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Location-based Services Portfolio Overview

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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

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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.

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AGENDA

Portfolio Goal & Overview

Indoor Mapping & Navigation

Indoor Localization

i-Axis

Collaborators & Related Activities

LBS Track – An Insider's Guide

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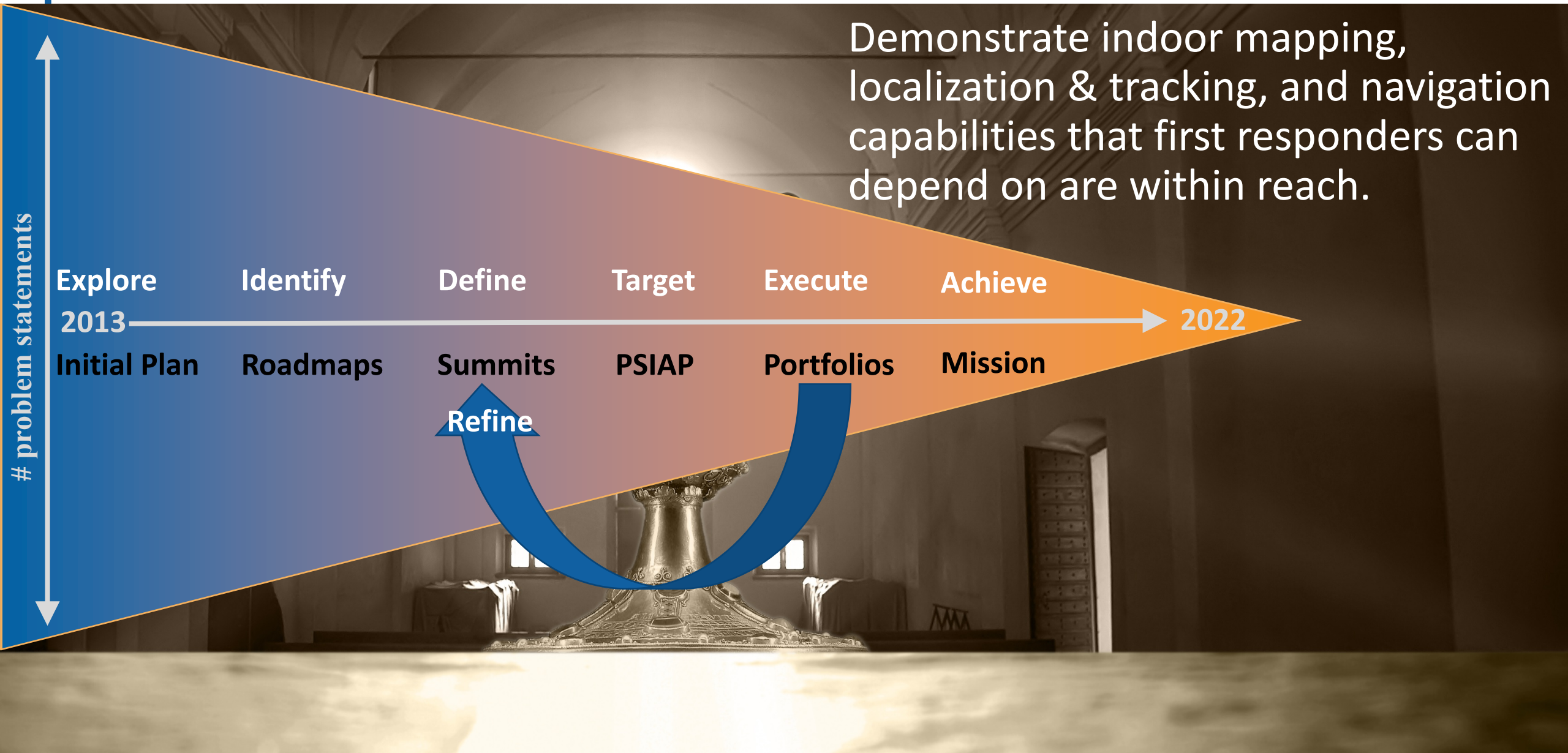
The Goal


Demonstrate indoor mapping, localization & tracking, and navigation capabilities that first responders can depend on are within reach.
problem statements
Explore
Identify
Define
Target
Execute
Achieve
2013
2022
Initial Plan
Roadmaps
Summits
PSIAP
Portfolios
Mission
Refine

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

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LBS Portfolio – How Will We Measure Success?

	2018	2019	2020	2021	2022
Research Capacity/ Innovation	Building an innovation engine and thriving R&D ecosystem focused on advancing public safety communications and operations.				
Standards	Creating, contributing, influencing technology and measurement standards				
Productization	Tech transfer, commercialization, moving markets, increasing investment				
PS Systems	Education and adoption of new technologies into public safety operations				

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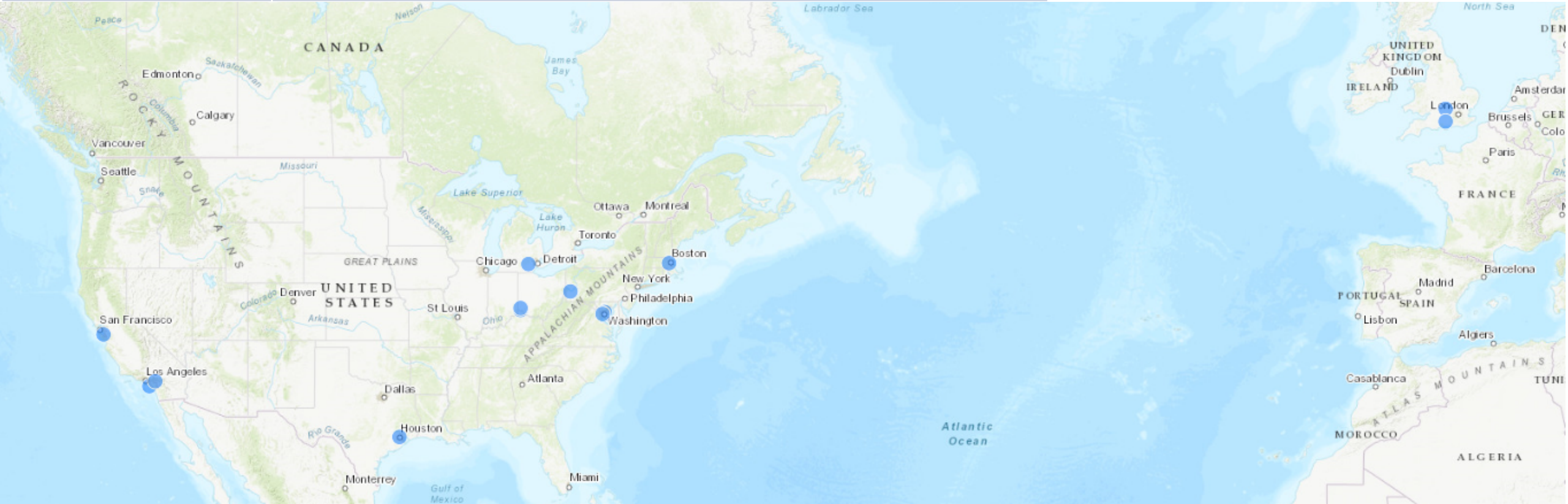
LBS Portfolio – Current Projects & Timelines

	2018	2019	2020	2021	2022
Research Capacity/ Innovation	PSIAP-2017 (8 projects, $8.2 M)				



LBS Portfolio – Current Projects & Timelines

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	Point Cloud City				
	Indoor Map & Nav Pilot				
	PerfLoc	UWB TX limits			
	Indoor Challenge				
Standards	Consortium	Mobile reference system			Data exchange
PS Systems	i-axis				

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Indoor Mapping & Navigation

Future of preplanning

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!

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Future of preplanning

3D model

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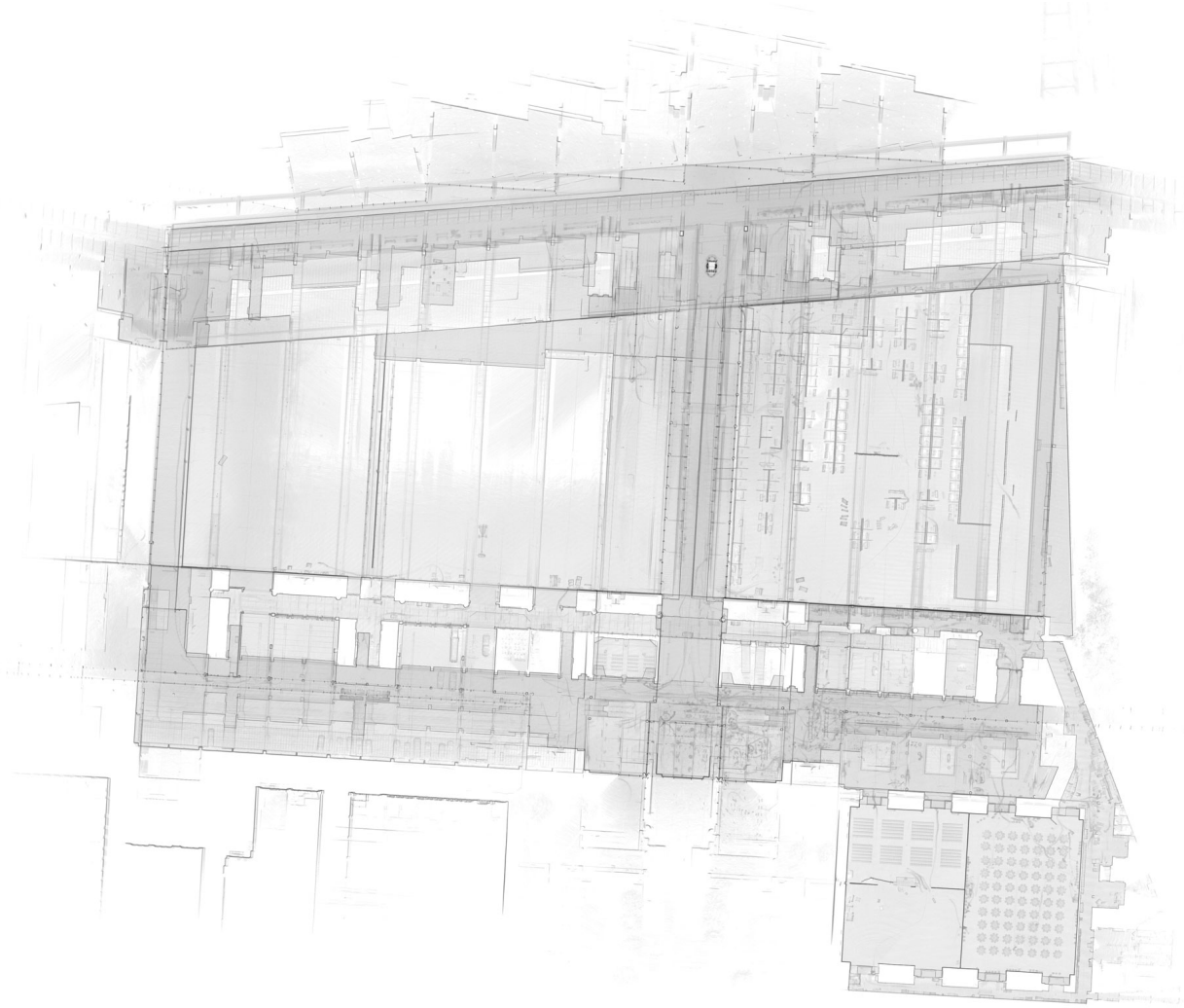
Future of preplanning

3D model

2D floorplan



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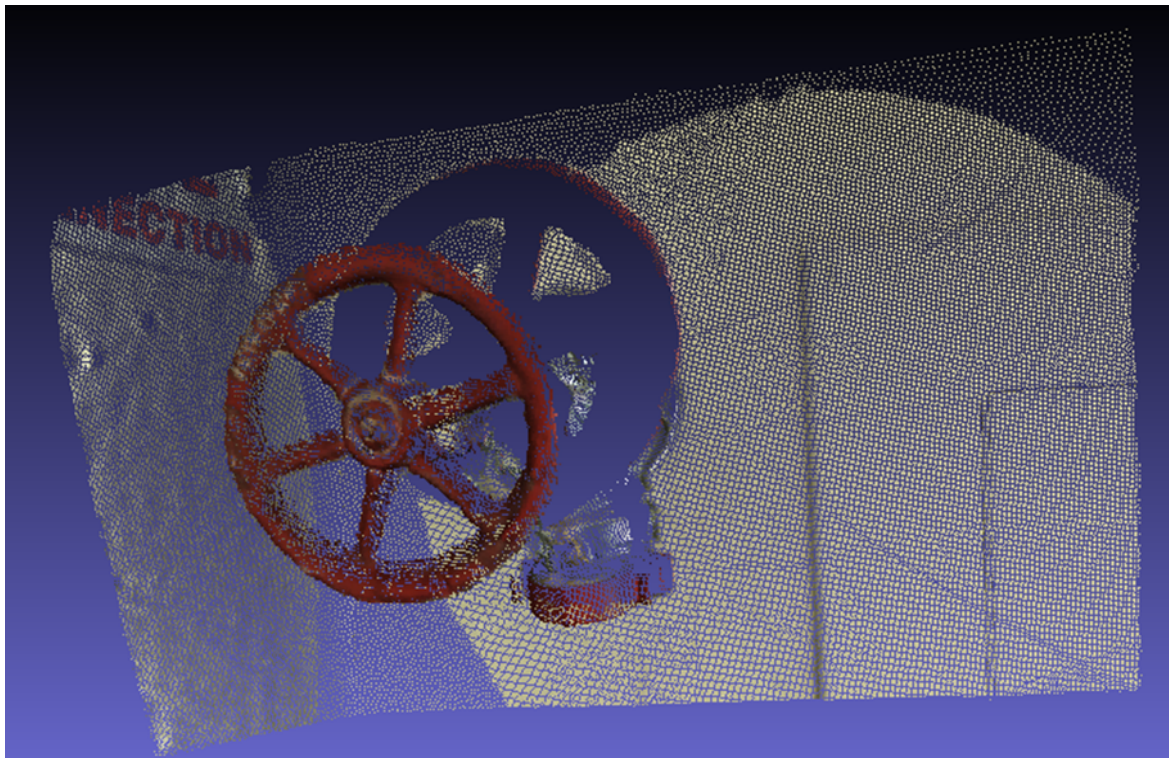
Future of preplanning

3D model

2D floorplan

Object identification



Future of preplanning

3D model

2D floorplan

Object identification

Scene labeling

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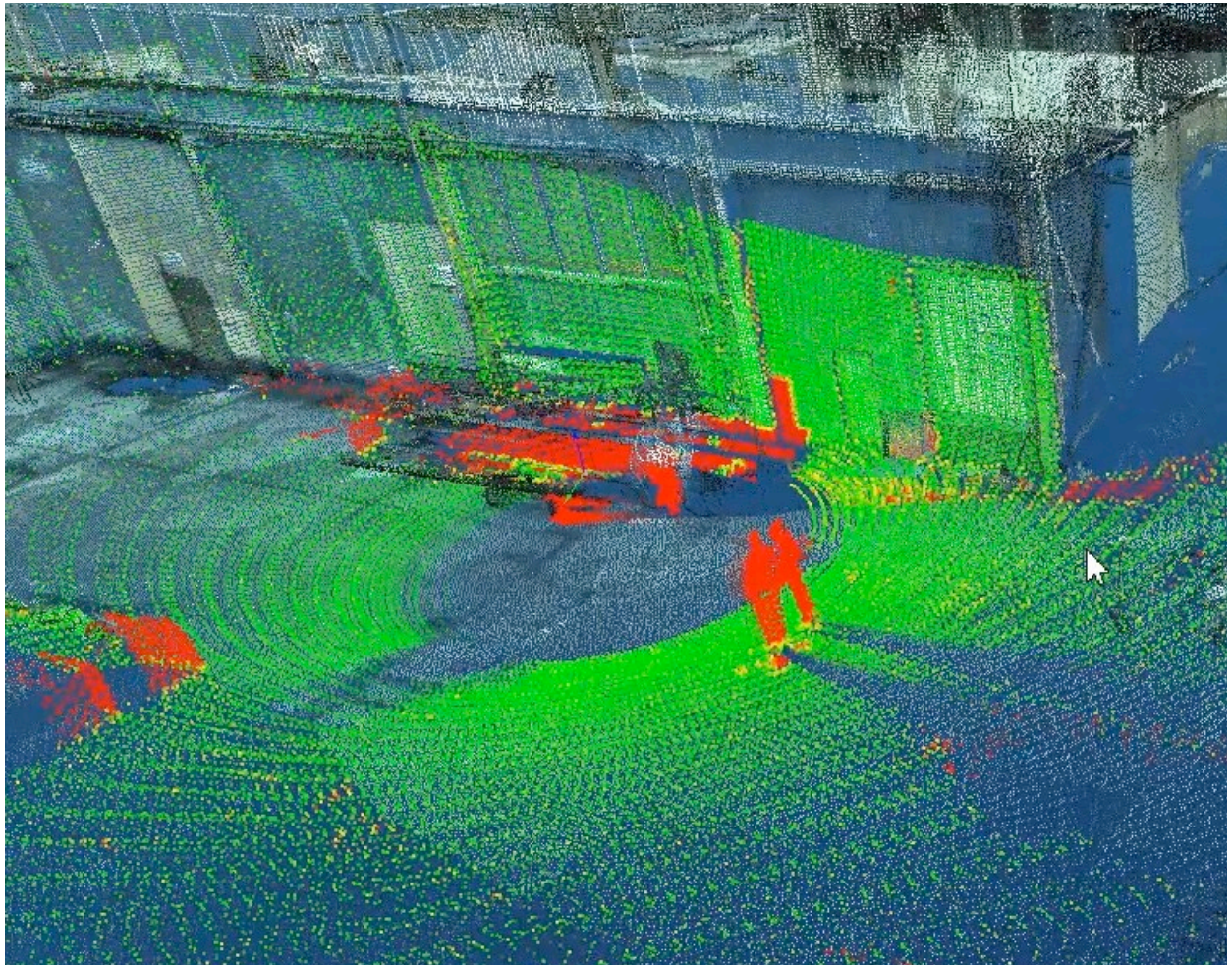
Future of preplanning

3D model
2D floorplan
Object identification
Scene labeling
Change detection



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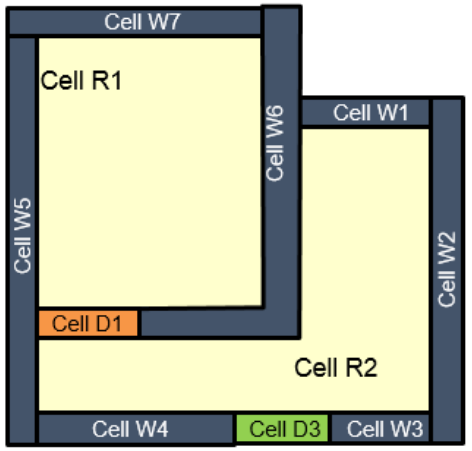
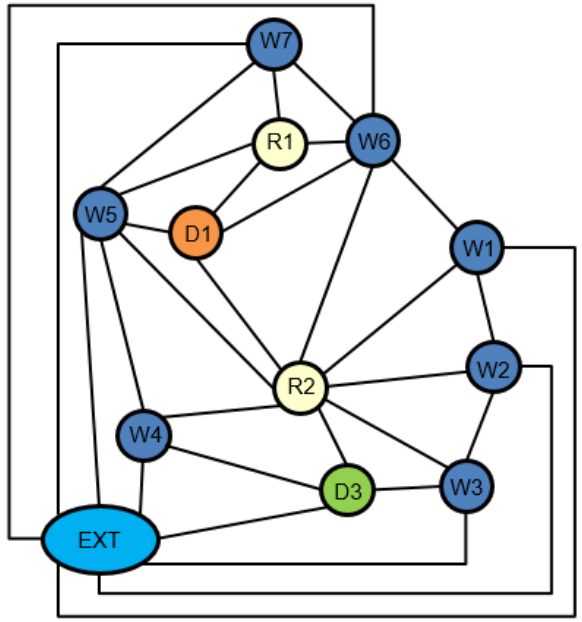
Future of preplanning

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



Ext

Original Space



Adjacency Relationship of Transformed Graph

- Non-Navigable Space (wall)
- Navigable Space (room)
- Connection Space (door)
- Anchor Space (gate)

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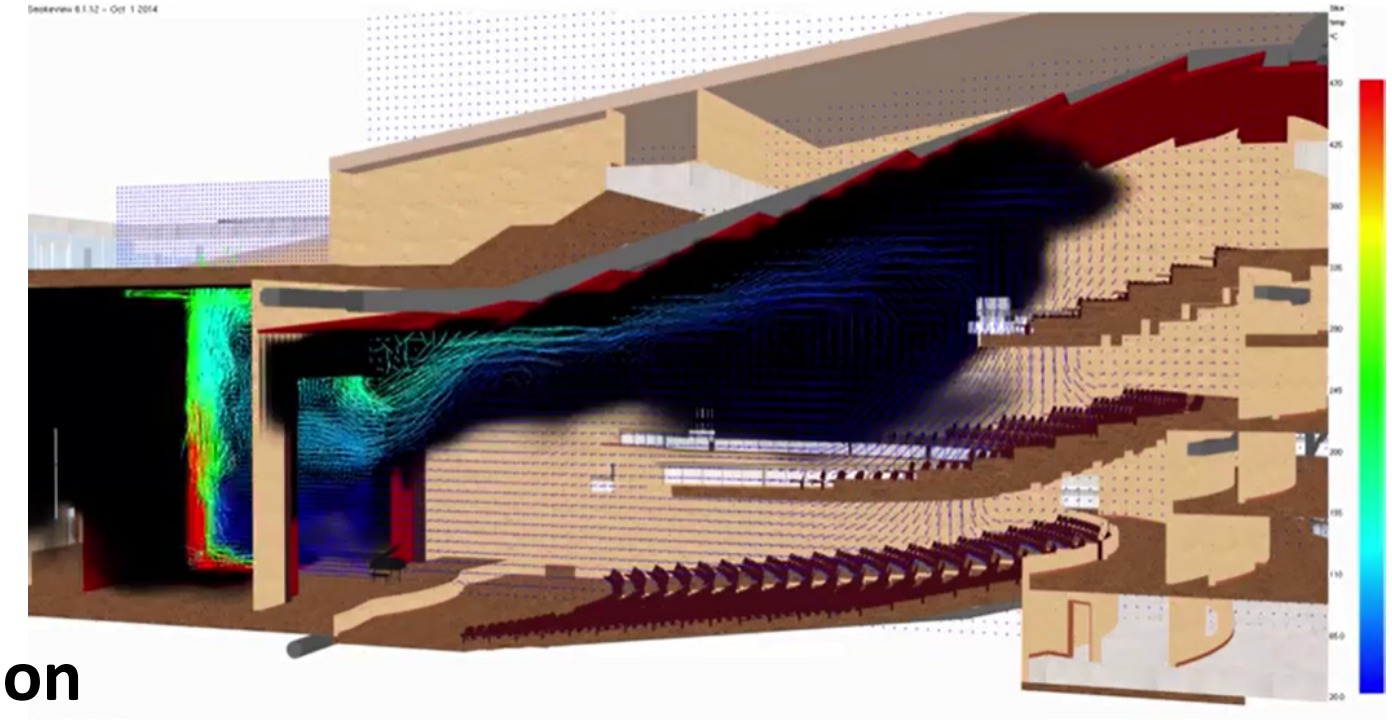
Future of preplanning

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



thunderheadeng.com

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Future of preplanning

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

barco.com

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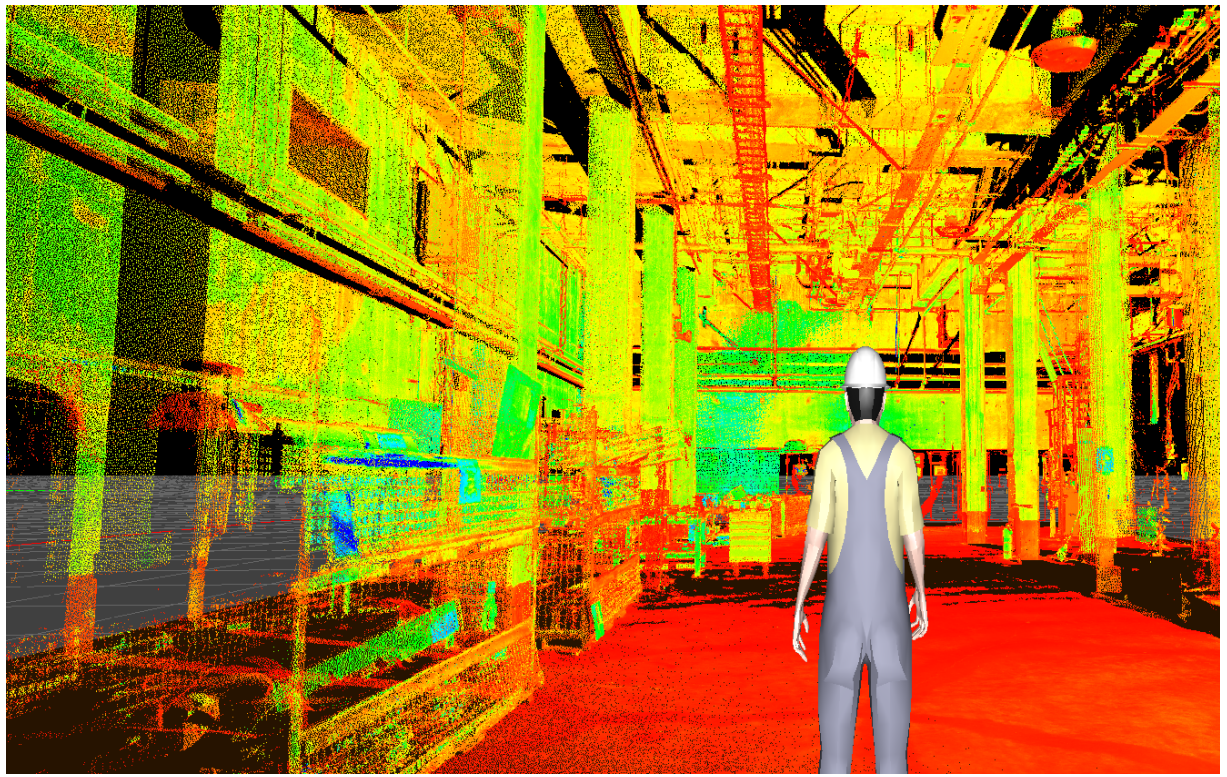
Future of preplanning

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



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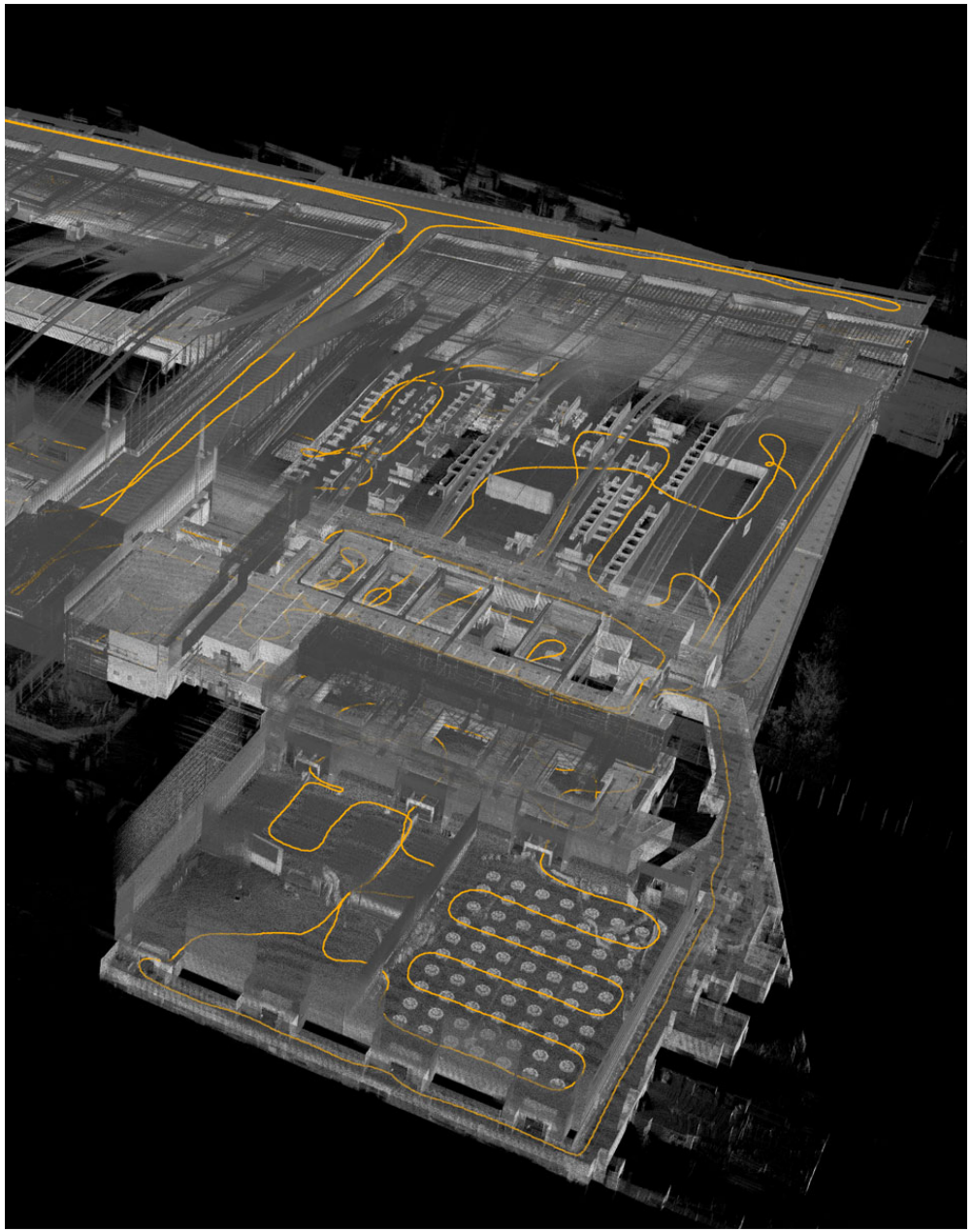
Future of preplanning

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



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Example systems*

Gexcel
Heron

Vexcel
Panther

Leica
Pegasus

Green Valley
LiBackpack

Paracosm
PX-80

Kaarta
Contour

Sanborn
SPIN

Geo-SLAM
Zeb-Revo

NavVis
M6

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.

LBS Portfolio – Current Projects & Timelines

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Point Cloud City

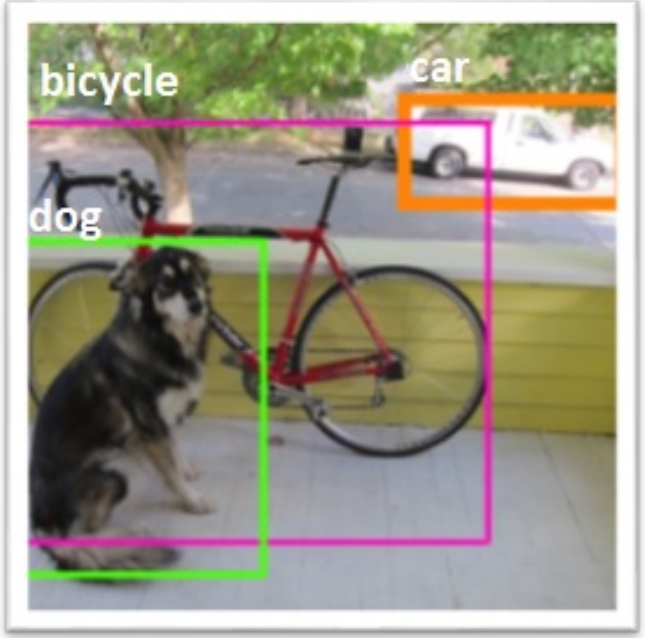
Major gap for R&D

$1 M funding for local governments and PSOs

Publish dataset, annotations

Partnership with NIST Global Cities Team Challenge

1 year, appendable



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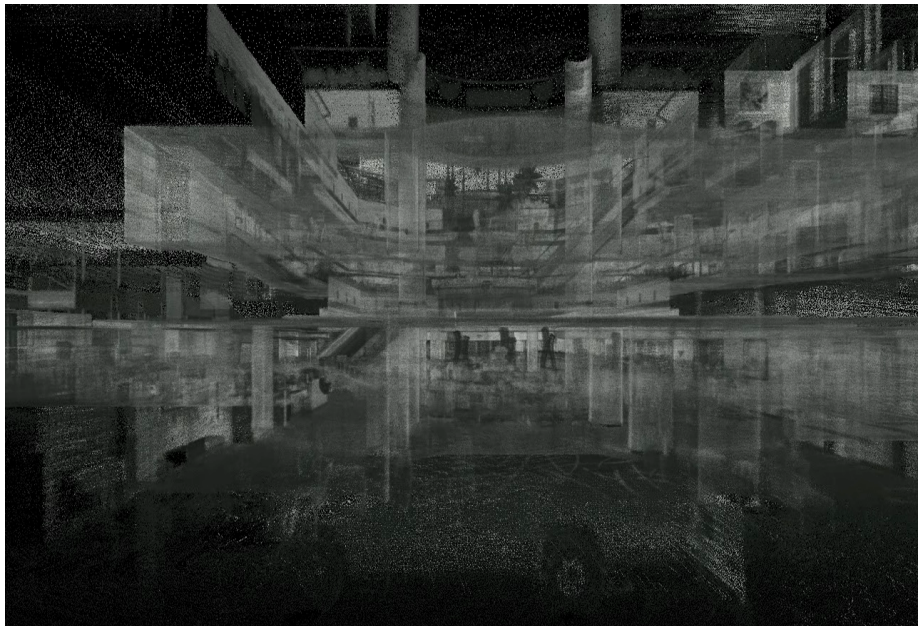
Indoor Map & Nav Pilot

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



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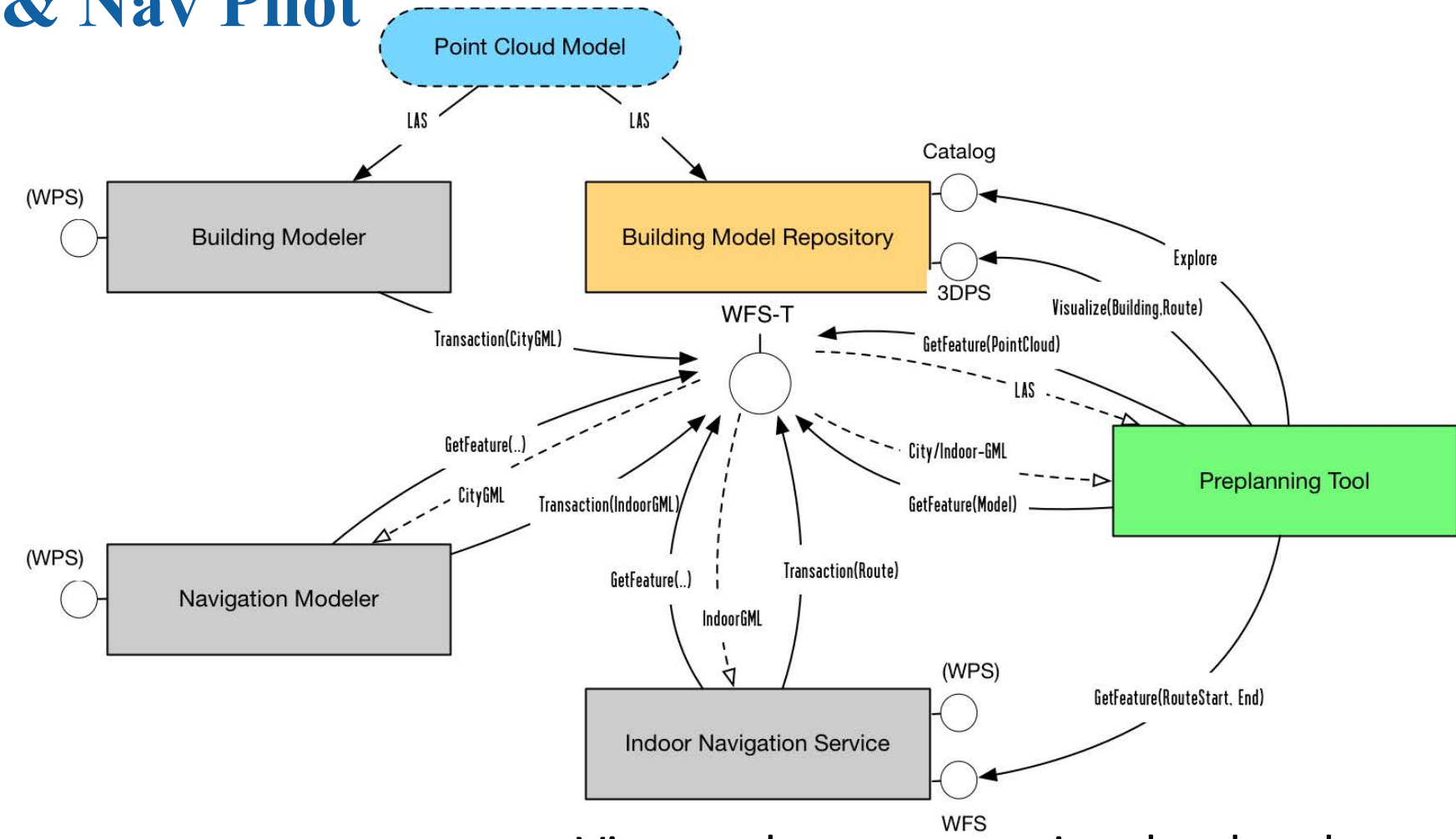
Open Geospatial Consortium

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.

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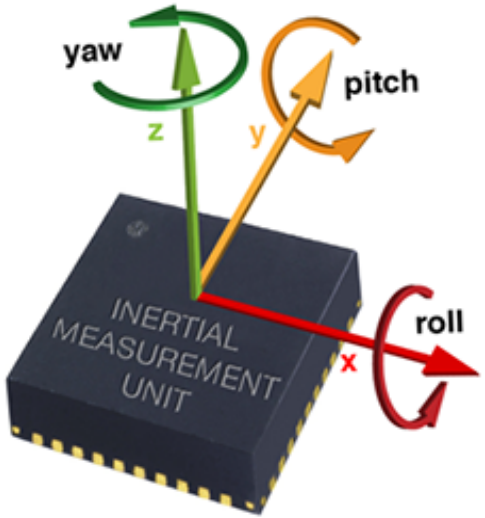
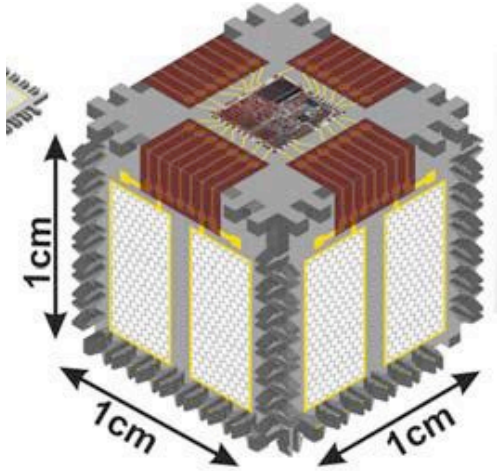
Indoor Localization & Tracking

Anatomy of an Indoor LTS

LTS = localization & tracking system

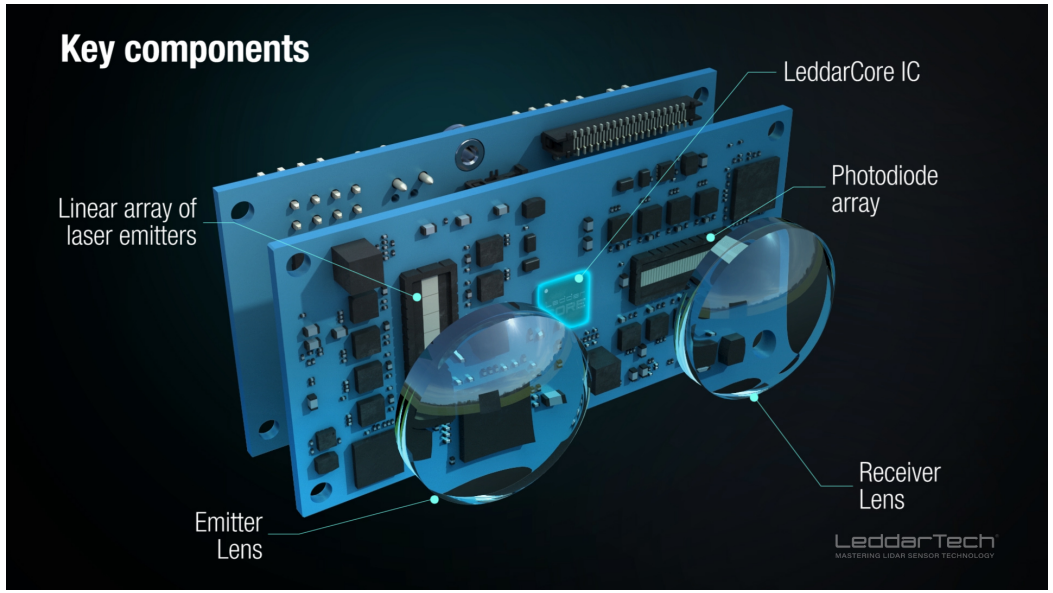
Sensors





+MAGNETOMETER

+BAROMETER

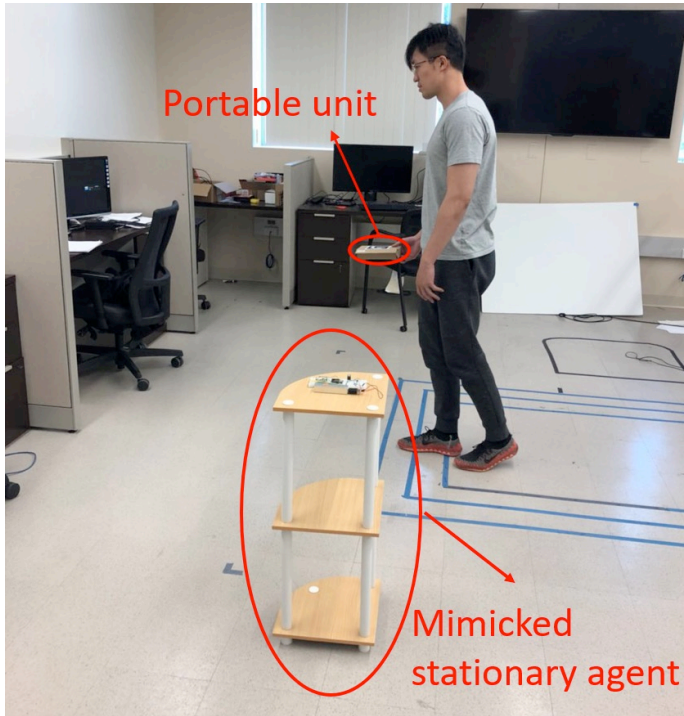


Anatomy of an Indoor LTS

Sensors

Signals: Ranging & Opportunistic

Ranging	Opportunistic
GPS	TV Broadcast
LTE OTDOA	LTE, ProSe
802.11 MC	802.11
UWB	BLE
RF Echo / i-LPS	
Metropolitan Beacon System	
COOPERATIVE	

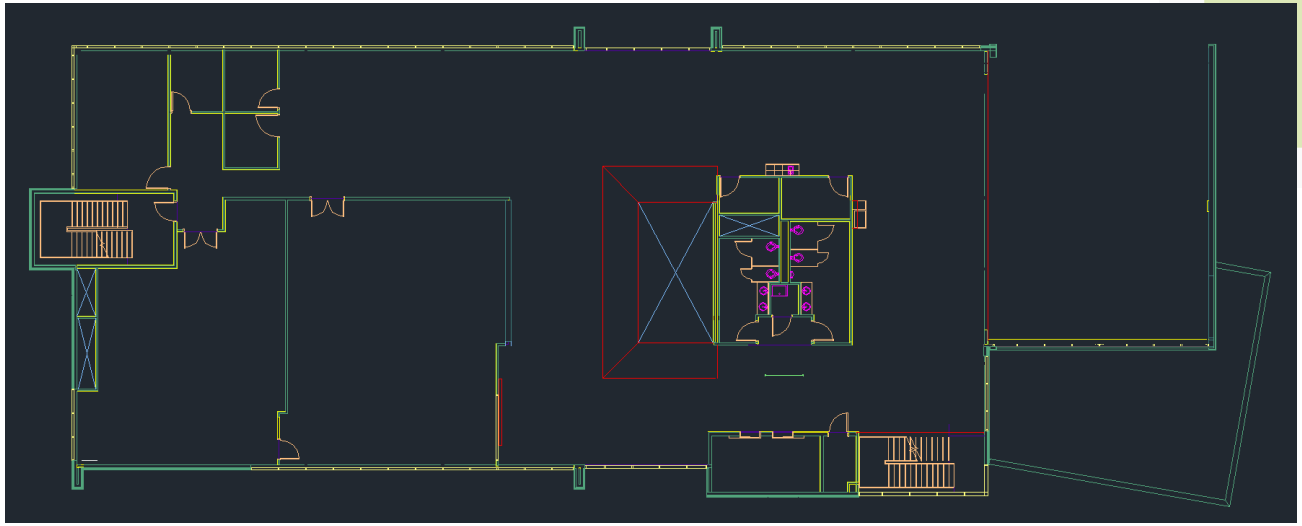


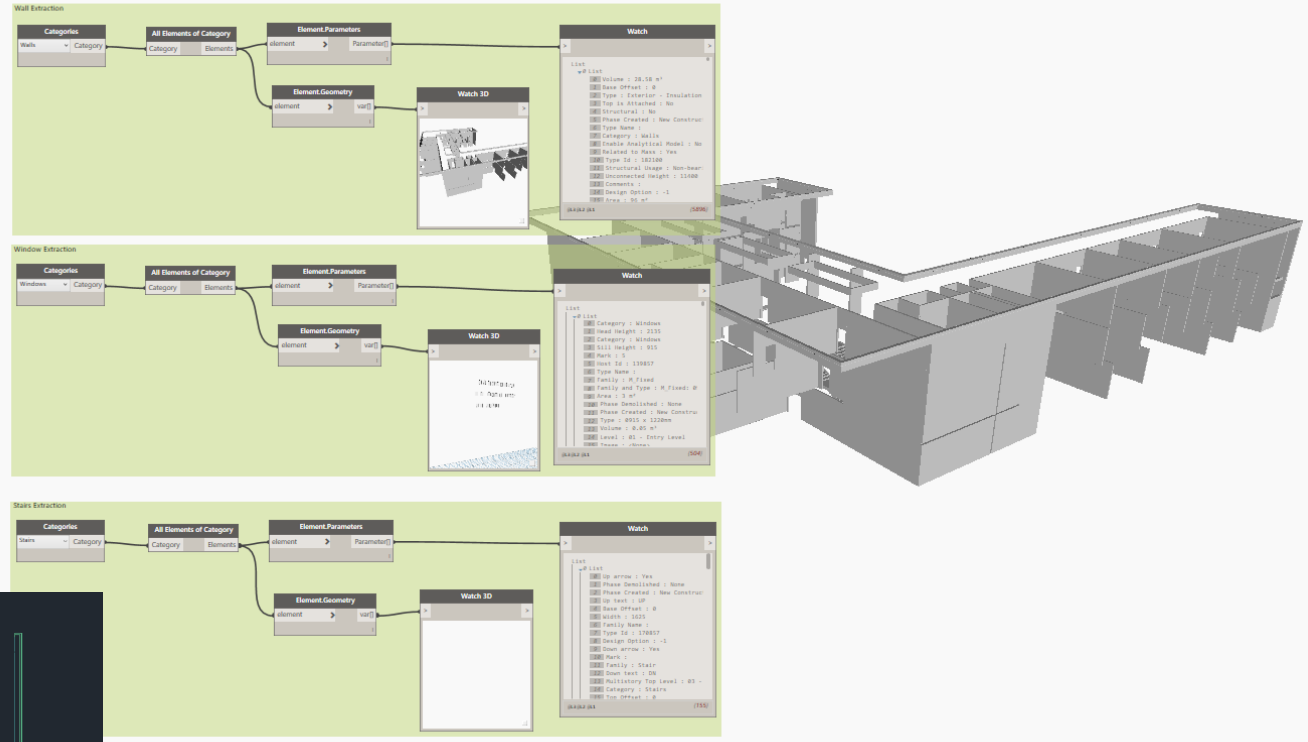
Anatomy of an Indoor LTS

Sensors

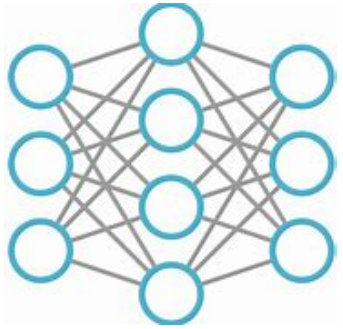
Signals: Ranging & Opportunistic

Reference





Anatomy of an Indoor LTS

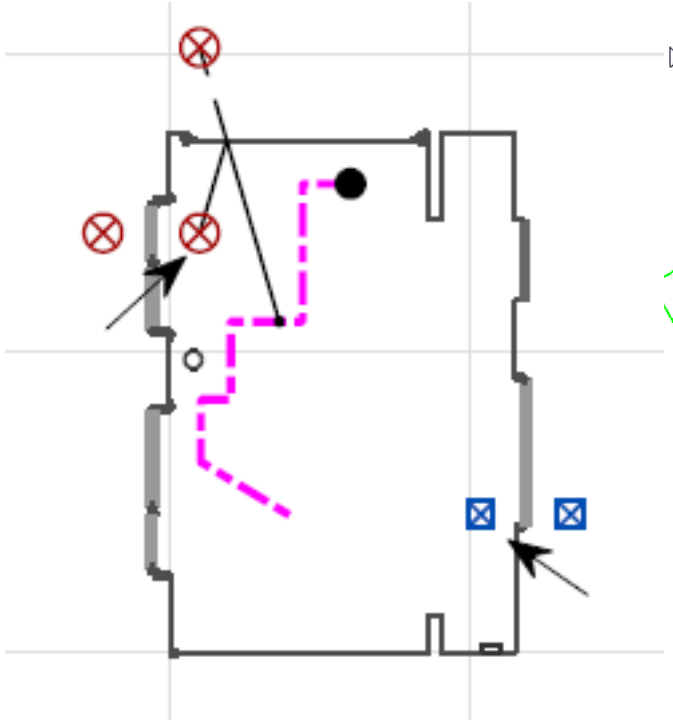


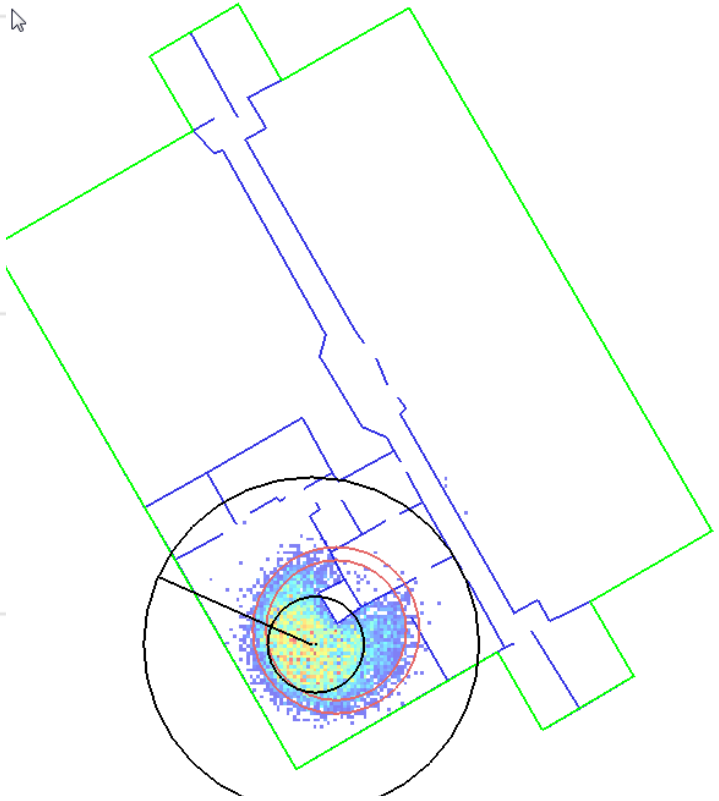
Sensors

Signals: Ranging & Opportunistic

Reference

Fusion & filtering





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

current estimation

measured value

Kalman Gain

previous estimation

Anatomy of an Indoor LTS

Sensors

Signals: Ranging & Opportunistic

Reference

Fusion & filtering

Tracking

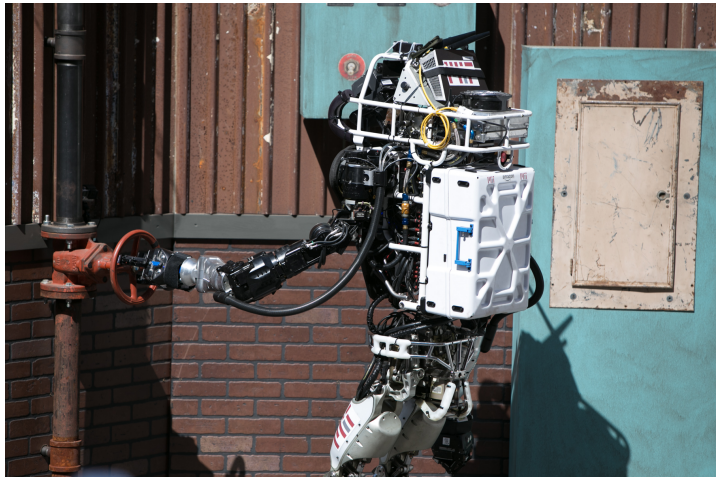
Indoor 3D Challenge & Open Innovation

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

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Indoor 3D Challenge

- Scenarios
- Factors
  - Performance
  - UI/UX
  - Reliability
  - Deployability
  - Interoperability
- Timeline
- Transformation
- Participation

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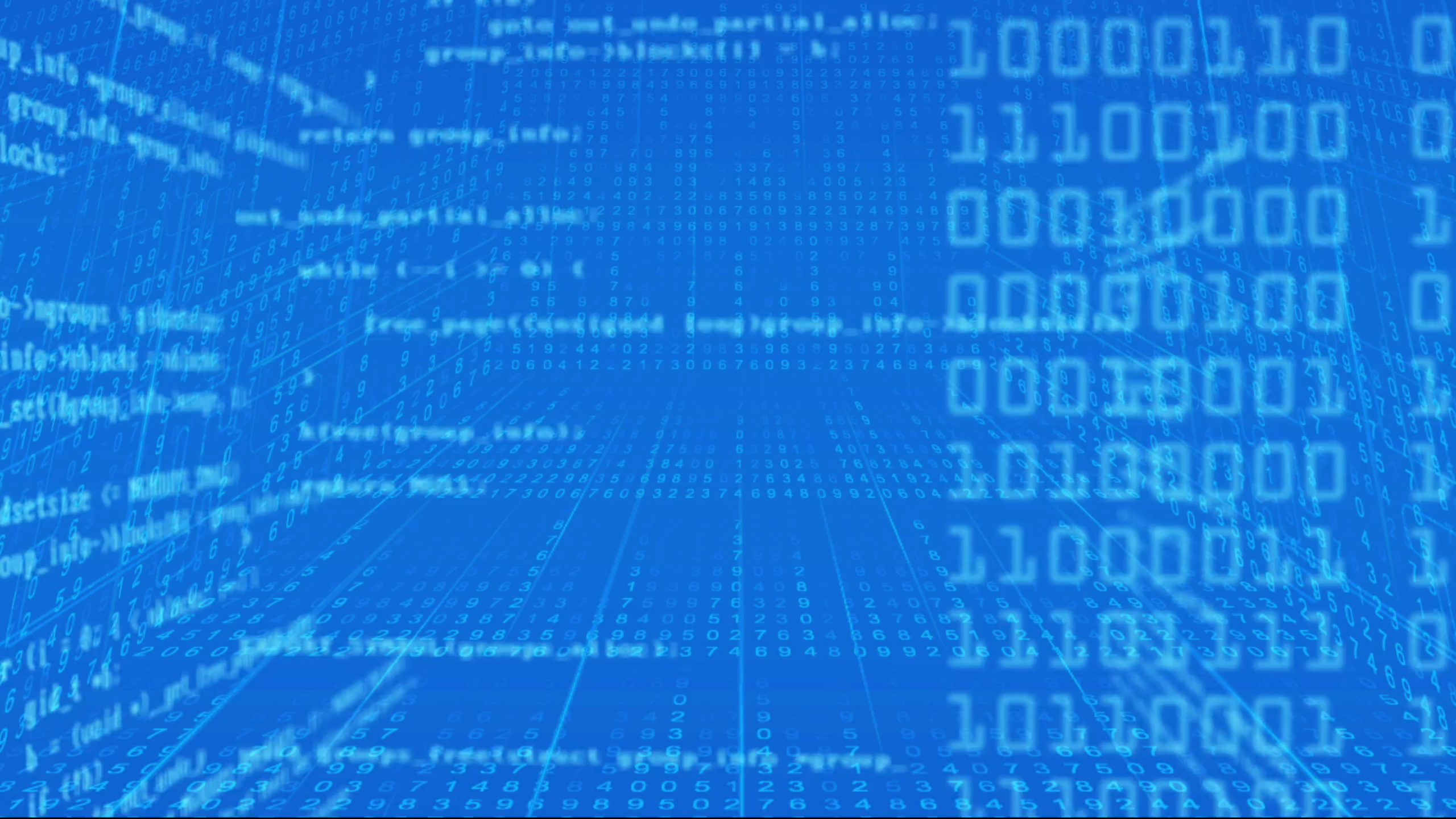


Portable Reference System

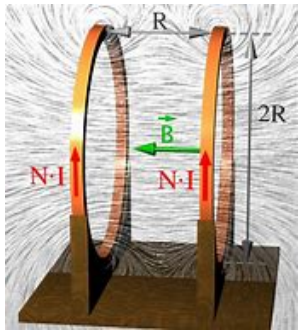
PROBLEM

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



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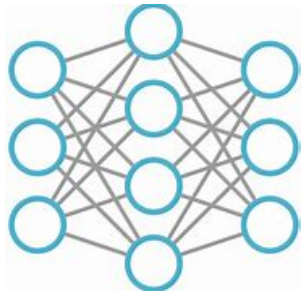
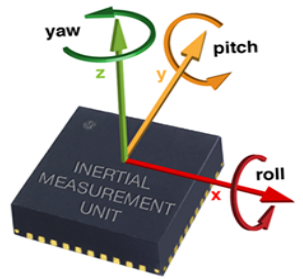
Lower-fidelity
Agile
Inexpensive





+MAGNETOMETER

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LBS Portfolio Overview

i-Axis

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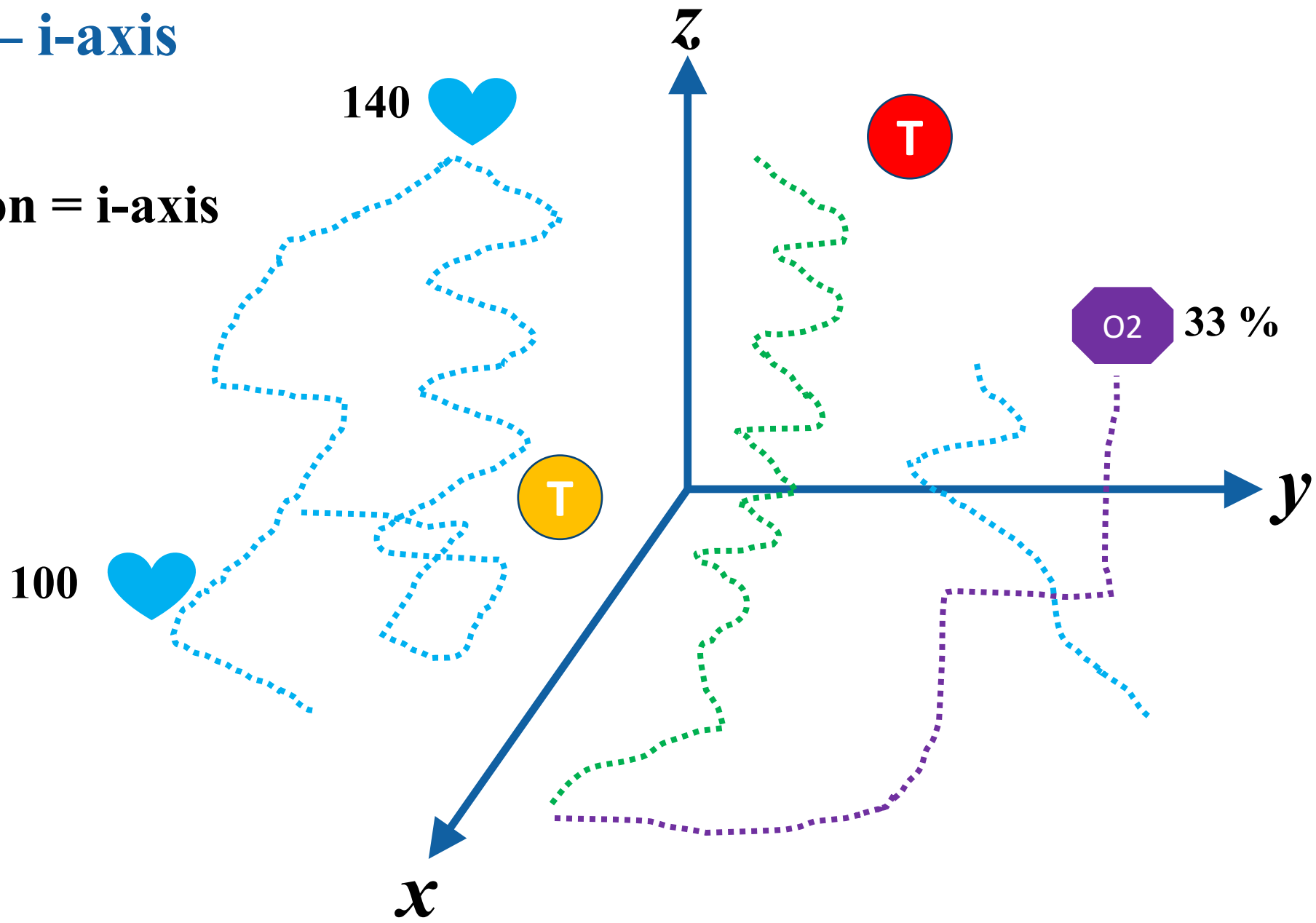
PSIAP – i-axis

Information = i-axis



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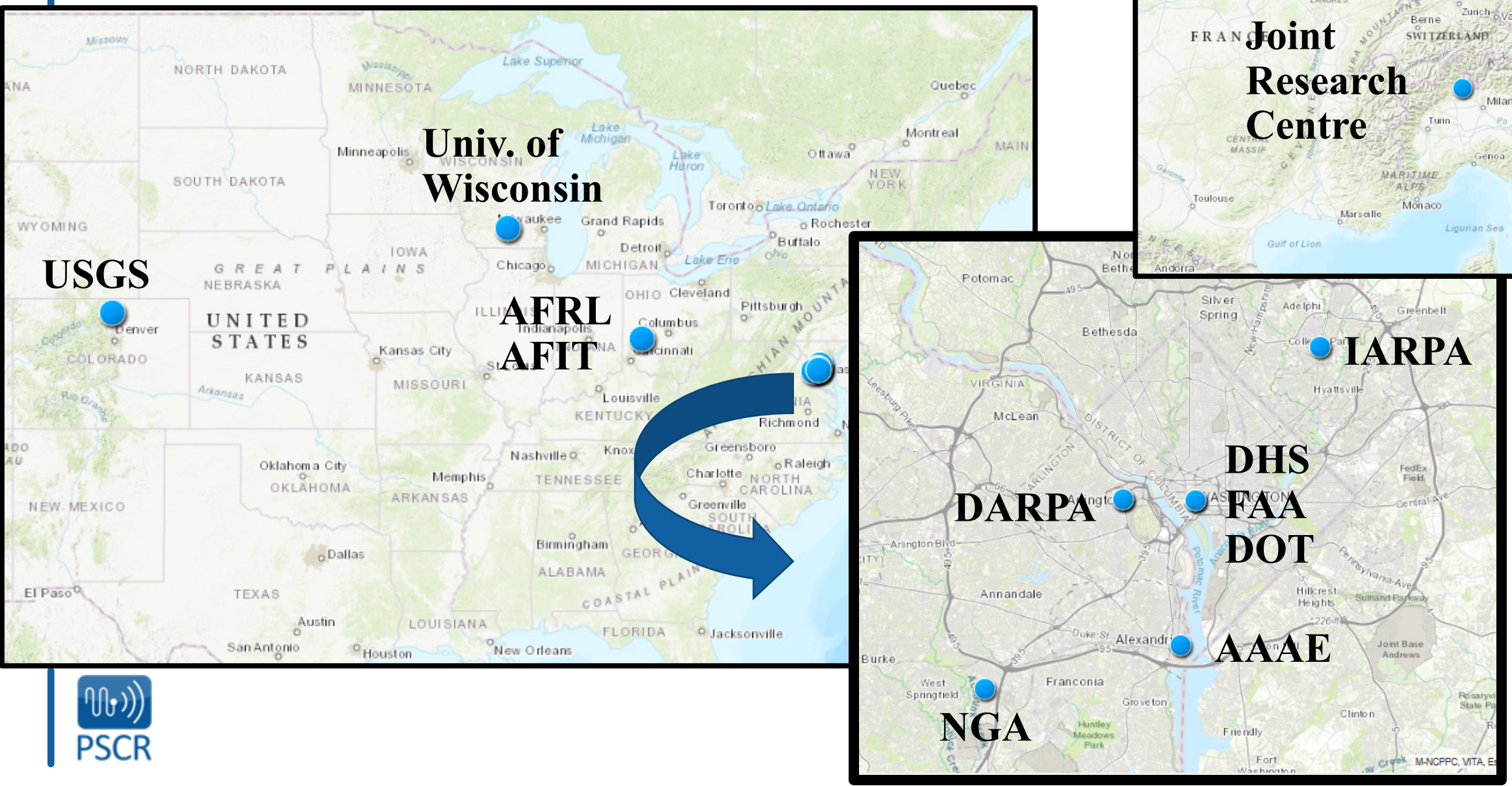
Collaborators & Related Activity



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PS Systems	i-axis				

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LBS Portfolio Track – An Insider's Guide

Time	Day 2	Day 3
0830-0920	MIT	University of Cincinnati
0930-1020	CMU: Rowe	Oxford University
1030-1120	University of California – Irvine	NIST: PerfLoc
1130-1220	University of Michigan	CMU: Cai
1220-1400	LUNCH	LUNCH
1400-1450	NIST: Compressive Sensing	
1500-1550	TRX Systems	

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LBS Portfolio Track – Multi-sensor Fusion

Time	Day 2	Day 3
0830-0920		
0930-1020	CMU: Rowe	Oxford University
1030-1120	University of California – Irvine	NIST: PerfLoc
1130-1220		
1220-1400		
1400-1450		
1500-1550	TRX Systems	

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LBS Portfolio Track – Sensors

Time	Day 2	Day 3
0830-0920	MIT	University of Cincinnati
0930-1020		
1030-1120		
1130-1220	University of Michigan	
1220-1400		
1400-1450	NIST: Compressive Sensing	
1500-1550		

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LBS Portfolio Track – UI/UX

Time	Day 2	Day 3
0830-0920		
0930-1020		
1030-1120		
1130-1220		CMU: Cai
1220-1400		
1400-1450		
1500-1550		

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THANK YOU
COLORADO
SPRINGS
5