TRX First Responder Location and Mapping Services

Public Safety Innovation Accelerator Program

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LOCATE. MAP. TRACK. INDOORS.

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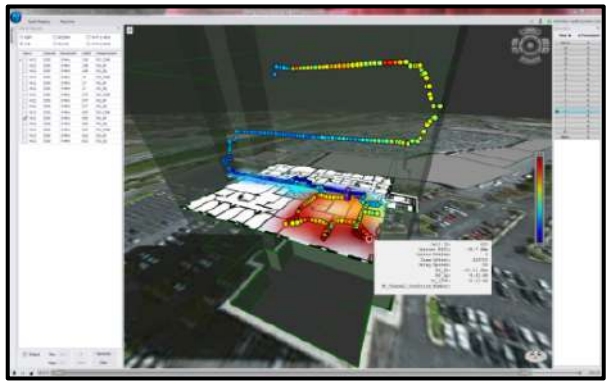
TRX Systems: 3D Mapping and Tracking

Ubiquitous Personnel Location and 3D Mapping:
Inside buildings, underground, in dense urban and GPS-denied areas

Events and Public Buildings

Critical Incident Response

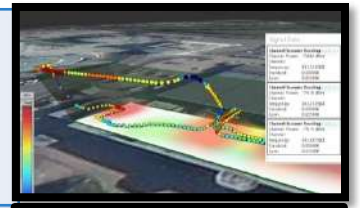
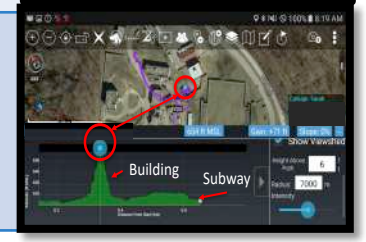


Network Coverage Validation

Urban and SubT Warfighter Tracking

Industrial – Defense – Public Safety
Improves Safety, Command Awareness, and Operational Effectiveness

NEON Use Cases, Exercises, Deployments

Signal Mapping, State, Local, Federal	• Mapping/geolocation of LMR, LTE and other signals with Anritsu, Viavi, Keysight, Tektronix, and standard mobile devices • Signal and sensor mapping for defense/federal depts	
SuperBowl LI, Large Event Venues	• Law enforcement, EMTs, Federal Security Personnel • NEON App (Superbowl) and ATAK App (LA Conv Ctr) • Situational awareness and safety; reduced radio traffic	
Immigration and Customs	• 24x7 situational awareness at large border checkpoint • 7 floors, indoor and outdoor 3D coverage (~1M sqft) • Integrated with Operations and Command Center	
DHS Active Violence and Disaster OpEx	• Active violence OpEx at Grand Central Terminal exercise (NYPD, FDNY, others); Harris County Opex • Disaster OpExs at Harris County, Birmingham, and GMU	
Radiation Mapping (DARPA)	• Tracking of law enforcement within transport hubs • Mapping radiation from low-cost, body worn detectors to support dirty bomb detection	
Warfighter Urban and SubT	• Situational awareness within urban, SubT environments • UWB Technology enables shared location using check-ins dropped beacons; user to user location collaboration	

Arlington County Fire Department

Arlington County, VA

- Northern Virginia, near DC
- ~250,000 residents
- 26 sq miles
- Home of the U.S. Pentagon

Battalion Chief Matt Herbert

Identified GPS-denied tracking as critical issue more than 5 years ago

- Many tall buildings creating urban canyons
- GPS-denied or impaired in many areas
- Chief Herbert providing technology leadership
- Station 5 supported feedback and testing

Station 5

The Need for GPS-Denied Tracking…

- Arlington County FD runs ~30,000 calls every year. Station 5 runs ~7000 calls per year.
- CAD provides tracking of vehicles (with some error in urban canyons) but not personnel

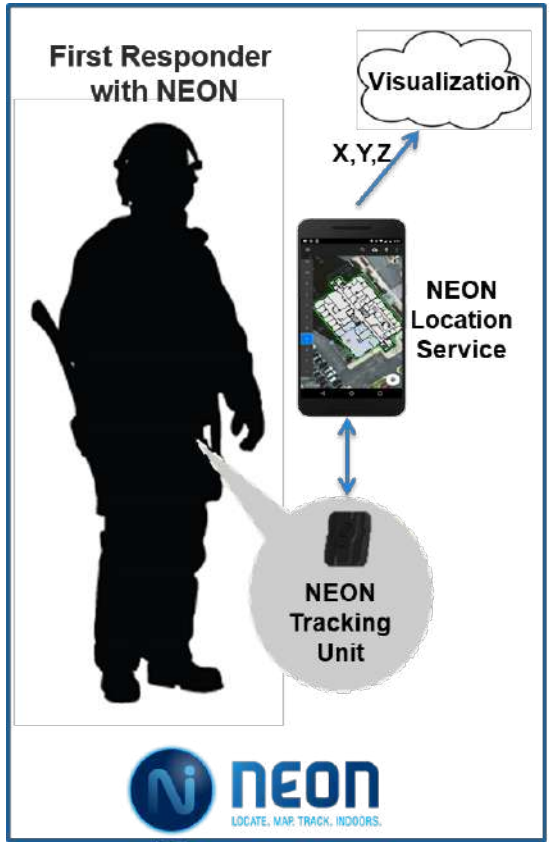
- The Location Technology Need:
  - Ubiquitous, seamless and reliable indoor and outdoor tracking of personnel both in and out of vehicles
  - Lightweight, rugged, integrated in/with something they already use or carry (radio, SCBA…phone?)
  - Limited or no interaction needed from firefighters
  - Little or no setup when arriving on-scene
  - Simple visualization that shows seamless team locations on-scene

Objective: Mission Critical Location and Mapping

Requirements

X/Y	Quadrant of building (~5-10m or better)
Z-Axis	Accurate floor level/relative location and 3D path
Device	Mission critical devices – radios, cellular, hubs
Coverage	100%. Urban, suburban, rural. Everywhere.
Environment	Extreme. Heat, fire, explosions, wind/storms…

Solution



100% Solution, Including in Difficult to Cover Basements, High Floors, Dense Buildings, Residential Buildings

7

NEON Personnel Tracker – Indoor & Outdoor Location

GPS-Denied Mapping and Tracking

- Improves operational efficiency, command effectiveness, and safety
- Real-time, 3D location calculated at every step
- Sensor fusion, map and ranging technologies
- Android smart phone paired with NEON Tracking Unit
- API delivers lat/long, altitude, floor level, building data

TRX PSIAP Program Goals

- Deliver robust, higher accuracy 3D location for first responders
  - Use wider array of location inputs and constraints
- Make available comprehensive map data sources and tools
  - Expand use of known and inferred building information
- Deliver easy to use 3D visualization
  - Enhance map databases to make them easy to modify, validate, synchronize

Program Contributors

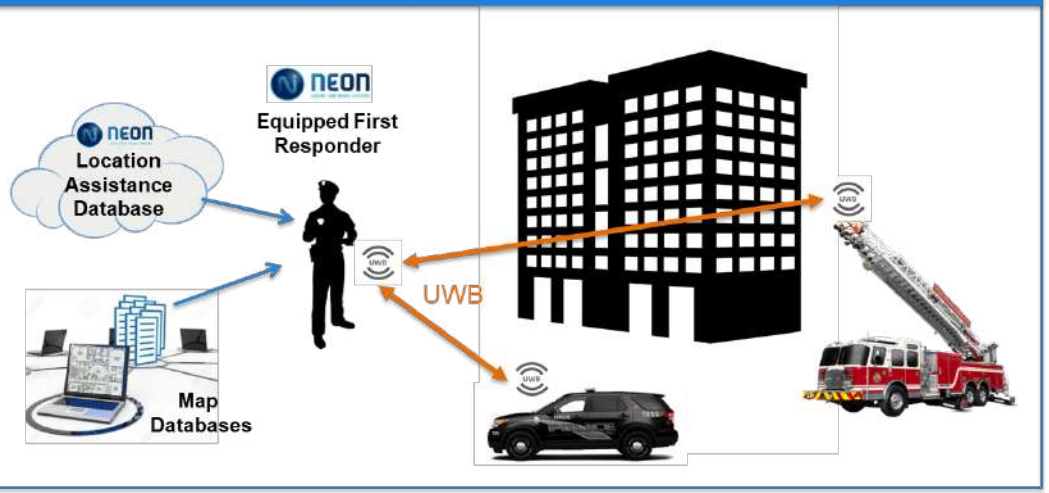
TRX Systems
Greenbelt, MD

Plain Township
New Albany, OH
Fire Department

Arlington County
Fire Department, VA

Harris County, TX
Public Safety
Technology
Services

Solution Architecture



Targeted Use Cases: Tactical Law Enforcement & Fire Personnel

NEON Fusion Solution Delivers Mission Critical Layer

Fusion of GPS, RF, Device-based Location, Inertial & Pressure Sensors, Map Data, and UWB

Initialization	Key parameters include start position, heading, user mounting location and gait; learned from GPS, beacons or manual input
Satellite and Terrain Data	Reference for placing user in global frame with latitude, longitude and altitude above sea-level; allows for 3D visualization
Sensor Fusion	Inertial sensors (gyro, accel, magnetometer, and pressure) plus other Android based sensors used to calculate movement in local frame
Building Data	Shape files give 3D construct for “floor level” tracking; structural features (stairs, entrances, elevators, ramps) provide constraints for matching
RF Signals	RF (cellular, Wi-Fi, BT) data can be learned/mapped such that it can be matched to when use case allows.
Beacons	Optional UWB or BLE beacons; Tactical use cases benefit from ad-hoc UWB “Drop” Beacons for team initialization and location updates.

TRX PSIAP Program Activity

Program Goals
1. Deliver robust, higher accuracy 3D location for first responders
2. Make available comprehensive map data sources and tools
3. Deliver easy to use 3D visualization
4. Test and validate with first responders

Year 2 Program Activity
1. Expand UWB technology usability for first responders
2. Continue development of mapping tools
3. Incorporate feedback from to enhance ease-of-use of mapping/visualization tools
4. Build on baseline user testing to demonstrate full-scale tracking performance

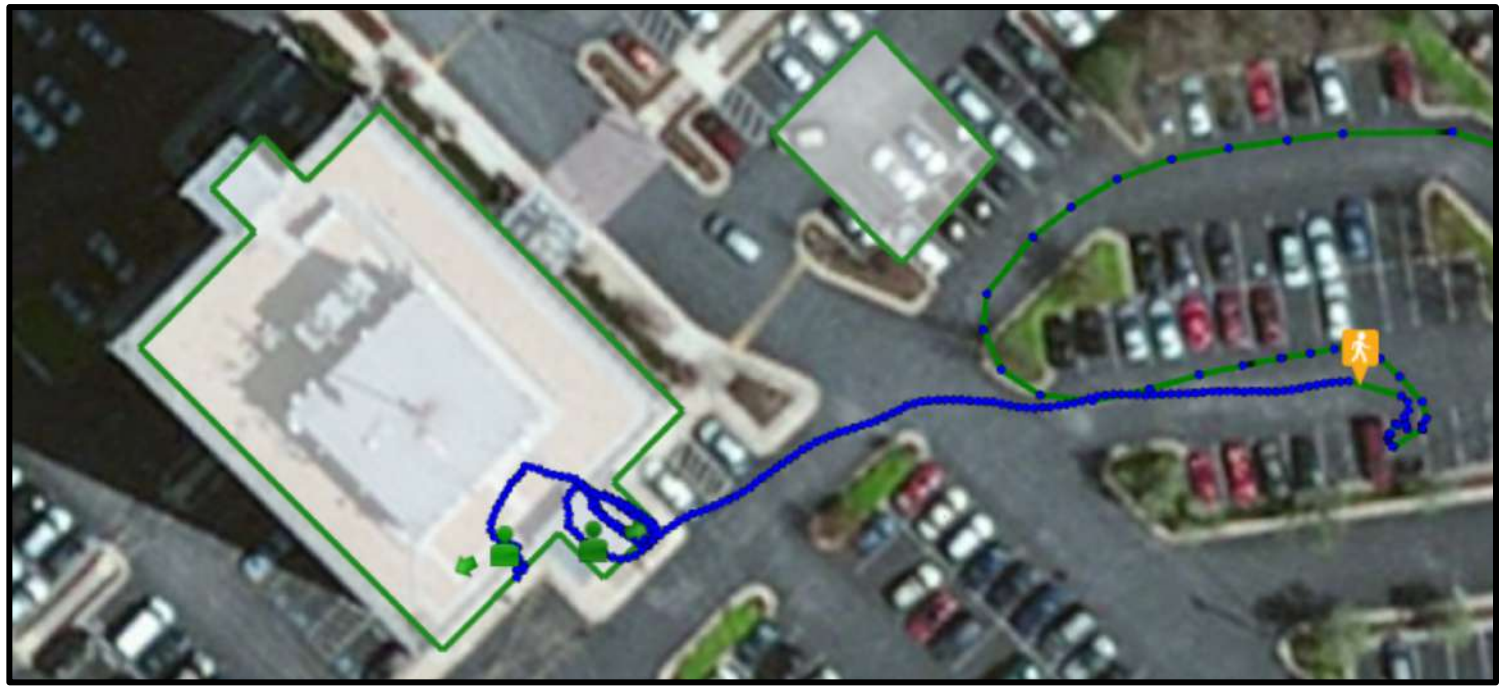
Enhancing Vehicle Based Tracking Capabilities

Goal #1: Deliver higher accuracy location

- First Responders typically ride in vehicles to incidents - maintaining initialization and tracking while riding in a vehicle improves overall accuracy for this use case

- Development Focus:
  a. Vehicle “mode” detection
  b. Maintaining initialization parameters when in vehicle mode
  c. Utilized new GPS-UWB config for beacon in vehicle to provide location while driving

Enhancing Vehicle Based Tracking Capabilities



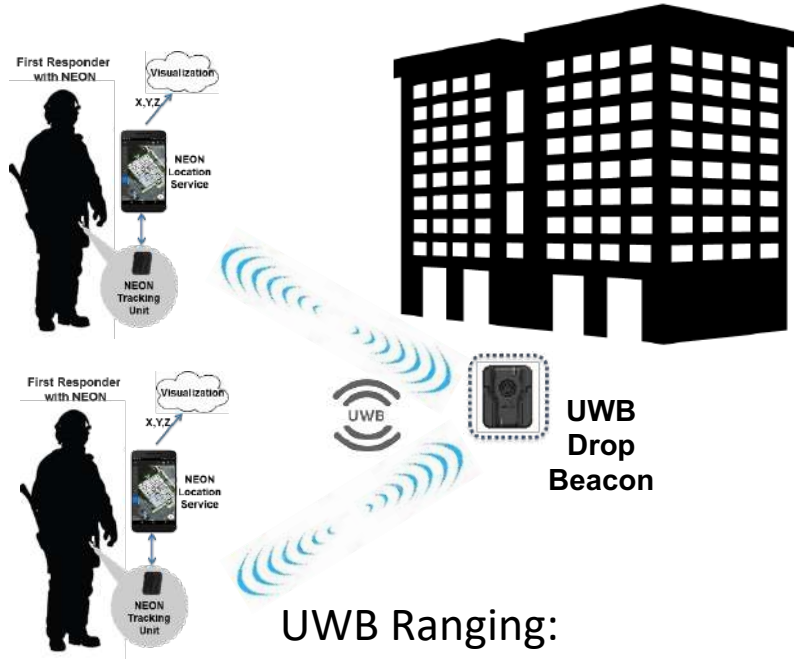
- Mode Transitions - Updates have been made to more accurately detect transitions to vehicle mode
- NEON maintains the users heading lock during vehicle transit enabling the user to more accurately track as they exit the vehicle near a building (where GPS is often unreliable)

Expanding Usability of UWB for First Responders

Goal #1: Deliver higher accuracy location

- Good initialization creating an accurate starting position and heading is important to achieving highest infrastructure-free accuracy
- GPS is a source of initialization but phones held in a pocket provide poor GPS accuracy
- UWB provides highly accurate range data and is an excellent technology for initialization when available
- TRX applied/tested UWB technology in the form of ad-hoc drop beacons that provide a highly accurate initialization constraint

UWB Drop Beacon - Provides initialization and ad-hoc accuracy enhancement; beacon "dropped" by "navigator" provides input for all other team members.

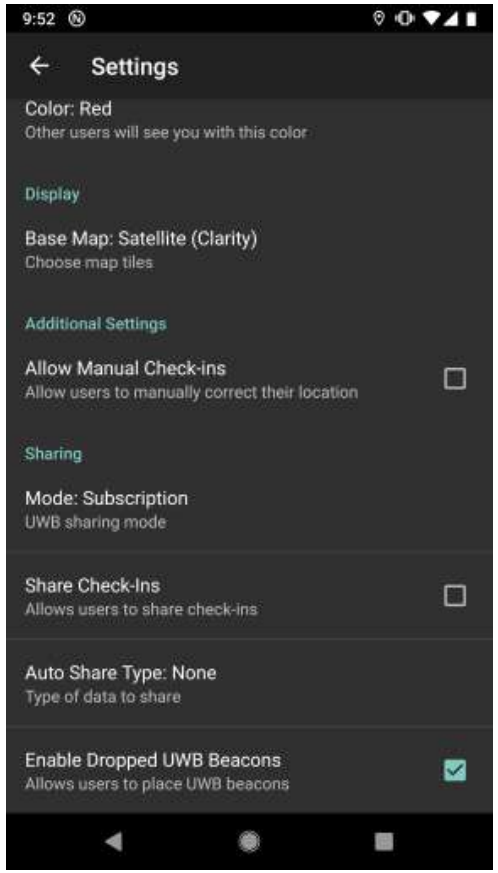


UWB Ranging:

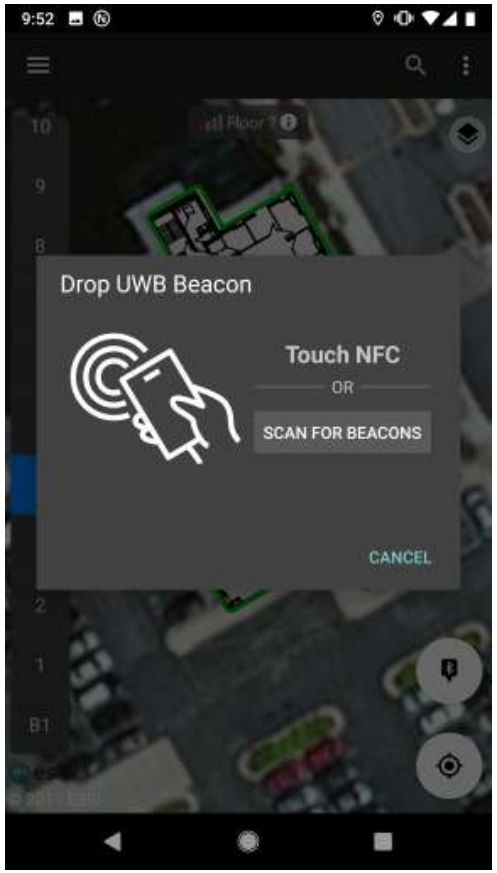
- EIRP: -41.3 dBm/MHz
- <.5m error @ ~30m

NEON UWB Drop Beacons

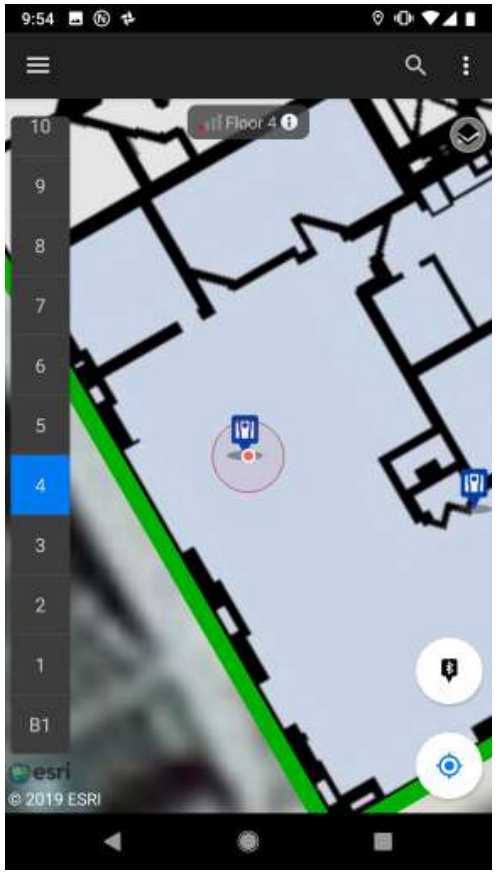
Enabling UWB Drop Beacons for “team lead” or “navigator”



“Drop” UWB Beacon with NFC (Touch the UWB beacon to the phone’s NFC.)



Beacon will auto enable and begin advertising to all users in subscription.



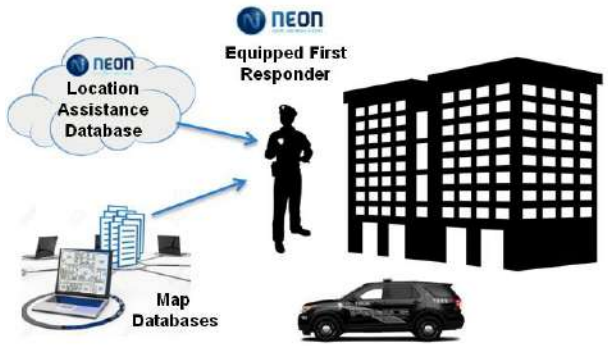
UWB technology designed for public safety incidents

- Multiple design iterations for ease-of-use
- Robust to movement, discontinues ranging if moved
- Doesn’t require Cloud connection
- Ranges within subscription only

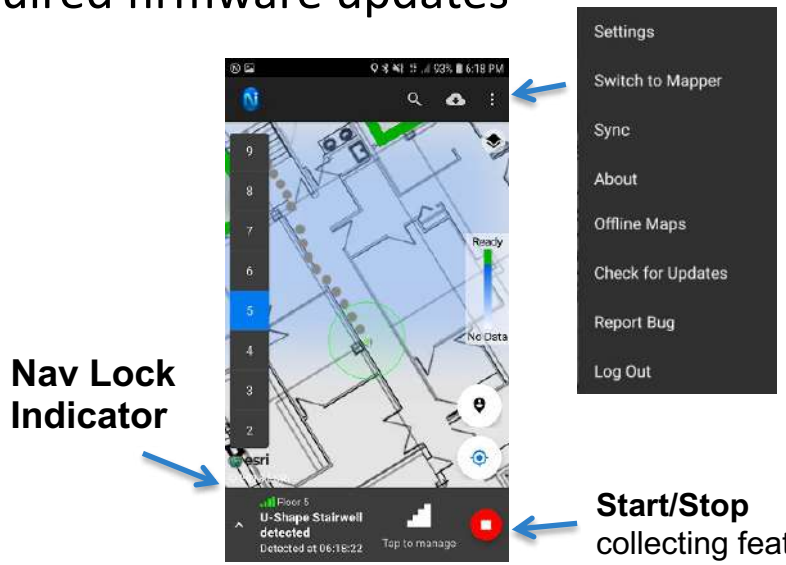
Mapping and Tools Enhancements

Goal #2: Make available map data and tools

- Map data provides valuable constraints that can improve location solution; also improves situational awareness
- Access to map data is limited so map data must be easy to import, generate and share
- "NEON Mapper" is a mobile app that allows for easy-to-use mapping of buildings and underground spaces from the handheld device



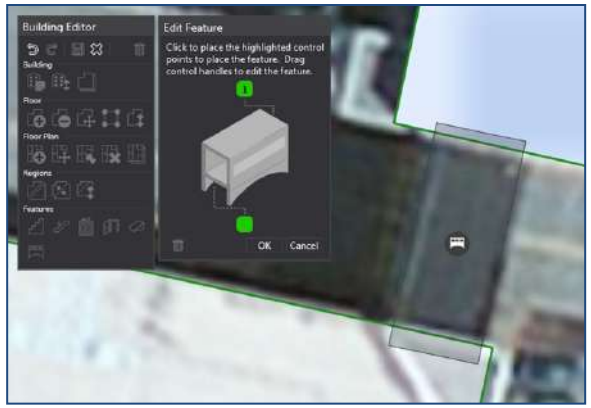
- Easier to Use – identified and eliminated common user errors
- Hierarchical Access – integrated Mapper function within Personnel Tracker as an "admin" capability
- Nav Lock Indicator – improved user experience while tracking
- Beacon Update Tool – IDs and enables required firmware updates

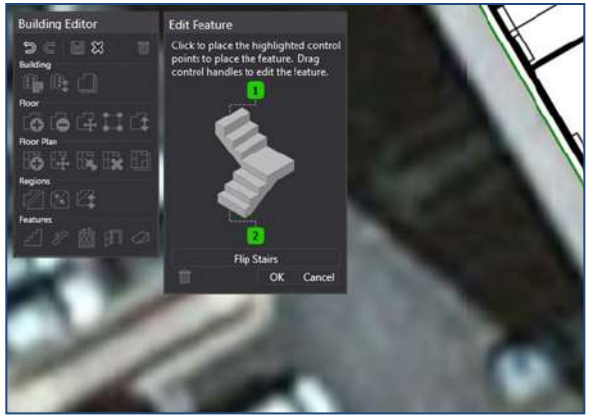


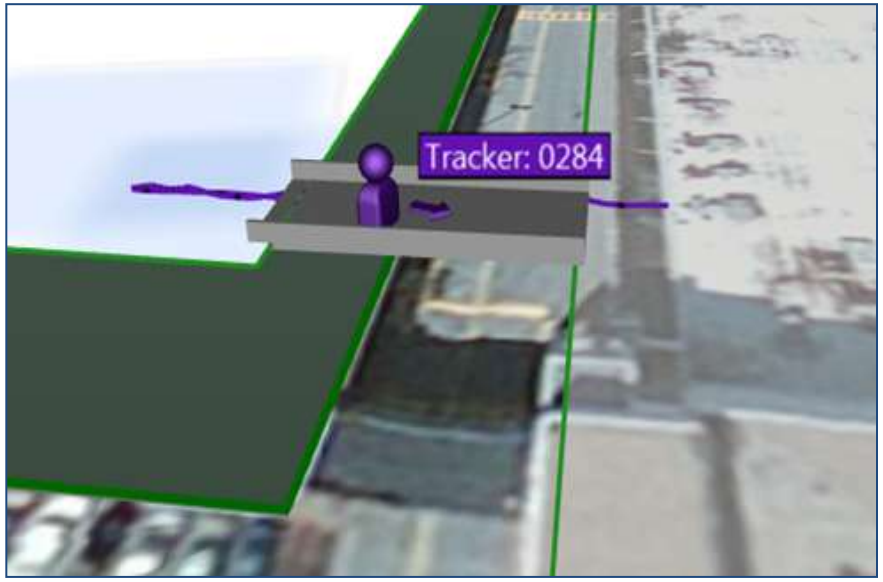
Creating Map Data - Command Building Editor

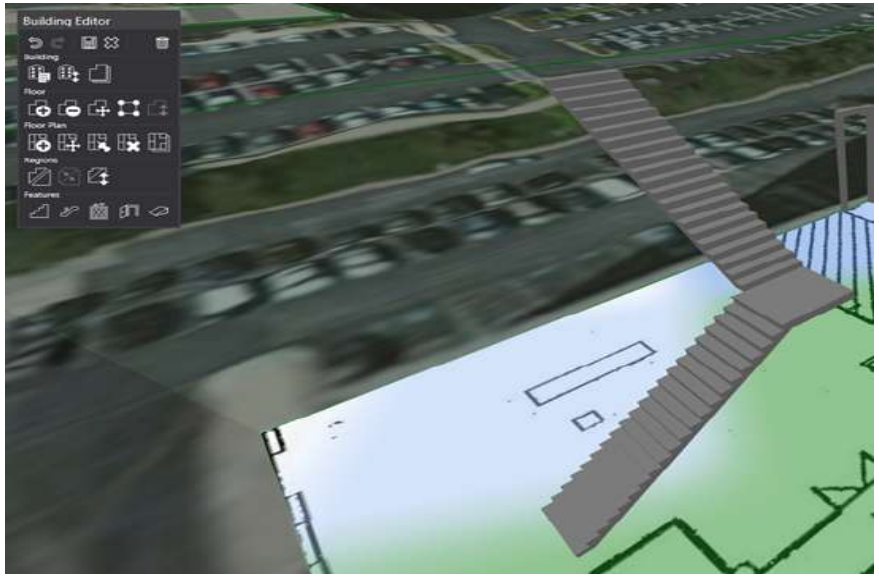
Goal #3: Deliver easy to use 3D mapping and visualization

- Preplanning of structural features provides improved tracking accuracy
- Added skybridges and other types of structures including ramps, raised regions, escalators, and multiple stair types

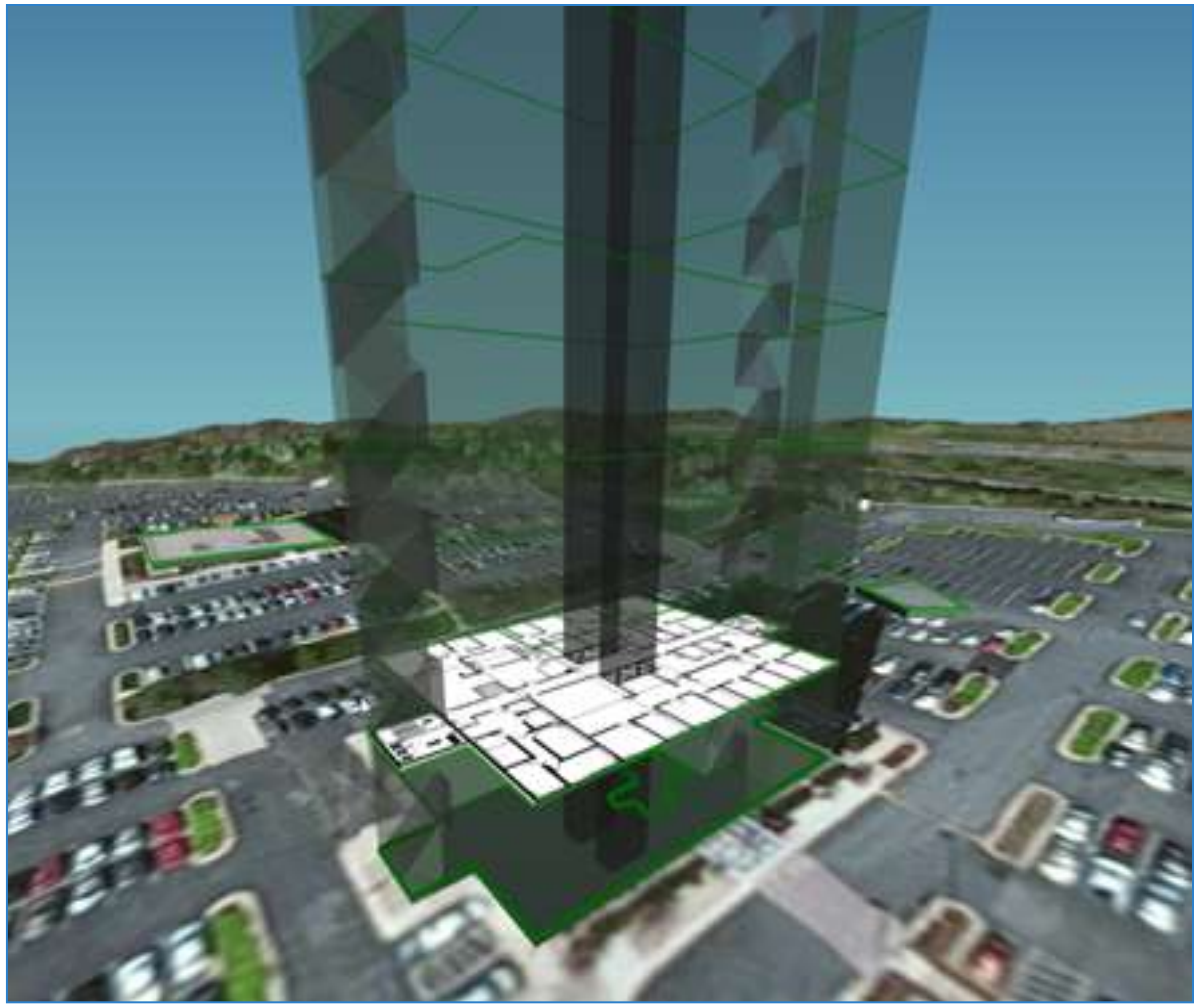




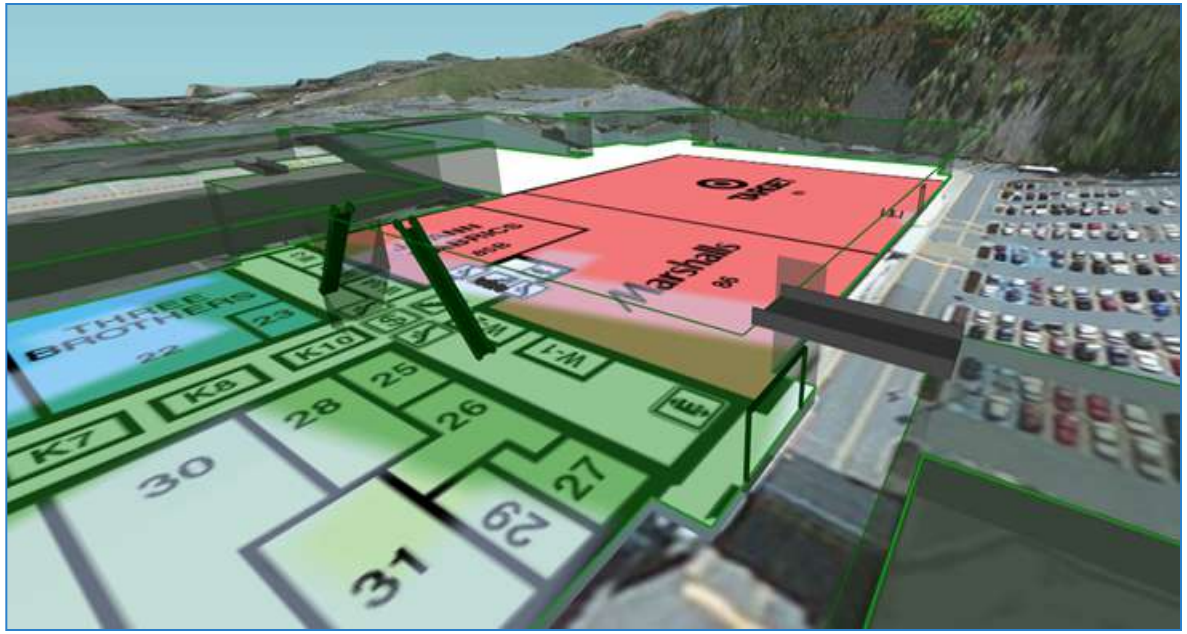




Creating Map Data - Command Building Editor



Enable users to more easily create and map complex buildings…



…and to use complex features for navigation constraints

Use Case Validation and Testing

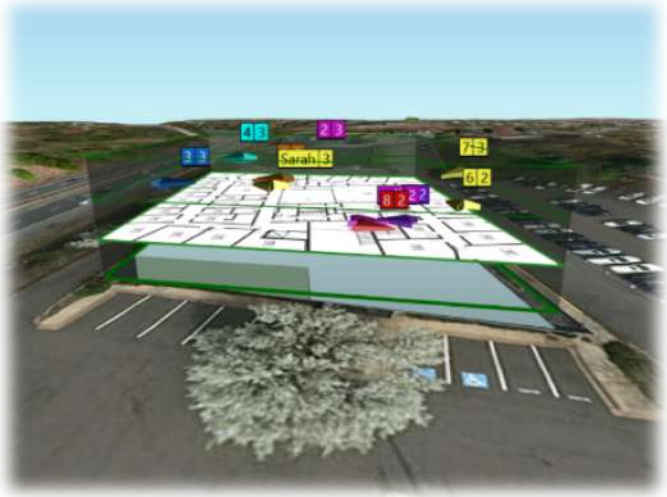
Goal #4: Feedback and testing

- Requirements, use case definition
- Training on the solution, new features
- Testing/trials with new features
- Usability assessments, gap analysis
- Performance analysis

Arlington County, VA
Fire Department

Testing Location

4 Level Abandoned Office Building



NEON Testing with ACFD - December 2018

Test Group – 2 groups of 4 ACFD Firefighters (Engine and Ladder Crews)

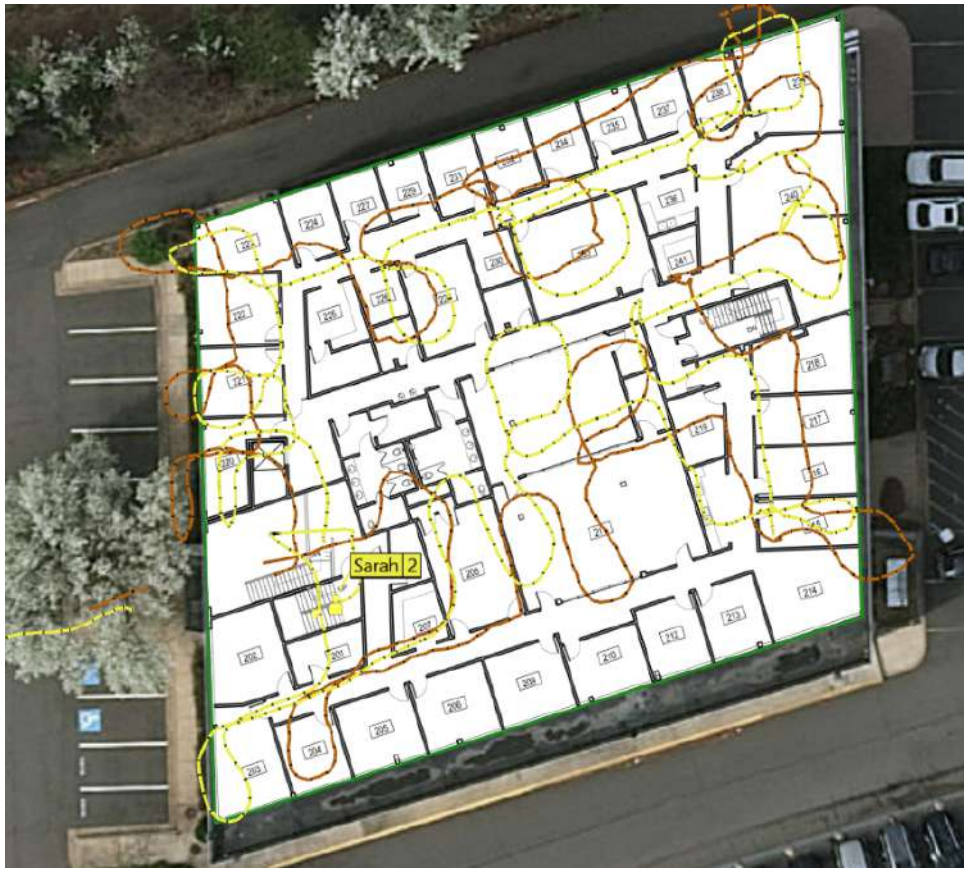
- 3 exercises; 10-15 minutes each
- Simulated structure fire incident

NEON Performance Testing

- Building – preplanned structural features, No Wi-Fi, no installed infrastructure
- Initialization – tested with 2 prototype "UWB Drop Beacons"

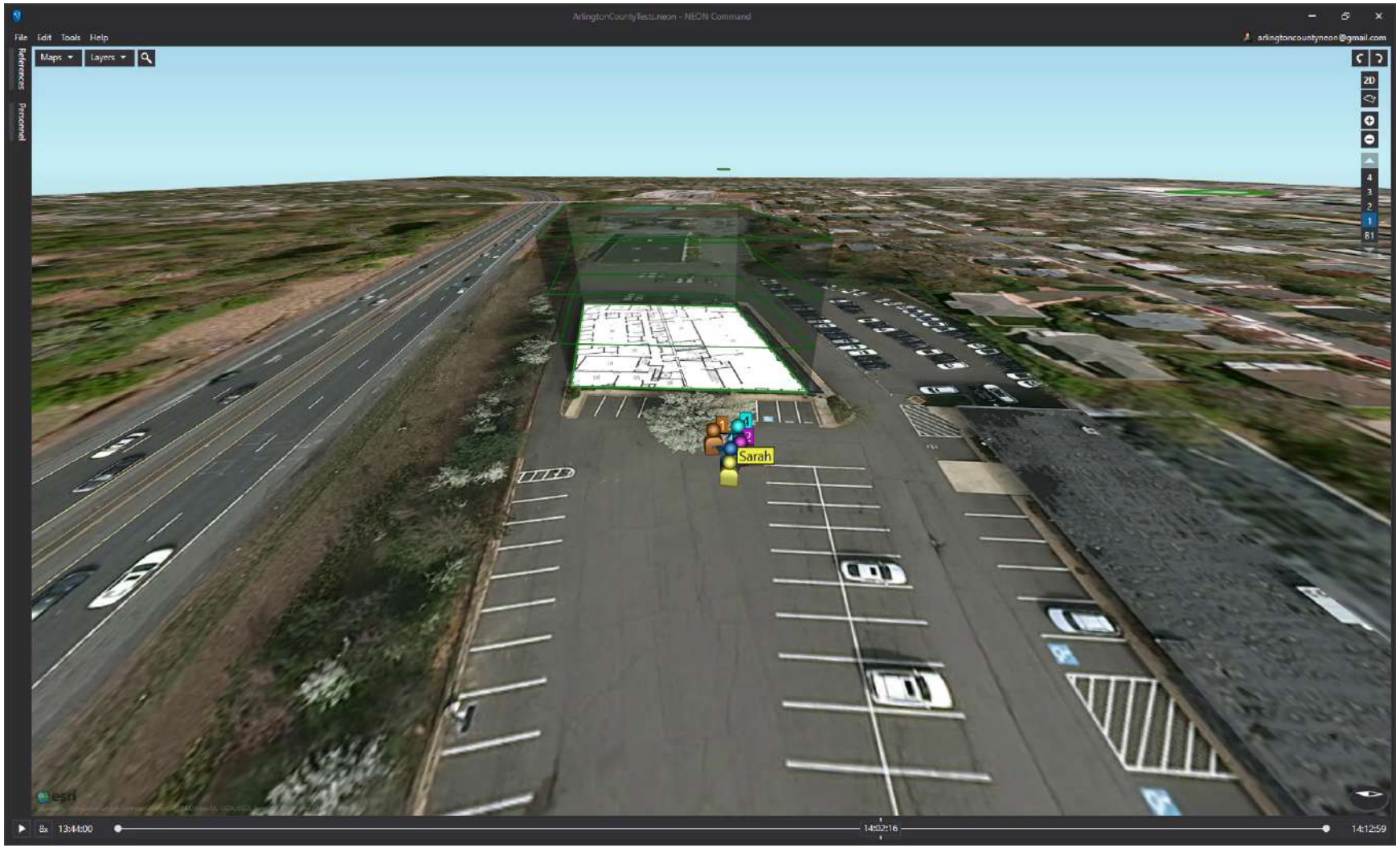
Performance

- Approximately 5m average error
- Ground Truth for FF testing is a challenge



Relative Accuracy: 2D image of "ground-truth" (yellow) and a firefighter track on 3rd floor

December 2018 Testing with ACFD



June 2019 Testing with ACFD

Test Group – 2 groups of 4 ACFD Firefighters (Engine and Ladder Crews)

- 3 exercises; 10-15 minutes each
- Simulated structure fire incident
- Added vehicle mode testing

NEON Performance Testing

- Building – preplanned structural features, No Wi-Fi, no installed infrastructure
- Vehicle Mode Testing including new vehicle beacon feature (GPS-UWB config)
- Initialization with single UWB Drop Beacon
- Ground-truth with new “Debug Beacons”
- New automated data analysis tools used

2D and 3D results with post processing

2D	Full Config	Without Beacons
Average	3.9 m	7.9 m
Measurement Points	3349	3349
Standard Deviation	3.7 m	8.2 m

3D	Full Config	Without Beacons
Average	.1 floors	.5 floors
Measurement Points	3349	3349
Standard Deviation	.3 floors	.6 floors

June 2019 Testing with ACFD

Real-time results and visualization:

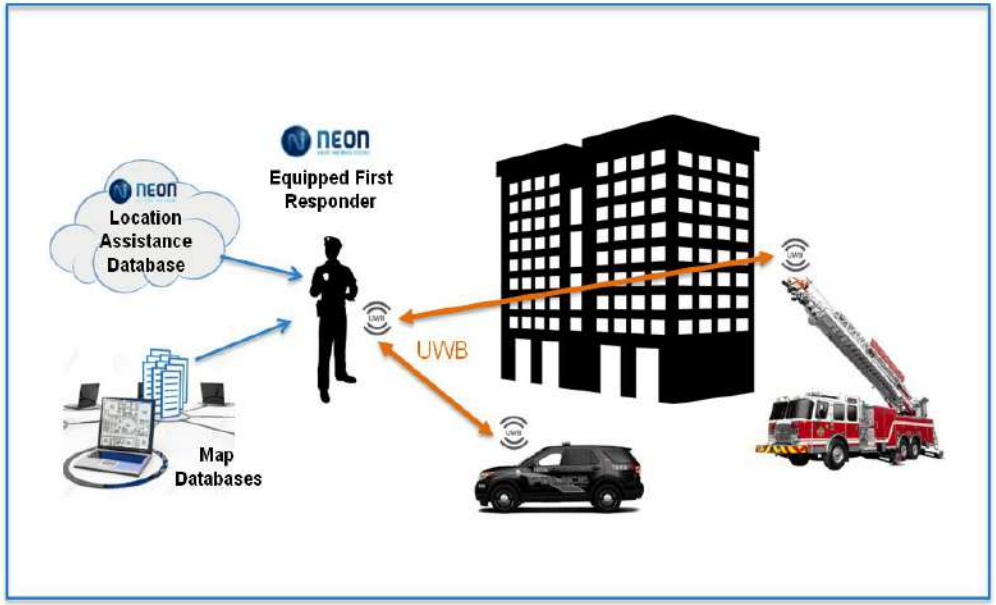
- X-Y accuracy was good
- Z-axis had ~1 floor error on some of the FFs during live testing

Data Analysis

- Analysis using ~20 debug beacons allowed for fast data analysis and accuracy calculation
- Analyzed data and changed algorithm for drop beacons to eliminate z-axis error
- Results showed that new “vehicle mode” and onboard UWB beacons were valuable but also required some algorithm changes
- TRX reprocessing software allows TRX to rerun navigation logs with updated algorithms

Where do we go from here?

- Field testing with the public safety community to enhance ease-of-use of mapping and visualization tools
- Continue to expand UWB technology application for first responders including for initialization and vehicle mode tracking
- Further development of mapping tools and database access to further simplify access to map data for first responders
- Continue to apply and test technologies from other use cases to improve safety and situational awareness for first responders



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Come back for the

Next Session

3:30 PM