

## Mobile Mesh Networks Connect First Responders

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### Public Safety Communications Challenges

Reliable wireless communications that enable real-time information sharing, constant availability, and interagency interoperability are imperative in emergency situations.

Greater situational awareness is an increasing requirement enabling emergency responders to see one another's positions in relation to the incident, terrain, neighborhood, or perimeter being secured.

Live video, voice communication, sensor and location data provide mission-critical information, but low-speed data networks cannot meet the bandwidth requirements to support such critical real-time information.

Traditional network availability has proven to be difficult to maintain in unpredictable environments such as firestorms, natural disasters, and terrorist situations. Too often communications depend on access to fixed or temporary infrastructure and are limited by range or line of sight constraints. Radio interoperability between jurisdictions, always an issue for responders, became a homeland security issue after 9/11. Proprietary radios and multiple standards make it virtually impossible for different agencies to cooperate in a scaled response to a major disaster.

Making data available instantly between emergency first responders from multiple agencies and jurisdictions and in even the most unpredictable situations requires a powerful, flexible, and reliable wireless solution.

### Case Study: 2003 San Diego Firestorms

When catastrophic emergencies happen, a comprehensive coordinated effort based on timely, effective communications between fire, police, and emergency services is necessary to cope with the situation. Unfortunately, during the California firestorms of 2003, coordination was hampered by competing communications standards.

In 1999, San Diego County and neighboring Imperial County to the east deployed a shared public safety and public service wireless radio communication network called the Regional Communications System. It provides the primary communication links for 163 local, county and state governmental agencies throughout the 4,500 square mile County of San Diego and another 28 agencies and 5,500 square miles in Imperial County. The system's 43 networked radio repeater sites use over 150 800-MHz frequencies and provide more than 97% coverage of the roadway network with capacity for 13,000 users. The system utilizes one network for voice and another for data communications.

Regional Communications System users in October 2003 included most the county's fire, law, EMS and public works departments in San Diego County, but not the Border Patrol, California Forestry Department and other local jurisdictions that came to help during the disaster.

The *San Diego Union-Tribune* reported that, "When firefighters went face to face with the most destructive wildfire in California history, their most reliable method for communicating with each other may have been shouting." The newspaper explained that, "mismatched radio systems left U.S. Forest Service crews unable to talk to their counterparts in other fire agencies."

Some first responders relied on overused cellular telephone channels and faced cross-border radio interference from Mexico, which competes with Southern California for frequencies yet has its own licensing process, which is frequently at odds with the Federal Communications Commission. At the same time, heavy public use of cell phones created many busy signals.

Other first responders resorted to handheld Family Radio Service (FRS) devices that sell for as little as \$25 apiece after their

regular radios, which cost thousands of dollars, failed. While helpful for peer-to-peer communications, the FRS created isolated communication groups.

Out-of-town 'strike teams' that were supposed to have radios "cloned" to enable them to talk to the local agencies never asked for them or never received them, contributing to the chaos of an already chaotic environment.

San Diego County's topography ranges from 100 feet below sea level to over 6,500 feet above, and the forest fires were often burning in deep mountain valleys and gorges. For firefighters to transmit signals using 800-MHz radios, they needed to be in the line of sight of a repeater. If they were obstructed, they were out of luck. Additional temporary repeaters, which were intended to be added, couldn't be installed on local mountain tops due to the Santa Ana winds and thick smoke, or were disabled by power outages.

According to one rural fire department chief in San Diego County, until all emergency responders achieve true interoperability, he plans to carry four radios: one each for the San Diego city 800-MHz system, the county's Regional Communications System, the U.S. Forest Service system, and the California Department of Forestry and Fire Protection system.

## Mesh Networks in Practical Use

The communications problems that arose between agencies during the 2003 California wildfires highlighted weaknesses in the existing system that mobile mesh networking technology can rectify.

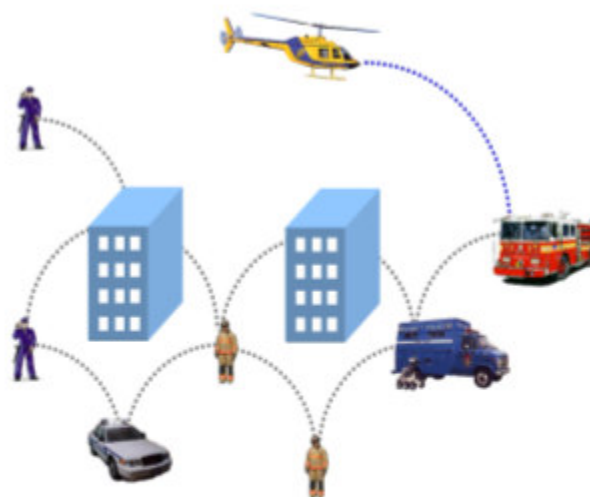
The majority of state and federal agencies use VHF systems to coordinate large-scale emergency response. Local agencies, however, have adopted 800-MHz systems for its efficiency for day-to-day operations. Only the military, at the time of the California wildfires, had adopted radios capable of bridging between disparate frequencies and protocols.

In an emergency nobody knows in advance where communications will be essential. A radio system must be able to work instantly virtually anywhere first responders are deployed or the system is useless.

With ad hoc mesh networks connecting the responders in the Cedar Fire case in San Diego County, interoperability and communications could be managed and the radios' ranges extended by virtue of a multihop self-assembling network that turns each radio in the system into a repeater for the network—in other words, the responders become the network. For those with legacy 800-MHz radios, some mesh networking systems are capable of also bridging the mesh network to traditional networks in the system.

A mobile mesh network normally relies on Internet Protocol (IP), a universal networking standard, to intertwine wirelessly between IP-enabled first responder devices and networks. Unlike existing point-to-point radio systems, there is no central point of failure with a mesh topology. The more radios that join the network, the more diverse and failure-resistant the network becomes.

For firefighters, such a communications system enables incident commanders to more effectively deploy trucks and personnel on the front lines of a fire by receiving video images of the fire and its direction relayed from air units. Mesh-networked devices can transmit and receive voice communications from incident commanders and front-line firefighters as well as receiving data such as changes in windspeed or humidity. For evacuations, these devices can ensure Sheriff's deputies have the same information as firefighters.



**In a multihop mesh network, the emergency responder becomes a network repeater and router.**

Police can use mesh solutions in much the same way. Such a communications system enables both ground and air units to share real-time video communications to catch criminals. Police helicopters tracking car chases can relay images through mesh-enabled devices to the pursuing car units and those setting up a roadblock ahead of the chase. Visual data such as a photo of a suspect or an Amber Alert victim can be relayed between handheld radios, patrol car radios, and local police stations. Wireless video surveillance can be set up and managed remotely with sensors and software that alert Police to breaches in security.

Search and rescue, hostage situations, firestorms, border patrols, and terrorist attacks are all situations where wireless mesh communications can be deployed to ensure all responders have enhanced situational awareness and real-time communication. With the addition of Global Positioning, GPS, mesh-enabled devices can track personnel and equipment to provide greater visibility to the incident commander.

## Mobile Mesh Networking Benefits

- Network communications in the absence of existing infrastructure when needed
- Communication beyond line-of-sight radio connection
- Interoperability through Internet Protocol (IP) standards
  - IP enables bridging to legacy systems
  - IP enables separate and connected groups over the same radio frequency
- Interoperability by supporting multiple radios and bridging to legacy systems
- Broadband support enabling real-time video, voice and data applications
- Self-configuring network eliminating manual network management
- Situational awareness using GPS or other location technologies
- Scalable to 100s and 1000s of networked devices
- Secure network based on AES encryption

## Mobile Mesh Applications

- Radio interoperability in a multi-jurisdiction crisis through networked devices and establishing a gateway to legacy devices
- Real-time video feeds to all networked devices including in-vehicle displays, command centers and handheld tactical units
- Situational awareness for all responders on the scene
- Automated data collection from sensors networked to the system including perimeter security, hazardous material detection, and video surveillance
- Robot communications for search & rescue or bomb clearing

## Conclusion

Mobile mesh networking enables broadband wireless communications in the absence of existing infrastructure ideal for first response situations. It ensures the interoperability, scalability and reliable performance required in large-scale emergencies where tactical communications are better served by networking on the fly enabled by a mesh network solution.

Mobile mesh topology links more than just voice communications. It also supports live video and high-activity data communications to incorporate valuable, real-time and possibly life-saving intelligence into the emergency response strategy.

The terrorist attacks in 2001, San Diego firestorms of 2003, and Florida hurricanes of 2004 all demonstrated shortcomings in the communications networks supporting first responders on the frontlines, many of which are solved by wireless networking technology.

## About Sensoria Corp.

Sensoria Corp. is an innovator in wireless sensor and mesh networks for public safety, military and physical security applications. For more, see [www.sensoria.com](http://www.sensoria.com).