2019 Public Safety Broadband Stakeholder Meeting

DHS Portfolio

Next Generation First Responder Deployables and Internet of Things Technology

Panel Members
Sam Ray, Alison Kahn, Hien Nguyen, Maxwell Maurice

#PSCR2019
This work is sponsored by:
DISCLAIMER

Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the entities, materials, or equipment are necessarily the best available for the purpose.

*Please note, unless mentioned in reference to a NIST Publication, all information and data presented is preliminary/in-progress and subject to change.
Project Background: Deployables and IoT

Deployable Systems
Configuration and integration of deployable LTE networks with applications and services to create a complete system for first responders.

Highly Mobile Deployable Networks
Interconnection of multiple deployable systems with limited or no backhaul connection (portable, manpacks, airborne).

Personal Area Networks for Public Safety
Issues surrounding Internet of things (IoT) technology for public safety. Determining how to maintain sensor data availability in mission critical scenarios.
Agenda

Introduction
Sam Ray, DHS Portfolio Lead

Personal Area Networks
Alison Kahn, Project Lead

Highly Mobile Deployed Networks
Maxwell Maurice, Project Lead - HMDN

Highly Mobile Deployed Networks
Hien Nguyen, Project Lead – Deployable Systems

Q & A

• Timeline, Architecture
• IoT Roundtable
• Issues, Future Research

• Why We Need Deployables
• Research Highlights
• Real Scenario, Dataset

• Drones for Public Safety Comms
• PSCR Research – Simulations
• Lab/Field Testing

Demonstration: Michigan Ballroom
Project Timeline
DHS Personal Area Networking Project

Public Safety Internet of Things
Assessing the state of IoT for Public Safety

Sensor Integration
Examining standards related to sensor integration

Architecture Development
Creating an architecture to address gaps
PSCR Architecture Overview

Sensor System
Commercial, custom, mobile, etc.

Database
For storing or distributing data in disrupted or denied environments

Local Database / API

API

Dashboard
Commercial, custom, mobile, etc.

SENSOR DATA
ZigBee, Thread, LoRA, etc.

OUTPUT DATA

Dashboard

Commercial, custom, mobile, etc.

Sensor System

lte
PSCR-Developed Components

Biosuit Sensor Hub
Multi-sensor platform for a first responder
Used to demonstrate sensor input to API

API
Ingests and stores data from sensors
Makes data available to dashboards
Goal: Discuss the current state of IoT for Public Safety, and determine issues that must be solved for it to succeed in the field.
Roundtable Activities

How the group examined IoT for public safety

1. Identification of Enabling Technologies
2. Gap Categorization and Prioritization
3. End to End Solution Brainstorming
Four Elements of a Personal Area Network

Where are the Gaps for Public Safety?

1. The interface through which the data is seen
2. The sensing, storage and display equipment
3. The protocols and architectures used to transmit data
4. The data necessary for first responders
PSCR Future Research Areas

Future PSCR Research Areas

**Data**

- What data elements are used by public safety?
- How can they be defined?

**Communication**

- How do we ensure that communication lines are available?
- How do we bring the data as close as possible?
Data Exchange Obstacles

A “Real World” Example
Data Exchange Obstacles

A “Real World” Example
Inter-Vendor Data Exchange – Current Model (Using JSON)

In object form:

```json
{
  "id":523525,
  "p":4388,   // PSAP ID
  "d":"06802",  // Department FDID
  "u":598,   // Responder ID
  "r":"F-B12",  // Unit type ('F'ire, 'B12' radio number)
  "s":"A-P",  // Status: 'A'vailable 'P'ersonnel
  "x":0,  // CFS Identifier Number (0=none)
  "c":null,  // CFS Identifier String
  "t":1558538807,  // UNIX timestamp for this IOT data
  "rack":0,  // Receive Acknowledge
  "l":35.96074,  // Latitude (floating point format)
  "g":-79.05737,  // Longitude
  "z":171,  // Altitude (MSL)
  "h":354,  // Heading
  "m":40,  // Speed in MPH
  "a":5  // GPS accuracy, Meters
}
```

Using JSON Objects

Data from A can be displayed on B
Inter-Vendor Data Exchange – Current Model (Using JSON)

First responders’ locations in Chapel Hill, NC being tracked on PageTrack in Efland, NC

ESRI taking JSON objects from PageTrack and displaying them in real time in Chapel Hill center

Goal: Disparate Systems To Communicate Without Losing Their Uniqueness By Using A Common Data Exchange Format
Issues with Current Data Exchange Model

Company A and Company B have an agreement:

What about:

And then we add in:
Defining Data Objects

Step Number One
Conduct Interviews with First Responders

Step Number Two
Determine data needed for success

Step Number Three
Establish what data is missing

Step Number Four
Compile information

Interested in Participating?
Sign up in our app!
Defining Data Objects

01 Conduct Interviews with First Responders

02 Determine data needed for success

03 Establish if data is missing

04 Compile information into document

Interested in Participating? Sign up in our app!
How to maintain these services

10 minutes ago

At the incident

This site can’t be reached

128.123.114 took too long to respond.

Try:
- Checking the connection
- Checking the proxy and the firewall
- Running Windows Network Diagnostics

ERR_CONNECTION_TIMED_OUT

Reload
Project Highlights

1. Defining how to combine deployable systems
2. Looked at some hardware requirements and specs
3. Spectrum study
4. Named Data Networking
5. Real deployment measurements
Real Deployment Scenario

The Objective:
Show the coverage and service potential of a realistic public safety scenario

The Scenario:
A fire team deployed to a brush fire

Pam Boyd. “Update on wildfire burning north of Gypsum” Vail Daily, July 23, 2018
Below are photos of the site where the deployable system was placed for operation.
Test Equipment

Full LTE System

- Generator
- Measurement Equipment
- Deployable System
Dataset

Reference signal received power (RSRP), is the power of the reference signals.

3GPP defined metric for LTE coverage prediction.
In total, the area measured was about 2 km$^2$ (less than a square mile).
Dataset

Deep Trench

Hill
Dataset

0.5 m separation (1.7 ft or 1.28 wavelengths)
Dataset

7 ft (no mast)

14 ft (mast)
What is RSRP? What do the colors mean? Why is it Negative?
The objective of this contest is to enable participants to create prototype network diagnostic tools to help emergency responders understand what coverage a broadband deployable system can provide.
Line of Sight is **King**
Drones for Public Safety Communications

Communication challenge for first responders
- Areas with no/degraded coverage
- Non-accessible terrain
Drones for Public Safety Communications

Public Safety Drone Survey
(May 2019)

- >94% Would have benefited from wireless communication
- >63% Agencies had some type of drone operation in the last 5 years

(Note: statistics based on more than 170 survey respondents)
Drones for Public Safety Communications

- Need for communication
  - Anytime
  - Anywhere

- For specific missions, drones carrying communication systems show great potential in fulfilling this need
Drones and Communication Research at PSCR

Field Test (Boulder, CO)

Simulation

Antenna Measurement

Sample of antenna pattern used in simulation

Anechoic Chamber at NIST (Boulder, CO)
Drones and Communication Research – Simulation Scenarios

Urban
Manhattan, NY
40.750983N, -73.972874W

Rural
Boulder, CO
40.120394N, -105.248196W

Mountains
Boulder, CO
40.22760N, -105.716700W
UAS and Antenna Measurement Research - Simulation

Urban Scenario

<table>
<thead>
<tr>
<th>Drone Altitude</th>
<th>RSRP (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 Ft</td>
<td>-70 to -60</td>
</tr>
<tr>
<td>300 Ft</td>
<td>-70 to -60</td>
</tr>
<tr>
<td>400 Ft</td>
<td>-70 to -60</td>
</tr>
</tbody>
</table>
UAS and Antenna Measurement Research - Simulation

Rural Scenario

Drone Altitude – 200 Ft

Drone Altitude – 300 Ft

Drone Altitude – 400 Ft

RSRP (dBm)

-70 to -60
-80 to -70
-90 to -80
-100 to -90
-110 to -100
-120 to -110
-130 to -120

RSRP (dBm)

-70 to -60
-80 to -70
-90 to -80
-100 to -90
-110 to -100
-120 to -110
-130 to -120

RSRP (dBm)

-70 to -60
-80 to -70
-90 to -80
-100 to -90
-110 to -100
-120 to -110
-130 to -120
UAS and Antenna Measurement Research - Simulation

Mountains Scenario

Drone Altitude – 200 Ft

Drone Altitude – 300 Ft

Drone Altitude – 400 Ft

RSRP (dBm)

-70 to -60
-80 to -70
-90 to -80
-100 to -90
-110 to -100
-120 to -110
-130 to -120

RSRP (dBm)

-70 to -60
-80 to -70
-90 to -80
-100 to -90
-110 to -100
-120 to -110
-130 to -120

RSRP (dBm)

-70 to -60
-80 to -70
-90 to -80
-100 to -90
-110 to -100
-120 to -110
-130 to -120
Drones and Communication Research
Anechoic Chamber Antenna Measurement Testing

NIST Anechoic Test Chamber – Boulder, CO

Robotic arm with 6 degrees of freedom

*Planned for 2019
Drones and Communication Research – Field Testing

Safety Flight – May 2019

LTE system

10-pound (4.5-kg) payload
Drones and Communication Research – YOU CAN HELP US

PULLING THE FUTURE FORWARD

- Completing Drone Survey for First Responders (Kiosk demo area)
- Participating In Upcoming Drone Challenge 2
- Providing Feedbacks
Questions?

Please join us at our demo table!
Michigan Ballroom
All wireless links are unlicensed 2.4/5 GHz (Wi-Fi, mesh radios, UAS signaling)
THANK YOU

Contacts:
Sam Ray
DHS Portfolio Lead
samuel.ray@nist.gov | 303-497-3262

Alison Kahn
Principle Investigator
alison.kahn@nist.gov | 303-497-3523

Maxwell Maurice
Principle Investigator
maxwell.maurice@nist.gov | 303-497-3775

Hien Nguyen
Principle Investigator
hien.nguyen@nist.gov | 303-497-5891

NIST-CTL PSCR Division
325 Broadway
Boulder, CO 80305
Get your hands on the tech!

Demos Open
BACK TOMORROW
8:00 AM

#PSCR2019