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Raytheon's Net-Centric Communications

Building a Foundation for Innovative Solutions



Raytheon

Customer Success Is Our Mission

First Responder Interoperable Communications

Instant, reliable communications have always been critical for providing a safe, timely response during any emergency. Comprehensive communications during a major crisis are even more important. The foundational communications technology for public safety and first responders since the 1930s has been two-way mobile radio, and is now generally referred to as land mobile radio (LMR), even though it is also used to provide communications with marine and airborne public safety personnel. The functionality has essentially remained unchanged since the beginning: provide two-way voice communications for users in a simple, reliable manner. The need for such communications continues to grow, and the pressure for more and more channels continues. In the quest for more channels, the range of spectrum used for such applications has increased, moving from 30 MHz to lo-band VHF to high-band VHF to UHF to 800 MHz — and now the 700 MHz band. Channel bandwidth and channel spacing have more or less evolved in an ad-hoc manner, even from the same vendors.

All of this has led to interoperability problems, where national, state and local first responders cannot communicate with each other using the equipment they have acquired. One of the primary reasons in the past has been a lack of standards. This is now changing, and the P25 standard will address many of these issues. However, using different frequencies of operation still presents an interoperability problem. The Federal Communications Commission and others are attempting to address this issue by allocating spectrum at 700 MHz to be used nationwide by all first responders.

Unfortunately, these efforts only address narrow-band voice and low-rate data needs, while the need to exchange large data files, photographs, graphics and

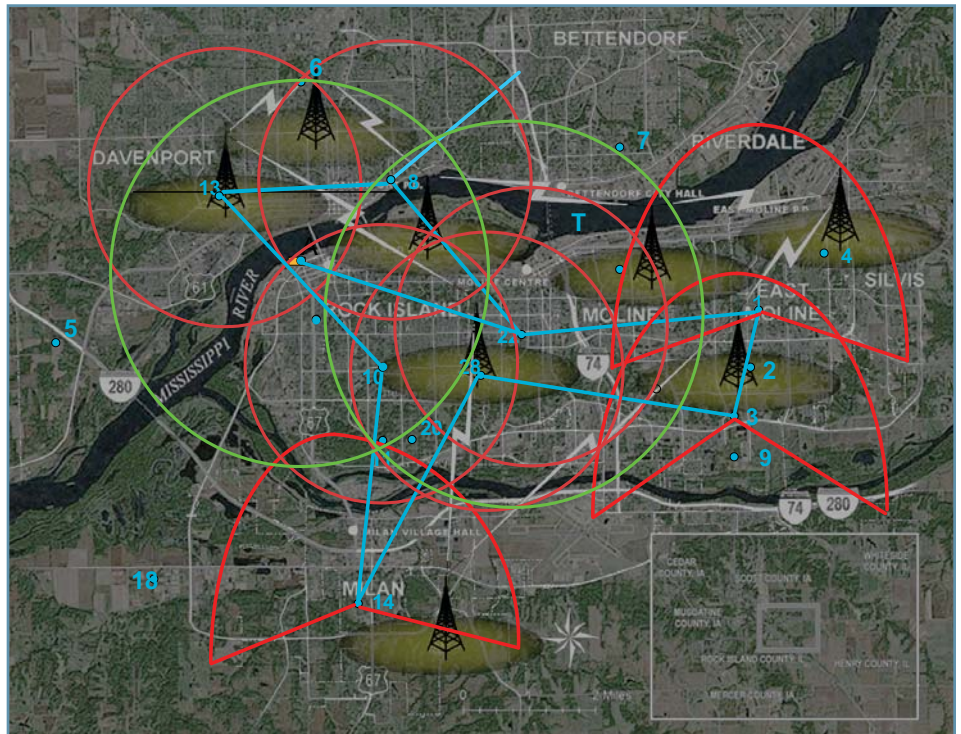


Figure 1. Pilot System RF coverage

streaming video is increasing. These needs require mobile data systems capable of providing broadband, high-rate data communications services. In addition to providing basic communications, there is also a need to provide resource tracking (including patients, food, water, personnel, vehicles, medical supplies, etc.). Thus, providing total interoperability requires integrating not only traditional LMR systems, but also broadband communications, networks, software, video and backhaul elements in a total networked environment across all levels of local, state and national agencies.

Raytheon believes there is an unfulfilled need to develop and deploy modern broadband interoperable communications capabilities across the nation to support state and local public safety and emergency operations. Thus, we developed and deployed a pilot system to provide a working laboratory to evaluate and demonstrate

many different broadband communications technologies and their application to public safety and first responder needs. Figure 1 depicts the pilot wireless network. It includes a microwave backhaul ring topology to provide independent connectivity between five cities, eight 4.9 GHz WiMAX wireless nodes for broadband fixed services, and two 1.79 GHz nodes for broadband mobile communications. Applications served by this network include remote video surveillance, remote monitoring of cameras in a high school, provision of broadband data access to mobile vehicles, and the interconnection of all the cities' networks. The fire department uses the system to access remote databases from fire trucks. Police use the system to view video from cameras, access records, view mug shots and, in conjunction with license-plate recognition software, to identify stolen vehicles or persons with outstanding warrants. The cities use the system to exchange

information related to emergencies. The network is used to connect multiple jurisdictional police and fire department LMR service. Public works uses the network to monitor and control pump stations for water control. The network provides broadband connectivity (including video) to a mobile command post, as well as broadband multimedia communications for mobile users. It provides an interactive collaborative environment for first responders, including VoIP telephony service, interconnectivity to the public switched telephone network for mobile users, Internet access for mobile users and the interconnection of city networks during emergencies. The system enables sharing of resources and sharing of different databases during emergencies.

System Description

The wireless network consists of three major segments: (1) A microwave backhaul system operating at approximately 30 GHz in a ring topology, (2) A 4.9 GHz WiMAX subsystem that provides fixed access to various users, and (3) A 1.79 GHz 802.20 wireless access subsystem to support mobile users. The backhaul system operating frequency is susceptible to significant rain attenuation, and hence was designed with large rain margins (>30 dB) to provide a link availability of 0.9999. The maximum distance between nodes is less than five miles. The ring topology was chosen to provide protection against total network outage due to a single failure or link outage. When the ring is fully functioning, the backhaul provides 60 Mbps of capacity between adjacent nodes. The ring terminates at the network operations center (NOC).

The 4.9 GHz nodes are implemented as either two-sector or three-sector cells, providing 240-degree or 360-degree coverage, respectively. The nominal radius of coverage

from each base station is 2.5 miles. (Actual coverage depends on terrain and cultural features of the area.) This system provides non-overlapping coverage of an area of approximately 60 square miles. The 4.9 GHz operating frequency was selected because the cities owned the license for the 4.9 GHz public safety band, and equipment that implements the 802.16 standard is available in this band. This system was used to connect remote video cameras, pump stations, building-to-building networks, nomadic users, high school video systems and different LMR systems.

Since the 802.16 standard for mobility had not been approved at the time the network was deployed, Raytheon deployed a new technology operating at 1.79 GHz to support mobile operations. The system architecture was designed along the draft IEEE 802.20 standard. It provides fully mobile broadband communications at data rates up to 1 Mbps (now 2 Mbps), with cell-to-cell handoff. The unique feature of the system is the use of "smart antenna" technology to improve range and spectrum efficiency. Two such base stations were deployed and covered approximately 10 square miles in the downtown area of three cities.

The NOC provides several functions, including network management of the backhaul system, the 4.9 GHz WiMAX system and the 1.79 GHz mobile system. It also provides continuous monitoring of the health and status of the entire network, a means for tracking and recording alarm events, a means for configuring and provisioning the network, etc. The NOC is used to demonstrate numerous capabilities available in the network, including video monitoring; pseudo-dispatch functions for setting up interconnections between LMR talk groups; and the exchange of voice, video and data with mobile users. It is also used to host

numerous applications, including the multimedia communications application, the virtual private network server, the DNS/DHCP server, etc. The NOC can be located anywhere on the network and provides the center of operations for the network. Thus it can be located at an IT center, the police or fire department, or an independent facility provided just for this purpose.

Summary

Raytheon has demonstrated several communications technologies and the use of several applications to significantly improve the ability of first responders to execute faster, safer and better responses in an emergency. The primary objective is to provide complete interoperability across all media and all jurisdictions. This includes not only LMR voice interoperability, but also video, data, interjurisdictional networks, disparate database formats, multiple frequencies, etc. The pilot has demonstrated our ability to achieve these objectives.

The pilot has also played a significant role in evaluating numerous technologies as well as acting as a working laboratory for users to evaluate the technologies. The pilot has contributed significantly to our ability to understand the operational uses of interoperable communications systems and the issues associated with getting multiple jurisdictions to work together, including both technical challenges and governance challenges. ●

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