PUBLIC SAFETY
PSWN PROGRAM
WIRELESS NETWORK

Saving Lives and Property Through Improved Interoperability

Wireless Firefighter Lifeline

Final

DECEMBER 2001

Note: The PSWN Program is dedicated to improving safety by facilitating the implementation of interoperable communications among public safety organizations. To fully support this initiative, the PSWN Program is monitoring wireless data standards activities in the United States and abroad.

Information Systems Laboratories (ISL), a San Diego-based engineering company with offices in Vienna, Virginia, is developing a promising new technology system to track the movements of public safety personnel in buildings or other enclosed structures while engaged in various aspects of incident response.

ISL's Wireless Firefighter Lifeline (WFL) is a new wireless information system technology that accurately locates a person equipped with a wireless transmitter within 1 meter of his/her specific position within an enclosed structure. The system is also purported to support the transmission of certain types of biometric data such as external oxygen and carbon dioxide levels; air-bottle levels; personnel heart rate, temperature, and motion; and device battery status.

Background

A letter drafted by *National Fire and Rescue Magazine* to President Clinton asked—

> "Why is it America has the technology to track a whale across oceans around the world and pinpoint rocks to the centimeter on the surface of Mars, but no devices to accurately pinpoint the location of downed firefighters inside a simple two-story building?"

During the past 10 years, 1,065 firefighters have died in the line of duty. One of the leading causes of firefighter death and injury is the inability of rescuers to locate and extract firefighters trapped in a structure or overcome by the progress of a fire. In 1999, six firefighters were killed in a large warehouse fire in Worcester, Massachusetts, subsequent to an internal structure collapse and a failed search and rescue effort. In calendar year 2000, five multiple fatality incidents resulted in the deaths of 10 firefighters. The tragic terrorist events of September 11, 2001, culminating in the loss of some 343 New York City firefighters at the World Trade Center, only amplifies the need for technology solutions that enhance incident scene accountability and assist in the search and rescue of trapped or downed personnel.

The WFL solution was developed primarily as a response to the lack of sufficient personnel tracking technology that operates effectively indoors. Public safety agencies have embraced the Global Positioning System (GPS) developed by the Department of Defense (DoD) to assist in expediting resource responses to active incidents. GPS serves this requirement well when incorporated with computer-aided dispatching (CAD) system and geographic information systems (GIS) technology. These systems, working in conjunction with each other, can identify the closest, most appropriate public safety vehicles to send to an incident.

However, GPS relies on a constellation of 24 Earth-orbiting satellites that transmit data to GPS receivers. For continuous and accurate operation, the receivers must maintain an unobstructed view of the constellation. Therefore, GPS is not well suited for tracking personnel or resources within structures or obstructed areas. There have been several attempts to extend GPS technology into structures, but they have met with limited success.

In the absence of adequate technology, public safety agencies have developed and incorporated sophisticated manual incident command procedures to safeguard and properly account for personnel involved in hazardous activities. Many fire and rescue departments across the Nation use Incident Command Systems (ICS) to enhance personnel safety. Agency personnel also use Personnel Alert Safety System (PASS)[1] devices that can assist in locating personnel who have become trapped or incapacitated within an incident scene. However, even with these efforts, the disconnect between the incident commanders and the line personnel remains because there is no connectivity other than via voice radio. No accurate, dependable, wireless data method is available to track the location, movement, and vital statistics of personnel in hazardous indoor environments.

One of the primary applications presently under consideration by Project Mobility for Emergency and Safety Applications (MESA)[2] for inclusion in its forthcoming Statement of Requirements (SoR) is enhanced fire ground data communications using broadband wireless data technology. The MESA firefighter concept incorporates and broadens the type and amounts of information transmitted from the firefighter to the incident operational control vehicle. MESA desires to provide full command, control, and communications (C3) capability through its firefighter applications, which would provide in-building location and biometric status similar to WFL. The MESA application requirements may also support at a minimum—

- Streaming Video Visible Light
- Streaming Video Infrared
- Thermal Imaging Unit Images
- Internet Protocol (IP) Voice
- Real-Time Medical Parameter Surveillance (i.e., heart rate, respiration rate, blood pressure, pulse oximeter, and body surface temperature)
- Real-Time Equipment Data Monitoring (i.e., battery/power status, dual axes accelerometers, self-contained breathing apparatus air levels, external temperature, carbon dioxide and other gas levels, radiation detection, and protective gear temperature).

Technology Overview

Responding to the need to accurately locate fire personnel indoors within a hazardous environment, ISL is developing the WFL. The ISL solution will be a combination of three different components that operate together to form this wireless information system.

[1] PASS devices, first introduced in the early 1980s, are transistor radio-sized motion detectors that incorporate sensors that register movement or lack of movement after a specific time period. A strobe light and loud alarm signals a fallen firefighter and guides rescuers to his or her location.

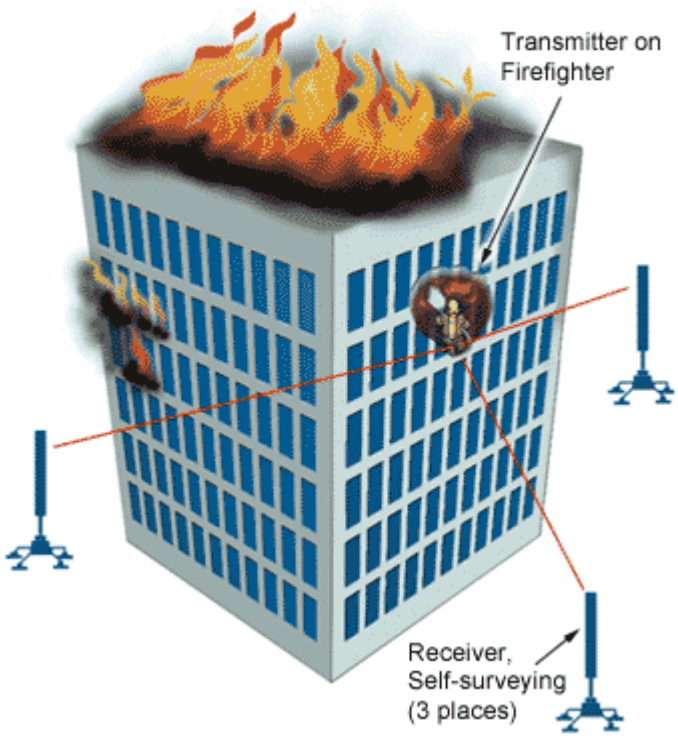
[2] Project MESA is a standardization Partnership Project within the Information and Communications Technology (ICT) area established between the Telecommunications Industry Association (TIA) of the United States of America and the European Telecommunications Standards Institute (ETSI) of Europe for the purpose of elaborating a joint specification of mobile broadband technology to be deployed in the service of the police, international rime and terror combating, intelligence, emergency and medical services, firefighting, and civil defense.

The first component is the system receiver/antenna infrastructure, which can be rapidly deployed outside structures such as office buildings, parking garages, strip malls, etc. These receivers either may be mounted on emergency vehicles or can be placed in position by hand by personnel outside the incident location. These outside receivers are self-surveying, i.e., they calculate their position relative to each other, as well as receive the information transmitted by the personnel within the structure. A minimum of three outdoor receivers must be operational and placed around the structure for the system to operate accurately. The receivers may be placed at street level, or for taller structures, may be placed on an adjacent structure, to improve performance and provide three-dimensional images of the building floors. Depending on the building's geometry, structure, and building construction materials, additional receivers may be necessary to maintain consistent operations in large-scale locations or events.

The second component of the system is the wireless transmitter device carried by the firefighter. This battery-powered pager-like device transmits the location and biometric sensor information to the central command terminal located at a command vehicle outside the structure. The device is built to rigorous standards to facilitate operations in wet, hazardous, and high-temperature environments. The wireless device transmits a coded waveform, which uniquely identifies each firefighter at the scene. These transmissions will enable the central command terminal operator to monitor individual movement and information in real time.

The final component of the system is the central command terminal. This computing device receives the information from the various receiver antennas located around the incident scene and positions the information on a user-selectable two- or three-dimensional presentation display. The central command terminal will allow the operator to uniquely identify each firefighter with a "tag," identifying a personnel, crew, unit, or company number. Additionally, the central command terminal will allow the use of digitized building floor plans to provide the perspective of the internal building structure. If the incident location has not been previously surveyed, the system will allow for real-time entry of floor plans as personnel progress through the structure. The data entry method is purported to be very straightforward and easy to accomplish so it does not impact incident command and control functions. ISL indicates that there may be future potential for the system to "learn" the building structure as personnel travel through it.

Figure 1, provided by ISL, depicts a WSL system deployed at a structure fire incident.



Information Systems Laboratories, Inc.

Figure 1
Depiction of the Deployed Wireless Firefighter Lifeline System

The WFL system will use a very narrowband, phase-only, low frequency approach that is purported to produce high accuracy and very good penetration into building structures with modest requirements for bandwidth, and will not succumb to unacceptably large positioning errors found in indoor positioning systems. The location information will be derived through the use of a carrier wave (CW) tone. The biometric data will be impressed upon this tone as a transport medium. ISL initially intends to operate these systems consistent with Federal Communications Commission Part 15 requirements in the unlicensed Industrial, Scientific and Medical (ISM) bands.

According to Doss Halsey, vice president of ISL, "Everything emits energy, so the thesis is to use a wavelength on the order or lower than those of the features inside a building, like hallways and rooms. If the wavelength is the same size or smaller [than the features] you get what we call 'guided wave modes,' where the energy will follow the hallways and the structure. So if you are in low frequency you get better penetration of the building, parking, and any structure where you have to go through a lot of material."

Public Safety Impact

The importance of this type of technology to public safety is the opportunity it provides to potentially reduce the number of personnel fatalities attributed to fire incident scene activities. Fire operation incident commanders consider the ability to monitor the environment around the firefighter as a significant benefit because, in many cases, due to their protective gear, the firefighters cannot or do not recognize the dangers around them. Another benefit is the opportunity to monitor firefighter biometrics, such as heart and respiration rates, which may also allow timely intervention to prevent or minimize firefighter death from heart attacks due to overexertion. According to the U.S. Fire Administration, heart attacks continue to be the number one cause of death for fire personnel over the past 10 years.

ISL indicates that the fire service is very interested and supportive of the advancement and ultimate completion of this technology solution. ISL believes that the technology can be expanded to support other specific sensory opportunities such as those discussed in the Project MESA SoR.

Anecdotal information indicates this type of communications technology would have been extremely beneficial during the response to the recent terrorist attack on the World Trade Center in New York City. The potential exists that this technology solution could have accurately identified the location of trapped or injured firefighters and rescue personnel and minimized the death toll. Additionally, the search and recovery operations for those killed could potentially be conducted more safely and effectively with accurate positioning data.

Potentially, the WFL solution appears to be well suited for other types of public safety applications. The technology could be used—

- To track corrections personnel and their prisoners within a facility
- By urban search and rescue teams (USART) in collapsed buildings or other confined-space rescues
- By law enforcement tactical or SWAT teams
- For military or public safety training opportunities
- For commercial applications such as for parents to track and monitor children at theme parks or other venues.

Additional information on ISL's WFL solution can be obtained from J. Doss Halsey, vice president of ISL, at (703) 448-1116 or www.islinc.com.

Through its research for this document, the PSWN Program has identified several other vendors that appear to be working on similar technology solutions for wireless in-building location. The program intends to monitor these developments and provide updates on this technology as warranted by advancements in the field.