the specialists can safely monitor the structure. Once a preliminary structural assessment is complete, the IC assigns the search teams to enter the structure to search for victims. The teams are assisted by hazardous materials specialists, which detect any nuclear, biological, or chemical hazards to the rescue personnel. A search of the appropriate data bases allow for an inventory of the building contents to be reviewed, examined and results transmitted to all officials involved.

27. Two search teams that will enter the garage area and federal building turn on their personal safety systems that include activity monitor and 3-dimensional location tracking systems. As the teams enter the hazard zone, they check in with a Safety Officer, who notes their entry using a PWD. This information is used at the base of operations to track all personnel inside the hazard zone. As the search teams search, they note the presence or absence of victims on their PWDs and the data is displayed on the floor plan of the structure at the base of operations. As the teams move through the garage, the locations of all team members are logged for use if a member becomes lost or incapacitated.

28. The HazMat Team links their hand-held monitoring equipment into a PWD, which relays any detection information to a Safety Officer's terminal at the MCC. As Search Team 2 proceeds into the parking garage, the HazMat team detects a potentially dangerous level of gasoline vapor in the air. A Safety Officer's instrument indicates the danger and he decides that this route into the garage is too hazardous and orders the team out of the garage, and to find another entrance. Before the team exits, they leave a remote combustible gas detector. This terminal will continuously monitor the air and, if an explosive condition is detected, will send an evacuation signal to all personnel in the structure.

29. Search Team 2 uses their voice radios and PWDs to coordinate their search and the search team leader uses his PWD to report their progress to the IC. Team 2 locates several victims trapped in vehicles under the concrete T-bar sections and notes the locations on their PWDs. The IC calls for a rescue team to go to the garage to assist in the rescue operation. Rescue Team 1 begins work on the extrication of the victims. As the rescue team accesses each patient, medical specialists treat the patient as much as possible in the confined space.

30. The medical team managers use their PWDs at the base of operations to inform the IST and the DMAT of the number of victims, the severity of their injuries and the estimated time of their extrication. When it is decided that one of the victims requires a leg amputation before extrication, the medical specialists consult with the medical team managers using voice and video exchange with their PWDs.

31. Due to the number of victims in the immediate area, the demands for communications exceed the available capabilities. The PWDs execute prioritization routines that prioritize communications based on need. Voice communications are given top priority; vital medical data is given second priority; medical video data is scaled back to fewer frames per second; on-scene medical personnel prioritize individual cases so that video is periodically dropped for lower priority patients.

6:00 PM

32. The IC, Safety Officer, and Operation Section Chief use data on the total time each team has been in the structure to rotate teams for rest and rehabilitation. Eventually, all victims in the garage are extricated, stabilized, and transported to the DMAT. The IC then contacts the Logistics Section Chief for re-supply of expended equipment and material and discusses priorities and the team's next assignments with the Planning Section Chief.

33. National Guard units activated by the governor begin arriving. These units are seamlessly integrated into the communications network utilizing their own PWDs.

9:00 PM

34. A Federal Urban Search and Rescue Task Force, flown by military air transport to Cooney Regional Airport, arrives to support the ongoing effort. Their voice and data PWDs are entered into the regional authentication database and the Communications Unit Leader authorizes their participation. They join the Incident's Network. The Task Force's leader uses his PWD to send the personnel and equipment manifests to the IST at the Mobilization Center. The Task Force uses robotic units capable of remotely providing video, audio, and sensing information from inside the building. The units transmit their information to the US&R incident base.

## Appendix C.7.3 Transmission History

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 9:02 | a1 | Fire and building inspectors dispatched to PSAP | | | Dispatched to PSAP | | Building inspectors dispatched to PSAP | Binary (Fire) & Voice (Inspectors) |
| 9:02 | a2 | | | | | | Building inspectors download building plans | Binary |
| Transmissions a2 and a3 are repeated numerous times during the course of the scenario as teams check the structural integrity of key facilities in the area | | | | | | | | |
| 9:02 | a3 | | | | Temporary network established for firefight-ers and build-ing inspectors at PSAP building | | Temporary network established for firefight-ers and build-ing inspectors at PSAP building | Voice & Binary |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 9:02 | a4 | | City/county EOC activated and key staff alerted | | | | | Binary & Text |
| 0:00 | a5 | | Temporary net established for key staff (emergency manager, mayor, county exec, etc.) en route to Ops Center | | | | | Voice |
| 9:02 | a6 | | Callback of off-duty workers | | | | | Binary |
| 9:02 | b1 | | State EOC activated, State Warning Center (SWC) automatically notifies state personnel | | | | | Text |
| 9:02 | b2 | | SWC notifies surrounding counties | | | | | Text |
| 9:02 | b3 | | SWC notifies NAWAS | | | | | Binary via wire-based tie line |
| 9:02 | b4 | | FEMA regional and national Operations Centers begin alerting of disaster personnel across the country | | | | | Binary via wire-based tie line |
| 9:02 | b5 | | SWC operator notifies governor's staff, key legislators, state agency heads | | | | | Voice via telephone |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 9:10 | c1 | Continuous incoming calls | | | | | | |
| 9:10 | d1 | Dispatch police, fire, and EMS | | Units dis-patched to area | Units dis-patched to area | Units dis-patched to area | | Binary |
| 9:10 | d2 | | | | Fire units report loca-tions of struc-ture fires | | | Binary |
| 9:10 | d3 | Receives request for preliminary damage assessment | SWC sends request for preliminary damage assessment | | | | | Binary via VSAT |
| 9:15 | e1 | | Emergency Managers, and key city and county staff arrive; as they arrive on-scene they are removed from tempo-rary net | | | | | |
| 9:20 | f1 | | | Police, fire, and EMS begin arriv-ing at various scenes; at each scene temporary net established for all first responders on scene | | | | Voice |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 9:20 | f2 | | | | | EMS units begin transporting victims to hospitals; patient vital signs relayed to hospitals; status information relayed to EOC | | Voice and binary |
| 9:20 | g1 | | | | | | RACES sets up at EOC, Fire Dept. stations, and outlying agencies | Voice & Binary |
| 9:20 | h1 | | Network established between city/ county EOC, SWC, and governor's office | | | | | Voice via VSAT |
| 9:30 | i1 | | | Field supervisors being to arrive at scenes, establish Incident Command | Mobile Command Center deployed at scene of building collapse; temporary net established linking site command-ers, MCC and EOC | | | Voice |
| 9:30 | i2 | | | Temporary net established linking on-scene commanders to EOC | Temporary net established linking on-scene commanders to EOC | | | Voice |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 9:30 | i3 | | | As first responders arrive at each scene, register electronically to be added to on-scene roster and included in temporary net | | | | Binary |
| 9:30 | i4 | | | State Police helicopters sent to area to perform aerial reconnaissance; video linked to EOC and MCC; pilots added to temporary net for command | | | | Video & Voice |
| 9:30 | i5 | | | | Overall IC contacts gas utility to shut off gas mains to city center | | | Voice |
| 9:30 | i6 | | | | IC contacts city Dept. of Public Streets to redirect traffic and establish barricades | | | Voice |
| 9:30 | j1 | | | | Ops Section Chief requests US&R and CERT | | | Voice |
| 9:30 | k1 | | Mayor requests state US&R and DMAT teams | | | | | Voice via telephone |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 9:30 | k2 | | State dispatches OEM Communications capability to Central City with reachback capability to State OEM | | | | | Voice & Binary & Image & Video via infrastructure & VSAT |
| 9:30 | l1 | | | | | | RACES operators report damage outside Central City and relay requests for assistance form outlying cities | Voice & Binary |
| 10:45 | m1 | | Display shows location of units (from reported GPS), damage reports on map; info used to select staging areas | | Display shows location of units (from reported GPS), damage reports on map | | | Binary (GPS) |
| 10:45 | n1 | | Governor activates National Guard, requests national US&R and MERS assistance | | | | | |
| 11:00 | o1 | | Conference call | | | | | Voice via VSAT |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 11:30 | p1 | | | | PIO uses location and damage information for placement of media teams, generates video and images that are transmitted electronically to media representatives | | | Binary & Image & Video |
| 11:30 | q1 | | | | | | DFFP US&R arrives, added to temporary command net; tactical net also established | |
| 11:30 | q2 | | | | | | Short range broadband net established to relay video, marked up blueprints, images among | |
| 11:30 | r1 | | | | CERT comm team sets up link to US&R | | | Binary & Image & Video |
| 11:30 | s1 | | | | | | Red Cross sets up emergency shelters; temporary net to link Red Cross representatives with EOC; link used to ex-change data on survivors, status | Voice & Binary |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 14:00 | t1 | | | | | DMAT deploys; links to EOC Medical Coordinator and hospitals to exchange victim data; DMAT commander added to command net | | Voice & Binary |
| 14:00 | u1 | | | | | | CERT team commanders are linked in a temporary net with EOC; when necessary linked into US&R temporary net as well | |
| 16:00 | v1 | | | | | | Structural specialists are linked into US&R temporary net | Voice & Binary |
| 16:00 | v2 | | Structural data is overlaid with blueprint information | | | | | |
| 16:00 | v3 | | Parking lot structure risk broadcast to all units | | | | | Voice & Binary |
| 16:00 | v4 | | | | Incident Command establishes hazard zone, requests barricades from Central City DPW Streets Maint. To establish perimeter | | | Voice |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 16:00 | w1 | | | | | | Engineering team informs IC of ruptured gas line | Voice |
| 16:00 | w2 | | | | IC directs police to establish perimeter area around gas leak | | | Voice |
| 16:00 | w3 | | | | | | Structural specialists set up theodolites | Binary & Video |
| 16:00 | w4 | | | | HazMat team queries database to identify any potential hazards in building | | | Binary |
| 16:00 | w5 | | | | | | Structural specialists verify structural integrity | Voice |
| 16:00 | w6 | | | | IC directs search and HazMat teams to enter building to search for victims; temporary net for personnel in building established | | | Voice |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 16:00 | x1 | | | | | | Search teams entering garage area establish net for activity monitoring and location information; data (such as location and status of victims) is also transmitted | Binary |
| 16:00 | y1 | | | | HazMat team links monitoring equipment to communications network; information transmitted to on-scene commander and MCC | | | Binary |
| 16:00 | y2 | | | | Units ordered out from structure | | | Voice |
| 16:00 | y3 | | | | Units leave behind remote monitor | | | Binary |
| 16:00 | z1 | | | | | | Search teams continue searching garage | Voice & binary |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 16:00 | z2 | | | | | Rescue team attends to victims; medical status and video transmitted to hospitals; due to data exceeding available bandwidth, degraded bandwidth management is in effect | | Voice & binary & video |
| 18:00 | aa1 | | Incident Command staff uses activity data to rest and rotate search and rescue teams | | | | | Voice & Binary |
| 18:00 | bb1 | | | | | | National Guard begins arriving; command added to command net; officers added in to temporary nets at specific scenes where they are working with first respond-ers | Voice & Binary |

| Time | ID | PSAP | EOC | Police | Fire | EMS | Other | Xmission Type |
|---|---|---|---|---|---|---|---|---|
| 21:00 | cc1 | | | | | | Federal US&R team arrive; command added command network; unit personnel added to on-scene responder rosters; robotic unit deployed with short range communication for transmitting video from inside collapsed buildings; video transmitted when requested to MCC and EOC | Voice & Binary & Video |

Table 33. Transmission Record Earthquake Scenario