Location-based Services Portfolio Overview
Acronym Glossary

- BLE = Bluetooth Low Energy
- GIS = Geographic Information Science
- GPS = Global Positioning System
- i-LPS = Indoor Local Positioning System
- LiDAR = Light Detection and Ranging
- LTE = Long Term Evolution
- LTE OTDOA = Long Term Evolution Observed Time Difference of Arrival
- PerfLoc – Performance Evaluation of Smartphone Indoor Localization Apps
- ProSe = Proximity Services
- PSIAP = Public Safety Innovation Accelerator Program
- RF = Radio Frequency
- TX = Transmit/Transmitter
- UWB = Ultra Wide Band
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, all information and data presented is preliminary/in-progress and subject to change.
AGENDA

Portfolio Goal & Overview
Indoor Mapping & Navigation
Indoor Localization
i-Axis
Collaborators & Related Activities
LBS Track – An Insider’s Guide
The Goal

Demonstrate indoor mapping, localization & tracking, and navigation capabilities that first responders can depend on are within reach.
The Reality

Firefighters die or seriously injured every year from being lost or disoriented.

Officers enter buildings alone or in great peril without any way to track their location.

Rapid industry growth driven by: manufacturing, logistics, health care, entertainment, and retail. Solution for first responders remains elusive…

Career female fire fighter dies after becoming lost and running out of air in a residential structure fire – Pennsylvania

Volunteer Captain Runs Low on Air, Becomes Disoriented, and Dies While Attempting to Exit a Large Commercial Structure – Texas

Volunteer Fire Fighter Dies While Lost in Residential Structure Fire – Alabama

Career Fire Fighter Dies of Carbon Monoxide Poisoning after Becoming Lost While Searching for the Seat of a Fire in Warehouse – New York
## LBS Portfolio – How Will We Measure Success?

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<td><strong>Productization</strong></td>
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# LBS Portfolio – Current Projects & Timelines

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United States Map with major cities and geographical features.
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## Standards
- Consortium
- Mobile reference system

## PS Systems
- i-axis

## Data exchange
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LBS Portfolio Overview

Indoor Mapping & Navigation
Indoor tracking requires indoor maps. Access to indoor maps/plans is scarce. First responders already walk most buildings to preplan. Why not give them a way to get their own indoor maps...
PLUS A WHOLE LOT MORE!
Future of preplanning

3D model
Future of preplanning

3D model

2D floorplan
Future of preplanning

3D model
2D floorplan
Object identification
Future of preplanning

3D model
2D floorplan
Object identification
Scene labeling
Future of preplanning

3D model
2D floorplan
Object identification
Scene labeling
Change detection
Future of preplanning

- 3D model
- 2D floorplan
- Object identification
- Scene labeling
- Change detection
- Turn-by-turn navigation
Future of preplanning

- 3D model
- 2D floorplan
- Object identification
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- Change detection
- Turn-by-turn navigation

Computational simulation

thunderheadeng.com
Future of preplanning

3D model
2D floorplan
Object identification
Scene labeling
Change detection
Turn-by-turn navigation
Computational simulation

Immersive data visualization
Future of preplanning

3D model
2D floorplan
Object identification
Scene labeling
Change detection
Turn-by-turn navigation
Computational simulation
Immersive data visualization

Immersive training
Future of preplanning

3D model
2D floorplan
Object identification
Scene labeling
Change detection
Turn-by-turn navigation
Computational simulation
Immersive data visualization
Immersive training
**Indoor tracking**
Example systems*

Gexcel Heron  
Vexcel Panther  
Leica Pegasus  
Green Valley LiBackpack  
Paracosm PX-80

COSTS ARE DECREASING!

CHECK OUT THE DEMO TABLE

*NIST is not recommending or endorsing any of these. The lawyers told me to tell you that.
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Point Cloud City

Major gap for R&D
$1 M funding for local governments and PSOs
Publish dataset, annotations
Partnership with NIST Global Cities Team Challenge
1 year, appendable
Indoor Map & Nav Pilot

Demonstrate prototype capability to generate/automate turn-by-turn indoor navigation from point cloud and image data

Leverage standardized, open GIS frameworks, data models, and data exchange formats
OGC Indoor Map & Nav Pilot

Create and convert 3D indoor LiDAR point cloud models to functional building and navigation models.

Store and serve point cloud, image, building, and navigation models for visualization and navigation.

Derive dynamic turn-by-turn indoor navigation instructions based on the navigation model.

View and annotate point cloud and building models, along with navigation routes and instructions into, through, and out of buildings.
LBS Portfolio Overview

Indoor Localization & Tracking
Anatomy of an Indoor LTS
LTS = localization & tracking system

Sensors

+MAGNETOMETER
+BAROMETER
Anatomy of an Indoor LTS

Sensors

Signals: Ranging & Opportunistic

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**COOPERATIVE**
Anatomy of an Indoor LTS

Sensors

Signals: Ranging & Opportunistic

Reference
Anatomy of an Indoor LTS

Sensors

Signals: Ranging & Opportunistic

Reference

Fusion & filtering

$$\hat{X}_k = K_k \cdot Z_k + (1 - K_k) \cdot \hat{X}_{k-1}$$

Kalman Gain
Anatomy of an Indoor LTS

Sensors
Signals: Ranging & Opportunistic
Reference
Fusion & filtering
Tracking
Indoor 3D Challenge & Open Innovation

Is this technical area lacking focus or need a shakeup?

Is it acceptable if the work doesn’t reach the end goal?

Will the technical community and media be interested?

If you build it, will they come?
The challenge of tracking first responders inside buildings
Indoor 3D Challenge Workshop
Indoor 3D Challenge

Scenarios

Factors
- Performance
- UI/UX
- Reliability
- Deployability
- Interoperability

Timeline

Transformation

Participation
Portable Reference System

PROBLEM
Current testbed limited by access, control, fixed points, trigger
You’ve seen one building…you’ve seen one building

POTENTIAL SOLUTION
High-fidelity
Not as agile
Expensive

+MAGNETOMETER
Lower-fidelity
Agile
Inexpensive
LBS Portfolio Overview

i-Axis
PSIAP – i-axis

Information = i-axis

140

100

T

T

O2

33 %

x

y

z
Collaborators & Related Activity

USGS

Univ. of Wisconsin

AFRL

AFIT

Joint Research Centre

DHS

FAA

DOT

IARPA

DARPA

NGA

AAAE
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