Homeland Security
Science and Technology

TechNote

U.S. Department of Homeland Security
SAVER
System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercially available equipment and systems, and develops knowledge products that provide relevant equipment information to the emergency responder community.

SAVER Program knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?" These knowledge products are shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities. This TechNote was prepared for the SAVER Program by the Space and Naval Warfare Systems Center Atlantic.

SPAWAR Systems Center ATLANTIC

For more information on this and other technologies, contact the SAVER Program by e-mail or visit the SAVER website.

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Blue Force Tracking in GPS-Denied Areas

Blue force tracking is a term coined by the U.S. military that refers to monitoring the location of friendly forces' personnel and resources in a particular area of operation. The term also includes civilian emergency responders. Blue force tracking systems use the Global Positioning System (GPS) constellation of satellites; however, tracking inside buildings and other locations with traditionally poor GPS signal conditions (GPS-denied areas) is challenging. Accurate blue force tracking in GPS-denied areas is an emerging technology—a hybrid of methods and technological advances that can be used to locate disabled, trapped, or disoriented personnel in multi-story structures, underground, or in tunnels. Real-time location information can be leveraged to offer dynamic situational awareness.

Figure 1. Tracking Units

Images courtesy of Chirange Technologies and TRX Systems

Technology Overview

Blue force tracking systems use a combination of tools in GPS-denied areas, such as specialized micro-sensors and wireless communications, to track personnel. The minimum primary components include a tracking unit carried by or attached to individual responders, and a sophisticated software mapping application. As shown in Figure 1, tracking units may include a graphical user interface (GUI) accessible to field personnel as well as incident commanders.

Tracking units: Many tracking units can receive and broadcast location information in real time. These units may be radios, smartphones, tablets or specialized devices. They are often GPS-enabled to allow for the establishment of initial reference points prior to entering a building, and contain embedded micro-sensors. These micro-sensors detect changes in emergency responders' speed, direction, and elevation, and may be able to determine whether personnel are lying down.

Tracking units also include a communications module that may offer multiple wireless technology options such as Wi-Fi®, Bluetooth®, Ultra-Wideband (UWB), and cellular. These wireless communications resources can help provide location information using radio frequency (RF)-based positioning methods, sometimes referred to as RF ranging. For example, location information may be calculated by measuring radio

signal strength and time delays between fixed reference points, such as cellular towers or Wi-Fi base stations, and the specific tracking unit. Then, the communications module can be used to transmit the collected location information to specialized servers for processing.

Mapping Application: Blue force tracking in GPS-denied areas requires a sophisticated software application to collect and fuse data from multiple types of micro-sensors, RF-ranging resources, and mapping databases. The mapping application may display location information in a GUI that depicts the exact path an individual has taken, called a breadcrumb trail, and incorporate a three-dimensional view to show changes in elevation (e.g., different floors of a building).

Mapping applications may be deployed on in-house servers (i.e., client/server model), web-based, or downloadable as a mobile application that specifically leverages the built-in micro-sensors of mobile devices.

Location Information Resources

Multiple resources can be used to increase the accuracy of location information in GPS-denied areas and provide environmental context. Examples include:

- **Site Data:** Floor plans, blueprints, maps, aerial views of buildings, and important structures can be used to help populate the mapping application;
- **Communications:** Pre-existing network infrastructure may provide RF-ranging resources, and serve as transmitters and repeaters; and
- **Sensor Fusion:** Specialized micro-sensors that track an individual's physical movement, in combination with magnetic sensors, may be used to correct calculation errors due to interference caused by building contents, layout, and construction materials (e.g., iron).

Some blue force tracking systems used in GPS-denied areas are accurate enough to differentiate floor levels, number of personnel present, and specific room locations.

Dynamic Mapping

As shown in Figure 2, site maps and floor plans for locations with little infrastructure information may be generated using a crowdsourcing method. As more people with tracking units move about the floors of a building (i.e., figures in blue and green), individual location information is merged to populate maps dynamically. This can improve location calculations and help identify structural features, such as elevators, hallways, stairwells, and exits. The GUI of some software applications may also include manual on-scene configuration tools to help build features.

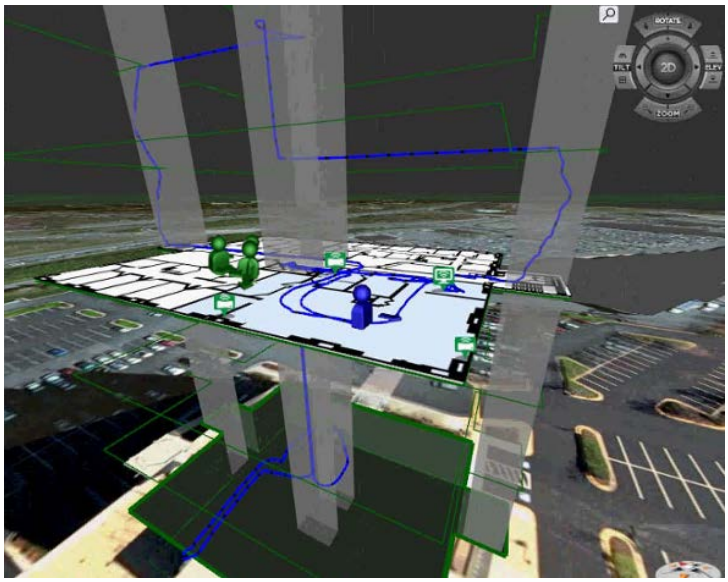

Figure 2. Crowdsourcing a Floor Plan (Indoor Tracking Application)

Image courtesy of TRX Systems

Case Studies

The following organizations have fielded blue force tracking systems in GPS-denied areas.

Arlington Fire Department, Joint Base Myer-Henderson Hall, VA, *Emerging Technology Demonstrated for First Responders in Old Barracks*. http://www.dvidshub.net/news/112113/emerging-technology-demonstrated-first-responders-old-barracks. Accessed January 2014.

Worchester Fire Department, Worchester, MA, *GLANSER Firefighter Locator Performance at WPI Workshop "Most Promising"*. http://www.fireengineering.com/articles/2012/08/glanser-personnel-locator-performance-at-wpi-workshop-most-promising.html. Accessed January 2014.