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September 10, 2018

Filed via ECFS

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: Notice of Ex Parte Presentation, *Wireless E911 Location Accuracy Requirements*, Public Safety Docket No. 07-114

Dear Ms. Dortch:

On September 6, 2018, Polaris Wireless, Inc. (Polaris Wireless) executives Tarun Bhattacharya, Chief Technology Officer, and Karl Kessenich, Executive Director of Business Development, and James Arden Barnett, Jr. of this firm met on the topic of the 9-1-1 vertical axis testing and results with Zenji Nakazawa, Public Safety and Consumer Protection Advisor to Chairman Ajit Pai and with the following representatives of the Public Safety and Homeland Security Bureau:

David Furth, Deputy Bureau Chief
Kenneth Carlberg, Chief Technologist
John Evanoff, Deputy Chief, Policy and Licensing Division
Rasoul Safavian, Electrical Engineer
Brenda Boykin, Attorney Advisor
Nellie Foosaner, Attorney Advisor

The attached presentation guided the discussion.

Polaris Wireless has developed and tested a highly accurate, software-based wireless solution for both vertical and horizontal location using multiple inputs. Its solution is not a set of sequential fall-back technologies, but a true hybrid that yields the altitude. Polaris Wireless was one of two participants in the

months long Stage Z Test Bed using barometric sensor information from cell phones to determine the probable altitude of an indoor wireless 9-1-1 call.

CTIA filed the 911 Location Test Bed, LLC's *Report on Stage Z* in a cover letter dated August 3, 2018.[1] The purpose of the September 6 meeting was to present the Polaris Wireless solution and test results and to clarify the report and the cover letter from CTIA that obscure Polaris Wireless's success in achieving highly accurate Z-axis fixes.

- Polaris Wireless was the only vendor to participate in all morphologies in all three test cities. The company used multiple cell phones by various device manufacturers (except as explained below), all three known smartphone barometric sensor manufacturers, and both new and used phones. Polaris Wireless also did not include any in-market barometric sensor bias compensation which proved to be a major disparity in performance affecting the test results.

- Polaris Wireless understood that this test would only provide for limited opportunities to compensate for barometric bias and that the company's active compensation measures should not be used. Accordingly, Polaris Wireless did not use the active compensation measures that it has meticulously developed to overcome sensor bias. Not until the draft report was circulated did the company realize that the other participant had been allowed to use active compensation measures within the test markets and throughout the duration of the trial.

  To address this disparity and verify fully compensated performance, Polaris Wireless requested that the Test Bed perform limited retesting or review and accept the computation of the very same test data but this time with the application of the active compensation measures. This computation yielded a z-axis accuracy of 2.8 meters overall (all test areas and morphologies), supporting floor level accuracy of 3 meters. The Test Bed LLC did not respond nor include this data in its report or in any supplement. At Polaris Wireless's request, the Test Bed LLC included a statement in the report that "variability in how the two vendors participated in the testing further rule out any side-by-side

[1] 911 Location Test Bed, LLC's *Report on Stage Z*, PS Docket No. 07-114, August 3, 2018.

comparison of the solutions." Yet, the Stage Z still inappropriately included numerous such unqualified side-by-side performance comparisons. Even in the final section, the Test Bed LLC failed to identify active barometric sensor bias correction as a key difference between the two solutions under test.

As a consequence, industry reports are now repeating this inaccurate comparison of performance and identifying the only difference being that Polaris Wireless was not tested on iOS devices. This is an oversimplification drawn by the clearly incorrect representation of results in the Stage Z report. With limited active correction of sensor bias, Polaris Wireless accuracy improved to 2.8 meters. Polaris Wireless and CTIA Test Bed LLC have subsequently met to discuss additional testing options, yet the timing for such testing is uncertain.

- Polaris Wireless had originally proposed to test a hybrid of barometric-sensor based location and 3D Wi-Fi capabilities. The 3D Wi-Fi provides important inputs that improve active compensation to overcome sensor bias which further improves accuracy and adds robustness to the overall solution. Test Bed LLC indicated that Polaris Wireless should not use the 3D Wi-Fi component because a nationwide 3D Wi-Fi database was not currently available nationwide and efforts to source the database jeopardized Stage Z testing. Polaris Wireless agreed and withdrew the 3D Wi-Fi capability completely from the test.

  Since iOS does not support the necessary measurements for 3D Wi-Fi, the Polaris Wireless test application supporting the full hybrid solution had been developed only for Android devices. The Polaris Wireless barometric-based vertical location solution is supported on iOS devices and could have been part of the test, but there was insufficient time to develop the test application for iOS devices.

- Polaris Wireless considers the Z Stage testing a success, achieving 4.8 meters with just a few compensation test calls outside of the test markets and prior to actual testing. Further, using only actual test call data, Polaris Wireless was able to demonstrate the ability to achieve 2.8 meters when active compensation was applied within the test markets as it was with NextNav.

- The Polaris Wireless active barometric sensor compensated results also validate the Stage Z test report conclusion that barometric sensor bias is a leading source of error. The use of Polaris Wireless compensation measurements improved accuracy in all cities. Additionally, as anticipated by ATIS testing guidelines and by the Test Bed, Chicago proved to be a challenging market despite relatively mild winter weather conditions.

- Although horizontal accuracy was not the focus of Stage Z testing, accurate horizontal indoor location is essential for estimating vertical location. Polaris Wireless noted that its solution achieved 25.8 meters indoor location at the 80th percentile, a meaningful improvement from Stage 2 testing which still demonstrated Polaris Wireless compliance through the complete mandate.

- Stage Z testing also demonstrated that the currently adopted standards for barometric sensor compensation are sufficient to support the Stage Z solutions under test, both demonstrating better than 3m accuracy. Standards will continue to adjust to technological improvements, but there is no need to wait. The standards support setting a benchmark now and it is incumbent upon carriers and device manufacturers to implement these standards.

- Since Polaris Wireless's solution is software-based, additional improvements in devices and carrier networks can be more easily accommodating. Demand from Public Safety and other markets will drive constant improvements even above and beyond these test results. Polaris Wireless is committed to ongoing innovation through its flexible and extensible platform and improving z-axis accuracy.

- Barometric-based vertical location technology solutions have been tested now from two location vendors. Polaris Wireless seeks additional forums in which to test its capabilities but strongly believes that more testing is not needed to set the metric. Polaris Wireless recommends that the FCC proceed with in establishing a vertical location benchmark metric of 3 meters on 80% of fixes for E9-1-1.

Polaris Wireless asks that the record reflect the points noted above. Pursuant to Section 1.1206(b) of the Commission's Rules, this submission is being filed for inclusion in the public record of the referenced proceeding.

Respectfully submitted,

James Arden Barnett, Jr.
Rear Admiral USN (Retired)

Attachment

cc: Zenji Nakazawa
David Furth
Kenneth Carlberg
John Evanoff
Rasoul Safavian
Brenda Boykin
Nellie Foosaner

Polaris Wireless – Vertical Location Solution and Stage Z Results

Wireless E911 Location Accuracy Requirements
PS Docket No. 07-114

before the
Public Safety and Homeland Security Bureau
Federal Communications Commission

September 6, 2018

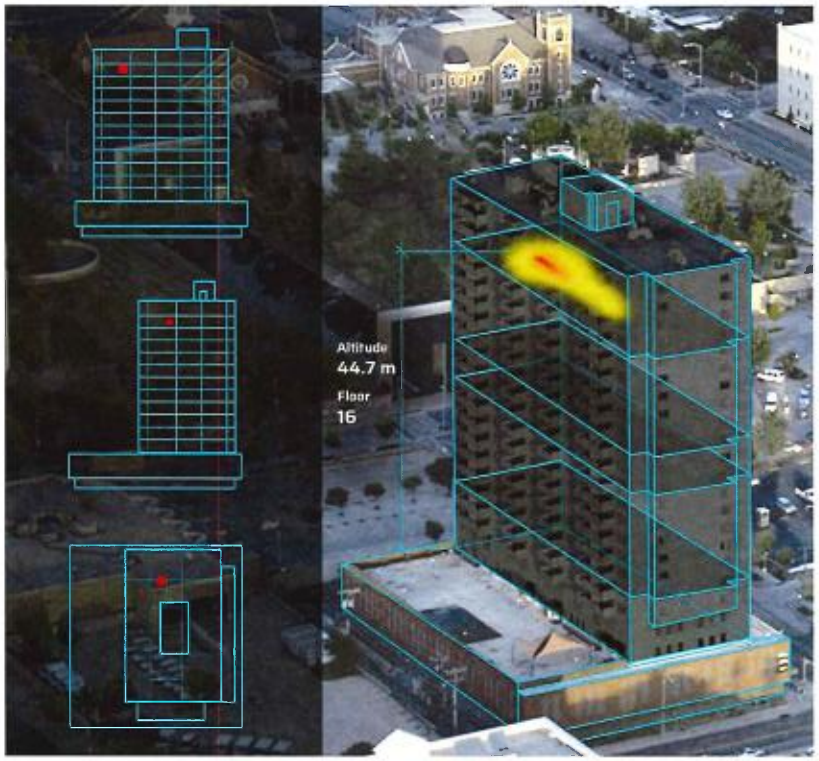
Global Leader in Wireless Location Solutions

Polaris Wireless

Agenda

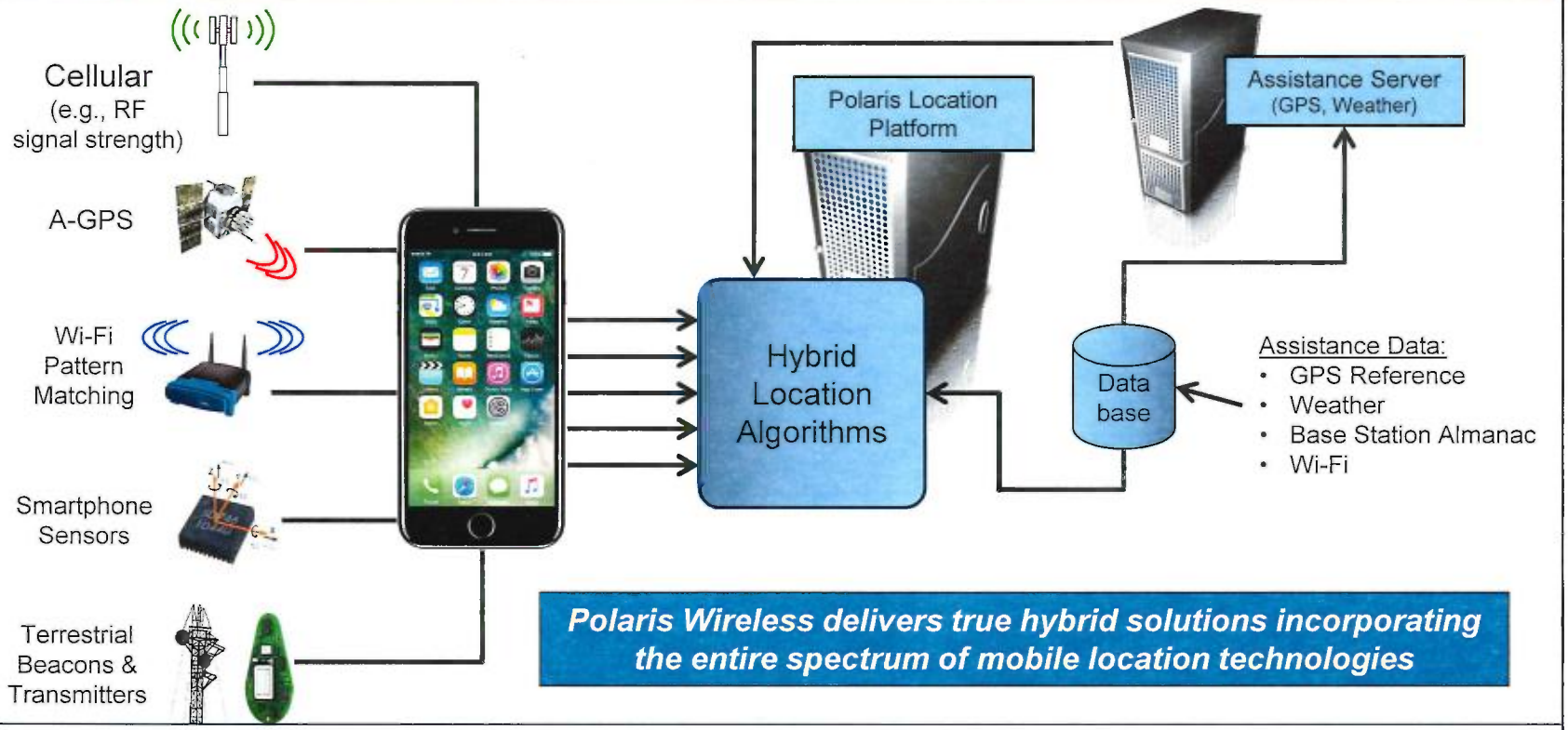
- Indoor Location Solution
- Barometric-based Location Impairments
- Stage Z Solution and Participation
- Report Commentary and Performance Results
- Accuracy Benchmark Statement
- Summary

Proven and Ready High Accuracy Capability



- High accuracy X, Y, and Z solution exists today
- Solution is software-based
- Solution provides nationwide coverage immediately upon initial deployment
- Capabilities have been thoroughly tested over the past 3 years

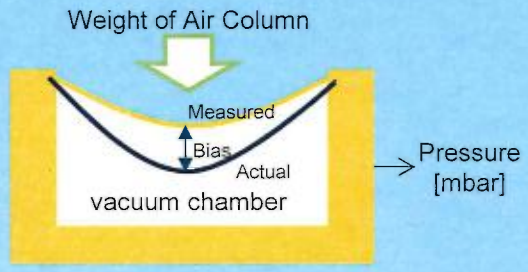
Leverages Multiple Location Technologies and Sensor Inputs



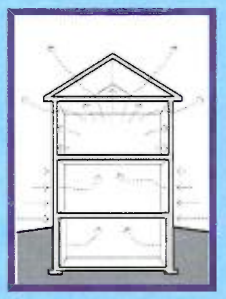
Polaris Wireless delivers true hybrid solutions incorporating the entire spectrum of mobile location technologies

Barometric Pressure-based Vertical Location – Impairments, Error Sources

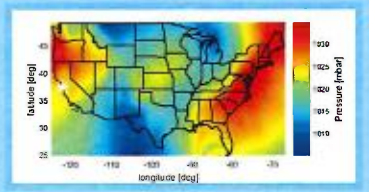
Barometric Sensor Bias

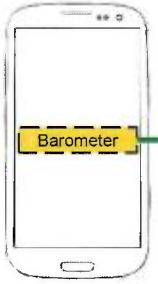


Building Effects



Weather Reference



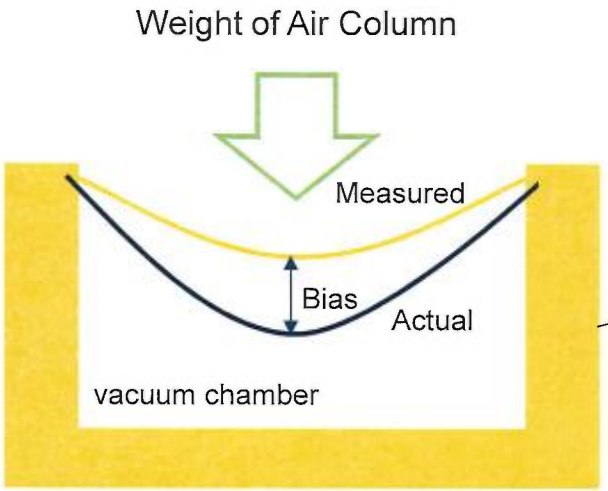


Polaris Location Server

Z-Axis Location

Barometric Pressure Z-Axis Location Estimation – Barometric Sensor Bias

Each barometric sensor has an intrinsic bias that, if not corrected, can cause 20+ meters of location error.



Uncompensated Pressure [mbar] + Bias Correction = Compensated Pressure

Estimating Barometric Sensor Bias is Critically Important

For E911 there are currently two possible approaches:

1. Standards-Based Approach
   - Current LPPe standard provides mechanisms today that allow for sensor bias estimation.
   - Devices will need to support this signaling and associated logic.

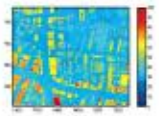
2. Proprietary Approach
   - One possible implementation is that the device periodically interacts with location server which in turn provides to the device a bias estimate. Future E911 calls then "compensate" pressure measurement to remove the bias.
   - Devices will need to implement any proprietary approach.

Polaris Wireless has solutions for both methods
Carriers and Devices need to support and implement industry standards

Stage Z Solution Under Test

Datalogger Application
Used for Test Purposes

GIS:
e.g., Terrain /
Canopy Data



Weather Station Reference :
Used to compensate barometric pressure readings and sort out weather conditions that would deem barometric pressure unreliable

Devices

User Plane

Polaris Location Server

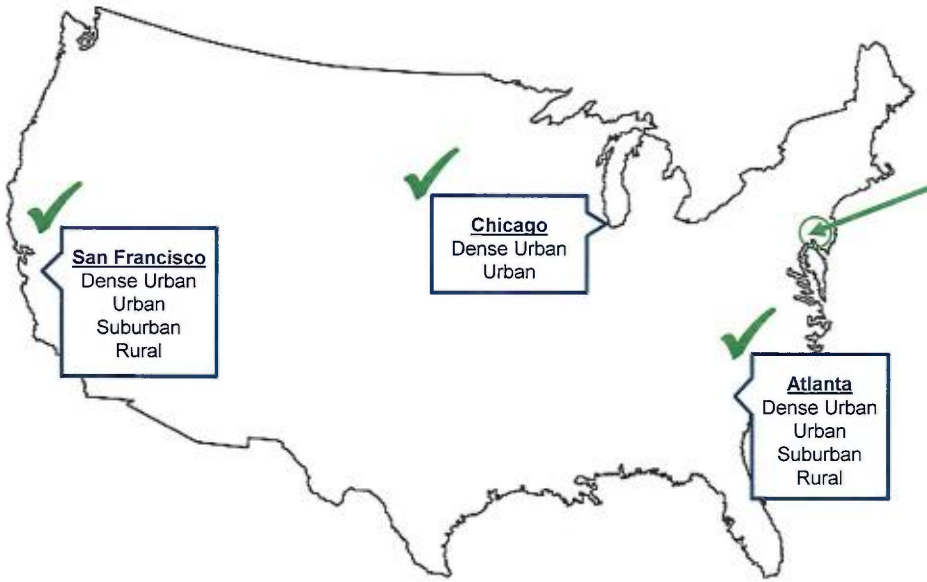
GNSS Reference Feed

Results Store

Base Station Almanac

Wi-Fi Database

Stage Z Participation



- ✓ All test markets
- ✓ All test environments
- ✓ Wide variety of devices
- ✓ Wide variety of baro sensors

Polaris Wireless Test Parameters	
Tier I Carrier Networks	2
Device Manufacturers	5
Barometric Sensor Manufacturers	3
Markets Tested	All
Test Market Compensation	None

Device Comments – Wide Range of Device and Sensor Manufacturers

	Tested in each Market	Details
Different Devices	6	
Device Manufacturers	5	Samsung (2), Sony, Motorola, Essential, Huawei
Barometric Pressure Sensor Manufacturers	3	ST Microelectronics (3), Bosch (2), Alps Electric
Device Condition	New and Used	Samsung (used), all others (new)
Device Types	Low End – High End Smart Phones	Retail price range: $400 to $950
OS	1	Android only. Polaris Wireless supports iOS, but test application not available at beginning of trial.

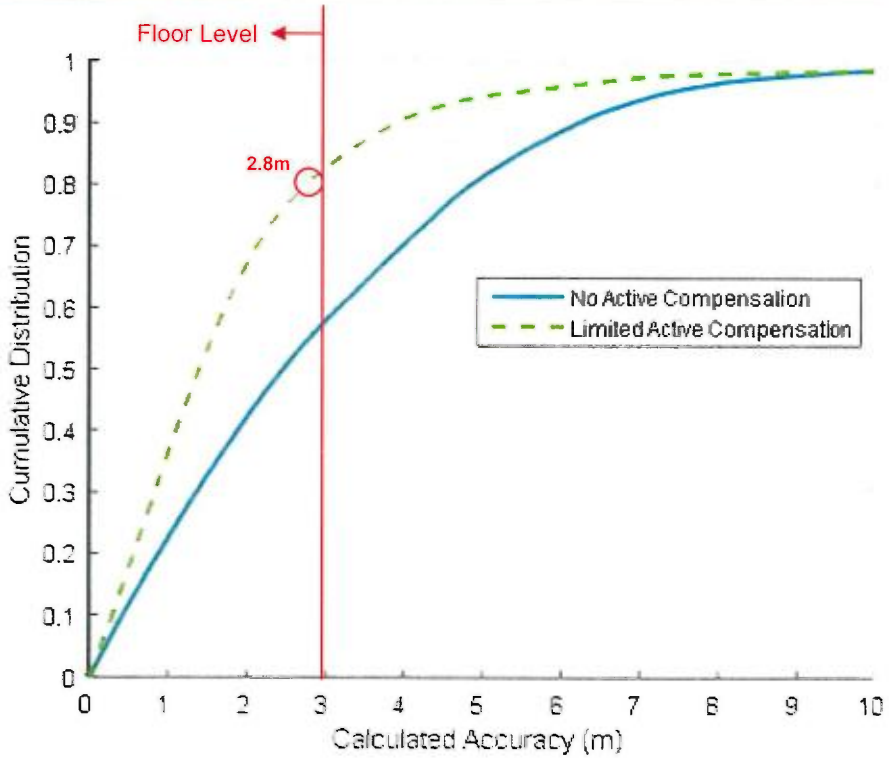
Polaris Wireless supported a wide range of devices to characterize performance and inform industry

Stage Z Report – Polaris Wireless Commentary

- Introduced Compensated Results
  - Data derived only from actual Stage Z test call data and were 'blind', meaning they were disclosed to the Tests Bed before any results were known.
  - Adjusted barometric sensor bias compensation on a monthly basis for duration of testing.
  - Requested limited market retesting or certification of compensated performance results.

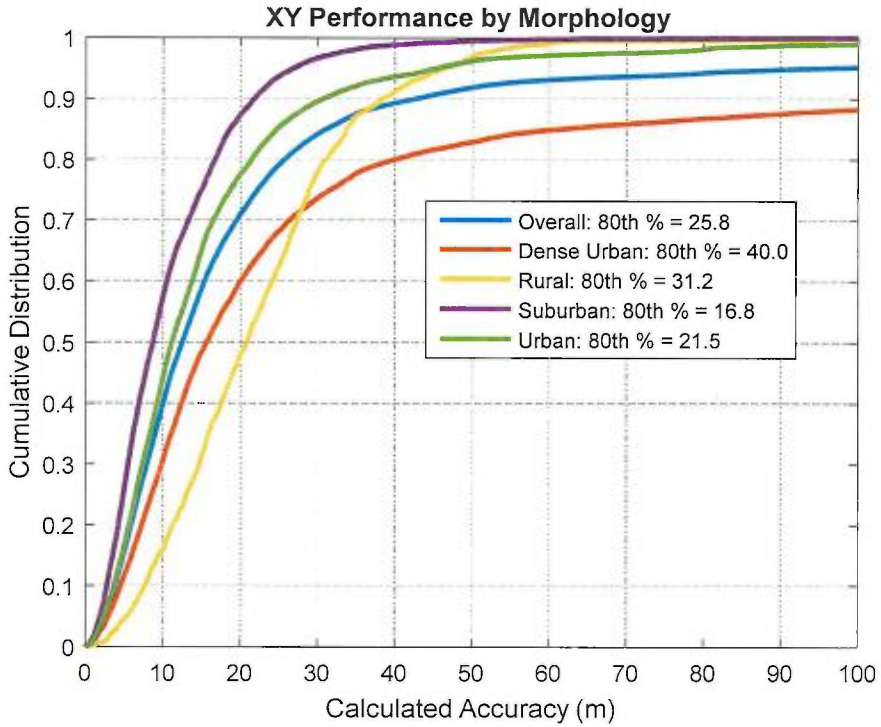
- Illustrated Two Key Findings:
  1. Validates Stage Z report conclusion that barometric sensor bias is a major source of error.
  2. Demonstrates Polaris Wireless achieves floor level accuracy, < 3m.

Stage Z Results: Polaris Wireless Achieves Floor Level Accuracy

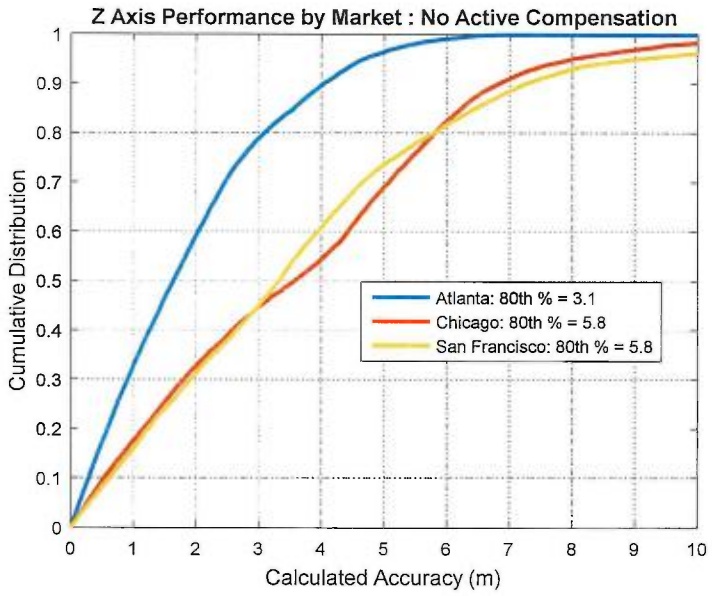


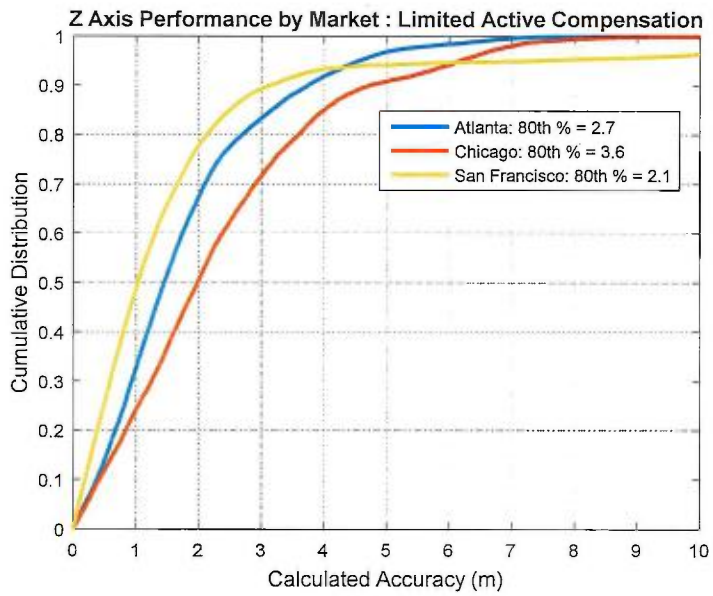
Limited Active Compensation	Markets	Aggregate Accuracy (m) at 80% Percentile
Disabled	All	4.8
Enabled	All	2.8

Stage Z Test Data – Horizontal Accuracy Continues to Improve



Chicago Introduced a Challenging Environment





As anticipated by ATIS testing guidelines, the Chicago test market represented a more challenging environment.

Accuracy Benchmark Statement

- The Polaris Wireless solution Stage Z performance:
  - 4.8m at 80% without active compensation
  - 2.8m at 80% with compensation
- Technology is not static
  - Improvements in devices, networks, and technology foster continual evolution
  - Other markets for 3D location demand improvements in accuracy
  - Polaris Wireless is committed to continual innovation
- Recommend vertical location benchmark metric of 3m at 80%for E911 mandate
- Current test data is sufficient to establish this vertical accuracy benchmark metric

Polaris Wireless is Ready to Serve Public Safety

- 18+ year commitment to innovating high accuracy location capabilities
- Software-based solution
- Flexible methods of delivery
- Fast deployment with immediate nationwide coverage
- Open to collaboration with technologies and solutions serving Public Safety
- Appreciates the opportunity to participate in industry testing

Thank you