

LOCATE | TRACK | EXTRACT

WIRELESS MESH NETWORKING ALLOWS COMMANDERS TO KEEP TRACK OF FIREFIGHTERS AT AN INCIDENT SCENE

BY RICK ROTONDO

A two-alarm fire in a large multistory building begins to escalate out of control. As the blaze involves the lower floors of the building, an evacuation order is given. A team of three firefighters in the southwest sector of the second story is unresponsive to the order; possibly heavy radio traffic, interference from the building structure, or injury to the team itself caused the order or response to be missed. The battalion chief directs a rapid intervention crew (RIC) to the last-known location of the missing team. The search party proceeds to the second floor, but heavy smoke and fanning flames prevent them from finding the missing team in time.

This is the nightmare scenario for any fire department: having down or lost firefighters who cannot be quickly located and rescued. According to a recent report by the National Fire Protection Association (NFPA), deaths resulting from

individuals being trapped or caught in a fire accounted for more than 25 percent of all firefighter fatalities in 2002.

In an effort to prevent this type of scenario, the Orange County Fire and Rescue Department (OCFRD) of Orange County, Fla., is testing location and tracking technology from MeshNetworks. The department's overall goal is to incorporate this wireless networking and location technology in an incident command standard to track, monitor, and rapidly locate firefighters. As Bill Godfrey, OCFRD deputy chief, explains, "Sometimes things go wrong. When they do, knowing the exact location of firefighters in a building is the difference between going home to family, or not."

The Current Situation

Incident management — the ability to account for the whereabouts and well-being of first responders at an incident scene — is a major concern for fire departments in the United States and abroad. Most fire departments use dry-erase or magnetic status boards as their primary incident management tool. As units enter and are engaged at the incident, a commander logs them on the board to both acknowledge their presence, and as best as possible, track their movements. Unfortunately, tracking boards are based largely on partial and/or out-of-date pieces of information.

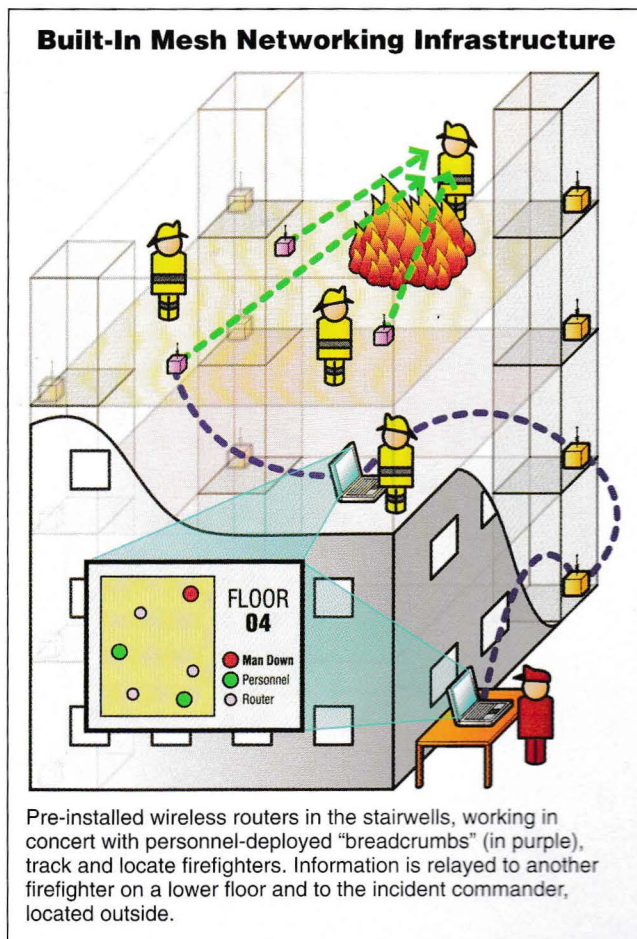
In rapidly changing situations, commanders are often faced with incomplete or poor situational awareness. For example, a commander may order a team to move from one area to another. The unit acknowledges the order and the commander rewrites their position on the board, never knowing if the unit actually makes it there.

Today, when a firefighter is unaccounted for, an RIC is sent in to conduct a search using the appropriate standard operating procedure (SOP). Traditional building SOP search tactics, such as "reach and sweep" and "the right-hand search" (an RIC team feels for personnel while keeping their right hands on the wall for bearing), are time-consuming multiroom and multistory structures. And while thermal-imaging cameras can certainly help shorten the time needed to locate nearby personnel through smoke and light debris, these devices are typically useful only once the RIC is in the same room as the downed firefighter.

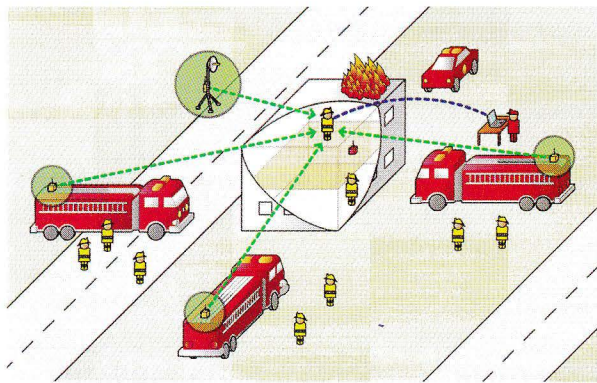
Improving Accountability and Response

MeshNetworks' Positioning System (MPS) offers incident managers and RICs an alternative set of tools and technologies to log, track, and locate firefighters at an incident.

The system consists of several components that work



Personnel Tracking Application



Fire truck-mounted wireless routers and a tripod-mounted "position" router penetrate the building to track/locate a firefighter on the second floor. Data is sent to the incident commander.

together, so it can be scaled to meet the needs of any size response. The first component is a small battery-powered wireless device carried by, or incorporated into, a firefighter's personal accountability system (PAS). The second, the MPS tracking and mapping application, runs on the incident commander's laptop. The final components consist of wireless routers that are deployed around the perimeter of the building, and/or small battery-powered units called "breadcrumb routers" that can be dropped by firefighters as they move throughout an incident. These wireless routers create an ad hoc, yet robust wireless communications and tracking network.

The system's technology determines the location of a first responder by combining time-of-flight measurements, three-dimensional triangulation, and mathematical filtering and prediction techniques. The various wireless routers determine the relative position of each firefighter and transmit the information back to the command computer in real time. Measurements from multiple wireless routers are fed into the MPS algorithm to determine a three-dimensional location of the target(s). Depending on the deployment, the position may be displayed relative to the local wireless routers' coordinate system (x, y, floor) or in absolute terms (longitude, latitude, and height in meters or feet). Either of these display methods can be overlaid on a satellite image or building diagram.

As personnel arrive on the scene, they are immediately identified and logged into the incident command computer's MPS system using automatic device discovery and self-forming network mechanisms. Wireless routers or breadcrumbs can be deployed immediately or during any part of the incident response, up to and including the RIC deployment. Once the MPS system is deployed, incident commanders can determine and track the location of each firefighter in real time. Labeled icons are mapped to a coordinate grid displayed on the commander's (and backup) computer. The commander can also track the movements of the RIC team and guide them via voice radio, or the RIC team can carry a small handheld computer and guide themselves toward their target. Simply put, MPS enables

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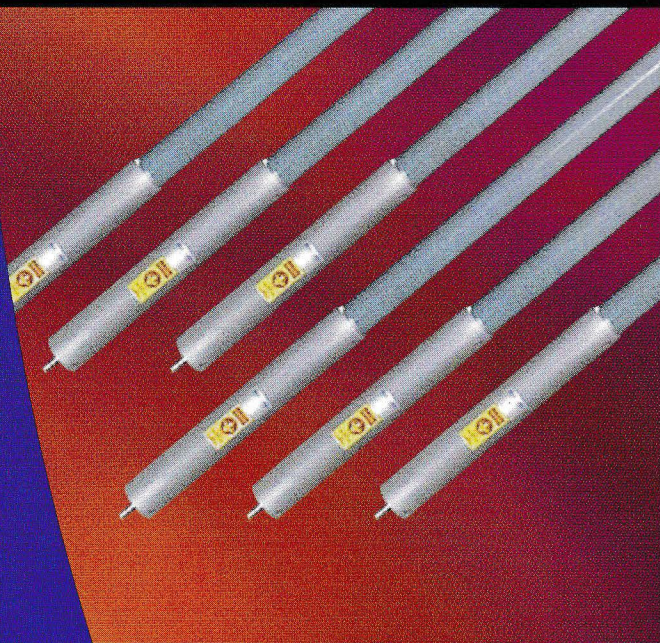
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downed personnel to be quickly identified, located, and extracted from dangerous situations.

Location Accuracy

Before deploying MPS for live incident responses, Orange County Fire and Rescue wanted to conduct an extensive evaluation at their training grounds. The OCFRD established that the minimum level of location accuracy required is 10 meters, which would pinpoint the target to within about a room of an individual's actual position. The OCFRD surmised that if an RIC could be rapidly directed to within 10 meters of their target, the PAS alarm or thermal-imaging camera would get them the rest of the way.

The tests were conducted in three types of environments: an open-air park with no obstructions, the Fire Academy's collapsed building simulator, and the Fire Academy's burn building.

In each scenario, wireless routers were positioned around the perimeter of the test area, and MPS location data was recorded and later compared to the actual location of the firefighters' positions. When the results were in, the OCFRD found that the positioning system could locate a firefighter in most environmental conditions within seven meters, well under the 10-meter accuracy goal.

Incident Communications and Management

In addition to location determination, wireless routers also act as radio relay/repeaters, so position and other data can be communicated over a wide area and from deep within a structure. While OCFRD is primarily planning to use Mesh-Networks technology for location determination to assist in search and rescue, the same system also creates a robust high-speed wireless network that can be used to carry high-speed voice, video, and data. Patented mobile ad hoc networking technology creates instant and self-healing broadband radio links between firefighters, breadcrumbs, wireless routers, and other mesh-enabled devices. First responders can quickly deploy a tactical mesh network throughout the incident or structure. No existing radio infrastructure is necessary, since they create the network as they go. Newly developed products, however, such as exit signs with built-in wireless routers, will allow MPS and its integrated broadband communications system to be predeployed in any building.

Exciting new technologies are being introduced that will radically improve incident management and first responder safety. Today, ad hoc networking and location solutions appear to offer tangible and deployable benefits. By working closely with local and state agencies, the development time for SOPs and product features have been significantly shortened. This is good news for first responders as it will help improve their safety, and ultimately ensure everyone gets to "go home to family." ■

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