NextNav, LLC

High Precision Urban and Indoor Positioning Services

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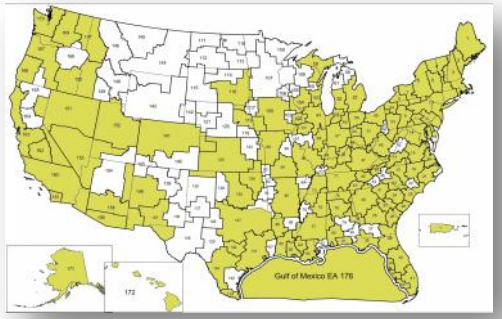
NextNav Overview

NextNav is a network services provider deploying a nationwide system to provide reliable, high-precision positioning information in urban and indoor environments



Nationwide spectrum licenses, significant intellectual property portfolio and wide-area architecture provide consistent store level / floor level precision across entire metropolitan areas

Experienced team has a long and successful history in network deployment, and is backed by Columbia Capital, Telcom Ventures and Goldman Sachs

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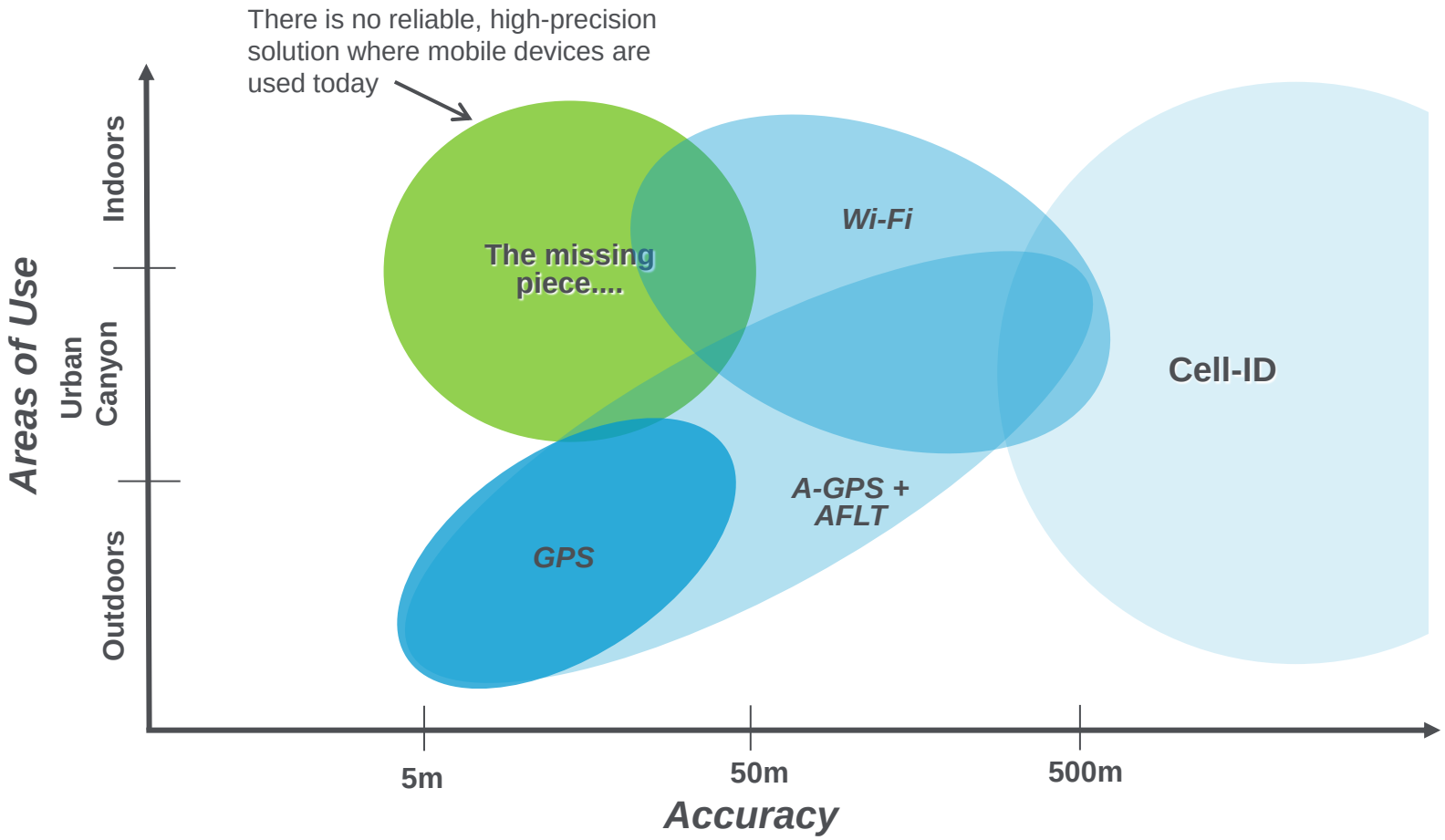
Positioning Technology State of Affairs



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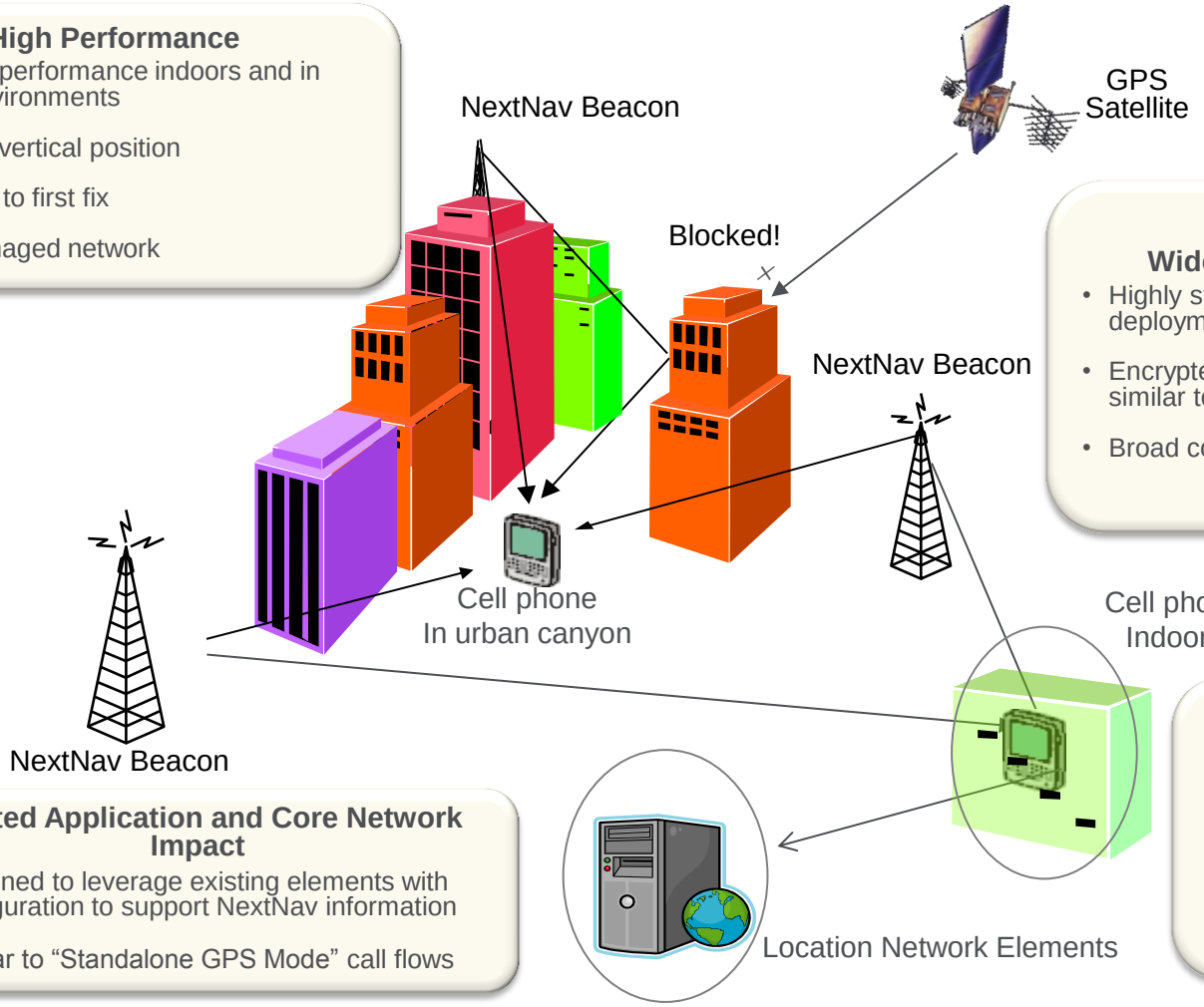
NextNav Metropolitan Beacon System (MBS)

High Performance
- GPS-like performance indoors and in urban environments
- Accurate vertical position
- Fast time to first fix
- Fully managed network



Wide Area Broadcast Network
- Highly synchronized beacons, with deployment optimized for location
- Encrypted signal on licensed spectrum, similar to GPS
- Broad coverage from minimal sites

Limited Application and Core Network Impact
- Designed to leverage existing elements with configuration to support NextNav information
- Similar to “Standalone GPS Mode” call flows

Limited Receiver Impact
- Firmware upgrade to typical GPS digital baseband: standalone solution
- Handset integration largely limited to band support
- On-device computation of location
- Reduced power consumption

NextNav is deploying a terrestrially-based positioning constellation, featuring significant technical commonality with GPS

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Key Principles & Innovations

- Network architecture effectively results in a terrestrial positioning constellation, featuring significant commonality with GPS
  - Timing-based system, using highly synchronized terrestrial transmitters for device-based trilateration
  - Wide-area network architecture, providing consistent indoor service across coverage area
- System designed for minimally-disruptive adoption in mobile handsets and other devices
  - Re-use of GPS digital baseband
- Air interface-agnostic system – allows for evolution of location technology independent of air interface (2G, 3G, 4G etc.)
- Unique height system results in 1 – 3m vertical precision by encoding real-time environmental reference information in positioning data payload
- Unique business model – shared network (similar to GPS) across multiple parties ensures costs are competitive
  - NextNav deploys, manages and runs the network on a nationwide basis

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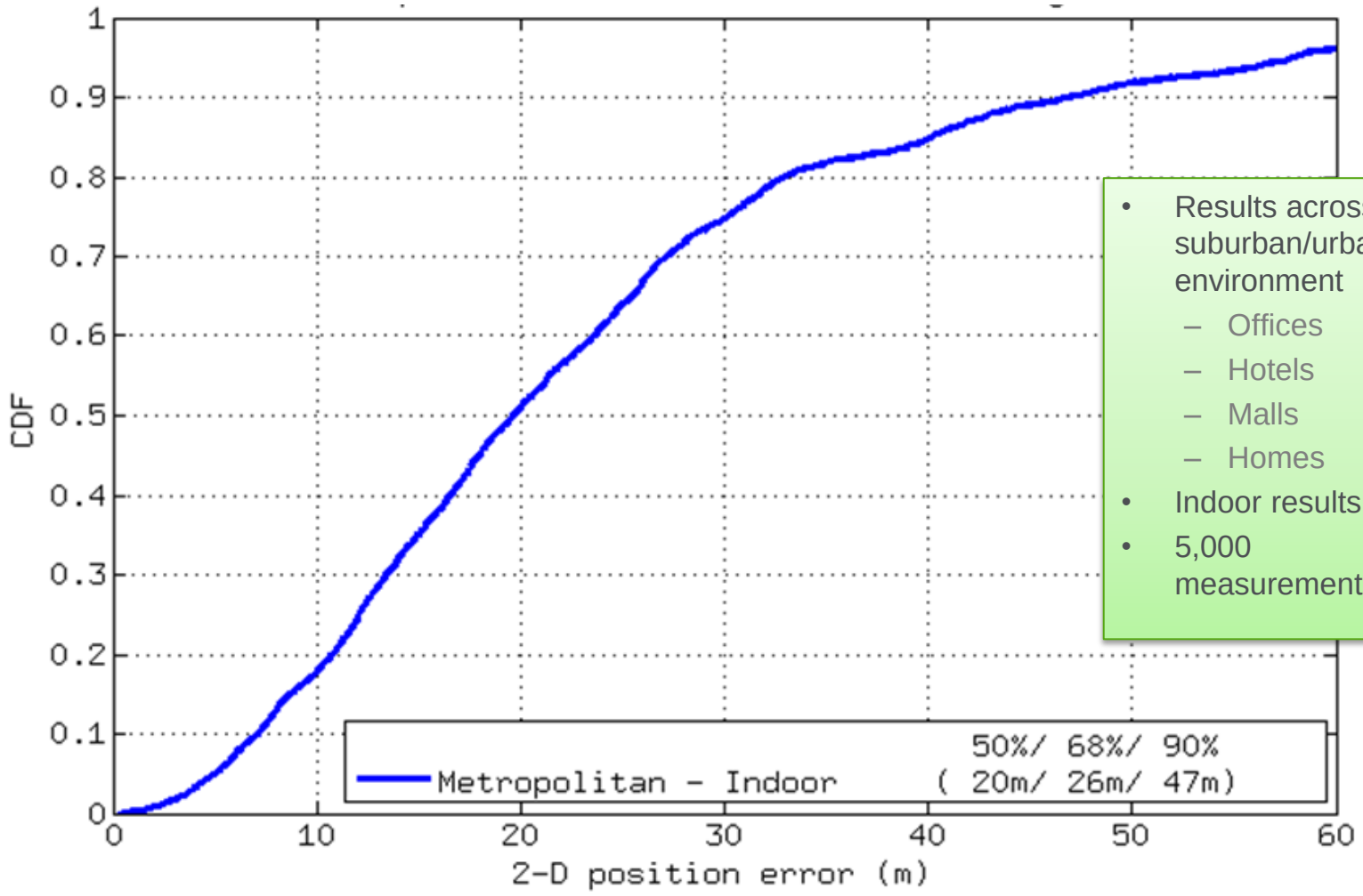
Indoor Accuracy Performance: Rev 1 System



- Results across suburban/urban environment
  - Offices
  - Hotels
  - Malls
  - Homes
- Indoor results only
- 5,000 measurements

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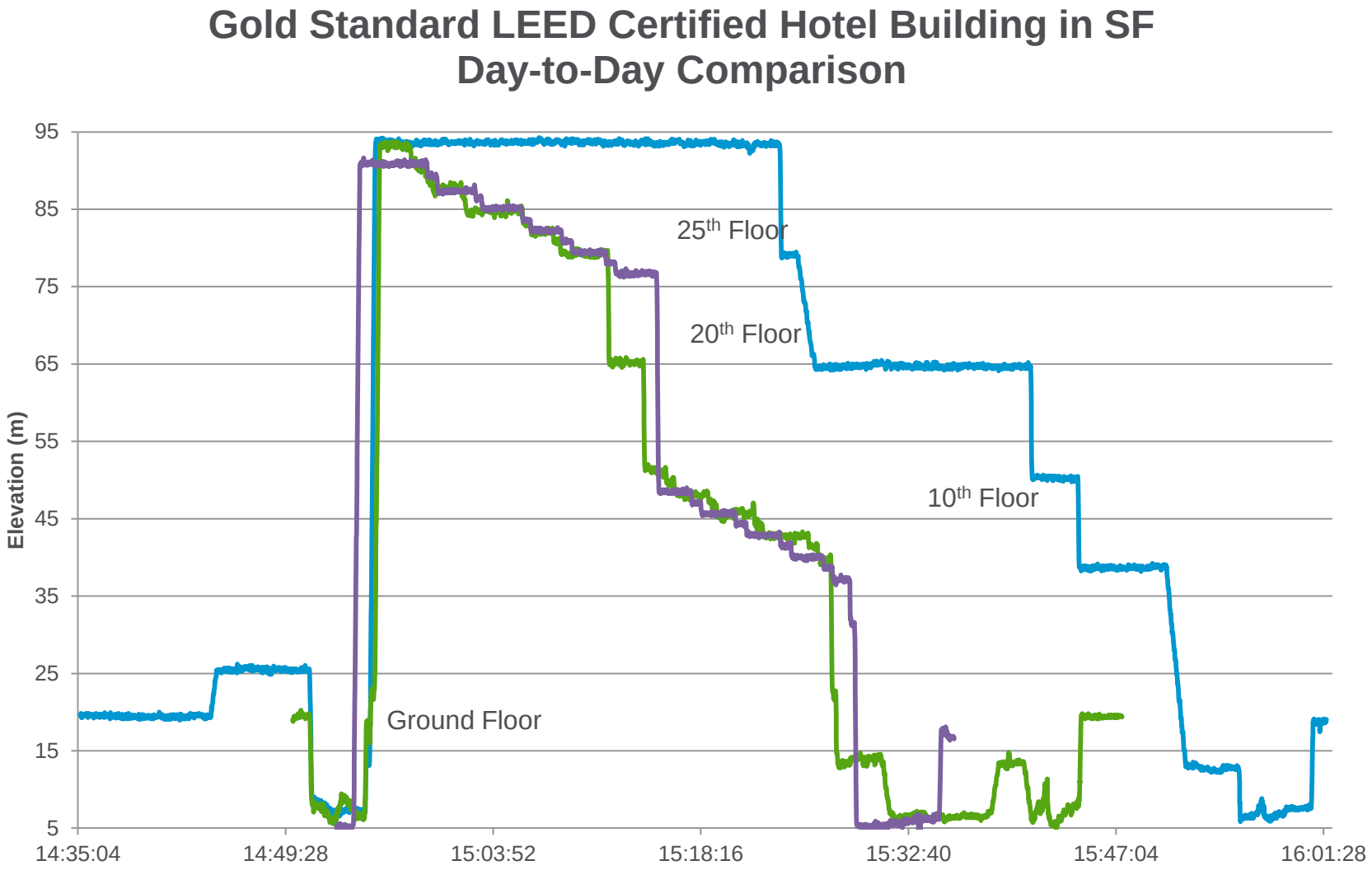
NextNav Elevation System Example



Mobile E911 Call Trends

Topic	2011, December	2010, December	2006, December	2001, December	1996, December
Wireless Subscriber Connections	**331.6M**	302.9M	233.0M	128.4M	44.0M
Wireless Penetration in US Households	**104.60%**	~98.5%	76.60%	44.20%	16%
Wireless-Only Households (as % of US households)	**31.60%**	26.60%	10.50%	N/A	N/A
Wireless E-911 Calls(per day)	**>400K**	>296K	260K	139K	55K
Wireless E-911 Calls(per year)	**>146M**	108M	~93.6M	~50M	~19.8M

Source: CTIA, NENA

- Wireless 911 Calls are accelerating (over 145 million annually)
  - >33% growth in just one year from 2010 to 2011
- Wireless only households are accelerating as well
  - Over 36% Households in US do not have a landline [2012, CDC]
- Vast majority of wireless calls originate from indoors
  - Over 56% of calls originate indoors [2011, JD Power]

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Communications Safety, Reliability and Interoperability Council Trials ("CSRIC")

- In 4Q12 the FCC's CSRIC advisory group held a comprehensive, independent trial of location technologies for indoor E911 in the San Francisco / Silicon Valley area.
- Joint effort by Public Safety, technology vendors and national wireless carriers. Results released March 2013

Urban
San Francisco Financial District

Suburban
Santa Clara County

Rural
San Benito County

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CSRIC Test Protocol Review

- CSRIC 3, Working Group 3 was chartered by the FCC with, among other things, creating an information base from which indoor location accuracy standards for E911 could be established
  - WG3 consists of technology vendors, public safety representatives and the four major U.S. wireless carriers
- Test program was performed by a 3rd party (TechnoCom), and was completely blind to participants
  - Over 13,000 test calls for each participating vendor at 75 indoor test points per building (including deep building core)
  - Test bias towards dense urban / urban (70% of test points)
- Extremely rigorous test process, appropriate for mission-critical applications, resulted in some vendor attrition, with performance for all vendors impacted (7 expressed interest, 4 started and 3 finished)
- Results published in March 2013
  - http://transition.fcc.gov/bureaus/pshs/advisory/csric3/WG3_Indoor_Test_Report_Bay_Area_Stage_1_Test_Bed_Jan_31%20_2013.pdf

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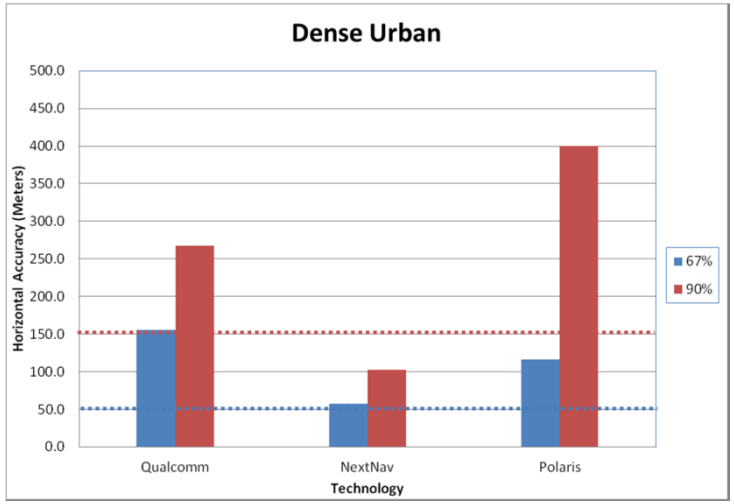
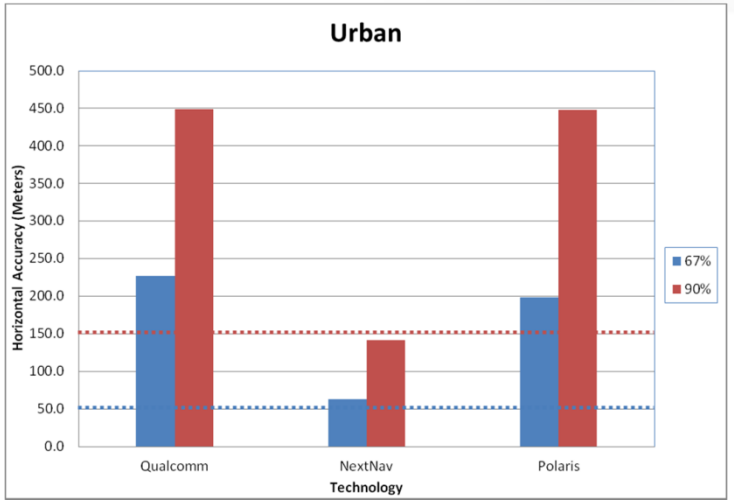
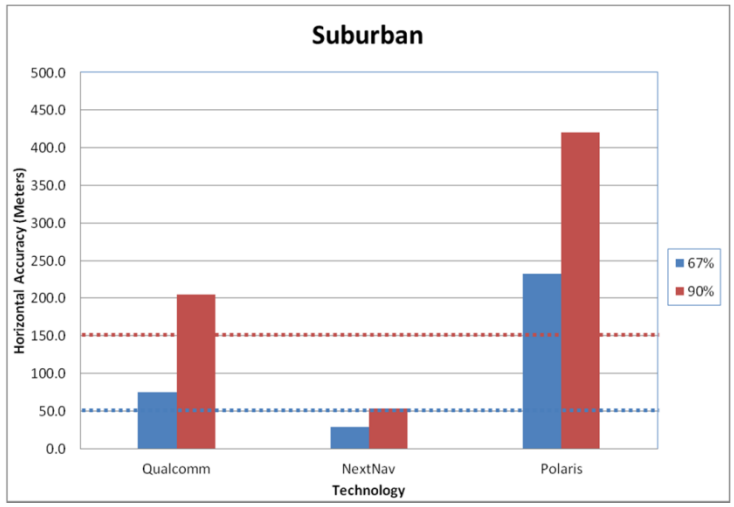
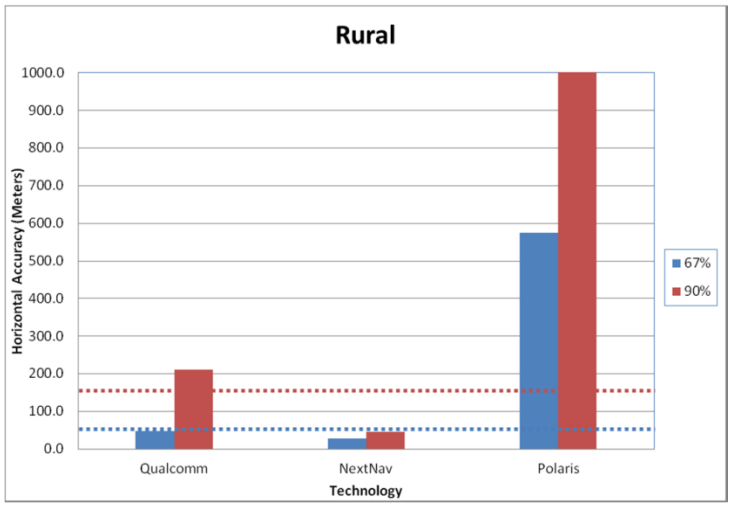
2D CSRIC Test Results by Morphology









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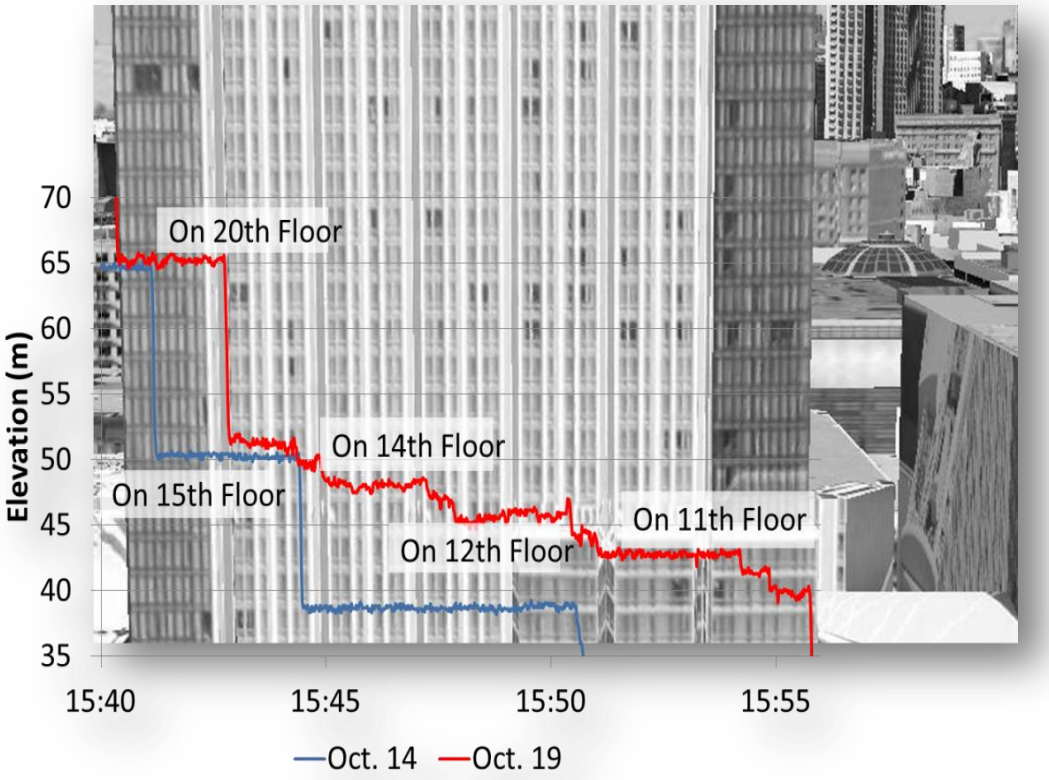
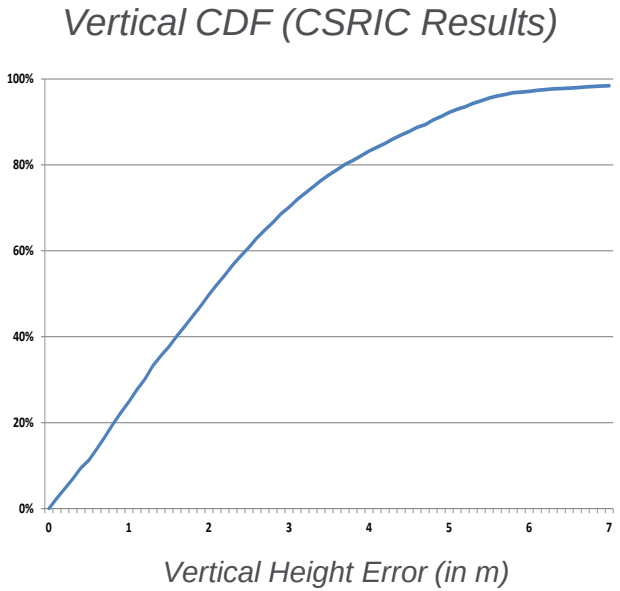
Floor-Level Height Accuracy





NextNav was the only company to have tested the Vertical in Indoor environments. Average vertical height error was 2m

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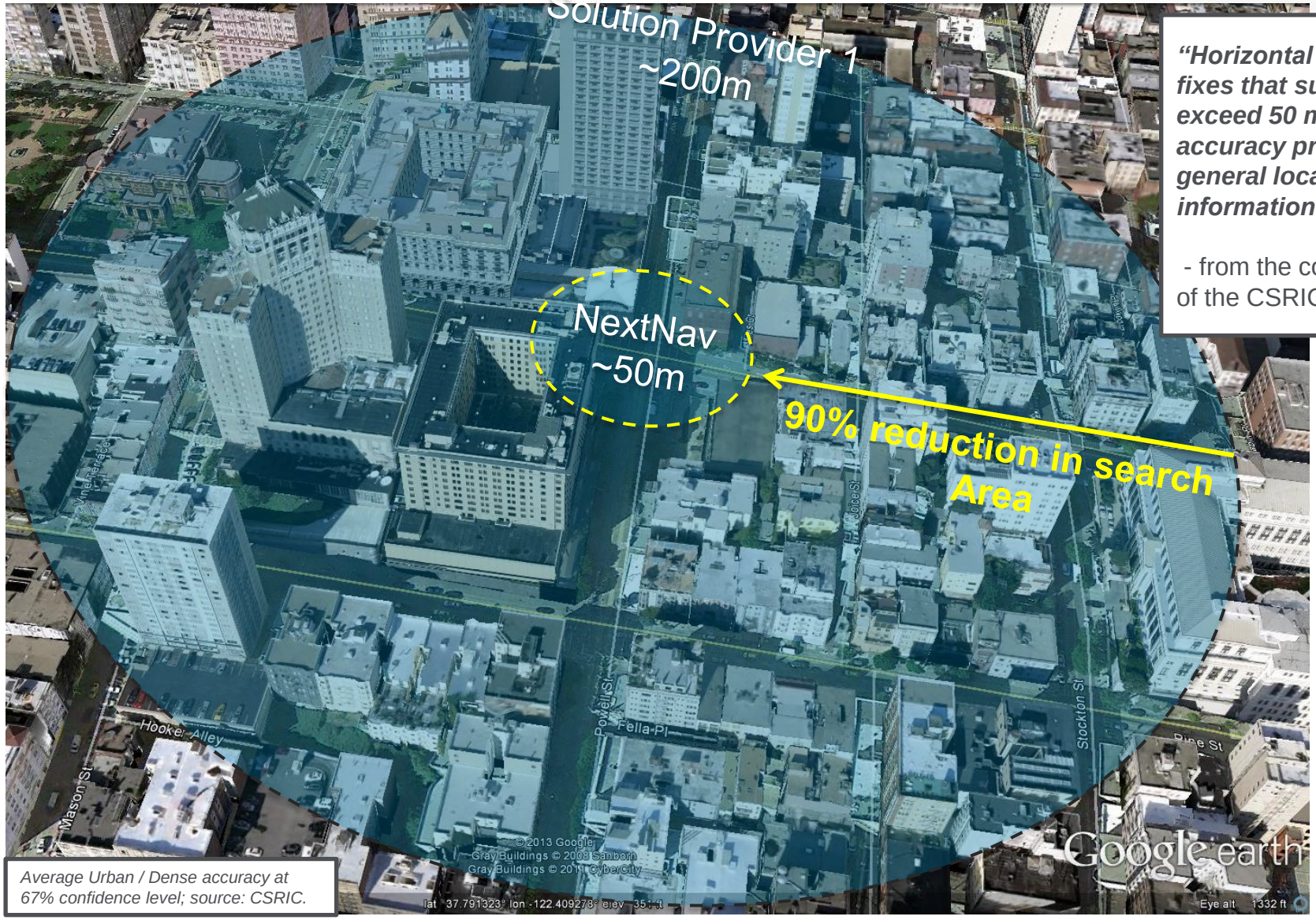
Urban Search Ring Results



Average Urban / Dense accuracy at 67% confidence level; source: CSRIC.

"Horizontal position fixes that substantially exceed 50 meter accuracy provide only general location information…"

- from the conclusions of the CSRIC report

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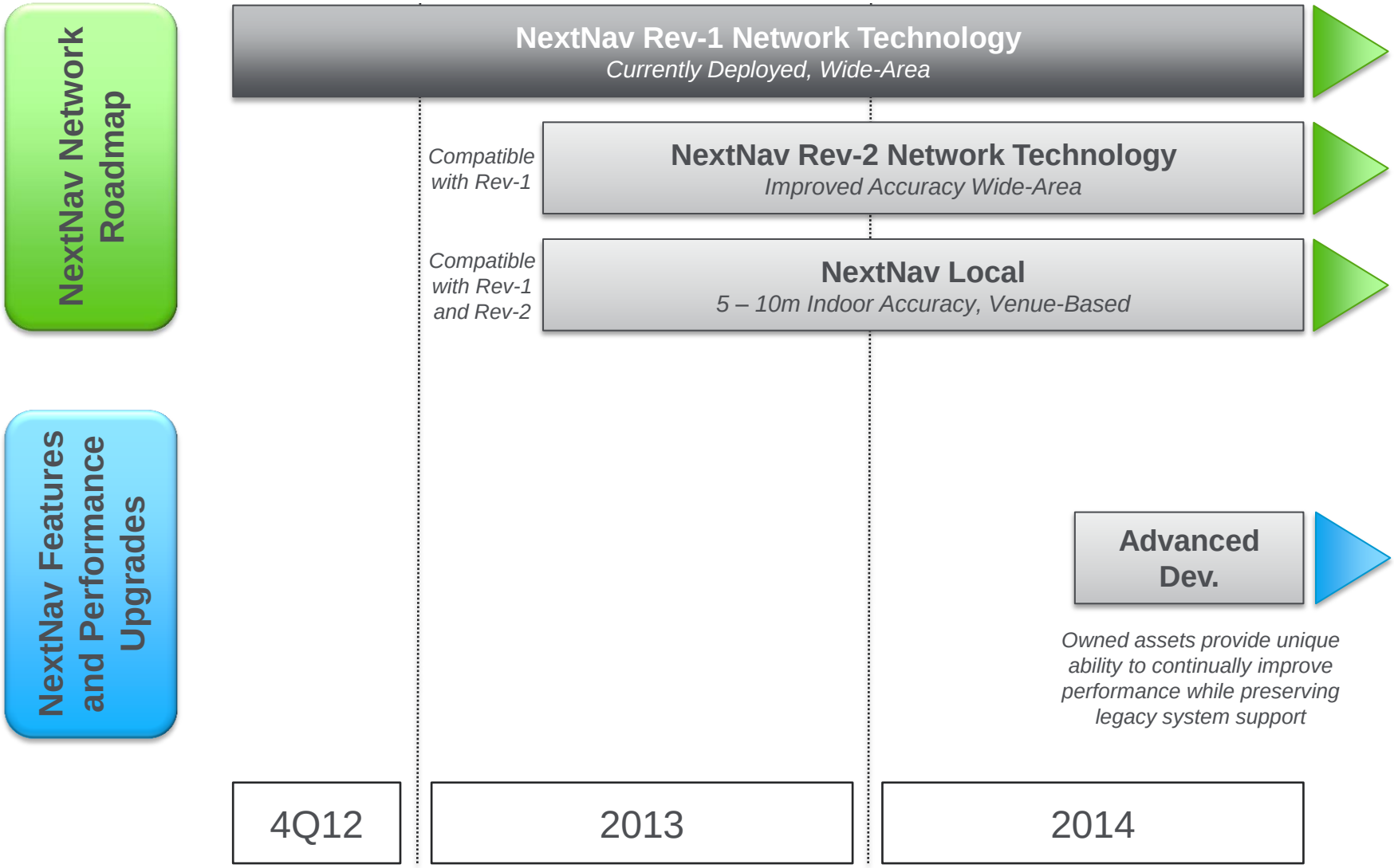
Product Roadmap



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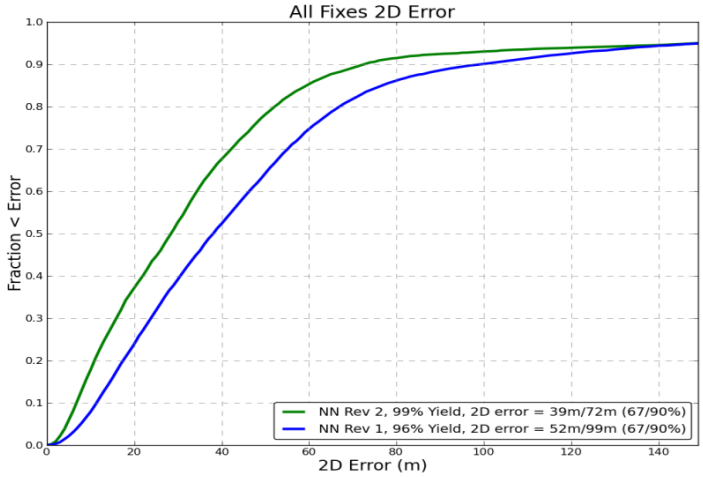
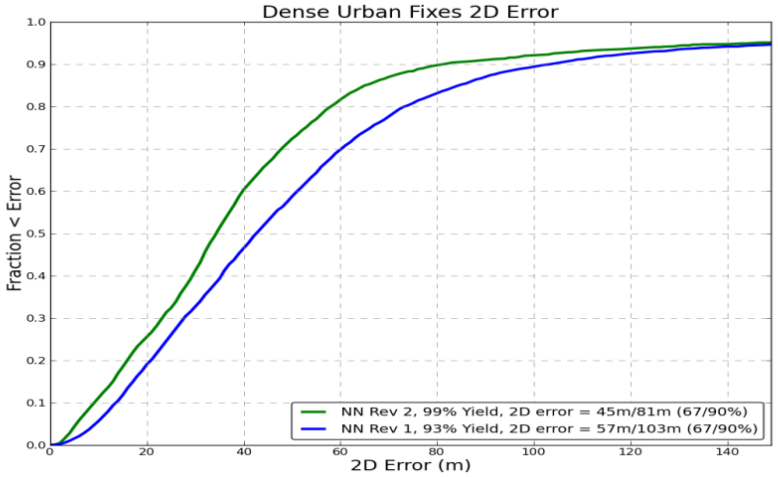
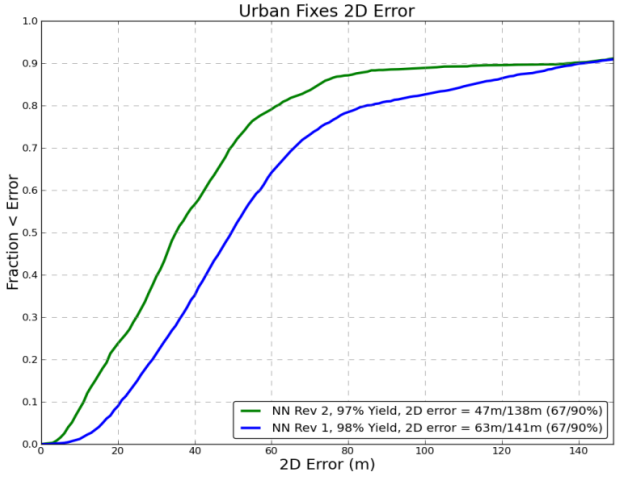
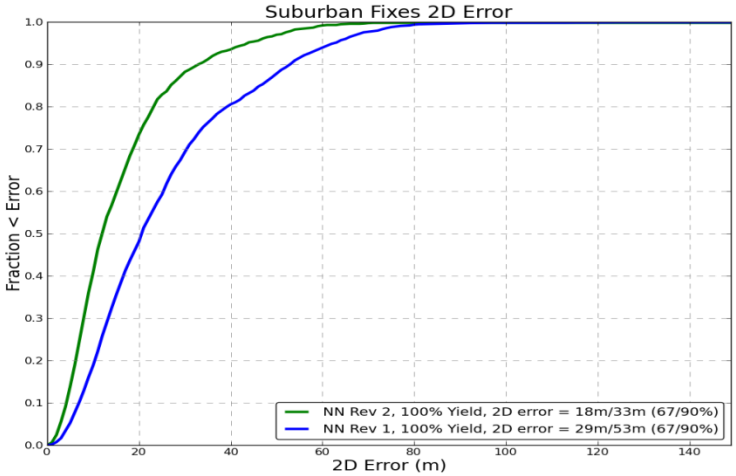
Rev 2 NextNav 2D Results









NextNav's Rev 2 system delivers a consistent 20 - 25% improvement in performance compared to its Rev 1 system

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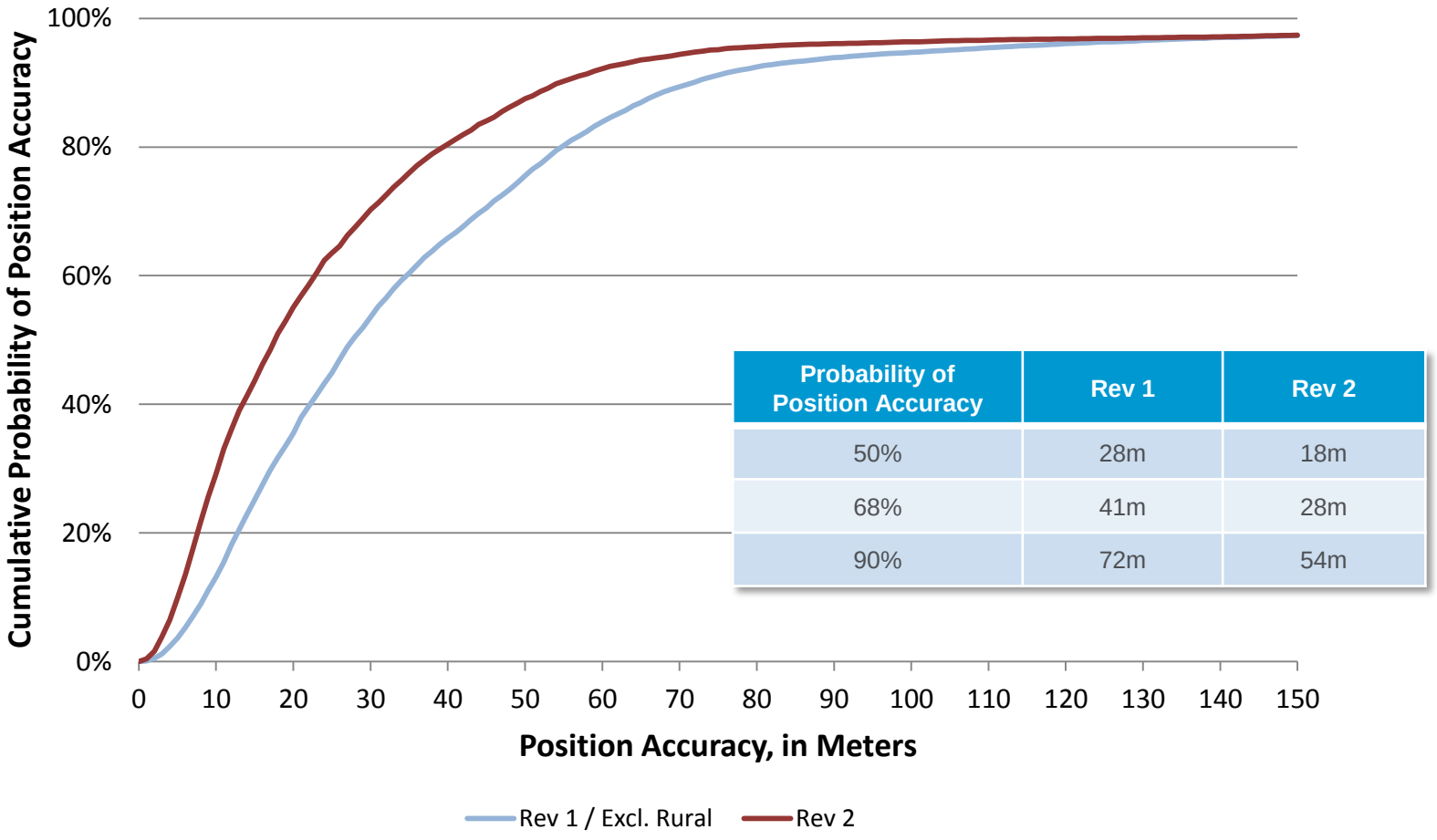
POP-Weighted Performance Metrics

The following chart depicts the CSRIC Rev 1 and Rev 2 performance data, weighted by US population density in urban and suburban areas[1]



Probability of Position Accuracy	Rev 1	Rev 2
50%	28m	18m
68%	41m	28m
90%	72m	54m

(1) The U.S. Census describes 30% of the population living in urban areas, 50% in suburban areas and 20% in rural areas. Data excludes testing in rural areas, where GPS functions adequately.

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In Commerce, Vertical Ambiguity Means Contextual Ambiguity…

Different places.
Different people.
Different intentions.

But all share the same latitude and longitude – altitude is the difference.

NextNav has demonstrated median height accuracy of <1.5m (better than floor level) in 3rd-party testing designed for mission-critical applications like 9-1-1.

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NextNav Tracking Performance – Westfield Valley Fair, Rev 1 System

- Walking test result in Valley Fair Mall, ground-truth (red) compared with NextNav measurements (green)
- Beta test – tracking algorithm still being tuned

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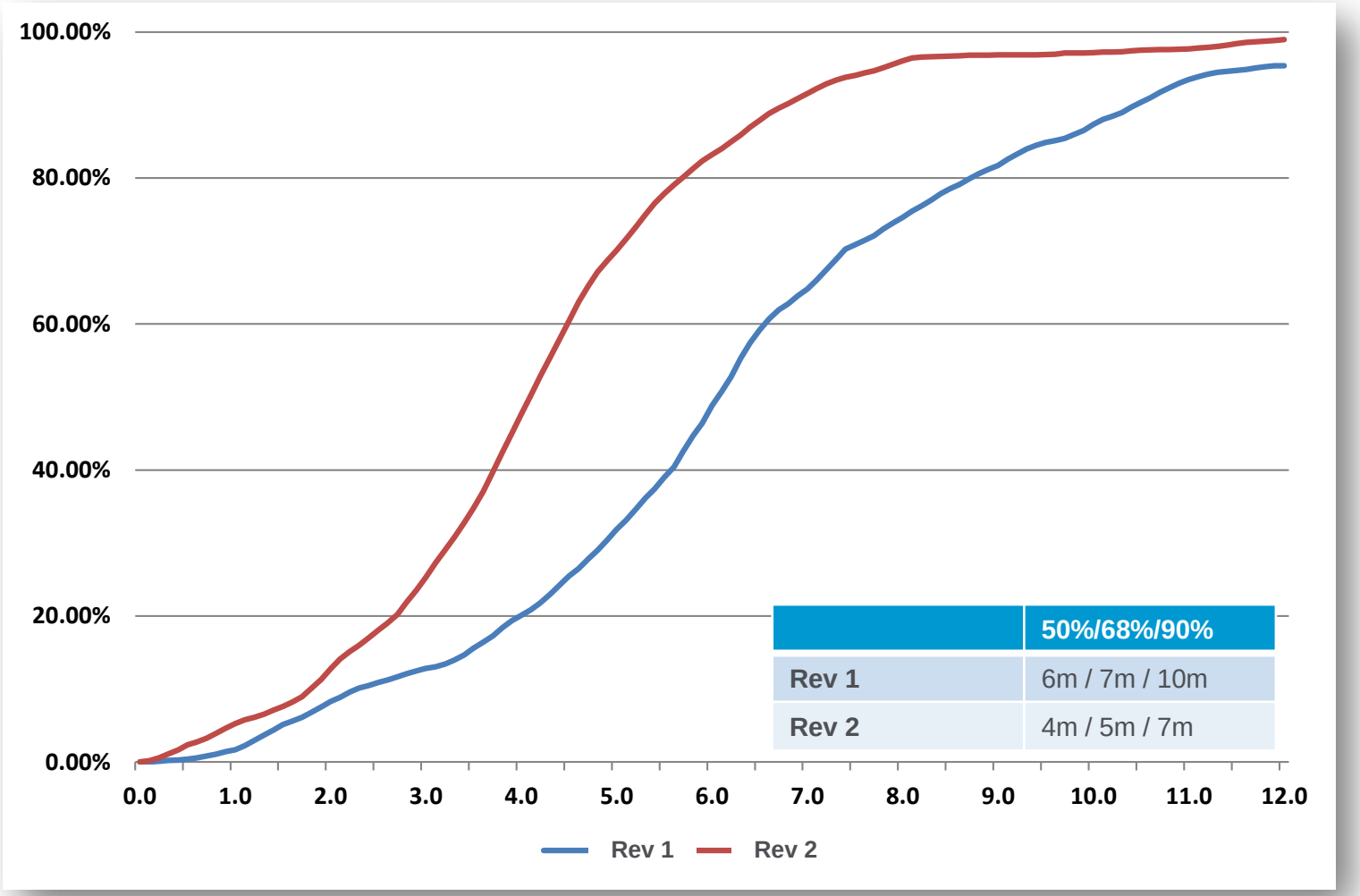
NextNav Local

- Optimized for campus, mall, warehouse or similar localized areas
- 5 – 10m horizontal accuracy
- ***Fully compatible with NextNav Metro deployments – effectively a high-performance underlay of same tech.***

NextNav Local Results



Summary

- NextNav is deploying a revolutionary wide-area positioning system
  - Fully managed network, based on owned assets, brings high-precision, reliable location indoors
  - Underlying technology requires minimal chipset and device integration
  - Encrypted signals allow management of access to technology
  - Shared network allows multiple customers, for different services (e.g., E911, commercial)
- FCC has established a process to bring indoor location standards to wireless E911
- NextNav brings “carrier grade” ubiquity, reliability and accuracy to location

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