DEFENSE PNT IN CHALLENGED ENVIRONMENTS

BEFORE WE BEGIN

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ABOUT OROLIA

A world leader in assured positioning, navigation and timing (PNT) solutions that improve the reliability, performance and safety of critical, remote or high-risk operations.

PNT Key Capabilities by Industry

Aerospace	**Enterprise**	**Government**	**Maritime**	**Defense**	**Space**	**Transportation**
Distress/Safety Systems (GADSS) Air Traffic Mgt. Emergency Mgt.	Network Timing Financial Services Energy/Telco Networks	Emergency Management Maritime Domain Awareness Critical Infrastructure/911	GMDSS Vessel Monitoring Systems Automatic Identification System (AIS)	Assured PNT C4ISR Combat SAR	Atomic Clocks Low-Noise Oscillators Satcom	Unmanned Autonomous Systems

With locations in more than 100 countries, Orolia provides virtually failsafe GPS/GNSS and PNT solutions to support government and commercial applications worldwide.

GNSS IS GREAT...

...UNTIL IT'S GONE.

PNT IS REQUIRED BY MANY CRITICAL SYSTEMS

Navigation and Maneuver

Command and Control

Sensor Platforms

Communications

Tactical Networks

Unmanned Vehicles

PNT IN LAND OPERATIONS

Command and Control

- Individual navigation
- Communications networking and security
- Digital blue force tracking
- Decisionmaker situational awareness
- Synchronize operations

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- Adversary posture and activities
- Identify critical decision points
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Time Sensitive Targeting

- Locate high-value targets
- Engage before the target is lost
- Assessment
- Minimize collateral damage

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Assured **PNT** =
- Faster, better informed decisions
- Greater synchronization
- Force Multiplication

= Doing More With Less!

WHAT HAPPENS WITHOUT PNT?

Poor **PNT**
Availability

(Less) **Military Effectiveness** (More)

Assured
PNT

- Non-Secure Voice Communications
- Map and Compass
- Analog Map Tracking
- Information Gaps
- Slower Actions

- Secure Digital Communications
- Digital Navigation
- Digital Blue and Red Tracking
- Superior Awareness
- Faster Actions

TRUE RESILIENCE = DEFENSE IN DEPTH

INTERFERENCE   **JAMMING**   **SPOOFING**

GNSS

ANTI-JAMMING

DATA INTEGRITY

SPOOFING DETECTION

COMPLEMENTARY PNT SIGNALS

INTERNAL PNT REFERENCES

PNT-RELIANT SYSTEM

THE REALM OF PNT POSSIBILITY

Iridium STL

GNSS/GPS

eLORAN

Cellular

Celestial Nav

Anti-Jam Antennas

WiFi

VORTAC/DME/ILS

Vision Systems

Signals of Opportunity

Encryption/SAASM

Radar/Lidar/Sonar

UAVs   Vehicle Systems   USVs

Odometer   Crowd-Sourced   Anti-Jam Algorithms   Precision Clock   Inertial Sensors   Map Matching   RFID

TIM ERBES
CTO
TALEN-X

OVERVIEW

- It is known that GPS-disruption can affect missions

- The ability to *access trusted* PNT data in these environments is critical

- Talen-X is working to develop a solution that assures the integrity of PNT data

  - ThreatBlocker

- This technology can enable modern land-warfare systems to operate in GPS-disrupted environments

THREATBLOCKER: HOW IT STARTED

JNC 2017

Blind Interference Signal Suppression (BLISS): A New Single-Antenna Method for GPS Interference Suppression

Phillip B Hess and Philip A Dafesh

The Aerospace Corporation

WHAT IS BLISS?

- Technology developed by The Aerospace Corporation

- Blind Interference Signal Suppression (BLISS)

- Digital processing technique to suppress jamming signals.

WHAT IS BROADSHIELD?

- Technology developed by Talen-X
- Jamming and Spoofing detection software.

EASY AS **1-2-3...**

YOUR **HARDWARE** ① + **BROADSHIELD** ② = **ASSURED-PNT** ③

WHAT IS THREATBLOCKER?
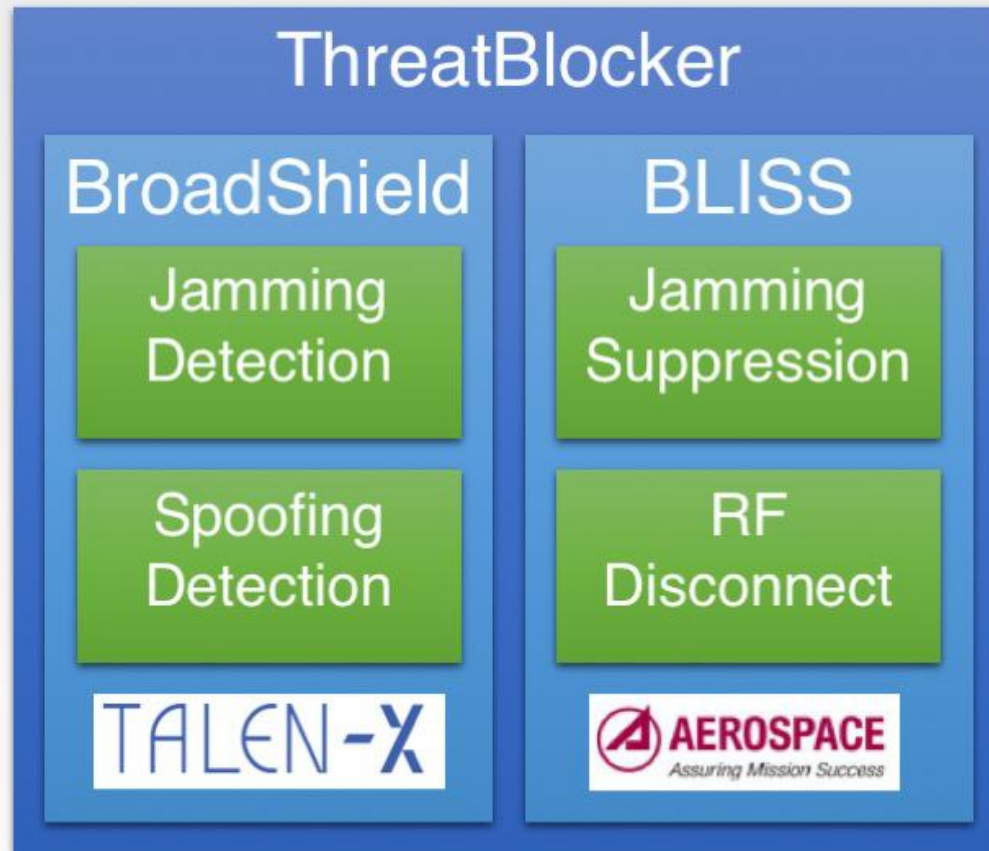
THREATBLOCKER ARCHITECTURE
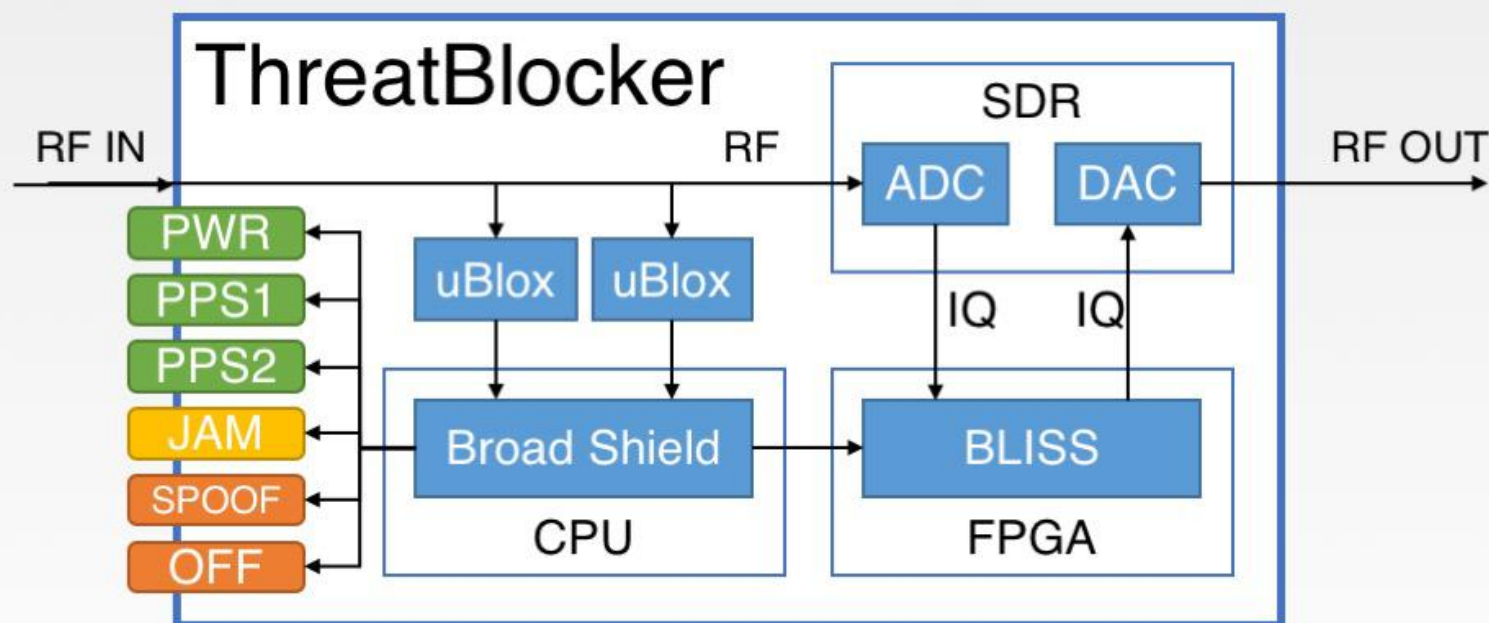
THREATBLOCKER INSTALLATION

Antenna

Exposed RF

ThreatBlocker

Protected RF

GPS Receiver

Power
5V
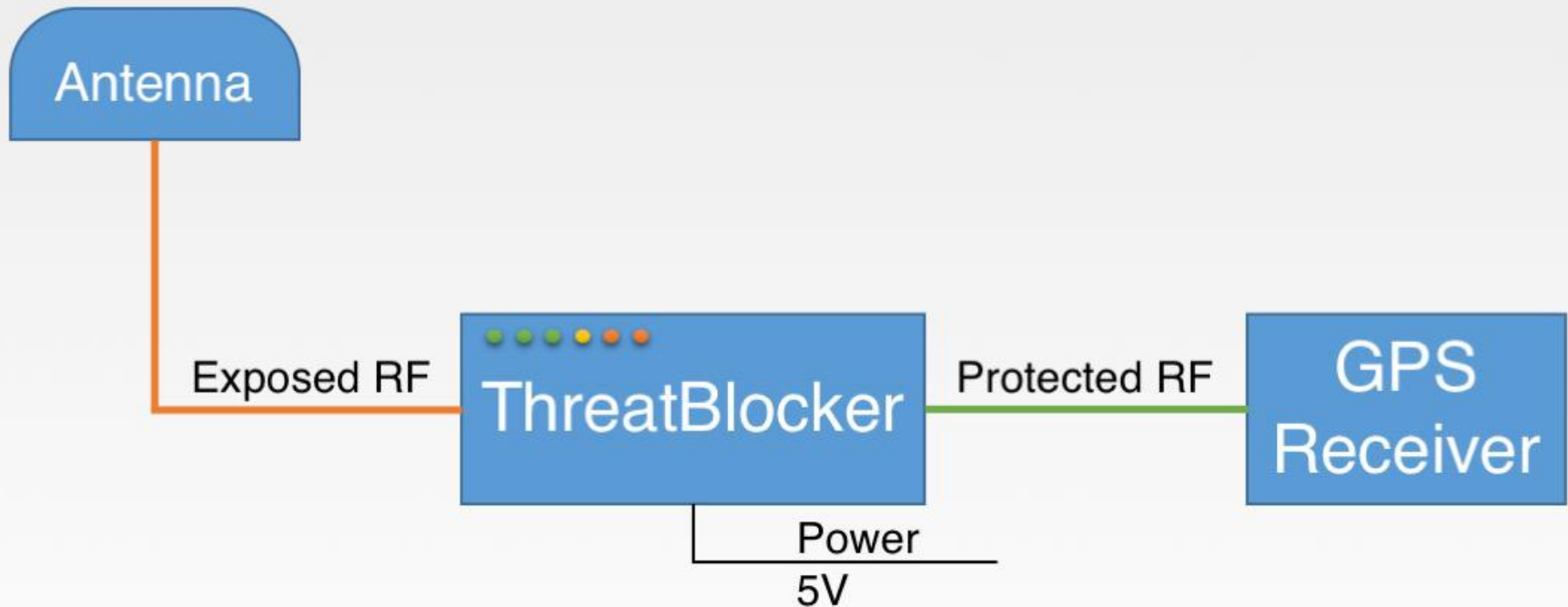
THREATBLOCKER PROTOTYPE
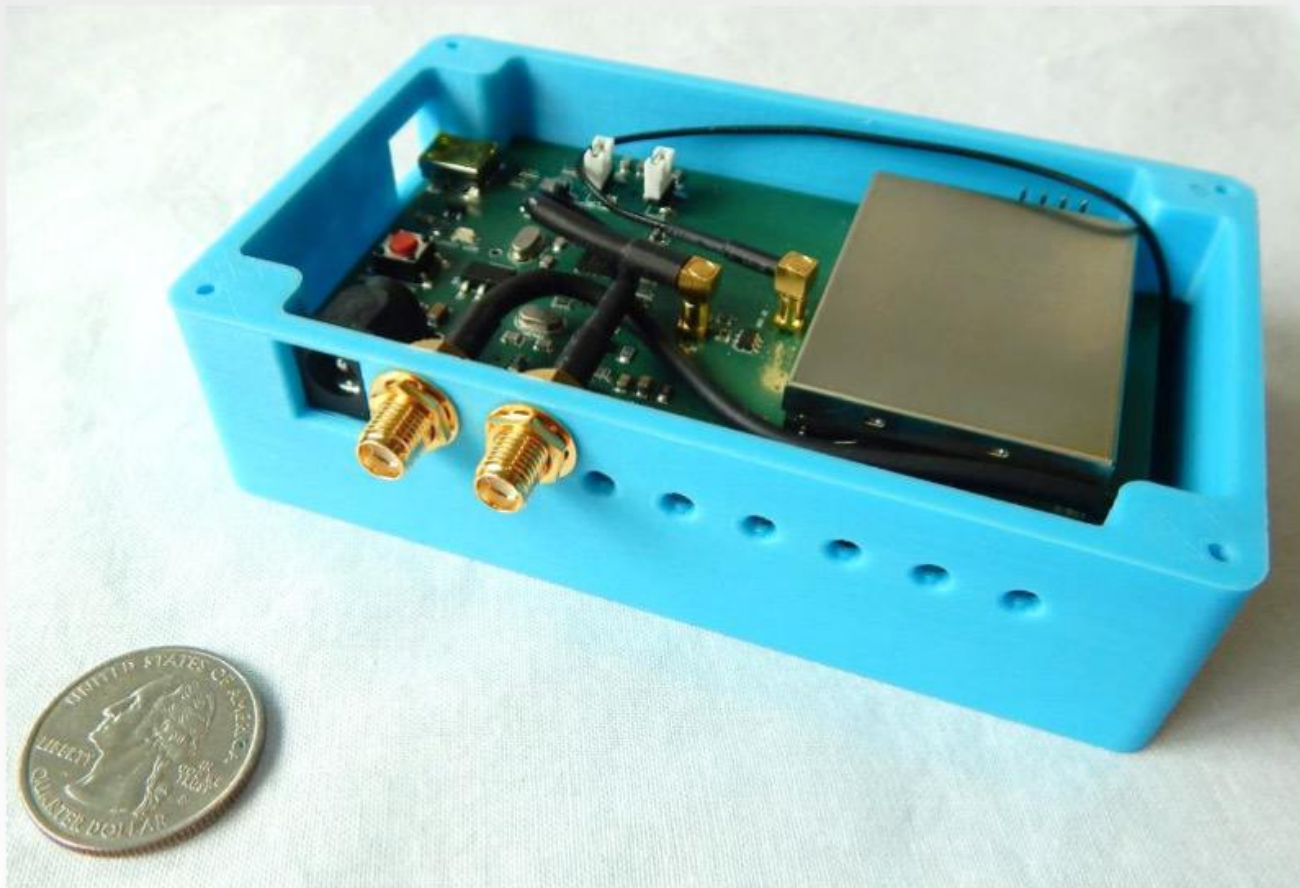
THREATBLOCKER JAMMING PERFORMANCE LAB TEST: CA VS MATCH SPECTRUM

Average C/No of Tracked SVs — By Receiver Over Time
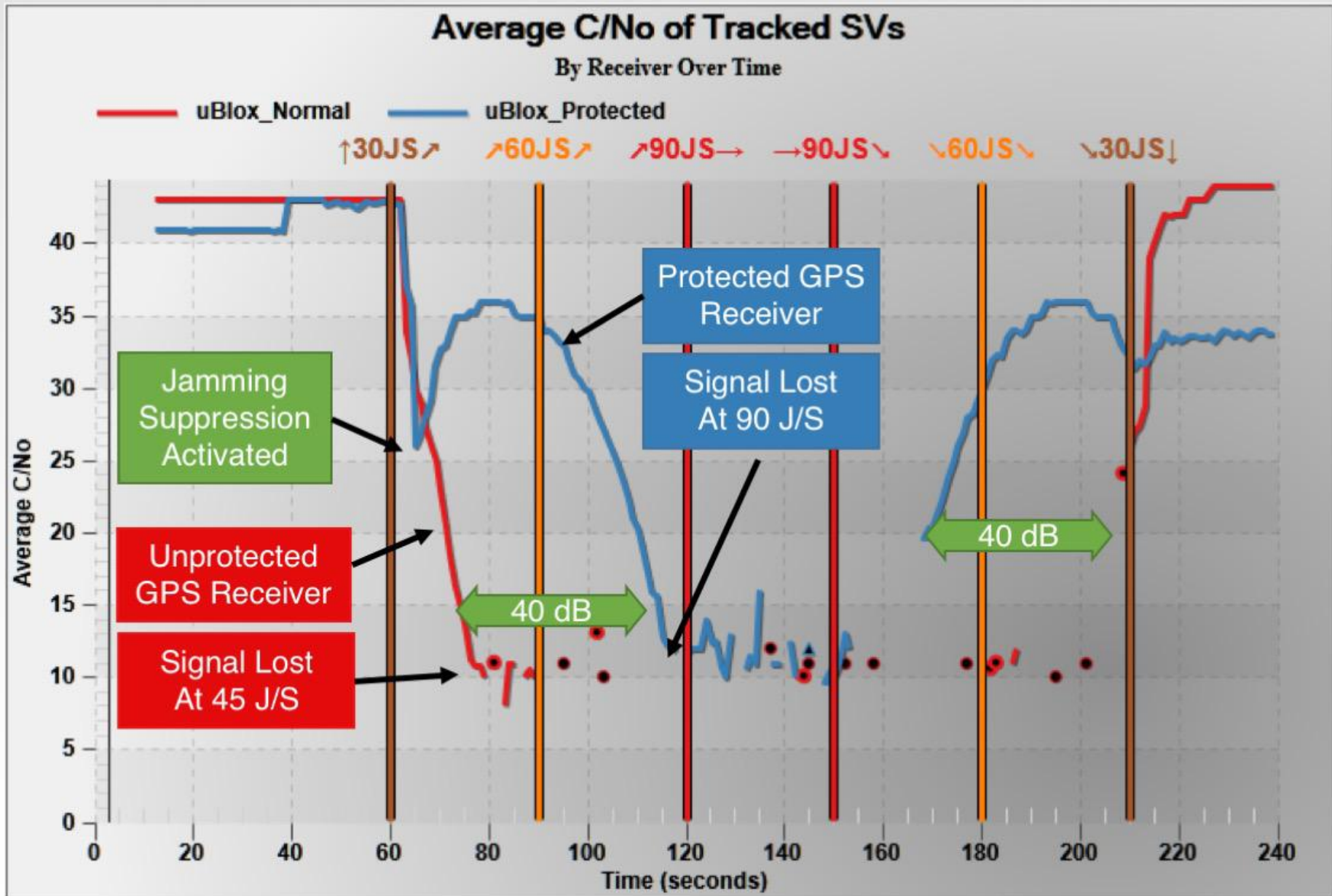
THREATBLOCKER JAMMING PERFORMANCE REAL WORLD DRIVE BY 250 WATT CHIRP

Without ThreatBlocker
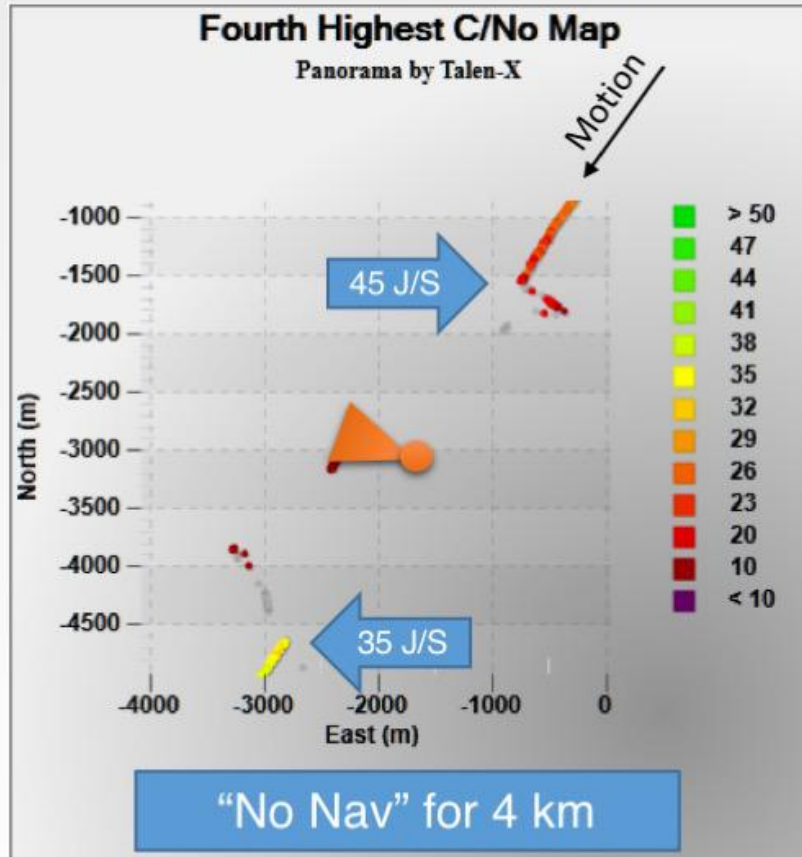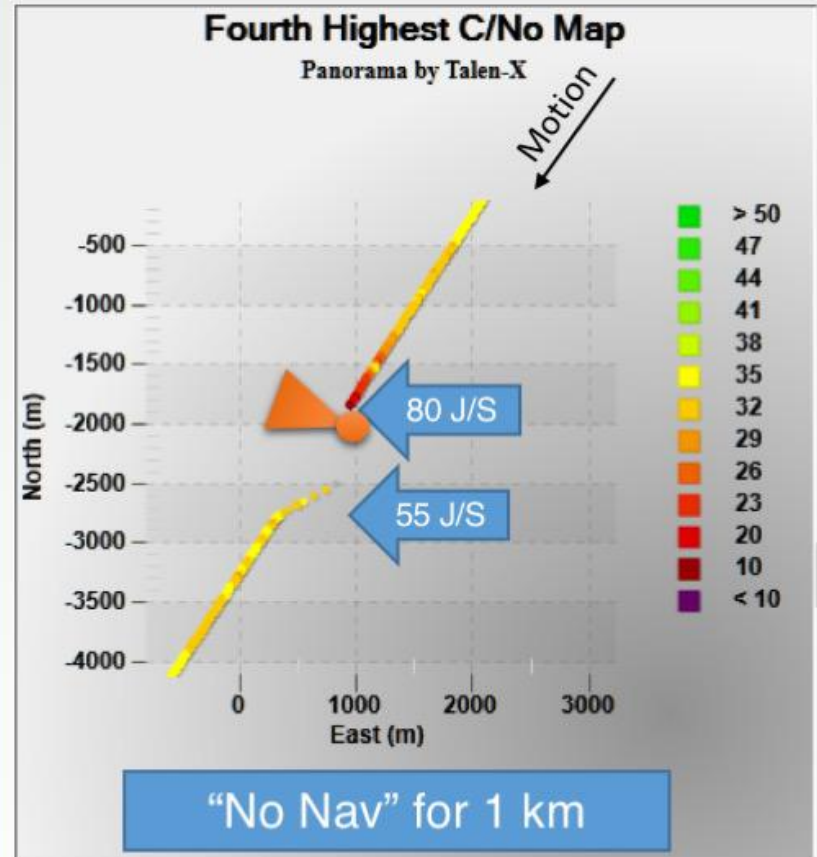
Fourth Highest C/No Map
Panorama by Talen-X

Motion

45 J/S

35 J/S

North (m): -1000, -1500, -2000, -2500, -3000, -3500, -4000, -4500

East (m): -4000, -3000, -2000, -1000, 0

Legend: > 50, 47, 44, 41, 38, 35, 32, 29, 26, 23, 20, 10, < 10

"No Nav" for 4 km

With ThreatBlocker

Fourth Highest C/No Map
Panorama by Talen-X

Motion

80 J/S

55 J/S

North (m): -500, -1000, -1500, -2000, -2500, -3000, -3500, -4000

East (m): 0, 1000, 2000, 3000

Legend: > 50, 47, 44, 41, 38, 35, 32, 29, 26, 23, 20, 10, < 10

"No Nav" for 1 km

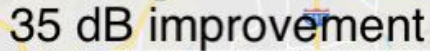# THREATBLOCKER JAMMING PERFORMANCE REAL WORLD CAR WASH 1000 WATT CHIRP

DENIAL AREA OF 100 WATT JAMMER WITH THREATBLOCKER

35 dB improvement
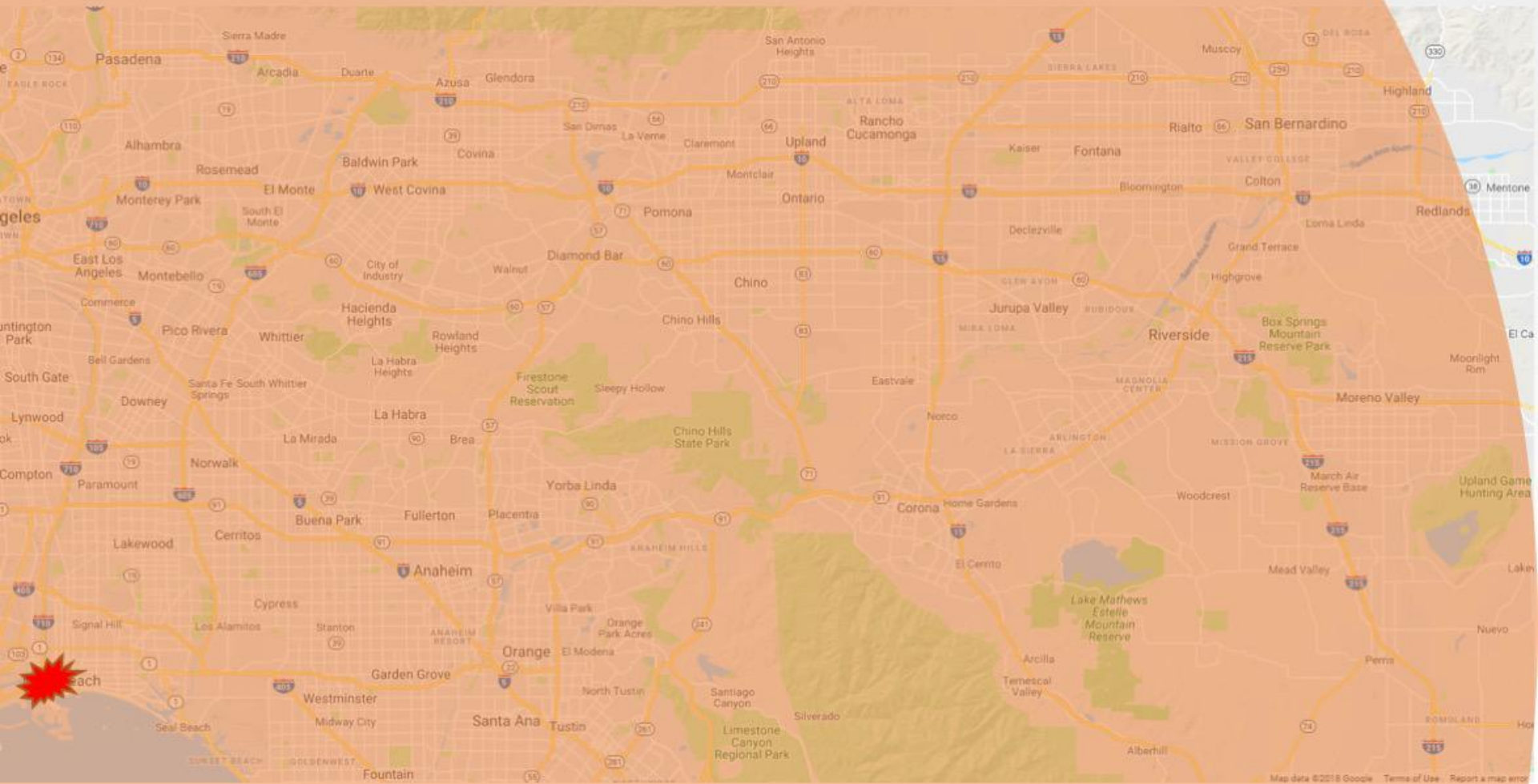
CONCLUSION

- ThreatBlocker can detect jamming, detect spoofing, protect from jamming, and protect from spoofing

- Small Size, Weight and Power (SWaP)

- Inline system

  - Compatible with legacy and modernized downstream PNT systems

- Enable operations in GPS-disrupted environments

CAROL POLITI
CEO
TRX SYSTEMS

GPS-DENIED LOCATION FOR DISMOUNTED PERSONNEL

INTENTIONALLY DENIED, INDOORS AND UNDERGROUND
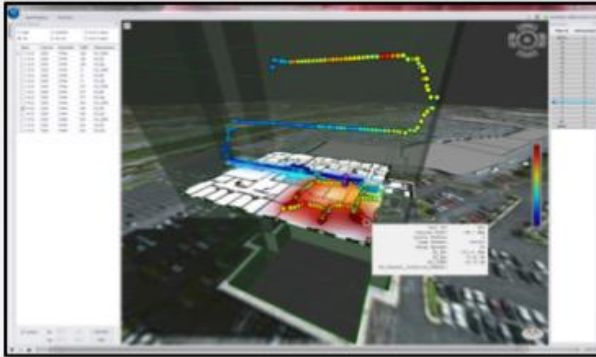
Carol Politi – President and CEO

TRX systems
LOCATE. MAP. TRACK. INDOORS.

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Suite 420
Greenbelt, MD 20770
(+1) 301–313–0053
info@trxsystems.com

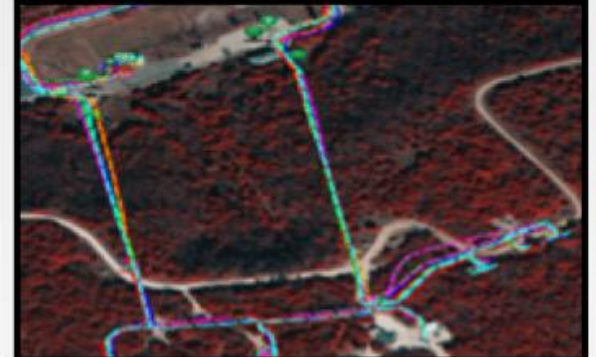# TRX SYSTEMS: GPS-DENIED LOCATION AND MAPPING

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

Network Coverage Validation and Sensor Mapping (LMR, LTE, Radiation, etc.)

Situational Awareness for National Security Events, Critical Infrastructure, Incident Response

Dismounted Tracking and Mapping within Urban and GPS-denied environments

GPS-DENIED LOCATION AND MAPPING CHALLENGE

- GPS does not work indoors, underground is inaccurate in dense urban areas, and is easily jammed

- For operations indoors and underground, map data required for optimal situational awareness is often unavailable, difficult to manage

- Solutions for locating and mapping without GPS are often high SWaP or rely on infrastructure
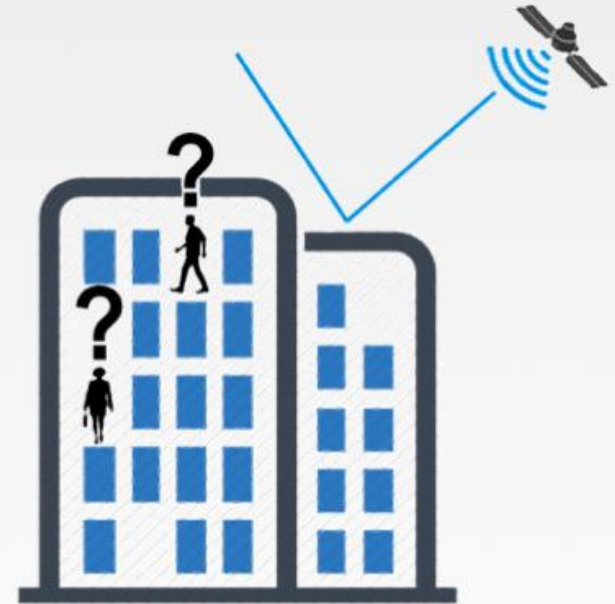
DISMOUNT GPS-DENIED NAVIGATION — KEY NEEDS

- Location urban canyon, indoors, underground, triple canopy, intentionally denied

- Low SWaP solution, integrated in soldier systems, easy to use

- Operation within denied environments for extended periods

- Robust to extended communications outages

LOW SWAP SENSORS HAVE MANY ERROR SOURCES

Inertial

- Measure relative motion
- Relatively low power and processing
- Compensation of sensor drift is the major issue

Pressure

- Measure relative elevation
- Susceptible to environmental interference

Magnetometers (compass)

- Deliver heading, magnetic features
- Significant magnetic disturbances indoors, near vehicles/equipment

Light

- Detects IR, visible light
- Device can be under coat

Acoustic

- Noise signatures and acoustic ranging
- Platform filtering varies, some frequencies can be heard

RF/Ranging

- Signal strength (e.g., BLE) - useful over very short distances, highly affected by environment
- Narrowband sources support high propagation distance, not precise
- UWB Time of flight - medium range, not yet embedded in all devices

Optical

- Can measure relative motion, support feature matching
- High computation and power
- Highly affected by lighting and texture of environment
- Lenses can be blocked, get dirty

Low SWAP sensors available for navigation are prone to errors over time, due to building or environmental conditions, and due to human motion.
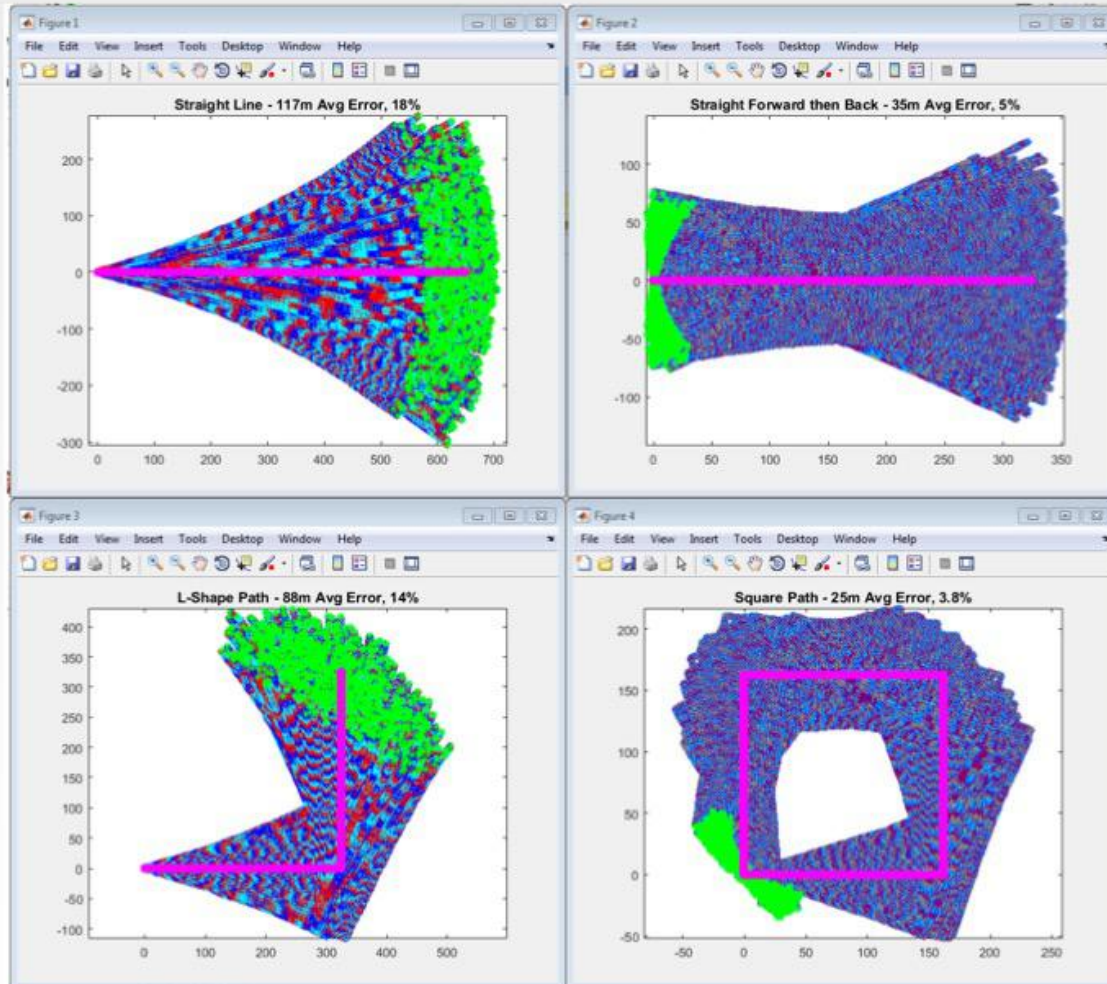
INERTIAL SENSOR FUSION + CONSTRAINTS

Inertial "dead reckoning" alone is infrastructure-free but accumulates error over distance travelled.
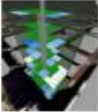
Other inputs - intermittent GPS, map data, and UWB/BLE ranging, etc. are needed to "constrain" inertial results and provide accurate location over extended periods
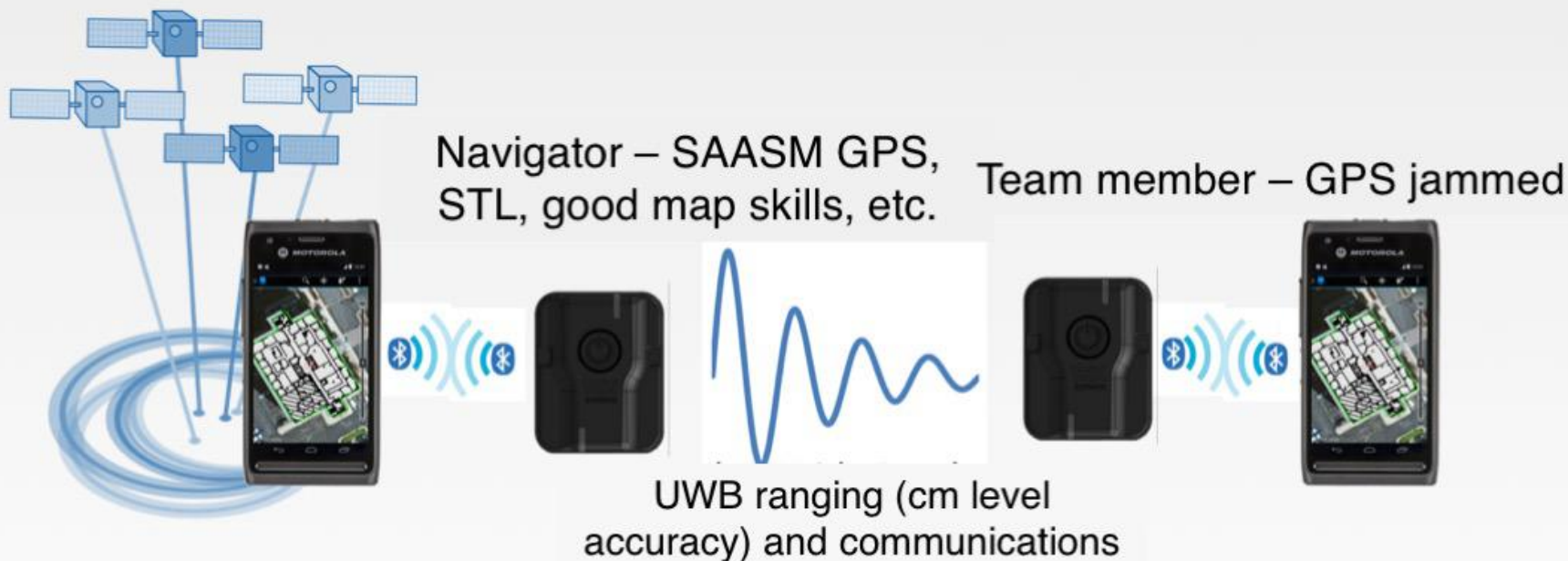

Inertial Dead Reckoning" Alone

Source: TRX Systems

LAYERED, MULTI-SENSOR FUSION APPROACH IS NEEDED – KEY CONSIDERATIONS

	Initialization	Key parameters include start position, heading, user mounting location and gait; learned from GPS, beacons or manual input
	Sensor Fusion	Inertial sensors (gyro, accel, compass) plus pressure and other Android based sensors used to calculate movement in local frame
	Satellite and Terrain Data	Provides for placement of user in global frame with latitude, longitude and altitude above sea-level; allows for 3D visualization
	Building or Tunnel Data	Shape files give 3D construct; learned data provides structural (stairs, entrances, elevator) constraints
	Collaborative Ranging	Position inputs can be shared between users, allowing users with high accuracy or assured position source to initialize team
	Inferred Mapping	Learned RF (cellular, Wi-Fi, BT) data combined with structural data can be geo-referenced to deliver location assistance data
	Beacons	Ranging to optional UWB and/or BLE beacons provide constraints where these can be dropped or placed

PERSON TO PERSON RANGING – BASIC APPLICATION

Navigator – SAASM GPS, STL, good map skills, etc.

Team member – GPS jammed

UWB ranging (cm level accuracy) and communications

Source: TRX Systems NEON

INTEGRATION INTO "SYSTEM OF SYSTEMS" SUPPORTS LAYERING OF POSITION/NAVIGATION CONSTRAINTS

Inertial Unit (with UWB and BLE ranging)

2.05"
2.55"
.75"

Source: TRX Systems NEON

UAVs

Nett Warrior EUD + Soldier Radio

Bluetooth

TRX NEON Tracking Accessory

Nett Warrior/ATAK
Source: TRX Systems NEON

- Sensor fusion & mapping delivers relative location

- Fusion with GPS, known waypoints, dropped anchors supports initialization, individual dismount constraints

- Ultra-wideband sub-meter relative location between devices allows assured position sharing

- *+ Location constraints from 3rd party sensors or systems (UAVs, vehicles and other positioning sources)*

- *+ Indoors/underground, structural information can be used to create map, store user path*

Fixed/dropped References

Ground Vehicles/Robots
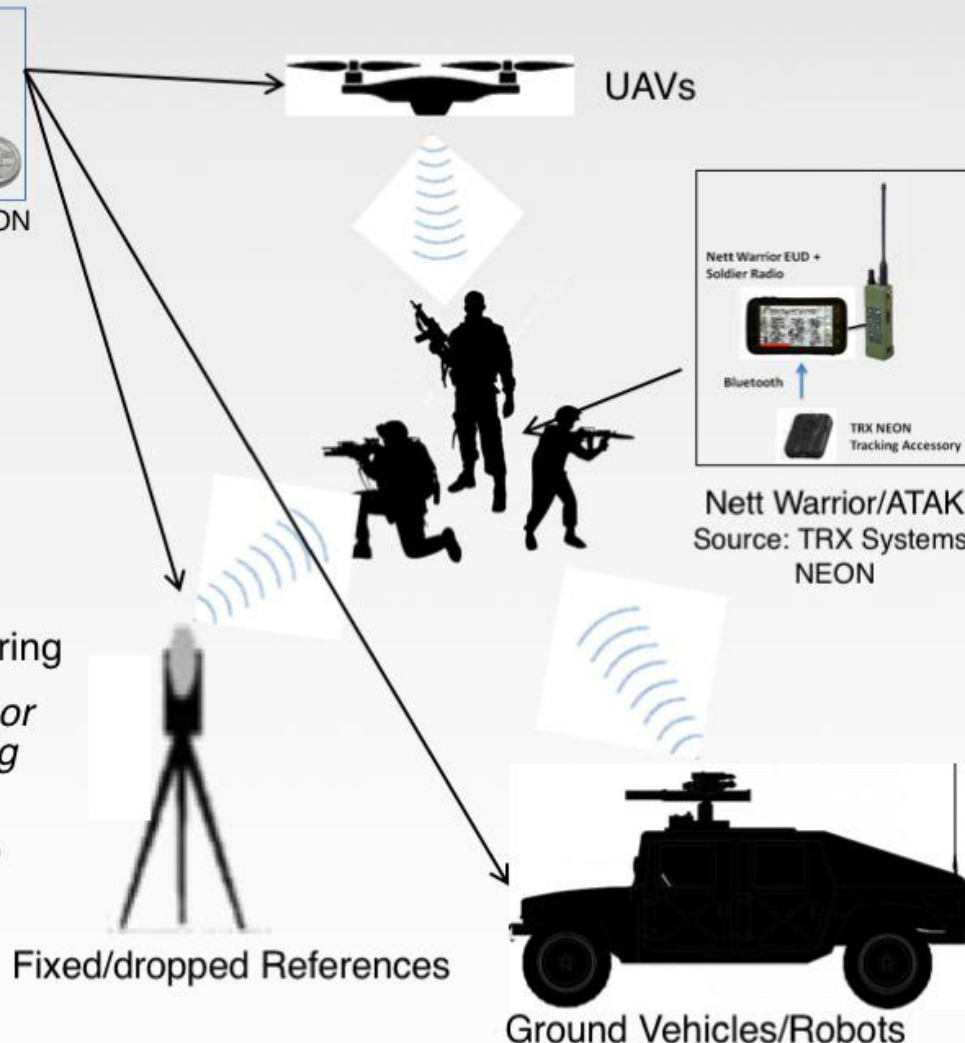
PERFORMANCE GIVEN LAYERED CONSTRAINTS

| Available Sensor Input And Constraints	Estimated Accuracy	Dependencies
Inertial Sensor Fusion	3-7% of distance traveled	Accuracy degrades over distance/time without corrections
+ UWB ranging	<1 meter relative accuracy	Person to person
+ Building shape files	5-15 meters	Dependency on size of building
+ Preplanning (WiFi, Structural features)	4-10 meters	Use NEON Mapper to preplan building; More features = better accuracy
+ UWB Beacons	1-5 meters	Low density deployment at chokepoints (entrances) or dropped during operations
+ BLE Beacons	3-7 meters	Low density deployment at chokepoints (entrances, etc.)

Source: TRX Systems NEON


Outdoor GPS-Denied
2/2018
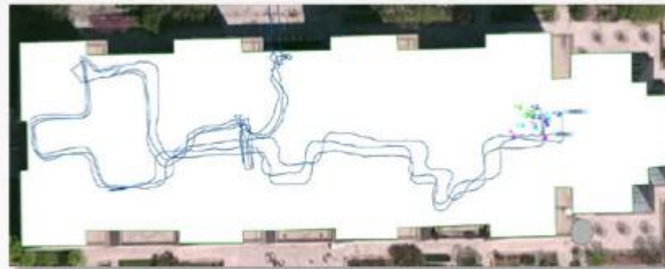
3D Indoor Tracking
GPS-Denied 10/2017
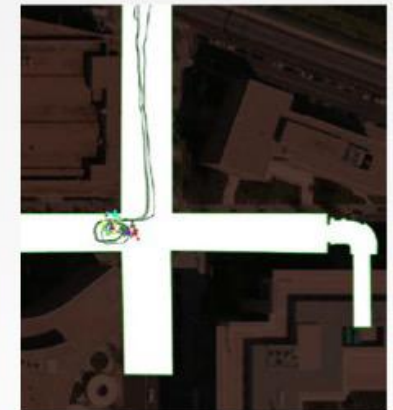
Underground Subway
2/2018

TRX NEON DISMOUNT LOCATION SERVICE

- Real-time, 3D location calculated every step
- Fusion of sensor fusion, map data and ranging technologies
- Android smartphone paired with optional inertial measurement unit
- API delivers lat/long, altitude, floor level, map data; accepts position constraints
- ATAK plug-in supports integration with soldier systems

Map, Location Assistance Data

Visualization

X,Y,Z

NEON Location Service with ATAK Plug-In

Wearable Inertial Measurement Unit
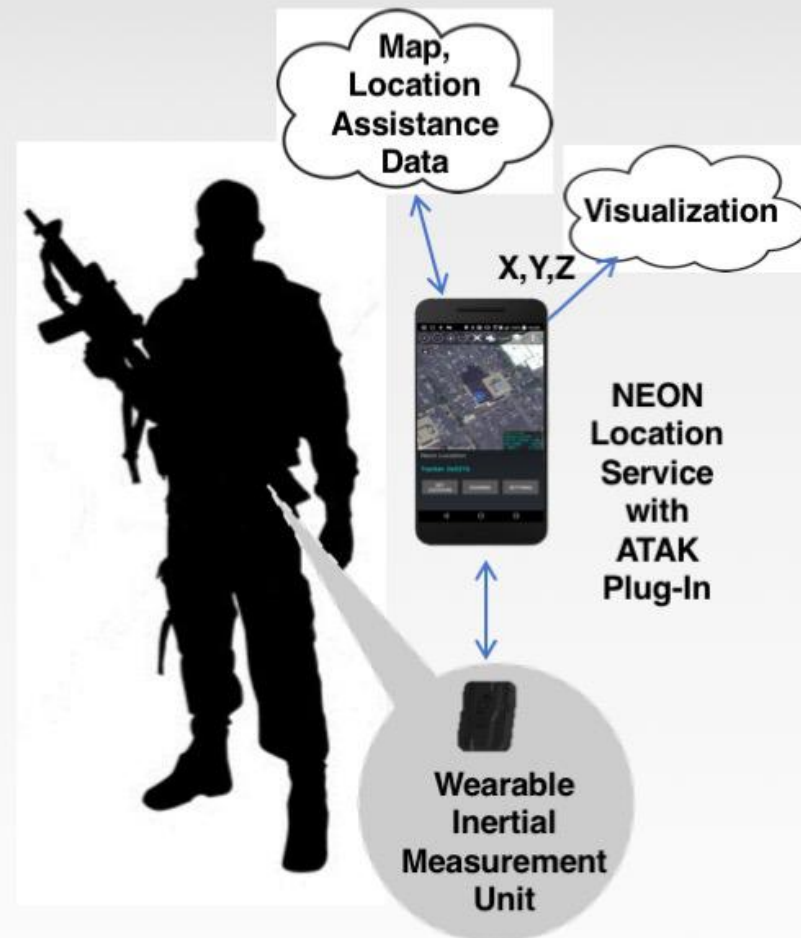
Source: TRX Systems NEON

Can be embedded in standard cellular as well as third party custom devices (e.g., radiation detectors, assured PNT devices, etc.)
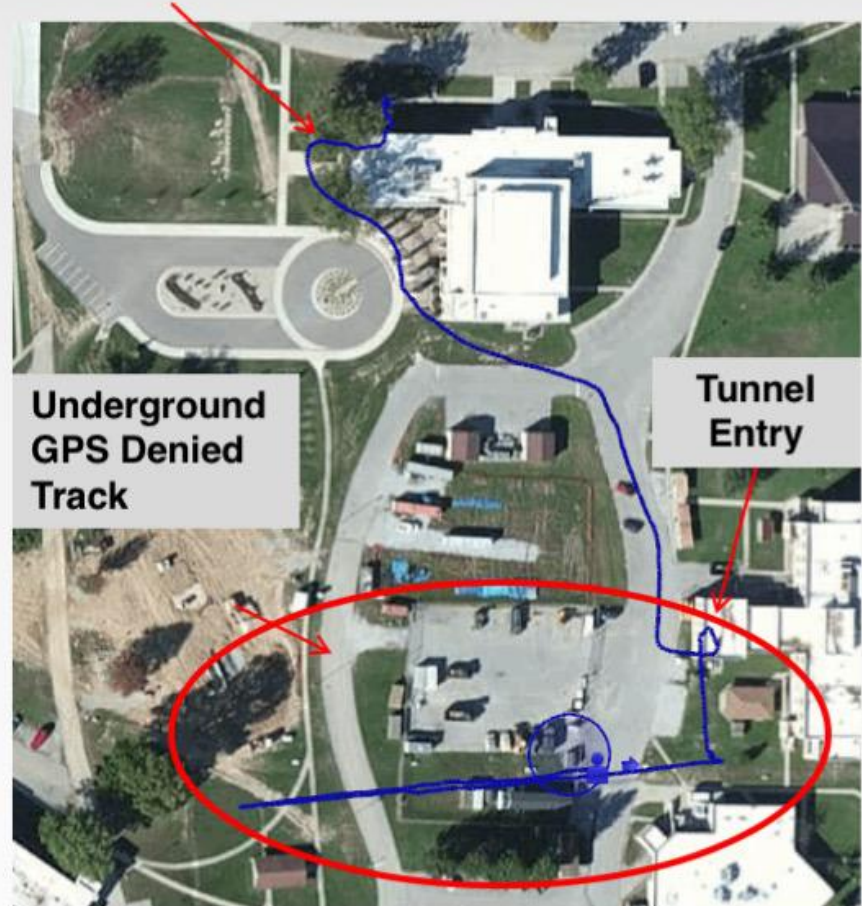
INTEGRATION INTO MILITARY SYSTEMS & CONOPS

Integration with ATAK, SAASM
(Rockwell RSR)

Source: TRX Systems NEON

Access to GPS

Underground GPS Denied Track

Tunnel Entry

Source: TRX Systems NEON

GROWING COMMERCIAL GPS-DENIED USE

SuperBowl LI Houston, TX	• Law enforcement, EMTs at Super Bowl LI in Houston • ~2M square feet and 7 levels of 3D tracking • Improved situational awareness & safety, reduced radio traffic	
Immigration and Customs Checkpoint	• 24x7 situational awareness at large border checkpoint • 7 floors, indoor and outdoor 3D coverage • Integrated with Operations and Command Center	
Active Violence Exercise Grand Central Terminal, NYC	• DHS first responder exercise in Grand Central Terminal involving NYPD, FDNY, and others • 3D situational awareness for remote command center	
Radiation Mapping DARPA/DHS	• Tracking of law enforcement within transport hubs • Mapping radiation from low-cost, body worn detectors to support dirty bomb detection	
Signal Mapping and Signal Geolocation	• Public safety radio, cellular, and WiFi geolocation and mapping • Mapping of signals from cellular devices and high capability test and measurement devices (e.g., Anritsu)	

Source: TRX Systems

QUESTIONS?

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