Localization Requirements for Homeland Security Applications: Emergency Responders

Opportunistic RF Localization for Next Generation Wireless Devices
June 14, 2010, WPI, Worcester, MA

Jalal Mapar
Program Manager
Infrastructure & Geophysical Division
Science and Technology Directorate
Department of Homeland Security
June 14, 2010

DHS S&T Directorate

U/S for Science and Technology

Director of Research
Director of Innovation
Director of Transition

Explosives
Chem/Bio
Command, Control & Interoperability
Borders/Maritime
Human Factors
Infrastructure/Geophysical

Sec Dir Research
Sec Dir Transition
Sec Dir Research
Sec Dir Transition
Sec Dir Research
Sec Dir Transition
Sec Dir Research
Sec Dir Transition
Sec Dir Research
Sec Dir Transition
Sec Dir Research
Sec Dir Transition
Sec Dir Research
Sec Dir Transition

Innovation

Research

Homeland Security

Applications

Homeland Security
Infrastructure and Geophysical Division

Objectives
Develop capabilities to identify and mitigate the vulnerabilities of the 17 critical infrastructure and improve the ability of the Nation to prepare for, respond to, and recover from all-hazards emergencies to keep our society and economy functioning

Program Elements
- Critical Infrastructure Protection
- Preparedness & Response
- Geophysical

Preparedness & Response

Objectives
- Enhance first responders ability to prepare for, respond to and recover from all-hazards emergencies through development and deployment of enabling technologies

Customer
- DHS/FEMA (primary), and others (CBP, CG, TSA, …)

End-User
- 44,000 Emergency Response Organizations
- 18,000 Law Enforcement Agencies
- 30,000 Fire Departments
- 83,000 State/Local Governments
Indoor Location Tracking

Where Are They?

Desired line of sight signal
Undesired multipath signal

Homeland Security

Locate 1st Responders in X, Y, and Z

"The Inter Agency Board, a working group of first responders that identifies and approves technologies for use by police, fire and ambulance services, has listed the development of a 3D tracking system as one of its top research priorities. Commanders want icons on a screen showing them where all their personnel are, especially while they're inside buildings ..."

Chief Bob Ingram, FDNY and IAB Chairman
http://www.nationaldefensemagazine.org/issue/2008/03/March/Tracking.htm
Location Tracking: **Requirements**

**Capability Need**
- Allow emergency managers, including fire chiefs and other incident commanders, to rapidly and effectively deploy and re-deploy their forces or understand and respond to the consequences of potential threats to their forces
- Accurately locate and track incident responders in X-Y-Z
- **Targeted situation areas**
  - Inside of threatened buildings
  - Collapsed buildings
  - Subterranean facilities or underground

**Requirements**
- Specify the location of its host in three dimensions within 6 meters (3 meters desired)
- "Assume building is not instrumented"
- Function in the extreme operational environments encountered by emergency responders
- Incident life of 2 hours or longer (4 hours desired)
- Include a distress button and indicator of non-movement
- Wirelessly transmit inside or outside of structures and through rubble to an off-site incident command post, on-site incident command posts, emergency responders
- Self-initializing, calibrating, adjusting, and with diagnostic capabilities to ensure speed and reliability
- Resistant to potentially damaging electrical charge, protected from potentially dangerous gases, impact resistant, and waterproof
- Operate outside all buildings and inside of almost all buildings, no matter their structural state and environmental conditions
- Primary incident command posts should be able to monitor the status of the locator and its host from a radial distance from 30 meters to 100 meters (per relay)
- Base station is a combination of additional communications equipment and the laptop/portable computer and required software.
- Base station software must be able to display location and identification of personnel.
- Base station software must be able to link the unique identifier of the locator to a specific individual
- Base station must include visualization tools to allow incident commanders and site personnel to easily interpret incoming displayed information
- *And many more …*

---

**3-D Locator: Building Visualization**

DHS S&T SBIR Phase II (NBCHC0800076)
3D Bldg Visualization Tool for Incident Commanders
Kutta Technologies, Phoenix, AZ
3-D Locator: Event Prototype

Summary:
- “Cocktail Solution” technology
  - GPS, Radio Frequency Ranging (UWB), Inertial Navigation System (INS), Barometric Altimeter, Pedometer, Wireless Mesh Network, ..., visual display for the incident commander
- Responder wears the unit that transmits location info via a wireless network to a command post

3-D Locator: Prototype Experience

- Lessons Learned From the prototyping project
  - Requirements are still the same
  - Indoor location tracking technology not mature as a product
  - Current systems work some of the time but not all of the time
  - Multipath, loss of signal, error correction, ...
  - End user input extremely essential and critical!
  - Has to be easy to use or it won’t be accepted
    - Size, weight, Automation & Power (SWAP)
    - Automation, non-intrusive
    - Integration with existing equipment
  - Cost is a major consideration
    - System/unit cost
    - Maintenance/upgrade
Geospatial Location Accountability and Navigation System for Emergency Responders (GLANSER)

Objective:
- Improve the precision of locating first responders during an incident in non-GPS environments (subterranean, sky-scrapers, etc.).
- Provide Incident Commanders the ability to accurately locate and track personnel in order to rapidly and effectively re/deploy and save at-risk responders during an incident.

Accomplishments and Future Goals:
- 2009-Initial prototype was developed and performance of 3 meters was demonstrated in several field tests
- 2010- BAA09-02 Selection Completed with 2 Awards and a Kick-Off with Stakeholders
- Conduct PDR and select performers for next development Phase of GLANSER
- Have performers demonstrate initial Prototype
GLANSER BAA09-02 Awardees

Prime contractor
System Integrator
Radio Development
Multipath Mitigation
Crosslink Waveform
Mesh Networking
Mechanical and Power
Inertial navigation
Visualization
Test & Evaluation
Operational Expertise

Prime contractor
System design and integration
Inertial navigation
Visualization

Mesh Network
Communication Radio

Ranging Radio (UWB)

Multipath Exploitation
Doppler Radar

2 Teams... One Goal...

Enhancements for a Stable Product

- System robustness
- **Improved accuracy to better than 1 meter (X,Y,Z)**
- Form/Fit/Function
- Ranging
- **Cost reduction**
- T&E with large groups of 1st Responders
- Algorithms, SW
- Network, bandwidth
- Integration of new components
GLANSER: Way Ahead

- A robust system that integrates the best components
- Spiral development w/ emphasis on T&E with responders

![Diagram showing system development stages and timelines.]

**Planned System Demo: Summer 2010**