Indoor Test Report to CSRIC III-WG3

Bay Area Stage-1 Test Bed

January 31, 2013

Prepared By:

TechnoCom

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Executive Summary

The San Francisco Bay Area was selected by CSRIC-III Working Group 3 (WG3) to serve as the setting for the Stage-1 Indoor Test Bed. The testing followed the methodology adopted in the CSRIC Test Plan, which was based upon the indoor test methodology defined, and adopted by consensus, in ATIS-0500013. This methodology centers on performing the indoor testing in sample buildings within the salient representative morphologies (i.e., wireless use environments), which are dense urban, urban, suburban and rural.

Polygons surrounding areas that contain the four morphologies were defined by WG3. They spanned the Bay area from the City of San Francisco and extending to 40 miles south of San Jose. 19 buildings were selected within those boundaries through intensive cooperation among WG3's building subcommittee, public safety, local officials, private contacts and the "test house" performing the indoor testing, TechnoCom. The eventual distribution of buildings tested was 6 dense urban, 5 urban, 6 suburban and 2 Rural. The selected buildings formed a diverse sample of building types commonly present in the four basic environments and a solid, challenging test sample that represented well beyond California.

75 test points were selected by TechnoCom in the 19 buildings per the criteria of the CSRIC test plan. Until the delivery of the test results in second half of January, the locations of the test points were not shared with any member of WG3, including any company participating in or funding the test bed.

Statistically significant samples of stationary test calls were placed from each test point using multiple test devices for each of the 3 location technologies under test by NextNav, Polaris Wireless, and Qualcomm. In all, over 13,000 valid test calls were collected across the test points for each of the 3 technologies. Polaris' results were aggregated over AT&T's and T-Mobile's networks. Qualcomm's results were aggregated over Sprint's and Verizon's networks. NextNav operated essentially as a stand-alone overlay location network. Broad and representative wireless industry participation was thus achieved in Stage-1 of the test bed.

To ensure that indoor ground truth accuracy did not introduce measurable errors in the results, TechnoCom used a certified land surveyor from the Bay Area, using well established land survey techniques. This ensured that the highest quality and reliability was achieved in comparing the test call locations to the actual ground truth. The surveyed information included latitude, longitude and altitude at each test point. The certified accuracy was +/-1cm horizontal a +/-2cm vertical, which is far better than the minimum required accuracy.

The test results are provided for the various location performance attributes under test, namely, horizontal location accuracy, vertical accuracy, yield, time to first fix (TTFF), and reported uncertainty. Furthermore, to provide CSRIC WG3 and the FCC with insight into the qualitative indoor performance of the location technologies in the different environments, and to place the location error distances in the proper indoor perspective, scatter diagrams have been prepared and provided for each technology at each test point.

The quantitative results have also been aggregated by building and by morphology. Summary results across the four morphologies are presented first, followed by the detailed results for the test points in each test building, grouped by morphology.

Concise observations on the results, which benefit from the insight gained by TechnoCom in selecting the test points and becoming intimately familiar with their surroundings, are also provided to aid the reader in interpreting the results. The report is then concluded with a summary of the lessons learned and suggestions for future test beds, presented from the perspective of the independent test house executing the indoor testing within the constraints of the real world.

1 Introduction

1.1 Test Bed Background and Objectives

CSRIC III Working Group 3 (WG3) was tasked by the FCC to investigate wireless location in the context of indoor wireless E911. In June 2012, WG3 submitted its initial report to the FCC regarding Indoor Location Accuracy for E9-1-1. As one of its primary findings, the report identified the lack of objective and validated information regarding the performance of available location technologies in various representative indoor environments. The Working Group identified obtaining this critical information as its highest priority and established a set of cooperative actions, including the creation of an independent test bed, to accomplish this task.

WG3 created the framework for the test bed whose objectives have been to:

- Objectively and independently test the accuracy and dependability of location technologies in a wide range of representative indoor environments reflective of wireless use.
- Provide the FCC with verified data on the capabilities of location technologies on which to base their decisions regarding the strategic direction of E911, which is increasingly affected by indoor wireless use.
- Establish a benchmark upon which emerging technologies can be compared to determine their relative promise in improving the capabilities that are currently available (both in terms of accuracy and/or consistency).

1.2 Independent Test House

One of the key attributes of the test bed, as well as key to its success, is employing a well-qualified, experienced, independent contractor to perform the tasks of test planning, test execution, data analysis and reporting to WG3.

Since its inception in 1995, TechnoCom has been providing its engineering expertise to a host of location technology companies and wireless carriers evaluating and subsequently deploying some of those technologies. Throughout its history, TechnoCom has opted to take a location technology vendor independent approach to its E911 quality of service assurance and testing business.

Over the last decade, TechnoCom has also been a key player in the development and adoption of industry standard E911 testing methodologies. Notably, TechnoCom was a lead contributor in the development of the indoor testing methodology within ATIS's ESIF, which is the methodology adopted by CSRIC WG3 as the basis for indoor testing within the test bed.

Upon a formal RFI process, TechnoCom was awarded the independent test house role. It has brought a strong commitment from its principals to the successful execution of this test bed effort.

1.3 Scope of Report

This report contains the results of the indoor testing performed by TechnoCom in November and December of 2012 on behalf of WG3. To cast the results in the proper context, introductory sections concisely describe the testing approach, testing criteria, and the three specific technologies tested in this stage of the test bed. A more detailed description of the representative environments (morphologies) is then presented along with the specific buildings selected within each of the morphologies for inclusion in

the test bed. The information included on the selected buildings is important in providing the reader with insight for interpreting the results of the testing. The results are then provided first in summary form and then in more detail for each of 75 test points. The summary results are aggregated by building and by morphology. Concise observations on the results, which benefit from the insight gained in selecting the test points and becoming intimately familiar with their surroundings, are also provided to aid the reader in interpreting the results. The report is then concluded with a summary of the lessons learned from playing the role of the independent test house and executing the indoor testing in the real world.

Per the direction of WG3, the precisely surveyed ground truth coordinates have been withheld and provided to the funding participants of the Stage-1 testing. Nineteen formal survey reports (one for each of 19 test buildings) containing the detailed coordinates and descriptions of the each of the test points along with additional pictures for site visits have also been provided to the funding participants of the test bed.

1.4 Contact Information

Company:	TechnoCom Corporation
Contact Person:	Dr. Khaled Dessouky
Title:	Executive Vice President
Phone:	818-523-7603
E-mail:	kdessouky@technocom-wireless.com

2 Test Approach

2.1 Side by Side Testing

In the dynamic, aggressively competitive wireless industry, a longstanding complaint voiced by wireless carriers centers on the unsubstantiated claims of some location technology vendors about the performance and reliability of their technologies. This is particularly true of new or emerging technologies that have not been subjected to extensive validation in the field. The tests conducted and the results presented in this report seek to provide a common base to test all technologies available.

Since the initial discussion within WG3, the concept of objective side-by-side testing of location technologies under well defined, clearly quantifiable conditions became a central tenet of the test bed concept. Fortunately, the test methodology developed in ATIS-0500013 for indoor testing readily lent itself to such rigorous side-by-side testing.

2.2 Representative Morphologies (Use Environments)

The many challenges of indoor testing compared to the mostly vehicle based outdoor testing are well publicized. Indoor testing cannot be practically performed (at least today) in hundreds or thousands of buildings in a given test area. From that reality arose the notion of testing indoor performance in representative scenarios. Figure 2.2-1 illustrates the logical flow-down in this methodology.

In each morphology (i.e., broad wireless use environment) a number of buildings of different sizes and types common in that morphology are identified. Within each building, different test points are selected to represent the range of conditions encountered within that building. The number of test points in a given building depends on its size and complexity. Then at each test point a statistically significant number of independent test calls is placed from one or multiple handsets. The morphologies (or wireless use environments) are those that were defined in ATIS-0500011, namely, dense urban, urban, suburban

and rural. These morphologies have subsequently been adopted in ATIS-0500013 defining the recommended indoor location test methodology.

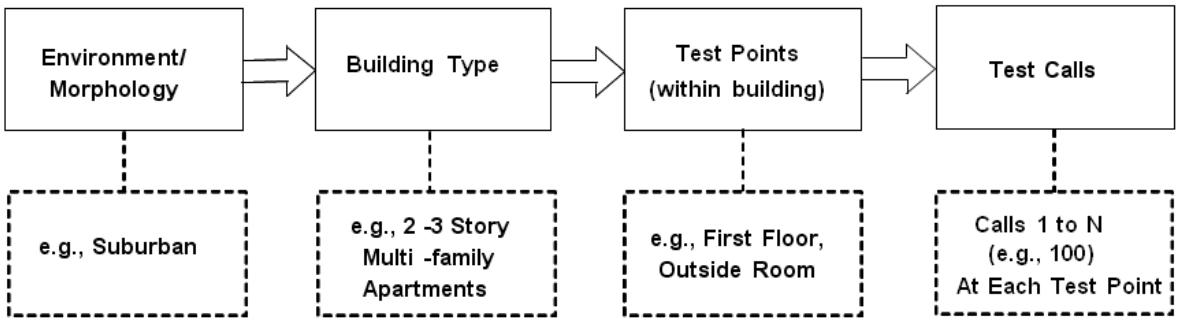


Figure 2.2-1. Morphology, Building and Test Point Flow Down

The San Francisco Bay area was chosen by WG3 because it has the various distinct morphologies sought. It enables efficient testing that could be achieved with one test team, with a reasonable amount of travel within the area. A dense urban polygon was identified in the City of San Francisco around its financial district. Two urban polygons were selected one in San Francisco adjacent to the dense urban polygon and one in Downtown San Jose. Those two urban settings are somewhat different with San Francisco representing an older urban clutter and San Jose a newer clutter with wider streets and more spaced large buildings. A large suburban polygon was selected in Silicon Valley centered around Santa Clara-Sunnyvale-San Jose. The rural polygon was chosen 40 miles south of Downtown San Jose between Gilroy and Hollister, primarily driven by the desire to have a relatively sparse cellular site density as seen in rural areas that are more remote or outside California. The polygons representing the 4 morphologies are described in detail, including the buildings chosen in each in Section 5.

Between the 19 buildings spanning the 4 distinct morphologies a wide spectrum of building types and settings were attained. This was complemented by a wide range of test point scenarios inside those buildings. This created a broadly representative sample with very meaningful results, demonstrative of indoor performance in many areas throughout the United States.

2.3 Statistically Significant Samples

Indoor location performance can suffer from rapid changes in signal conditions and can experience significant performance variation from call to call even within a short period of time. It is therefore necessary to use a large enough sample of independent calls at each test point to arrive at reliable (statistically significant) performance statistics. The consensus of the WG3 Test Plan sub-group has been that a minimum recommended sample size per technology per test point is 100 calls.

Test planning proceeded based on that requirement to arrive at the best combination of number of devices to test simultaneously per technology, the minimum required length of the test calls, and how long it takes to place the required calls vis-à-vis the need to complete testing in each building in no more than a day.

This delicate balance, after some adjustments during the early days of actual testing, resulted in that this target was easily met at the vast majority of test points. Over 13,400 test calls were placed from the devices of each of the 3 technologies at 74 valid test points, averaging over 180 calls per test point. On few sporadic occasions, which coincided with the most RF challenging indoor situations, smaller samples were collected from some devices because the units or their applications encountered some difficulties in placing the test calls. Still adequate statistical samples were collected essentially everywhere. Aiding in this regard was the aggregation of the data gathered over two wireless networks to create a joint sample

for a technology. (Verizon and Sprint data was aggregated to produce the Qualcomm results whereas AT&T and T-Mobile data was aggregated to produce the Polaris results.)

2.4 Accurate, Reliable Indoor Ground Truths

The general requirements for indoor ground truth accuracy have been quoted in ATIS-0500013. For general test purposes a 5 m accuracy is likely acceptable, and that is was the minimum required accuracy in TechnoCom's Statement of Work.. However, since this test bed is a particularly visible benchmark and a model for the future, TechnoCom deemed it important to follow the most exacting of ground truth determination methods described in 0500013, namely using a professional survey company. TechnoCom selected a certified land surveying vendor from the Bay Area, who is intimately familiar with the morphology and terrain. This has ensured that the highest quality and reliability is achieved in comparing the test call locations to the actual ground truth of the selected test points. The survey information provided by the vendor included latitude, longitude and height. The certified accuracy is +/-1cm horizontal a +/-2cm vertical, which is far better accuracy than the minimum required 5 m accuracy. The survey method and equipment are described in Section 4.2, along with a sample survey ground truth output measurement.

2.5 Performance Attributes Analyzed

2.5.1 Location Accuracy

The error in estimating the location of the device under test was computed by comparing each vendor's reported horizontal position (provided to TechnoCom) to the surveyed ground truth position of the test location (determined through a precise survey). Each test call (or equivalent) was assumed to be independent from prior calls and accuracy was based on the first location delivered by the vendor after "call initiation."

This accuracy information is presented in Section 6 for each technology at each test point and aggregated by morphology. The accuracy statistics include the 67th, 90th and 95th percentiles of horizontal accuracy along with the average distance error, standard deviation of error, and minimum and maximum errors, all in meters. Aggregate statistics are also provided by building and by morphology. In addition, the error CDF has also been provided for each technology per point and aggregated by morphology. Comparative results for the 3 technologies under test have also been provided in the form of overlaid CDFs and bar graphs for the 4 morphologies (dense urban, urban, suburban and rural).

Vertical distance error has also been reported separately for the NextNav technology. The absolute vertical distance error has been used in these statistical computations. CDFs are also provided for the vertical error by morphology.

For AGPS, valuable information that has a close relationship to accuracy is fix type (e.g., GPS, AFLT, Hybrid, etc.). The obtained accuracy is directly related to the fix type, particularly the proportion of GPS fixes attainable. Since fix type information is available from the extracted PDE logs, it is included in the detailed per test point results for AGPS.

2.5.2 Latency (TTFF)

The Time to First Fix (TTFF) or the time to obtain the first computed caller location is reported for each technology at each test point and aggregated by building and by morphology. This processing time is calculated by establishing the precise time for call initiation (or an equivalent initiation event if the vendor's test configuration did not support the placement of an emergency like call, e.g., 922). TTFF statistics are reported in Section 6 on a per test point per technology and aggregated per building and by morphology.

2.5.3 Yield

The yield of each technology is evaluated by relying on the information received from each vendor's log files and/or that which is generated inside the device that is accessible to TechnoCom. For each test point, the calls that result in no location fix will be deemed as calls with no delivered location. Yield will be the % of calls with delivered location to overall "call attempts" at each test point. Even though 30 seconds is considered the de facto standard maximum latency, if a location fix is delivered after 30 seconds it is still included in successful call attempts.

The yield results are reported in Section 6 on a per test point per technology and aggregated per building and by morphology.

2.5.4 Reported Uncertainty

The horizontal uncertainty reported by the location systems has been captured and as needed normalized to correspond to 90% confidence. The reported uncertainty at each test point is compared to the fraction of calls for which the resulting (empirically measured) location falls inside the uncertainty circle. The ideal number would be 90% of the calls have an actual error that causes the reported locations to fall inside the reported uncertainty circle. In some instances technology vendors opt for a more conservative measure with a target of more than 90% falling inside the circle. Importantly, the quality of the uncertainty measure generally reflects how well a location system is operating, with poor performance very often associated with a low proportion of computed locations falling inside the reported uncertainty circle. The uncertainty results are also aggregated by building and by morphology for each technology.

2.5.5 Location Scatter

To provide CSRIC WG3 and the FCC with insight into the qualitative indoor performance of the various location technologies in the different environments, to aid in discerning possible effects of specific structural features at certain test points, and to place any common reference error distances in the proper indoor perspective, scatter diagrams have been prepared and provided for each technology at each test point. Overlaying the location scatter results on the building landscape, e.g., from Google Earth imagery, yields considerable insight into the potential and limitations of the attained indoor performance in each setting. Building sizes and densities vary significantly with the change in morphology and overlaying the obtained locations on an actual map of the buildings in the target area yields a rich insight into attainable versus aspired for or ideal accuracy performance for the E911 application.

3 Location Technologies Tested in Stage-1

3.1 Technology from NextNav

The NextNav location system utilizes GPS-like signals transmitted by the NextNav terrestrial beacon transmitters deployed across a geographical area. The signals transmitted from the beacons are spread-spectrum signals using Gold codes at a 1.023 Mcps chipping rate, similar to GPS. The beacons transmit in the 900 MHz licensed band. The NextNav network uses two identical signals, one with a center frequency at 926.227 MHz and one with a center frequency at 920.773 MHz. Using two channels is intended to provide frequency diversity, aiming to enhance the robustness of the service. The beacon broadcast transmissions carry all the necessary information for positioning at the NextNav receiver (handset based positioning).

3.1.1 Devices Tested

The devices utilized in this stage of the test bed were standalone receivers (sleeves) that received the NextNav beacons and computed their location. The received signal was attenuated at the output of the RF antenna by 2 dB to make it more equivalent to the envisioned handset based implementation.

A smartphone was connected to the NextNav receiver (the sleeve) and contained the test application utilized in creating the events equivalent to an emergency test call. The smartphone placed a call on the wireless network to include the effect of such RF transmission (although it was not intended for the placement of an emergency type test call such as 922). It was also used in transmitting the test logs via wireless data simultaneously to a servers at TechnoCom and NextNav. A smartphone/NextNav combo is shown in Figure 3.1.1-1.

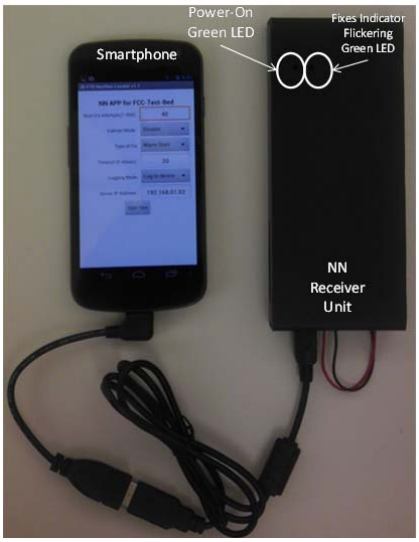


Figure 3.1.1-1. NextNav Receiver and Smartphone

The software test application (App) running on the smartphone was a key element of the NextNav test setup; it automated the capture and logging of the indoor location fixes. It also extracted from the NextNav receiver the computed location at each test point.

3.1.2 Test Configuration

The test configuration for the NextNav technology is shown in Figure 3.1.2-1.

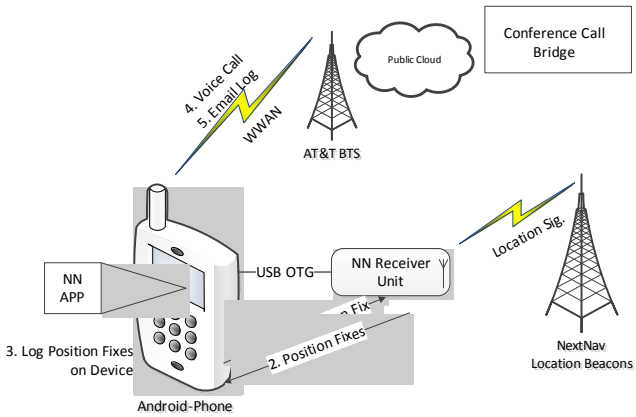


Figure 3.1.2-1. NextNav Indoor Test Configuration

In this test setup no network interfaces were invoked to trigger a test emergency type call. Instead, the App on the handset instructed the NextNav receiver to perform certain steps that emulated the events that occur during a positioning session concurrent with an emergency phone call. The concurrent call on the AT&T Wireless network emulated the effect of simultaneous RF transmission from the handset.

To create a positioning session, the NextNav receiver was turned on and the ON time was recorded by looking at the time value of RX-ON-ACK message sent out by the firmware of the receiver. The receiver then received the NextNav beacon signals and processed them to obtain the position. The position fix time was recorded by looking at the time value of the position message bearing a valid fix. The receiver was then turned off.

In the NextNav system the Warm-Fix mode was achieved by issuing a Receiver OFF command and then issuing a Receiver ON at the beginning of a subsequent location session, so that no state, location or other information was carried over between attempts.

3.1.3 Vendor Data Logs and/or Processing

The NextNav App logged the location fixes locally in a separate file for every "Start Test" button press. The log was closed at the end of a test session at a given test point. The App also sent via e-mail the individual test point logs to both NextNav and TechnoCom. At times, especially in difficult settings, the NextNav test application encountered problems, which resulted in the logs not being automatically e-mailed. In those cases the TechnoCom field engineer manually e-mailed the logs to NextNav and TechnoCom between the test points. TechnoCom also encountered situations where a manual restart of the application was necessary in order to resume test calls at a test point. These cases resulted in multiple logs that had to be handled carefully.

In addition to computed location coordinates and uncertainty, the log files recorded the relative time stamps in milliseconds for turning the NextNav receiver on and off (emulating the start and end of a test call) and of the computed location fix. The absence of an absolute GPS-type time stamp has caused some challenges in managing the log files and quickly ascertaining the time of the test call during subsequent analysis. However, this had no impact on the integrity or quality of the results.

3.2 Technology from Polaris Wireless

Polaris Wireless' technology uses RF pattern matching (RFPM), referred to a times as RF fingerprinting, uses radio frequency pattern matching to compare mobile measurements (signal strengths, signal-to-interference ratios, time delays, etc.) against a geo-referenced database of the mobile operator's radio environment

3.2.1 Devices Tested

Two standard, off the shelf Nokia C7 2G/3G smartphones locked to 2G (GSM) networks of AT&T and T-Mobile were tested.

Figure 3.2.1-1. Sample of Nokia C7 Handset Used in Testing Polaris' Technology

3.2.2 Test Configuration

As depicted in Figure 3.2.2-1 the Polaris Wireless test setup consisted of a laptop running Windows XP with Nemo Outdoor software installed, three handsets, and a Nemo USB key. The approach of using the laptop with the Nemo monitoring software made it possible to extract the RF measurements observed or received at the handset in lieu of accessing the L_b interface inside the wireless carrier network.

One of the handsets was locked to T-Mobile 2G (GSM), one was locked to T-Mobile 3G (UMTS), and one was locked to AT&T 2G (GSM). (Only 2G testing and data analysis was actually performed in this stage of indoor testing.) The laptop logged the test call related RF data from the test handsets. At the end of one or more days of testing, these handset logs were forwarded to Polaris for subsequent processing. This offline process was required because the Polaris position computing platforms were not integrated into the AT&T or T-Mobile networks serving the Bay Area. This also resulted in some call related information (available inside the network but not in the handset RF logs) possibly not being available for processing by the Polaris algorithms.

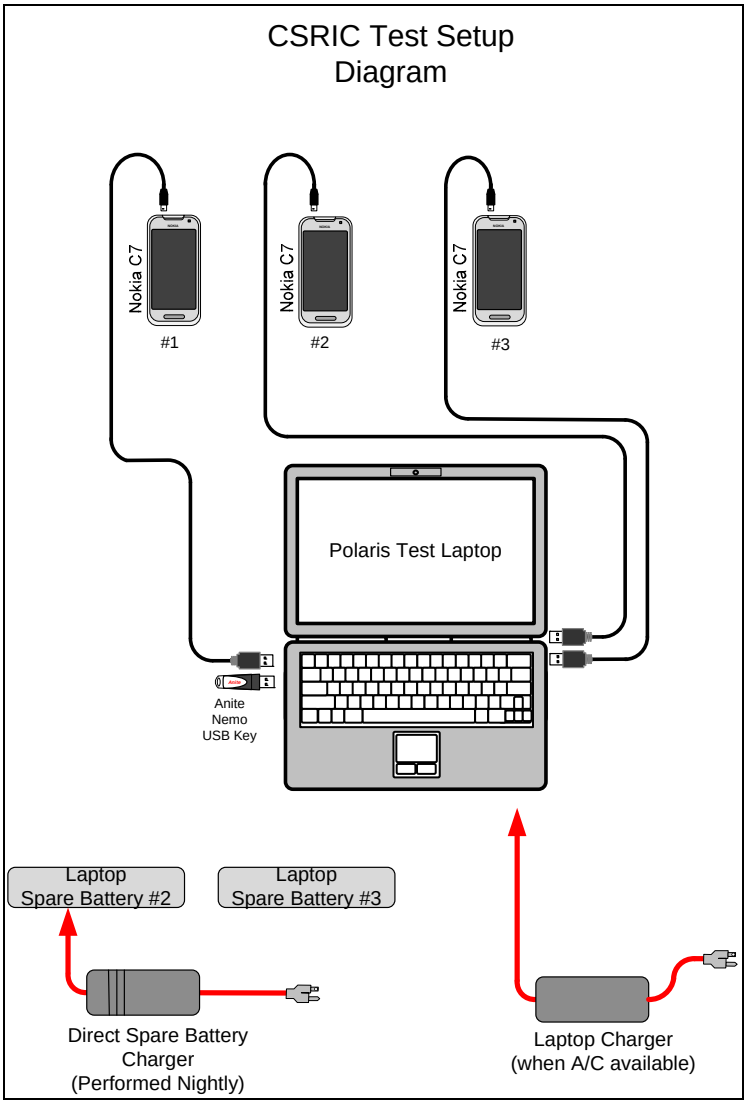


Figure 3.2.2-1. Polaris Indoor Test Configuration

3.2.3 Vendor Data Logs and/or Processing

Polaris' data processing was done off line as mentioned above. Polaris was experiencing some delays in resolving certain issues in the RF data bases it received from the wireless carriers. Rather than receiving the handset logs on a daily basis from TechnoCom and not being able to process them for several days till after the database issues were resolved, TechnoCom was instructed to retain the test logs until Polaris became ready to process them. In the beginning of the field testing period this delay was as much as two weeks. Toward the end of the testing period the long delays were overcome. Turning around the logs by Polaris to generate result files was often within 24 hours, although on a few occasions it took several days.

In its analysis of the result files from Polaris, TechnoCom aggregated the location results from the AT&T and T-Mobile networks. The results reported in Section 6 of this report are therefore reflective of the aggregate performance of 2G (GSM).

3.3 Technology from Qualcomm

Qualcomm's AGPS location solution takes advantage of the complementary nature of the GPS satellite constellation and the terrestrial wireless network. It creates a significant range of solutions depending on the achievable satellite visibility and network conditions. Because these solutions combine to work as one, it is viewed as a hybrid solution. This technology was the first commercially available, integrated wireless AGPS technology; it is very widely deployed and in regular use. It has been field-tested extensively for E911, albeit generally in an outdoor context.

The types of fixes that can be produced, listed in order of best to worse accuracy, are listed in Table 3.3-1.

Table 3.3-1. AGPS Fix Types

Measurement Type	Description
GPS	Position computed using GPS pseudorange measurements.
AFLT	Position computed using pilot phase measurements.
Hybrid	Position computed using a combination of GPS and pilot phase measurements.
Mixed Mode	Position computed using a combination of pseudorange measurements (GPS, AFLT/pilot) and coordinate measurements (from a pre-fix determined position).
Cell Sector Round Trip Delay (Safety Net)	Position computed using a combination of BSA information and network RTD measurement.
Mixed Cell Sector	Position computed using an average of one or more BSA cell sector center positions.
Cell Sector	Position computed from the BSA using the cell sector position of a single transmitter.
Base Station Region	Position computed from an average of one or more BSA cell sector antenna positions, all having the same NID (switch number) and SID (system ID or market ID) values.
SID-Region	Position obtained from BS region identified only by a SID.

3.3.1 Devices Tested

Qualcomm provided 4 commercial handsets that it had purchased from the respective carriers' stores. No "custom software upgrades," nor any special calibration to improve accuracy, were performed. As such, this was an excellent example of existing technology in its most recent state. The devices used were:

- Sprint: HTC EVO 4G LTE
- Verizon: HTC Droid Incredible 4G LTE

Figure 3.3.1-1 Handsets Used in Testing the Qualcomm AGPS Technology

3.3.2 Test Configuration

The handsets were configured to disable WiFi and BlueTooth connections, to remove any possibility of inadvertent information coming across these data links or contributing to fix accuracy. GPS measurements were allowed, but not background Android processing. In a true 911 dial situation, the GPS user privacy settings in the handset are bypassed. The actual testing, however, used dial strings other than 911 so as not to burden the PSAPs with high volumes of test calls. Commercial software builds did not allow the "911" string to be changed, so the handsets had to explicitly allow GPS usage in support of the dialed strings used for test calling. The setting screens for the two handset types are shown in Figure 3.3.2-1.

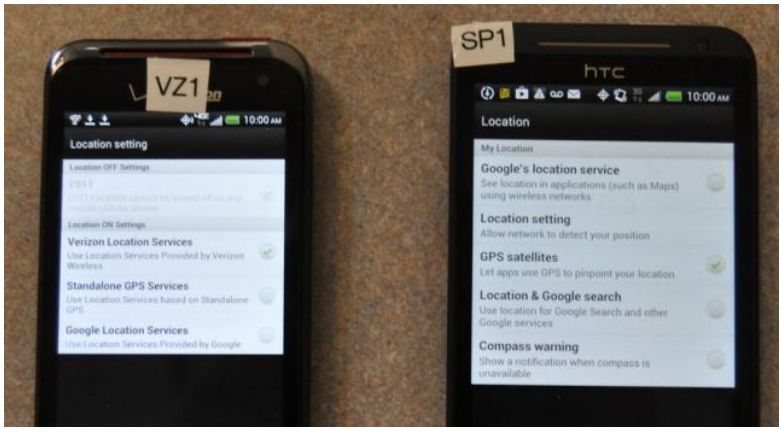


Figure 3.3.2-1. Handset Configuration Screens

The carriers have implemented an emulation of 911 testing in their MSC by recognizing a unique dial string. When this string is dialed, the normal network actions force a phase 1 position fix in the MPC and a phase 2 position fix in the PDE. This is shown Figure 3.3.2-2 first published in 2000 and in continuous usage since then.

Commercial builds for MS-Assisted IS-801 call flows implement a "cold start" where all of the necessary assistance data is derived wholly from each independent PDE call flow and current network time. The PDE generates GPS assistance data relative to the position of the serving tower. The synchronous CDMA network transfers highly precise time to the handset. This combination allows very rapid acquisition of satellite ranging

information, comparable to the usual warm start operation. No prior fix data is used in the calculation, which assures independent fixes, even though the same handset was used repeatedly at the same location.

The commercial PDEs are configured to allow the handset to search for GPS signals for a maximum of16 seconds, and return back whatever results were obtained at the end of that period. The IS-801 standard also allows 32 seconds, but this is not used to be compliant with the requested 30 second response time. Additional time beyond the GPS search time is used for call setup and message transfer.

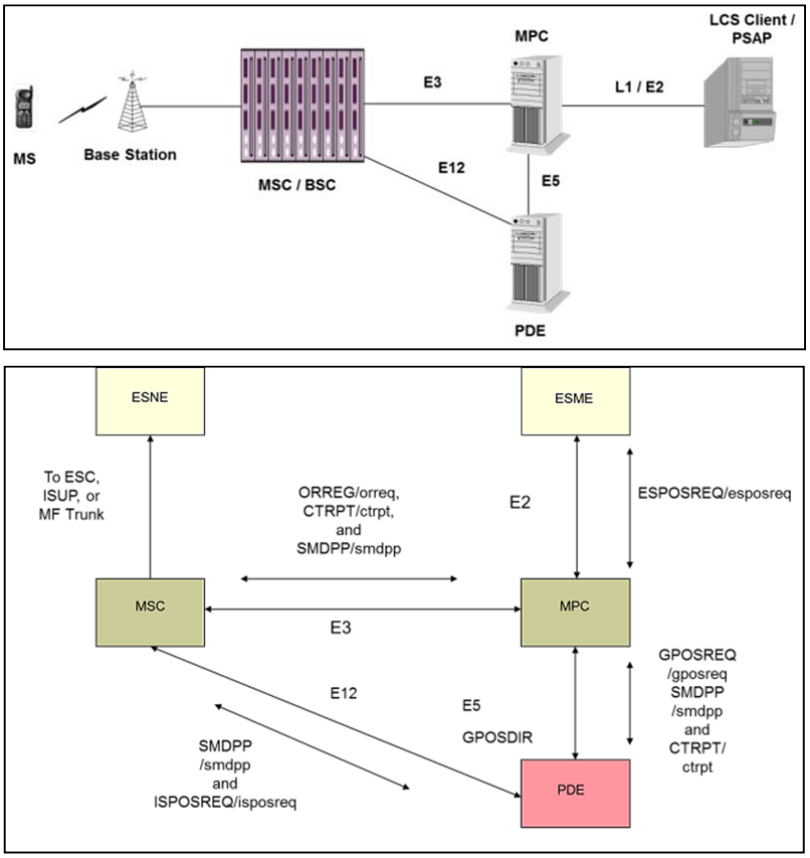


Figure 3.3.2-2. Network Configuration per J-STD-036 for Emergency Call Processing

3.3.3 Vendor Data Logs and/or Processing

Calls were dialed by an application developed by TechnoCom for that purpose. The application ran on the four Android handsets and allowed call dialing and hang up time between calls to be timer controlled and logged. The application created the 'handset logs' which were emailed from the handset operated by TechnoCom personnel directly to TechnoCom; they were not processed by Qualcomm.

The PDE logs were collected by the wireless carriers on a periodic basis and forwarded directly to TechnoCom with no processing or review by Qualcomm ahead of TechnoCom. The PDE logs recorded the interaction between the PDE and the handset, and the results of the various stages of the location process. The logs used were actually extracts from the more detailed PDE BIN files via a tool employed by the wireless carriers in monitoring their E911 systems.

The two wireless carriers had different internal processes to extract the logs and forward them to TechnoCom. Because of the tightness of the available time to do the testing and preparation for it, this resulted in some initial delays as well occasional delays of up to a week in receiving the logs. This

caused some initial delays in processing the data and identifying possible timer issues but had no real impact on the end results.

4 Test Execution

4.1 Test Point Selection

TechnoCom's principal engineer/location expert (Dr. K. Dessouky, who is also leading author of the CSRIC test plan) worked closely with members of the Building sub-group of WG3 to review possible candidate building selections and suggest additional candidate buildings for contact. The evaluation of the possible buildings was in the context of the requirements of the test plan. Buildings were evaluated for their fit into the criteria of selection for each morphology, including their location, their type of construction, their broad RF characteristics, their distinction from other buildings previously selected, and their physical and logistical access.

Initial contact with building managers or owners was generally facilitated by public safety membership of the building sub-group. Upon granting of permission for access/testing, TechnoCom's principal engineer performed a walkthrough of each of the identified buildings to determine the appropriate test points. The test points were selected to meet the general requirements of the test plan with adequate diversity in their RF environment (including adequate cellular signal coverage), placement of the point in the building, and non-intrusive test performance. The test points were then documented and pictures taken to ensure that the ground truth survey team surveyed the specific points intended. At some buildings, access restrictions implied that the walkthrough, the formal survey, and the actual testing were all coordinated and performed on the same day.

In all 75 points were selected as suggested in the test plan. Due to real world building availability and access limitations in the limited time window the eventual test point distribution somewhat favored dense urban over urban settings. As will be seen in Section 6 of this report, dense urban performance observed was actually somewhat better than urban performance (in the selected sample of buildings).

Table 4.1-1 Summary of Test Point Distribution

Morphology	Number of Test Points
Dense Urban	29
Urban	23
Suburban	19
Rural	4
Total	75

The identity and specific location of all the test points were maintained strictly anonymous to all location technology vendors participating in the test bed. Apart from some members of the building sub-group of WG3, the identities of the specific buildings were maintained anonymous to the remainder of the test bed participants. Since the vendors had access to their own location output logs, they could, after a day of testing, guess the building that was used, but certainly could not guess where exactly, in what part of the building, or on what floor the test point was, not even for the simplest of buildings where performance was quite good.

4.2 Ground Truth Determination

A professional land survey company with experience in indoor surveying and local knowledge was selected by TechnoCom to perform the precise ground truth surveys. The surveyor used established land

survey techniques using modern technology. The equipment used of the survey inside the buildings is shown in Figure 4.2-1. The following is a quote form one of the 19 formal survey reports that have been provided to the funding participants in Stage 1 of the test bed.

"Surveyed positions were established using the Leica RTK GPS spider network and a GNSS receiver. These positions were established on California State Plane Zone 3 and converted to Latitude and Longitude. Elevations were established as a GPS Ellipsoidal Height WGS 84 and corrected with Geoid 09. GPS control points were established at each site and transferred into the building sites with a Trimble S6, 3" robotic total station. The accuracy of the RTK GPS ground control is +/-2cm vertical and +/-1cm horizontal. The accuracy of the total station interior shots are +/- 1cm. The significant figures of the data reflect the stated accuracy."

Figure 4.2-1. Setup Used by Professional Surveyor for Ground Truth Determination

A sample surveyed location took the form:

Building6. Westfield Valley Fair Mall, Santa Clara
Test Point: 1
Description: Lower level, next to store XYZ close to Entrance K
LAT: 37°19'XX.YYY" LONG: -121°56'XX.YYY"
ELEV: 126.7' (38.62 Meters) per Geoid 09
WGS84 ellipsoid height = 19.4' (5.92 Meters)

Although the test points were surveyed with exceptional accuracy and precision, in this as in any similar field testing with so many devices under test, a practical accuracy in test device placement relative to surveyed location is better than one meter. The contribution of such placement tolerance to overall location error is completely negligible.

4.3 Test Fixture

For ease of transportation the test devices were mounted on a rolling cart. As shown in Figure 4.3-1 the cart had three levels with the top level dedicated to the devices under test, the middle level to the laptops required by the location technology vendors, and the bottom tray to the backup batteries and TechnoCom data gathering laptops.

The top tray included two NextNav Receiver/smartphone combinations, three handsets from Polaris Wireless, and four from Qualcomm (two on the Verizon and two on the Sprint network. Each handset/receiver was mounted using a cradle on a 12" arm. A minimum separation of 10" was maintained between the different devices (except between the NextNav receiver/smartphone combination). The approximate height from the ground of the devices on top of the cart was 1.2 meters.

Figure 4.3-1. Test Fixture (Cart) Used During Indoor Testing

4.4 Placement of Test Calls

The field testing staff of TechnoCom performed the following steps at a given test point:

1. Coordinated with building management the sequence of access to the various test points
2. Located the room or area in the building containing the target test point.
3. Used the documented notes and pictures to determine the precise location of the test point.
4. Placed a mark on the ground as a reference.
5. Placed the test cart on top of or very close to the marked point for the duration of the test.
6. Took 4 pictures of the test setup from 4 directions, similar to those in the original pictures used as a guide for point placement.
7. Started the needed warm-up procedures for some of the devices under test
8. Started the test applications for the devices of the various technologies
9. Started the application's dialer on some applications as needed in a certain order
10. Monitored all the handsets or devices under test to ensure their proper operation
11. As needed reset or restarted some of the applications that failed to respond or place test calls during the period of time assigned to the test point
12. From time to time during the placement of the test calls partially rotated the test cart or moved it slightly (about a foot) ensuring it stays essentially over the marked ground truth.
13. Documented any deviations or anomalies observed during the execution of the processes at the test point
14. At some points as needed due to operational issues manually e-mailed or uploaded test call data logs to the technology vendor

4.5 Time Budget for Test Calls

The above sequence of events implied a certain overhead associated with each test point. The need to complete 5 or occasionally a maximum of 6 test points in a building in a day, dictated by access constraints, implied that an hour and a half is allocated to each test point, in which 75 minutes could be spent placing test calls. (Additional overhead time was consumed in meeting the building management, familiarizing the building engineering staff with what was needed, and in certain cases obtaining temporary credentials to permit unfettered access.)

Working backwards it was determined that if one device is used to place 100 calls then the 45 seconds are needed for each call and pause between calls. This neatly fit with a 30 second on 15 second off cycle. This is consistent with 30 second de facto requirement for delivery of a location result in an E911 situation. This was possible with certain of the technologies under test, basically when the test environment was under the complete control of the location technology company, as was the case with NextNav and Polaris for the configurations tested. Testing AGPS on the operational networks of Verizon and Sprint wasn't as straightforward and required some workarounds as will be explained in the next section.

NextNav and Polaris by design set the length of their call or call equivalent duration (integration period or measurement period) to be a bit under 30 seconds. The large majority of the NextNav test calls declared their location result at around 27 seconds. There was very little variation in that number, essentially by

design. The large majority of Polaris' test calls declared their location result around 24 seconds. The standard deviation was relatively small (see TTFF summary results in Section 6.1.3).

Qualcomm AGPS was tested on operation networks with its complexities and these are discussed below.

4.6 Timer Issues Encountered with Operational E911 Networks

Qualcomm used the commercially installed E911 networks of Verizon and Sprint. Both networks comprise multiple components (MSC, MPC, PDE) that have been built to ensure a high degree of reliability and redundancy.

The E911 location system has been built with the assumption that 911 is typically dialed once, and that there is normally a gap before 911 is dialed again from the same phone. Accuracy testing with repeated calls made by the same phone is an artificial configuration, created by necessity, which can introduce timing issues among the network elements that are not seen during normal 911 call processing.

Based on limited initial testing prior to the start of formal testing it appeared that a 25 second on/20 second off cycle would work, enabling the possibility of only one handset per wireless carrier network to collect the required number of calls per test point. As more calls and logs were collected in the first few days of testing, it was observed that due to the variant production and test network configurations, repeated calls from the same phone with the fast pacing of 25 on/20 off, appeared to have different impacts on location calculation within each carrier network. Location and yield issues occurred because of the nature of the repeated test calls from the same handset, tripping system timers that are in place to deal with live 911 call throughput. Hence, after the initial test calls were placed and reviewed, the test call configuration was changed to 30 on/60 off to minimize production timer impacts on test call results. The use of two handsets on each wireless carrier network enabled the collection of required number of test calls.

One of the issues that arose during the initial period with the 25 on/20 off spacing with one of the wireless carrier networks was that cached fixes were delivered on subsequent test calls from the same test device. This caused a degradation in yield as the first call from a test device received a location fix, but subsequent location queries for test calls made 20 seconds later on the same device, received the cached first test call fix and had to be discarded. This is due to the appearance to the production location system that the query was from the same "emergency call." At the longer interval of 30 on/60 off, the caching disappeared and a location fix was generated for each test call.

Another issue encountered pertained to a wireless carrier's use of a separate test platform which allowed for the 30-second on time to be long enough that a second position request was initiated at the PDE. However, the call would then terminate before the GPS measurements have had a chance to be returned. In that case there were "extra" fixes which had poor performance due to only being network based. The original 25 second time was "just enough" to let the first fix get completed within the 16 second IS-801 session, and a second fix was not kicked off. But with the 30 second on time, a new fix was started, but did not have time to complete properly and thus "failed."

In the end to resolve a number of these timer related issues within the time frame of the test, a robust call log analysis method was created by TechnoCom to identify the correct "first fix" and ignore the second (duplicate) fix. This was mostly effective, but may still have left a small percentage of calls with less than optimal performance due to the repeated calls from the same phone. Overall, though, the timer related issues where sufficiently mitigated so as not to have significant impact on the overall results.

5 Detailed Test Environments

5.1 Dense Urban Environment

5.1.1 Dense Urban Polygons

The dense urban and urban polygons postulated by the polygon committee of CSRIC WG3 are shown in Fig. 5.1.1-1. The dense urban polygon is shown in green and the adjacent urban polygon in magenta. These shapes were considered preferred polygons to initiate the process of searching for different categories of buildings. Satellite/aerial maps, primarily using Google Earth as a tool, were the primary source of morphology information, in addition to broad general knowledge of San Francisco.

During the process of building identification in the field and initial site visits, detailed field examination of the buildings and their density in the area revealed that some modification of the polygon boundaries is warranted. Specifically, some expansion of the dense urban polygon by one to two blocks, and in two corners three blocks, better reflects the nature of the area. The dense urban polygon, updated as observed in the field, is shown in Fig. 5.1.1-2 in light blue. The adjacent urban polygon has also been adjusted consistent with the refinement of the dense urban polygon.

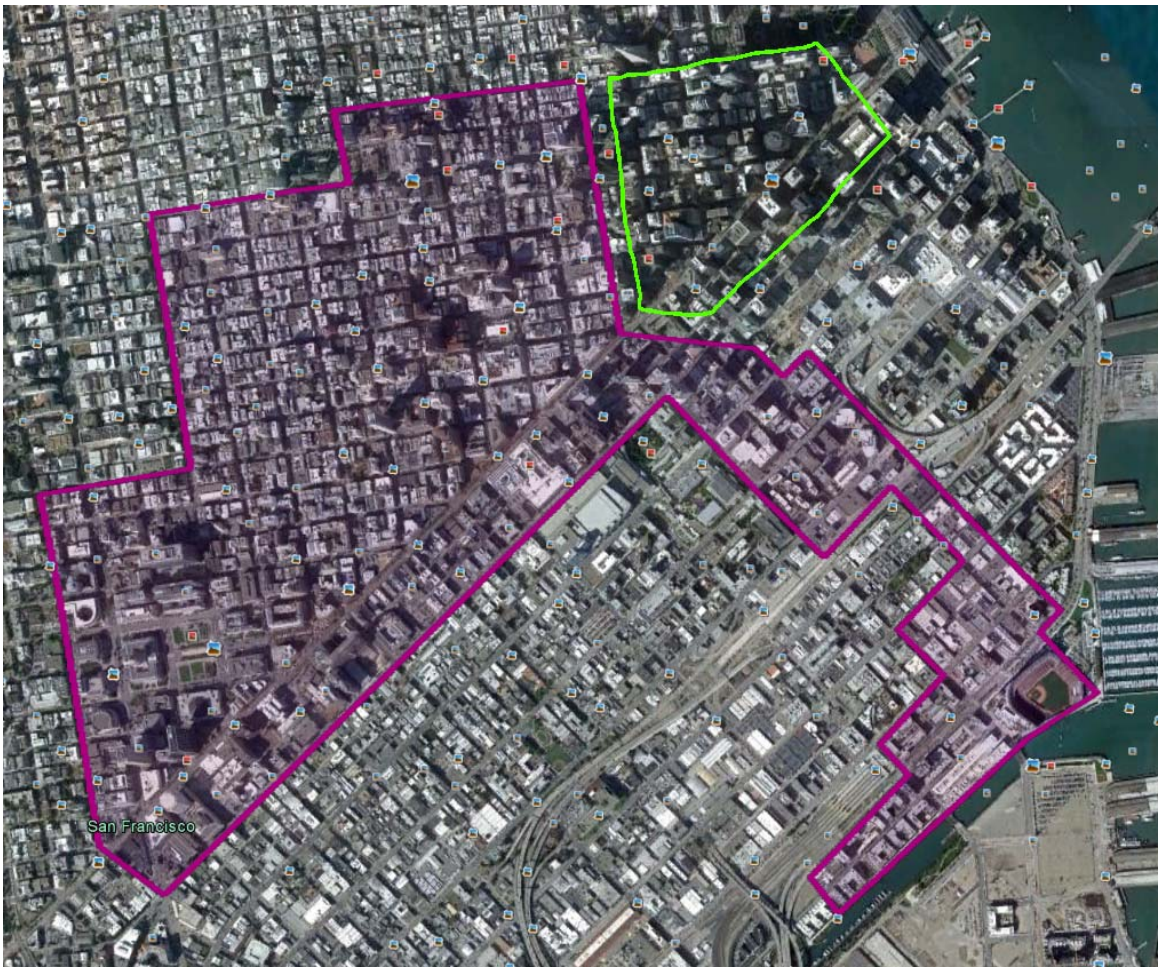


Figure 5.1.1-1. Dense Urban and Urban Polygons in SF postulated by Polygon Sub-Group

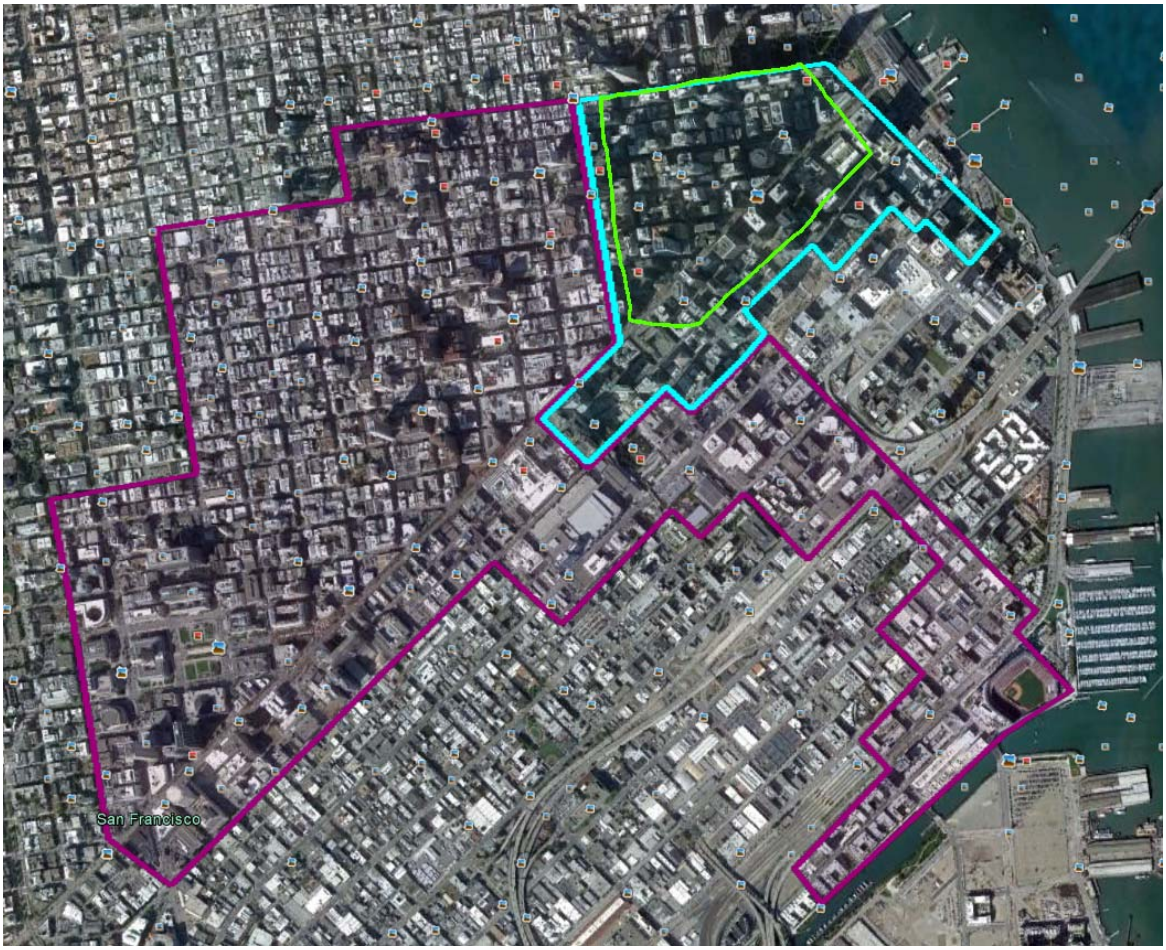


Figure 5.1.1-2. Updated Dense Urban and Urban Polygons in SF (as Observed in the Field)

After intense effort by the building committee of WG3 supported by this test contractor (TechnoCom) six excellent sample buildings were identifed inside the dense urban polygon. There relative locations are shown in Fig. 5.1.1-3.

Inital site visits to these buildings were performed that resulted in the detailed identification and the test point sin each of the bbuildings. Indoor testing per the CSRIC test plan was then perfomed at those test points. Additonally professional land surveying was perfomed to obtain the ground truths with a high degree of accuracy and precision.

Figure 5.1.1-3. Relative Locations of the Test Buildings Used in the Dense Urban Morphology

5.1.2 Dense Urban Buildings Used

The dense urban buildings used for indoor testing in this stage of the test bed were:

Bldg. 1: Marriott Marquis Hotel, SF

Bldg. 2: One Front Street, SF

Bldg. 3: 201 Spear Street, SF

Bldg. 14: The Hearst Office Building (699 Market Street), SF

Bldg. 15: The Omni Hotel, SF

Bldg. 16: One Embarcadero Plaza, SF

The sample of these 6 dense urban buildings selected for testing provided an excellent representation of building types in such a dense city environment. Distinct common building types were included. Steel buildings with glass, concrete and masonry with glass, brick veneer (in the East Coast tradition), tall buildings over 40 stories high, medium height buildings of around 15 stories high, and buildings surrounded by other tall buildings on all sides and on fewer sides were all represented. In addition, the geography of the City of San Francisco, on the tip of the peninsula, made for challenging cellular

propagation, at times experiencing signals from across the Bay (e.g., Pt. 2 in BD3 had a clear view of the Bay Bridge and beyond, and Pt.1 on the 42nd floor of BD16 had far reaching visibility across the bay to the north and the city of SF to the south). These are not unusual conditions in a dense city with high rises but they may be more difficult than in a flat city away from the water. The sample of buildings selected and the range of test points chosen in each building therefore offered a wide and challenging cross section of real world situations in which wireless calls could be placed.

Figure 5.1.2-1. Bldg. 1: Marriott Marquis, SF

Figure 5.1.2-2. Bldg. 2: One Front Street, SF

Figure 5.1.2-3. Bldg. 3: 201 Spear Street, SF

Figure 5.1.2-4. Bldg. 14: Hearst Office Bldg (699 Market St.), SF

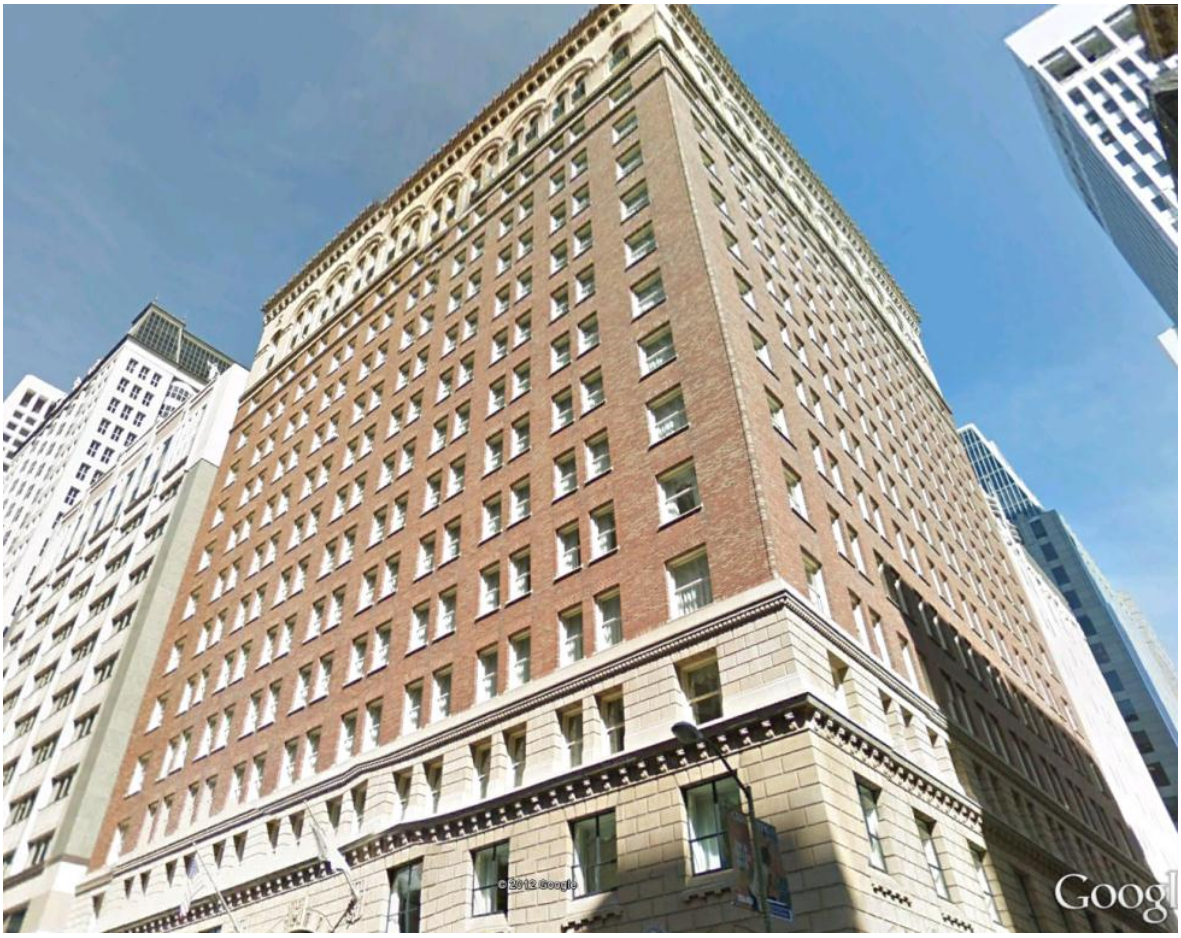


Figure 5.1.2-5. Bldg. 16: The Omni Hotel, SF

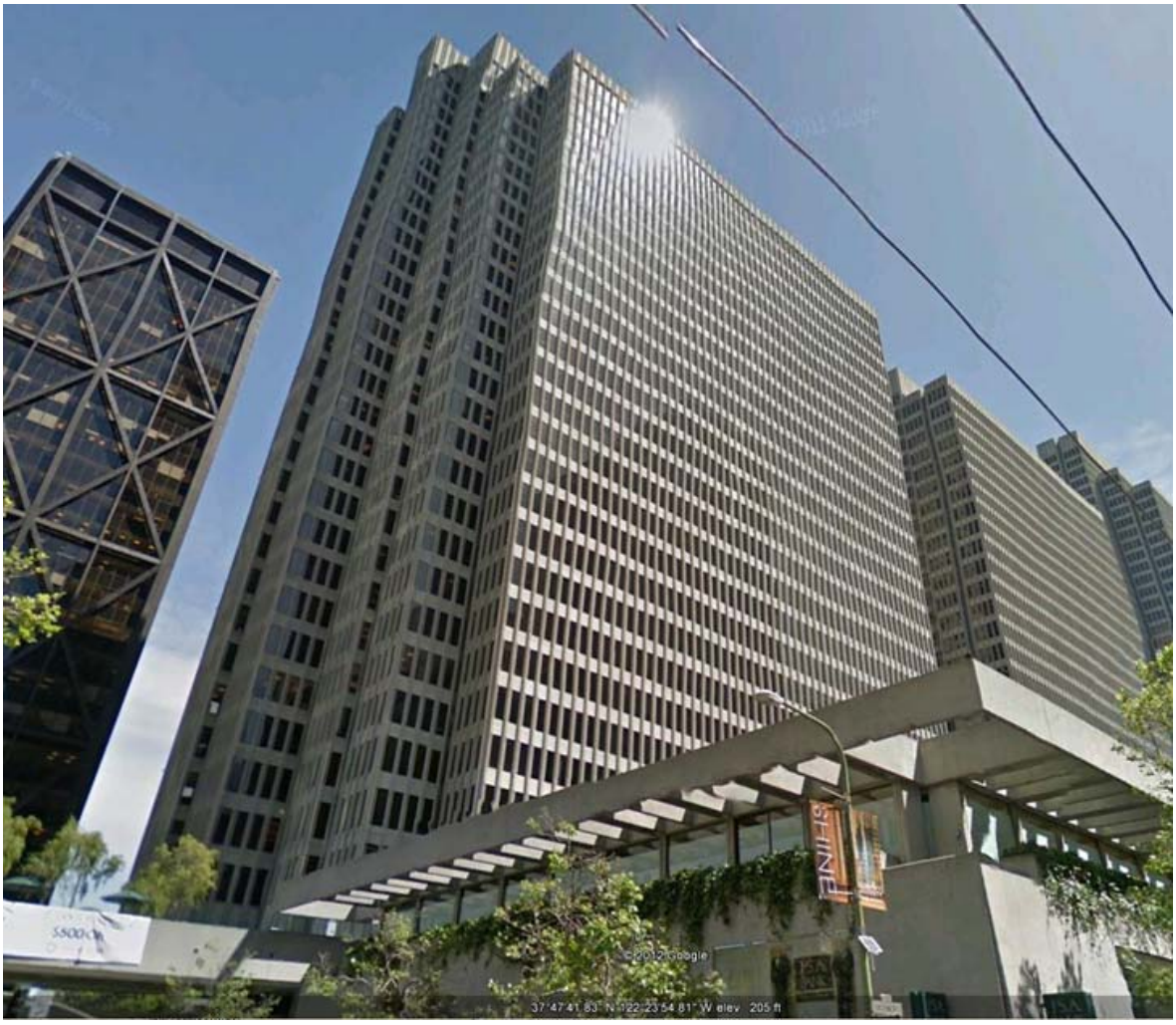


Figure 5.1.2-6. Bldg. 16: One Embarcadero Center, SF

5.2 Urban Environment

5.2.1 Urban Polygons

The urban polygon in San Francisco contains varied building densities and construction types that range from larger commercial buildings (near the downtown dense urban polygon), to older mixed-use neighborhoods with medium and smaller sized buildings (both commercial and residential in the middle of urban clutter), as well as newer, redeveloped areas with medium height residential and commercial buildings, city government buildings, and a large stadium. The San Francisco urban polygon is typical of an "older urban" area with densely packed construction (regardless of building height), somewhat narrower streets, and similar or narrower building separation than the dense urban polygon.

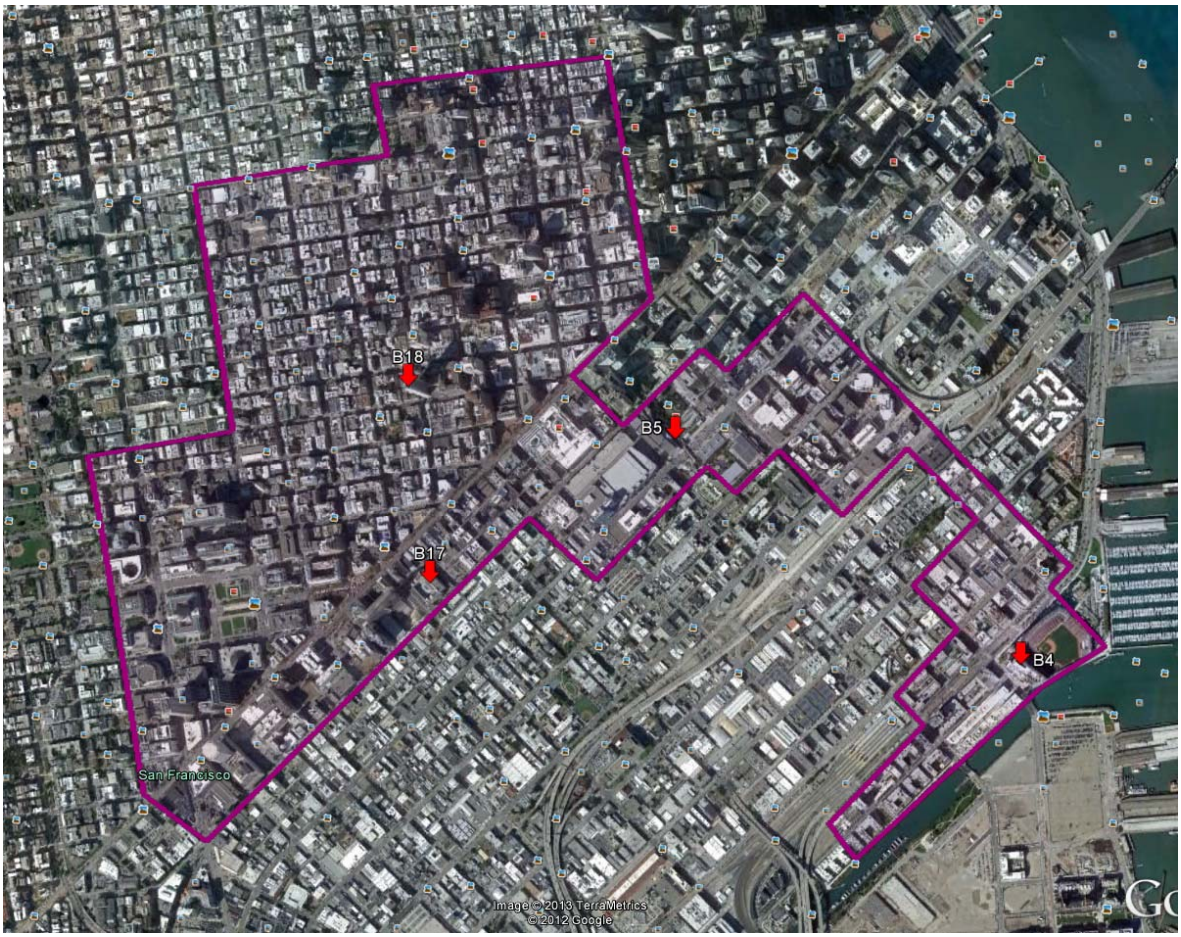


Figure 5.2.1-1. Relative Locations of the Test Buildings Used in the Urban Morphology in SF

The urban polygon in San Jose is representative of “newer urban” development, with a downtown typified by tall buildings of up to 30 stories, but with somewhat wider streets and somewhat greater building separation than in older urban or dense urban morphologies.

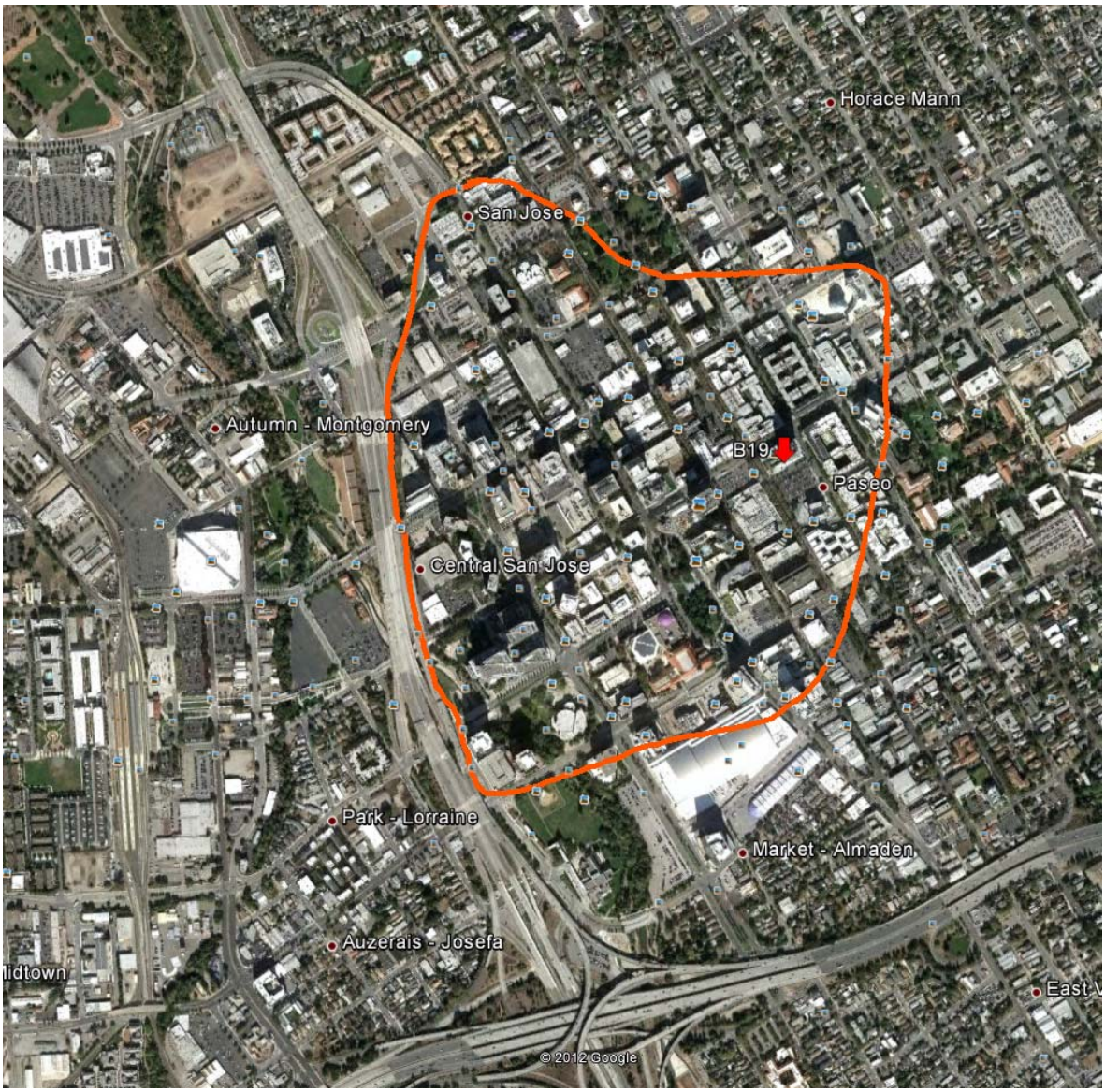


Figure 5.2.1-2. Urban Polygon in San Jose and Location of Building Selected in It

5.2.2 Urban Buildings Used

The urban buildings used for indoor testing in this stage of the test bed were:

Bldg. 4: AT&T Park (baseball stadium), SF

Bldg. 5: Moscone Convention Center, SF

Bldg. 17: US Federal Court of Appeals Building, SF

Bldg. 18: Super 8 Motel on O'Farrell St., SF

Bldg. 19: The 88 San Jose (condominium building), SJ

These five buildings offered a challenging environment, each in their own way. The convention center had large areas under the surface of the street, with excellent internal cellular coverage but considerable attenuation when viewed from the outside (e.g., by a beacon). The baseball stadium on the bay (BD4) offered a challenging RF signal environment. The US Court of Appeals building (BD17) is a heavily constructed masonry structure (that survived the famous 1906 earthquake) with considerable use of tile on the inside. The motel (BD18), although not itself large or high, is sandwiched in a row of continuous side to side five story urban buildings, with higher buildings across the street and down the corner. Finally, the high rise in urban San Jose presented its own challenges in having considerable visibility to the whole valley from its high floors and the presence of tall buildings within a few hundred yards. The combination of buildings selected created a solid, challenging urban sample that represents well beyond California.

Figure 5.2.2-1. Bldg. 4: ATT Park (Stadium), SF

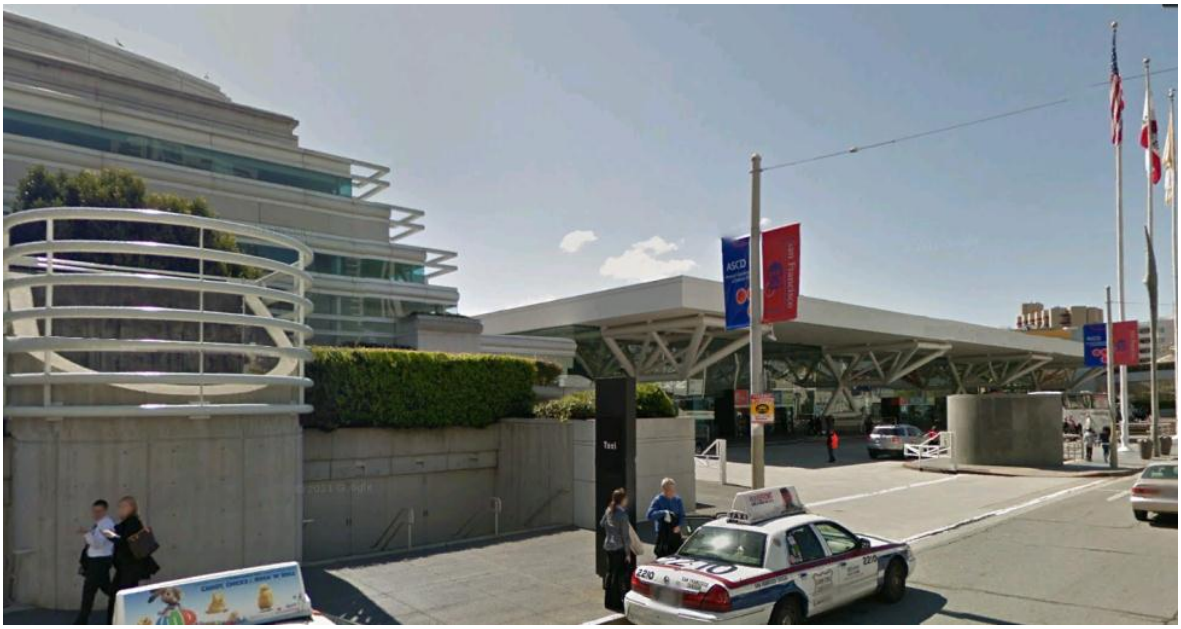


Figure 5.2.2-2. Bldg. 5: Moscone Convention Center, SF

Figure 5.2.2-3. Bldg. 17: US Federal Court of Appeals Building, SF

Figure 5.2.2-4. Bldg. 18: Super 8 Motel on O'Farrell St., SF

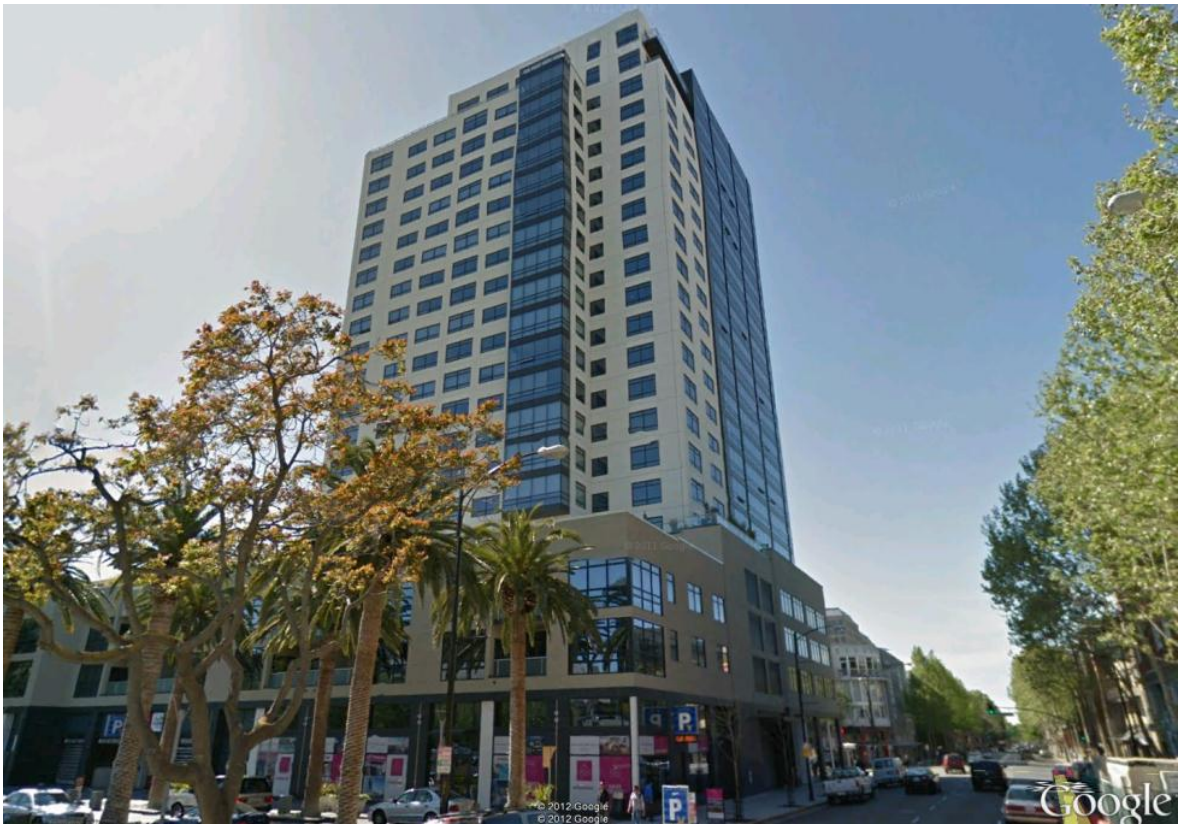


Figure 5.2.2-5. Bldg. 19: The 88 San Jose (condominium building), SJ

5.3 Suburban Environment

5.3.1 Suburban Polygon

The suburban polygon of Silicon Valley includes a variety of suburban office buildings, industrial and commercial complexes, government buildings, and a range of residential buildings, including single and multi-family dwellings. Also included in the suburban polygon are shopping malls, large discount retail buildings and an airport.

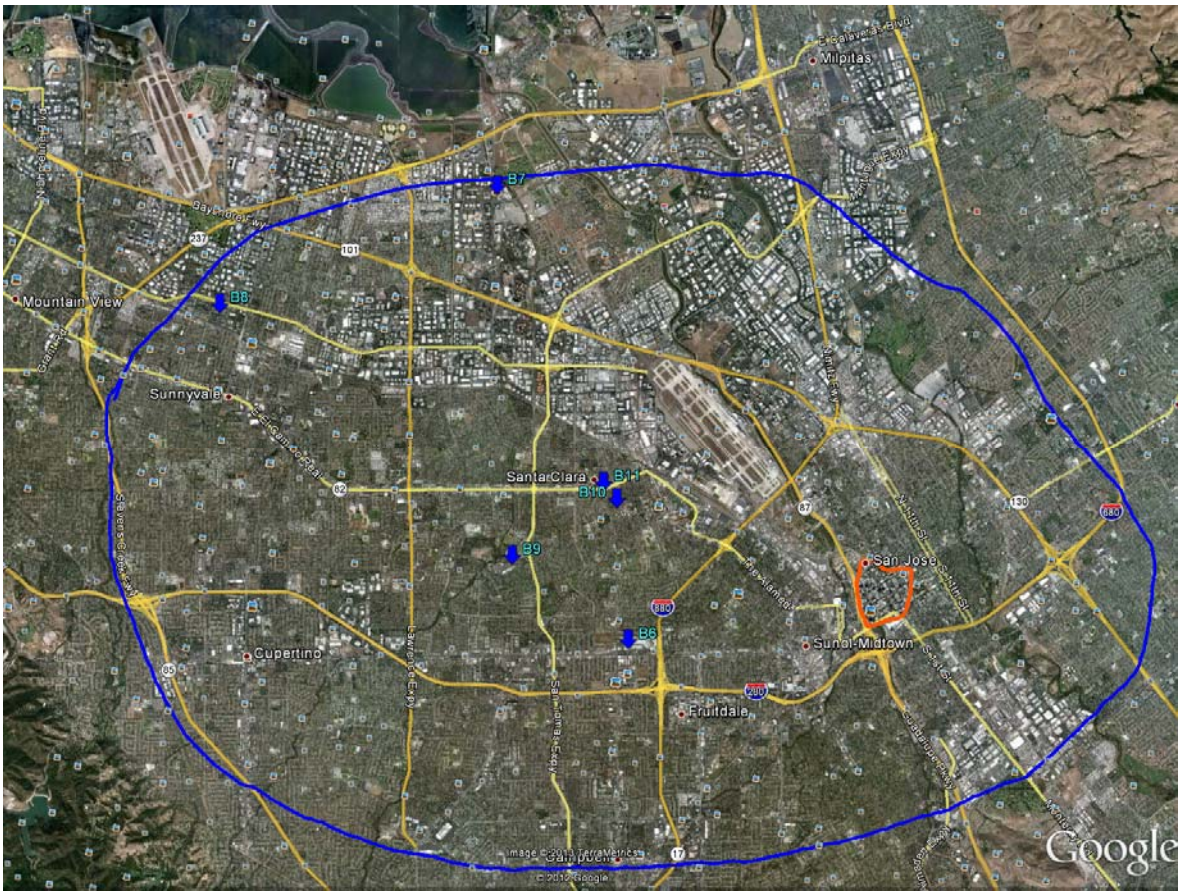


Figure 5.3.1-1. Suburban Polygon and Location of Buildings Used

5.3.2 Suburban Buildings Used

The suburban buildings used for indoor testing in this stage of the test bed were:

Bldg. 6: Westfield Valley Fair Mall, SJ

Bldg. 7: Techmart Office Building, Santa Clara

Bldg. 8: 861 Shirley Avenue (house), Sunnyvale

Bldg. 9: City Library, Santa Clara

Bldg. 10: Senior Center, Santa Clara

Bldg. 11: 1405 Civic Center, Santa Clara

This suburban building sample contained smaller, lighter constructed buildings common in the Southwest as well as an office building and a major mall. The latter two structures could be found in virtually any part of the US. In all cases significant relative space existed between the tested structure and its neighbors, reflecting the lower density suburban setting.

Figure 5.3.2-1. Bldg. 6: Westfield Valley Fair Mall, SJ

Figure 5.3.2-2. Bldg. 7: Techmart Office Building, Santa Clara

Figure 5.3.2-3. Bldg. 8: 861 Shirley Avenue (house), Sunnyvale

Figure 5.3.2-4. Bldg. 9: City Library, Santa Clara

Figure 5.3.2-5. Bldg. 10: Senior Center, Santa Clara

Figure 5.3.2-6. Bldg. 11: 1405 Civic Center, Santa Clara

5.4 Rural Environment

5.4.1 Rural Polygon

The rural polygon is located in the area between Gilroy and Hollister, and is characterized by large farming tracts, isolated residences and limited commercial development. Of particular note is the low density of cell sites due to distances and the intervening terrain on the periphery of the area. The low cellular site density was a key factor in the selection of this polygon, which is about 40 miles south of downtown San Jose.

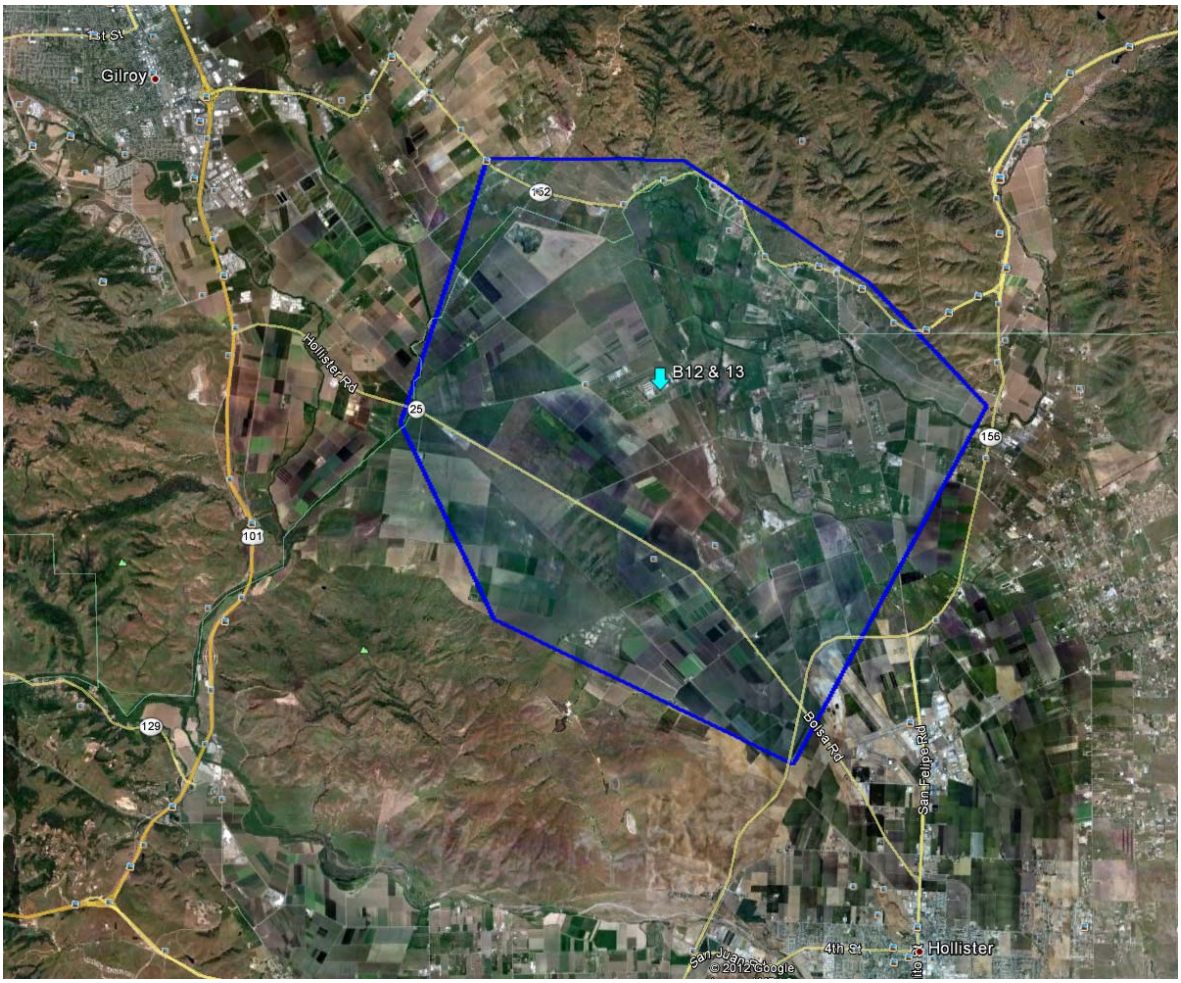


Figure 5.4.1-1. Rural Polygon and Location of Buildings Used

5.4.2 Rural Buildings Used

The rural buildings used in this stage of the test bed are:

Bldg. 12: Gilroy Gaits, green building (riding stable with metal roof), Hollister, CA

Bldg. 13: Gilroy Gaits, beige building (riding stable with metal roof), Hollister, CA

This selection of rural buildings used was influenced by the paucity of available building in the defined rural polygon (a selection that was driven by a desired lower cell site density). The lack of public-like buildings in the area compounded the difficulty. The chosen buildings are both large one story buildings with metal roofing, which is a common combination in rural operations. They generally represent a more challenging environment than a rural home, whose performance would be more similar to a suburban home, e.g., BD 8, or other smaller apartment type structure like BD10.

Figure 5.4.2-1. Bldg. 12: Gilroy Gaits, Green Stable Building, Hollister, CA

Figure 5.4.2-2. Bldg. 13: Gilroy Gaits, Beige Stable Building, Hollister, CA

6 Test Results

6.1 Summary Results

6.1.1 Number of Test Calls and Yield

Table 6.1.1-1. NextNav Summary Indoor Test Yield Results

Number of Test Calls and Yield			
Building ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD1	350	112	32.0%
NextNav_BD2	1020	1020	100.0%
NextNav_BD3	809	809	100.0%
NextNav_BD4	692	690	99.7%
NextNav_BD5	765	612	80.0%
NextNav_BD6	825	825	100.0%
NextNav_BD7	934	934	100.0%
NextNav_BD8	395	395	100.0%
NextNav_BD9	598	598	100.0%
NextNav_BD10	423	423	100.0%
NextNav_BD11	406	406	100.0%
NextNav_BD12	443	443	100.0%
NextNav_BD13	400	377	94.3%
NextNav_BD14	998	998	100.0%
NextNav_BD15	1200	1123	93.6%
NextNav_BD16	797	797	100.0%
NextNav_BD17	972	958	98.6%
NextNav_BD18	800	800	100.0%
NextNav_BD19	1215	1178	97.0%
NextNav_All Dense Urban Buildings	5174	4859	93.9%
NextNav_All Urban Buildings	4444	4238	95.4%
NextNav_All Suburban Buildings	3581	3581	100.0%
NextNav_All Rural Buildings	843	820	97.3%

Table 6.1.1-2. Polaris Summary Indoor Test Yield Results

Number of Test Calls and Yield			
Building ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD1	700	700	100.0%
Polaris_BD2	970	970	100.0%
Polaris_BD3	668	638	95.5%
Polaris_BD4	392	392	100.0%
Polaris_BD5	650	649	99.8%
Polaris_BD6	814	814	100.0%
Polaris_BD7	891	888	99.7%
Polaris_BD8	400	400	100.0%
Polaris_BD9	600	599	99.8%
Polaris_BD10	398	396	99.5%
Polaris_BD11	394	392	99.5%
Polaris_BD12	351	328	93.4%
Polaris_BD13	398	398	100.0%
Polaris_BD14	998	998	100.0%
Polaris_BD15	1115	1114	99.9%
Polaris_BD16	955	952	99.7%
Polaris_BD17	988	987	99.9%
Polaris_BD18	812	812	100.0%
Polaris_BD19	1035	1034	99.9%
Polaris_All Dense Urban Buildings	5406	5372	99.4%
Polaris_All Urban Buildings	3877	3874	99.9%
Polaris_All Suburban Buildings	3497	3489	99.8%
Polaris_All Rural Buildings	749	726	96.9%

Table 6.1.1-2. Qualcomm Summary Indoor Test Yield Results

Number of Test Calls and Yield			
Building ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
QualComm_BD1	798	705	88.3%
QualComm_BD2	899	868	96.6%
QualComm_BD3	1598	1227	76.8%
QualComm_BD4	1375	1240	90.2%
QualComm_BD5	720	651	90.4%
QualComm_BD6	760	726	95.5%
QualComm_BD7	1689	1407	83.3%
QualComm_BD8	359	358	99.7%
QualComm_BD9	539	507	94.1%
QualComm_BD10	360	359	99.7%
QualComm_BD11	360	359	99.7%
QualComm_BD12	354	353	99.7%
QualComm_BD13	360	356	98.9%
QualComm_BD14	899	810	90.1%
QualComm_BD15	900	812	90.2%
QualComm_BD16	900	723	80.3%
QualComm_BD17	900	876	97.3%
QualComm_BD18	720	677	94.0%
QualComm_BD19	1061	894	84.3%
QualComm_All Dense Urban Bldgs	5994	5145	85.8%
QualComm_All Urban Buildings	4776	4338	90.8%
QualComm_All Suburban Buildings	4067	3716	91.4%
QualComm_All Rural Buildings	714	709	99.3%

6.1.2 Summary Accuracy Results

Summary accuracy results are provided below, first in tables then summarized in comparative bar charts by morphology and by technology.

6.1.2.1 Summary Accuracy Statistics Tables

Table 6.1.2-1. NextNav Summary Indoor Accuracy Statistics

Horizontal Error Statistics (m)								
Building ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD1	112	177.6	236.3	270.1	142.0	125.8	735.0	2.57
NextNav_BD2	1020	51.7	72.1	82.4	41.8	22.4	127.0	0.63
NextNav_BD3	809	74.0	136.2	179.5	76.6	74.3	1059.2	4.30
NextNav_BD4	690	64.0	91.2	114.4	69.1	189.7	4367.2	2.75
NextNav_BD5	612	138.8	235.1	270.0	126.9	70.3	408.0	20.17
NextNav_BD6	825	36.0	54.2	63.3	32.3	16.6	122.3	1.43
NextNav_BD7	934	36.3	58.0	65.7	29.5	19.7	91.0	0.38
NextNav_BD8	395	16.7	24.1	27.8	14.7	7.0	42.5	1.28
NextNav_BD9	598	38.7	63.8	71.5	42.9	240.5	5854.2	1.13
NextNav_BD10	423	17.4	24.5	26.3	14.8	6.9	35.6	0.48
NextNav_BD11	406	15.0	29.4	32.4	13.7	9.9	53.7	0.54
NextNav_BD12	443	26.6	38.0	41.2	21.7	11.6	56.7	1.58
NextNav_BD13	377	29.9	64.1	85.0	127.5	1815.9	35255.9	1.53
NextNav_BD14	998	42.7	96.5	114.5	41.0	34.7	186.0	0.57
NextNav_BD15	1123	65.7	177.4	318.5	77.6	92.3	665.9	0.85
NextNav_BD16	797	43.8	71.2	91.0	38.7	28.3	236.0	0.64
NextNav_BD17	958	48.1	60.5	80.3	48.5	75.5	1221.4	2.15
NextNav_BD18	800	54.3	66.5	73.0	45.6	17.7	144.0	8.02
NextNav_BD19	1178	69.7	190.6	203.0	73.1	70.6	617.2	2.81
NextNav_All Dense Urban Buildings	4859	57.1	102.4	154.0	57.5	64.9	1059.2	0.6
NextNav_All Urban Buildings	4238	62.8	141.1	196.1	69.5	99.9	4367.2	2.1
NextNav_All Suburban Buildings	3581	28.6	52.9	62.2	27.2	99.7	5854.2	0.4
NextNav_All Rural Buildings	820	28.4	44.9	60.3	70.3	1231.5	35255.9	1.5

Table 6.1.2-2. Polaris Summary Indoor Accuracy Statistics

Horizontal Error Statistics (m)								
Building ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD1	700	273.7	476.1	667.9	247.0	245.6	1304.3	16.41
Polaris_BD2	970	83.4	207.9	636.7	125.4	160.9	1070.2	8.27
Polaris_BD3	638	167.2	600.5	891.3	209.6	277.0	1656.1	3.55
Polaris_BD4	392	112.7	297.6	304.8	125.0	118.7	1049.4	7.10
Polaris_BD5	649	133.3	236.6	295.1	135.2	84.5	586.7	13.08
Polaris_BD6	814	137.6	261.9	324.7	137.4	100.9	1089.1	23.21
Polaris_BD7	888	330.9	606.7	667.9	274.6	188.8	962.7	30.07
Polaris_BD8	400	154.5	201.4	215.3	133.9	48.9	242.8	8.42
Polaris_BD9	599	255.0	320.5	325.5	195.6	93.6	595.4	49.19
Polaris_BD10	396	381.4	538.8	681.5	301.8	192.6	952.5	34.39
Polaris_BD11	392	323.8	563.9	582.8	266.4	200.7	828.2	13.24
Polaris_BD12	328	1748.0	3080.1	3135.9	1361.8	1202.1	5809.2	66.17
Polaris_BD13	398	468.0	587.2	689.2	420.2	309.3	3232.0	182.74
Polaris_BD14	998	60.7	127.6	175.3	71.7	119.2	1270.8	3.21
Polaris_BD15	1114	77.5	146.9	165.2	77.3	82.2	796.2	2.22
Polaris_BD16	952	285.7	558.7	602.5	232.4	191.7	787.0	4.35
Polaris_BD17	987	218.6	553.8	717.1	237.2	201.9	1206.7	21.74
Polaris_BD18	812	178.4	256.4	354.8	141.7	216.2	3131.9	0.39
Polaris_BD19	1034	282.0	850.1	901.0	290.7	298.2	2727.6	4.61
Polaris_All Dense Urban Buildings	5372	116.7	400.1	569.3	150.3	193.3	1656.1	2.2
Polaris_All Urban Buildings	3874	198.4	447.8	729.9	203.0	225.9	3131.9	0.4
Polaris_All Suburban Buildings	3489	232.1	420.7	571.4	215.1	161.9	1089.1	8.4
Polaris_All Rural Buildings	726	575.7	3005.1	3072.3	845.6	961.3	5809.2	66.2

Table 6.1.2-3. Qualcomm Summary Indoor Accuracy Statistics

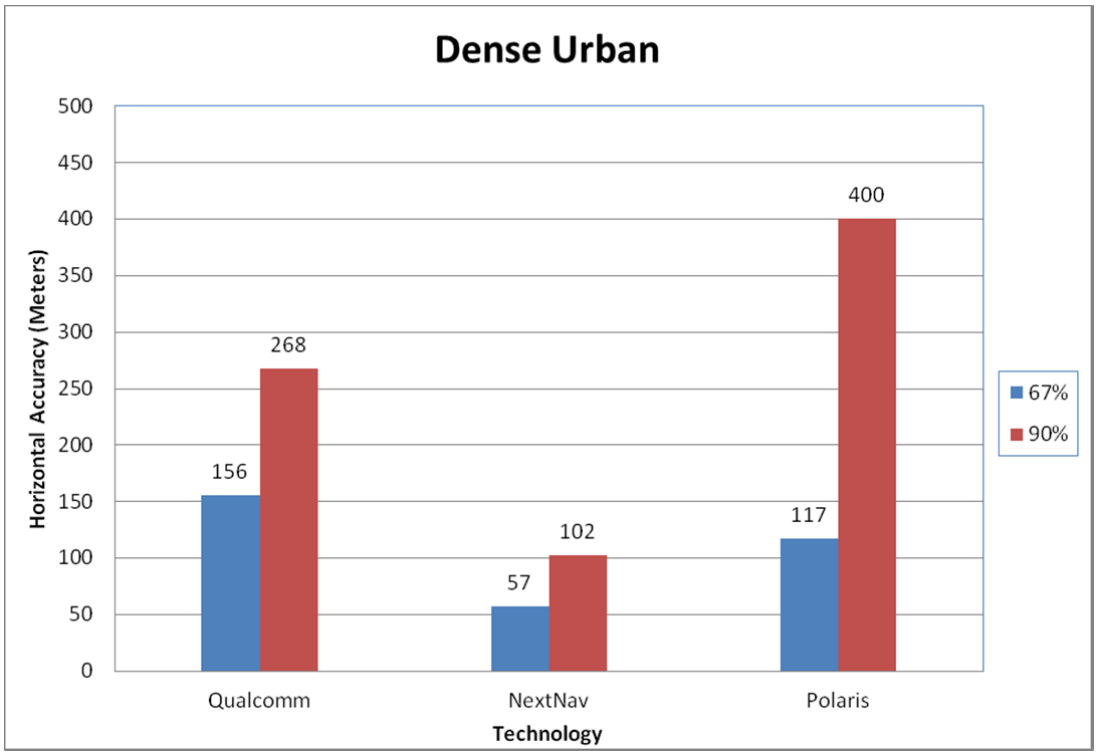
Horizontal Error Statistics (m)								
Building ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD1	705	187.5	249.9	302.8	145.3	106.9	621.0	7.57
Qualcomm_BD2	868	103.3	165.6	188.4	95.6	55.3	405.1	2.53
Qualcomm_BD3	1227	185.7	335.1	355.6	169.0	110.7	722.5	10.65
Qualcomm_BD4	1240	243.7	434.4	701.5	348.8	983.2	18236.7	1.79
Qualcomm_BD5	651	173.4	201.3	287.4	150.1	76.5	793.3	7.28
Qualcomm_BD6	726	95.5	192.1	336.6	105.7	200.4	4639.4	2.68
Qualcomm_BD7	1407	151.0	245.5	576.4	139.9	174.9	1665.3	1.44
Qualcomm_BD8	358	9.3	14.5	17.0	7.9	4.7	24.8	0.66
Qualcomm_BD9	507	68.3	191.4	388.3	101.7	229.3	4078.5	1.76
Qualcomm_BD10	359	19.6	34.8	43.3	22.3	71.9	1329.5	1.03
Qualcomm_BD11	359	11.9	19.6	26.0	15.7	66.7	1097.1	0.23
Qualcomm_BD12	353	37.7	143.9	253.8	374.8	2023.9	18875.5	1.00
Qualcomm_BD13	356	67.9	236.7	3651.7	902.7	3706.7	27782.4	1.41
Qualcomm_BD14	810	176.3	230.3	257.1	144.5	85.4	711.5	1.86
Qualcomm_BD15	812	166.6	262.3	304.1	146.9	76.6	424.4	2.12
Qualcomm_BD16	723	125.3	209.9	264.4	100.4	89.9	707.3	0.53
Qualcomm_BD17	876	129.5	278.6	331.1	120.7	114.1	977.1	1.62
Qualcomm_BD18	677	211.5	333.8	369.0	143.4	131.4	622.7	3.82
Qualcomm_BD19	894	446.3	509.7	530.6	315.1	191.2	2405.1	6.62
Qualcomm_All Dense Urban Bldgs	5145	155.8	267.5	328.1	136.4	94.7	722.5	0.5
Qualcomm_All Urban Buildings	4338	226.8	449.3	507.1	233.9	547.7	18236.7	1.6
Qualcomm_All Suburban Buildings	3716	75.1	204.8	295.7	92.0	173.6	4639.4	0.2
Qualcomm_All Rural Buildings	709	48.5	210.1	312.3	639.9	2999.2	27782.4	1.0

Table 6.1.2-4. NextNav Indoor Vertical Distance Error Statistics Summary

Vertical Distance Error Statistics(m)								
Building ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Distance Error	Standard Deviation	Max Error	Min Error
NextNav_BD1	112	4.3	22.3	22.4	7.1	8.7	23.1	0.04
NextNav_BD2	1020	3.4	5.1	5.9	2.7	1.6	8.2	0.01
NextNav_BD3	809	3.6	6.9	7.3	3.3	6.4	173.6	0.01
NextNav_BD4	690	1.7	3.4	3.8	5.0	23.0	193.5	0.02
NextNav_BD5	612	2.8	3.5	4.0	2.2	1.1	5.3	0.03
NextNav_BD6	825	2.4	2.8	3.0	1.9	0.8	3.6	0.06
NextNav_BD7	934	4.3	5.0	5.2	3.7	1.1	7.4	0.62
NextNav_BD8	395	4.5	5.2	5.4	3.1	1.7	6.0	0.39
NextNav_BD9	598	5.2	7.3	8.1	4.7	1.8	9.7	0.28
NextNav_BD10	423	5.2	5.7	5.8	5.0	0.5	6.7	3.20
NextNav_BD11	406	5.2	5.7	6.0	4.8	0.7	6.7	2.83
NextNav_BD12	443	0.7	1.2	1.5	0.6	0.4	2.3	0.01
NextNav_BD13	377	0.8	1.0	1.2	0.6	0.4	1.6	0.01
NextNav_BD14	998	2.6	3.2	3.4	2.4	0.7	6.5	0.03
NextNav_BD15	1123	1.6	2.9	3.2	1.5	0.9	5.1	0.03
NextNav_BD16	797	3.0	3.8	4.2	2.5	1.1	6.5	0.04
NextNav_BD17	958	1.3	2.0	2.2	1.0	0.7	4.0	0.02
NextNav_BD18	800	2.3	2.7	2.9	2.0	0.6	3.8	0.10
NextNav_BD19	1178	1.1	1.9	2.2	0.9	0.7	4.6	0.01
NextNav_All Dense Urban Buildings	4859	2.9	4.0	5.6	2.5	3.2	173.6	0.0
NextNav_All Urban Buildings	4238	1.9	2.8	3.2	2.0	9.4	193.5	0.0
NextNav_All Suburban Buildings	3581	4.6	5.5	5.8	3.6	1.6	9.7	0.1
NextNav_All Rural Buildings	820	0.7	1.1	1.4	0.6	0.4	2.3	0.0

6.1.2.2 Summary Accuracy Charts

6.1.2.2.1 Summary Accuracy by Morphology



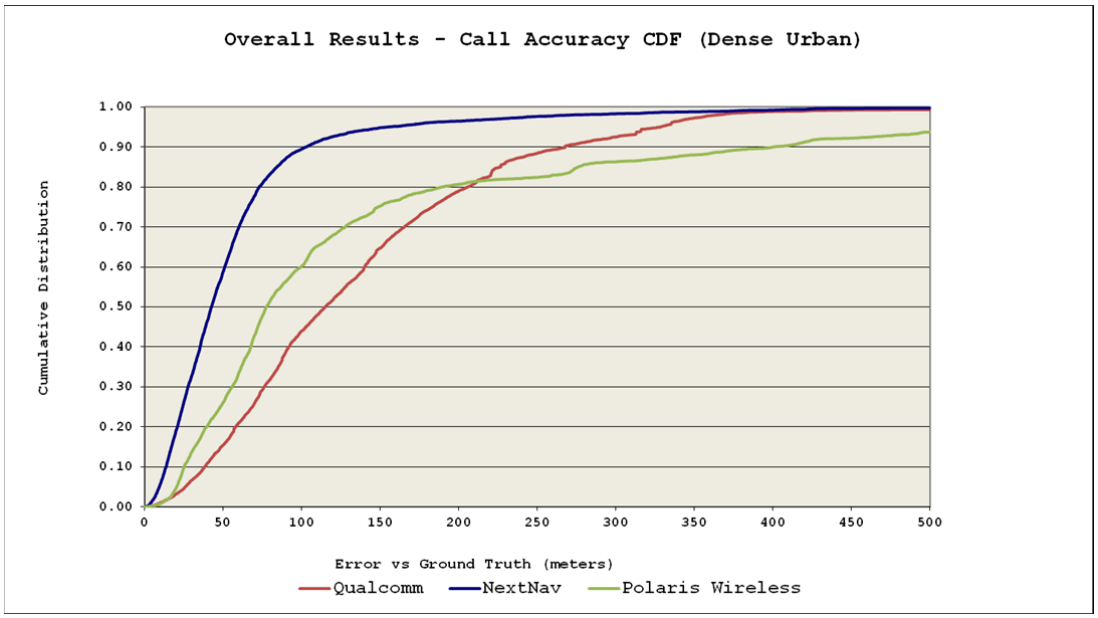
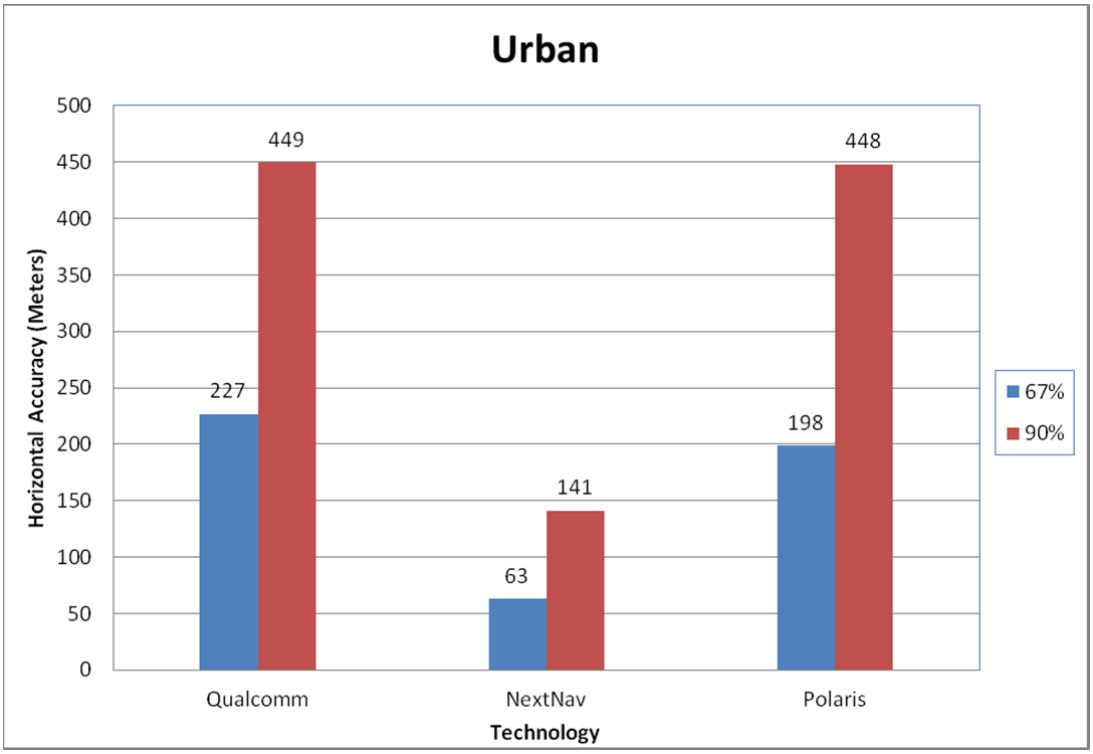


Figure 6.1.2-1 Indoor Accuracy in the Dense Urban Environment



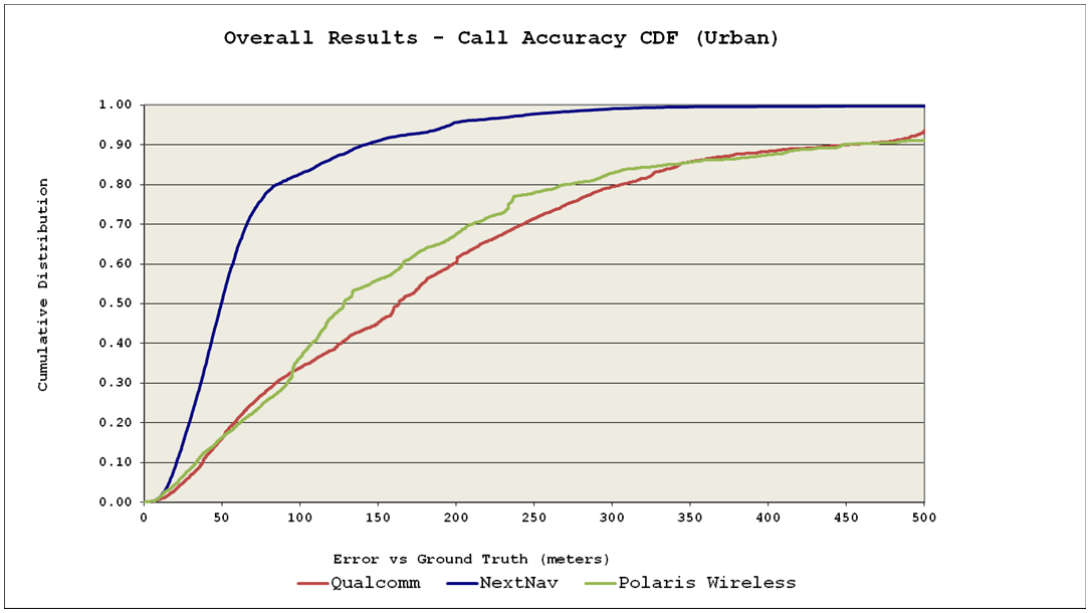
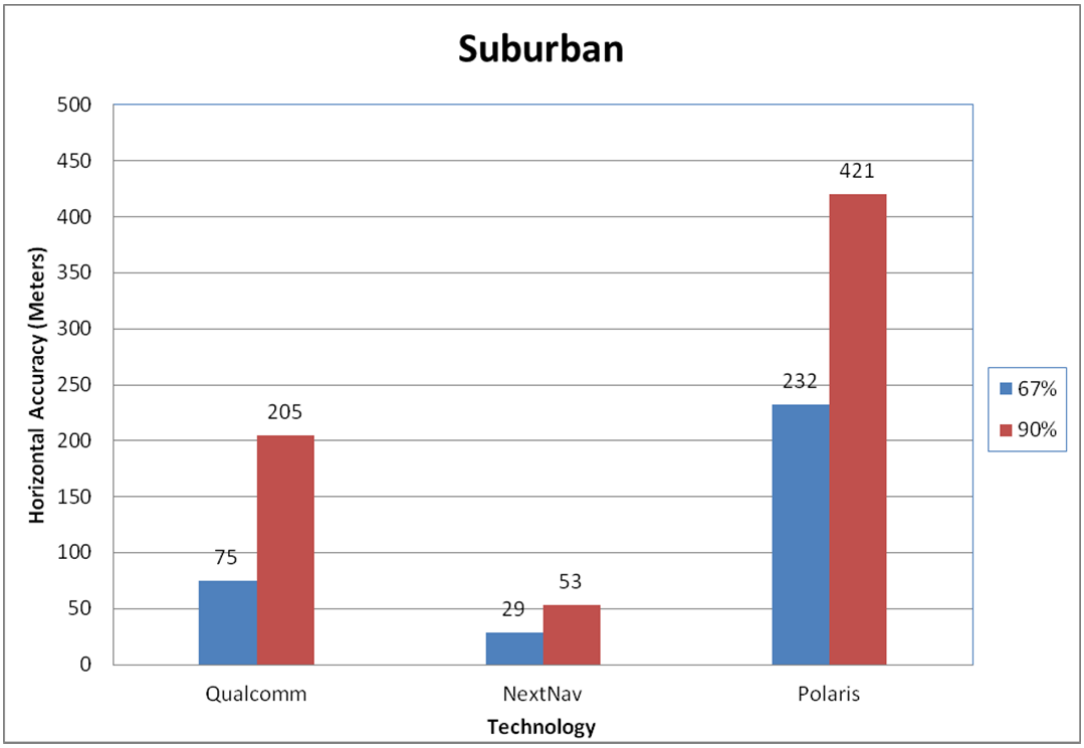


Figure 6.1.2-2 Indoor Accuracy in the Urban Environment



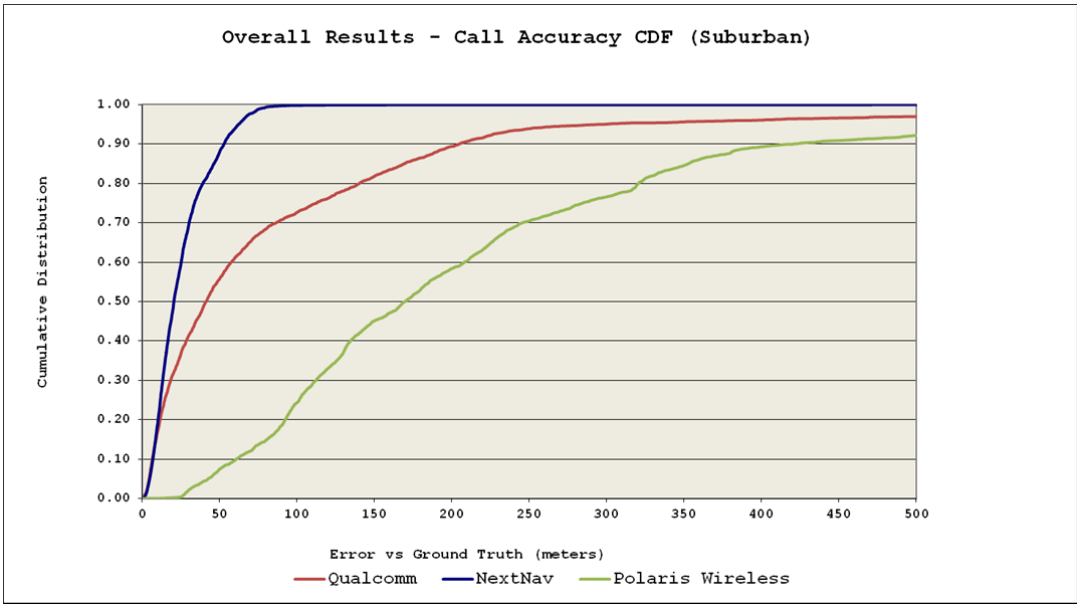
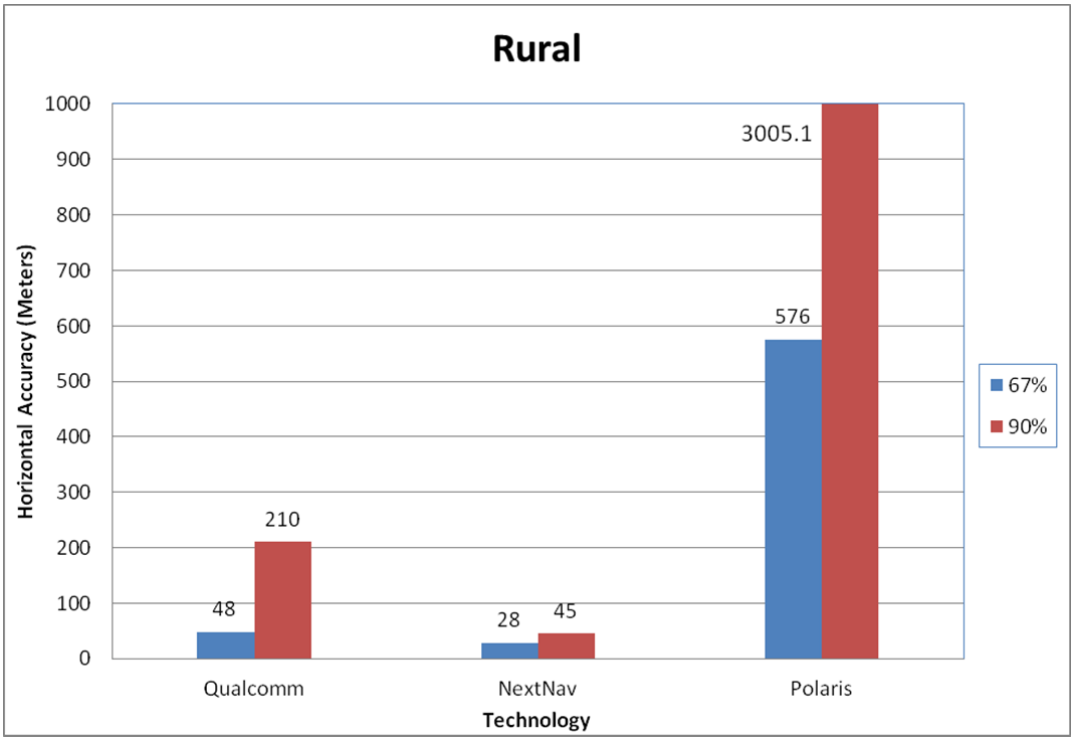


Figure 6.1.2-3. Indoor Accuracy in the Suburban Environment



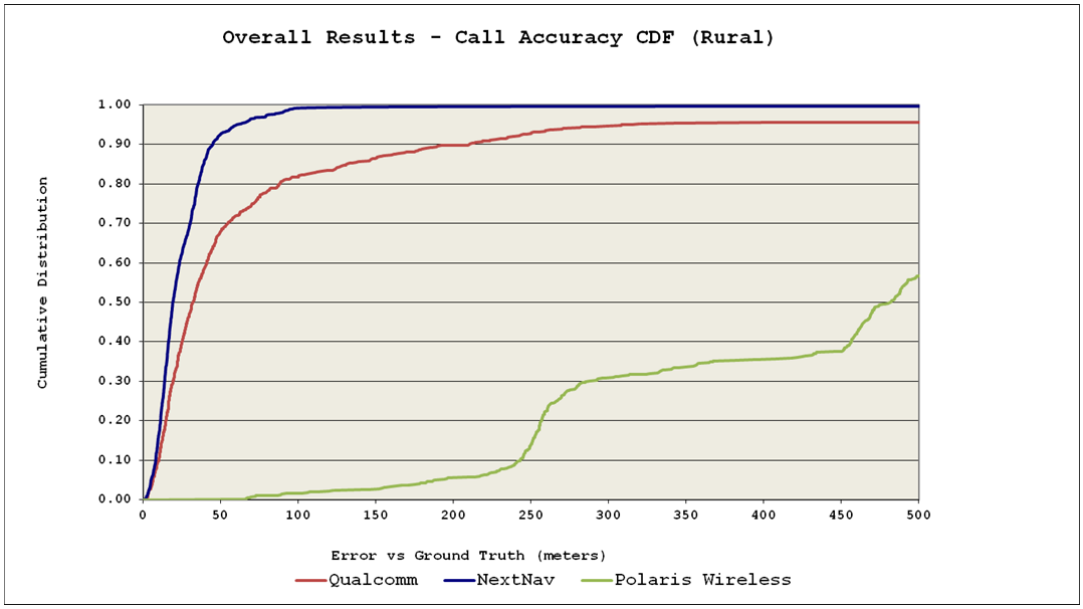


Figure 6.1.2-4 Indoor Accuracy in the Rural Environment

6.1.2.2.1 Summary Accuracy by Technology

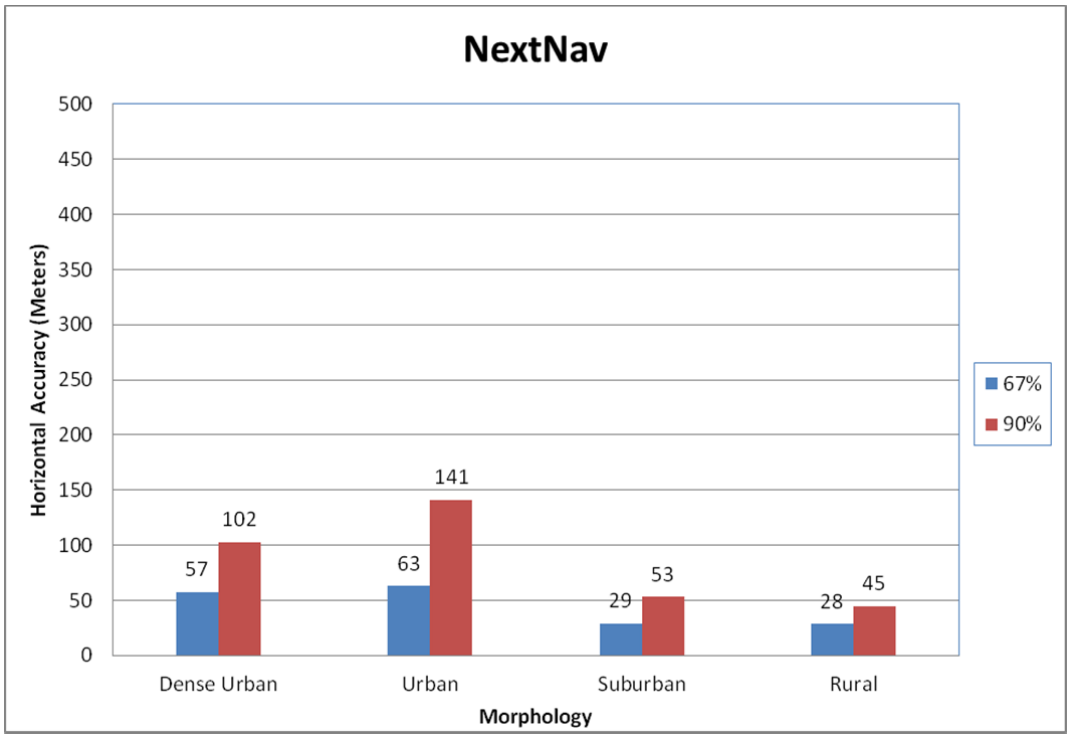


Figure 6.1.2-5. Indoor Accuracy by Morphology for NextNav

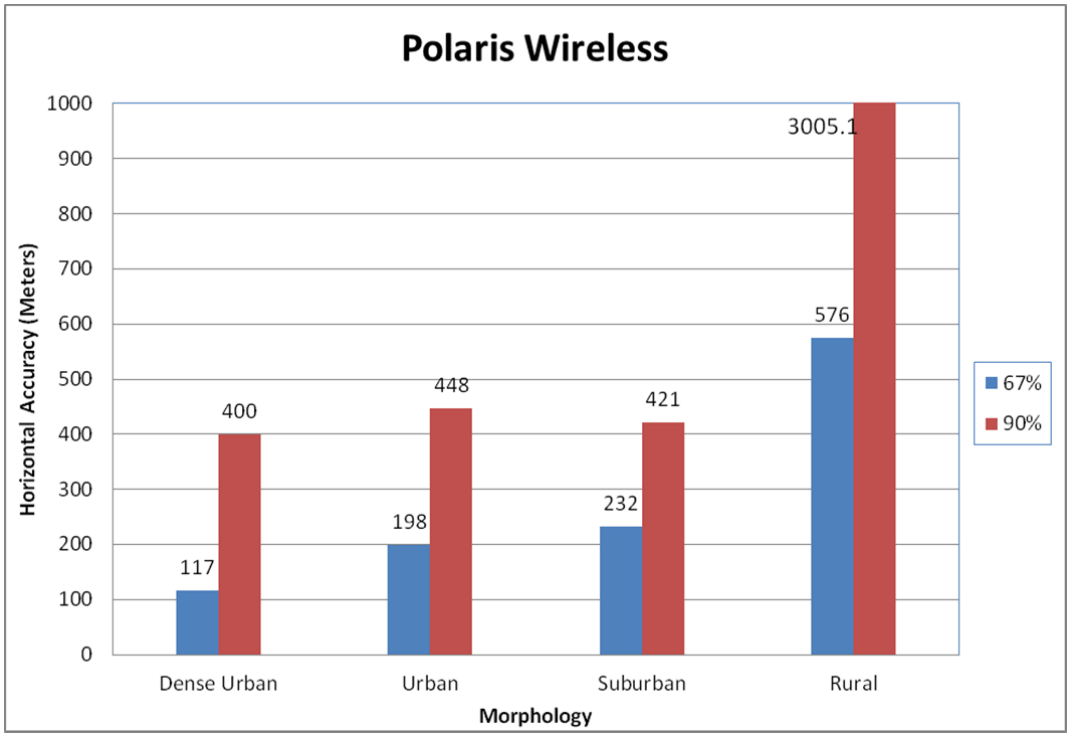


Figure 6.1.2-6. Indoor Accuracy by Morphology for Polaris

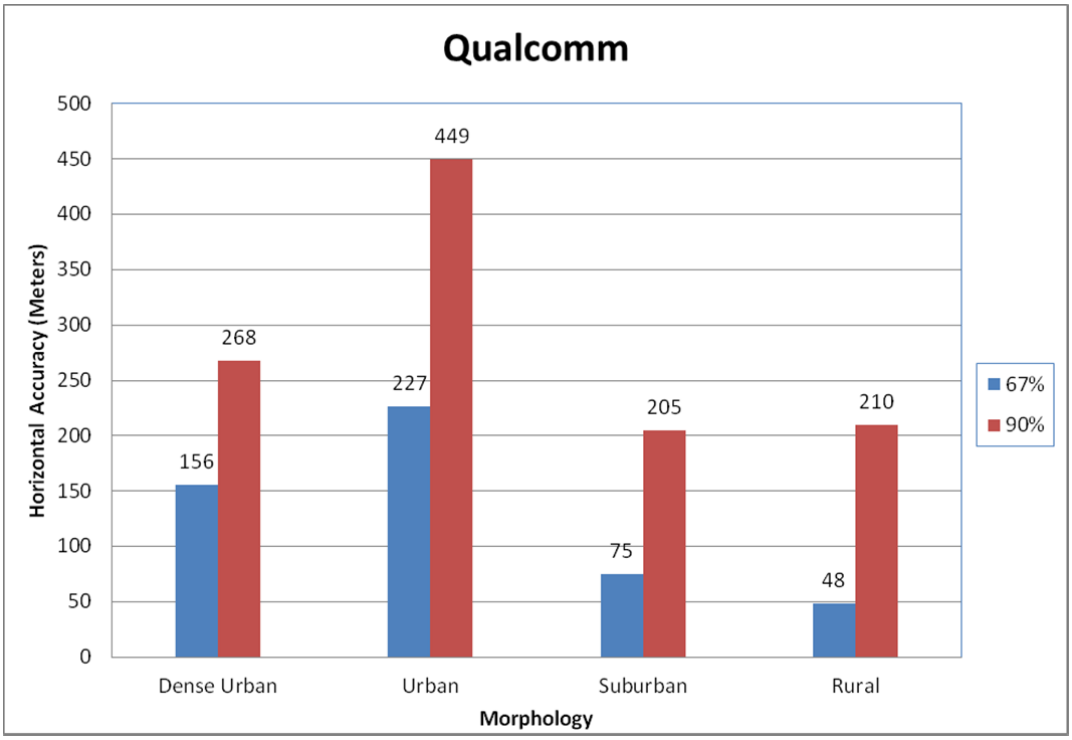


Figure 6.1.2-7. Indoor Accuracy by Morphology for Qualcomm

6.1.3 TTFF

6.1.3.1 TTFF Summary Results by Morphology

Table 6.1.3-1. Summary Indoor Test TTFF by Morphology and Technology

TTFF(Sec)					
Building ID	Average Duration	Standard Deviation	Max Duration	Min Duration	90th Percentile
NextNav_All Dense Urban Buildings	27.36	0.61	32.98	8.35	27.45
NextNav_All Urban Buildings	27.40	0.48	32.59	14.61	27.64
NextNav_All Suburban Buildings	27.39	0.52	32.67	12.35	27.52
NextNav_All Rural Buildings	27.56	0.35	32.69	26.96	27.86

TTFF(Sec)					
Building ID	Average Duration	Standard Deviation	Max Duration	Min Duration	90th Percentile
QualComm_All Dense Urban Buildings	28.24	7.46	95.00	1.00	33.00
QualComm_All Urban Buildings	27.83	8.21	94.00	1.00	33.00
QualComm_All Suburban Buildings	23.53	4.79	91.00	1.00	26.00
QualComm_All Rural Buildings	24.88	2.94	49.00	17.00	26.00

TTFF(Sec)					
Building ID	Average Duration	Standard Deviation	Max Duration	Min Duration	90th Percentile
Polaris_All Dense Urban Buildings	24.37	2.00	28.02	1.11	25.92
Polaris_All Urban Buildings	24.11	3.09	29.32	1.36	25.93
Polaris_All Suburban Buildings	24.68	1.51	27.64	1.54	25.69
Polaris_All Rural Buildings	23.38	3.82	26.02	1.23	25.50

6.1.3.2 TTFF Results by Building

Table 6.1.3-2. Summary Indoor Test TTFF by Building for NextNav

TTFF(Sec)				
Building ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD1	26.73	0.98	27.89	19.31
NextNav_BD2	27.34	0.68	32.36	8.35
NextNav_BD3	27.37	0.80	32.39	13.32
NextNav_BD4	27.35	0.63	32.36	15.34
NextNav_BD5	27.41	0.40	32.44	26.99
NextNav_BD6	27.42	0.51	32.67	20.37
NextNav_BD7	27.39	0.63	32.46	14.38
NextNav_BD8	27.40	0.78	27.90	12.35
NextNav_BD9	27.41	0.32	32.34	26.98
NextNav_BD10	27.36	0.35	32.34	27.27
NextNav_BD11	27.34	0.26	32.34	26.33
NextNav_BD12	27.60	0.40	32.69	26.99
NextNav_BD13	27.52	0.27	27.98	26.96
NextNav_BD14	27.38	0.54	32.68	21.36
NextNav_BD15	27.42	0.44	32.98	26.84
NextNav_BD16	27.35	0.38	32.35	23.35
NextNav_BD17	27.32	0.39	32.36	16.36
NextNav_BD18	27.36	0.36	32.44	27.27
NextNav_BD19	27.51	0.52	32.59	14.61
NextNav_All Dense Urban Buildings	27.36	0.61	32.98	8.35
NextNav_All Urban Buildings	27.40	0.48	32.59	14.61
NextNav_All Suburban Buildings	27.39	0.52	32.67	12.35
NextNav_All Rural Buildings	27.56	0.35	32.69	26.96

Table 6.1.3-3. Summary Indoor Test TTFF by Building for Polaris

TTFF(Sec)				
Building ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD1	25.11	1.03	27.25	18.81
Polaris_BD2	24.05	2.30	27.52	6.98
Polaris_BD3	24.06	2.52	27.47	1.11
Polaris_BD4	23.93	2.23	27.77	3.01
Polaris_BD5	24.46	2.17	26.75	5.52
Polaris_BD6	24.45	1.80	26.45	2.53
Polaris_BD7	24.97	1.17	27.25	5.36
Polaris_BD8	24.62	1.09	26.12	19.26
Polaris_BD9	24.86	1.02	26.37	11.15
Polaris_BD10	24.65	2.02	27.11	1.54
Polaris_BD11	24.34	1.78	27.64	2.33
Polaris_BD12	22.74	5.22	26.02	1.23
Polaris_BD13	23.91	1.89	25.97	5.84
Polaris_BD14	24.78	1.16	26.65	15.89
Polaris_BD15	23.83	2.59	28.02	1.68
Polaris_BD16	24.54	1.32	27.61	17.88
Polaris_BD17	23.85	4.09	27.91	1.36
Polaris_BD18	24.01	3.56	29.32	1.58
Polaris_BD19	24.30	2.17	28.76	4.69
Polaris_All Dense Urban Buildings	24.37	2.00	28.02	1.11
Polaris_All Urban Buildings	24.11	3.09	29.32	1.36
Polaris_All Suburban Buildings	24.68	1.51	27.64	1.54
Polaris_All Rural Buildings	23.38	3.82	26.02	1.23

Table 6.1.3-4. Summary Indoor Test TTFF by Building for Polaris

TTFF(Sec)				
Building ID	Average Duration	Standard Deviation	Max Duration	Min Duration
QualComm_BD1	29.33	11.68	71.00	1.00
QualComm_BD2	29.71	5.33	91.00	12.00
QualComm_BD3	25.57	6.60	69.00	1.00
QualComm_BD4	24.58	6.42	43.00	1.00
QualComm_BD5	30.58	10.99	91.00	15.00
QualComm_BD6	25.25	5.34	91.00	1.00
QualComm_BD7	23.58	5.00	47.00	1.00
QualComm_BD8	19.17	1.24	25.00	18.00
QualComm_BD9	25.49	4.25	67.00	7.00
QualComm_BD10	22.59	3.27	44.00	17.00
QualComm_BD11	22.37	3.48	64.00	17.00
QualComm_BD12	24.57	1.85	42.00	17.00
QualComm_BD13	25.19	3.69	49.00	18.00
QualComm_BD14	30.19	8.58	95.00	17.00
QualComm_BD15	30.05	5.57	67.00	16.00
QualComm_BD16	25.73	3.03	47.00	17.00
QualComm_BD17	27.57	7.51	94.00	17.00
QualComm_BD18	26.63	5.37	91.00	16.00
QualComm_BD19	31.49	8.40	94.00	2.00
QualComm_All Dense Urban Bldgs	28.24	7.46	95.00	1.00
QualComm_All Urban Buildings	27.83	8.21	94.00	1.00
QualComm_All Suburban Buildings	23.53	4.79	91.00	1.00
QualComm_All Rural Buildings	24.88	2.94	49.00	17.00

6.1.4 Reported Uncertainty

Table 6.1.4-1. Reported Uncertainty Summary Results for NextNav

Uncertainty			
Building ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD1	112	47	41.96%
NextNav_BD2	1020	965	94.61%
NextNav_BD3	809	758	93.70%
NextNav_BD4	690	664	96.23%
NextNav_BD5	612	420	68.63%
NextNav_BD6	825	784	95.03%
NextNav_BD7	934	909	97.32%
NextNav_BD8	395	395	100.00%
NextNav_BD9	598	544	90.97%
NextNav_BD10	423	423	100.00%
NextNav_BD11	406	405	99.75%
NextNav_BD12	443	427	96.39%
NextNav_BD13	377	351	93.10%
NextNav_BD14	998	943	94.49%
NextNav_BD15	1123	1037	92.34%
NextNav_BD16	797	786	98.62%
NextNav_BD17	958	865	90.29%
NextNav_BD18	800	729	91.13%
NextNav_BD19	1178	1010	85.74%
NextNav_All Dense Urban Buildings	4859	4536	93.35%
NextNav_All Urban Buildings	4238	3688	87.02%
NextNav_All Suburban Buildings	3581	3460	96.62%
NextNav_All Rural Buildings	820	778	94.88%

Table 6.1.4-2. Reported Uncertainty Summary Results for Polaris

Uncertainty			
Building ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD1	700	122	17.43%
Polaris_BD2	970	783	80.72%
Polaris_BD3	638	409	64.11%
Polaris_BD4	392	293	74.74%
Polaris_BD5	649	288	44.38%
Polaris_BD6	814	528	64.86%
Polaris_BD7	888	451	50.79%
Polaris_BD8	400	357	89.25%
Polaris_BD9	599	455	75.96%
Polaris_BD10	396	317	80.05%
Polaris_BD11	392	356	90.82%
Polaris_BD12	328	172	52.44%
Polaris_BD13	398	185	46.48%
Polaris_BD14	998	884	88.58%
Polaris_BD15	1114	985	88.42%
Polaris_BD16	952	547	57.46%
Polaris_BD17	987	631	63.93%
Polaris_BD18	812	583	71.80%
Polaris_BD19	1034	682	65.96%
Polaris_All Dense Urban Buildings	5372	3730	69.43%
Polaris_All Urban Buildings	3874	2376	61.33%
Polaris_All Suburban Buildings	3489	2465	70.65%
Polaris_All Rural Buildings	726	357	49.17%

Table 6.1.4-3. Reported Uncertainty Summary Results for Qualcomm

Uncertainty			
Building ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
QualComm_BD1	705	659	93.48%
QualComm_BD2	868	835	96.20%
QualComm_BD3	1227	1200	97.80%
QualComm_BD4	1240	838	67.58%
QualComm_BD5	651	497	76.34%
QualComm_BD6	726	627	86.36%
QualComm_BD7	1407	1105	78.54%
QualComm_BD8	358	348	97.21%
QualComm_BD9	507	422	83.23%
QualComm_BD10	359	327	91.09%
QualComm_BD11	359	344	95.82%
QualComm_BD12	353	295	83.57%
QualComm_BD13	356	286	80.34%
QualComm_BD14	810	652	80.49%
QualComm_BD15	812	795	97.91%
QualComm_BD16	723	630	87.14%
QualComm_BD17	876	719	82.08%
QualComm_BD18	677	634	93.65%
QualComm_BD19	894	744	83.22%
QualComm_All Dense Urban Bldgs	5145	4771	92.73%
QualComm_All Urban Buildings	4338	3432	79.11%
QualComm_All Suburban Buildings	3716	3173	85.39%
QualComm_All Rural Buildings	709	581	81.95%

6.2 Aggregate Accuracy by Morphology Plots

6.2.1 Dense Urban Morphology

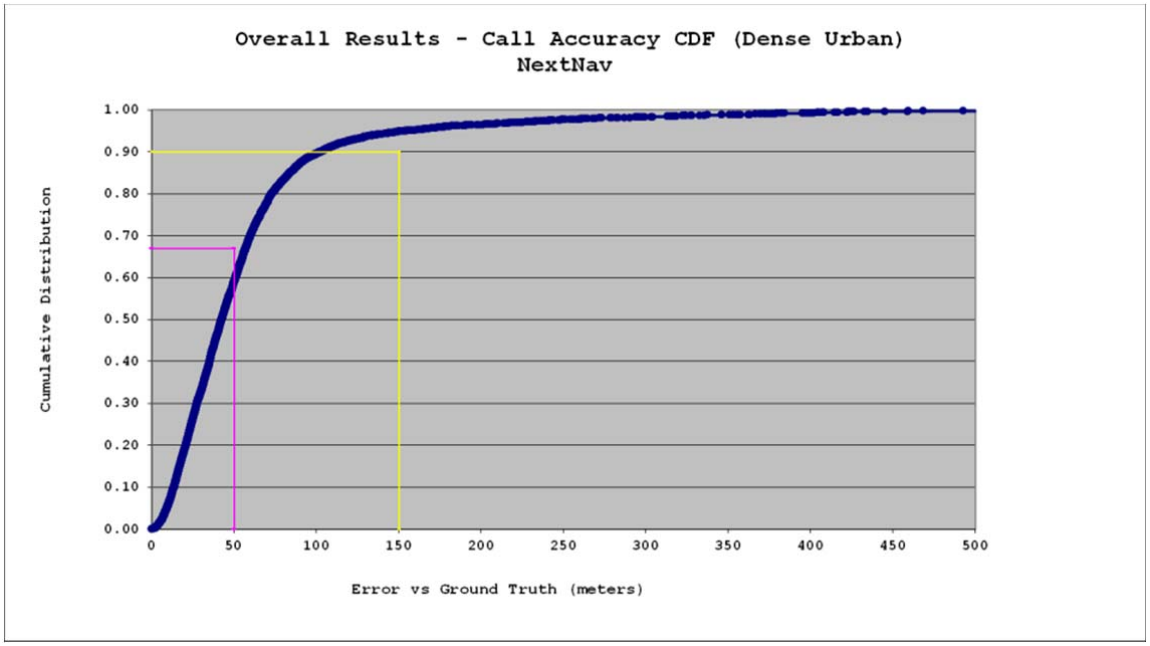


Figure 6.2.1-1. NextNav Aggregate Accuracy—Dense Urban Environment

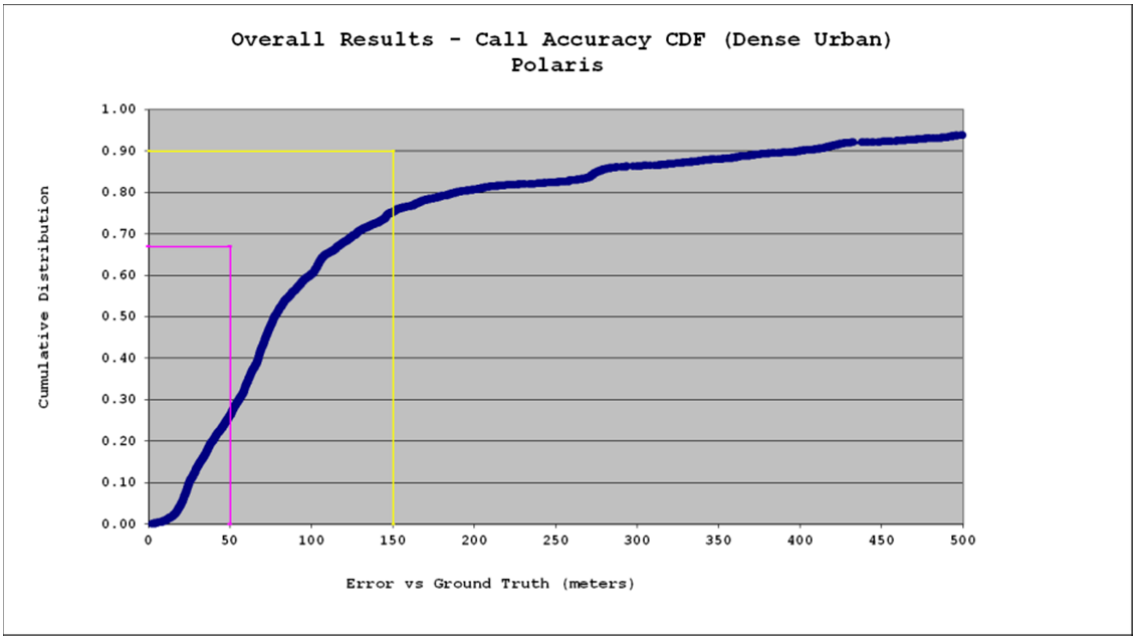


Figure 6.2.1-2. Polaris Aggregate Accuracy—Dense Urban Environment

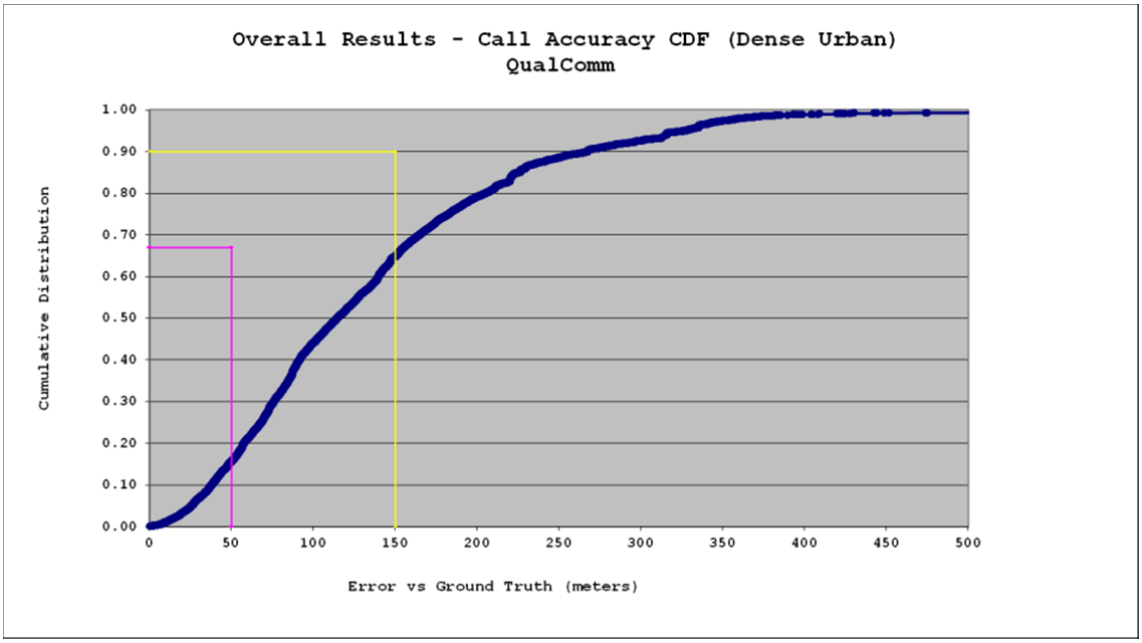


Figure 6.2.1-3. Qualcomm Aggregate Accuracy—Dense Urban Environment

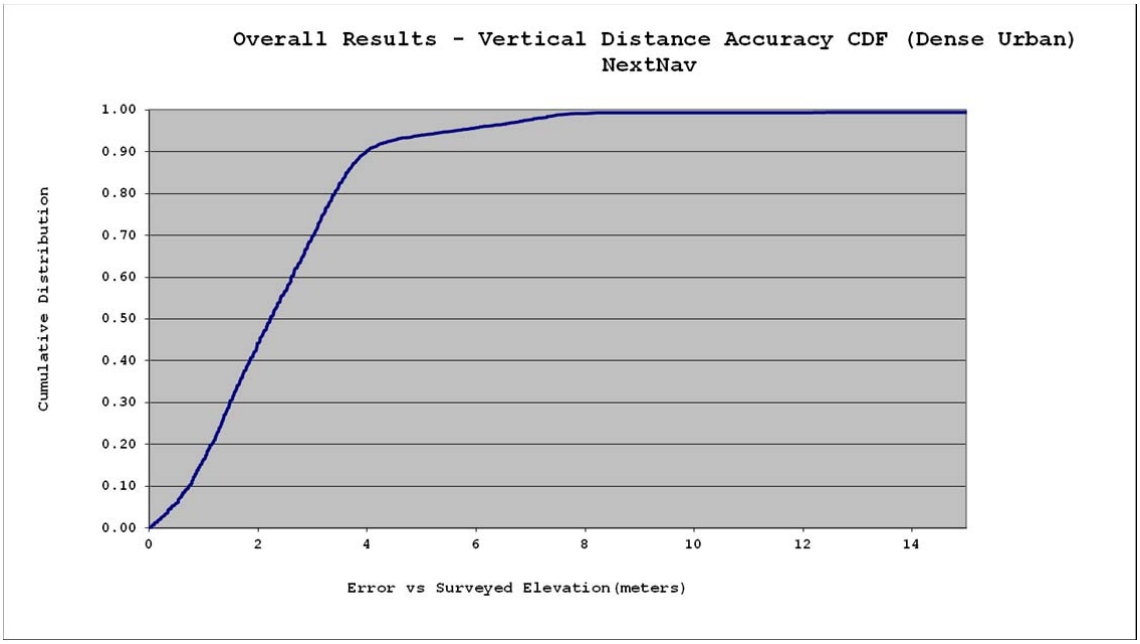


Figure 6.2.1-4. NextNav Vertical Distance Error CDF—Dense Urban Environment

6.2.2 Urban Morphology

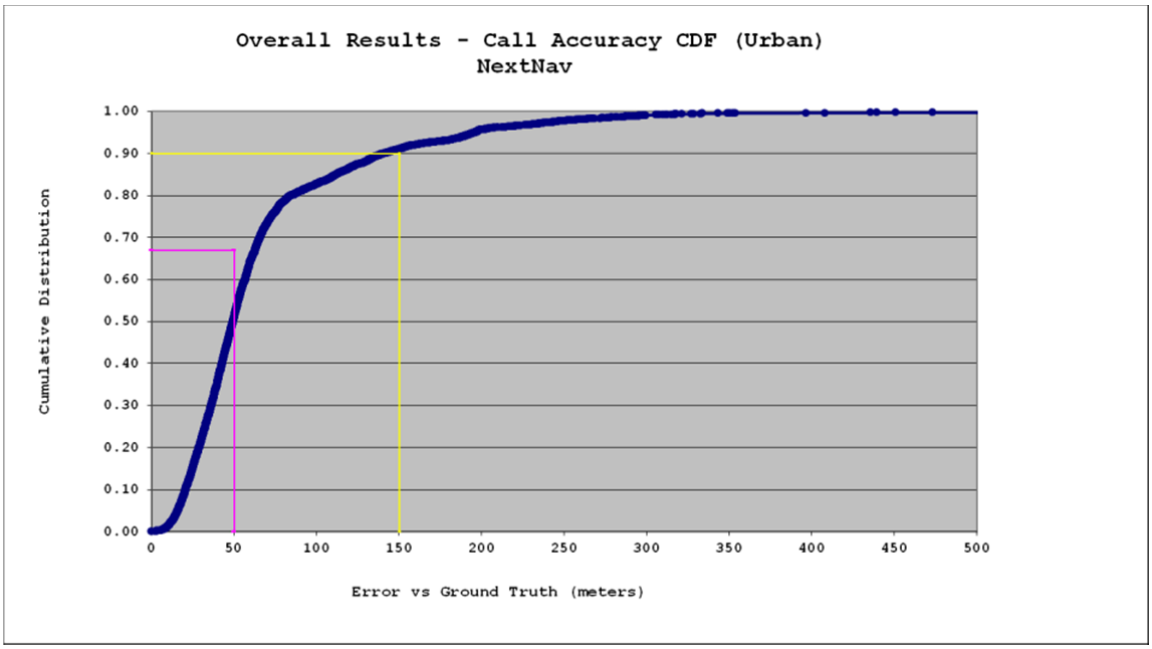


Figure 6.2.2-1. NextNav Aggregate Accuracy—Urban Environment

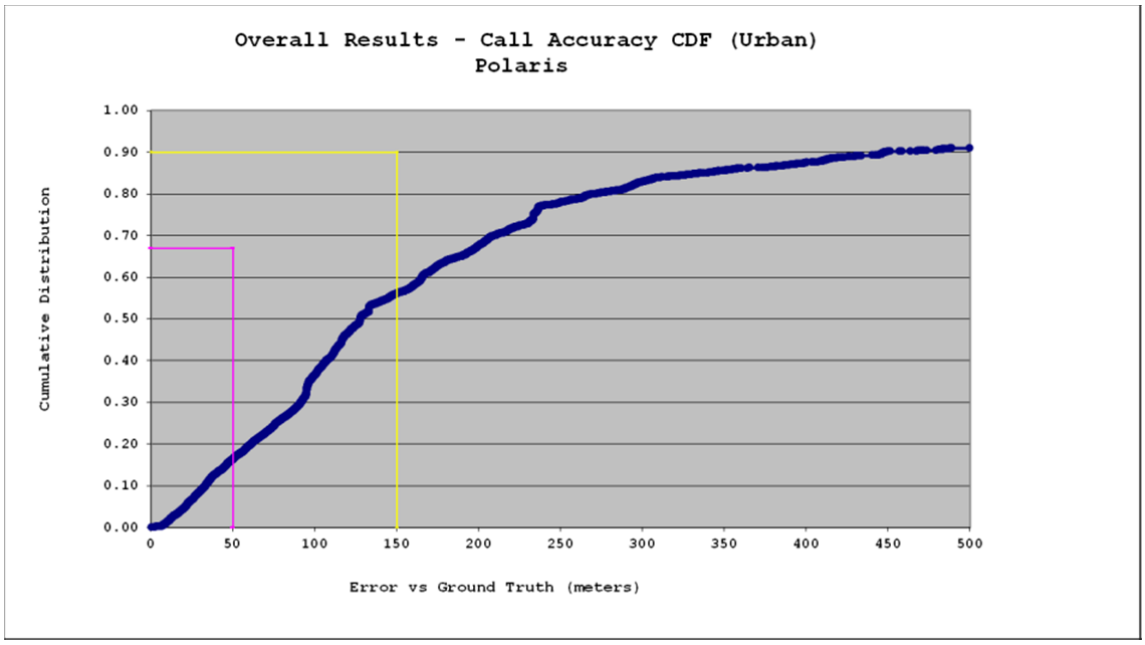


Figure 6.2.2-2. Polaris Aggregate Accuracy—Urban Environment

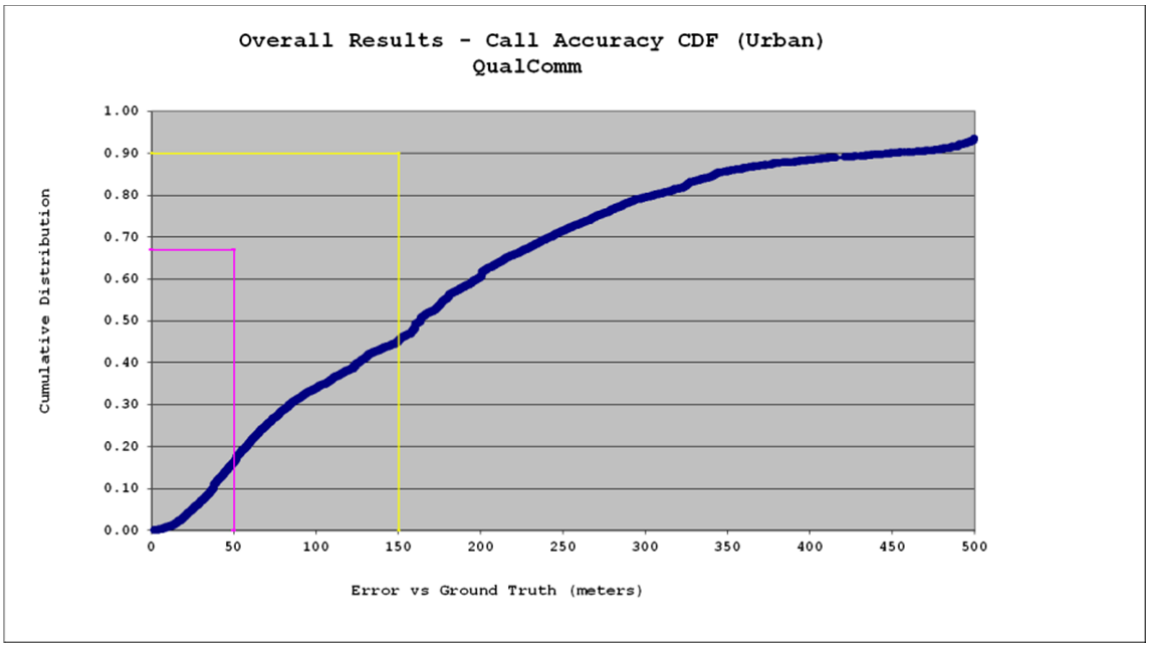


Figure 6.2.2-3. Qualcomm Aggregate Accuracy—Urban Environment

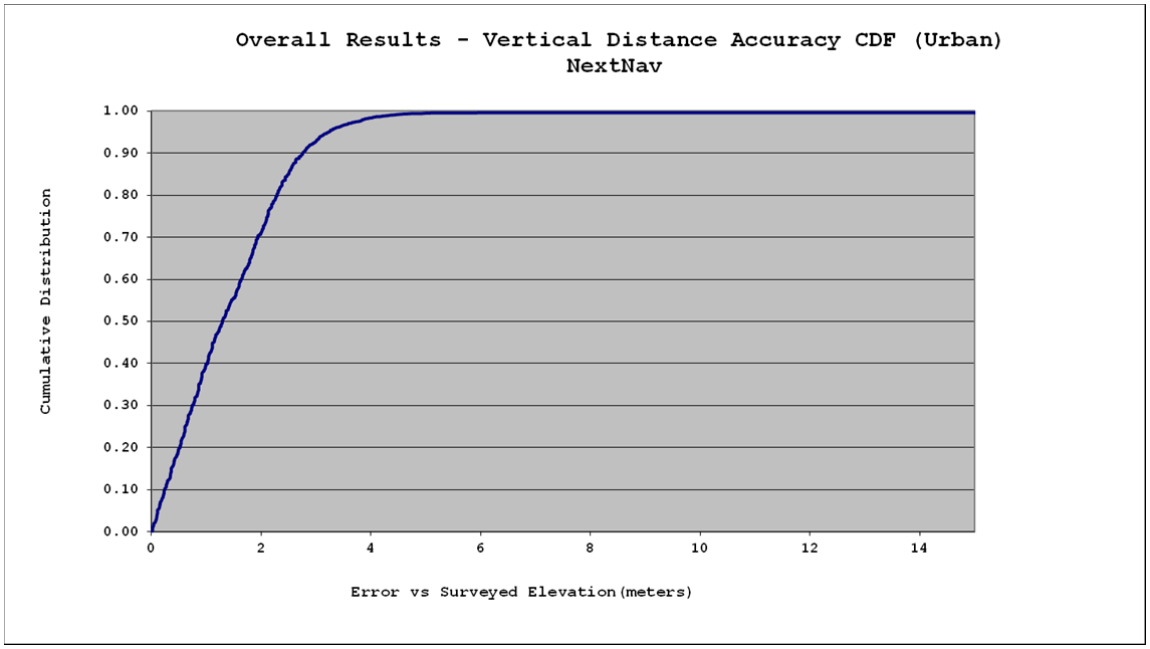


Figure 6.2.2-4. NextNav Vertical Distance Error CDF—Urban Environment

6.2.3 Suburban Morphology

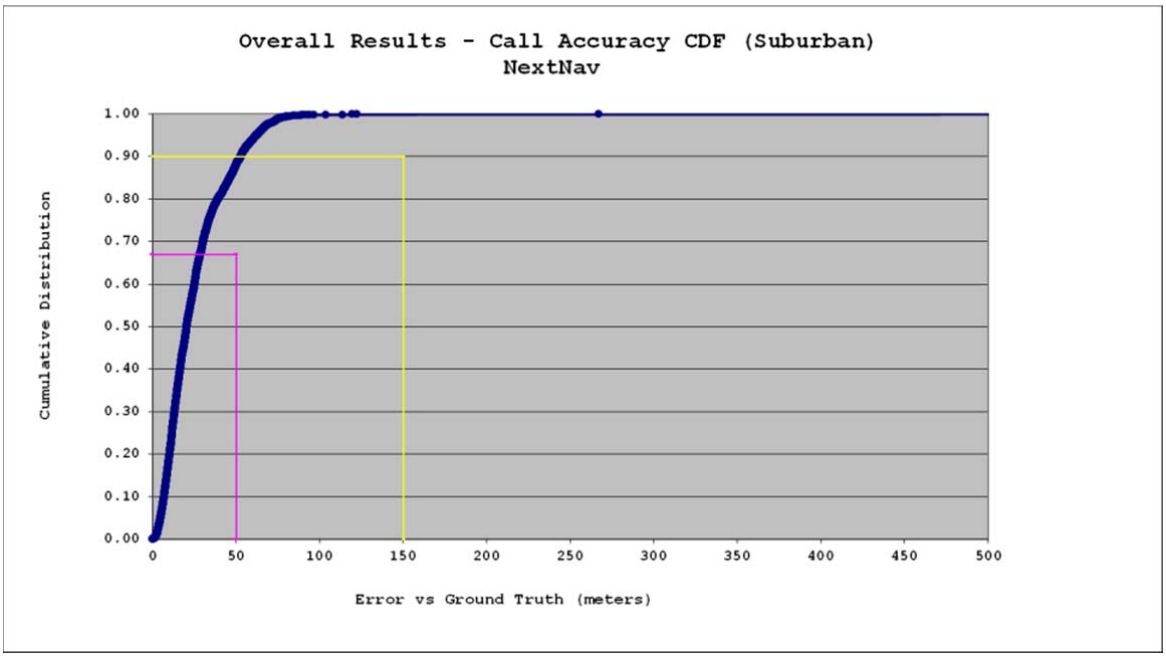


Figure 6.2.3-1. NextNav Aggregate Accuracy—Suburban Environment

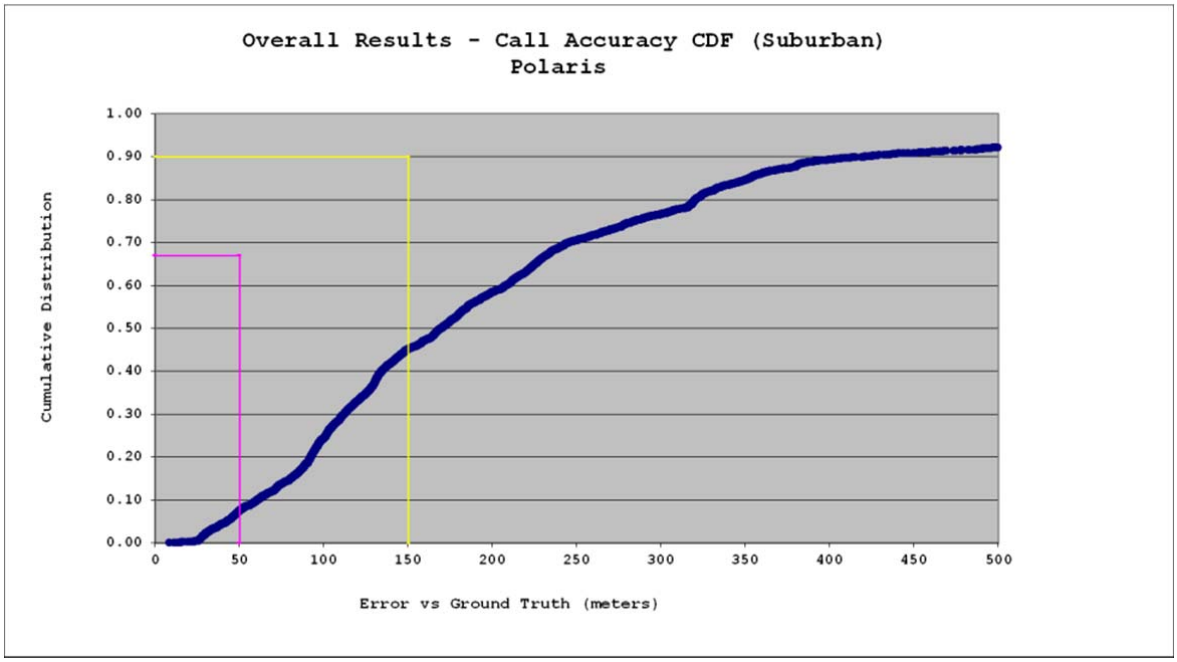


Figure 6.2.3-2. Polaris Aggregate Accuracy—Suburban Environment

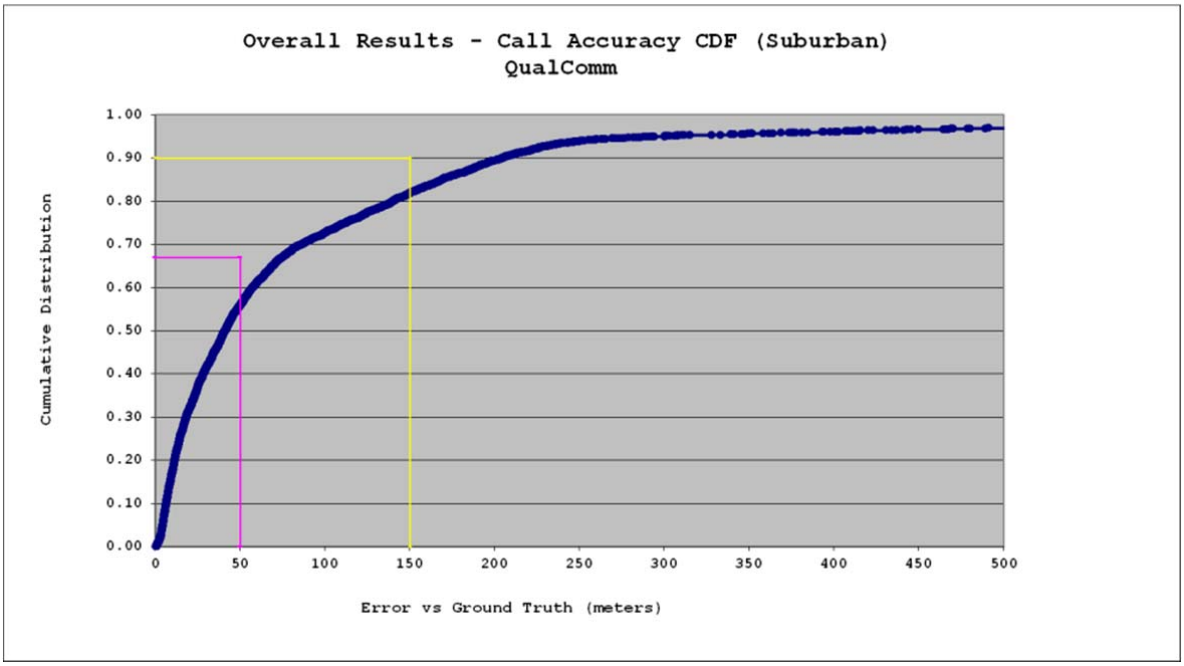


Figure 6.2.3-3. Qualcomm Aggregate Accuracy—Suburban Environment

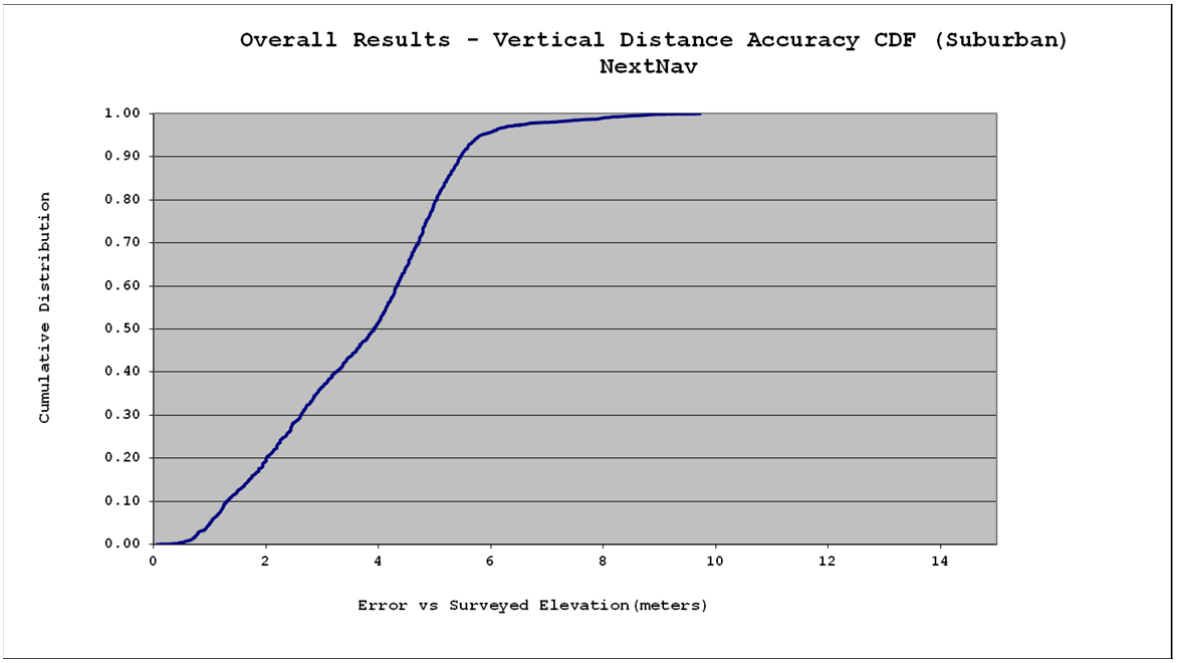


Figure 6.2.3-4. NextNav Vertical Distance Error CDF—Suburban Environment

6.2.4 Rural Morphology

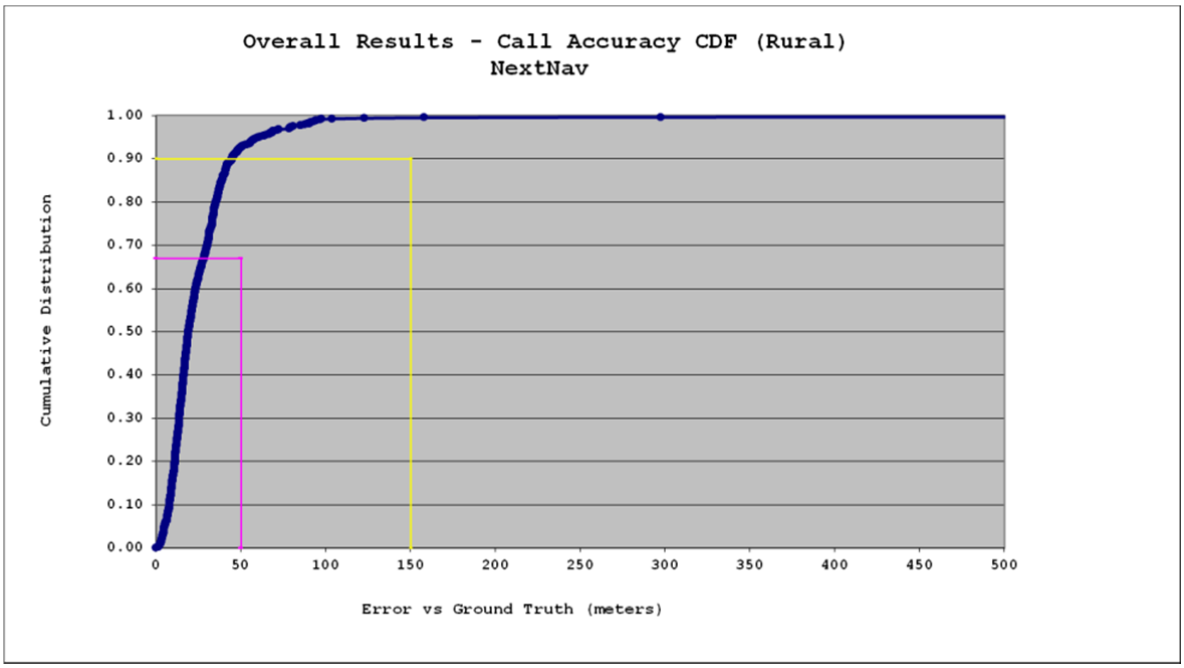


Figure 6.2.4-1. NextNav Aggregate Accuracy—Rural Environment

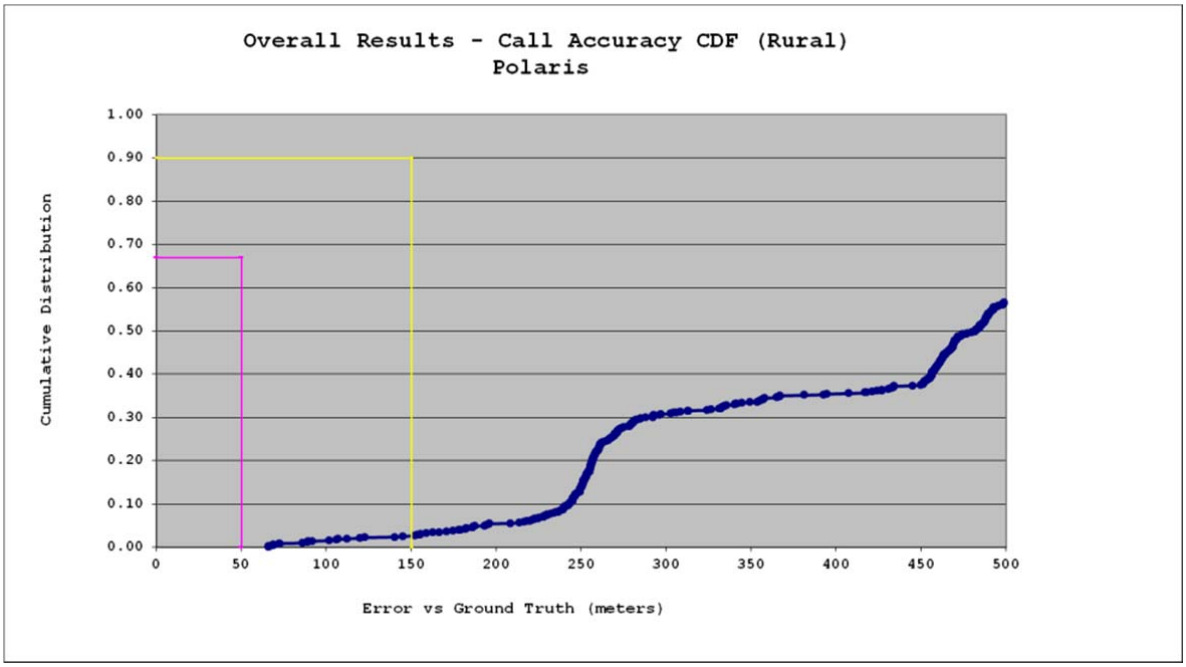


Figure 6.2.4-2. Polaris Aggregate Accuracy—Rural Environment

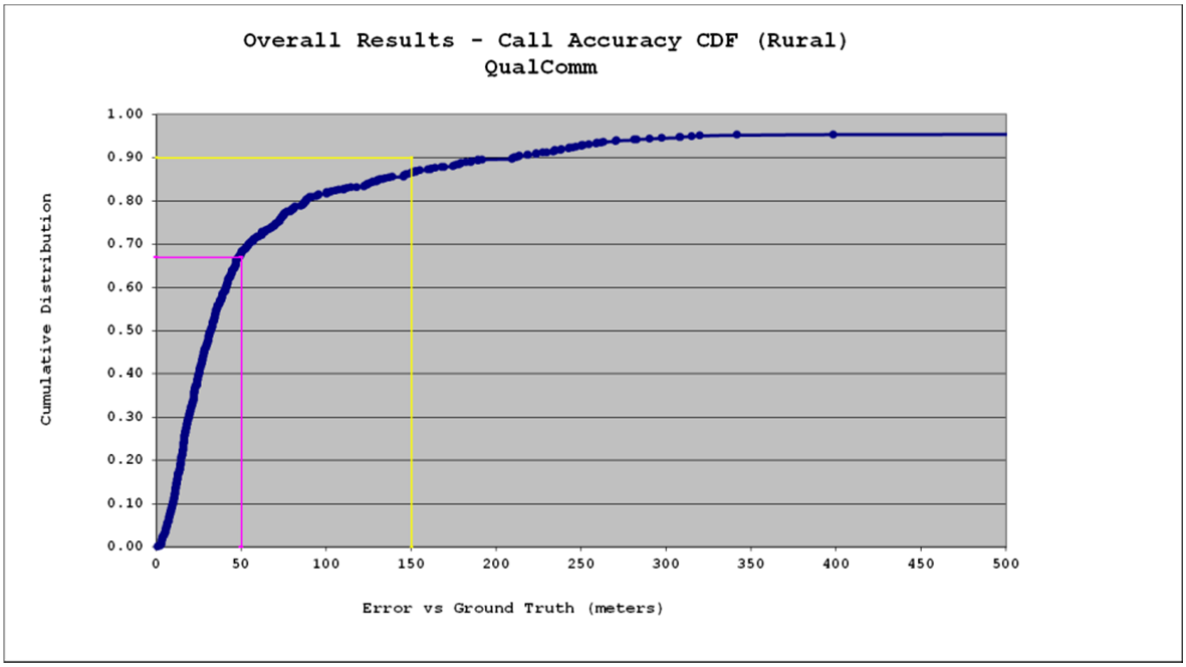


Figure 6.2.4-3. Qualcomm Aggregate Accuracy—Rural Environment

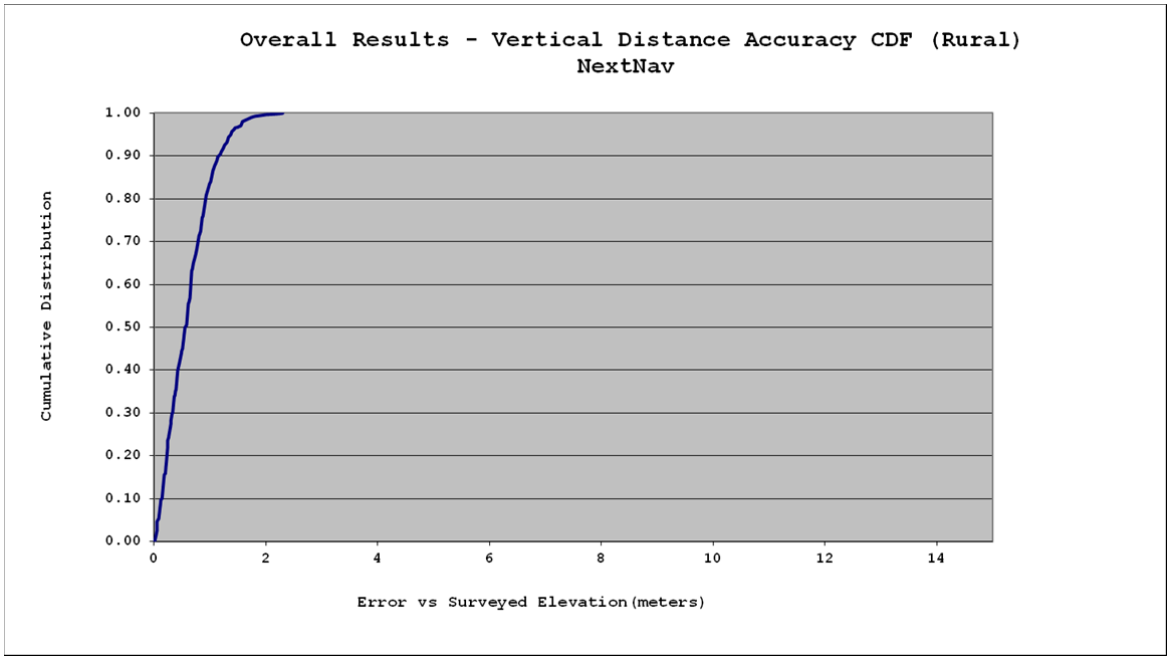


Figure 6.2.4-4. NextNav Vertical Distance Error CDF—Rural Environment

6.3 Accuracy and Location Scatter per Test Point

6.3.1 Dense Urban Buildings

6.3.1.1 Building 1:

6.3.1.1.1 Building 1 Environment and Test Points:

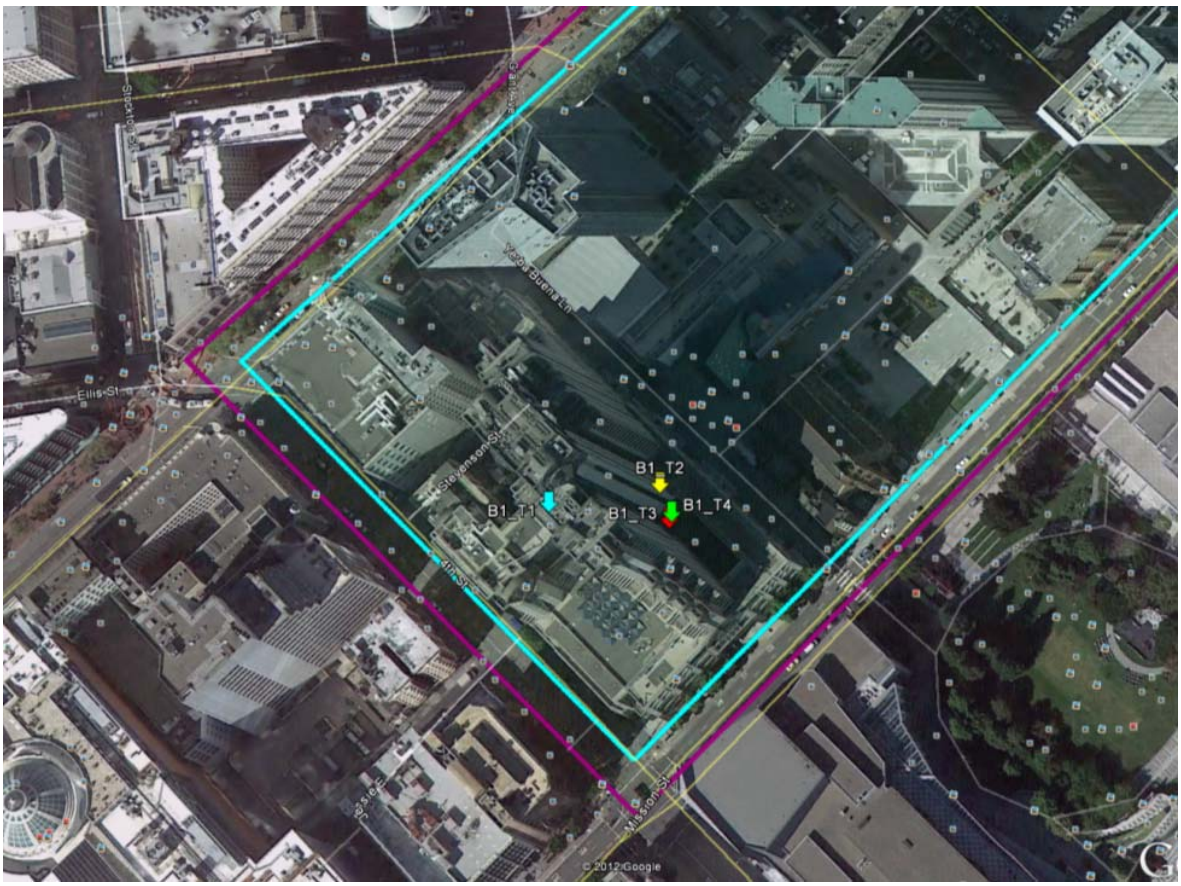
Building 1 is the Marriott Marquis Hotel in SF. It is a large structure, almost like an irregular graded pyramid with its high floors significantly smaller than the lower floors.

TP1: In lobby bar (deep indoors)

TP2: 4th floor interior corridor

TP3: 31st floor, end of corridor, near window

TP4: 8 floor side corridor, near window



6.3.1.1.2 NextNav per Test Point Results—BD1:

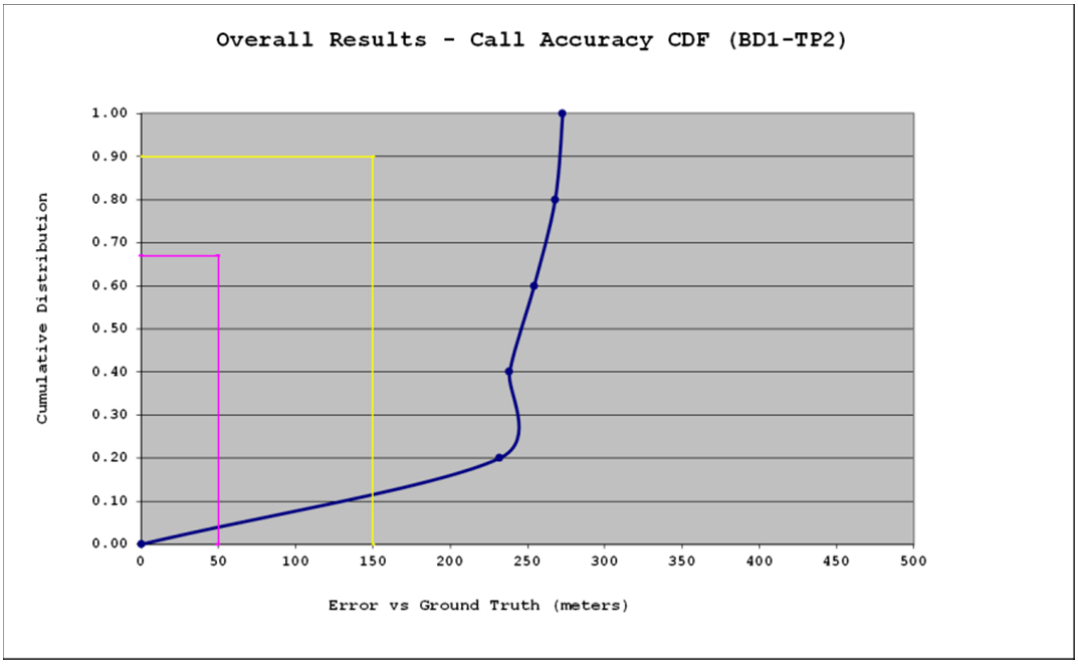
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD1_TP1	0	0	
NextNav_BD1_TP2	5	5	100.0%
NextNav_BD1_TP3	145	67	46.2%
NextNav_BD1_TP4	200	40	20.0%

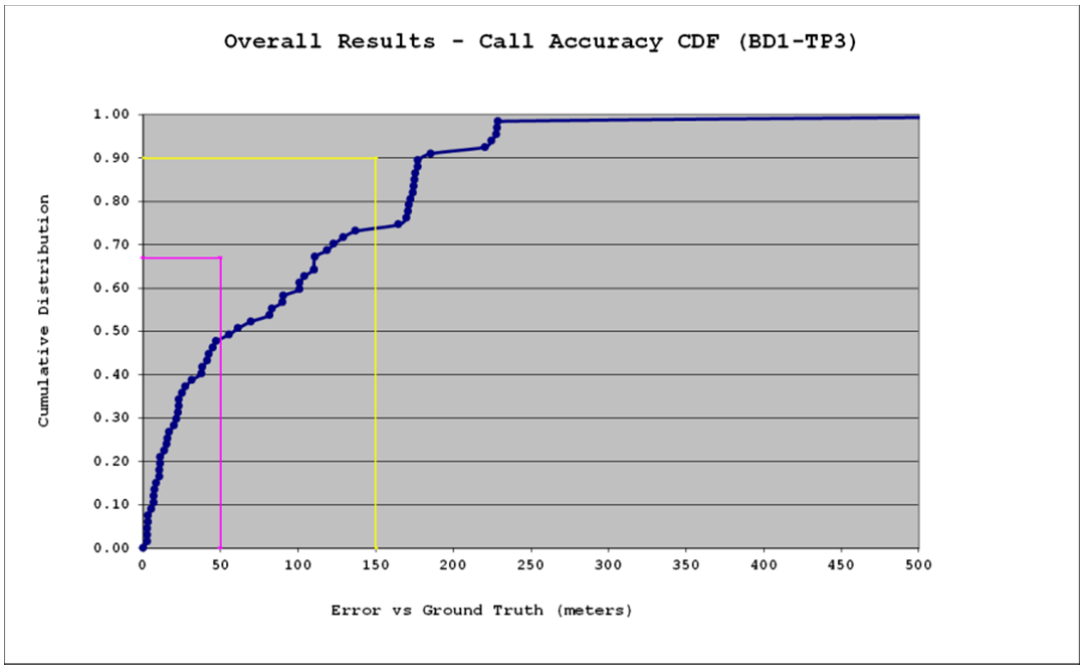
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD1_TP1	0							
NextNav_BD1_TP2	5	263.5	270.8	271.8	253.1	17.8	272.8	231.93
NextNav_BD1_TP3	67	112.6	180.7	226.7	93.0	108.1	735.0	2.57
NextNav_BD1_TP4	40	209.1	283.3	516.3	210.2	121.6	642.5	48.17

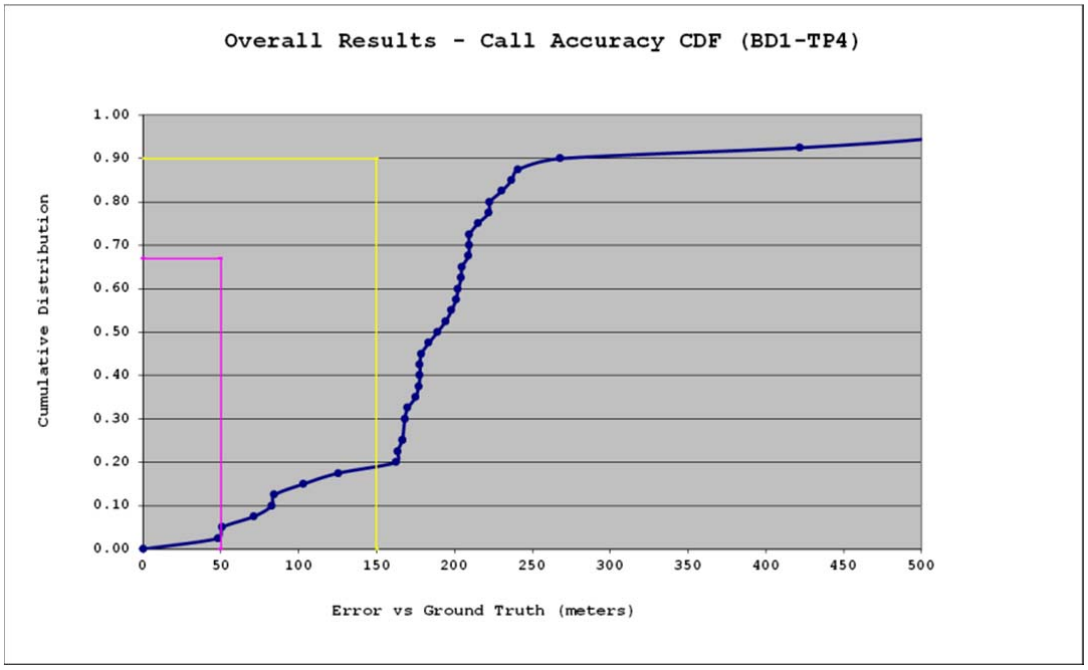
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD1_TP1	0							
NextNav_BD1_TP2	5	12.4	12.4	12.5	12.3	0.2	12.5	12.06
NextNav_BD1_TP3	67	2.1	4.2	4.6	1.7	1.5	4.8	0.04
NextNav_BD1_TP4	40	22.2	22.6	23.0	15.5	9.4	23.1	1.68

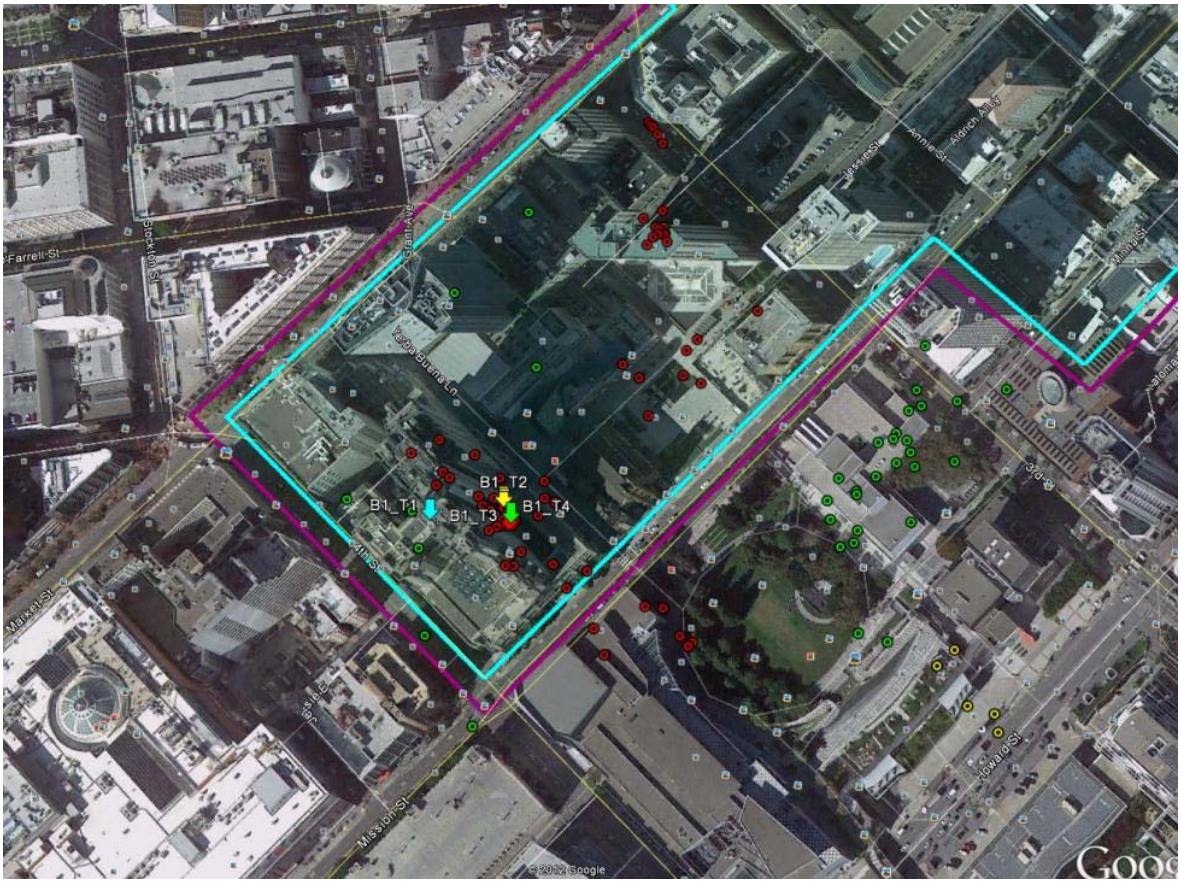
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD1_TP1				
NextNav_BD1_TP2	27.32	0.03	27.36	27.27
NextNav_BD1_TP3	27.06	0.67	27.89	24.41
NextNav_BD1_TP4	26.10	1.15	27.28	19.31

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD1_TP1			
NextNav_BD1_TP2	5	0	0.00%
NextNav_BD1_TP3	67	39	58.21%
NextNav_BD1_TP4	40	8	20.00%


Overall Results - Call Accuracy CDF (BD1-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD1-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD1-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B1_T1
B1_T2
B1_T3
B1_T4
Stockton St
Grant Ave
Yerba Buena Ln
Mission St
Howard St
Market St
Jessie St
Minna St
Anne St
Aldrich Alley
Mary St
3rd St
Farrell St
© 2012 Google

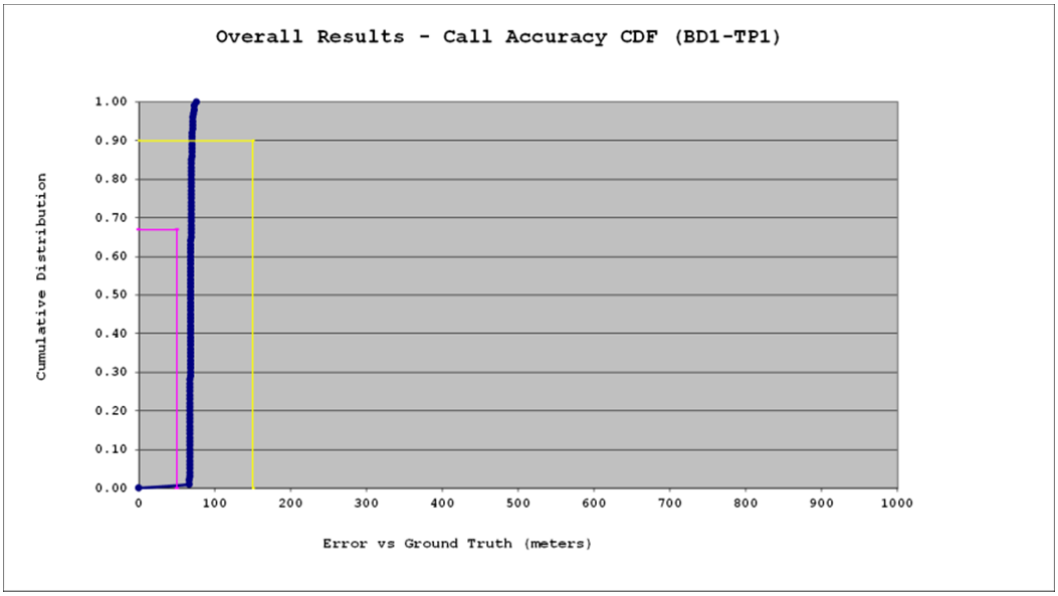
6.3.1.1.3 Polaris per Test Point Result—BD1:

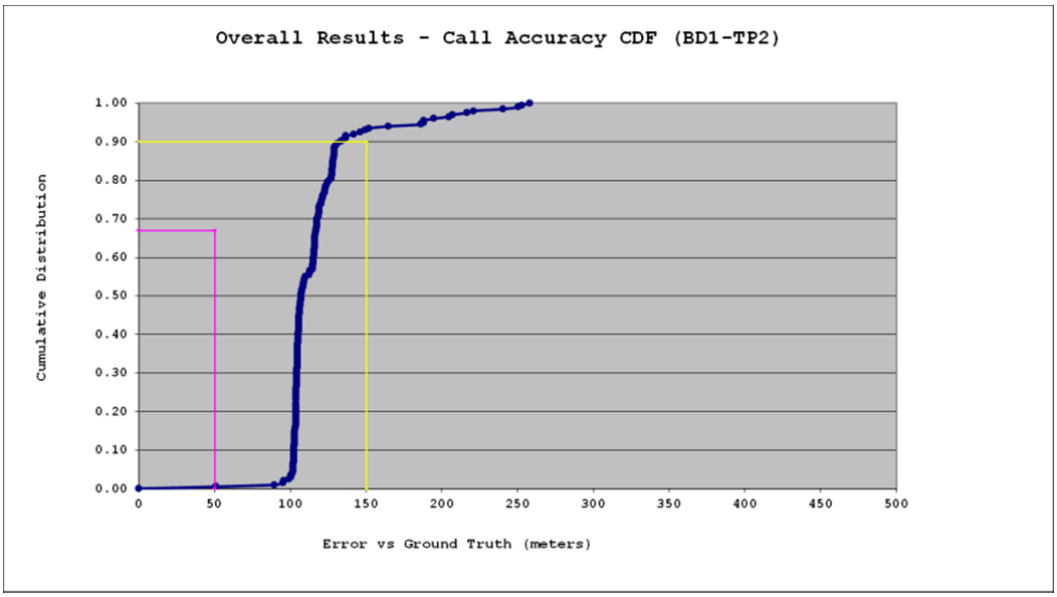
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD1_TP1	100	100	100.0%
Polaris_BD1_TP2	200	200	100.0%
Polaris_BD1_TP3	200	200	100.0%
Polaris_BD1_TP4	200	200	100.0%

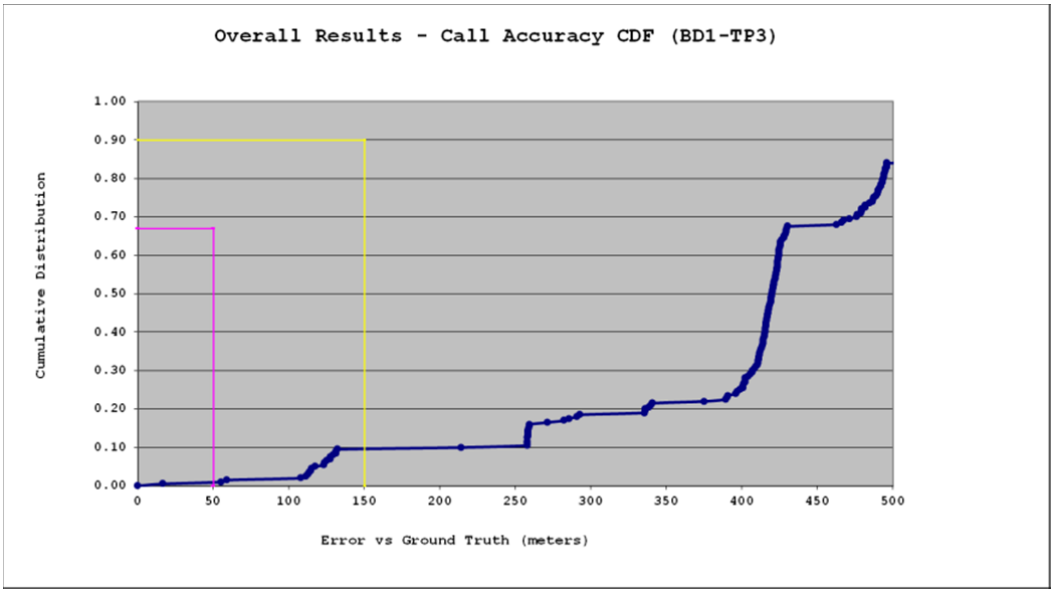
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD1_TP1	100	69.0	70.4	71.5	68.8	1.4	75.7	66.69
Polaris_BD1_TP2	200	117.1	133.3	187.8	118.2	28.5	258.0	51.09
Polaris_BD1_TP3	200	430.0	1210.5	1214.7	497.1	307.9	1304.3	16.41
Polaris_BD1_TP4	200	273.6	287.8	322.3	214.9	140.3	781.9	58.26

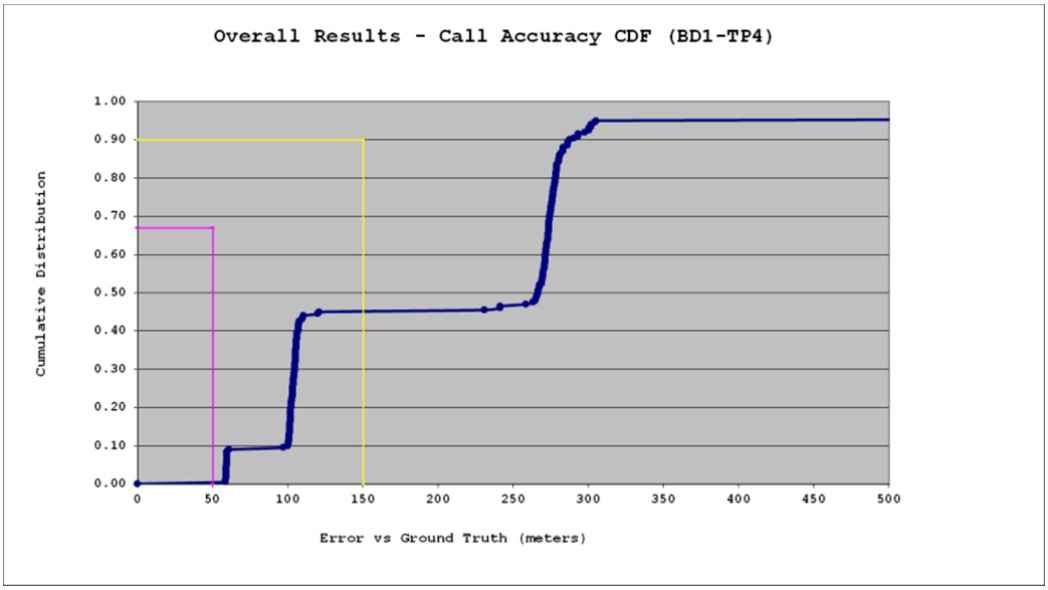
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD1_TP1	25.44	0.50	26.42	24.09
Polaris_BD1_TP2	25.02	0.96	26.40	19.37
Polaris_BD1_TP3	25.02	1.34	27.25	18.81
Polaris_BD1_TP4	25.13	0.90	26.43	20.28

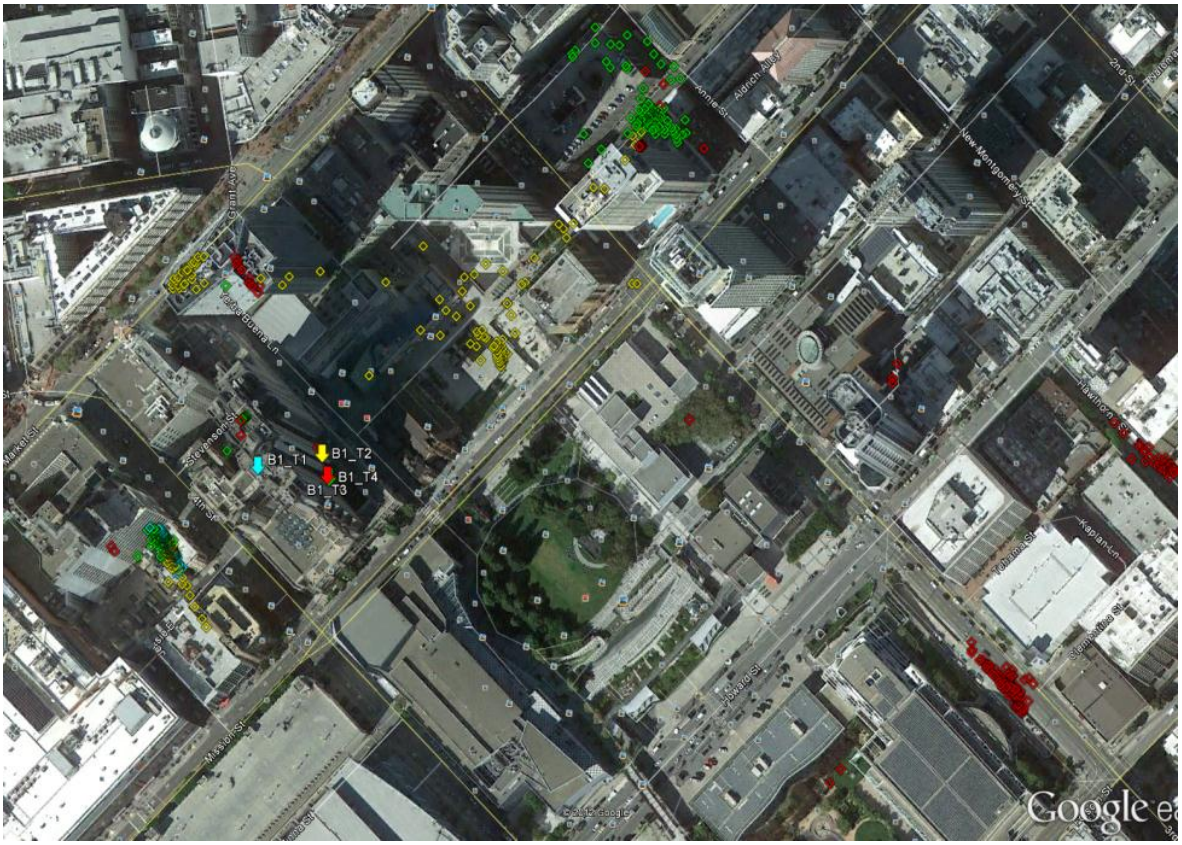
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD1_TP1	100	0	0.00%
Polaris_BD1_TP2	200	77	38.50%
Polaris_BD1_TP3	200	22	11.00%
Polaris_BD1_TP4	200	23	11.50%


Overall Results - Call Accuracy CDF (BD1-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD1-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD1-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD1-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



6.3.1.1.4 Qualcomm per Test Point Results—BD1:

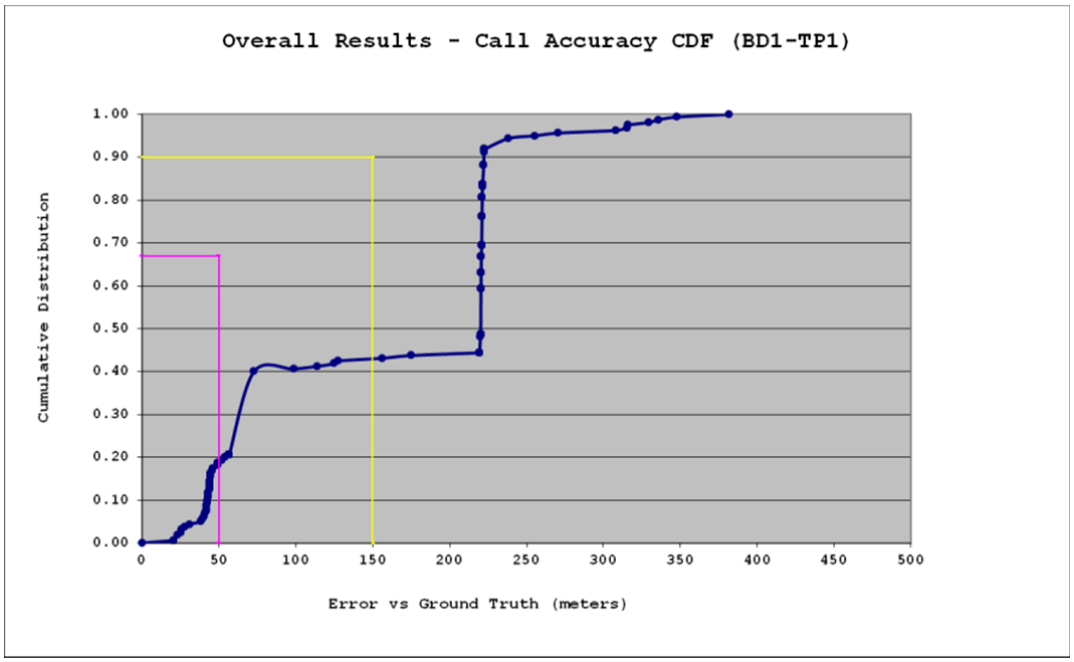
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD1_TP1	**198**	**160**	**80.8%**
Qualcomm_BD1_TP2	**200**	**157**	**78.5%**
Qualcomm_BD1_TP3	**200**	**190**	**95.0%**
Qualcomm_BD1_TP4	**200**	**198**	**99.0%**

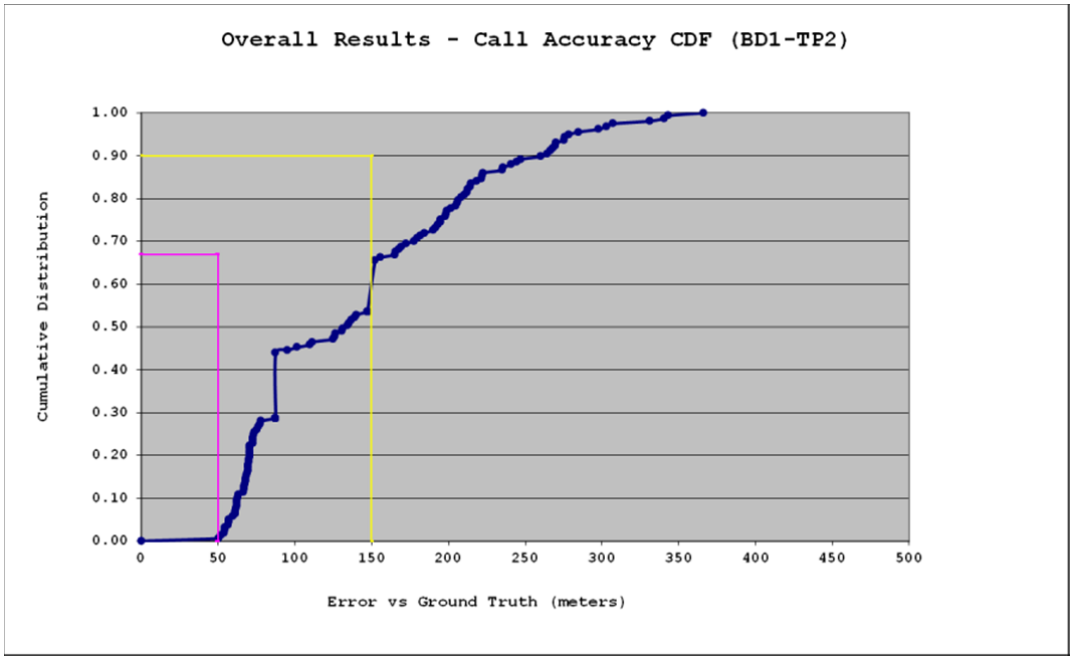
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD1_TP1	**160**	**220.7**	**222.2**	**256.2**	**154.2**	**91.9**	**382.0**	**20.55**
Qualcomm_BD1_TP2	**157**	**165.4**	**261.9**	**279.6**	**141.8**	**75.9**	**366.1**	**50.45**
Qualcomm_BD1_TP3	**190**	**171.0**	**309.9**	**567.0**	**164.6**	**147.7**	**567.0**	**7.69**
Qualcomm_BD1_TP4	**198**	**139.4**	**242.9**	**282.5**	**122.2**	**87.0**	**621.0**	**7.57**

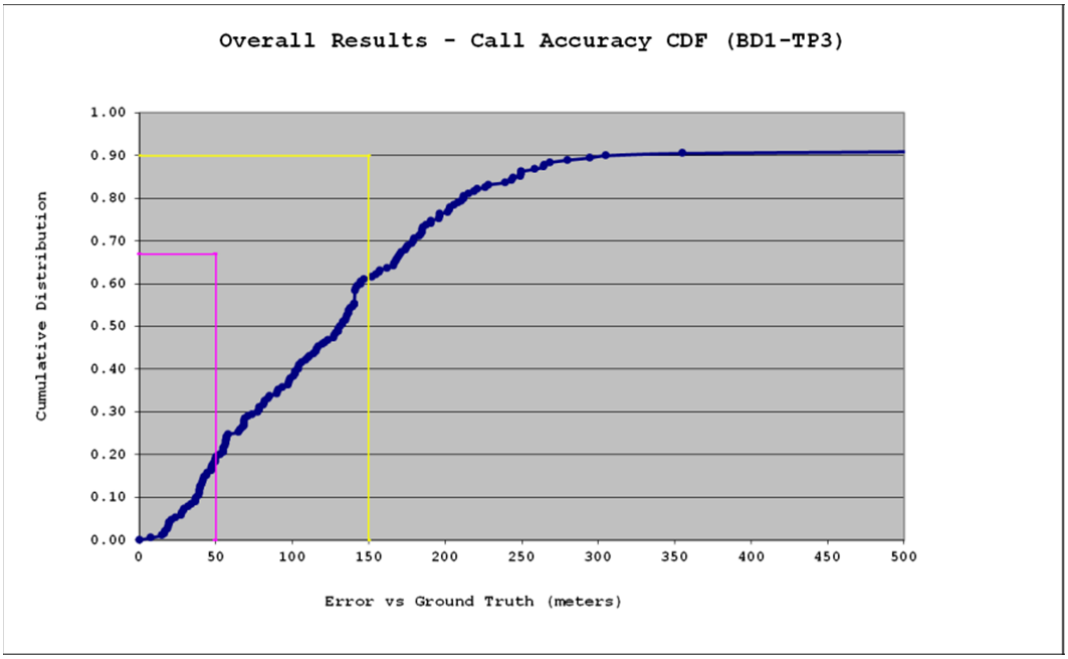
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD1_TP1	Number of Calls	31	5	0	0	26	80	18	0	160
	Percentage	19.4%	3.1%	0.0%	0.0%	16.3%	50.0%	11.3%	0.0%	100.0%
Qualcomm_BD1_TP2	Number of Calls	43	55	35	0	16	2	6	0	157
	Percentage	27.4%	35.0%	22.3%	0.0%	10.2%	1.3%	3.8%	0.0%	100.0%
Qualcomm_BD1_TP3	Number of Calls	24	4	146	16	0	0	0	0	190
	Percentage	12.6%	2.1%	76.8%	8.4%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD1_TP4	Number of Calls	14	0	118	50	2	0	14	0	198
	Percentage	7.1%	0.0%	59.6%	25.3%	1.0%	0.0%	7.1%	0.0%	100.0%

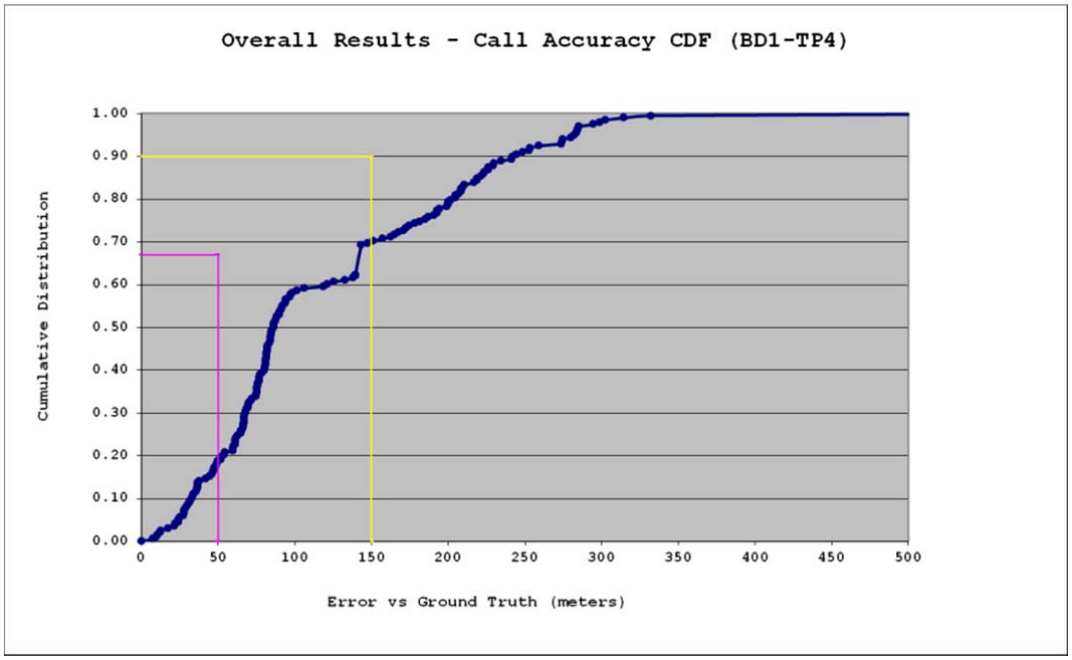
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD1_TP1	37.30	13.50	71.00	29.00
Qualcomm_BD1_TP2	33.93	13.65	66.00	1.00
Qualcomm_BD1_TP3	23.70	6.90	46.00	1.00
Qualcomm_BD1_TP4	24.45	4.63	46.00	1.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD1_TP1	160	160	100.00%
Qualcomm_BD1_TP2	157	154	98.09%
Qualcomm_BD1_TP3	190	165	86.84%
Qualcomm_BD1_TP4	198	180	90.91%




Overall Results - Call Accuracy CDF (BD1-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD1-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD1-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Post St
Maiden Ln
Mearry St
Annie St
O'Farrell St
Stockton St
Grant Ave
Geary St
Ellis St
Powell St
Market St
Stevenson St
4th St
B1_T1
B1_T2
B1_T3
Howard St
Minna St

6.3.1.2 Building 2:

6.3.1.2.1 Building 2 Environment and Test Points:

Building 2 is One Front Street, SF. This is a classical steel and glass sky scraper with 42 tenant floors. It is surrounded in all directions by other tall buildings of different heights.

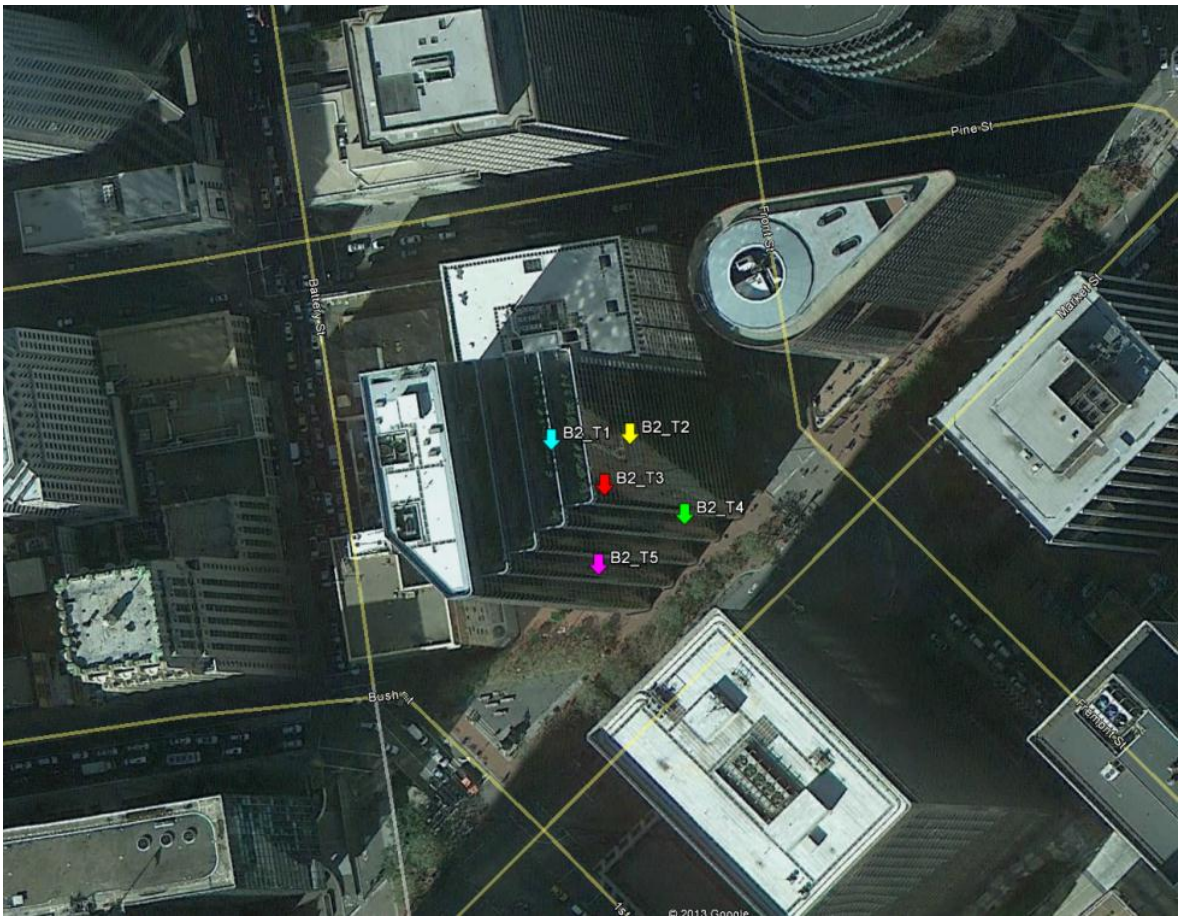
TP1: 9th floor conference room (with windows)

TP2: 9th floor interior hallway

TP3: Floor 3, stairway

TP4: 28th floor wide open (unfinished) tenant space with surrounding windows

TP5: Break room, one floor under plaza



6.3.1.2.2 NextNav per Test Point Results—BD2:

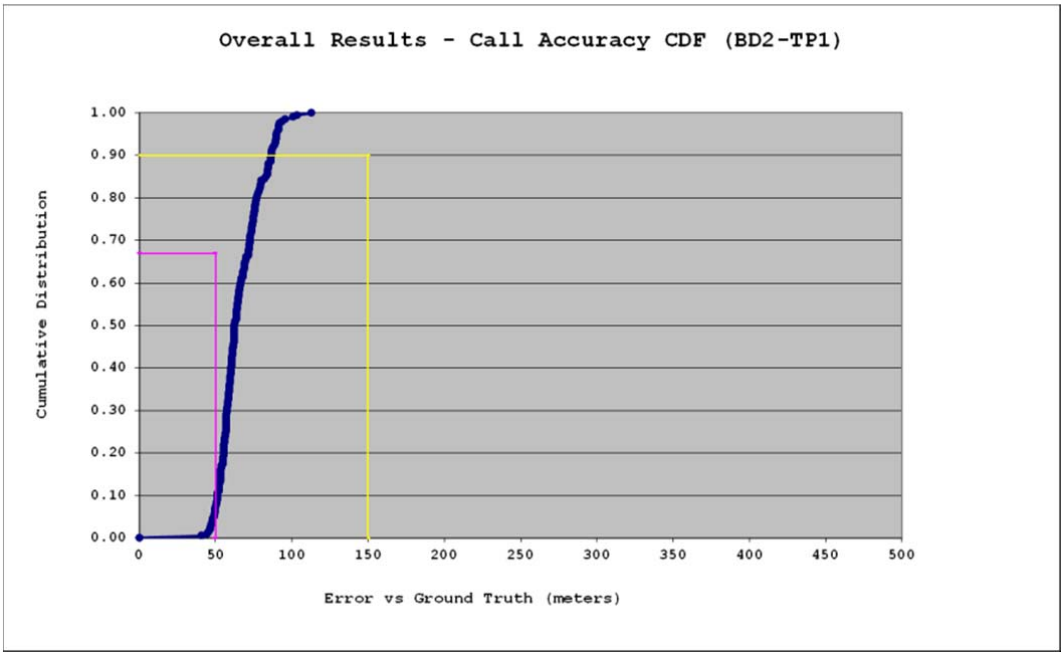
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD2_TP1	200	200	100.0%
NextNav_BD2_TP2	200	200	100.0%
NextNav_BD2_TP3	200	200	100.0%
NextNav_BD2_TP4	181	181	100.0%
NextNav_BD2_TP5	239	239	100.0%

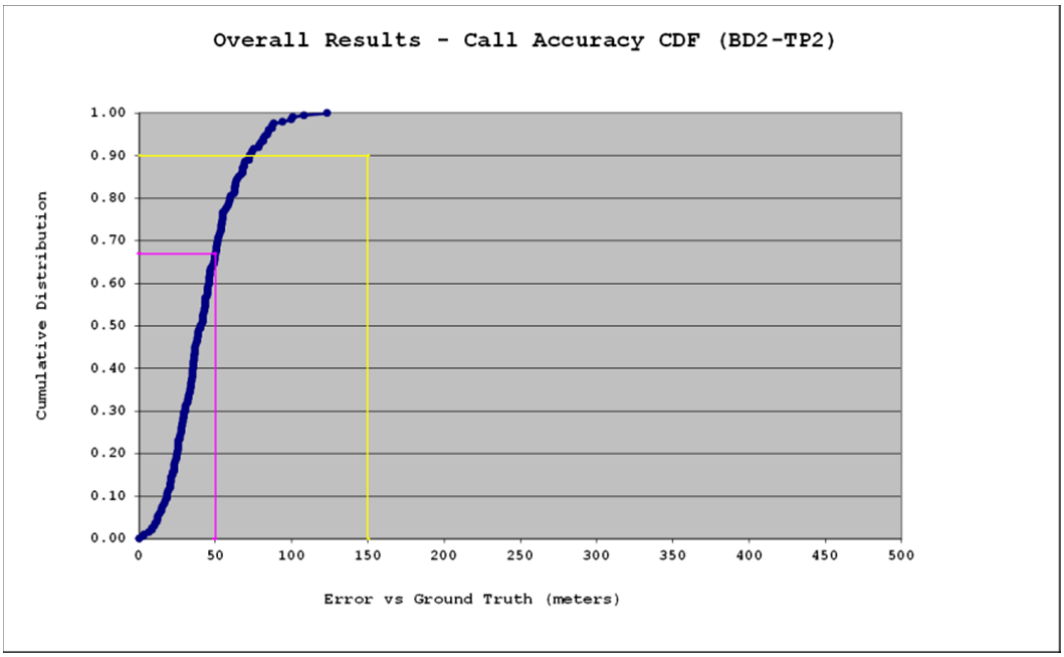
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD2_TP1	200	71.8	86.7	90.2	66.4	13.3	113.0	41.02
NextNav_BD2_TP2	200	50.6	73.0	84.4	43.5	21.6	123.3	2.96
NextNav_BD2_TP3	200	55.2	69.1	77.3	50.0	16.0	127.0	14.18
NextNav_BD2_TP4	181	17.8	23.4	28.0	15.1	7.3	40.5	0.63
NextNav_BD2_TP5	239	38.9	48.8	52.3	33.2	12.9	77.7	5.97

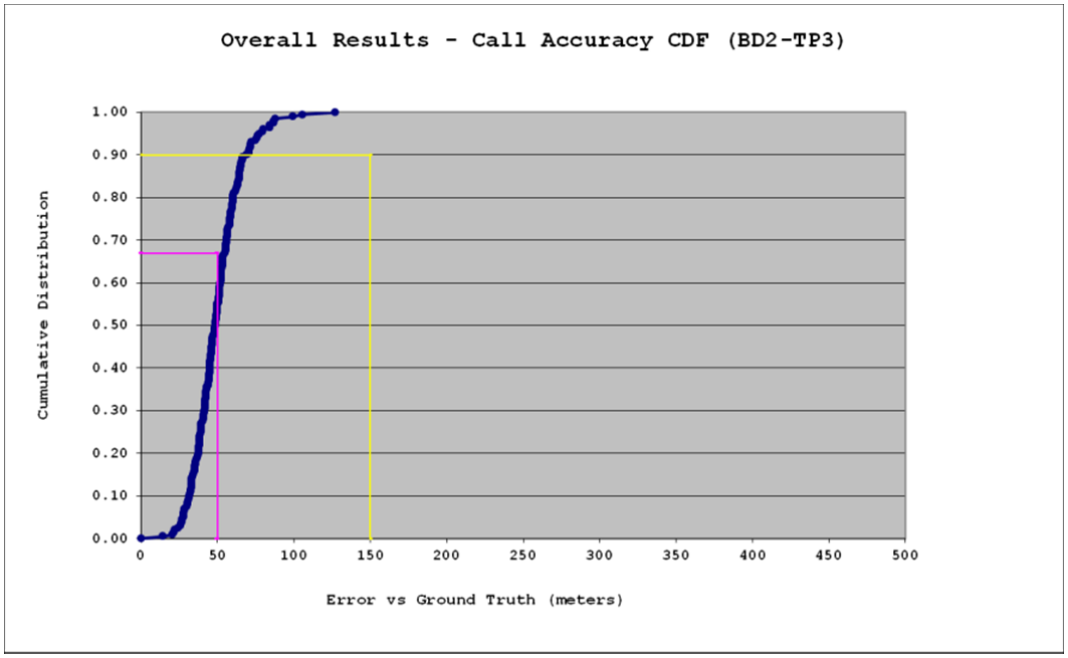
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD2_TP1	200	2.9	3.7	5.1	2.6	1.1	5.5	0.09
NextNav_BD2_TP2	200	3.2	3.7	4.2	2.5	1.2	6.1	0.03
NextNav_BD2_TP3	200	3.4	3.9	4.1	2.4	1.4	6.1	0.07
NextNav_BD2_TP4	181	3.4	3.9	4.0	2.2	1.4	4.3	0.02
NextNav_BD2_TP5	239	4.9	6.3	7.1	3.7	2.2	8.2	0.01

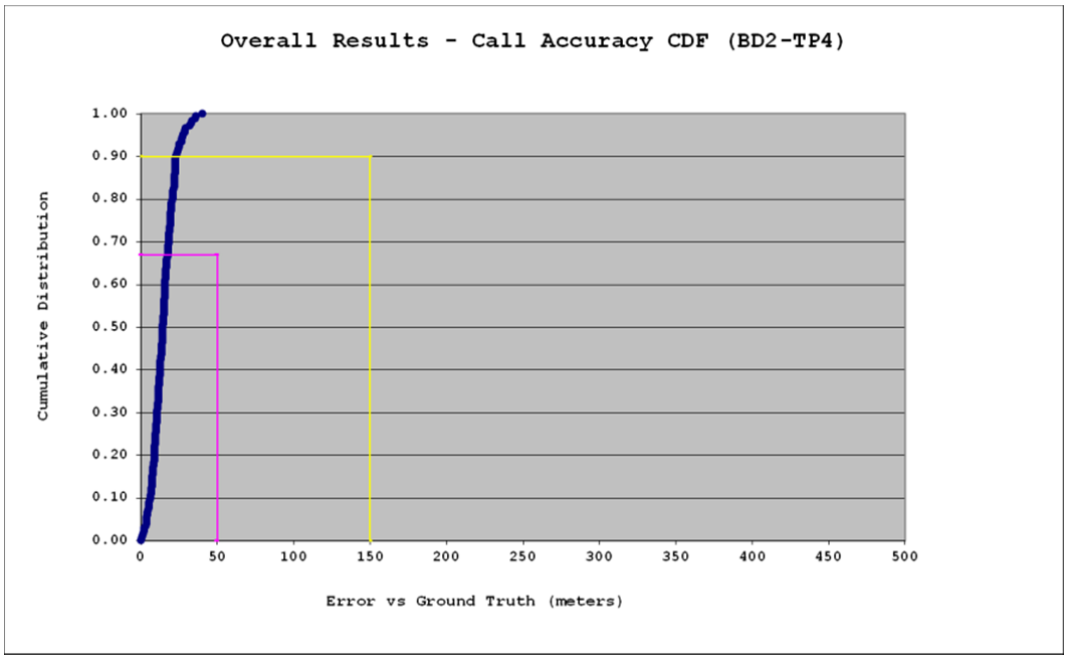
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD2_TP1	27.35	0.36	32.36	27.27
NextNav_BD2_TP2	27.35	0.05	27.54	27.27
NextNav_BD2_TP3	27.39	0.12	27.97	27.27
NextNav_BD2_TP4	27.35	0.37	32.35	27.27
NextNav_BD2_TP5	27.26	1.33	32.35	8.35

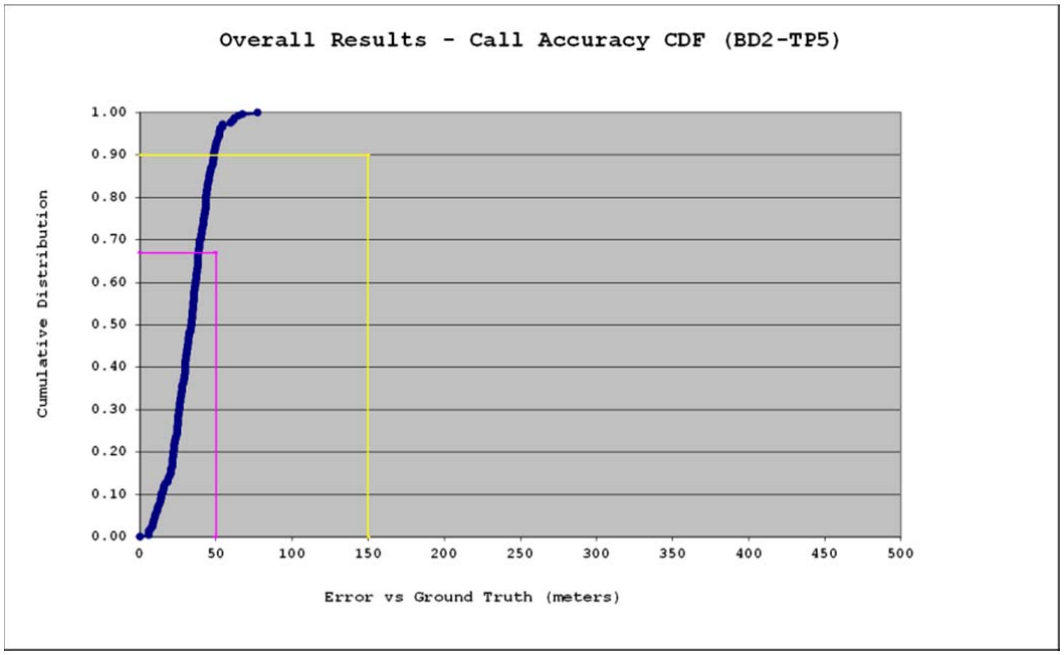
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD2_TP1	200	162	81.00%
NextNav_BD2_TP2	200	190	95.00%
NextNav_BD2_TP3	200	193	96.50%
NextNav_BD2_TP4	181	181	100.00%
NextNav_BD2_TP5	239	239	100.00%


Overall Results - Call Accuracy CDF (BD2-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Pine St
Battery St
Front St
Market St
B2_T1
B2_T2
B2_T3
B2_T4
B2_T5
1st St
© 2012 Google

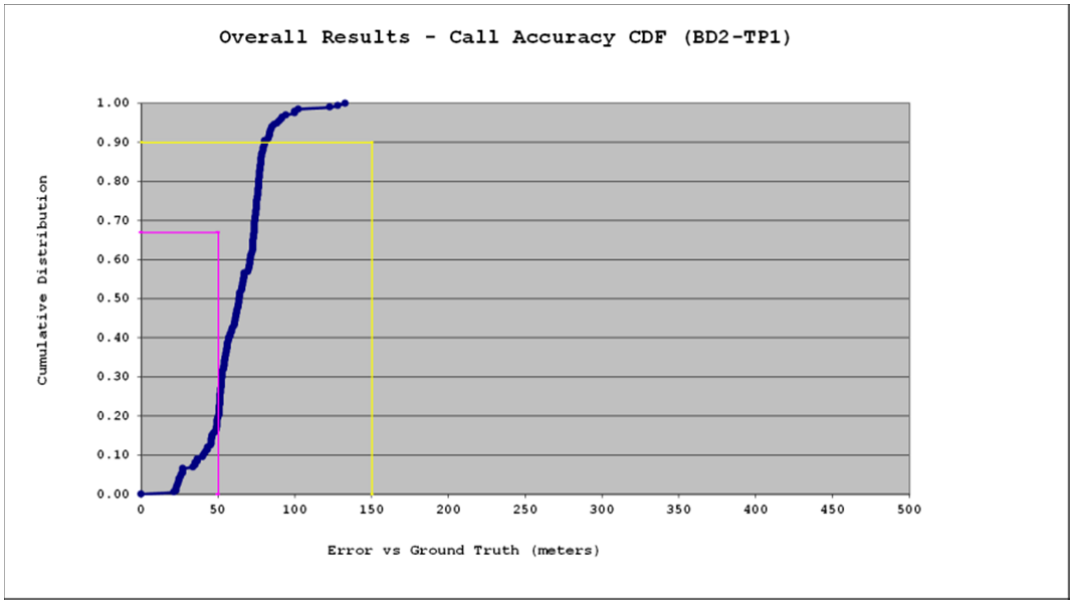
6.3.1.2.3 Polaris per Test Point Results—BD2:

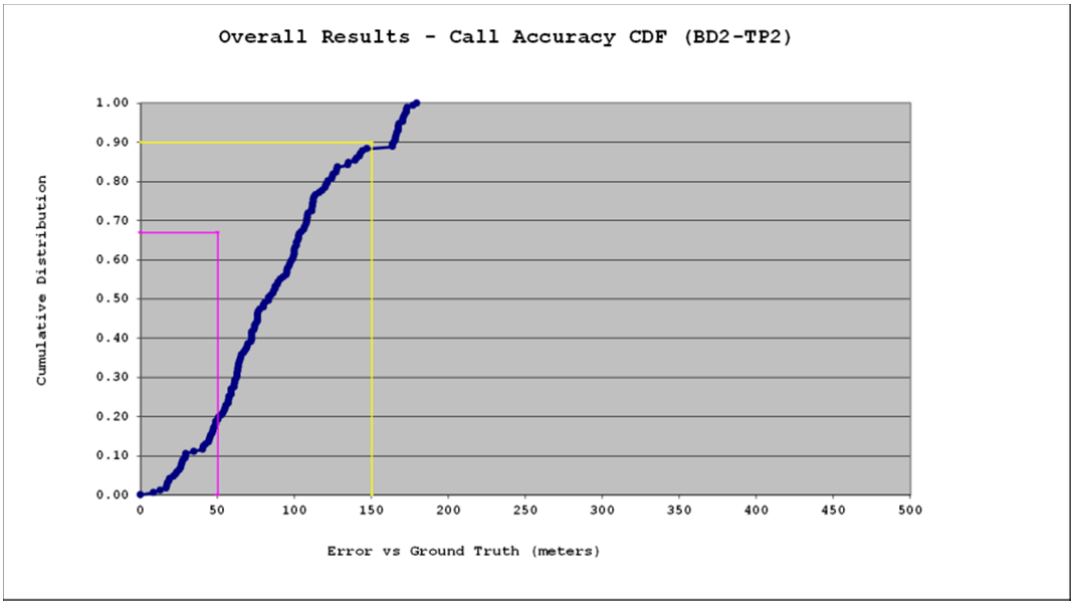
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD2_TP1_Combined	200	200	100.0%
Polaris_BD2_TP2_Combined	171	171	100.0%
Polaris_BD2_TP3_Combined	200	200	100.0%
Polaris_BD2_TP4_Combined	200	200	100.0%
Polaris_BD2_TP5_Combined	199	199	100.0%

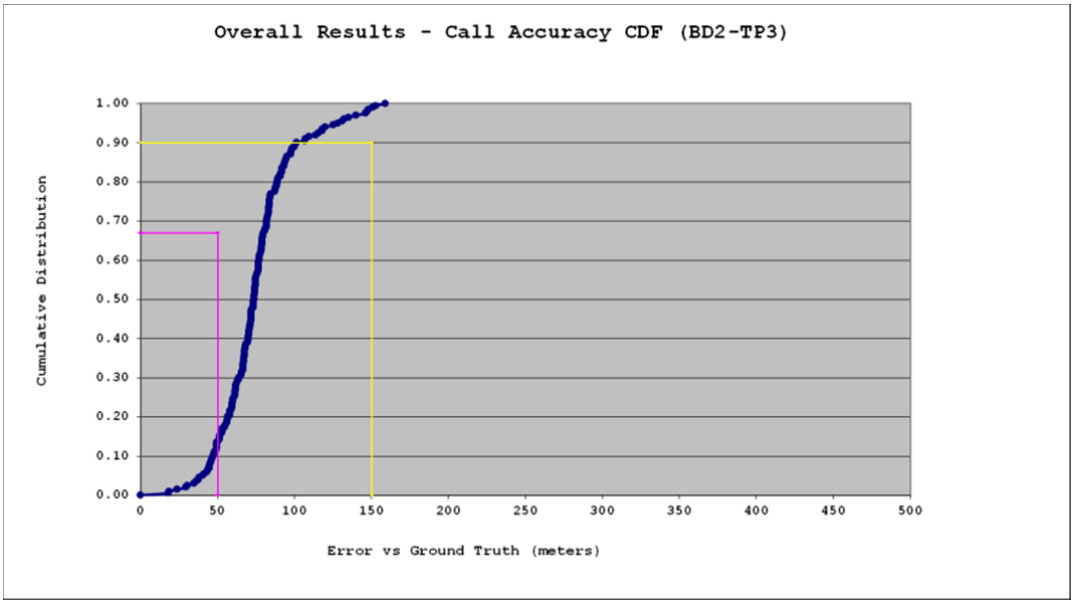
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD2_TP1_Combined	200	73.5	80.4	88.7	63.2	18.6	132.7	21.44
Polaris_BD2_TP2_Combined	171	104.7	164.4	169.2	88.5	43.0	179.3	8.27
Polaris_BD2_TP3_Combined	200	80.3	101.8	128.2	75.4	24.8	159.1	17.88
Polaris_BD2_TP4_Combined	200	559.1	664.6	674.3	307.2	259.1	685.5	37.03
Polaris_BD2_TP5_Combined	199	67.4	95.8	251.6	87.3	119.2	1070.2	28.59

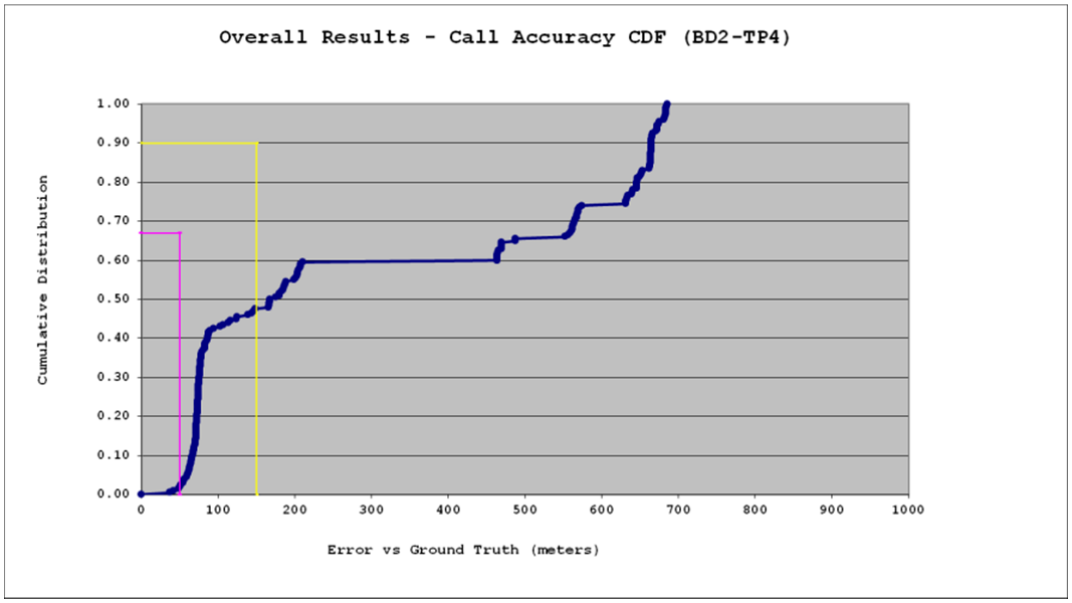
TTFF				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD2_TP1_Combined	24.27	1.57	26.44	17.39
Polaris_BD2_TP2_Combined	24.70	1.66	26.59	6.98
Polaris_BD2_TP3_Combined	22.94	2.97	27.52	7.04
Polaris_BD2_TP4_Combined	25.12	0.75	26.68	21.73
Polaris_BD2_TP5_Combined	23.31	2.89	26.73	16.34

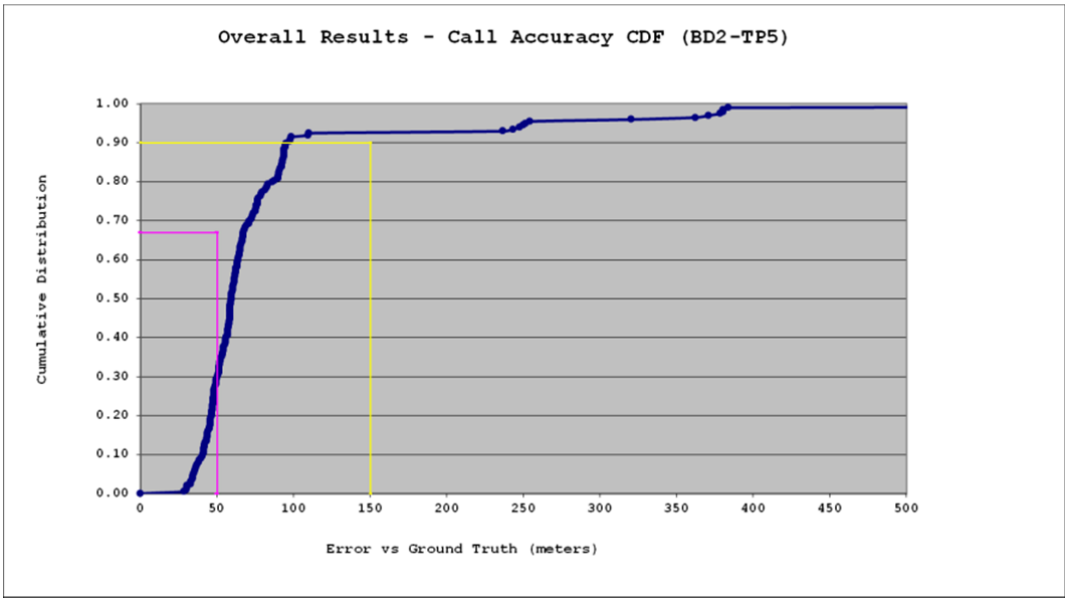
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD2_TP1_Combined	200	183	91.50%
Polaris_BD2_TP2_Combined	171	127	74.27%
Polaris_BD2_TP3_Combined	200	178	89.00%
Polaris_BD2_TP4_Combined	200	108	54.00%
Polaris_BD2_TP5_Combined	199	187	93.97%


Overall Results - Call Accuracy CDF (BD2-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Halleck St
Pine St
Bush St
Sutter St
Davis St
Drumm St
Sansome St
Battery St
Montgomery St
Trinity St
Mission St
Fremont St
Stevenson St
Jessie St
1st St
B2_T1
B2_T2
B2_T3
B2_T4
B2_T5
© 2012 Google

6.3.1.2.4 Qualcomm per Test Point Results—BD2:

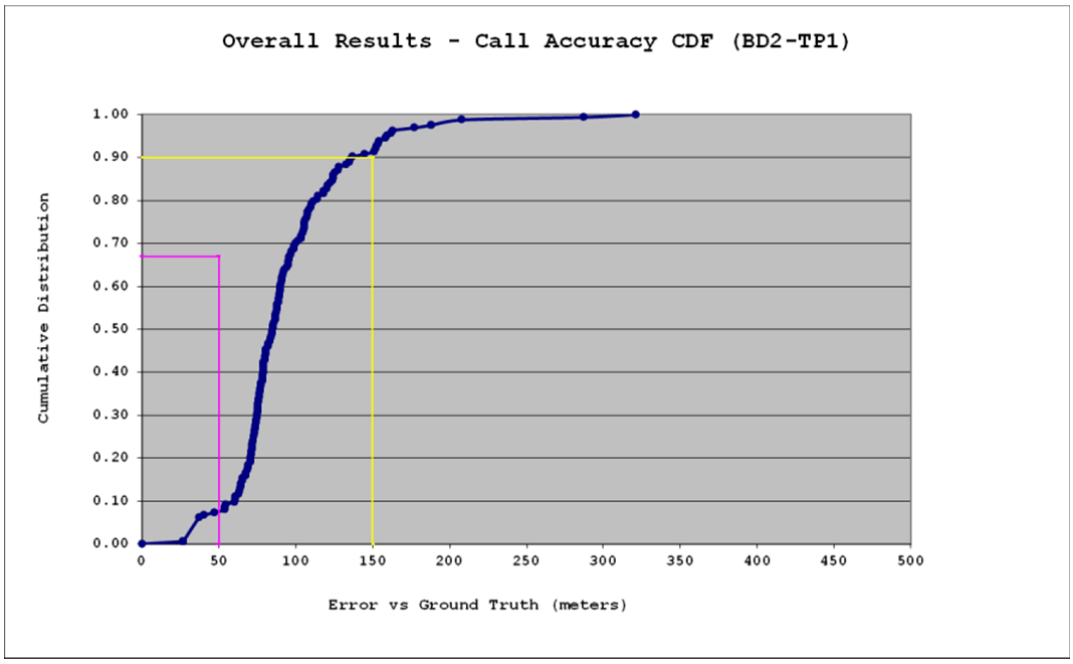
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD2_TP1	180	163	90.6%
Qualcomm_BD2_TP2	180	178	98.9%
Qualcomm_BD2_TP3	180	180	100.0%
Qualcomm_BD2_TP4	180	174	96.7%
Qualcomm_BD2_TP5	180	173	96.1%

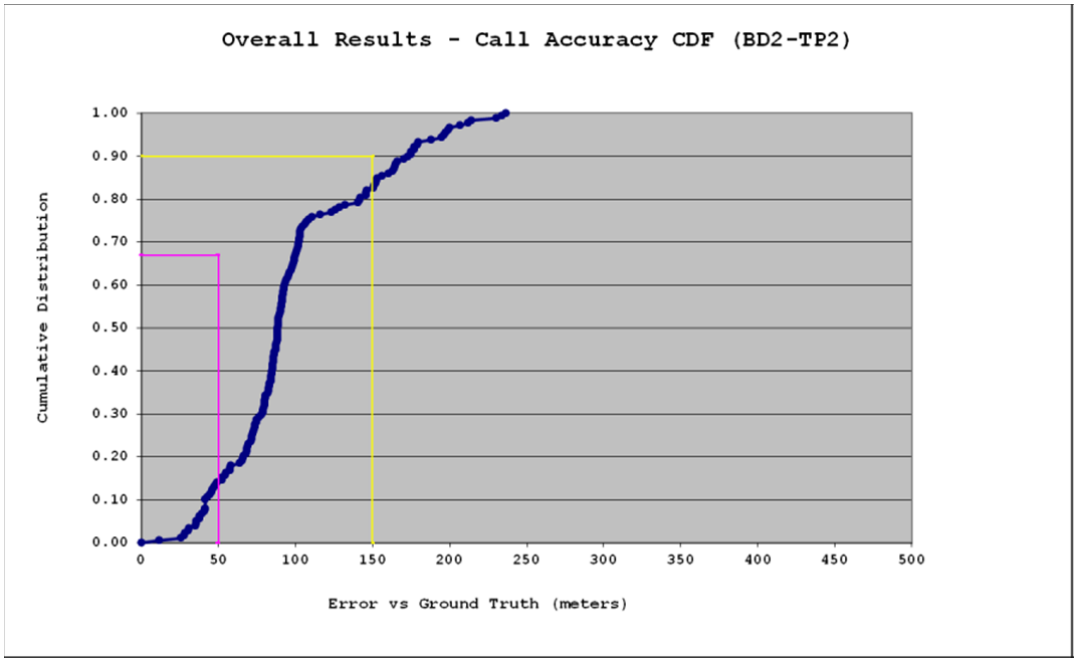
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD2_TP1	163	96.3	136.8	159.2	93.1	40.6	321.3	26.87
Qualcomm_BD2_TP2	178	100.3	173.6	196.8	99.1	46.9	236.6	11.92
Qualcomm_BD2_TP3	180	111.5	180.9	187.6	97.1	55.2	349.4	4.70
Qualcomm_BD2_TP4	174	79.9	119.7	155.3	72.7	45.9	322.1	2.53
Qualcomm_BD2_TP5	173	128.6	187.4	247.5	115.9	73.2	405.1	16.23

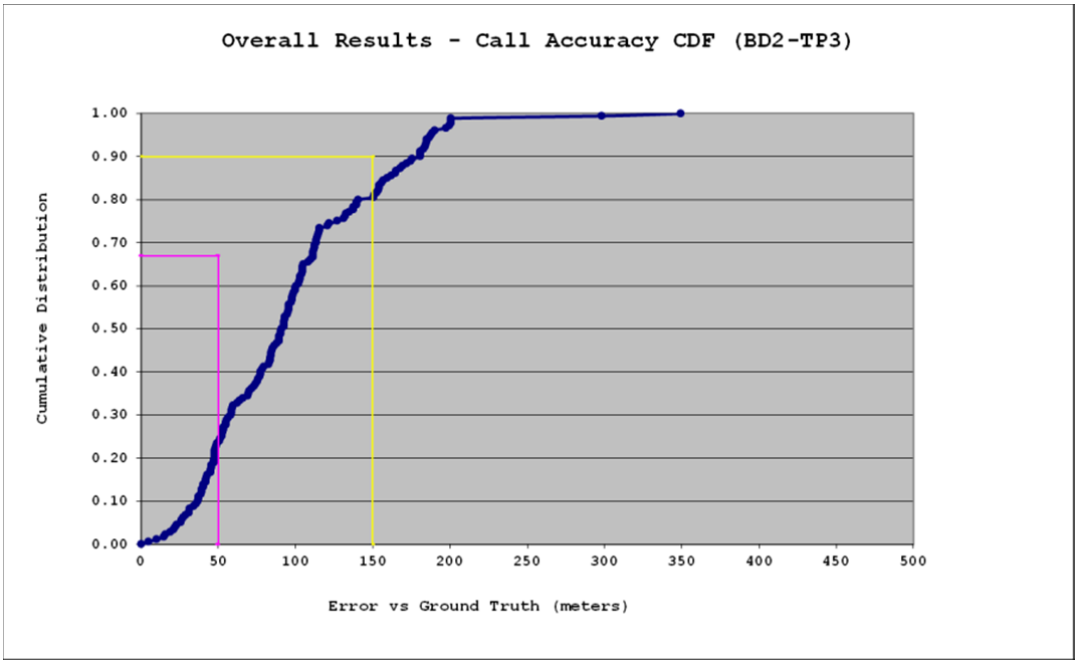
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD2_TP1	Number of Calls	11	11	140	0	0	0	1	0	163
	Percentage	6.7%	6.7%	85.9%	0.0%	0.0%	0.0%	0.6%	0.0%	100.0%
Qualcomm_BD2_TP2	Number of Calls	4	96	1	0	76	0	1	0	178
	Percentage	2.2%	53.9%	0.6%	0.0%	42.7%	0.0%	0.6%	0.0%	100.0%
Qualcomm_BD2_TP3	Number of Calls	3	135	0	0	42	0	0	0	180
	Percentage	1.7%	75.0%	0.0%	0.0%	23.3%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD2_TP4	Number of Calls	8	8	95	63	0	0	0	0	174
	Percentage	4.6%	4.6%	54.6%	36.2%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD2_TP5	Number of Calls	14	115	2	0	42	0	0	0	173
	Percentage	8.1%	66.5%	1.2%	0.0%	24.3%	0.0%	0.0%	0.0%	100.0%

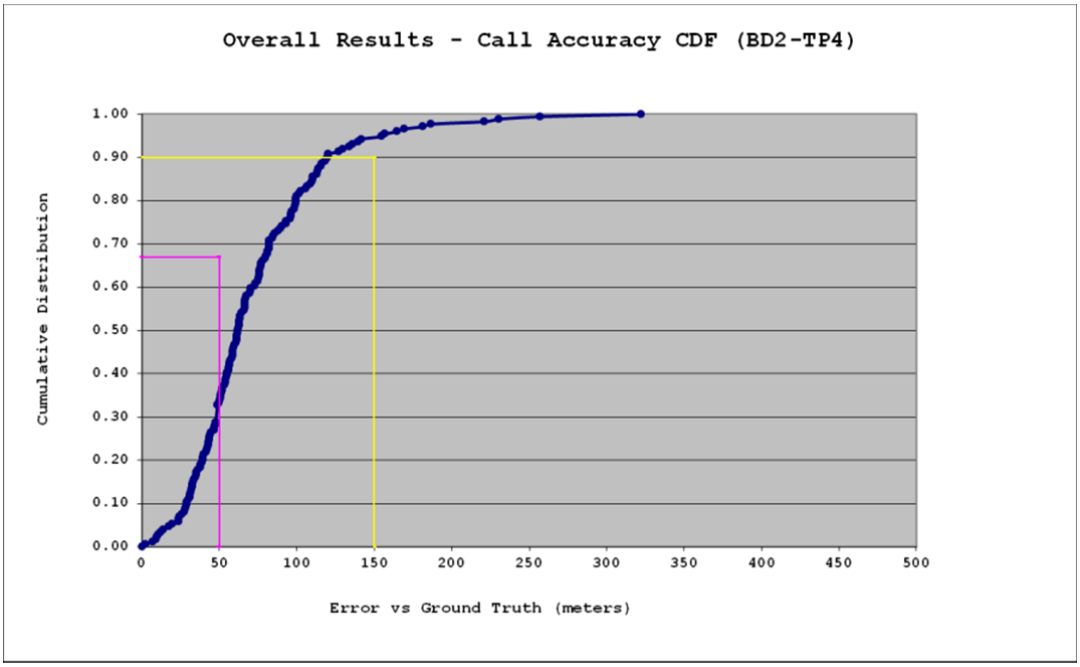
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD2_TP1	26.44	6.87	91.00	19.00
Qualcomm_BD2_TP2	31.89	3.24	65.00	17.00
Qualcomm_BD2_TP3	32.09	2.98	66.00	20.00
Qualcomm_BD2_TP4	25.32	2.98	47.00	16.00
Qualcomm_BD2_TP5	32.47	4.64	53.00	12.00

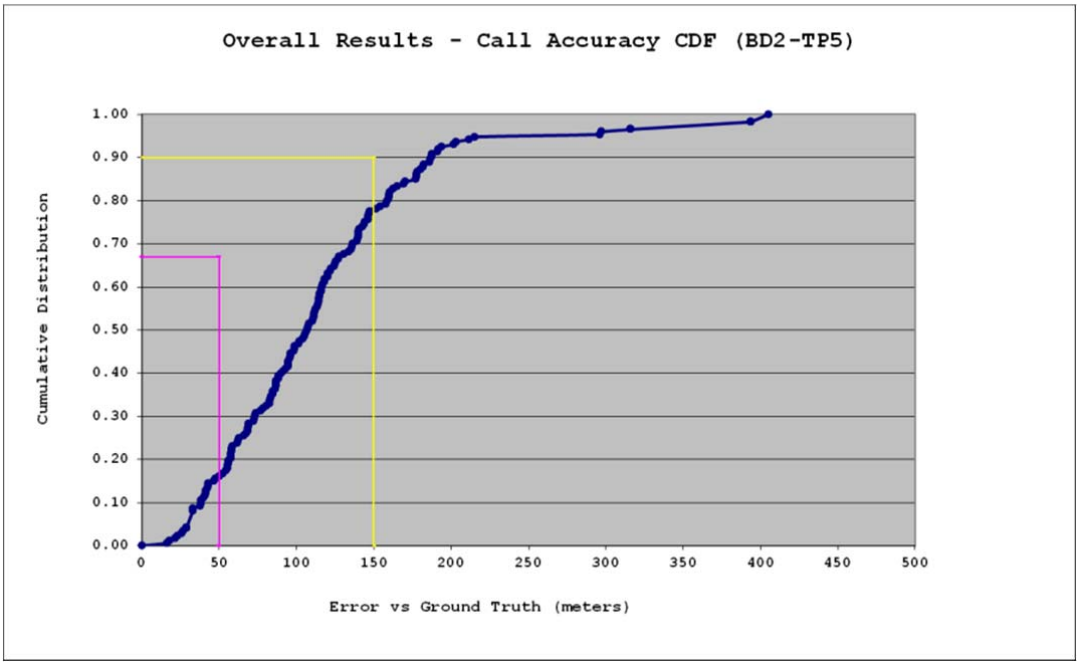
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD2_TP1	163	163	100.00%
Qualcomm_BD2_TP2	178	178	100.00%
Qualcomm_BD2_TP3	180	180	100.00%
Qualcomm_BD2_TP4	174	149	85.63%
Qualcomm_BD2_TP5	173	165	95.38%


Overall Results - Call Accuracy CDF (BD2-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD2-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Halleck St
Pine St
Bush St
Sutter St
Davis St
Drumm St
Battery St
Sansome St
Montgomery St
Pelarch Pl
Mason St
Beale St
Jessie St
Stevenson St
Ecker Pl
Minna St
Natoma St
Folsom St
B2_T1
B2_T2
B2_T3
B2_T4
B2_T5
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Google

6.3.1.3 Building 3:

6.3.1.3.1 Building 3 Environment and Test Points:

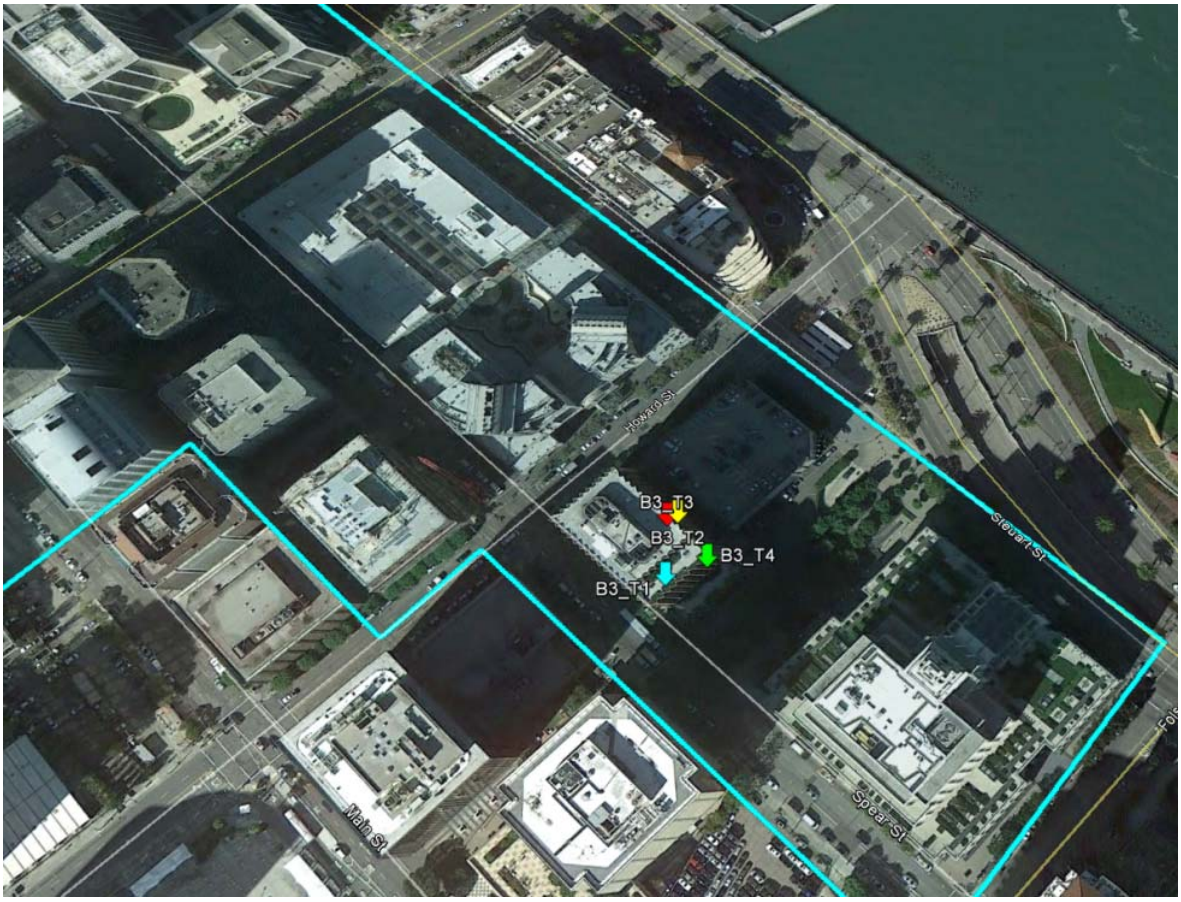
Building 3 is the high rise at 201 Spear Street, SF. This building is on the edge of the test area and the SF peninsula, creating a particularly interesting and challenging network coverage environment. The test points on the ninth floor are in the Verizon Innovation Center suite.

TP1: 9th floor employee space with windows overlooking other tall buildings

TP2: 9th floor near demo/conference room area with windows having a good view of the Bay Bridge

TP3: Back lobby of building (street level)

TP4: Garage level (1 floor below street level)



6.3.1.3.2 NextNav per Test Point Results—BD3:

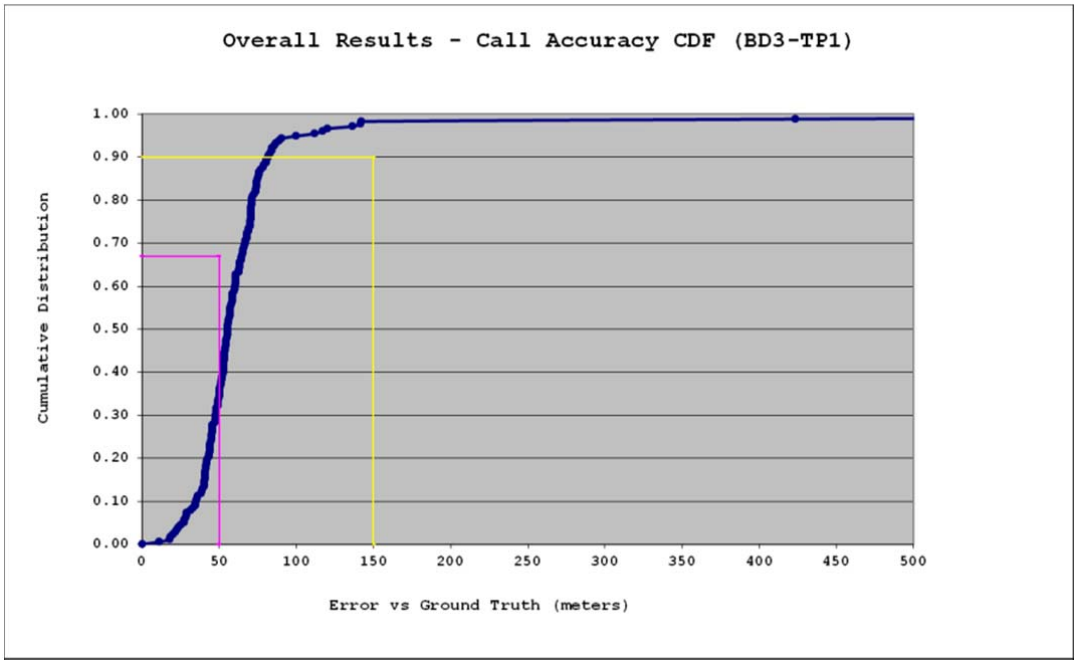
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD3_TP1	177	177	100.0%
NextNav_BD3_TP2	167	167	100.0%
NextNav_BD3_TP3	275	275	100.0%
NextNav_BD3_TP4	190	190	100.0%

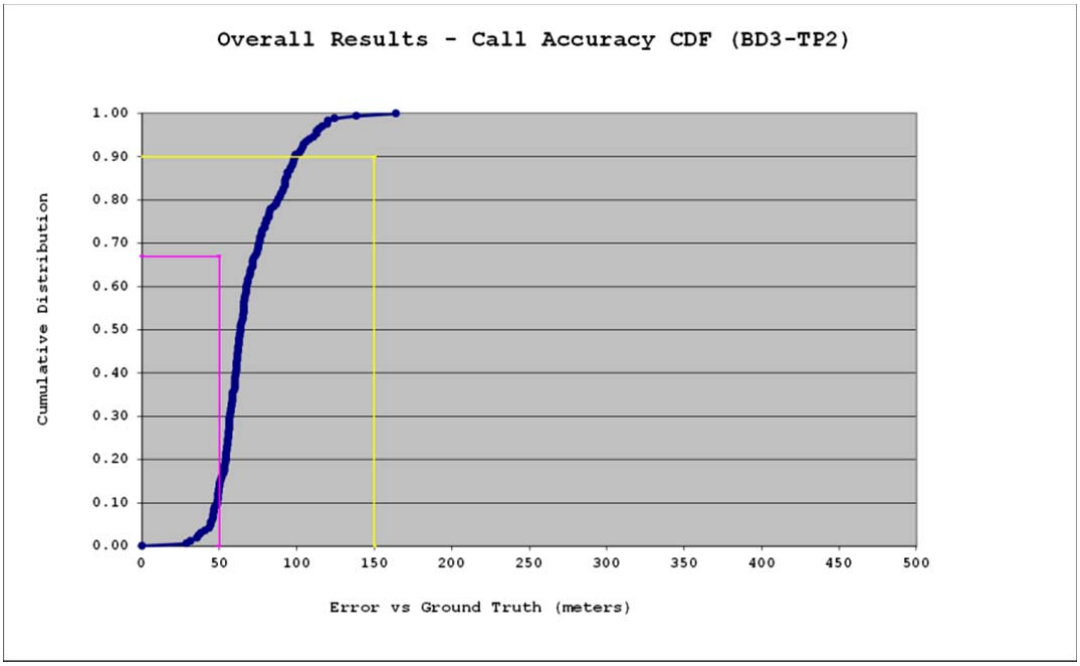
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD3_TP1	177	65.1	81.9	102.4	70.0	100.5	1059.2	11.26
NextNav_BD3_TP2	167	73.4	99.1	112.2	70.0	21.6	164.0	29.04
NextNav_BD3_TP3	275	46.2	65.3	75.0	41.0	18.7	133.1	4.30
NextNav_BD3_TP4	190	145.1	225.7	276.1	139.9	85.7	700.9	13.88

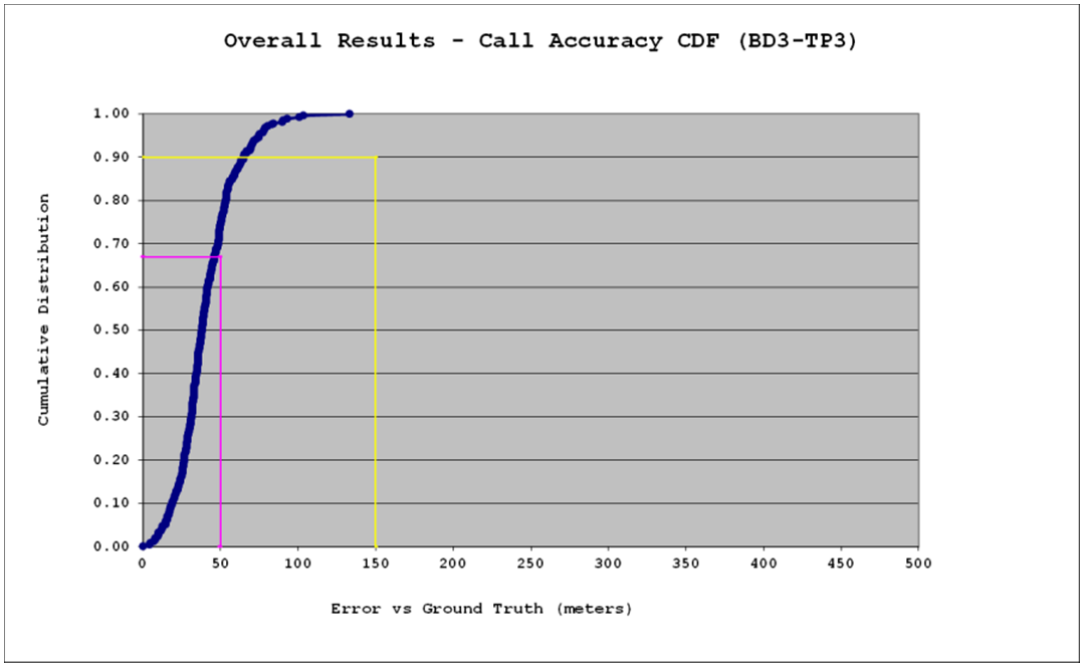
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD3_TP1	177	6.1	6.9	7.1	5.4	12.9	173.6	0.01
NextNav_BD3_TP2	167	6.9	7.4	7.6	5.1	1.8	8.2	2.74
NextNav_BD3_TP3	275	3.2	3.7	3.9	1.9	1.5	4.5	0.04
NextNav_BD3_TP4	190	2.0	3.0	3.7	1.9	0.8	4.2	0.03

TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD3_TP1	27.29	1.12	32.31	13.32
NextNav_BD3_TP2	27.40	0.54	32.31	27.27
NextNav_BD3_TP3	27.36	0.90	32.39	14.37
NextNav_BD3_TP4	27.45	0.37	32.34	27.27

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD3_TP1	177	173	97.74%
NextNav_BD3_TP2	167	166	99.40%
NextNav_BD3_TP3	275	273	99.27%
NextNav_BD3_TP4	190	146	76.84%


Overall Results - Call Accuracy CDF (BD3-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD3-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD3-TP3)
Cumulative Distribution
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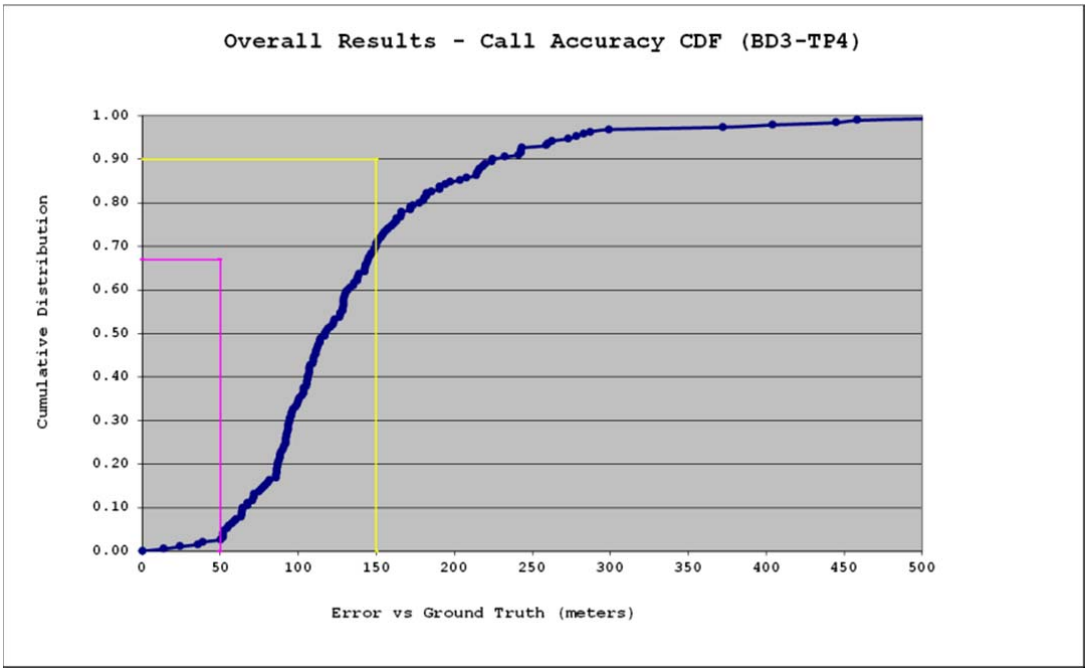
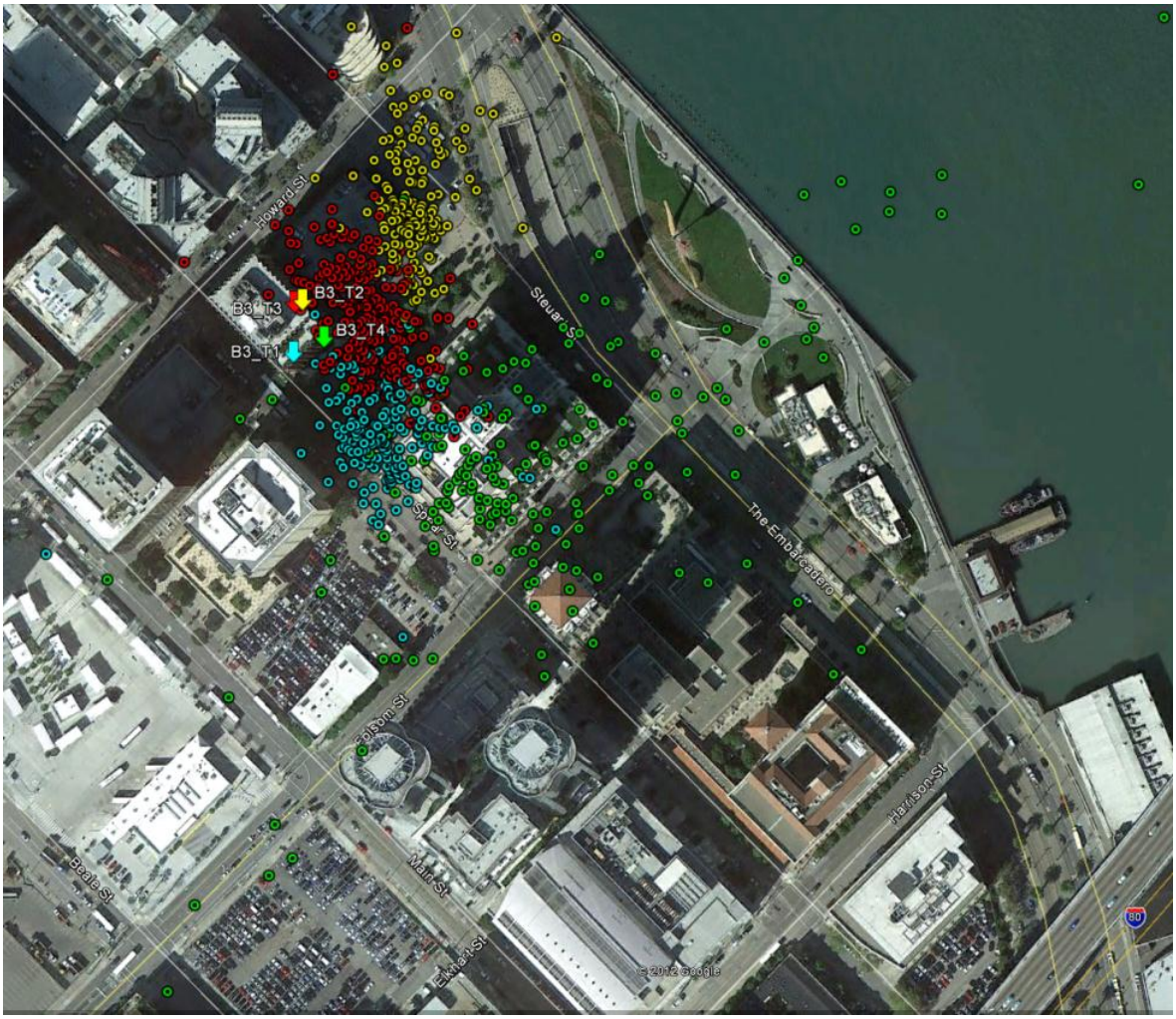
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD3-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



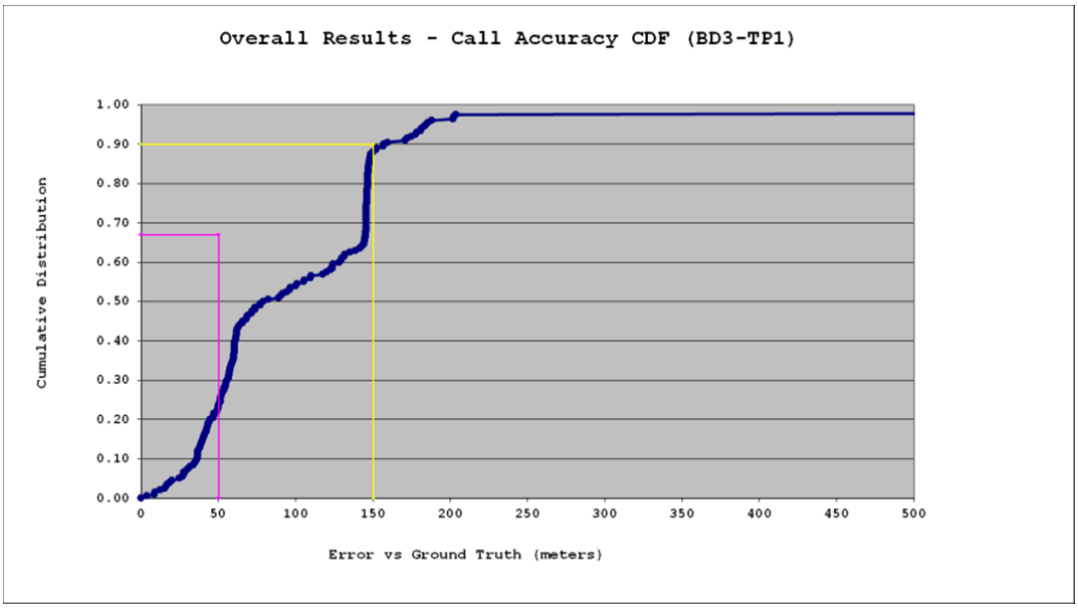
6.3.1.3.3 Polaris per Test Point Results—BD3:

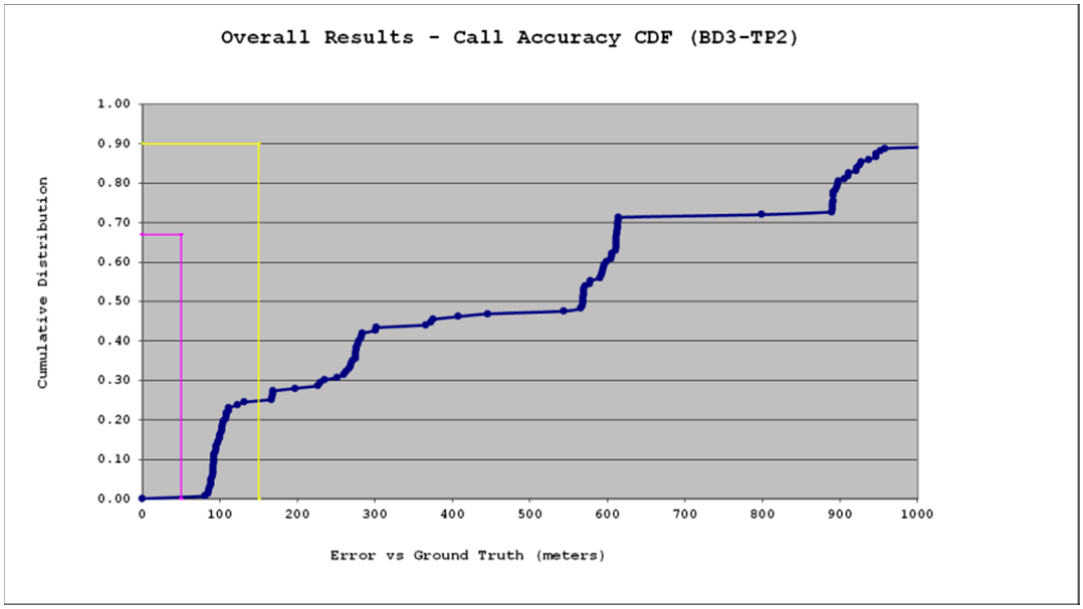
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris BD3_TP1	**200**	**200**	**100.0%**
Polaris_BD3_TP2	**173**	**143**	**82.7%**
Polaris_BD3_TP3	**100**	**100**	**100.0%**
Polaris_BD3_TP4	**195**	**195**	**100.0%**

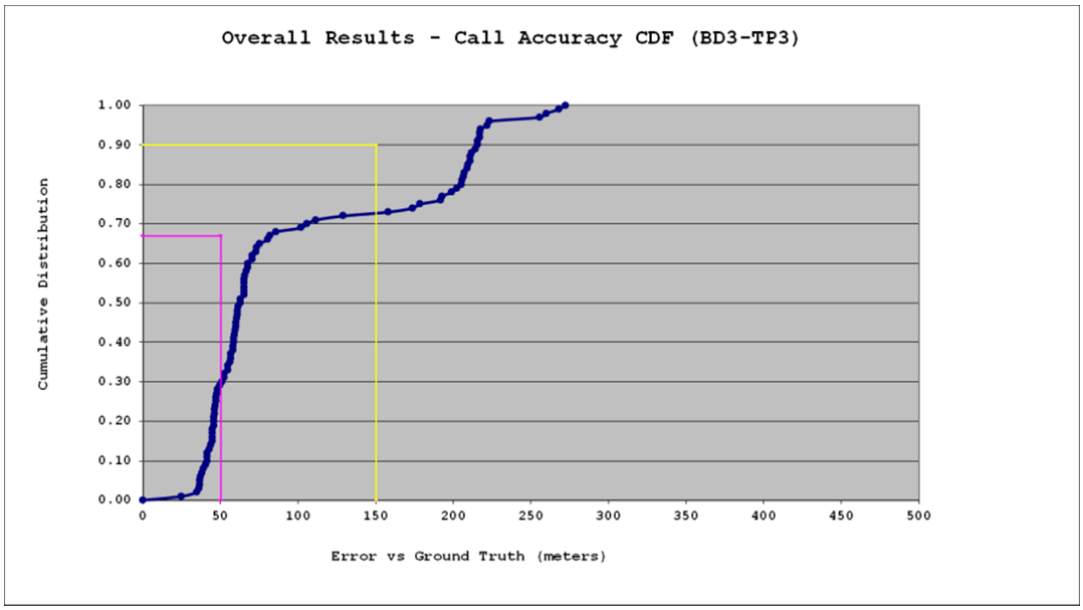
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris BD3_TP1	**200**	**145.1**	**157.1**	**184.0**	**110.3**	**111.7**	**748.1**	**3.55**
Polaris_BD3_TP2	**143**	**611.7**	**1116.0**	**1328.3**	**539.0**	**406.9**	**1656.1**	**80.80**
Polaris_BD3_TP3	**100**	**83.0**	**215.4**	**222.0**	**101.2**	**73.1**	**272.1**	**24.60**
Polaris_BD3_TP4	**195**	**111.9**	**273.4**	**279.7**	**125.4**	**108.9**	**649.8**	**19.16**

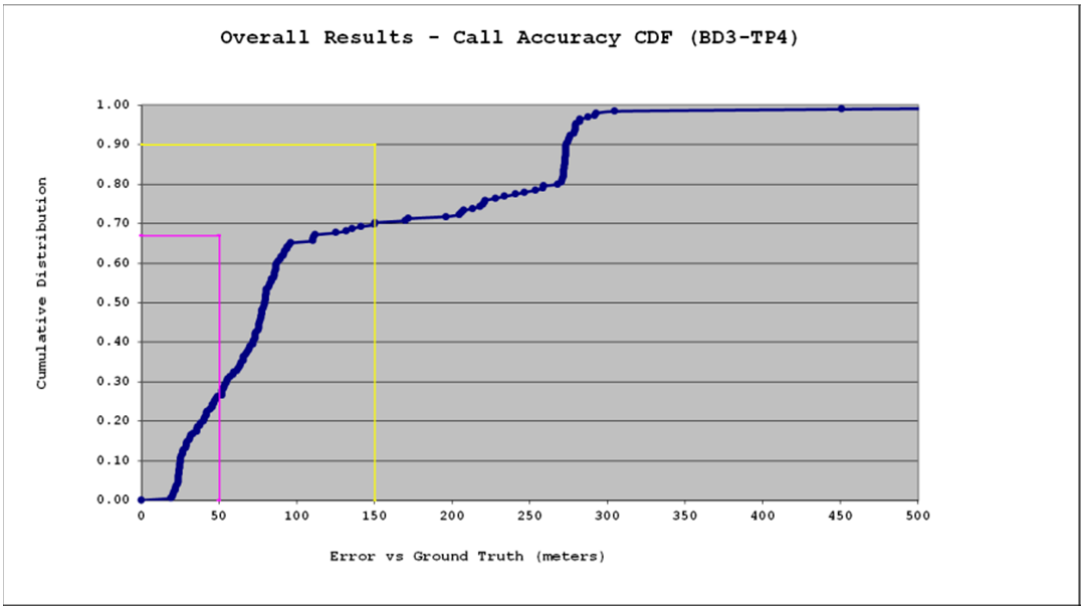
TTFF				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris BD3_TP1	24.07	1.71	27.45	19.32
Polaris_BD3_TP2	23.68	3.72	26.72	3.01
Polaris_BD3_TP3	24.51	1.16	26.33	18.86
Polaris_BD3_TP4	24.11	2.61	27.47	1.11

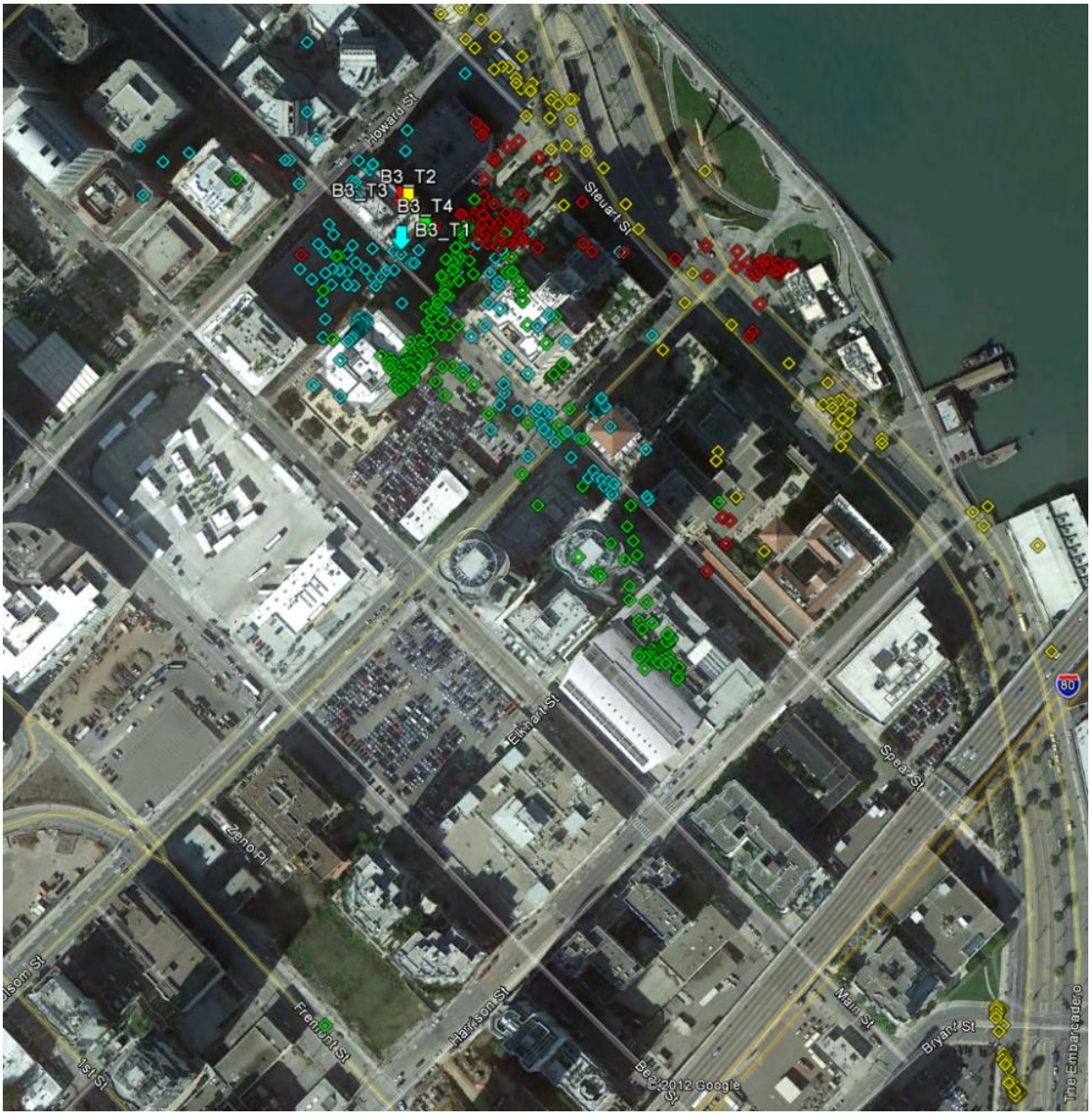
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris BD3_TP1	200	129	64.50%
Polaris_BD3_TP2	143	51	35.66%
Polaris_BD3_TP3	100	73	73.00%
Polaris_BD3_TP4	195	156	80.00%




Overall Results - Call Accuracy CDF (BD3-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD3-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD3-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



6.3.1.3.4 Qualcomm per Test Point Results—BD3

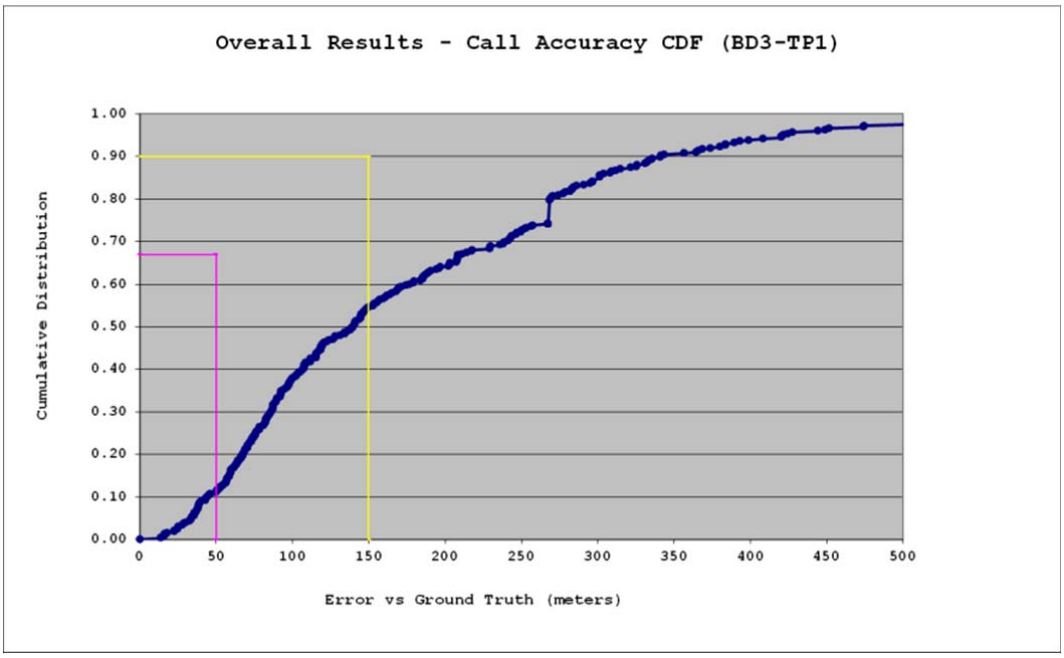
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD3_TP1	**400**	**325**	**81.3%**
Qualcomm_BD3_TP2	**400**	**306**	**76.5%**
Qualcomm_BD3_TP3	**400**	**224**	**56.0%**
Qualcomm_BD3_TP4	**400**	**372**	**93.0%**

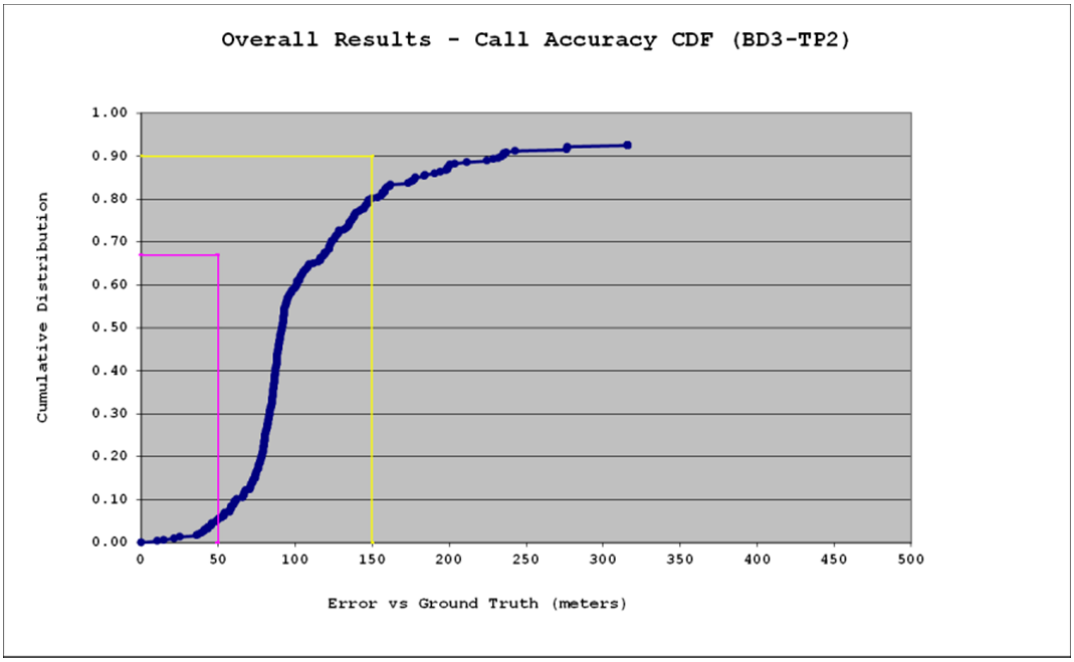
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD3_TP1	325	211.5	341.6	421.5	175.5	127.1	722.5	14.01
Qualcomm_BD3_TP2	306	119.2	234.8	315.8	120.9	71.9	315.8	10.65
Qualcomm_BD3_TP3	224	148.9	312.6	312.6	130.4	89.8	338.5	14.86
Qualcomm_BD3_TP4	372	326.1	351.8	361.9	226.1	105.8	692.3	39.03

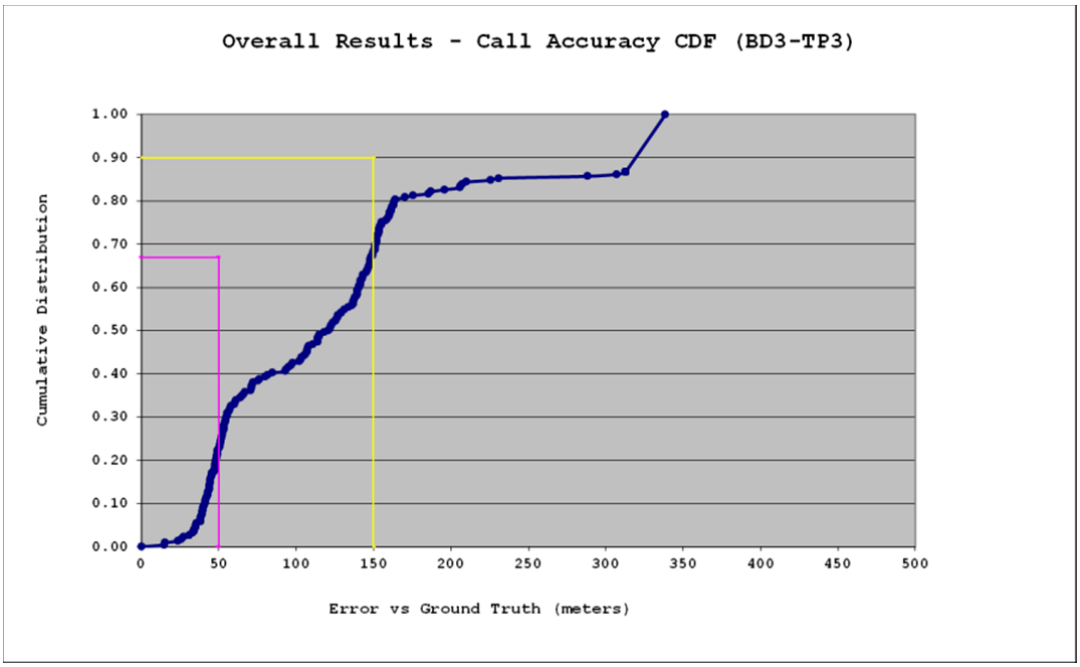
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD3_TP1	Number of Calls	24	17	256	25	1	0	2	0	325
	Percentage	7.4%	5.2%	78.8%	7.7%	0.3%	0.0%	0.6%	0.0%	100.0%
Qualcomm_BD3_TP2	Number of Calls	24	10	135	2	22	1	112	0	306
	Percentage	7.8%	3.3%	44.1%	0.7%	7.2%	0.3%	36.6%	0.0%	100.0%
Qualcomm_BD3_TP3	Number of Calls	30	5	48	0	68	0	73	0	224
	Percentage	13.4%	2.2%	21.4%	0.0%	30.4%	0.0%	32.6%	0.0%	100.0%
Qualcomm_BD3_TP4	Number of Calls	20	132	2	0	199	6	13	0	372
	Percentage	5.4%	35.5%	0.5%	0.0%	53.5%	1.6%	3.5%	0.0%	100.0%

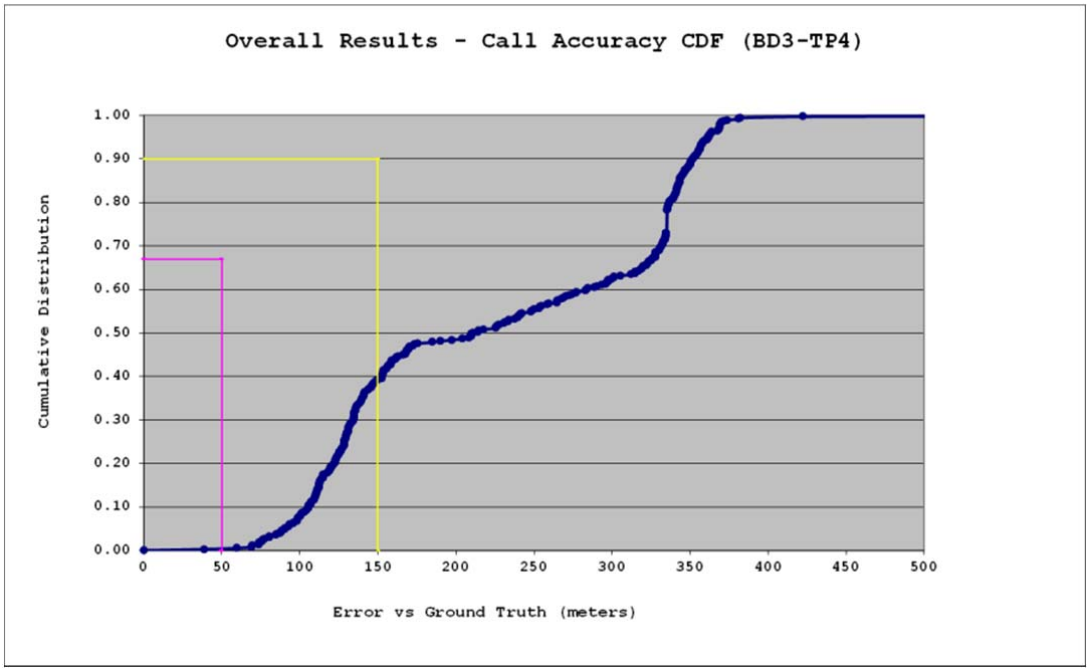
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD3_TP1	23.88	4.45	44.00	2.00
Qualcomm_BD3_TP2	23.80	6.00	69.00	2.00
Qualcomm_BD3_TP3	23.18	7.54	42.00	1.00
Qualcomm_BD3_TP4	29.94	5.95	44.00	2.00

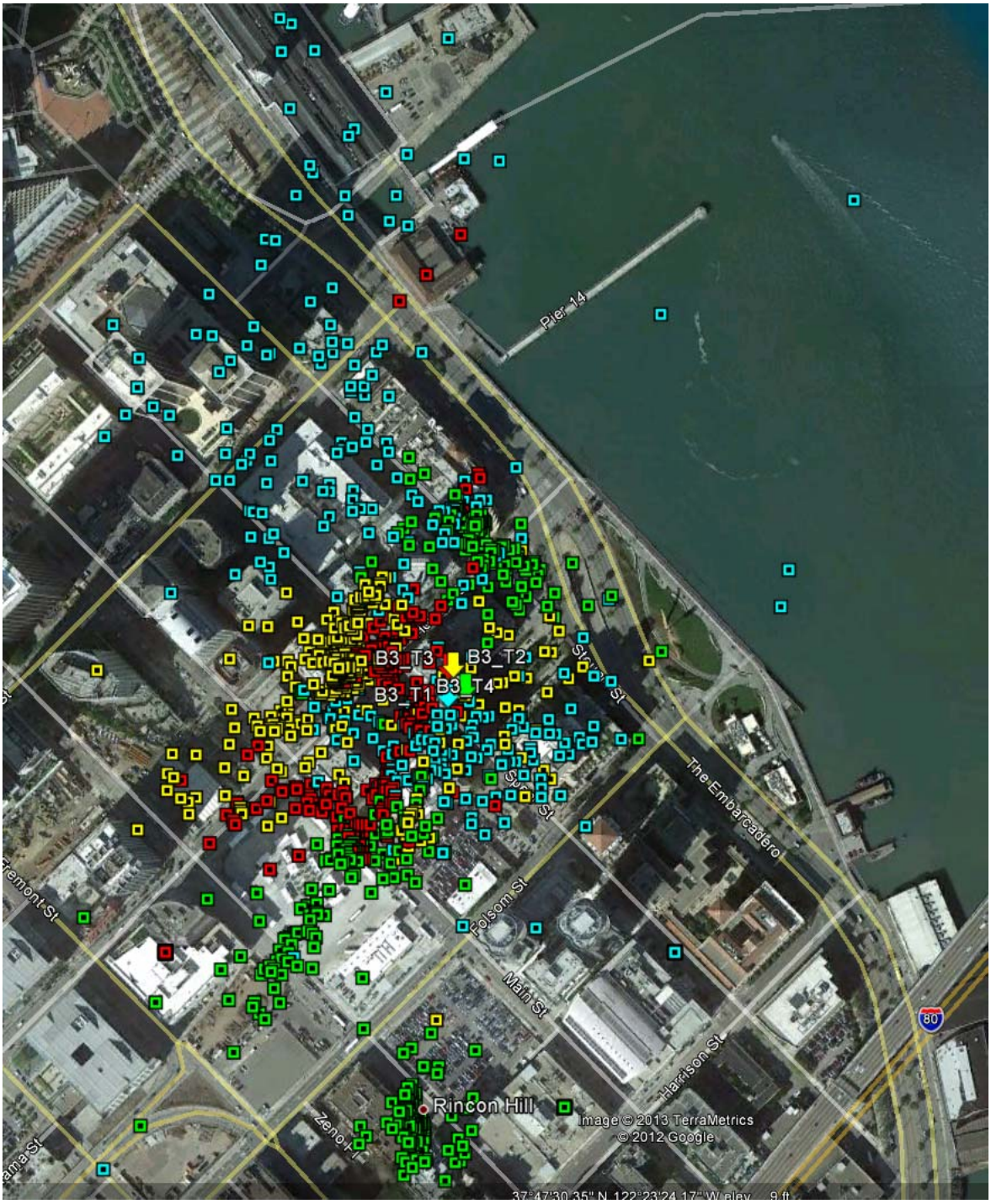
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD3_TP1	325	310	95.38%
Qualcomm_BD3_TP2	306	299	97.71%
Qualcomm_BD3_TP3	224	224	100.00%
Qualcomm_BD3_TP4	372	367	98.66%




Overall Results - Call Accuracy CDF (BD3-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD3-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD3-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B3_T3
B3_T2
B3_T1
B3_T4
Pier 14
The Embarcadero
Folsom St
Main St
Harrison St
Rincon Hill
Image © 2013 TerraMetrics
© 2012 Google

6.3.1.4 Building 14:

6.3.1.4.1 Building 14 Environment and Test Points:

Building 14 is the "Hearst Office Building," a 12 story commercial building of masonry, metal and glass relatively older construction. It is located on a busy intersection in downtown SF and has a popular T-Mobile store on the ground floor.

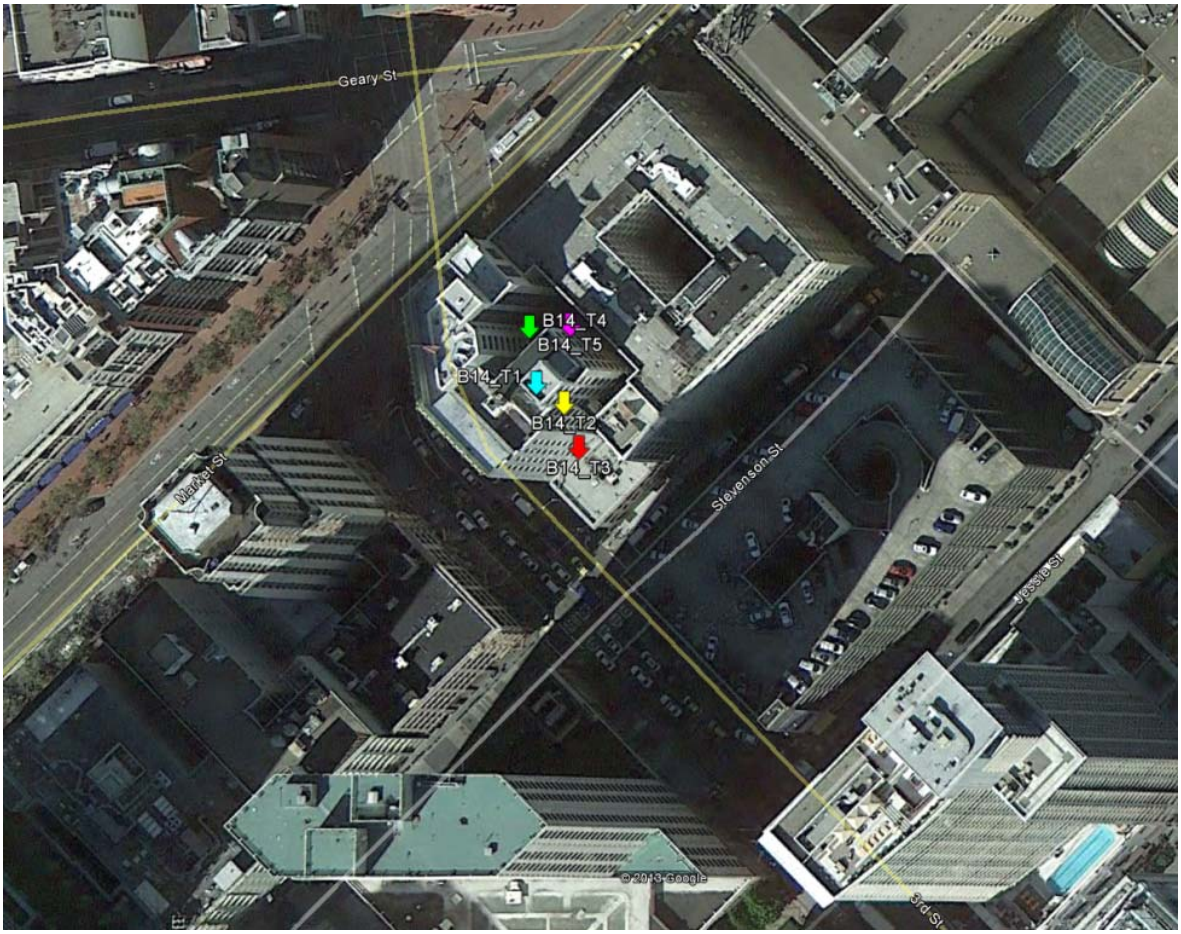
TP1: Interior hallway on 2nd floor

TP2: One room window suite, 7th floor overlooking back of building

TP3: One room window suite, 9th floor overlooking 3rd Street

TP4: Interior hallway on 12th floor

TP5: Interior of the T-Mobile store on the ground floor



6.3.1.4.2 NextNav per Test Point Results—BD14:

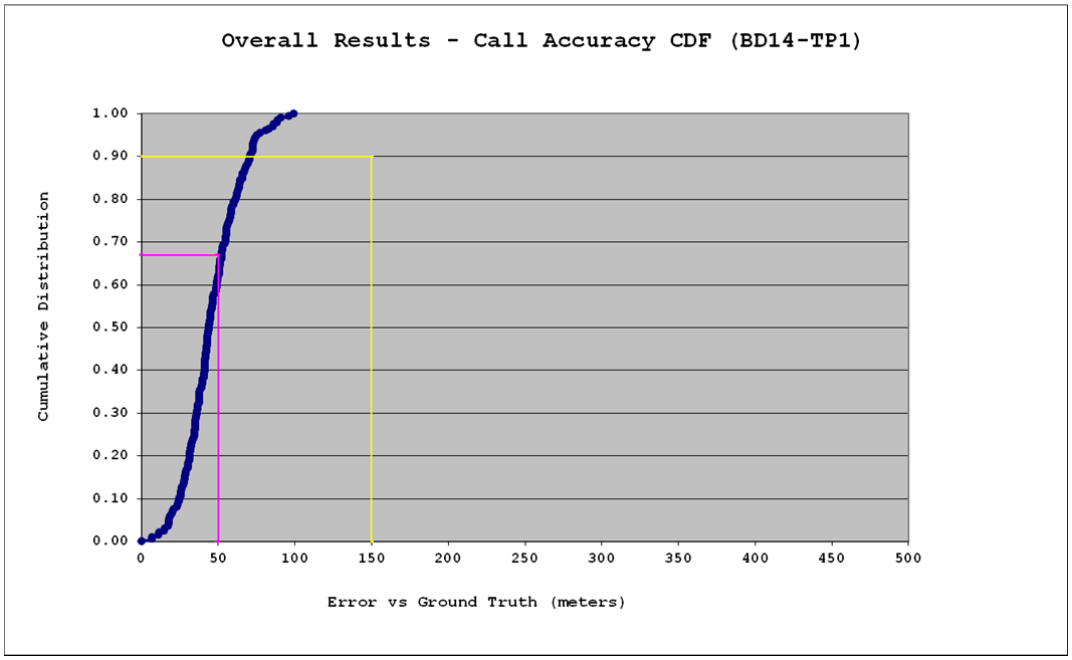
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD14_TP1	198	198	100.0%
NextNav_BD14_TP2	200	200	100.0%
NextNav_BD14_TP3	200	200	100.0%
NextNav_BD14_TP4	200	200	100.0%
NextNav_BD14_TP5	200	200	100.0%

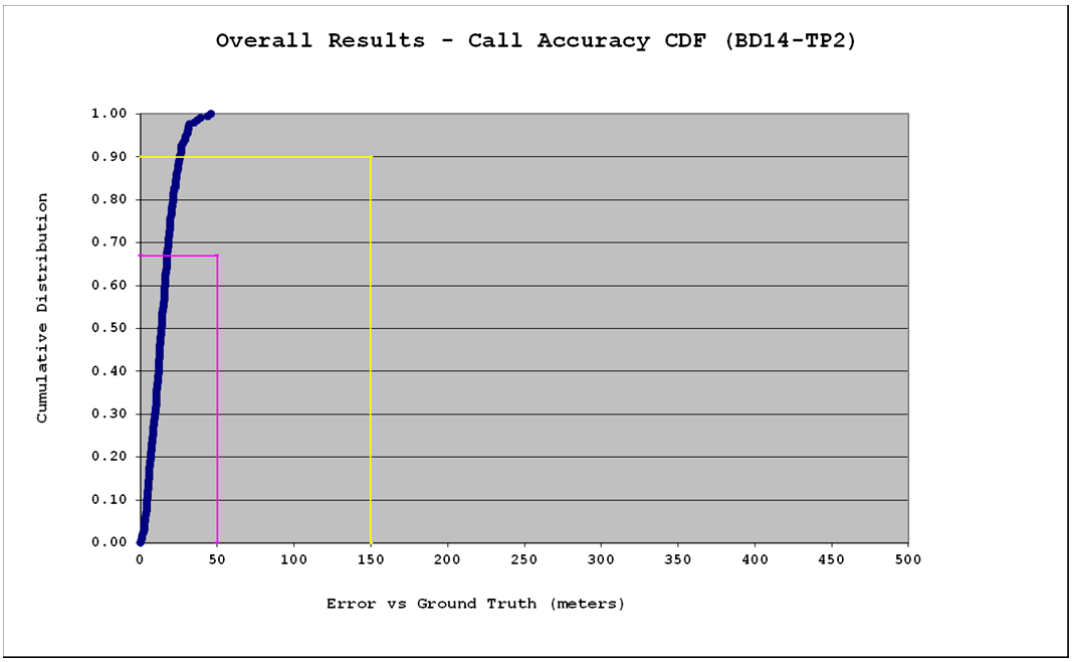
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD14_TP1	198	52.5	70.9	75.6	46.5	17.9	99.6	6.75
NextNav_BD14_TP2	200	17.6	26.0	30.1	14.9	8.5	46.0	0.57
NextNav_BD14_TP3	200	108.2	136.2	149.0	95.1	32.9	186.0	19.70
NextNav_BD14_TP4	200	31.3	47.9	58.9	27.4	15.0	81.2	2.24
NextNav_BD14_TP5	200	25.0	32.8	36.7	21.3	9.4	55.0	0.69

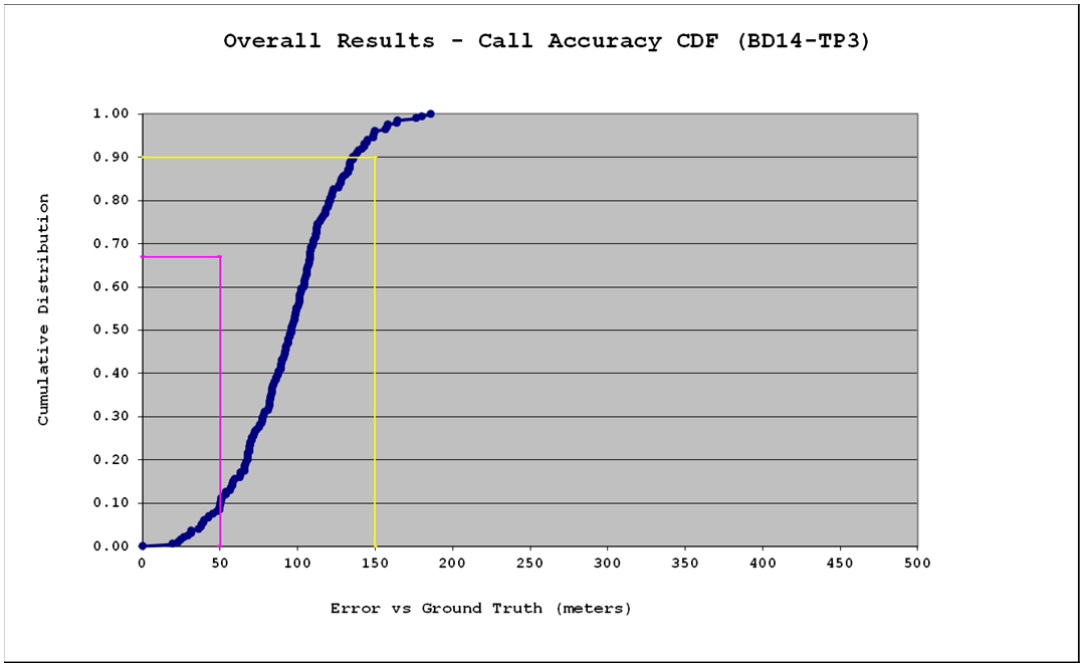
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD14_TP1	198	2.7	3.5	4.1	2.2	1.1	6.5	0.03
NextNav_BD14_TP2	200	2.7	3.2	3.4	2.5	0.5	4.0	1.34
NextNav_BD14_TP3	200	2.7	3.2	3.4	2.4	0.6	3.8	0.90
NextNav_BD14_TP4	200	2.7	3.1	3.4	2.4	0.6	4.3	0.57
NextNav_BD14_TP5	200	2.5	2.9	3.1	2.3	0.5	3.3	0.89

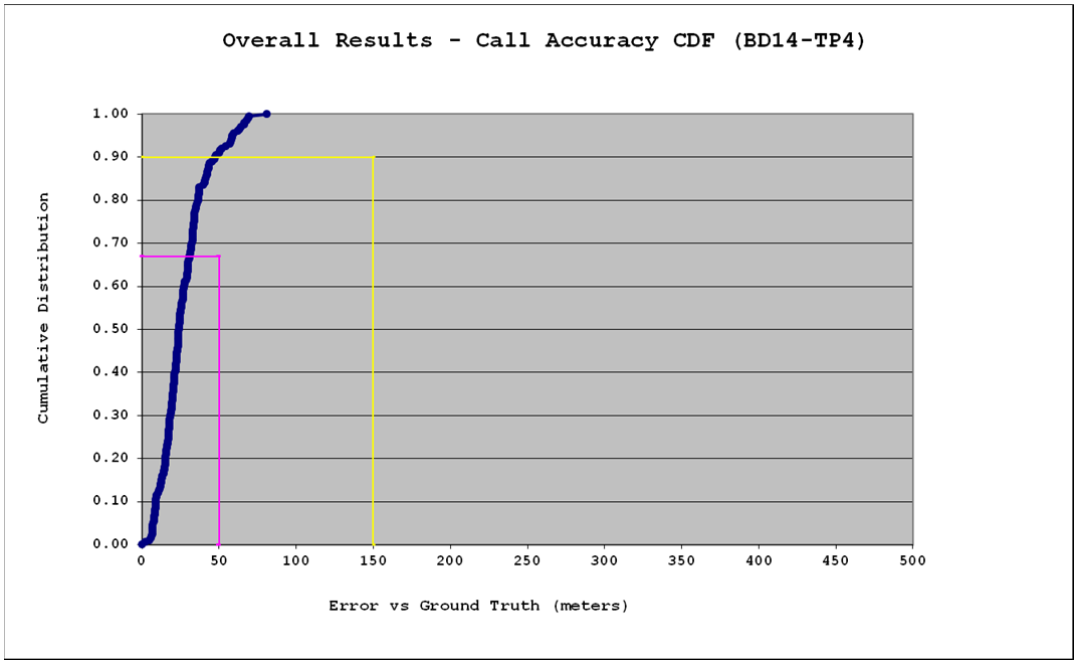
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD14_TP1	27.41	0.76	32.45	21.36
NextNav_BD14_TP2	27.42	0.52	32.68	27.27
NextNav_BD14_TP3	27.37	0.50	32.36	27.27
NextNav_BD14_TP4	27.35	0.36	32.37	27.27
NextNav_BD14_TP5	27.37	0.50	32.35	27.27

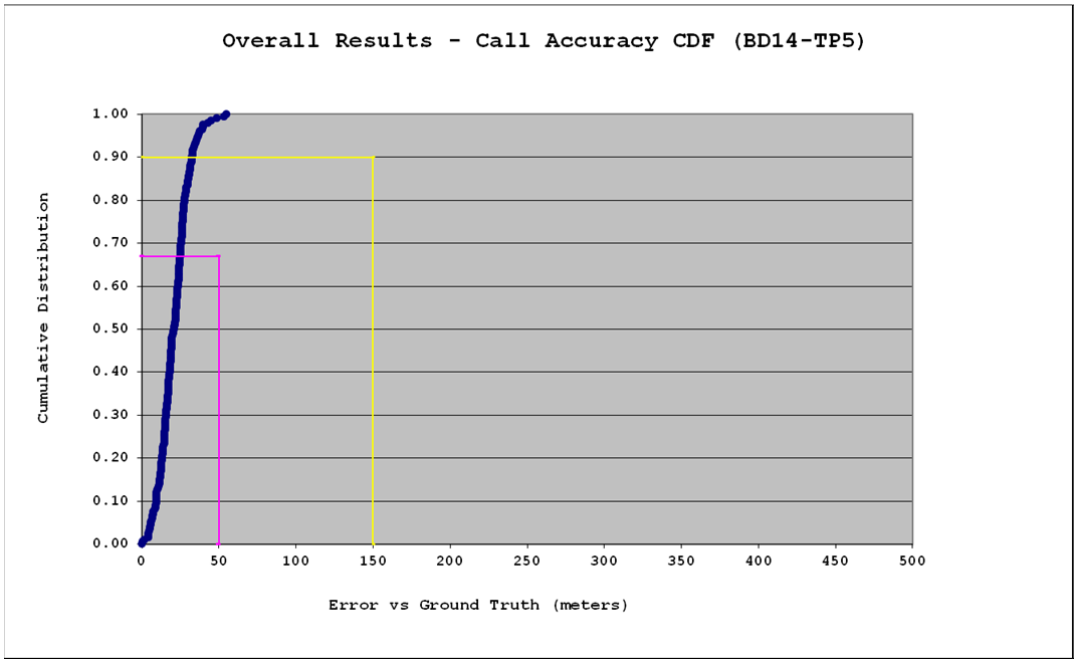
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD14_TP1	198	175	88.38%
NextNav_BD14_TP2	200	200	100.00%
NextNav_BD14_TP3	200	168	84.00%
NextNav_BD14_TP4	200	200	100.00%
NextNav_BD14_TP5	200	200	100.00%


Overall Results - Call Accuracy CDF (BD14-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Geary St
B14_T4
B14_T5
B14_T1
B14_T2
B14_T3
O'Farrell St
Giant Ave
Yerba Buena Ln
Stevenson St
Jessie St
Mission St
© 2013 Google

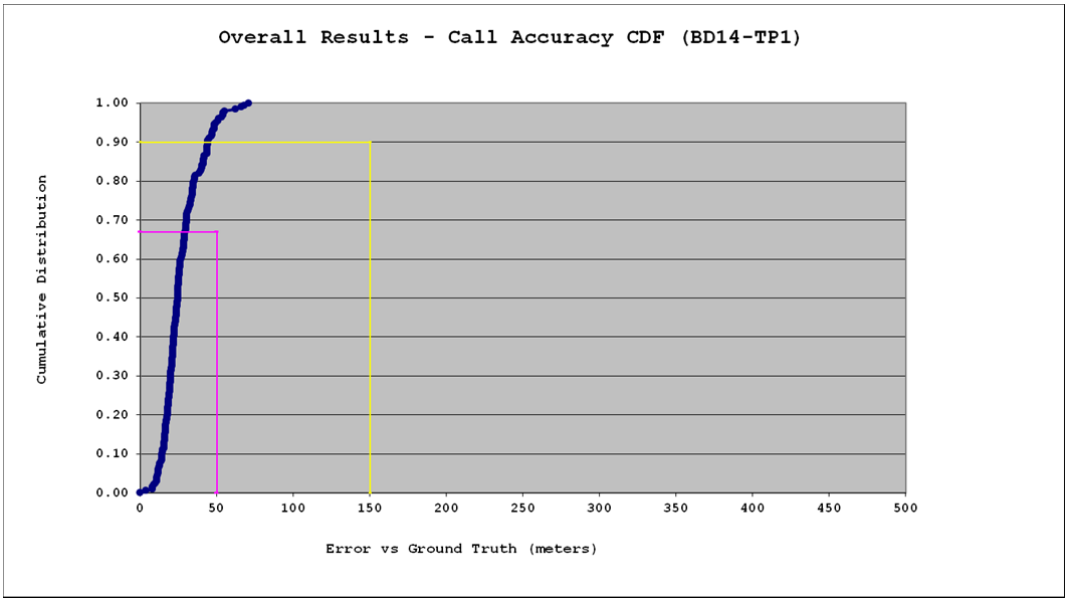
6.3.1.4.3 Polaris per Test Point Results—BD14:

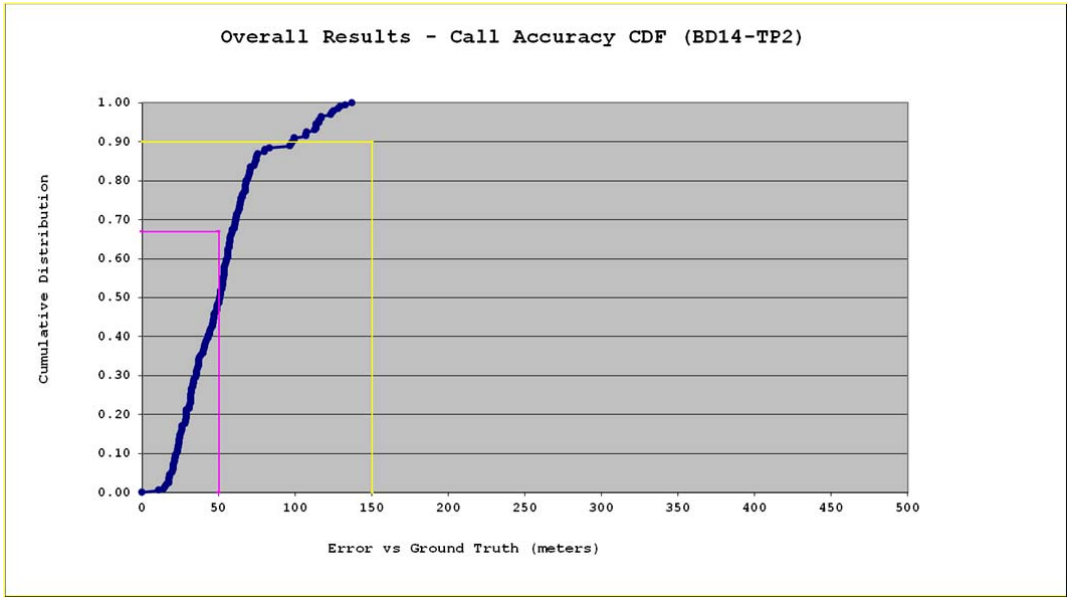
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD14_TP1	200	200	100.0%
Polaris_BD14_TP2	199	199	100.0%
Polaris_BD14_TP3	200	200	100.0%
Polaris_BD14_TP4	199	199	100.0%
Polaris_BD14_TP5	200	200	100.0%

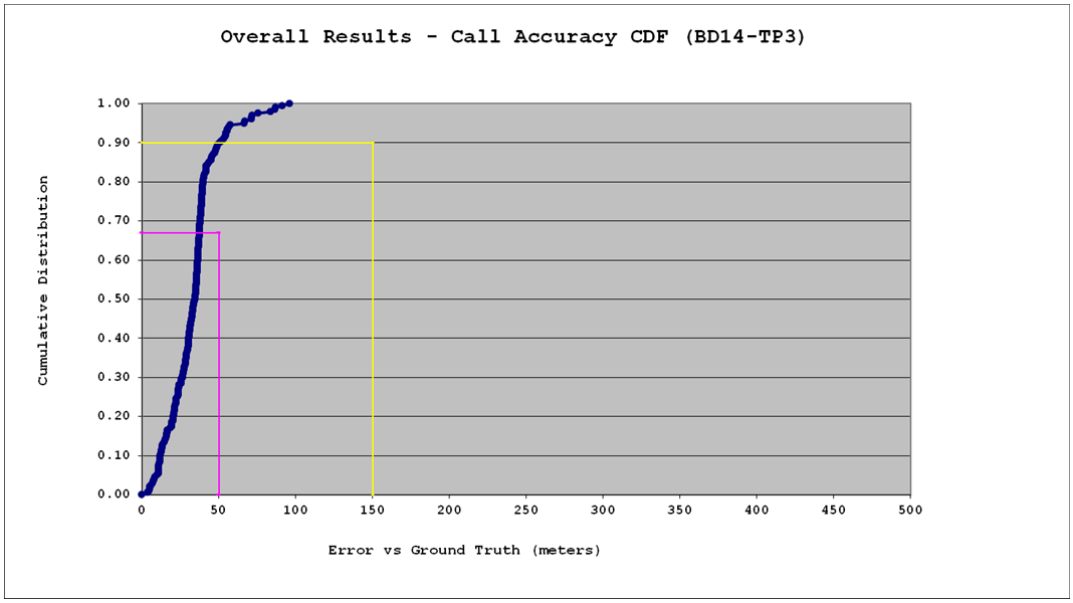
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD14_TP1	200	29.5	44.0	49.3	27.2	12.1	70.7	3.84
Polaris_BD14_TP2	199	58.9	98.4	115.6	53.4	27.8	137.2	10.63
Polaris_BD14_TP3	200	37.3	51.2	66.7	33.4	16.2	96.3	3.58
Polaris_BD14_TP4	199	160.4	389.5	490.5	200.1	220.4	1270.8	17.14
Polaris_BD14_TP5	200	57.6	78.0	87.4	45.1	25.3	135.1	3.21

TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD14_TP1	24.79	0.81	26.65	22.09
Polaris_BD14_TP2	24.78	1.25	26.46	18.30
Polaris_BD14_TP3	24.82	0.89	26.49	18.84
Polaris_BD14_TP4	24.64	1.73	26.21	15.89
Polaris_BD14_TP5	24.89	0.83	26.44	21.26

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD14_TP1	200	200	100.00%
Polaris_BD14_TP2	199	187	93.97%
Polaris_BD14_TP3	200	200	100.00%
Polaris_BD14_TP4	199	100	50.25%
Polaris_BD14_TP5	200	197	98.50%


Overall Results - Call Accuracy CDF (BD14-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP3)
Cumulative Distribution
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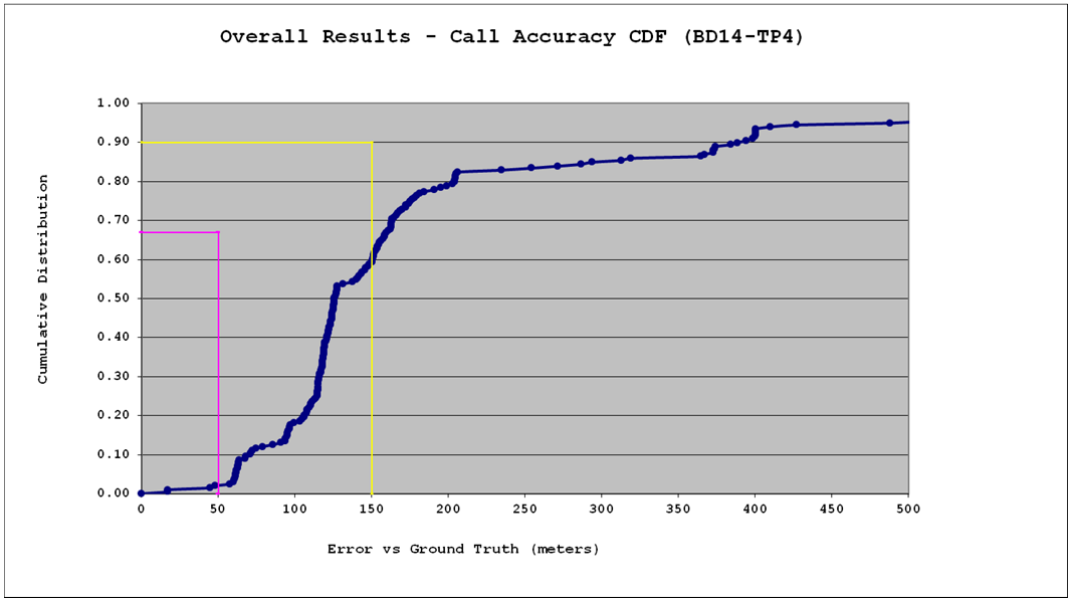
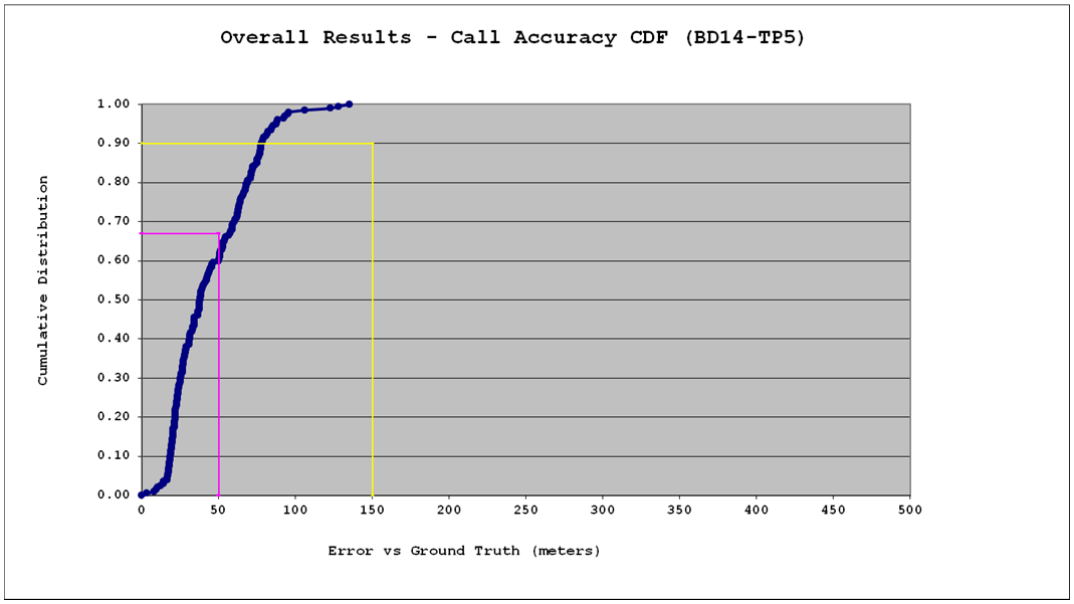
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

6.3.1.4.4 Qualcomm per Test Point Results—BD14:

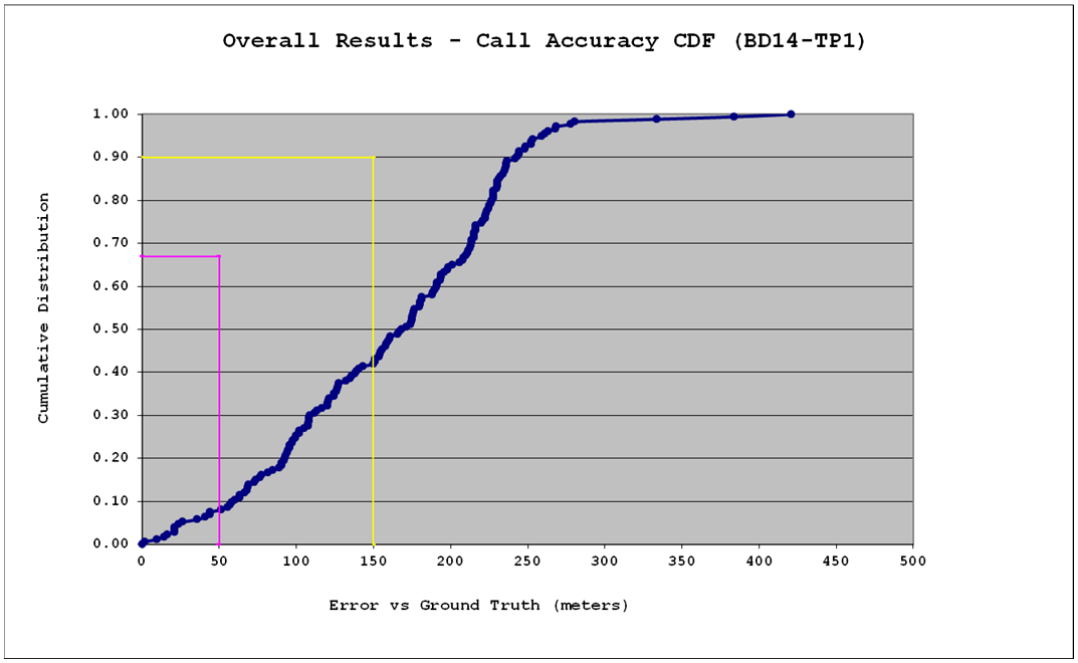
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD14_TP1	**179**	**174**	**97.2%**
Qualcomm_BD14_TP2	**180**	**155**	**86.1%**
Qualcomm_BD14_TP3	**180**	**180**	**100.0%**
Qualcomm_BD14_TP4	**180**	**149**	**82.8%**
Qualcomm_BD14_TP5	**180**	**152**	**84.4%**

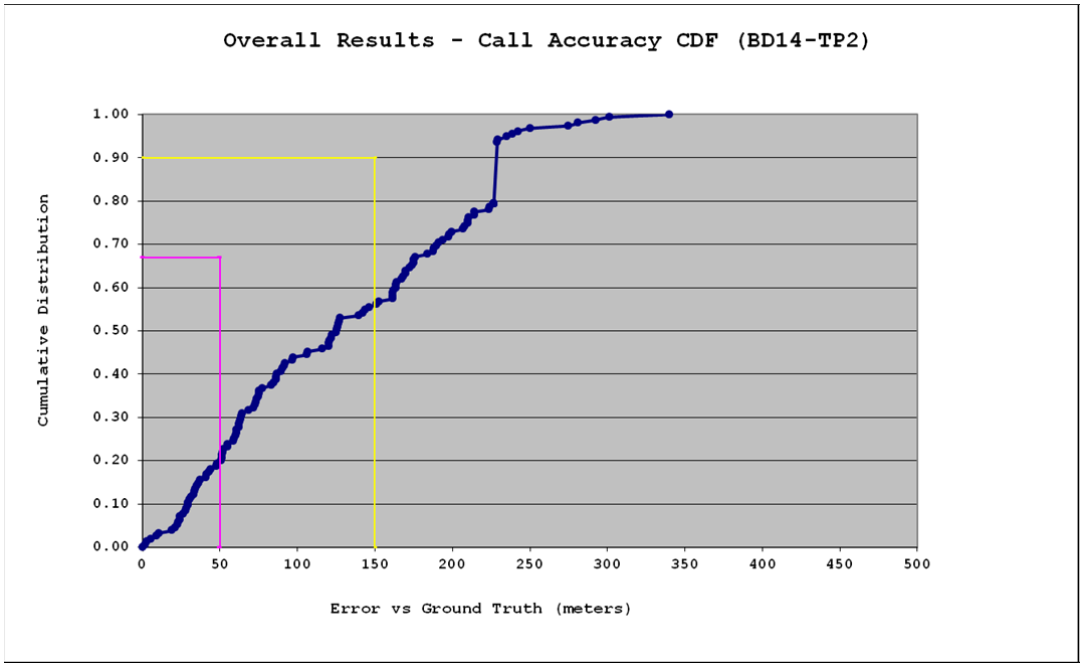
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD14_TP1	174	210.1	243.1	259.8	160.7	75.3	421.0	1.86
Qualcomm_BD14_TP2	155	177.7	226.7	236.2	131.3	80.6	340.1	1.97
Qualcomm_BD14_TP3	180	164.5	253.3	280.8	148.9	80.7	585.5	17.99
Qualcomm_BD14_TP4	149	174.4	229.6	329.2	148.1	109.4	711.5	14.54
Qualcomm_BD14_TP5	152	166.9	211.9	226.2	130.9	76.2	372.5	5.98

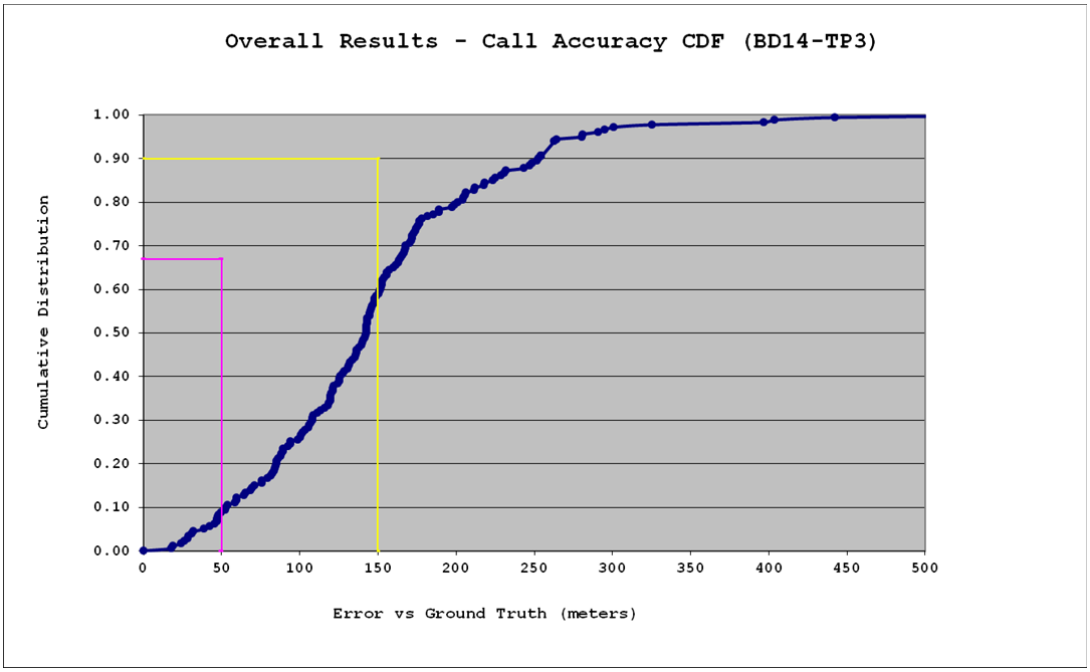
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD14_TP1	Number of Calls	3	156	0	0	15	0	0	0	174
	Percentage	1.7%	89.7%	0.0%	0.0%	8.6%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD14_TP2	Number of Calls	22	101	32	0	0	0	0	0	155
	Percentage	14.2%	65.2%	20.6%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD14_TP3	Number of Calls	7	0	69	104	0	0	0	0	180
	Percentage	3.9%	0.0%	38.3%	57.8%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD14_TP4	Number of Calls	31	44	72	1	0	0	1	0	149
	Percentage	20.8%	29.5%	48.3%	0.7%	0.0%	0.0%	0.7%	0.0%	100.0%
Qualcomm_BD14_TP5	Number of Calls	22	26	101	0	1	0	2	0	152
	Percentage	14.5%	17.1%	66.4%	0.0%	0.7%	0.0%	1.3%	0.0%	100.0%

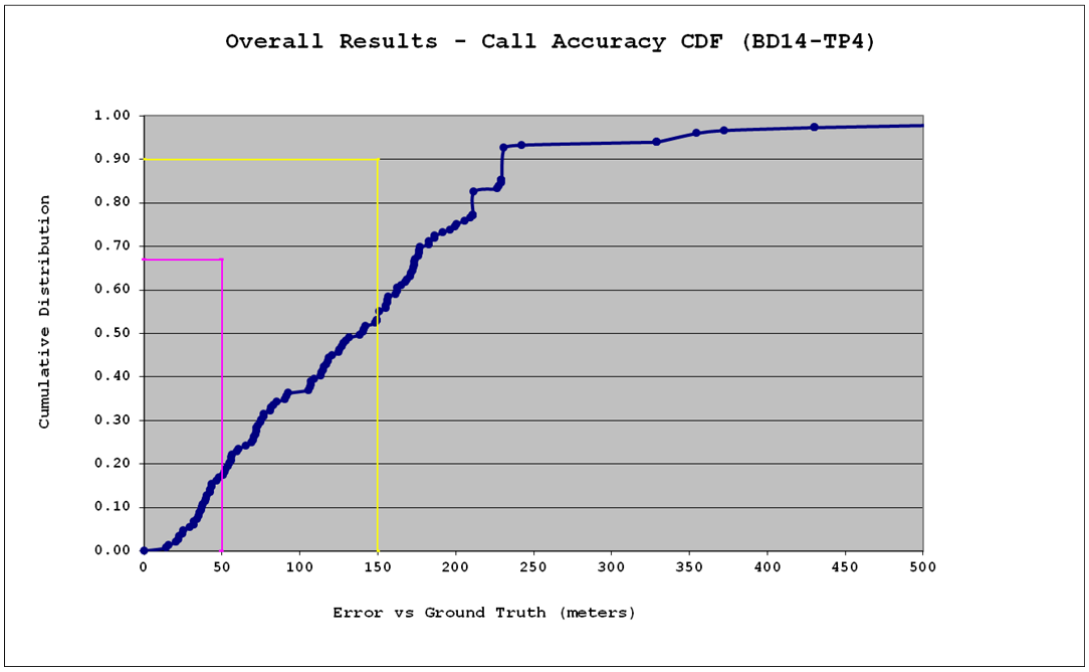
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD14_TP1	32.18	3.42	67.00	17.00
Qualcomm_BD14_TP2	31.97	8.04	95.00	17.00
Qualcomm_BD14_TP3	26.34	6.48	66.00	17.00
Qualcomm_BD14_TP4	32.14	12.63	93.00	18.00
Qualcomm_BD14_TP5	28.75	8.81	91.00	17.00

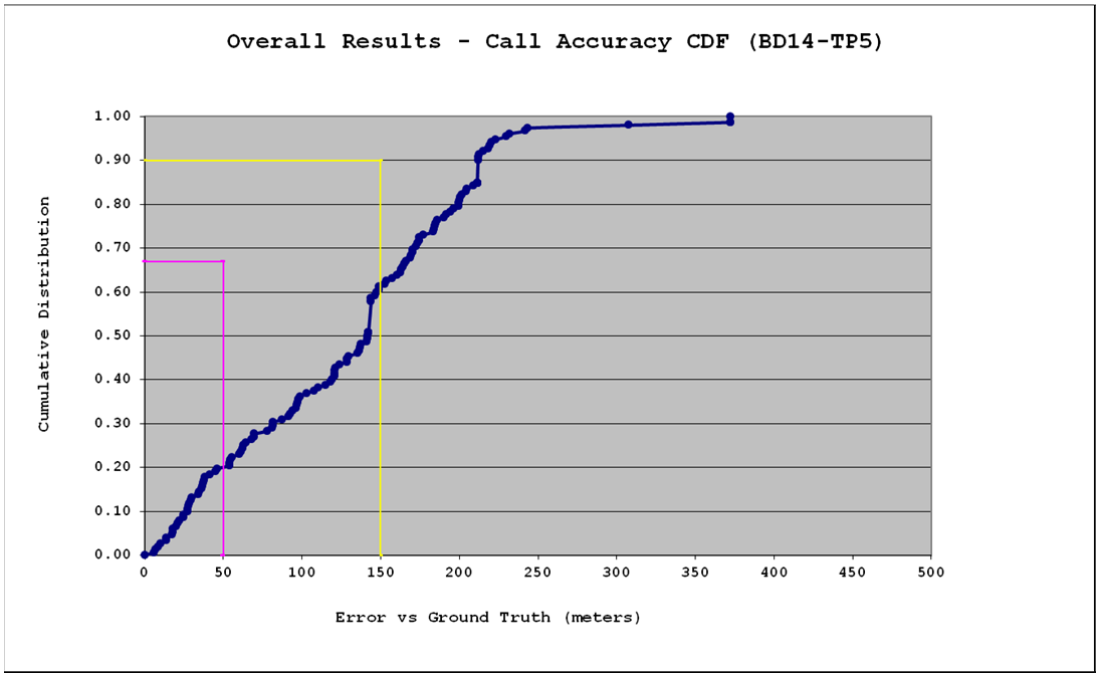
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD14_TP1	174	137	78.74%
Qualcomm_BD14_TP2	155	152	98.06%
Qualcomm_BD14_TP3	180	95	52.78%
Qualcomm_BD14_TP4	149	135	90.60%

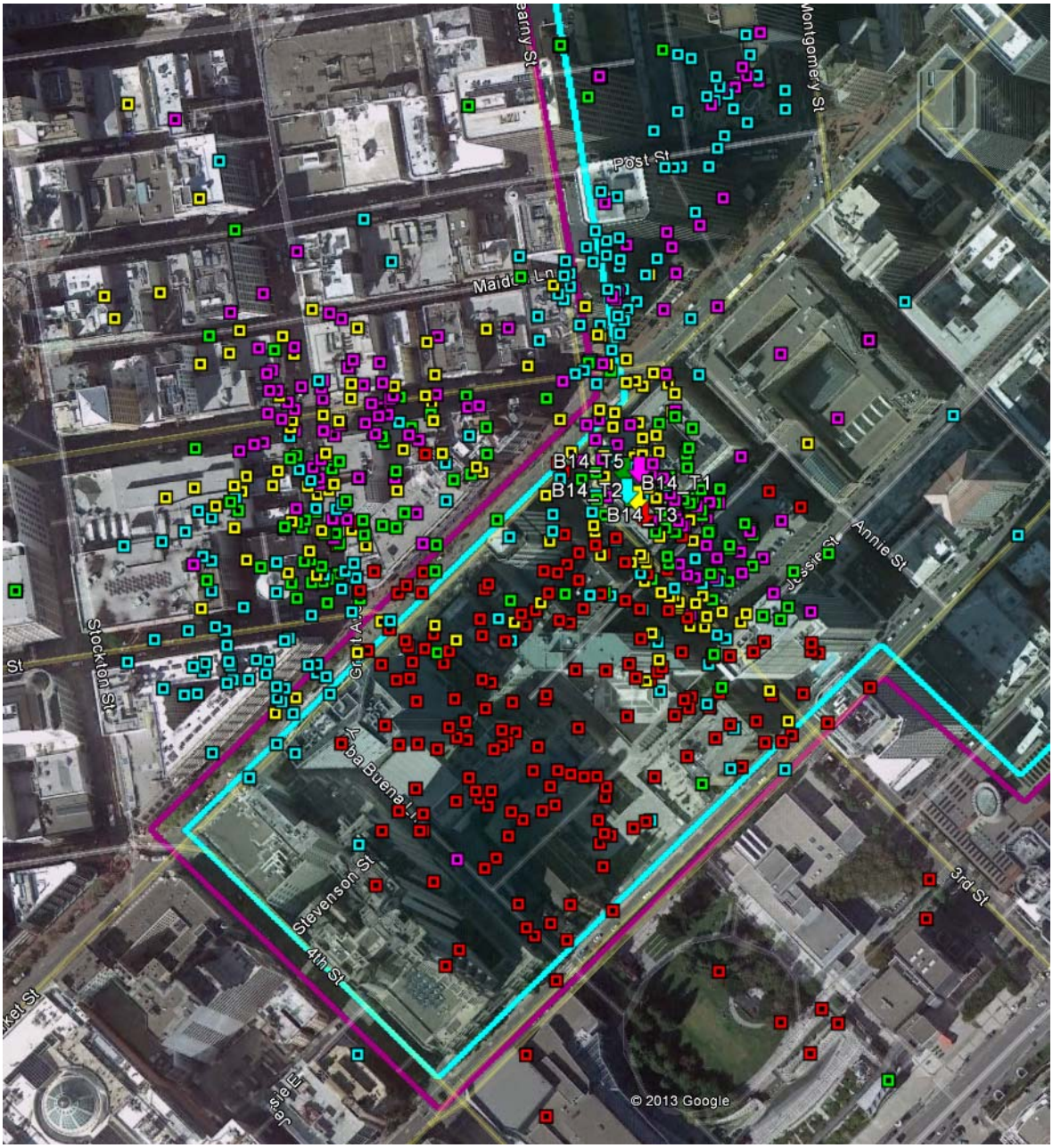

Overall Results - Call Accuracy CDF (BD14-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD14-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



6.3.1.5 Building 15:

6.3.1.5.1 Building 15 Environment and Test Points:

Building 15 is the Omni Hotel in SF. It is a 15 story inverted L shaped structure with a brick façade finish. It is attached on both ends to other buildings.

TP1: Service area to restaurant on first floor, moderately interior from street

TP2: Mezzanine foyer above lobby at main entrance

TP3: Exit stairwell hallway at north end of building, 12th floor

TP4: Mezzanine level meeting room (2nd floor) with window to street

TP5: Employee area corridor (1 floor below lobby)

TP6: Mezzanine foyer (further from street than TP2)

6.3.1.5.2 NextNav per Test Point Results—BD15:

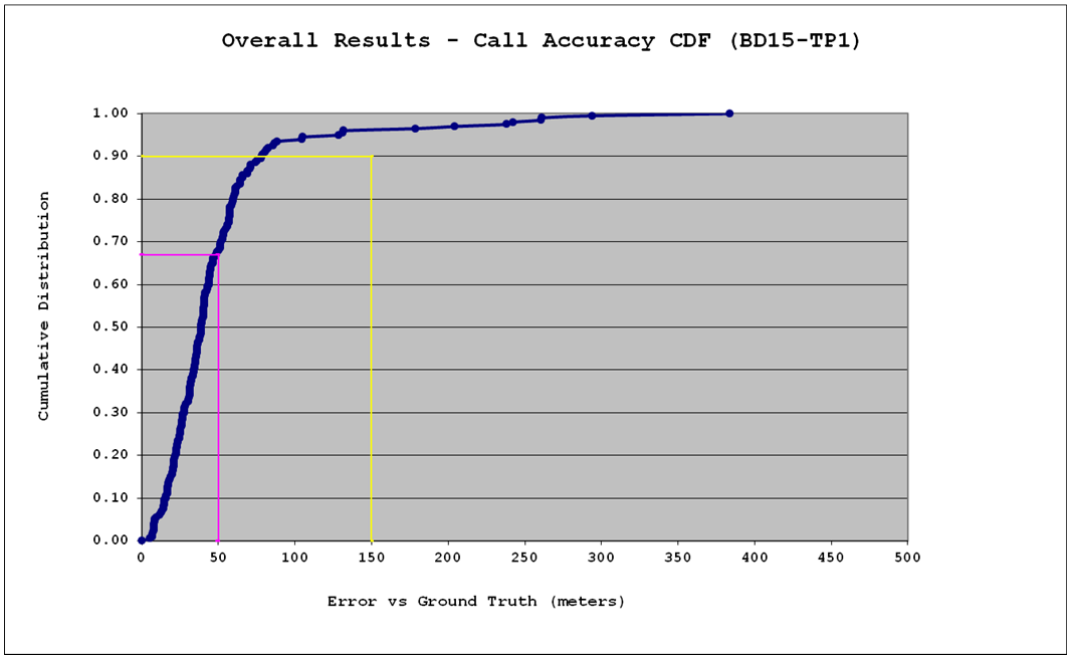
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD15_TP1	200	200	100.0%
NextNav_BD15_TP2	200	200	100.0%
NextNav_BD15_TP3	200	200	100.0%
NextNav_BD15_TP4	200	200	100.0%
NextNav_BD15_TP5	200	123	61.5%
NextNav_BD15_TP6	200	200	100.0%

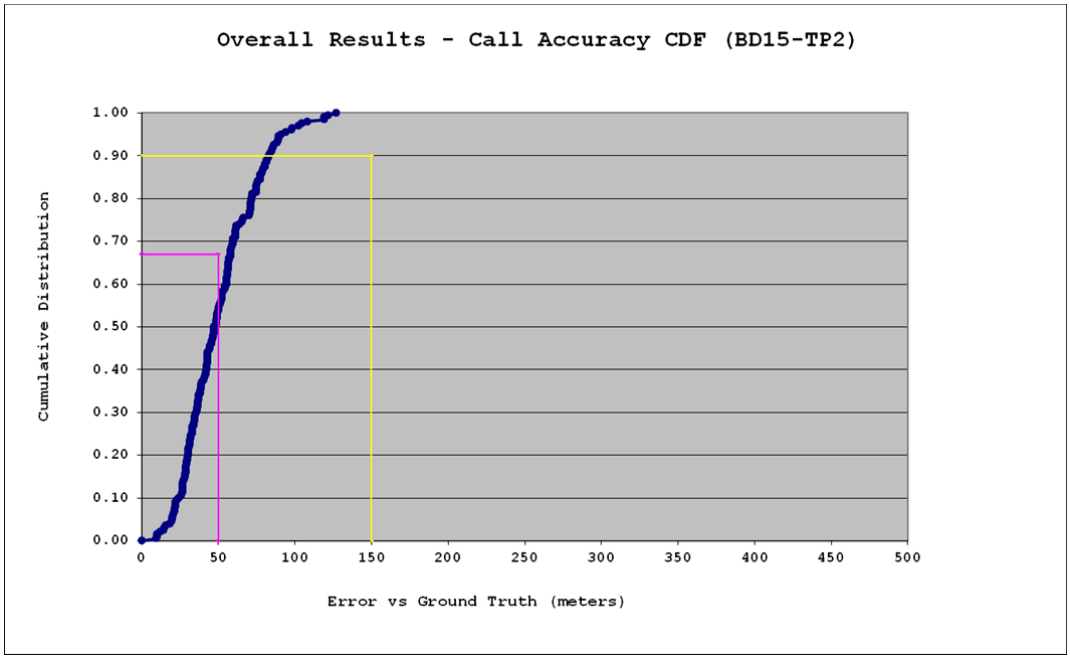
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD15_TP1	200	48.8	78.5	128.8	49.8	49.6	384.2	5.43
NextNav_BD15_TP2	200	58.1	83.3	91.0	51.4	23.7	127.3	9.49
NextNav_BD15_TP3	200	70.1	83.8	87.3	56.0	22.4	107.8	0.85
NextNav_BD15_TP4	200	39.0	55.7	60.6	32.1	17.3	79.9	2.75
NextNav_BD15_TP5	123	354.9	423.8	456.8	304.2	109.9	665.9	76.18
NextNav_BD15_TP6	200	69.3	94.8	102.9	59.7	26.9	185.0	6.78

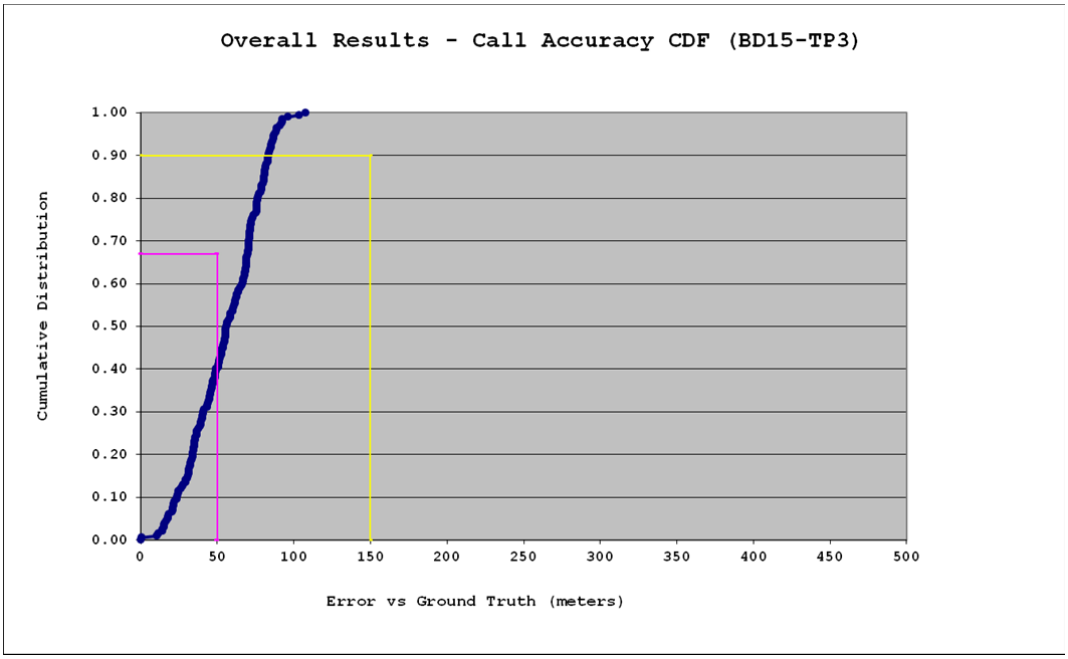
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD15_TP1	200	1.0	1.5	1.8	0.8	0.5	2.8	0.03
NextNav_BD15_TP2	200	1.4	1.8	1.9	1.2	0.4	2.2	0.05
NextNav_BD15_TP3	200	3.2	3.5	3.6	2.7	0.7	3.9	1.23
NextNav_BD15_TP4	200	1.8	2.9	3.1	1.5	0.9	5.1	0.11
NextNav_BD15_TP5	123	1.5	1.8	2.0	1.4	0.4	2.3	0.15
NextNav_BD15_TP6	200	1.4	1.7	1.8	1.1	0.4	2.3	0.08

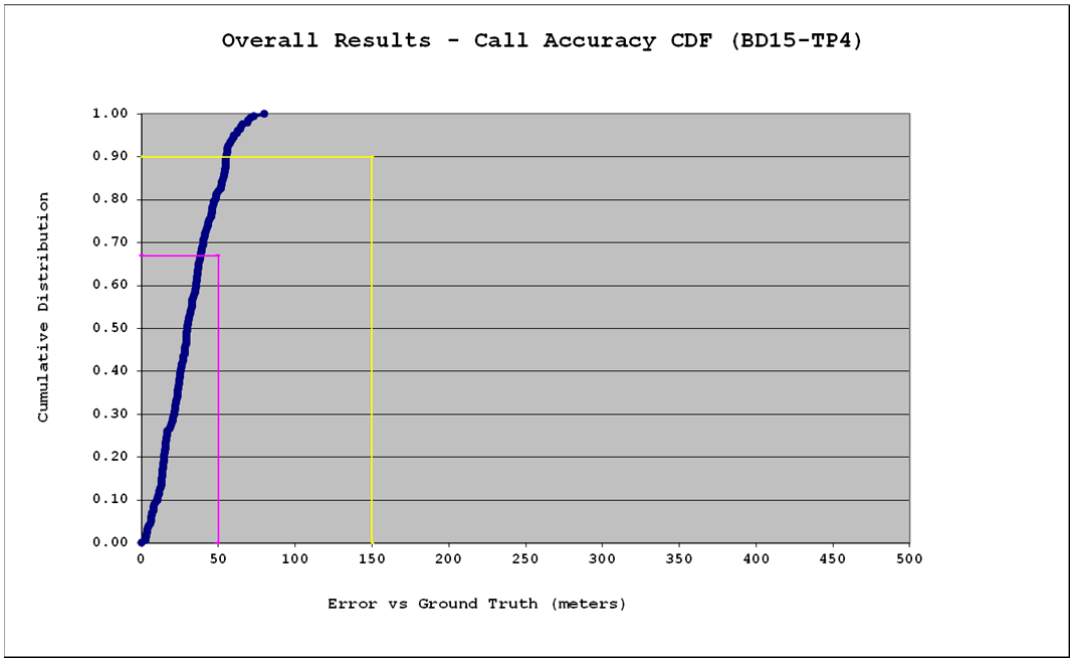
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD15_TP1	27.44	0.36	32.31	27.27
NextNav_BD15_TP2	27.38	0.50	32.33	27.27
NextNav_BD15_TP3	27.40	0.10	27.67	27.27
NextNav_BD15_TP4	27.35	0.36	32.36	27.27
NextNav_BD15_TP5	27.57	0.58	32.98	26.84
NextNav_BD15_TP6	27.45	0.61	32.36	27.27

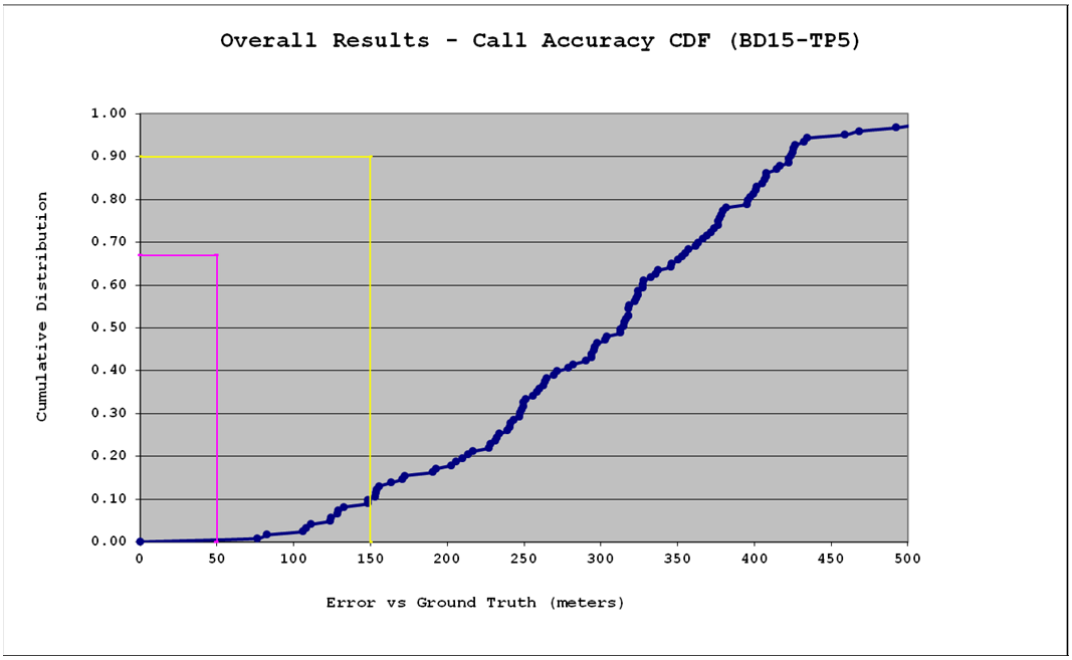
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD15_TP1	200	192	96.00%
NextNav_BD15_TP2	200	196	98.00%
NextNav_BD15_TP3	200	187	93.50%
NextNav_BD15_TP4	200	200	100.00%
NextNav_BD15_TP5	123	65	52.85%
NextNav_BD15_TP6	200	197	98.50%

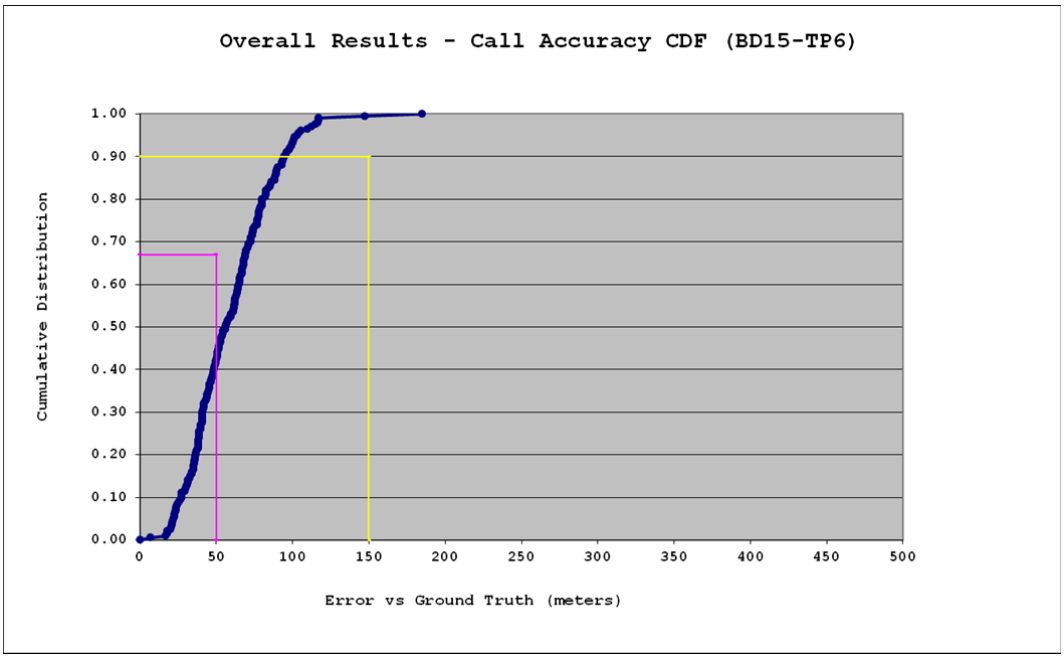

Overall Results - Call Accuracy CDF (BD15-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP6)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

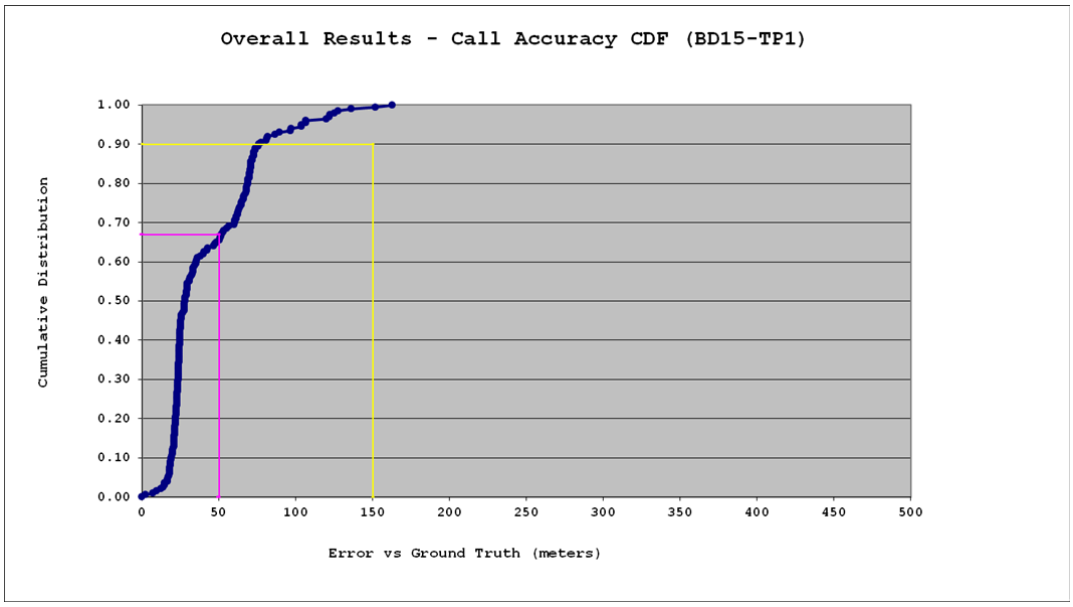
6.3.1.5.3 Polaris per Test Point Results—BD15:

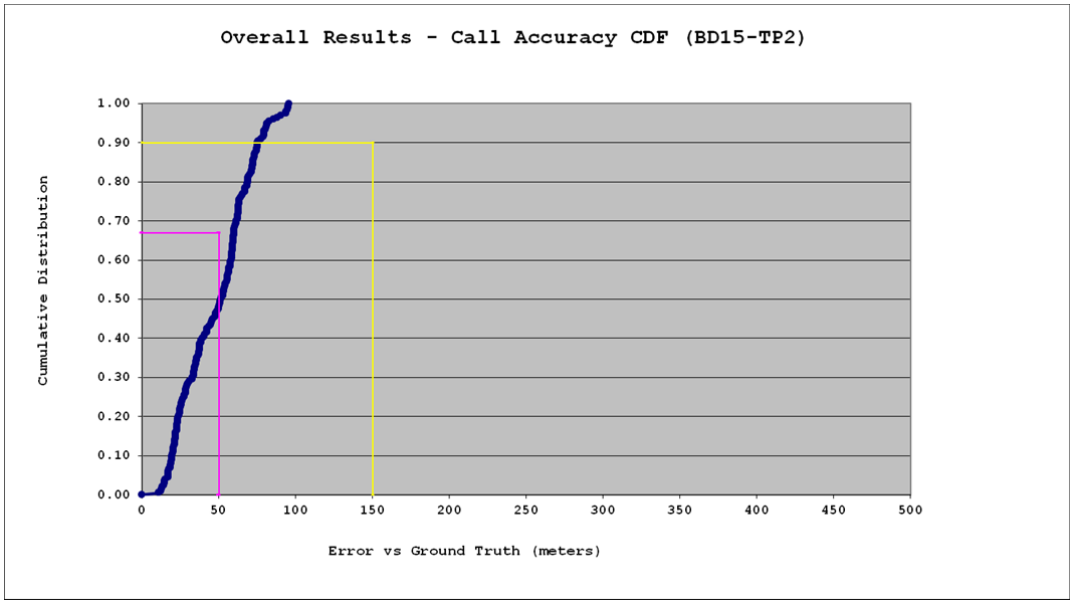
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD15_TP1	**200**	**200**	**100.0%**
Polaris_BD15_TP2	**200**	**200**	**100.0%**
Polaris_BD15_TP3	**196**	**195**	**99.5%**
Polaris_BD15_TP4	**200**	**200**	**100.0%**
Polaris_BD15_TP5	**120**	**120**	**100.0%**
Polaris_BD15_TP6	**199**	**199**	**100.0%**

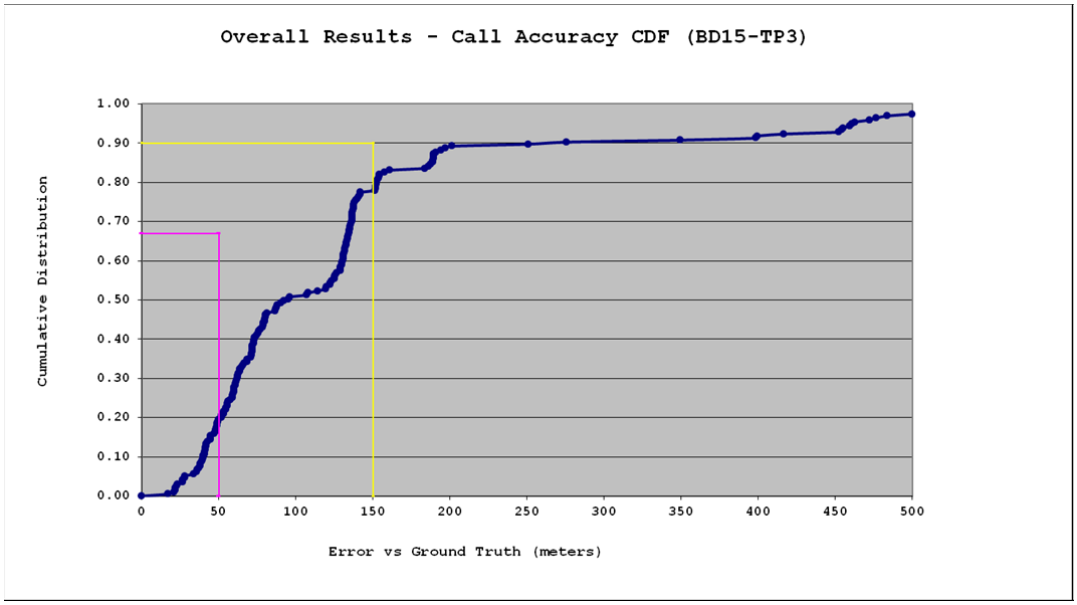
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	**Average Error**	**Standard Deviation**	**Max Error**	**Min Error**
Polaris_BD15_TP1	**200**	**52.0**	**76.2**	**103.9**	**43.4**	**29.7**	**162.9**	**2.30**
Polaris_BD15_TP2	**200**	**59.8**	**75.4**	**81.6**	**48.6**	**21.9**	**95.4**	**10.80**
Polaris_BD15_TP3	**195**	**134.5**	**265.7**	**461.3**	**137.3**	**139.2**	**796.2**	**17.14**
Polaris_BD15_TP4	**200**	**35.8**	**77.2**	**91.0**	**36.5**	**23.9**	**114.1**	**2.22**
Polaris_BD15_TP5	**120**	**156.4**	**358.7**	**361.6**	**173.8**	**76.1**	**370.2**	**53.96**
Polaris_BD15_TP6	**199**	**79.7**	**86.6**	**89.1**	**64.1**	**22.9**	**102.1**	**18.11**

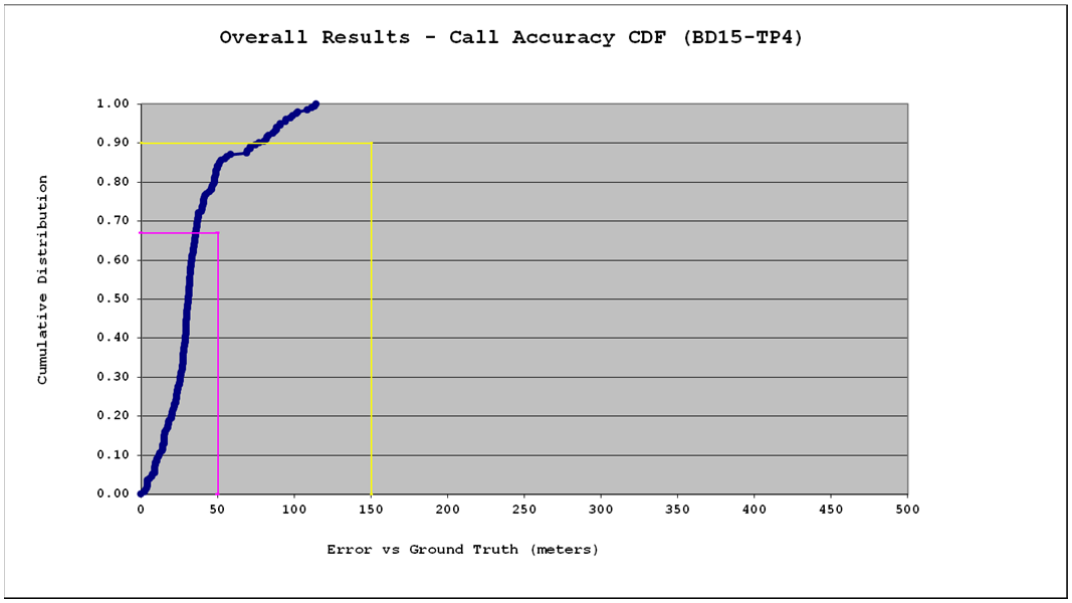
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD15_TP1	23.47	2.50	26.51	1.68
Polaris_BD15_TP2	24.23	2.36	26.19	1.73
Polaris_BD15_TP3	23.07	2.99	28.02	1.75
Polaris_BD15_TP4	24.17	1.43	26.17	19.32
Polaris_BD15_TP5	22.75	4.28	26.48	4.40
Polaris_BD15_TP6	24.83	1.09	26.36	15.45

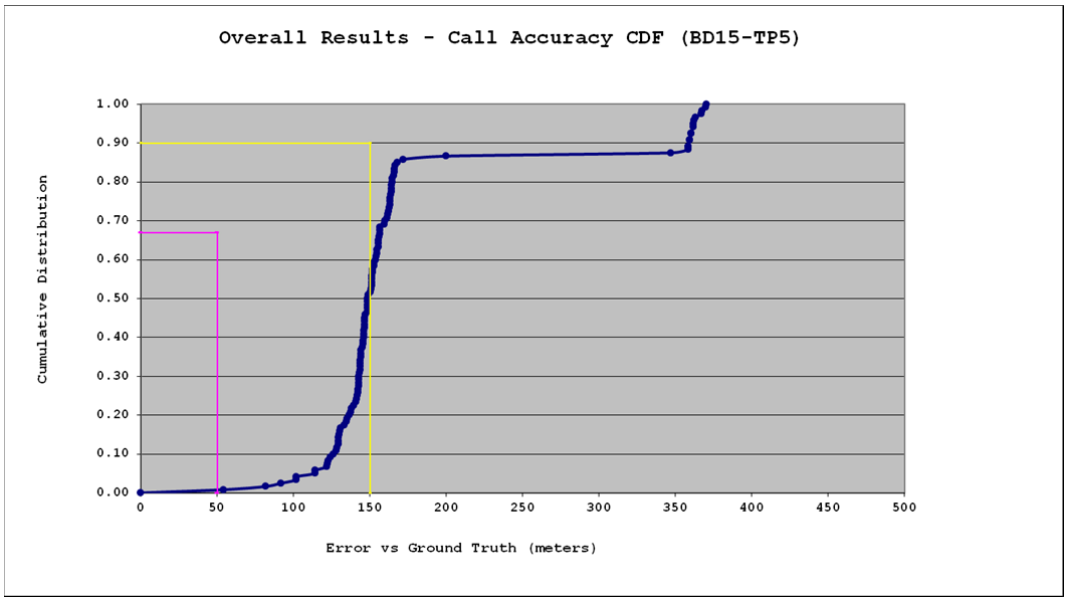
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD15_TP1	200	187	93.50%
Polaris_BD15_TP2	200	191	95.50%
Polaris_BD15_TP3	195	131	67.18%
Polaris_BD15_TP4	200	182	91.00%
Polaris_BD15_TP5	120	102	85.00%
Polaris_BD15_TP6	199	192	96.48%

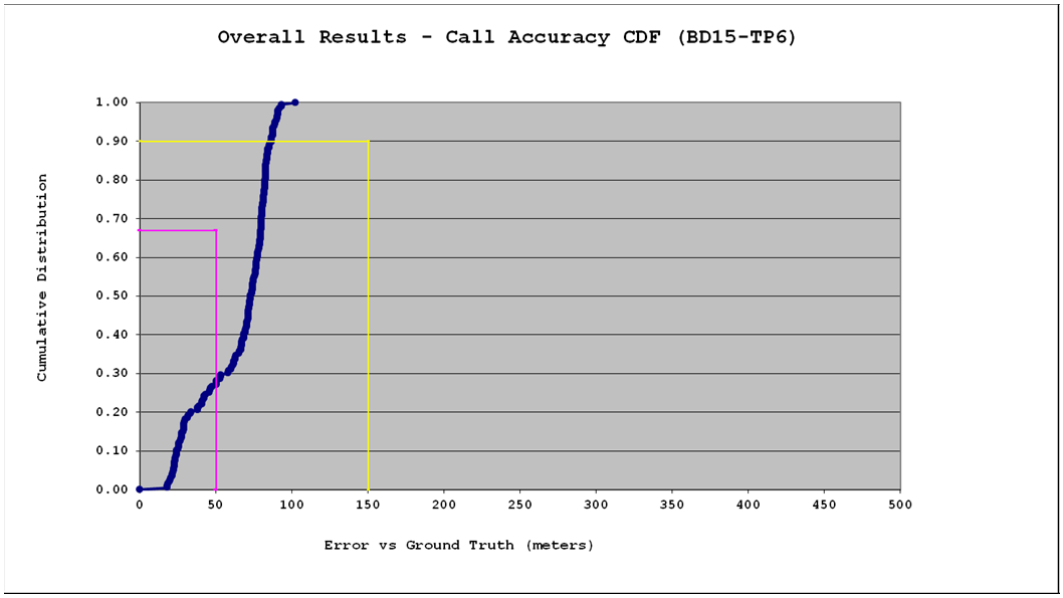



Overall Results - Call Accuracy CDF (BD15-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP6)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Merchant St
Clay St
Sacramento St
Kearny St
Spring St
Montgomery St
Sansome St
Pine St
B15_T3
B15_T4
B15_T1
B15_T6
B15_T5
© 2013 Google

6.3.1.5.4 Qualcomm per Test Point Results—BD15:

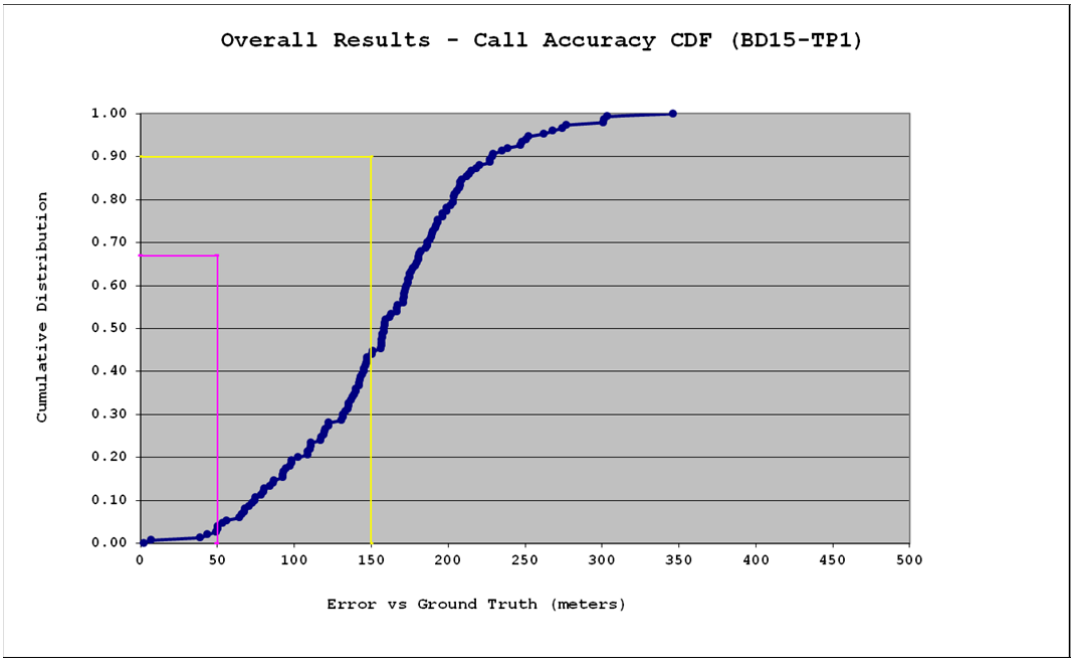
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD15_TP1	180	151	83.9%
Qualcomm_BD15_TP2	180	150	83.3%
Qualcomm_BD15_TP3	180	162	90.0%
Qualcomm_BD15_TP4	180	175	97.2%
Qualcomm_BD15_TP5	180	56	31.1%
Qualcomm_BD15_TP6	180	174	96.7%

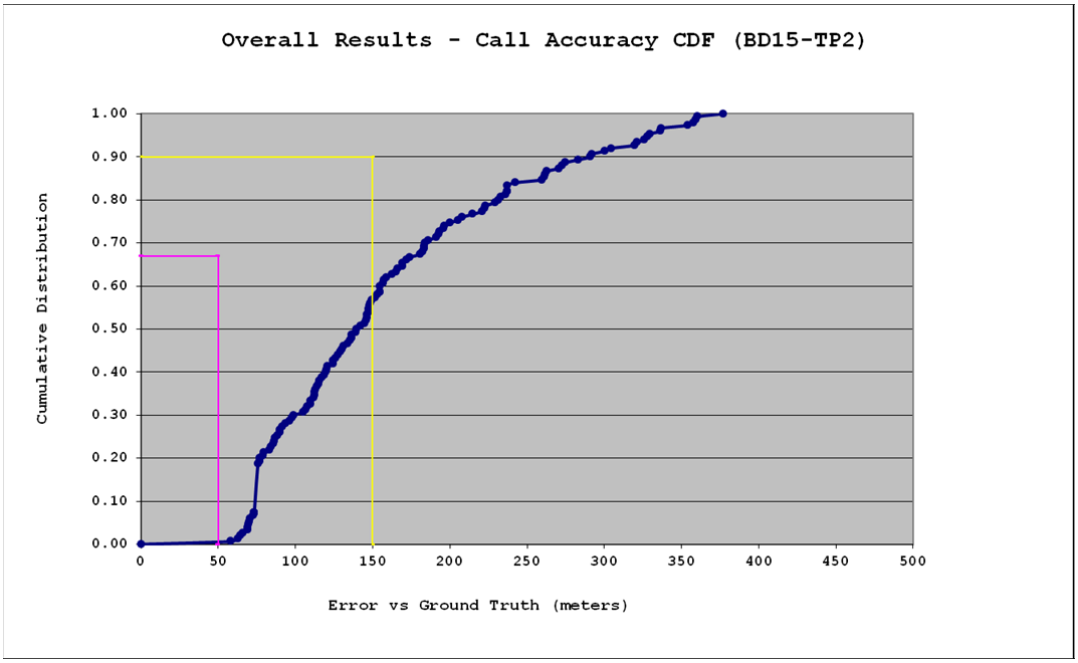
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD15_TP1	151	181.2	229.1	257.5	157.1	61.4	346.1	2.12
Qualcomm_BD15_TP2	150	179.5	291.2	328.9	159.3	82.3	377.0	58.23
Qualcomm_BD15_TP3	162	110.0	192.2	215.0	101.4	60.1	332.3	13.33
Qualcomm_BD15_TP4	175	158.3	194.7	204.5	128.1	56.9	318.6	19.39
Qualcomm_BD15_TP5	56	200.2	336.8	486.1	175.5	155.6	723.5	33.53
Qualcomm_BD15_TP6	174	211.2	328.9	347.4	188.7	86.6	424.4	69.87

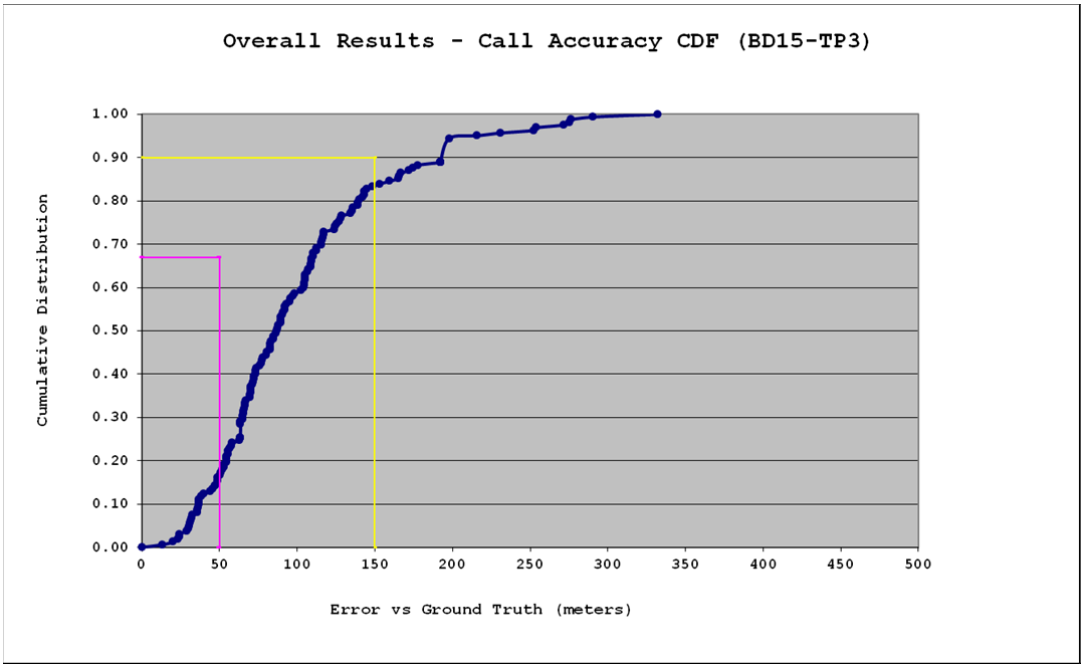
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD15_TP1	Number of Calls	3	143	4	0	1	0	0	0	151
	Percentage	2.0%	94.7%	2.6%	0.0%	0.7%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD15_TP2	Number of Calls	19	48	79	0	1	3	0	0	150
	Percentage	12.7%	32.0%	52.7%	0.0%	0.7%	2.0%	0.0%	0.0%	100.0%
Qualcomm_BD15_TP3	Number of Calls	16	122	20	0	4	0	0	0	162
	Percentage	9.9%	75.3%	12.3%	0.0%	2.5%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD15_TP4	Number of Calls	10	9	131	25	0	0	0	0	175
	Percentage	5.7%	5.1%	74.9%	14.3%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD15_TP5	Number of Calls	8	17	24	0	2	0	5	0	56
	Percentage	14.3%	30.4%	42.9%	0.0%	3.6%	0.0%	8.9%	0.0%	100.0%
Qualcomm_BD15_TP6	Number of Calls	7	160	3	0	2	0	2	0	174
	Percentage	4.0%	92.0%	1.7%	0.0%	1.1%	0.0%	1.1%	0.0%	100.0%

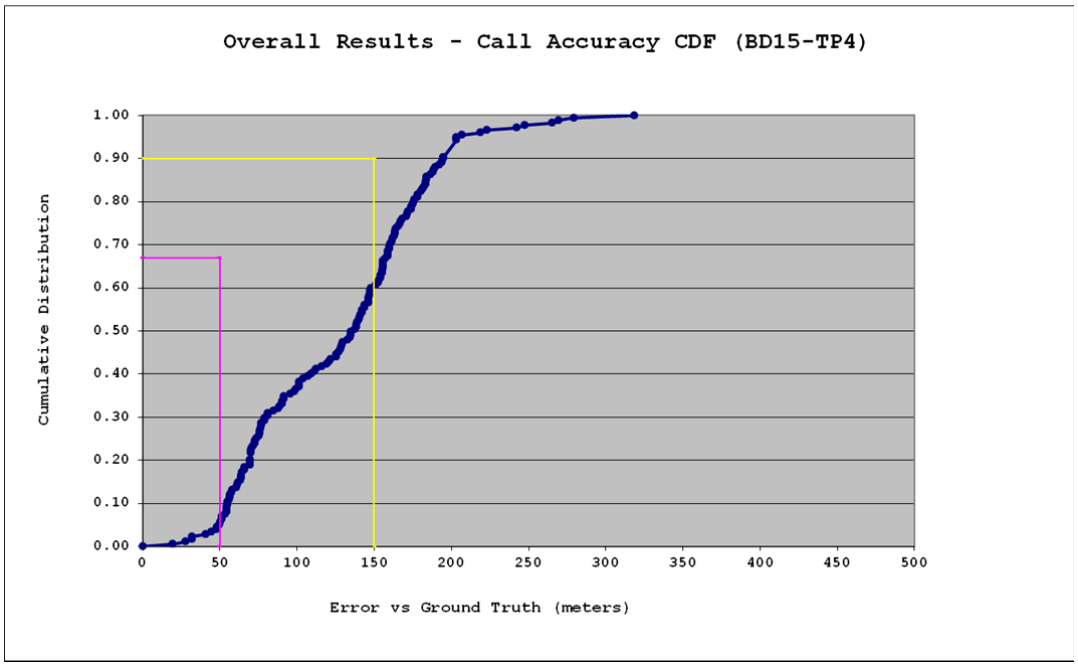
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD15_TP1	31.15	2.80	40.00	16.00
Qualcomm_BD15_TP2	29.64	6.87	51.00	19.00
Qualcomm_BD15_TP3	32.07	5.89	67.00	18.00
Qualcomm_BD15_TP4	25.68	4.81	67.00	18.00
Qualcomm_BD15_TP5	28.80	7.76	46.00	18.00
Qualcomm_BD15_TP6	31.95	3.80	55.00	18.00

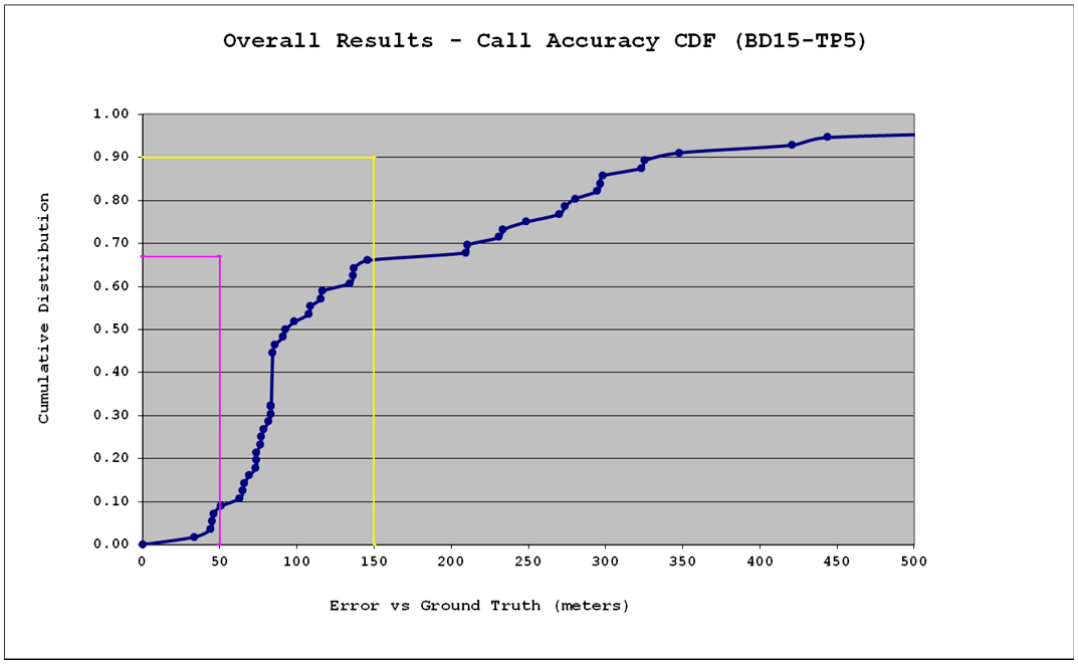
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD15_TP1	151	144	95.36%
Qualcomm_BD15_TP2	150	149	99.33%
Qualcomm_BD15_TP3	162	162	100.00%
Qualcomm_BD15_TP4	175	166	94.86%
Qualcomm_BD15_TP5	56	53	94.64%
Qualcomm_BD15_TP6	174	174	100.00%

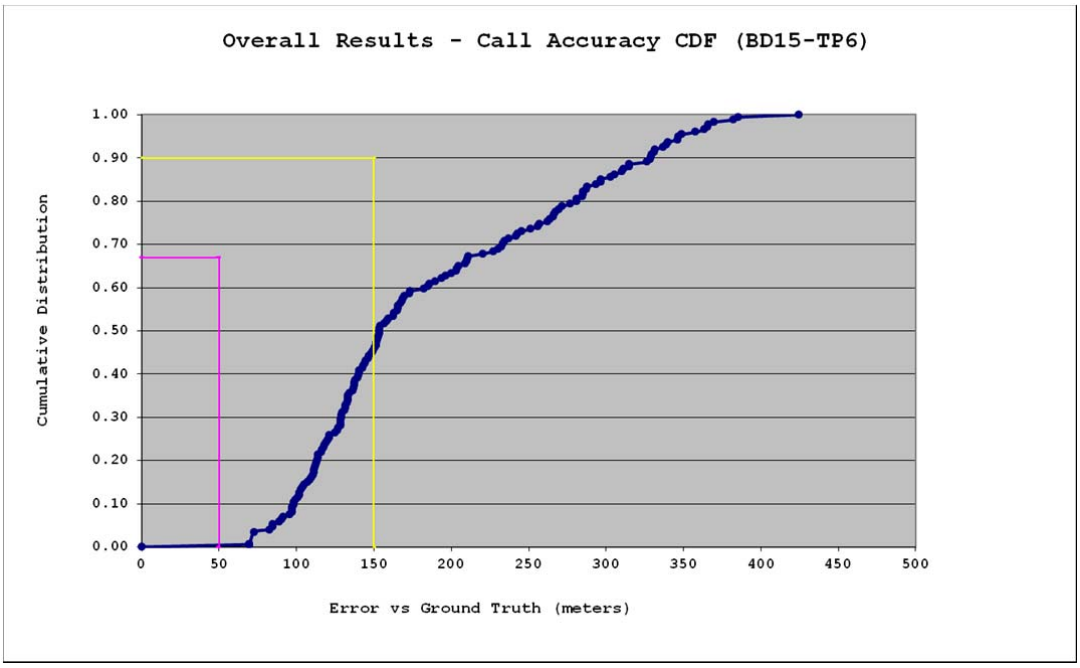


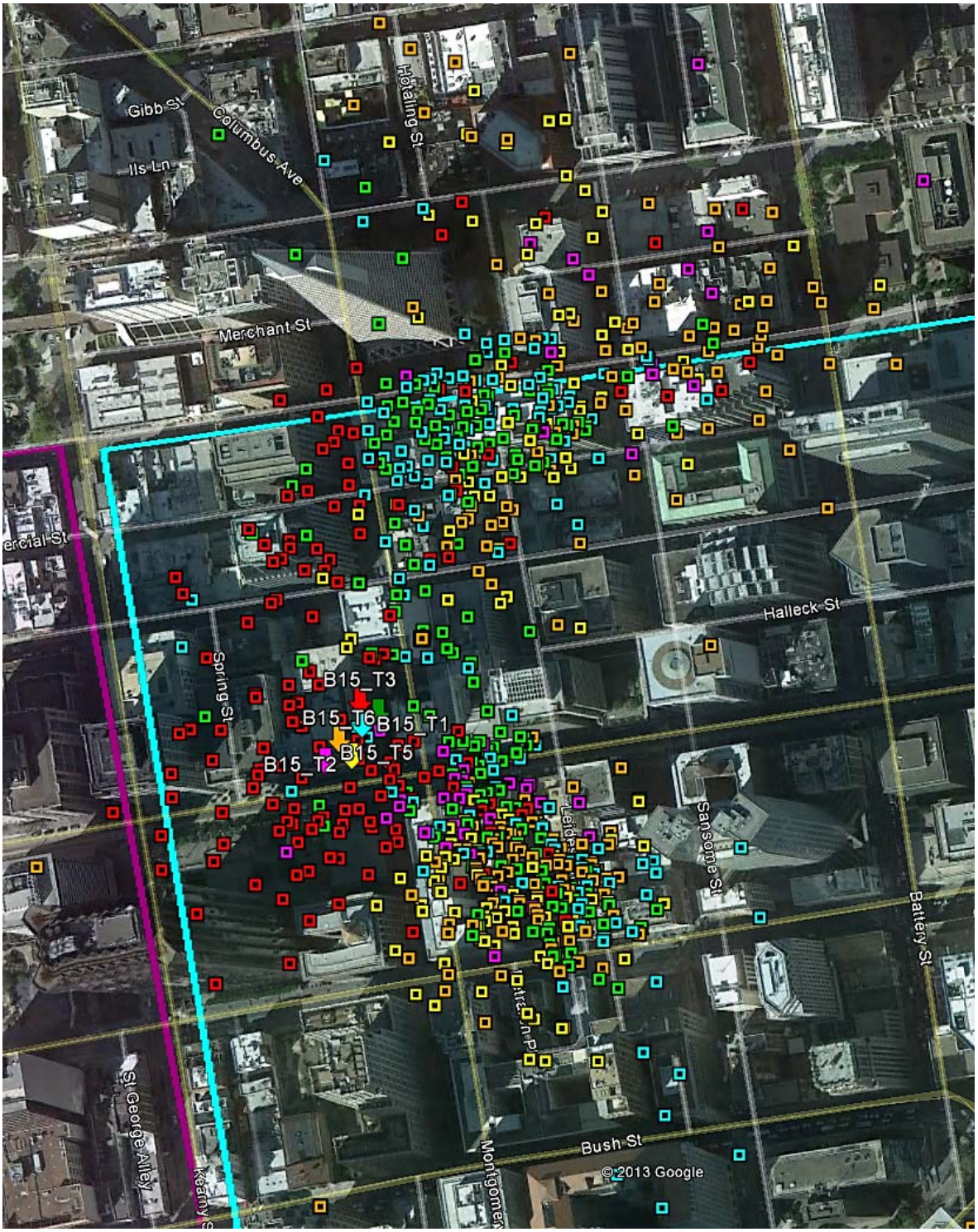



Overall Results - Call Accuracy CDF (BD15-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD15-TP6)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



6.3.1.6 Building 16:

6.3.1.6.1 Building 16 Environment and Test Points:

Building 16 is One Embarcadero Center, SF, which is one of a group of four high rise buildings in that commercial center. One Embarcadero is the furthest west. It's surrounded with high rises more on its

south than north side. It towers above the buildings in its immediate vicinity. This is particularly significant here because two test point were on the 42 floor, which is a floor reserved for building engineering, and it is higher than the buildings immediately around it, and consequently with excellent sky visibility. That floor is also narrower than lower floors in the building.

TP1: Engineering workshop; 42 floor, many windows

TP2: 42 floor hallway; obscured windows

TP3: Office 2929; window office on 29th floor

TP4: Next to entrance lobby, under plaza roof

TP5: 3rd floor interior hallway

6.3.1.6.2 NextNav per Test Point Results—BD16:

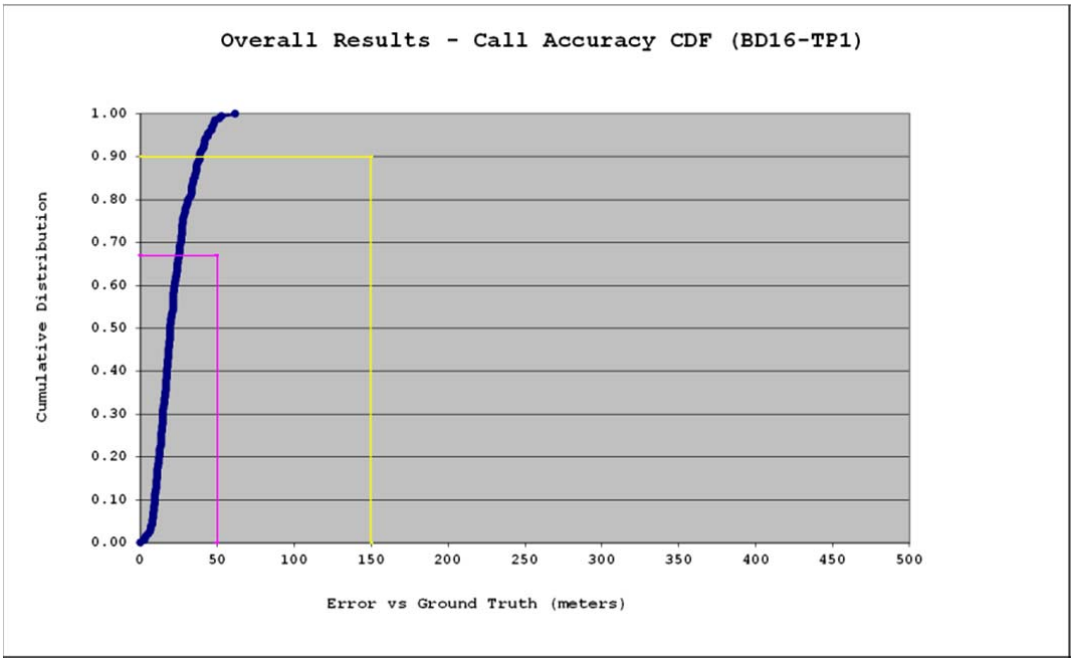
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD16_TP1	188	188	100.0%
NextNav_BD16_TP2	162	162	100.0%
NextNav_BD16_TP3	147	147	100.0%
NextNav_BD16_TP4	200	200	100.0%
NextNav_BD16_TP5	100	100	100.0%

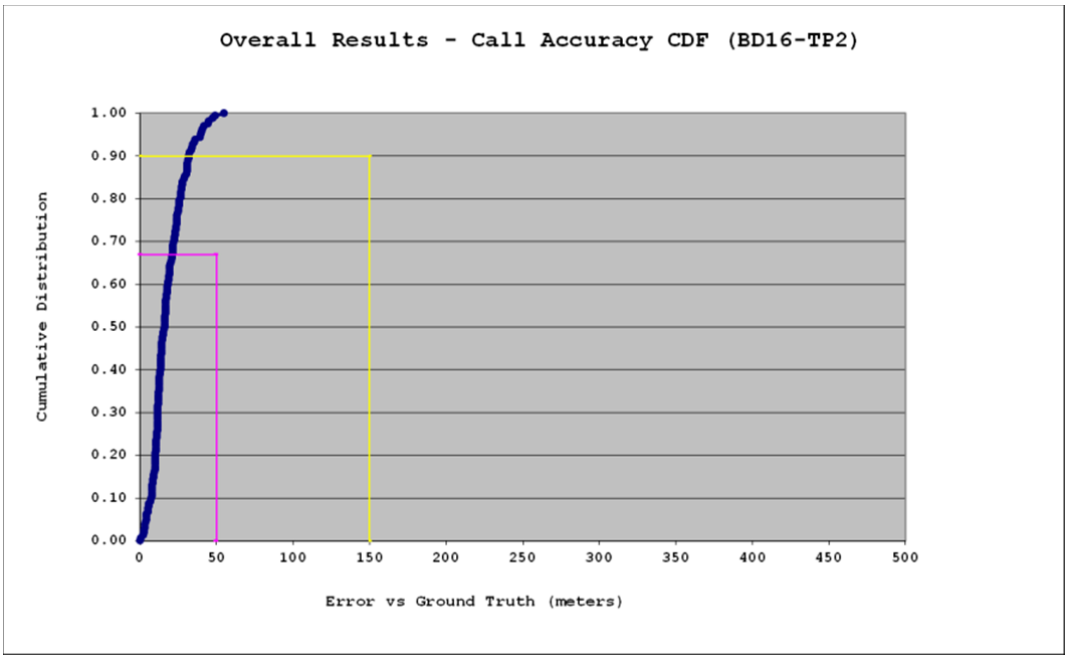
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD16_TP1	188	25.2	39.1	44.0	22.3	11.3	61.6	2.89
NextNav_BD16_TP2	162	21.4	32.3	39.8	18.4	10.5	55.2	0.64
NextNav_BD16_TP3	147	42.9	56.0	59.4	38.1	13.1	91.9	3.50
NextNav_BD16_TP4	200	72.2	112.8	124.5	69.0	31.3	236.0	5.22
NextNav_BD16_TP5	100	47.5	67.9	82.8	42.5	27.1	194.1	5.07

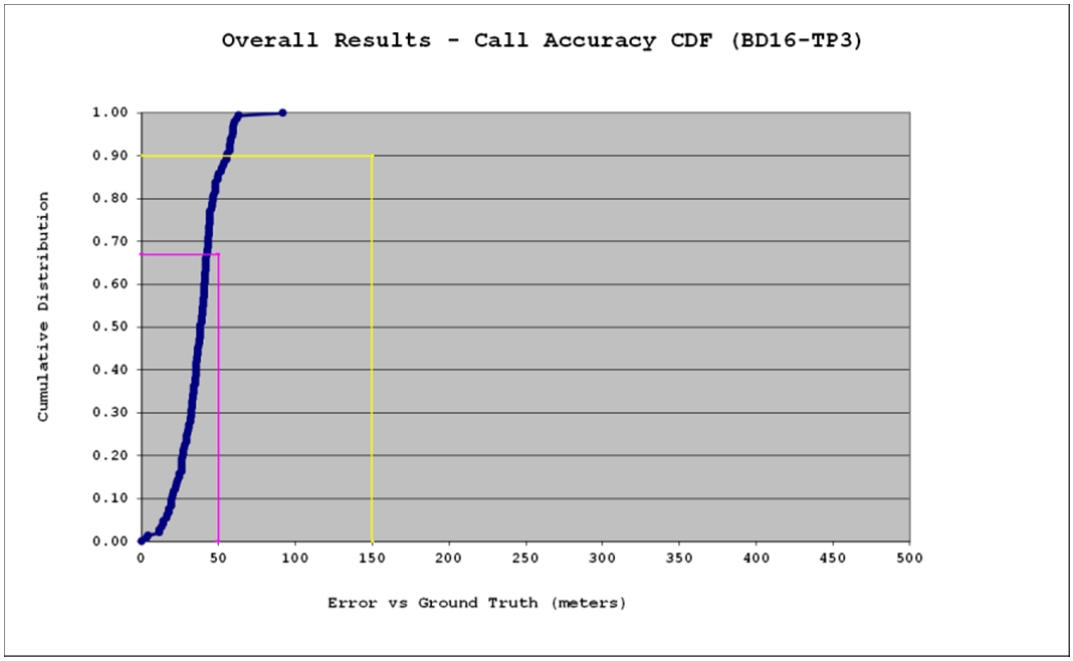
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD16_TP1	188	3.1	4.4	4.5	2.4	1.3	6.5	0.15
NextNav_BD16_TP2	162	2.7	3.4	3.7	2.4	0.8	5.0	0.60
NextNav_BD16_TP3	147	3.7	4.1	4.4	2.8	1.3	5.2	0.06
NextNav_BD16_TP4	200	2.7	3.2	3.4	2.5	0.6	5.5	0.04
NextNav_BD16_TP5	100	3.3	3.6	3.8	2.8	1.0	4.5	0.04

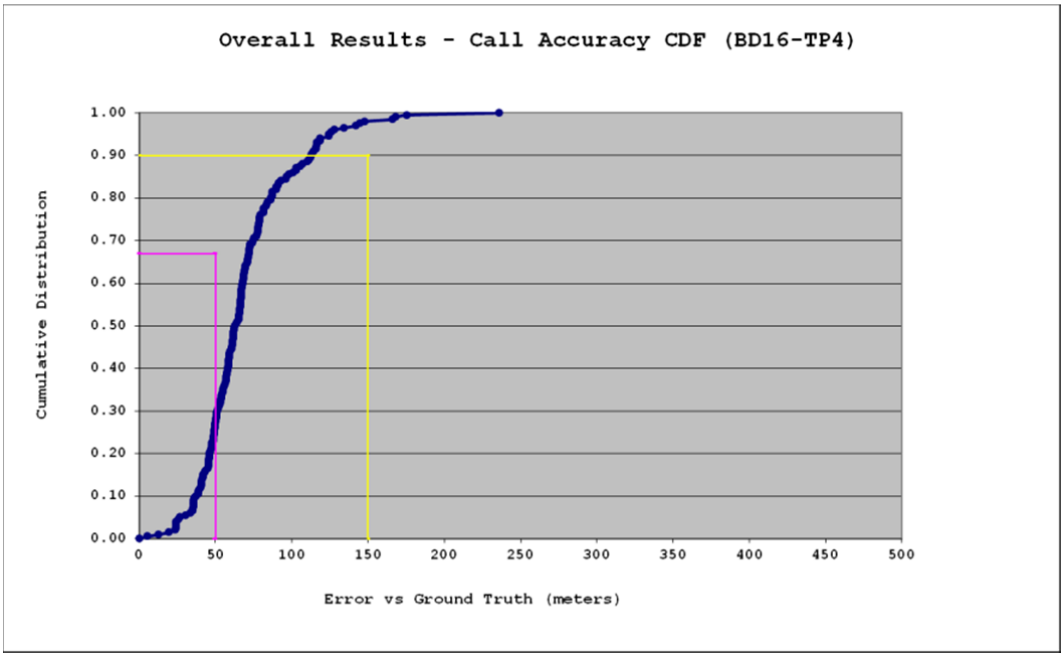
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD16_TP1	27.35	0.36	32.31	27.27
NextNav_BD16_TP2	27.33	0.05	27.75	27.27
NextNav_BD16_TP3	27.37	0.67	32.34	23.35
NextNav_BD16_TP4	27.36	0.36	32.35	27.27
NextNav_BD16_TP5	27.34	0.05	27.56	27.27

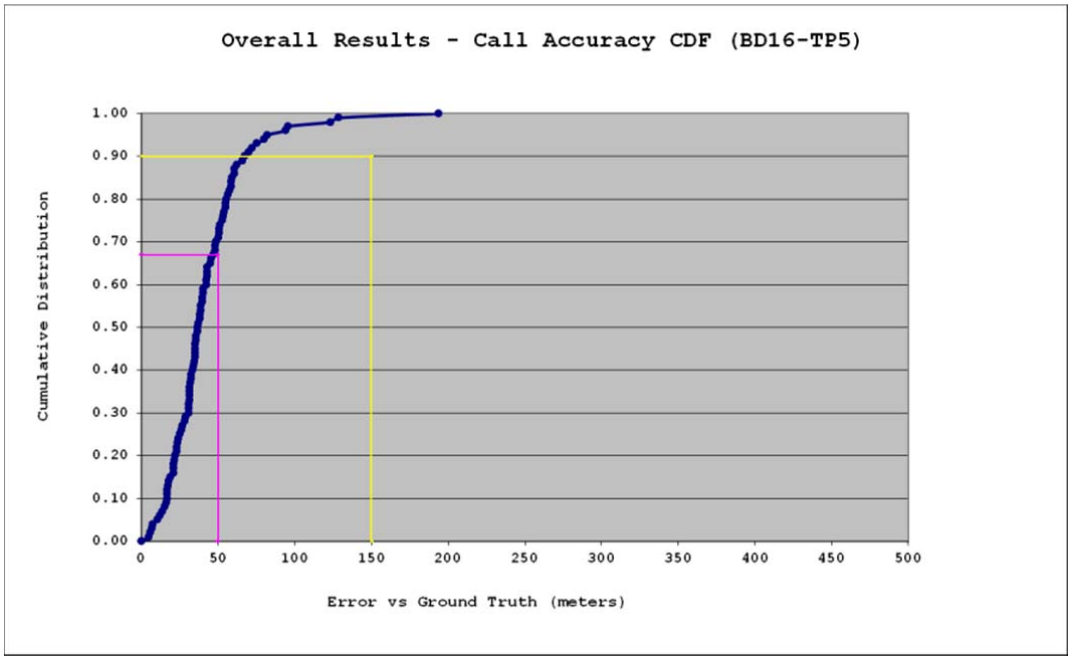
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD16_TP1	188	188	100.00%
NextNav_BD16_TP2	162	162	100.00%
NextNav_BD16_TP3	147	146	99.32%
NextNav_BD16_TP4	200	191	95.50%
NextNav_BD16_TP5	100	99	99.00%

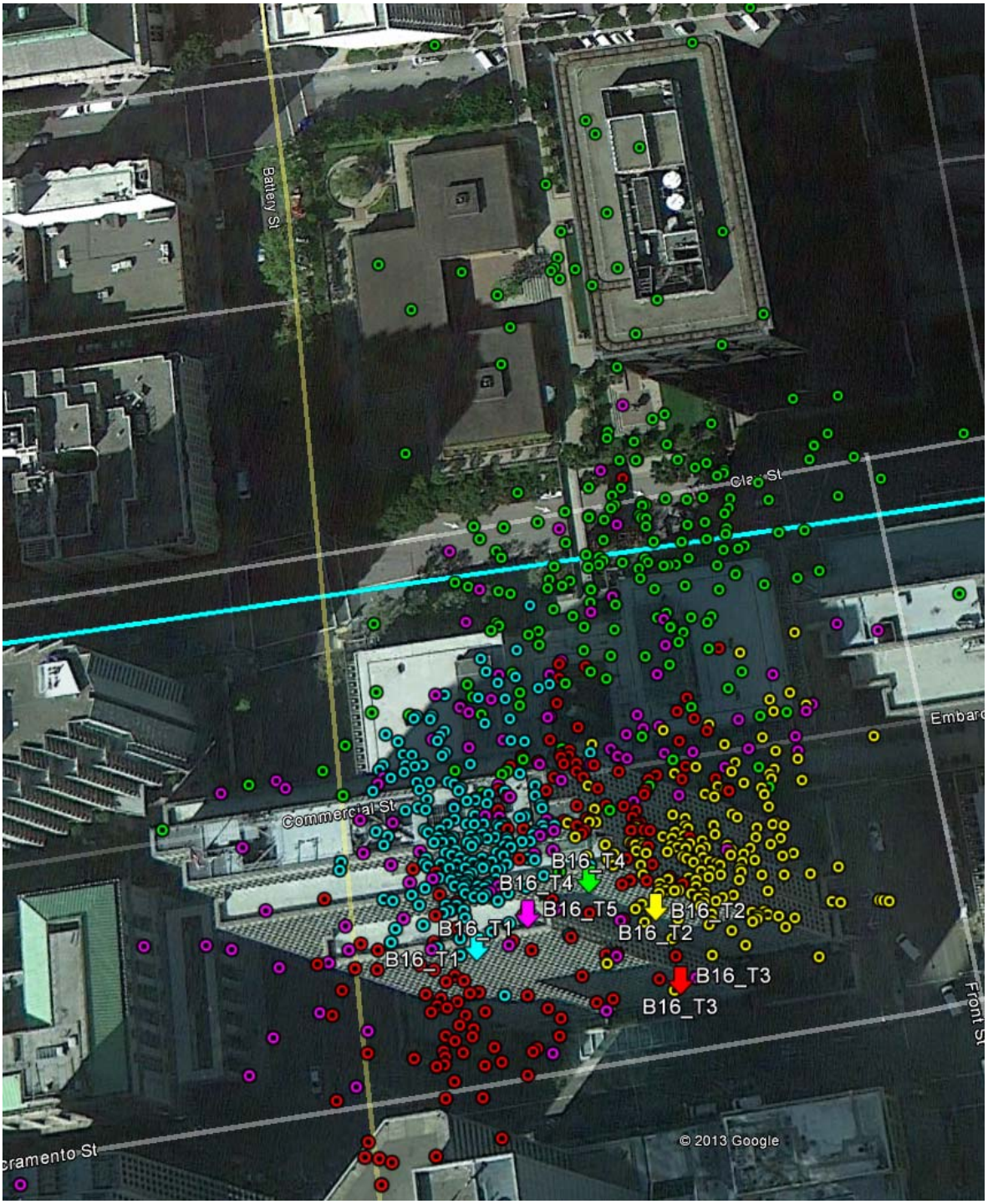

Overall Results - Call Accuracy CDF (BD16-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Battery St
Commercial St
B16_T4
B16_T4
B16_T5
B16_T2
B16_T2
B16_T1
B16_T1
B16_T3
B16_T3
© 2013 Google

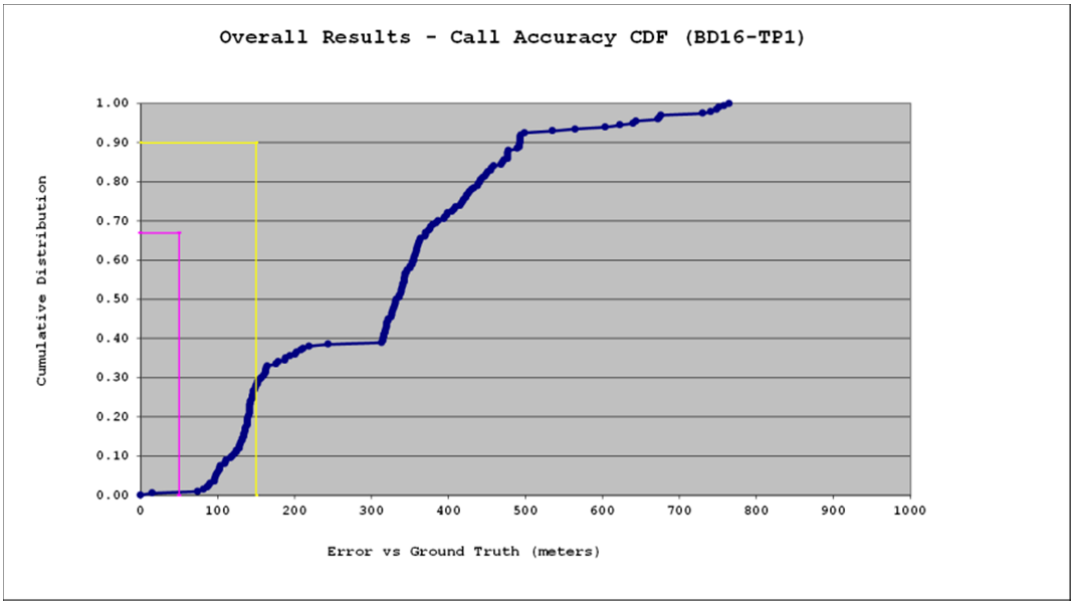
6.3.1.6.3 Polaris per Test Point Results—BD16:

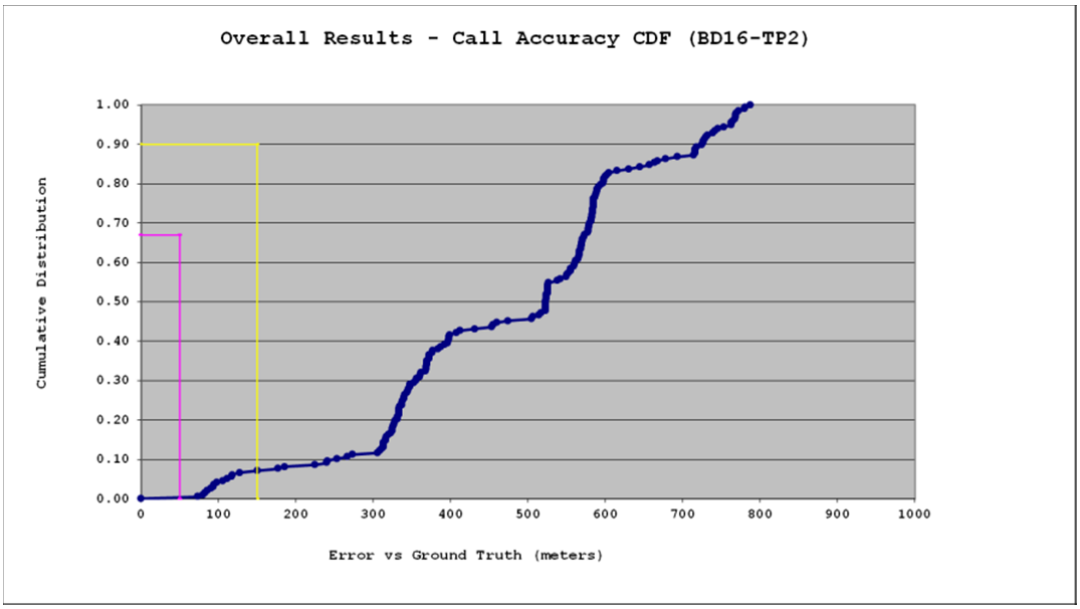
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD16_TP1	200	200	100.0%
Polaris_BD16_TP2	200	197	98.5%
Polaris_BD16_TP3	200	200	100.0%
Polaris_BD16_TP4	156	156	100.0%
Polaris_BD16_TP5	199	199	100.0%

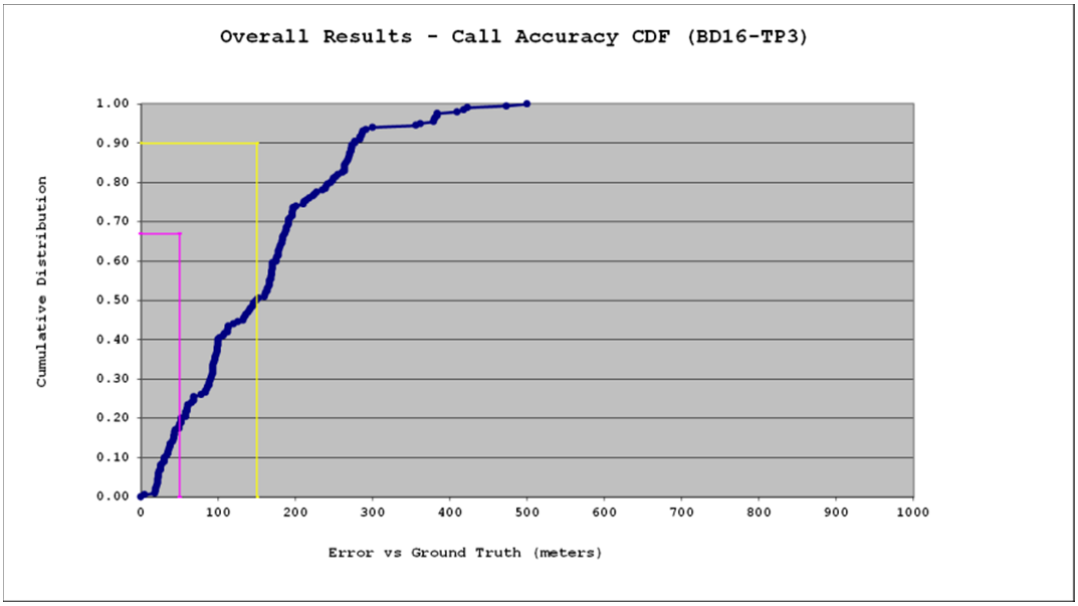
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD16_TP1	200	371.7	493.0	639.9	313.1	165.4	764.9	15.15
Polaris_BD16_TP2	197	574.1	725.1	762.4	474.5	178.7	787.0	73.14
Polaris_BD16_TP3	200	186.6	276.9	362.5	154.9	102.1	499.5	4.35
Polaris_BD16_TP4	156	121.6	177.4	183.1	110.1	37.6	186.6	27.60
Polaris_BD16_TP5	199	82.9	142.5	190.3	85.5	37.8	230.7	40.11

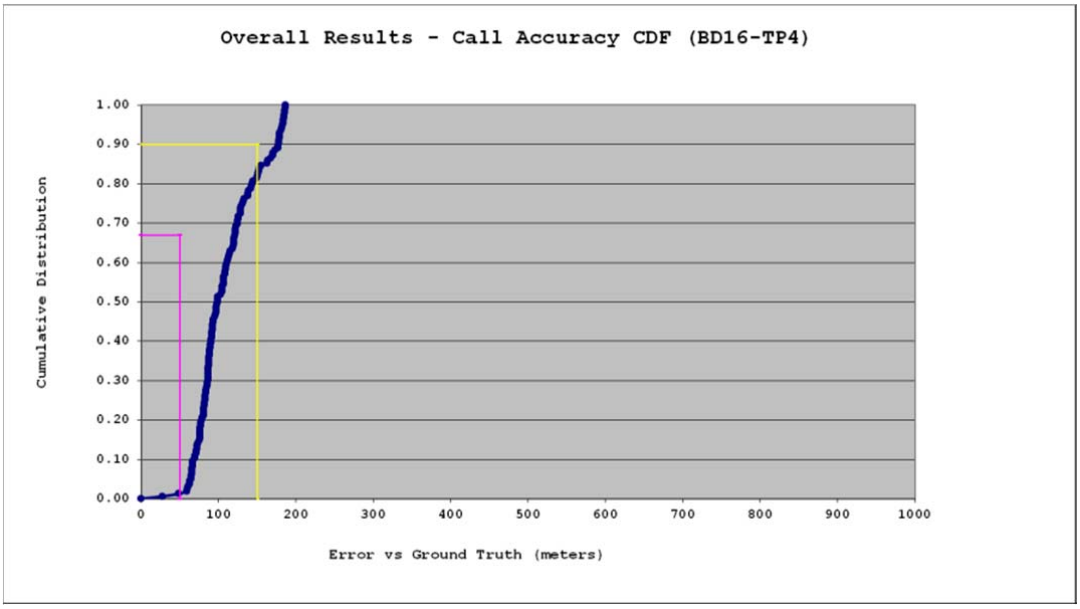
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD16_TP1	24.67	1.81	26.54	17.88
Polaris_BD16_TP2	24.62	1.34	27.61	19.35
Polaris_BD16_TP3	24.36	1.24	26.13	20.32
Polaris_BD16_TP4	24.53	0.99	26.47	21.73
Polaris_BD16_TP5	24.52	0.96	26.49	20.77

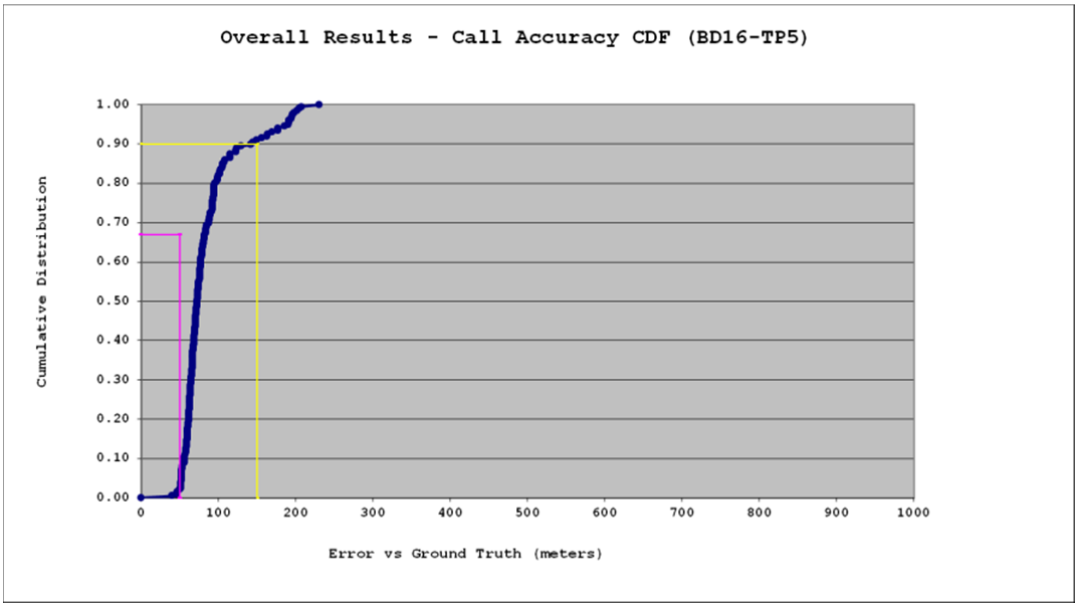
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD16_TP1	200	63	31.50%
Polaris_BD16_TP2	197	29	14.72%
Polaris_BD16_TP3	200	145	72.50%
Polaris_BD16_TP4	156	132	84.62%
Polaris_BD16_TP5	199	178	89.45%


Overall Results - Call Accuracy CDF (BD16-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)

6.3.1.6.4 Qualcomm per Test Point Results—BD16:

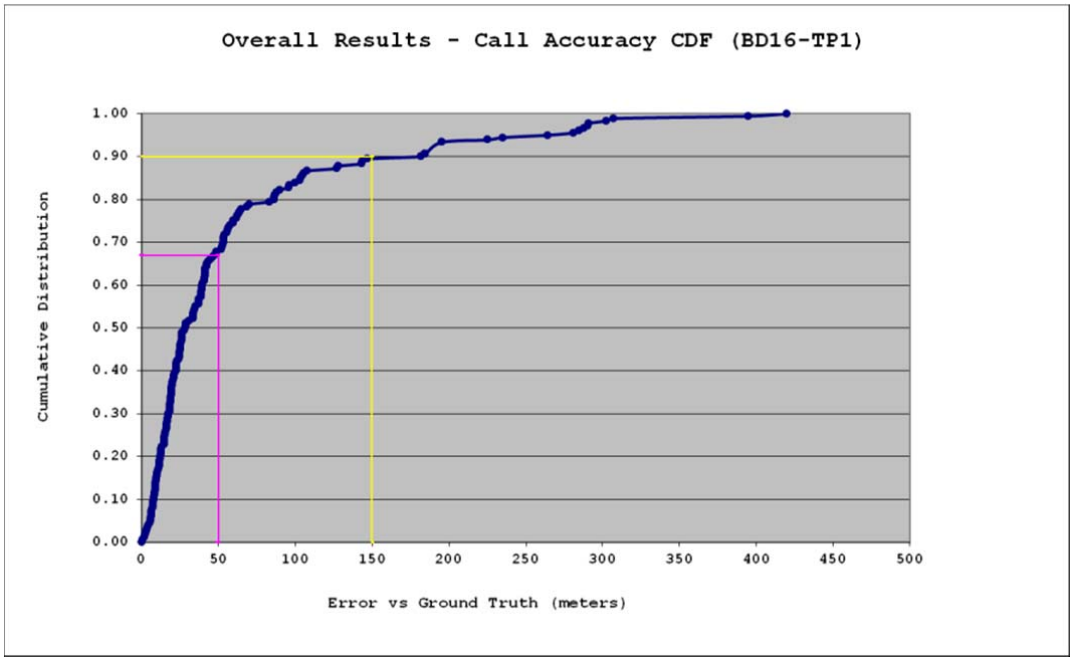
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD16_TP1	**180**	**180**	**100.0%**
Qualcomm_BD16_TP2	**180**	**179**	**99.4%**
Qualcomm_BD16_TP3	**180**	**138**	**76.7%**
Qualcomm_BD16_TP4	**180**	**147**	**81.7%**
Qualcomm_BD16_TP5	**180**	**79**	**43.9%**

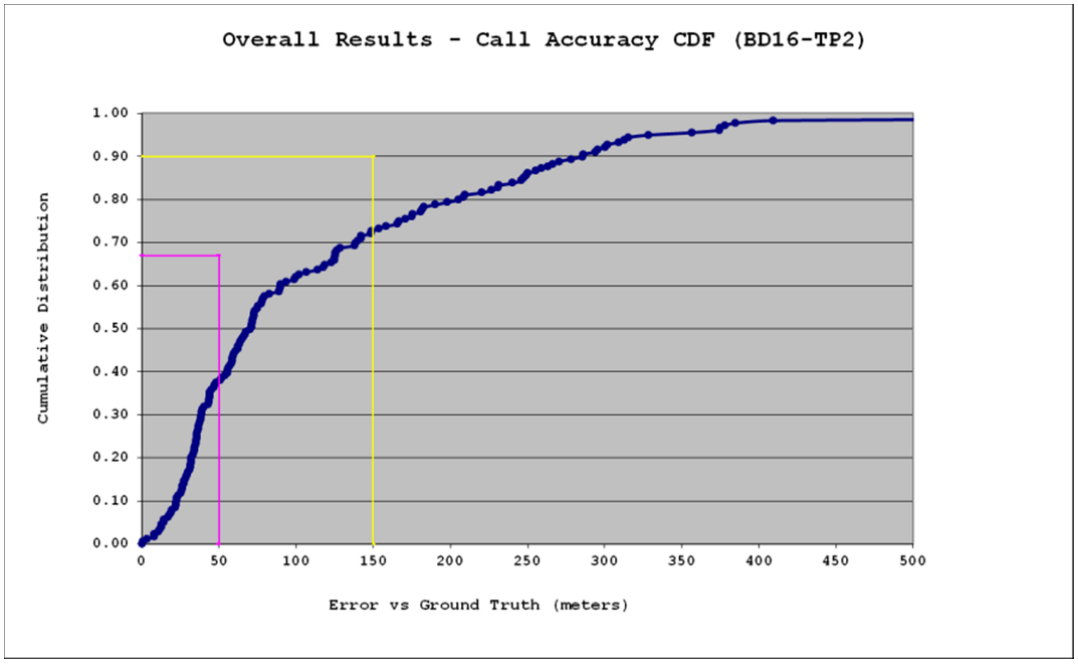
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD16_TP1	180	47.9	182.0	265.3	59.4	77.7	419.8	0.82
Qualcomm_BD16_TP2	179	125.4	285.9	331.6	119.3	123.2	707.3	0.53
Qualcomm_BD16_TP3	138	145.6	196.2	220.7	113.7	65.6	324.9	12.35
Qualcomm_BD16_TP4	147	103.7	144.0	177.3	82.6	54.9	252.2	8.93
Qualcomm_BD16_TP5	79	183.5	213.9	228.7	161.0	61.4	353.0	18.13

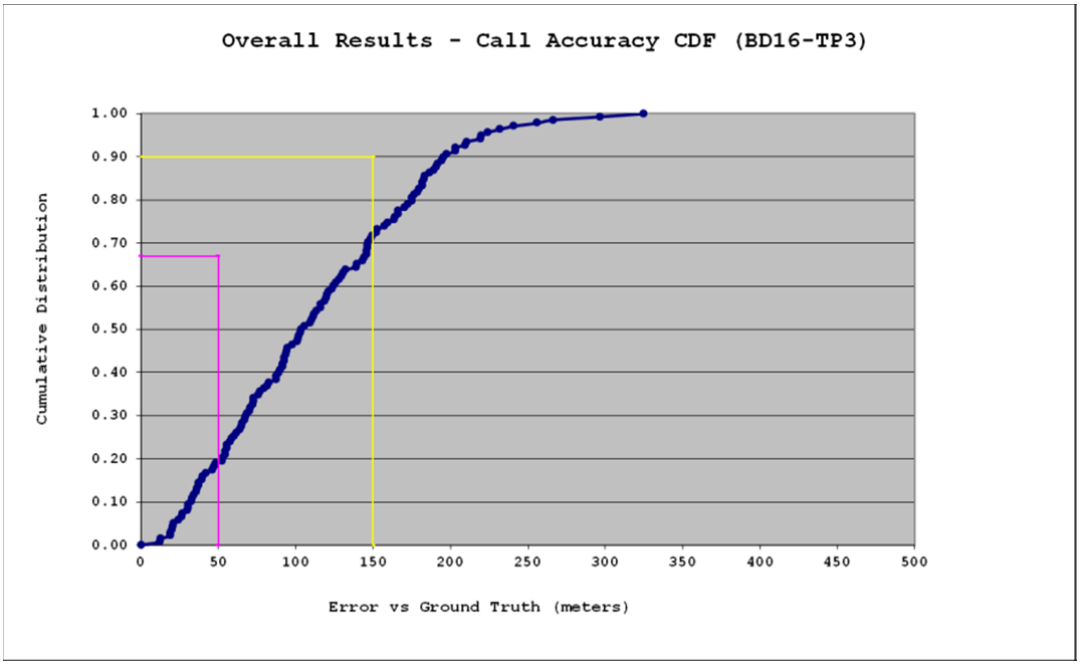
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD16_TP1	Number of Calls	8	2	19	151	0	0	0	0	180
	Percentage	4.4%	1.1%	10.6%	83.9%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD16_TP2	Number of Calls	4	5	73	97	0	0	0	0	179
	Percentage	2.2%	2.8%	40.8%	54.2%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD16_TP3	Number of Calls	2	1	85	50	0	0	0	0	138
	Percentage	1.4%	0.7%	61.6%	36.2%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD16_TP4	Number of Calls	3	1	86	56	1	0	0	0	147
	Percentage	2.0%	0.7%	58.5%	38.1%	0.7%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD16_TP5	Number of Calls	0	60	18	0	1	0	0	0	79
	Percentage	0.0%	75.9%	22.8%	0.0%	1.3%	0.0%	0.0%	0.0%	100.0%

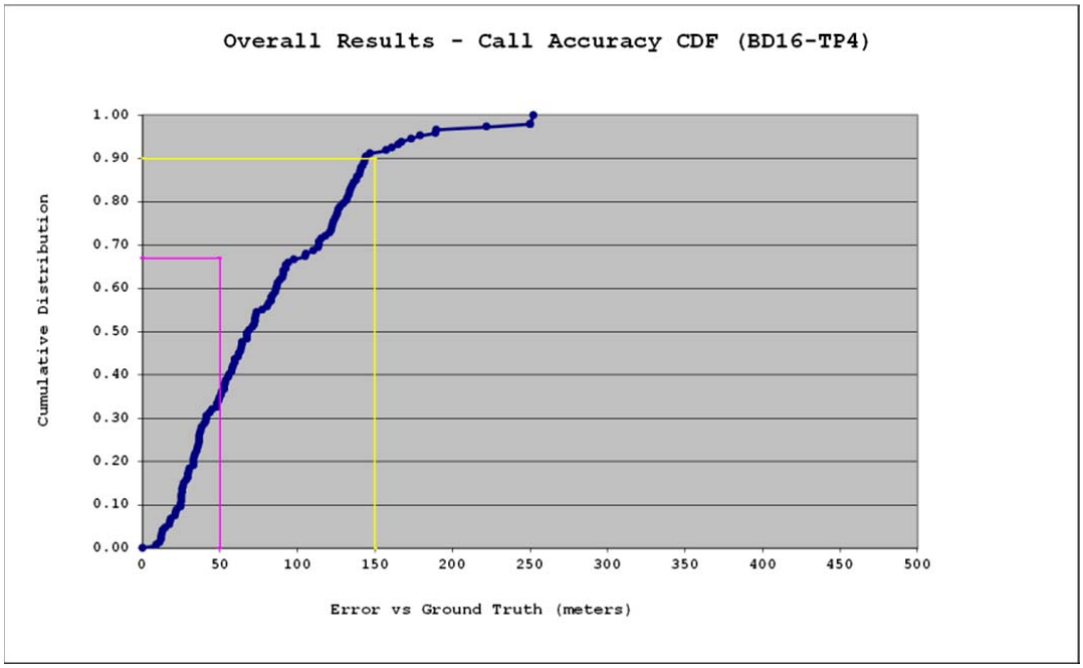
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD16_TP1	25.13	3.06	45.00	17.00
Qualcomm_BD16_TP2	25.68	3.06	47.00	17.00
Qualcomm_BD16_TP3	25.28	1.86	43.00	19.00
Qualcomm_BD16_TP4	25.22	2.60	47.00	17.00
Qualcomm_BD16_TP5	29.00	3.27	33.00	24.00

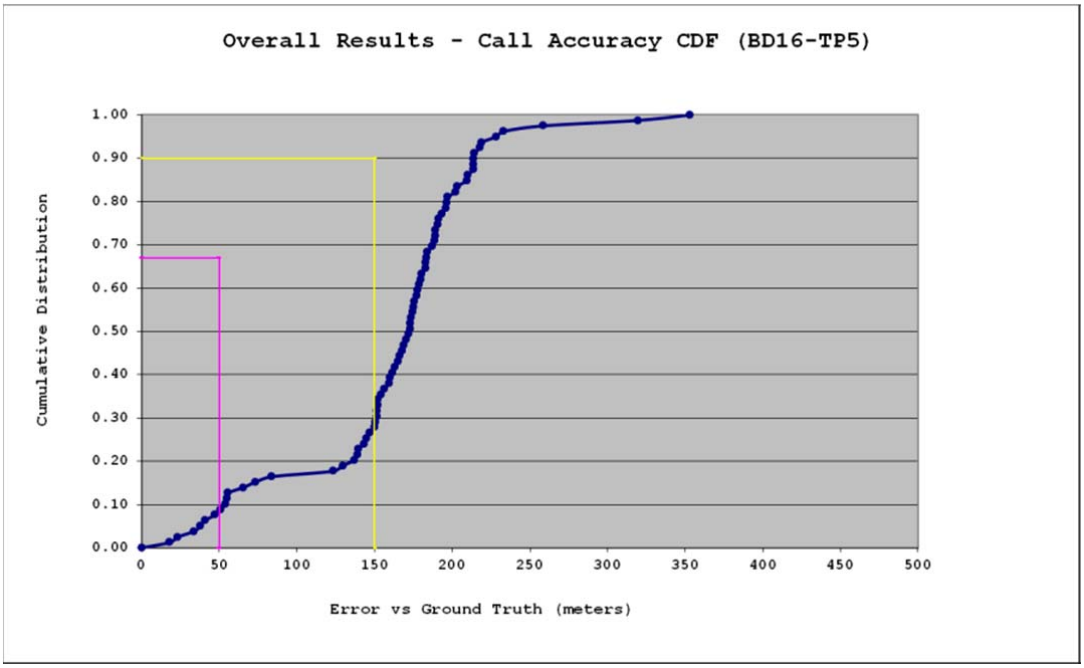
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD16_TP1	180	155	86.11%
Qualcomm_BD16_TP2	179	140	78.21%
Qualcomm_BD16_TP3	138	125	90.58%
Qualcomm_BD16_TP4	147	136	92.52%
Qualcomm_BD16_TP5	79	74	93.67%


Overall Results - Call Accuracy CDF (BD16-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD16-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

6.3.2 Urban Buildings

6.3.2.1 Building 4:

6.3.2.1.1 Building 4 Environment and Test Points:

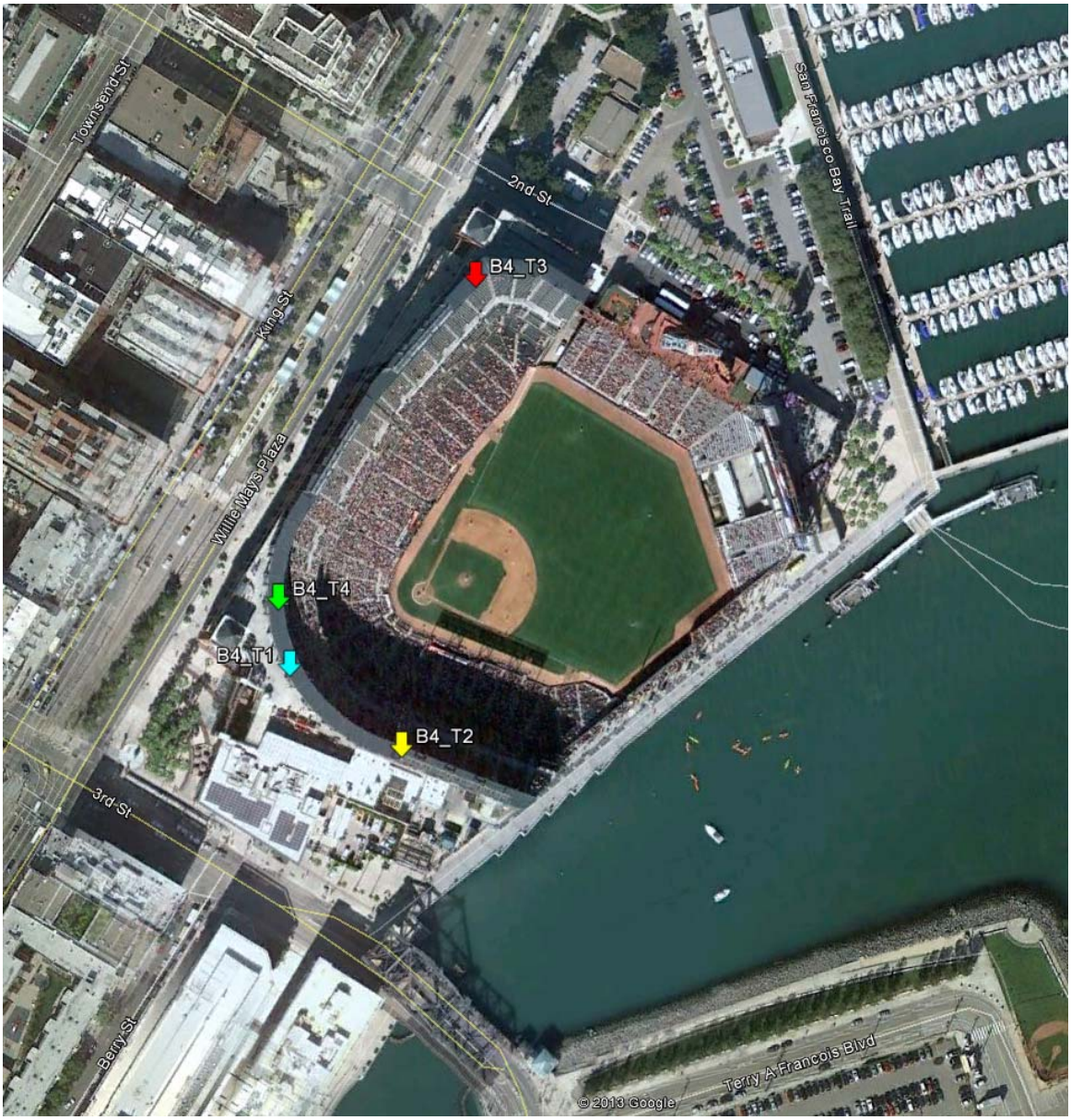
Building 4 is AT&T Park, a baseball stadium, where a major league baseball team plays (the San Francisco Giants). It is located near the eastern edge of the SF peninsula creating unique propagation challenges.

TP1: In food court on club field level (deep indoors)

TP2: Promenade Level in first base area (2nd floor)

TP3: Club field level, in left foul pole area (3rd floor)

TP4: Suite level, inside a central suite (4th floor w/ window)



6.3.2.1.2 NextNav per Test Point Results—BD4:

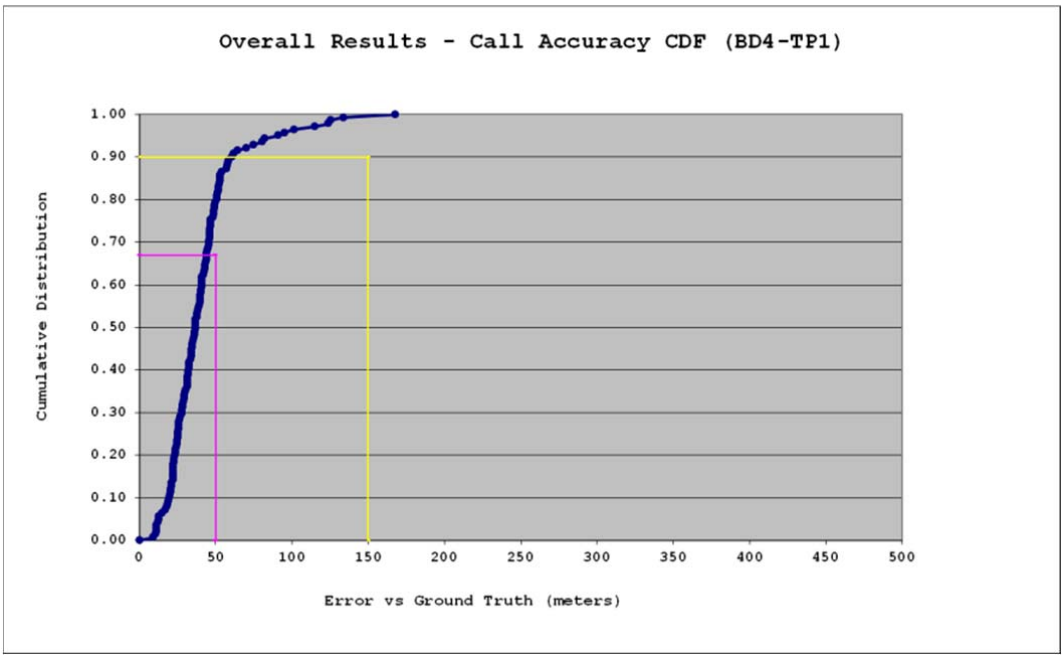
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD4_TP1	**141**	**141**	**100.0%**
NextNav_BD4_TP2	**169**	**167**	**98.8%**
NextNav_BD4_TP3	**184**	**184**	**100.0%**
NextNav_BD4_TP4	**198**	**198**	**100.0%**

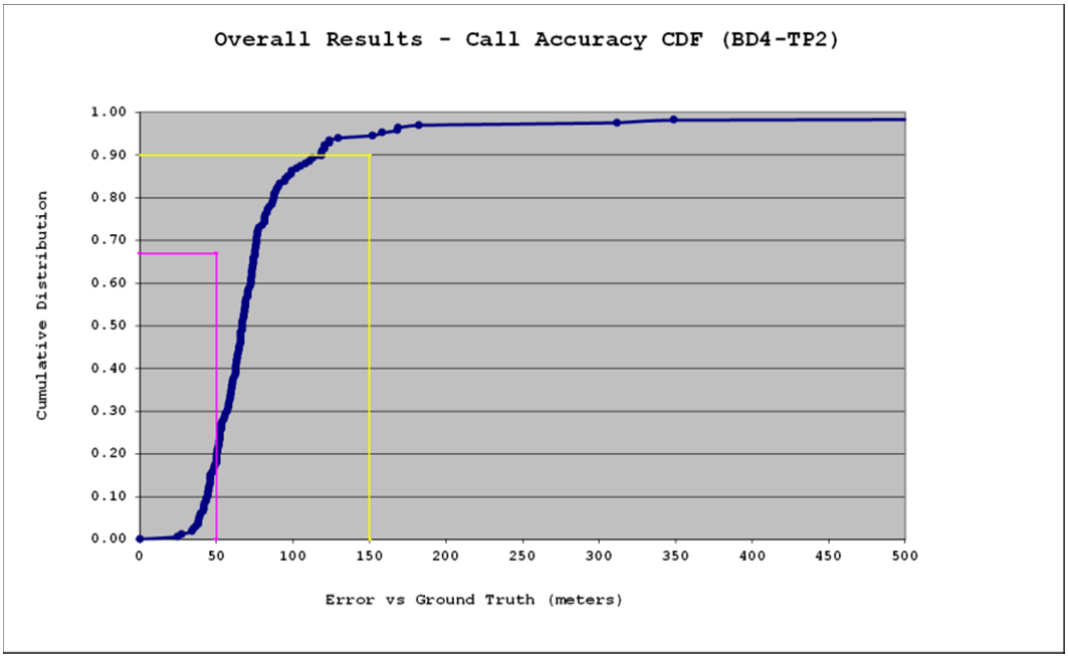
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD4_TP1	141	44.2	61.0	91.2	41.0	24.6	167.7	9.33
NextNav_BD4_TP2	167	75.4	118.8	156.4	118.7	378.8	4367.2	24.83
NextNav_BD4_TP3	184	62.5	83.3	90.8	56.4	23.7	170.3	2.75
NextNav_BD4_TP4	198	63.6	92.3	110.8	58.9	32.6	317.8	6.23

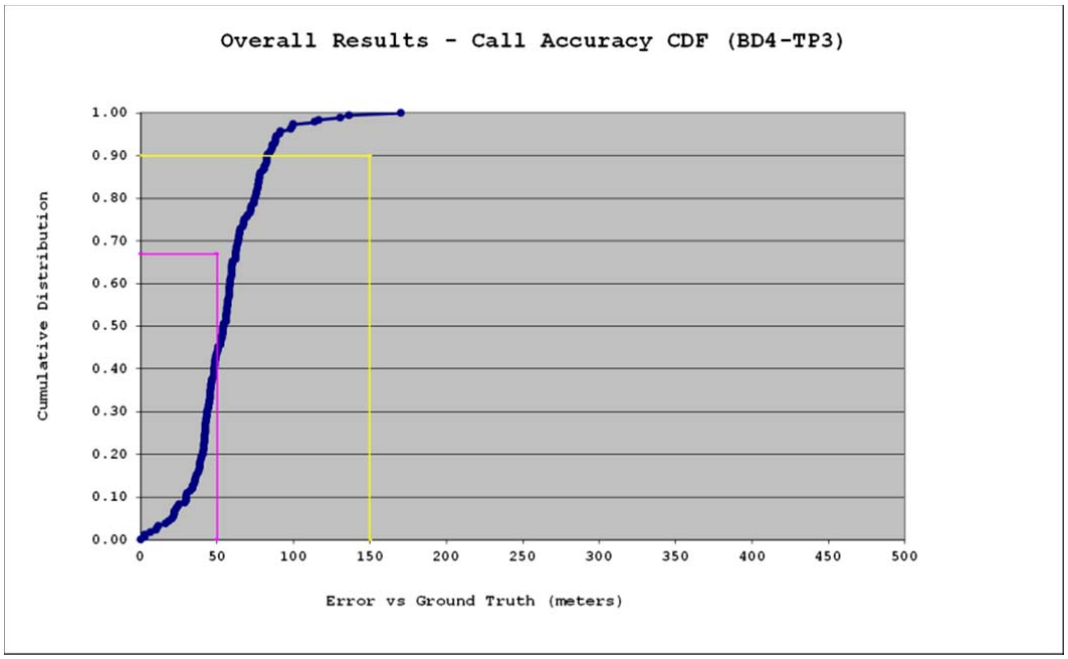
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD4_TP1	141	1.2	1.9	2.0	1.0	0.6	2.6	0.03
NextNav_BD4_TP2	167	1.4	2.4	3.3	4.8	18.6	112.7	0.09
NextNav_BD4_TP3	184	2.3	3.0	3.2	1.4	1.1	3.5	0.04
NextNav_BD4_TP4	198	3.3	3.9	117.2	11.2	38.6	193.5	0.02

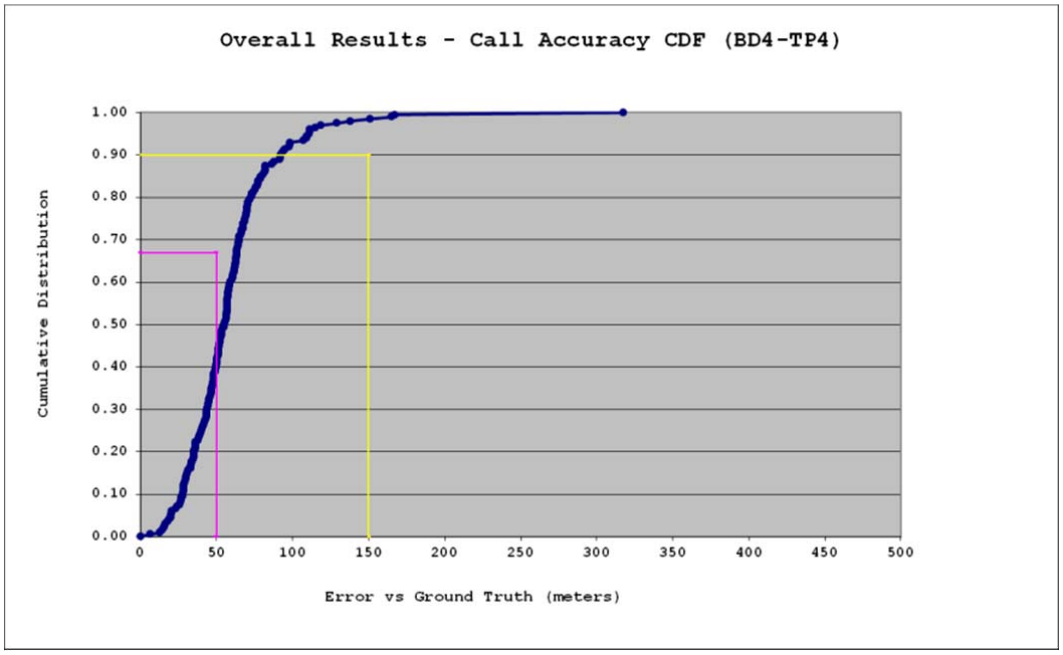
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD4_TP1	27.33	0.03	27.46	27.27
NextNav_BD4_TP2	27.45	0.77	32.36	27.27
NextNav_BD4_TP3	27.28	0.89	27.80	15.34
NextNav_BD4_TP4	27.36	0.36	32.30	27.27

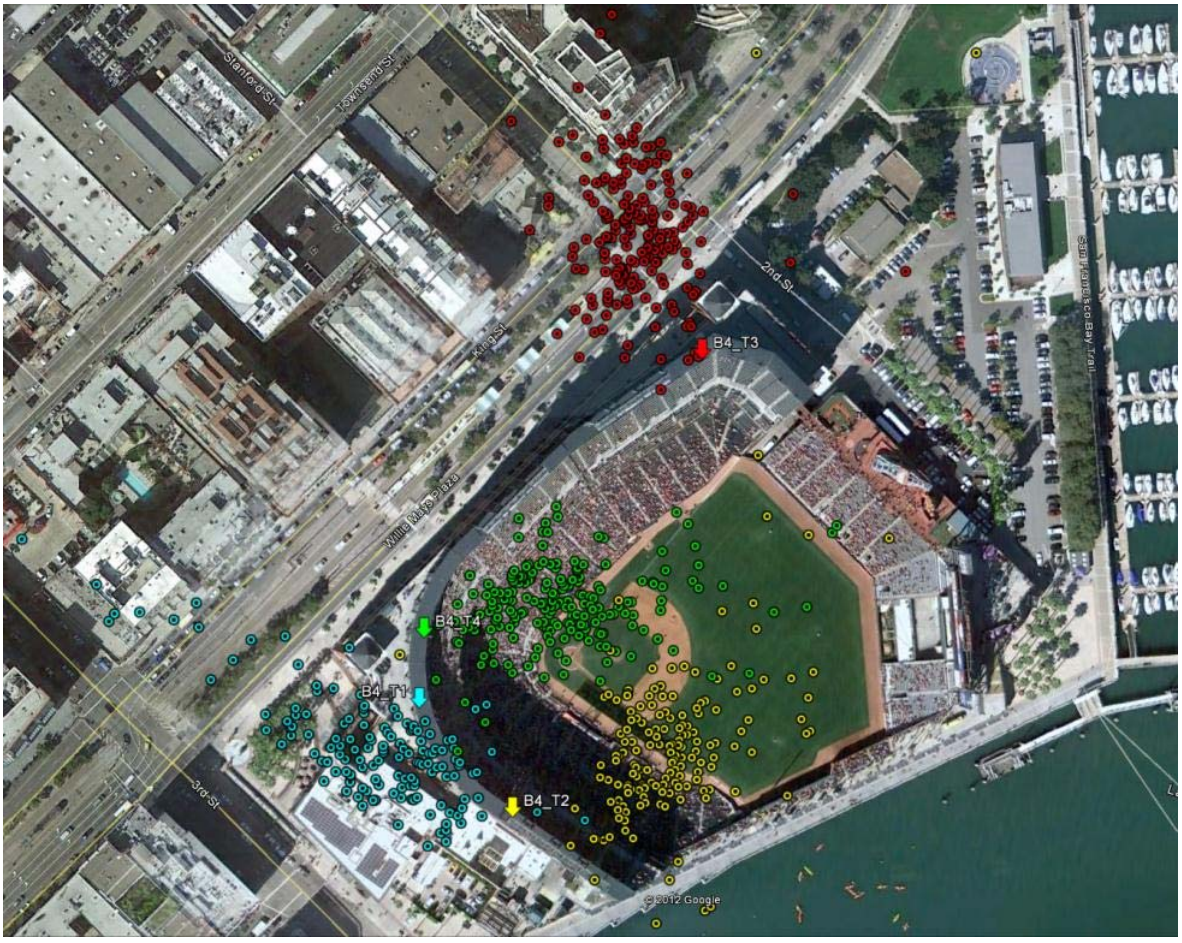
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD4_TP1	141	136	96.45%
NextNav_BD4_TP2	167	155	92.81%
NextNav_BD4_TP3	184	183	99.46%
NextNav_BD4_TP4	198	190	95.96%




Overall Results - Call Accuracy CDF (BD4-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD4-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD4-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Stanford St
Townsend St
King St
2nd St
3rd St
Willie Mays Plaza
San Francisco Bay Trail
B4_T1
B4_T2
B4_T3
B4_T4
© 2012 Google

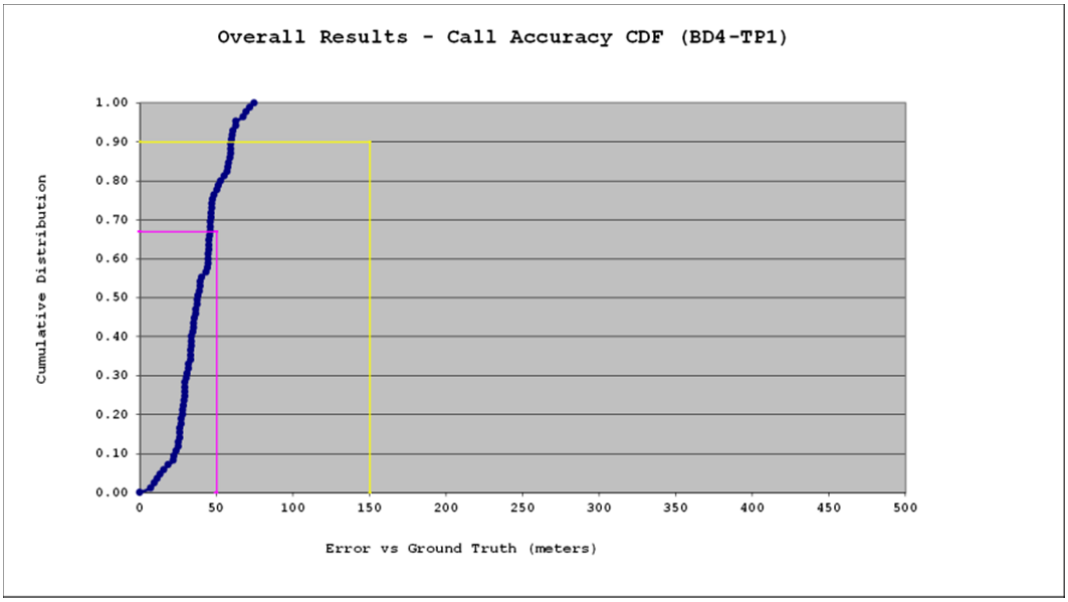
6.3.2.1.3 Polaris per Test Point Results—BD4:

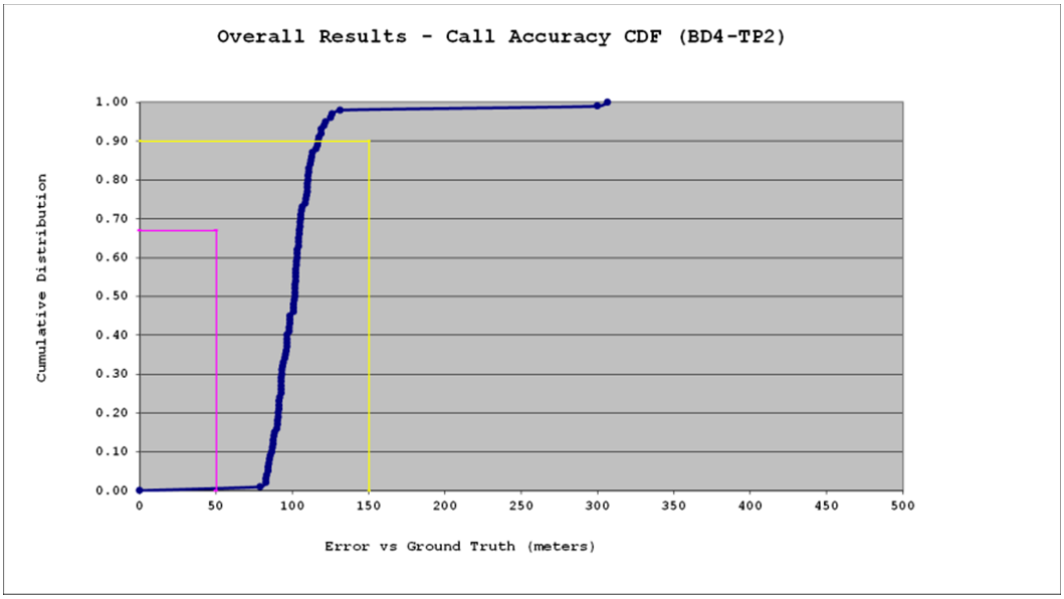
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD4_TP1	85	85	100.0%
Polaris_BD4_TP2	100	100	100.0%
Polaris_BD4_TP3	100	100	100.0%
Polaris_BD4_TP4	107	107	100.0%

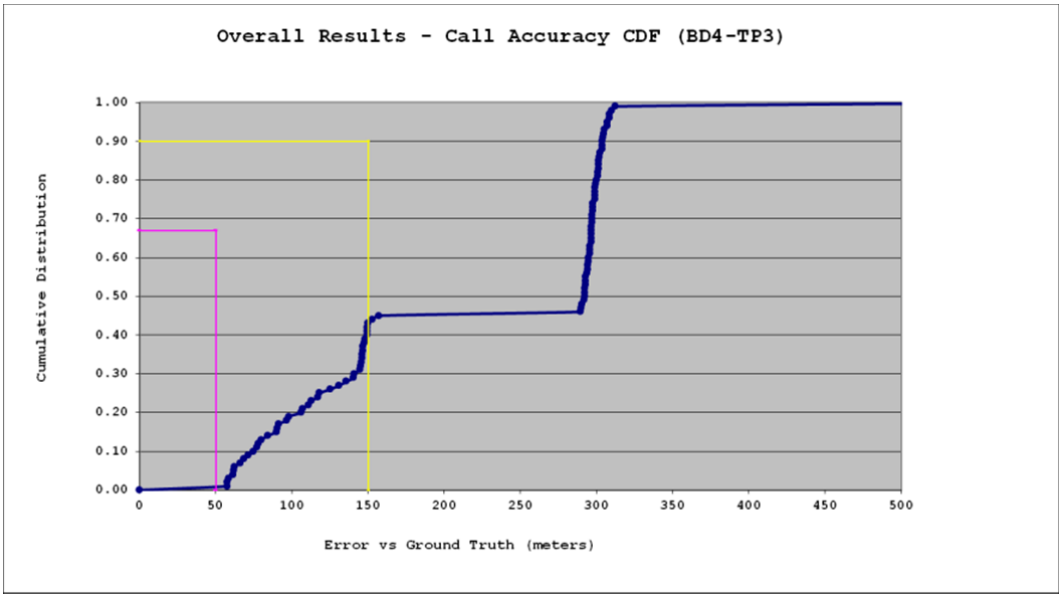
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD4_TP1	85	46.0	59.9	62.8	40.0	14.8	74.7	7.10
Polaris_BD4_TP2	100	104.9	117.2	121.9	104.8	30.5	306.5	79.08
Polaris_BD4_TP3	100	296.6	303.8	306.9	217.2	103.8	600.5	57.34
Polaris_BD4_TP4	107	121.7	300.3	431.6	125.3	163.4	1049.4	7.98

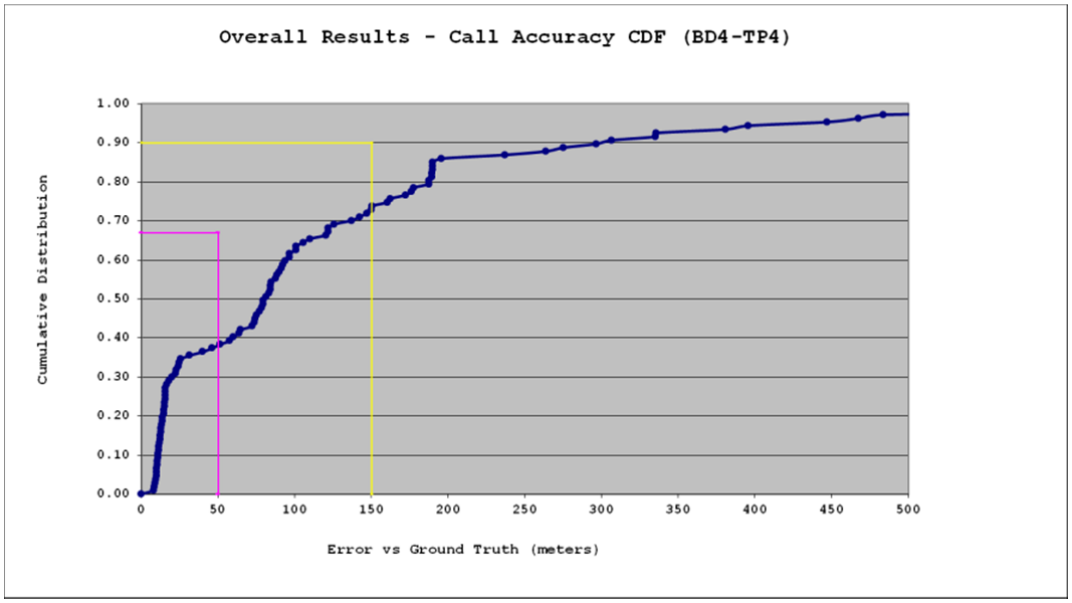
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD4_TP1	24.90	0.55	26.06	23.65
Polaris_BD4_TP2	24.57	0.81	26.32	21.25
Polaris_BD4_TP3	23.07	3.07	25.61	3.01
Polaris_BD4_TP4	23.36	2.56	27.77	4.06

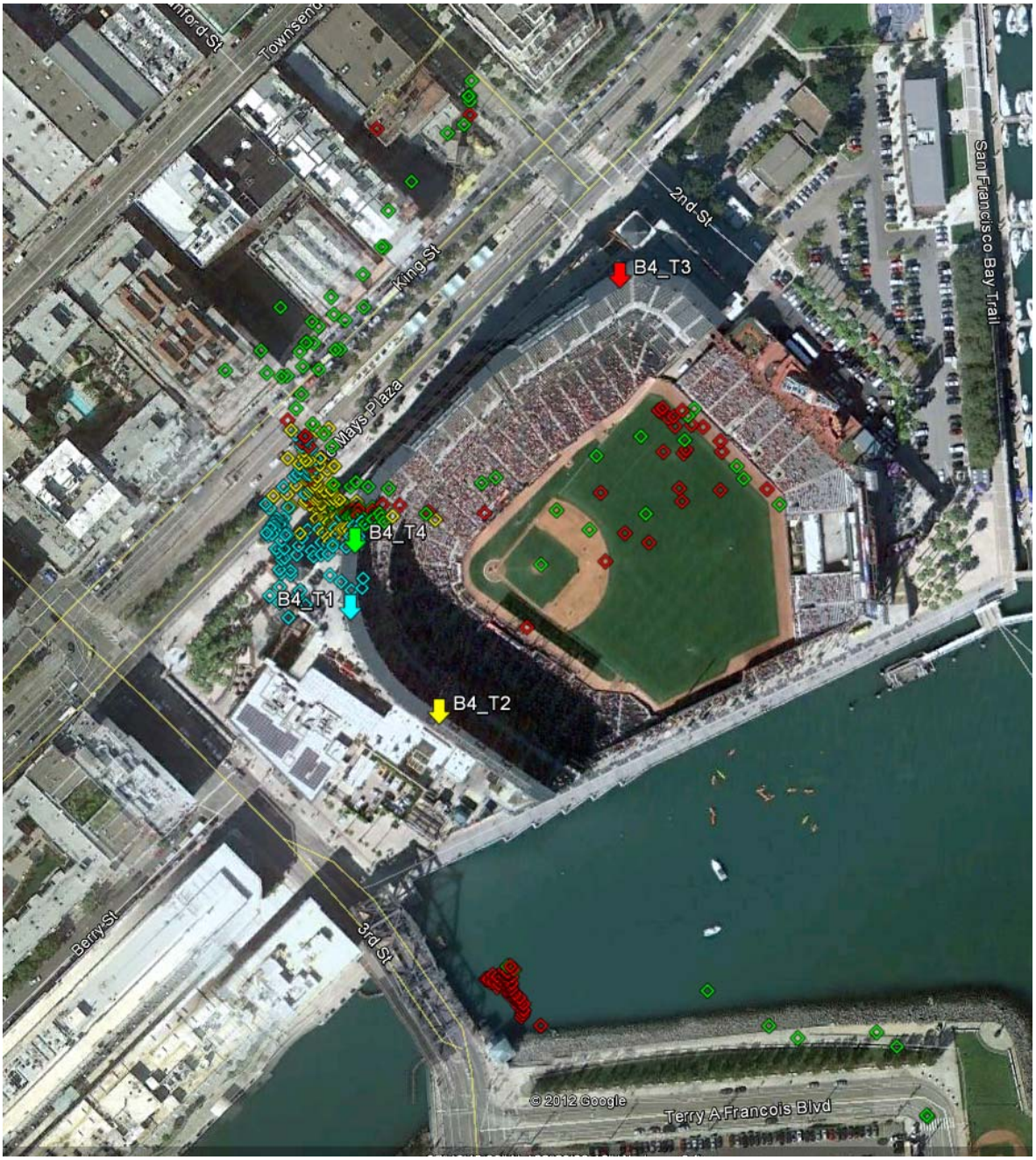
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD4_TP1	85	85	100.00%
Polaris_BD4_TP2	100	79	79.00%
Polaris_BD4_TP3	100	34	34.00%
Polaris_BD4_TP4	107	95	88.79%


Overall Results - Call Accuracy CDF (BD4-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD4-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD4-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD4-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Townsend
Mays Plaza
King St
2nd St
B4_T3
San Francisco Bay Trail
B4_T4
B4_T1
B4_T2
Berry St
3rd St
© 2012 Google
Terry A Francois Blvd

6.3.2.1.4 Qualcomm per Test Point Results—BD4

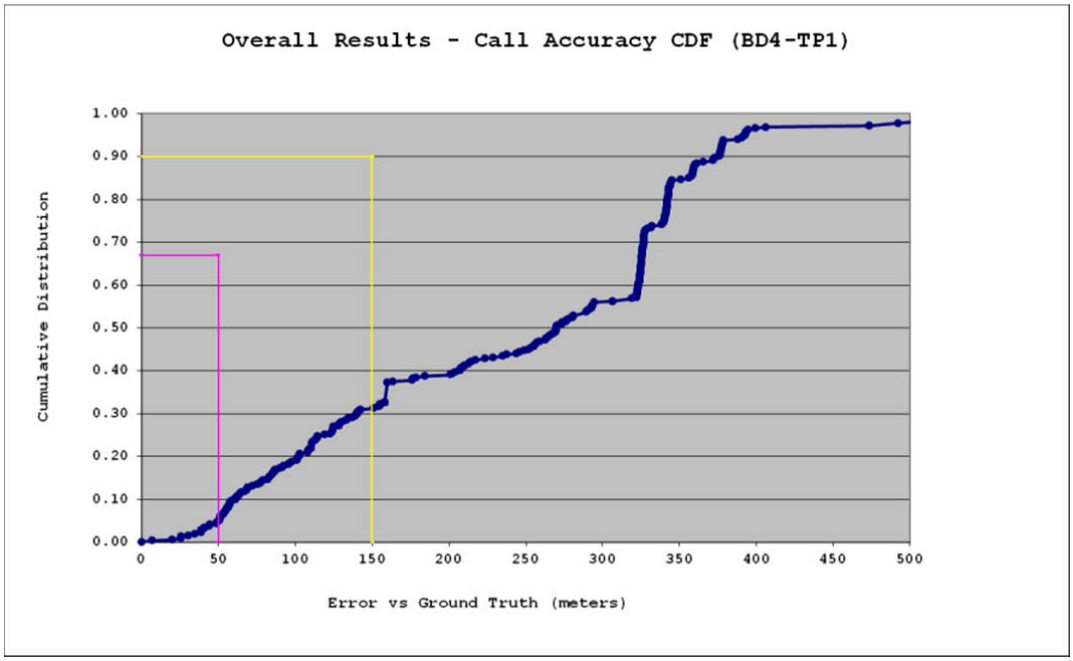
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD4_TP1	400	320	80.0%
Qualcomm_BD4_TP2	304	286	94.1%
Qualcomm_BD4_TP3	366	335	91.5%
Qualcomm_BD4_TP4	305	299	98.0%

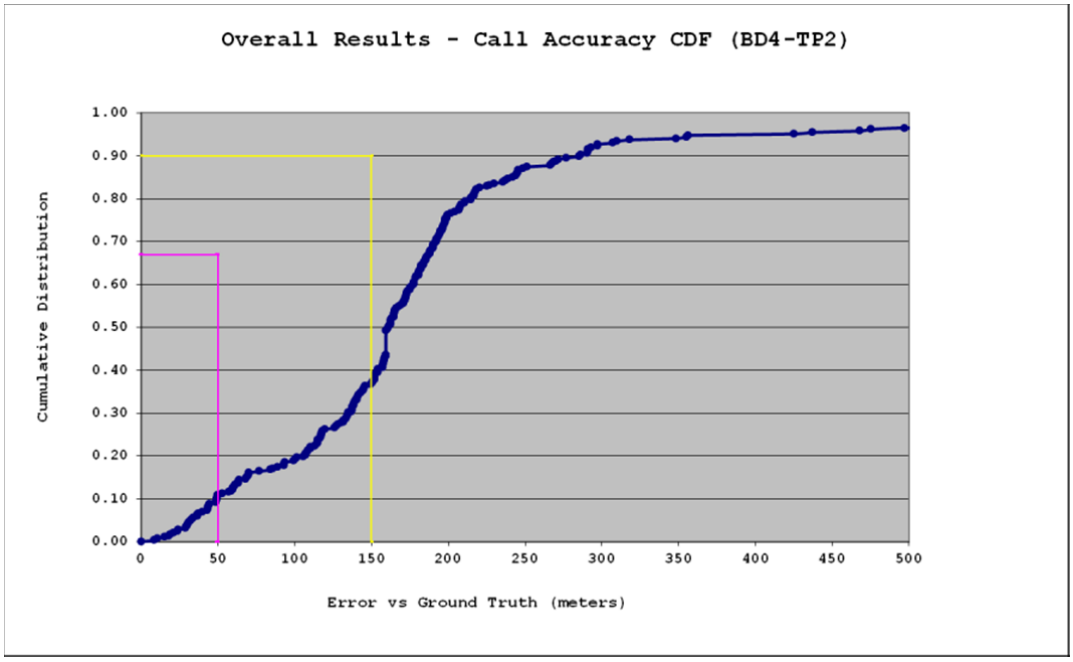
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD4_TP1	320	325.8	375.4	392.9	242.8	140.3	1369.9	6.91
Qualcomm_BD4_TP2	286	188.0	285.9	408.0	292.4	890.1	12117.1	8.52
Qualcomm_BD4_TP3	335	246.5	647.4	731.6	304.1	520.1	3676.6	1.79
Qualcomm_BD4_TP4	299	221.8	569.5	3037.3	566.1	1694.9	18236.7	11.12

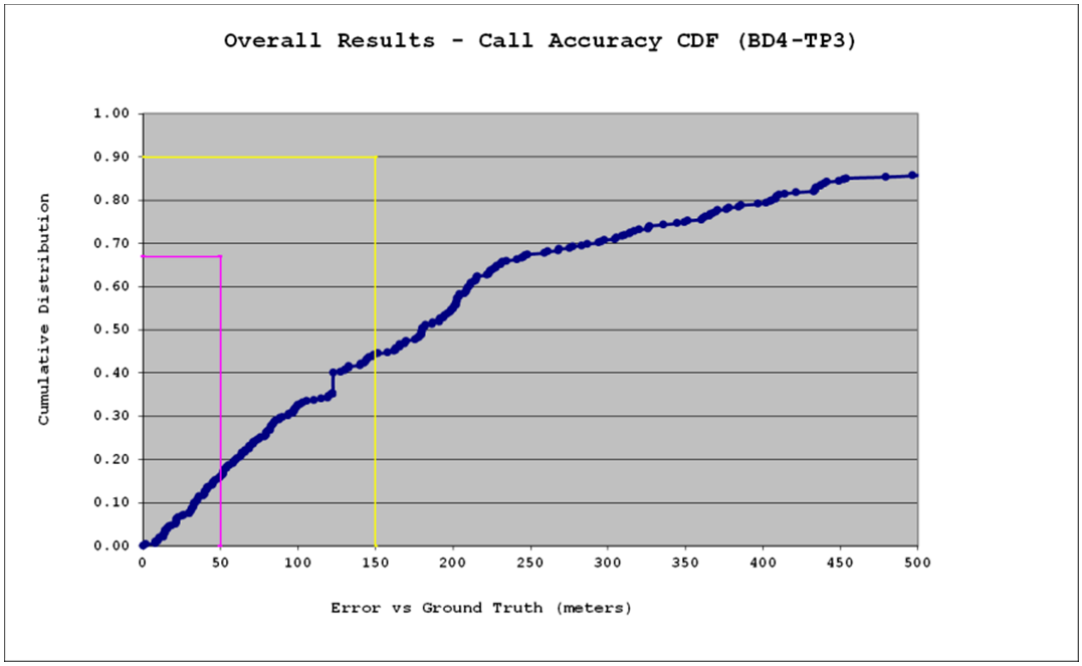
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD4_TP1	Number of Calls	20	117	13	0	10	2	158	0	320
	Percentage	6.3%	36.6%	4.1%	0.0%	3.1%	0.6%	49.4%	0.0%	100.0%
Qualcomm_BD4_TP2	Number of Calls	17	0	46	210	7	0	6	0	286
	Percentage	5.9%	0.0%	16.1%	73.4%	2.4%	0.0%	2.1%	0.0%	100.0%
Qualcomm_BD4_TP3	Number of Calls	18	17	184	99	5	0	12	0	335
	Percentage	5.4%	5.1%	54.9%	29.6%	1.5%	0.0%	3.6%	0.0%	100.0%
Qualcomm_BD4_TP4	Number of Calls	10	9	167	97	7	1	8	0	299
	Percentage	3.3%	3.0%	55.9%	32.4%	2.3%	0.3%	2.7%	0.0%	100.0%

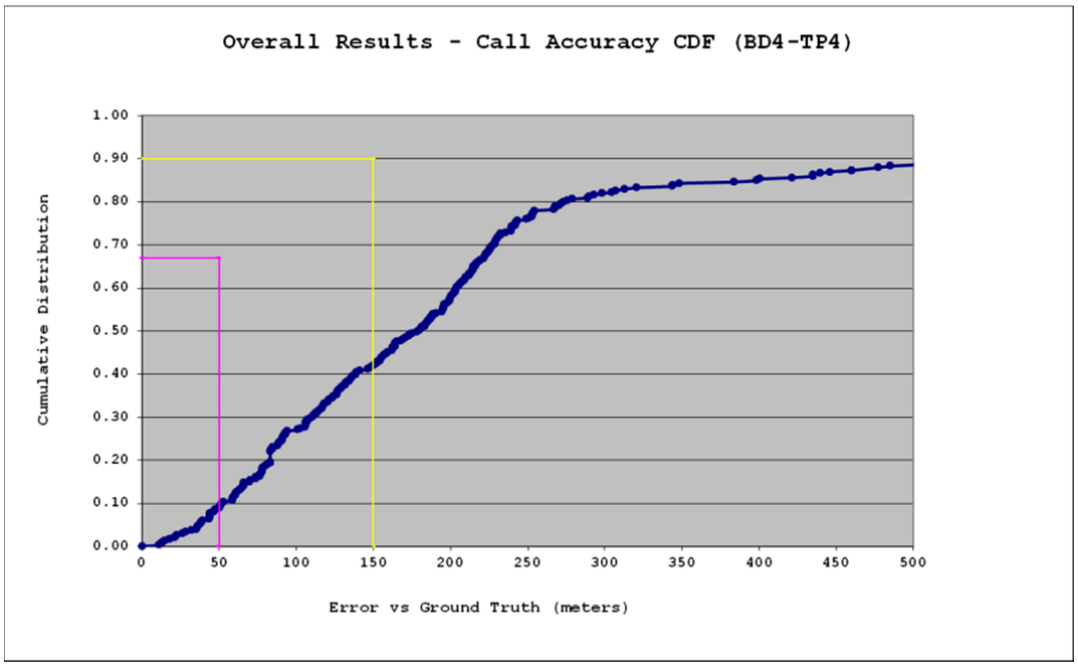
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD4_TP1	28.95	7.42	42.00	2.00
Qualcomm_BD4_TP2	22.85	5.24	35.00	2.00
Qualcomm_BD4_TP3	23.04	5.92	43.00	2.00
Qualcomm_BD4_TP4	23.30	4.38	43.00	1.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD4_TP1	320	304	95.00%
Qualcomm_BD4_TP2	286	152	53.15%
Qualcomm_BD4_TP3	335	221	65.97%
Qualcomm_BD4_TP4	299	161	53.85%


Overall Results - Call Accuracy CDF (BD4-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD4-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD4-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD4-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Alcatraz Island
Treasure Island
Yerba Buena Island
Oakland
San Francisco
B4_T1
B4_T2
B4_T3
B4_T4


B4_T1
B4_T2
B4_T3
B4_T4
China Basin
Channel St
4th St
3rd St
King St
Townsend St
Pier 48
Larkspur
AT&T Park
San Francisco Bay Trail
The Embarcadero
Colin P Kelly Jr St
Brannan St
Stanford St
2nd St
S Park Ave
Bryant St
Zoe St
Ritch St
Freelon St
Berry St
Tunnel Rd

6.3.2.2 Building 5:

6.3.2.2.1 Building 5 Environment and Test Points:

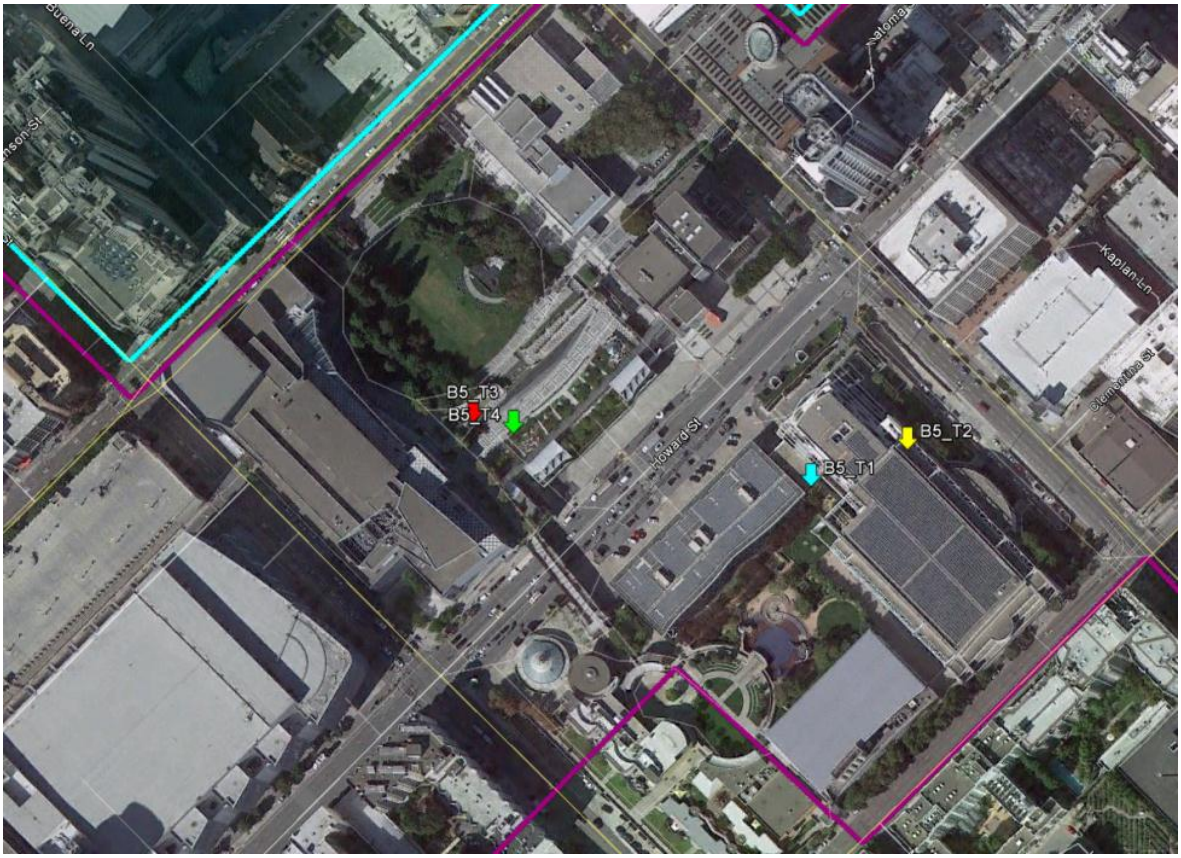
Building 5 is the Moscone Convention Center in San Francisco

TP1: Upper Lobby-- South (street level)

TP2: Interior hallway between meeting rooms, mezzanine level (1/2 floor below street level)

TP3: On Exhibit Hall D floor, near emergency exit (1 tall floor below street level)

TP4: Upper Lobby—North (street level)



6.3.2.2.2 NextNav per Test Point Results—BD5:

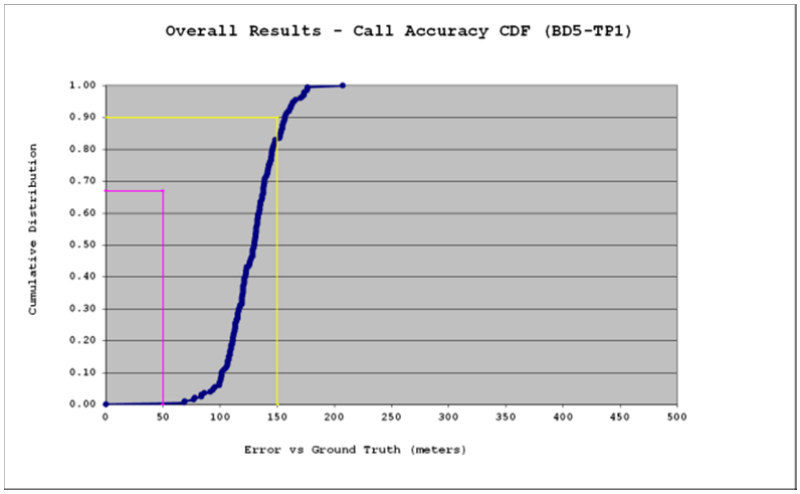
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD5_TP1	200	200	100.0%
NextNav_BD5_TP2	224	210	93.8%
NextNav_BD5_TP3	141	2	1.4%
NextNav_BD5_TP4	200	200	100.0%

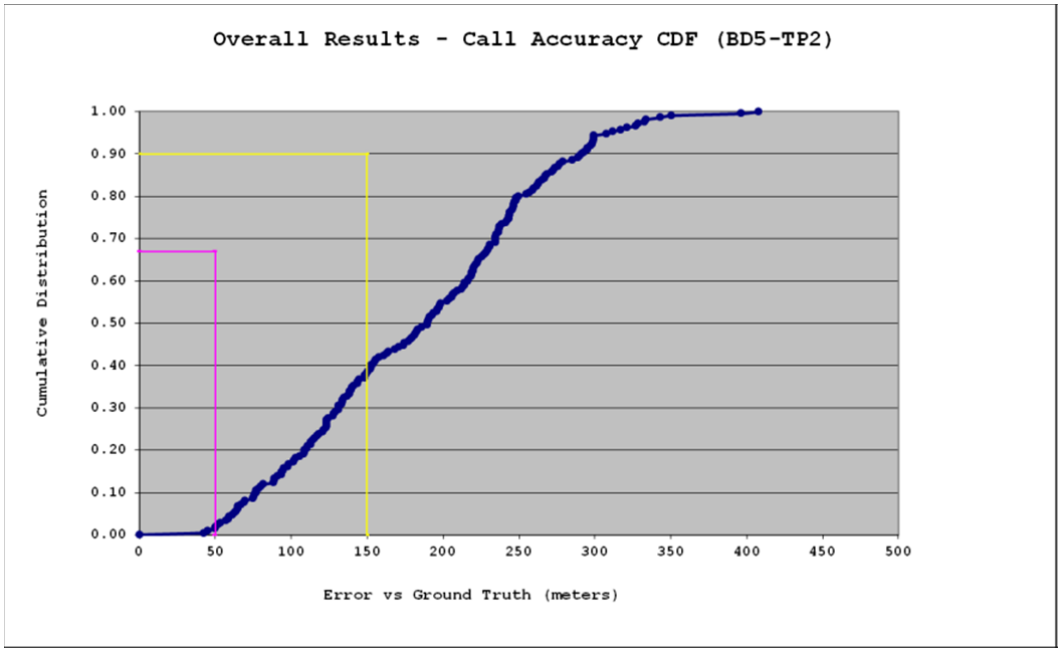
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD5_TP1	200	138.0	157.1	164.6	129.3	22.1	207.6	68.80
NextNav_BD5_TP2	210	229.5	291.6	309.8	185.5	79.1	408.0	42.25
NextNav_BD5_TP3	2	143.2	175.8	182.8	119.2	100.0	189.9	48.43
NextNav_BD5_TP4	200	67.5	83.9	95.8	63.0	18.2	134.1	20.17

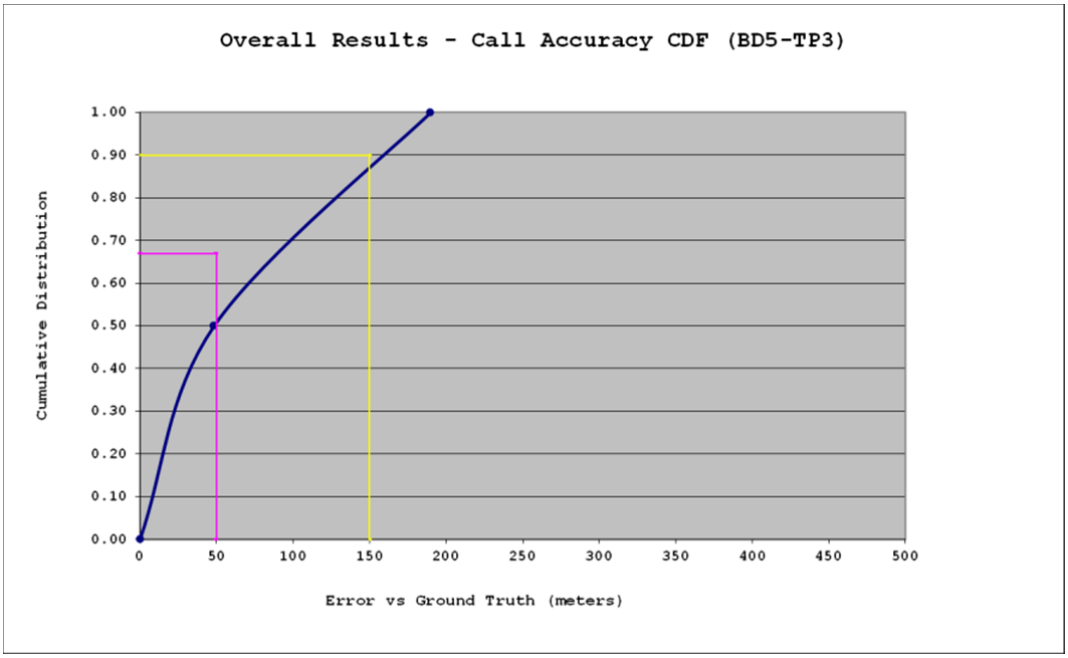
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD5_TP1	200	1.2	2.5	2.9	1.1	0.8	3.2	0.03
NextNav_BD5_TP2	210	3.3	4.2	4.5	3.1	0.8	5.3	0.37
NextNav_BD5_TP3	2	2.0	2.1	2.1	1.9	0.3	2.1	1.75
NextNav_BD5_TP4	200	2.7	3.2	3.5	2.4	0.7	4.3	0.84

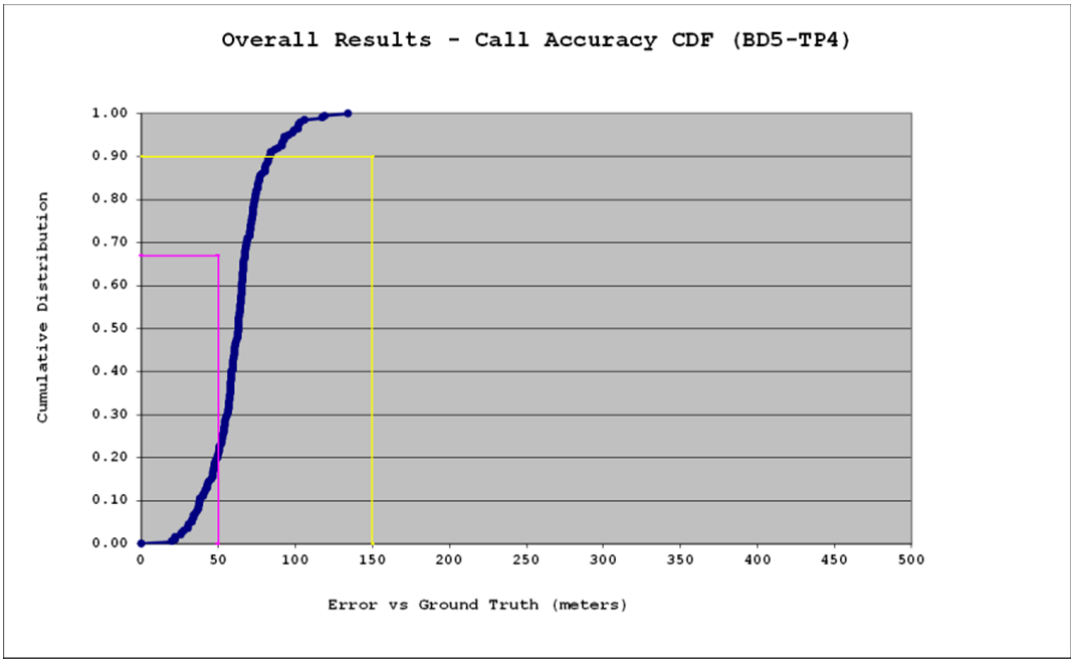
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD5_TP1	27.35	0.35	32.30	27.27
NextNav_BD5_TP2	27.52	0.46	32.44	26.99
NextNav_BD5_TP3	27.88	0.03	27.91	27.86
NextNav_BD5_TP4	27.35	0.35	32.29	27.27

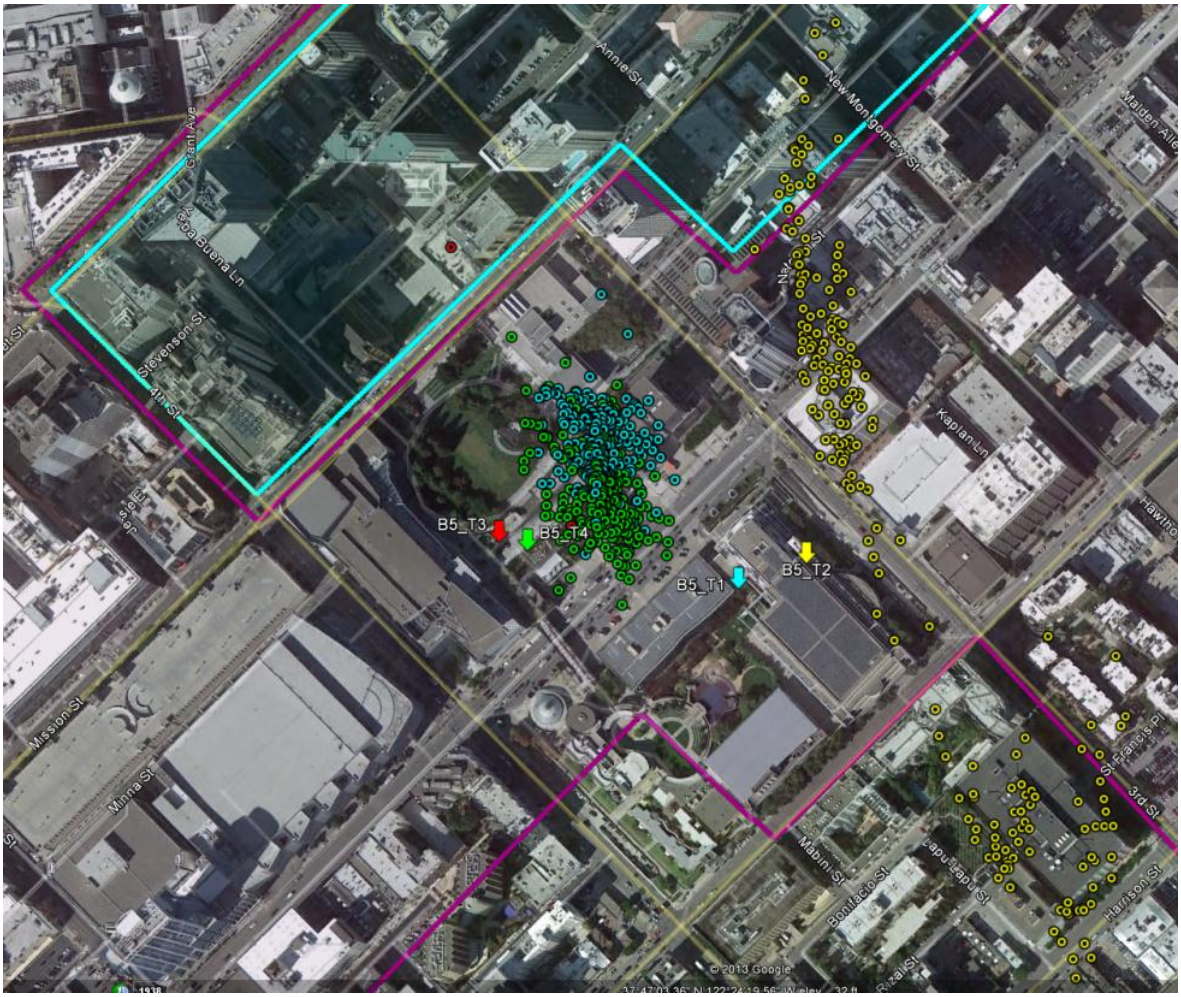
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD5_TP1	200	60	30.00%
NextNav_BD5_TP2	210	159	75.71%
NextNav_BD5_TP3	2	1	50.00%
NextNav_BD5_TP4	200	200	100.00%


Overall Results - Call Accuracy CDF (BD5-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD5-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD5-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD5-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



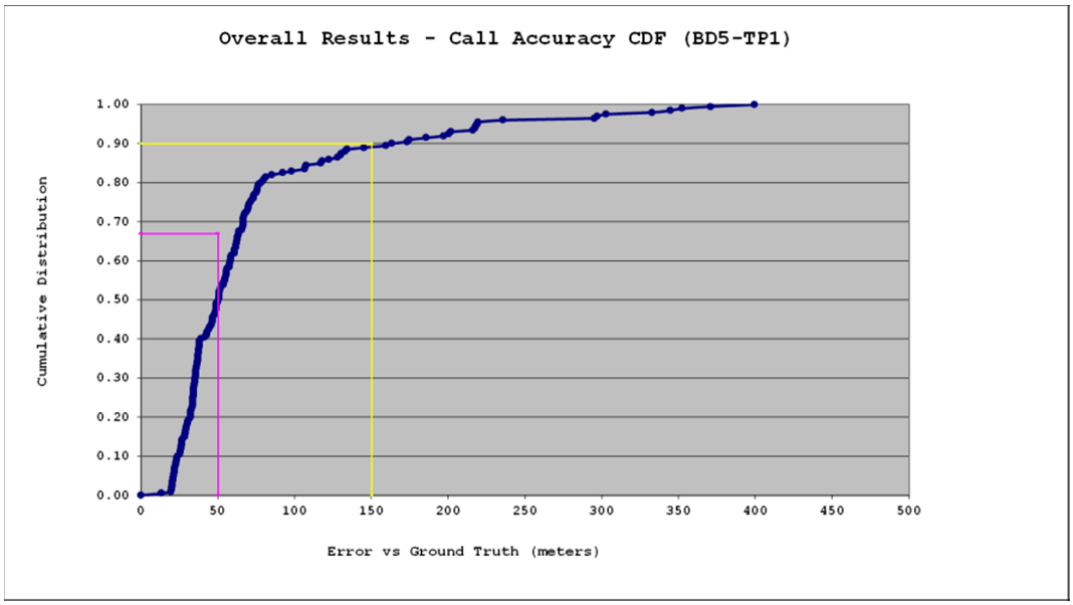
6.3.2.2.3 Polaris per Test Point Results—BD5:

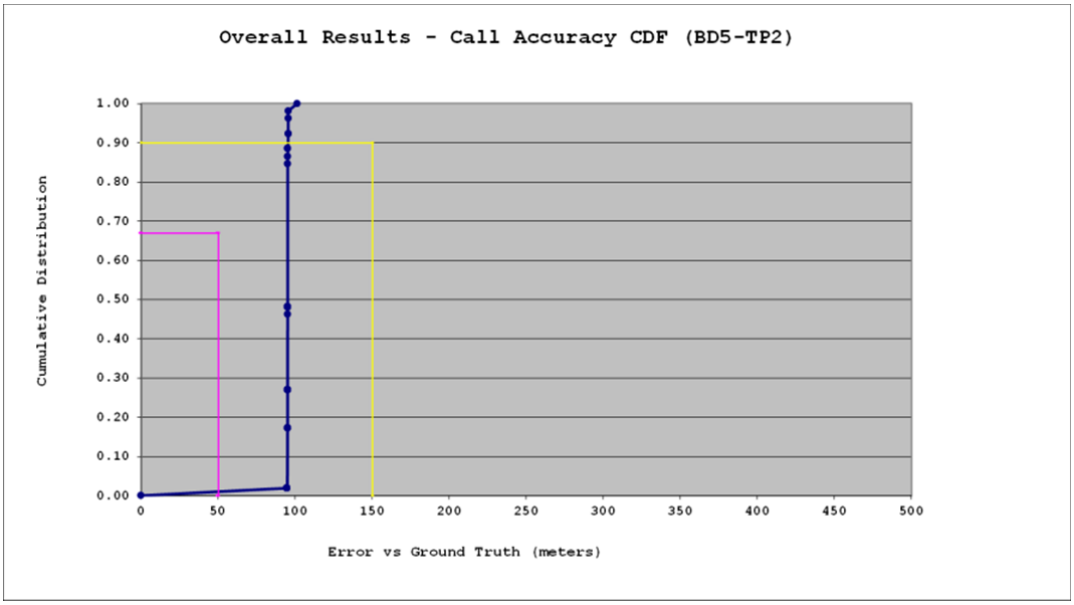
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD5_TP1	**200**	**200**	**100.0%**
Polaris_BD5_TP2	**53**	**52**	**98.1%**
Polaris_BD5_TP3	**198**	**198**	**100.0%**
Polaris_BD5_TP4	**199**	**199**	**100.0%**

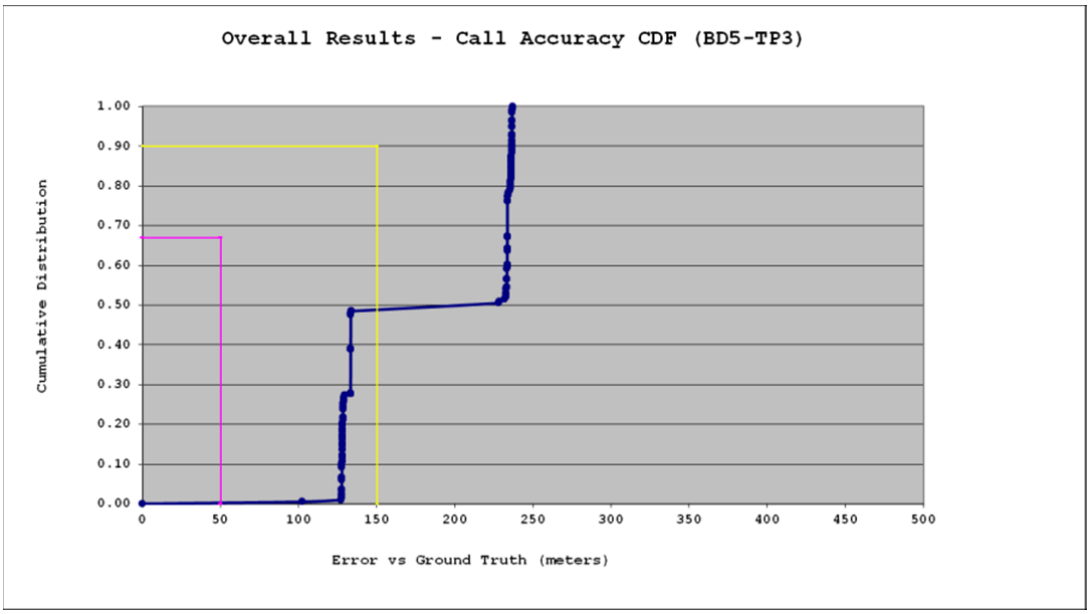
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD5_TP1	**200**	**63.8**	**164.2**	**219.1**	**72.9**	**71.0**	**399.6**	**13.08**
Polaris_BD5_TP2	**52**	**95.1**	**95.3**	**95.4**	**95.2**	**0.9**	**101.3**	**94.84**
Polaris_BD5_TP3	**198**	**233.5**	**236.4**	**236.5**	**182.3**	**52.4**	**236.8**	**102.33**
Polaris_BD5_TP4	**199**	**145.0**	**305.6**	**322.6**	**161.3**	**91.2**	**586.7**	**37.15**

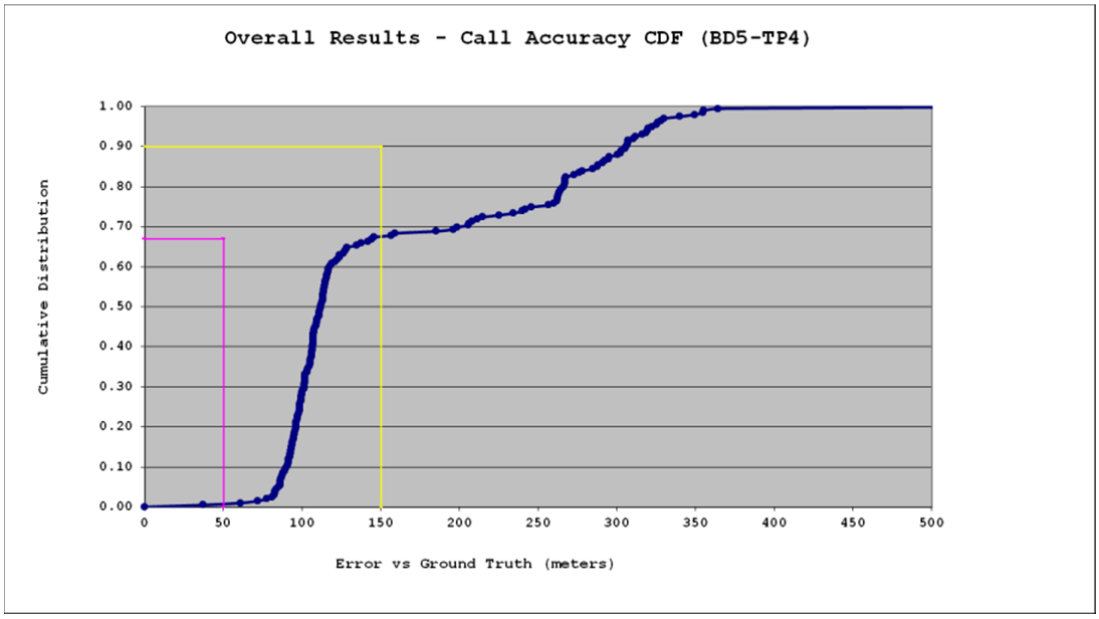
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD5_TP1	24.48	1.21	26.49	18.35
Polaris_BD5_TP2	23.22	4.55	26.25	5.52
Polaris_BD5_TP3	25.07	2.22	26.75	9.14
Polaris_BD5_TP4	24.14	1.70	26.58	16.96

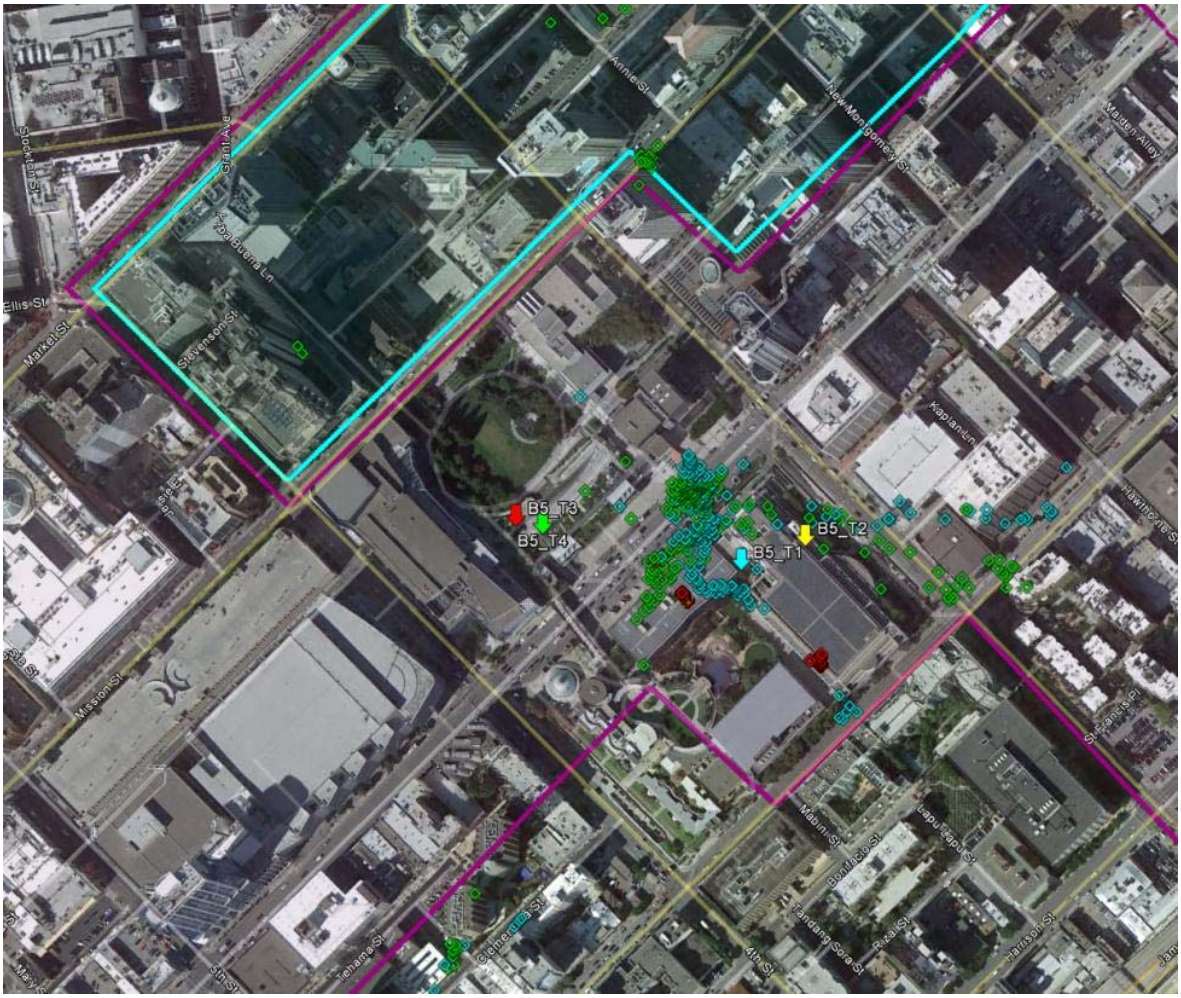
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD5_TP1	200	186	93.00%
Polaris_BD5_TP2	52	1	1.92%
Polaris_BD5_TP3	198	0	0.00%
Polaris_BD5_TP4	199	101	50.75%




Overall Results - Call Accuracy CDF (BD5-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD5-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD5-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B5_T3
B5_T4
B5_T2
B5_T1
Annie St
New Montgomery St
Maiden Alley
Stockton St
Ellis St
Market St
Stevenson St
Mission St
Kapiolani Ln
Hawthorne St
St Francis Pl
Mabini St
Bonifacio St
Rizal St
Harrison St
4th St
Tehama St
Clementina St
5th St

6.3.2.2.4 Qualcomm per Test Point Results—BD5

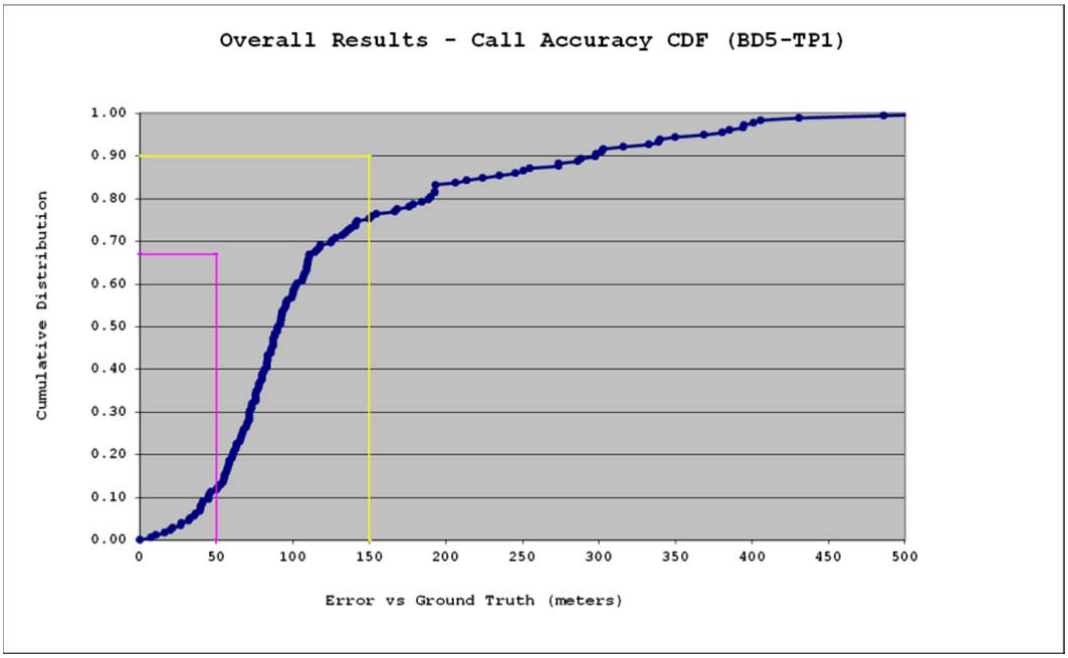
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD5_TP1	180	178	98.9%
Qualcomm_BD5_TP2	180	146	81.1%
Qualcomm_BD5_TP3	180	162	90.0%
Qualcomm_BD5_TP4	180	165	91.7%

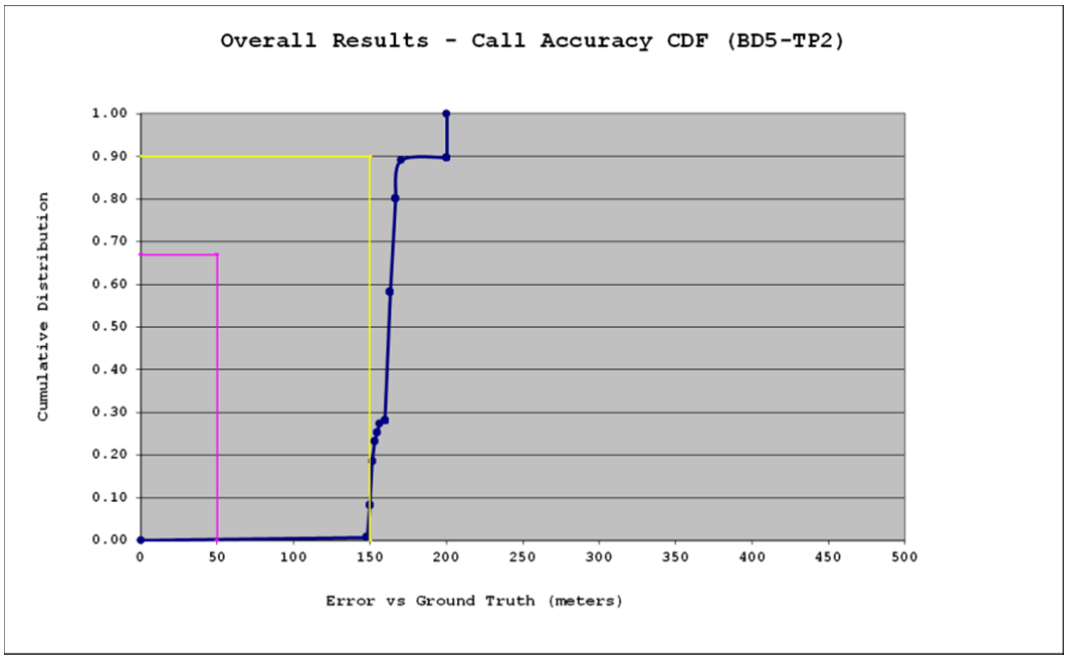
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD5_TP1	178	113.0	298.1	370.7	129.2	102.0	529.2	7.28
Qualcomm_BD5_TP2	146	163.3	200.4	200.4	163.1	14.3	200.4	148.20
Qualcomm_BD5_TP3	162	177.2	200.6	200.6	165.1	26.5	200.6	121.14
Qualcomm_BD5_TP4	165	180.8	263.3	317.1	146.6	101.2	793.3	7.84

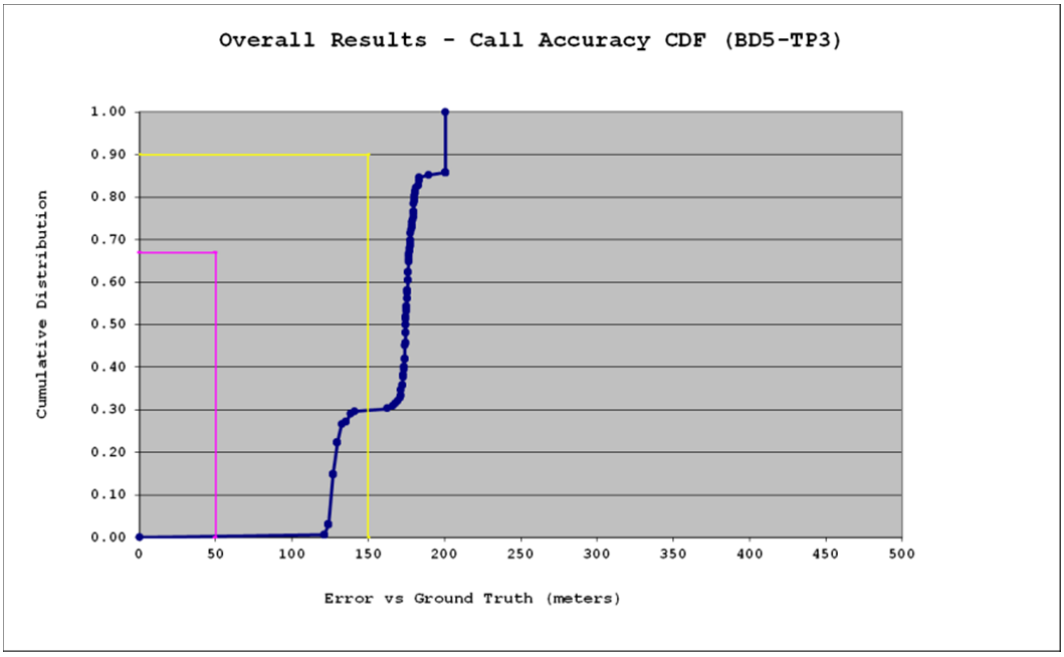
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD5_TP1	Number of Calls	5	0	17	156	0	0	0	0	178
	Percentage	2.8%	0.0%	9.6%	87.6%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD5_TP2	Number of Calls	16	0	0	0	130	0	0	0	146
	Percentage	11.0%	0.0%	0.0%	0.0%	89.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD5_TP3	Number of Calls	24	0	0	0	137	0	1	0	162
	Percentage	14.8%	0.0%	0.0%	0.0%	84.6%	0.0%	0.6%	0.0%	100.0%
Qualcomm_BD5_TP4	Number of Calls	18	1	82	58	2	0	4	0	165
	Percentage	10.9%	0.6%	49.7%	35.2%	1.2%	0.0%	2.4%	0.0%	100.0%

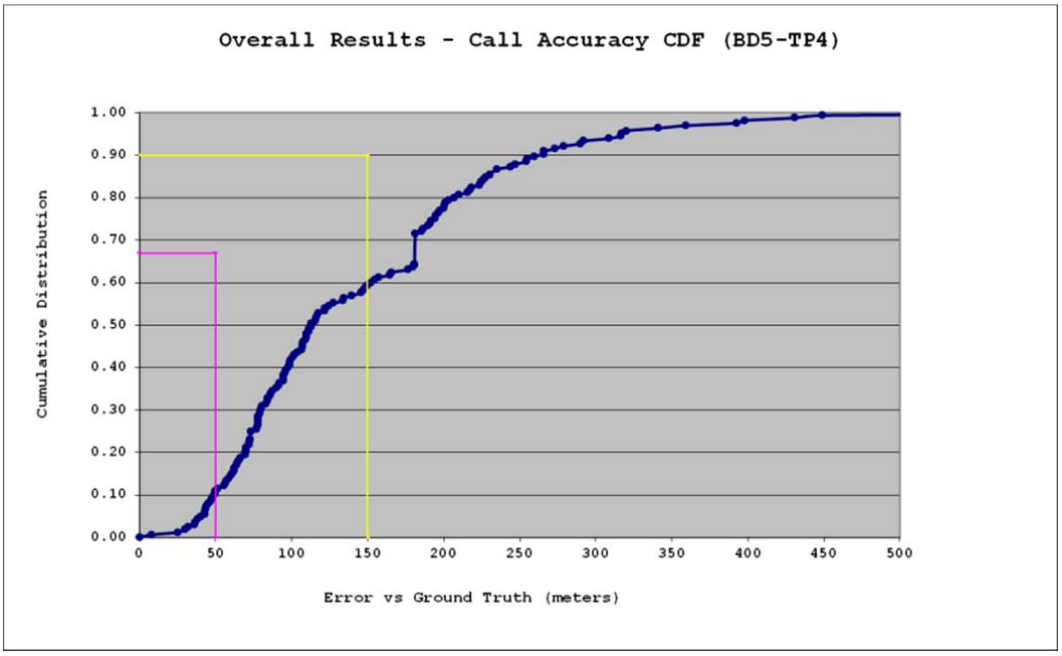
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD5_TP1	25.53	4.85	69.00	18.00
Qualcomm_BD5_TP2	33.32	10.12	67.00	15.00
Qualcomm_BD5_TP3	35.86	11.96	68.00	29.00
Qualcomm_BD5_TP4	28.41	12.48	91.00	19.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD5_TP1	178	57	32.02%
Qualcomm_BD5_TP2	146	146	100.00%
Qualcomm_BD5_TP3	162	162	100.00%
Qualcomm_BD5_TP4	165	132	80.00%


Overall Results - Call Accuracy CDF (BD5-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD5-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD5-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD5-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

6.3.2.3 Building 17:

6.3.2.3.1 Building 17 Environment and Test Points:

Building 17 is the James R. Browning U.S. Court of Appeals in San Francisco in SF, a historical landmark building. Completed in 1905, it is only one of two buildings south of Market Street to survive the massive 1906 San Francisco earthquake that devastated the city. It has a heavy masonry construction, with considerable tile surfacing on the interior.

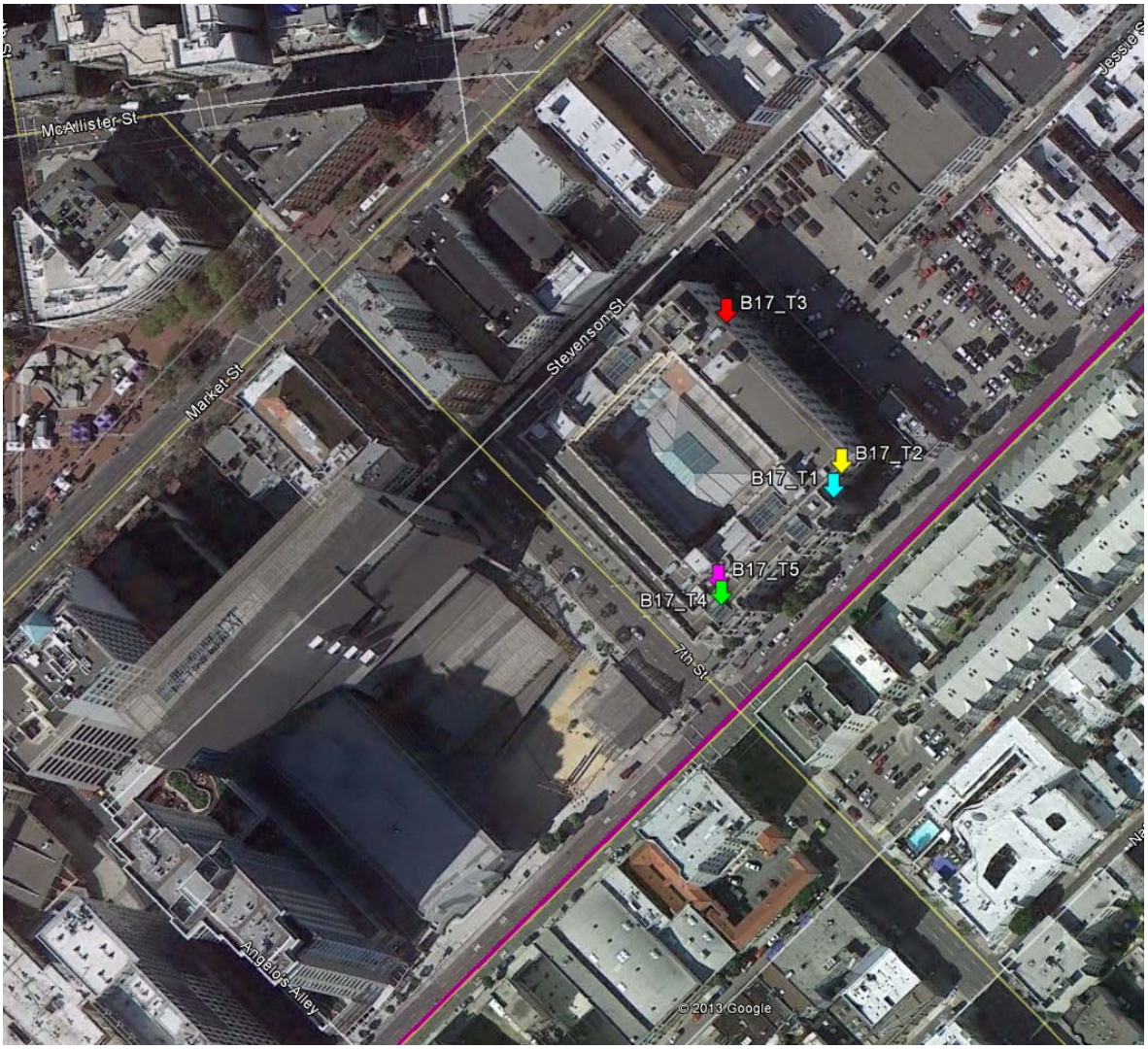
TP1: First floor elevator lobby

TP2: Courtroom # 4, 2nd floor south, impressive large chamber with tall windows and 26 ft high ceilings

TP3: Courtroom # 5, 2nd floor north, impressive large chamber with tall windows and 26 ft high ceilings

TP4: 3rd floor hallway by large central atrium

TP5: 4th floor elevator lobby (with windows)



6.3.2.3.2 NextNav per Test Point Results—BD17:

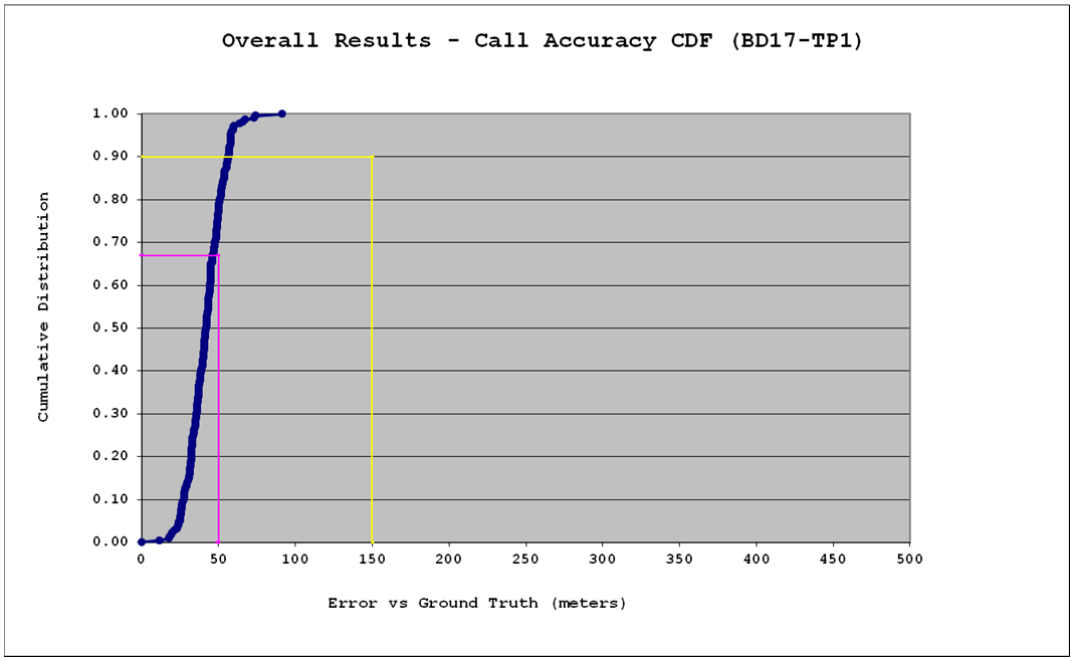
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD17_TP1	**214**	**214**	**100.0%**
NextNav_BD17_TP2	**239**	**237**	**99.2%**
NextNav_BD17_TP3	**200**	**188**	**94.0%**
NextNav_BD17_TP4	**200**	**200**	**100.0%**
NextNav_BD17_TP5	**119**	**119**	**100.0%**

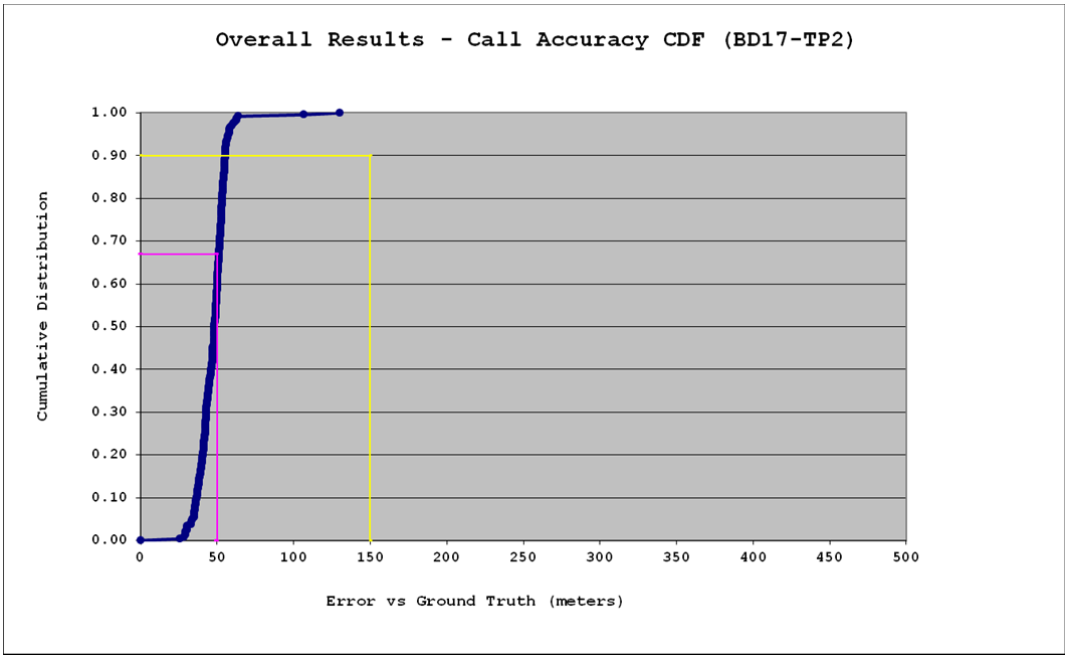
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD17_TP1	214	46.6	56.4	58.3	42.1	11.4	91.5	11.72
NextNav_BD17_TP2	237	51.4	55.4	57.7	47.8	9.9	130.2	25.78
NextNav_BD17_TP3	188	69.5	147.9	299.8	97.2	159.1	1221.4	4.80
NextNav_BD17_TP4	200	25.4	33.5	40.1	22.3	9.8	75.1	2.15
NextNav_BD17_TP5	119	31.9	38.5	40.7	28.7	7.9	51.8	8.54

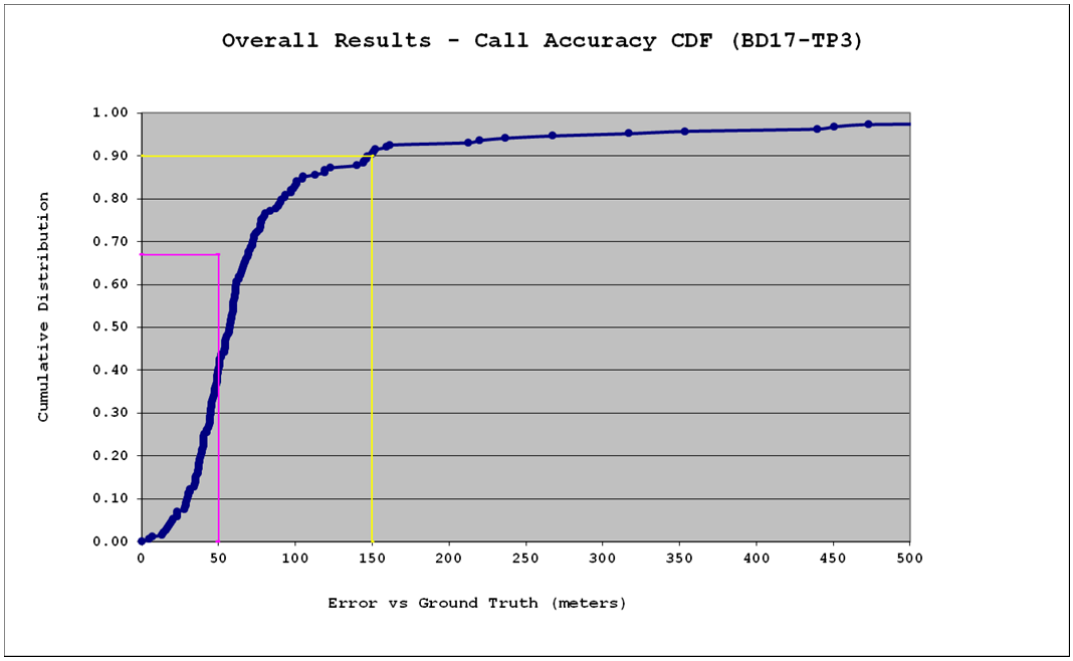
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD17_TP1	214	0.8	1.3	1.7	0.6	0.5	2.2	0.02
NextNav_BD17_TP2	237	0.7	1.2	1.4	0.6	0.5	3.9	0.02
NextNav_BD17_TP3	188	1.4	1.9	2.0	1.2	0.6	4.0	0.04
NextNav_BD17_TP4	200	2.1	2.4	2.6	1.8	0.5	3.2	0.30
NextNav_BD17_TP5	119	1.3	2.0	2.2	1.2	0.6	2.5	0.14

TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD17_TP1	27.32	0.03	27.42	27.27
NextNav_BD17_TP2	27.32	0.03	27.37	27.27
NextNav_BD17_TP3	27.33	0.03	27.52	27.27
NextNav_BD17_TP4	27.35	0.36	32.36	27.27
NextNav_BD17_TP5	27.23	1.01	27.37	16.36

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD17_TP1	214	197	92.06%
NextNav_BD17_TP2	237	210	88.61%
NextNav_BD17_TP3	188	141	75.00%
NextNav_BD17_TP4	200	200	100.00%
NextNav_BD17_TP5	119	117	98.32%


Overall Results - Call Accuracy CDF (BD17-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP3)
Cumulative Distribution
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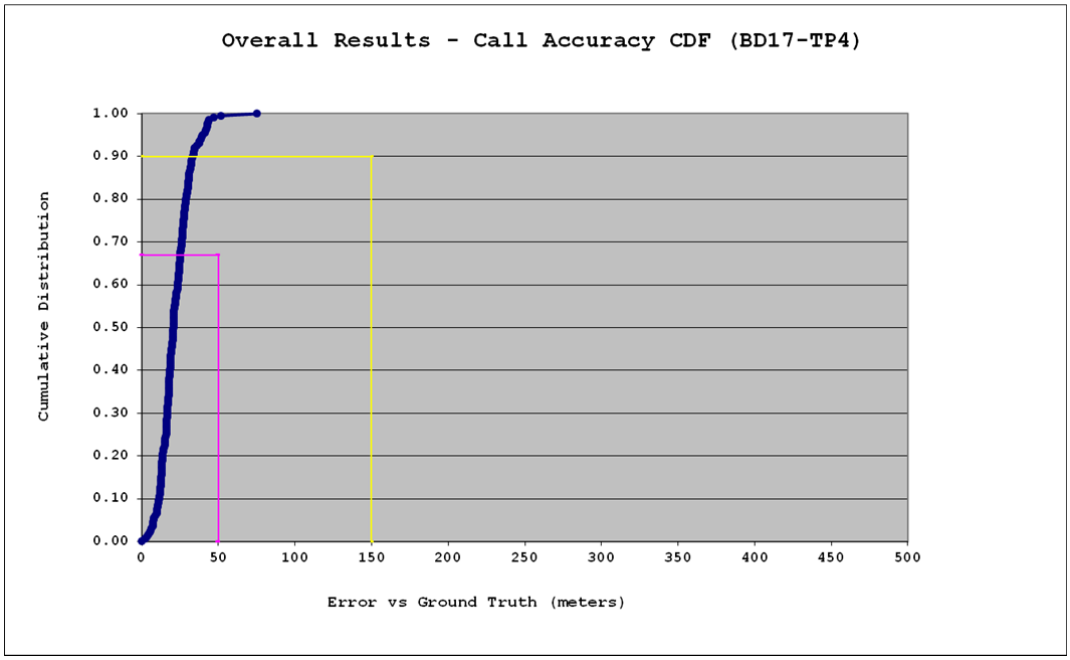
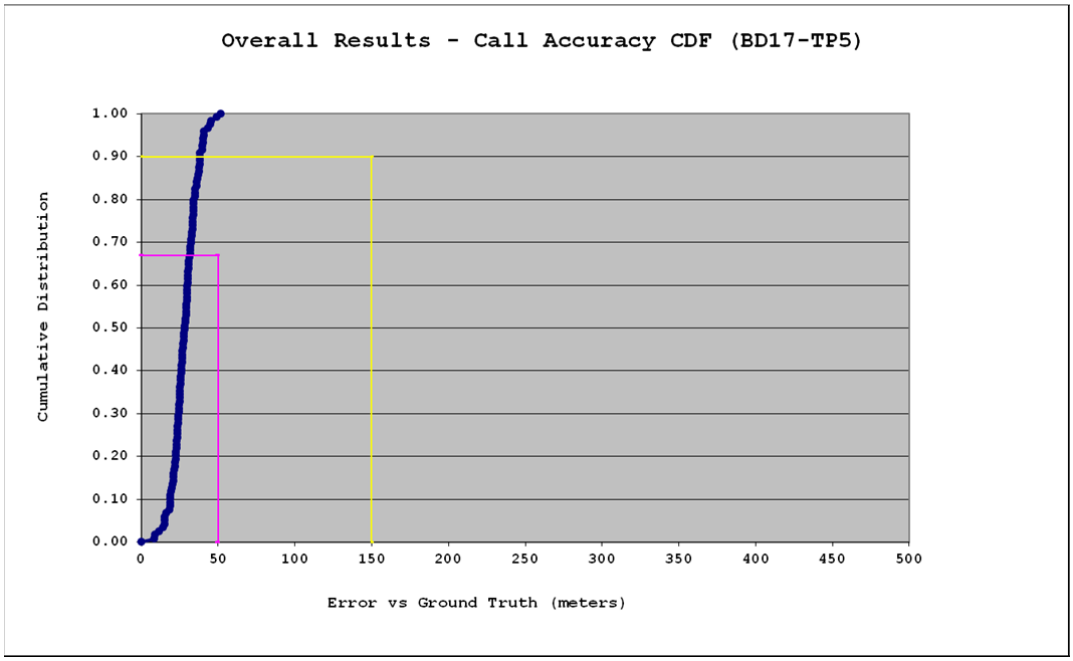
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


McAllister St
Stevenson St
B17_T3
B17_T2
B17_T1
B17_T5
B17_T4
7th St
© 2013 Google

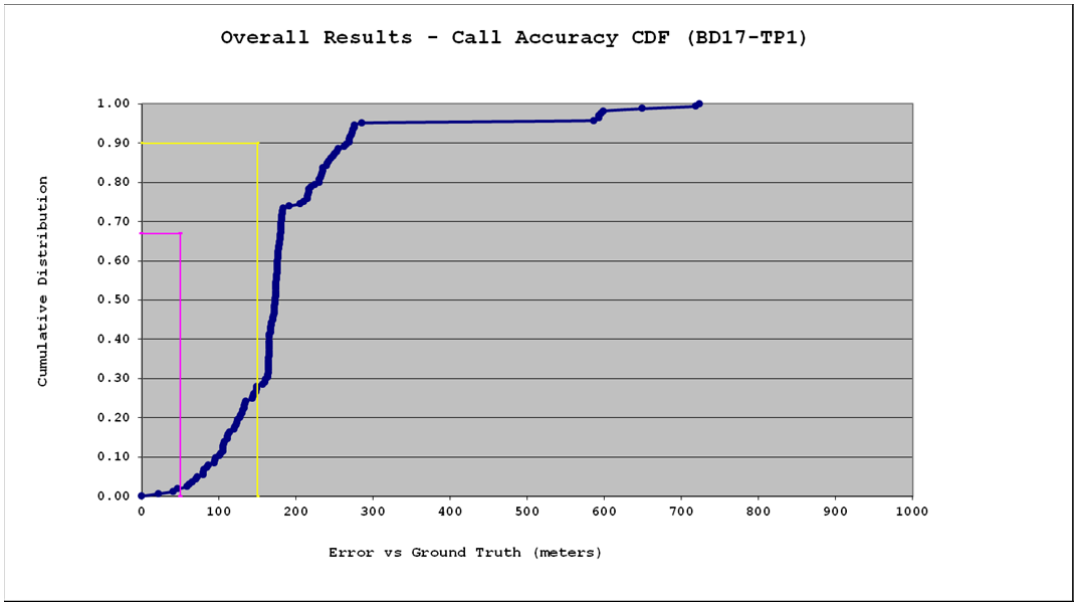
6.3.2.3.3 Polaris per Test Point Results—BD17:

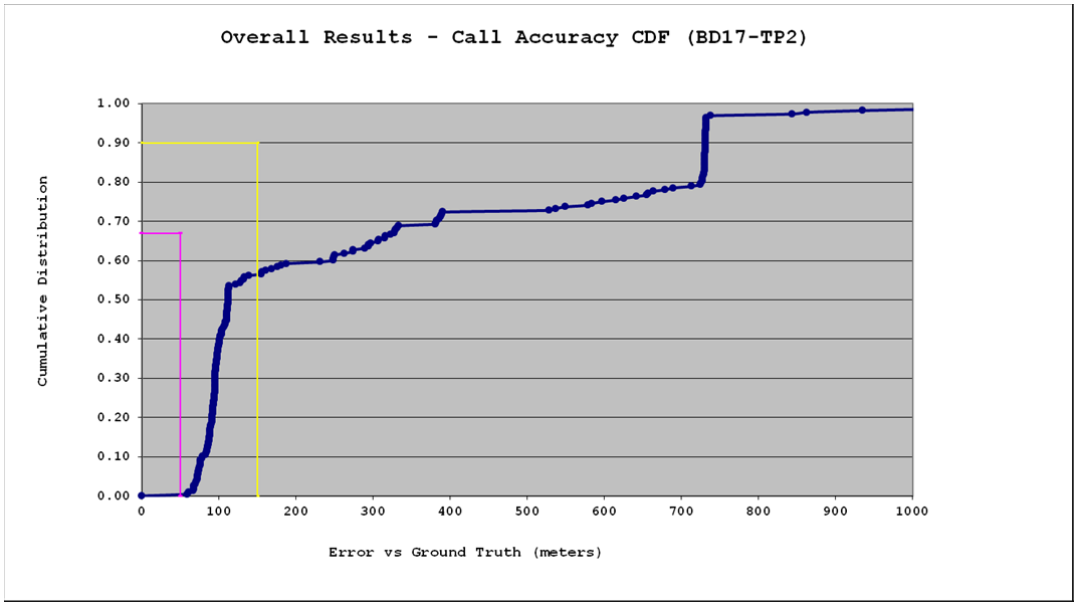
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD17_TP1	165	165	100.0%
Polaris_BD17_TP2	229	228	99.6%
Polaris_BD17_TP3	200	200	100.0%
Polaris_BD17_TP4	200	200	100.0%
Polaris_BD17_TP5	194	194	100.0%

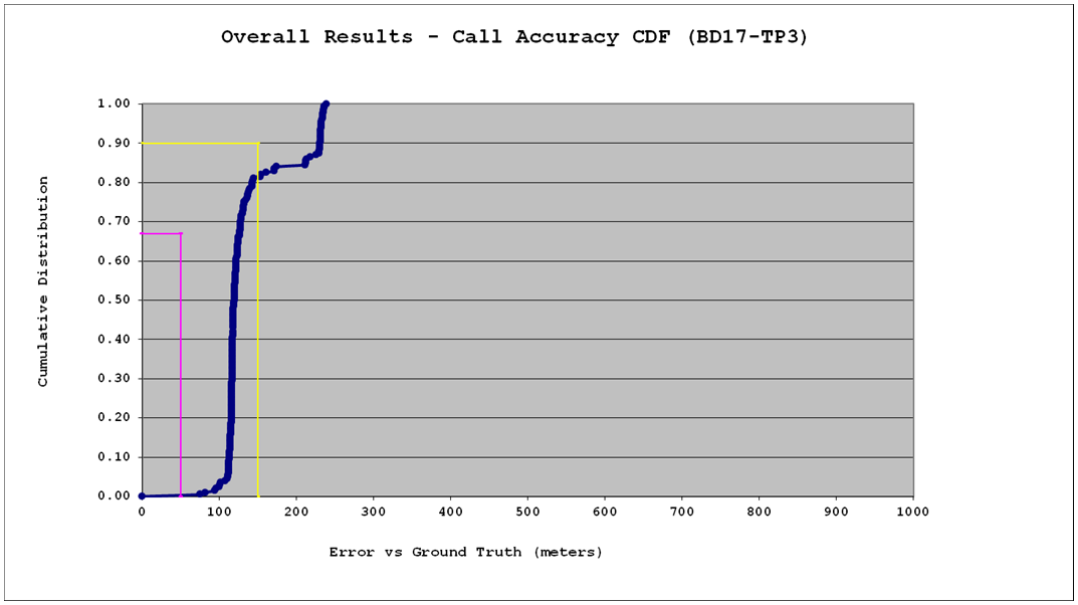
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD17_TP1	165	180.4	267.9	283.6	191.4	113.3	723.8	21.74
Polaris_BD17_TP2	228	327.5	730.8	731.8	303.8	286.3	1206.7	58.71
Polaris_BD17_TP3	200	126.5	230.7	231.8	138.1	41.6	238.7	75.41
Polaris_BD17_TP4	200	166.2	492.9	546.7	182.6	171.8	613.5	22.64
Polaris_BD17_TP5	194	552.4	554.0	554.4	356.4	184.8	676.0	34.39

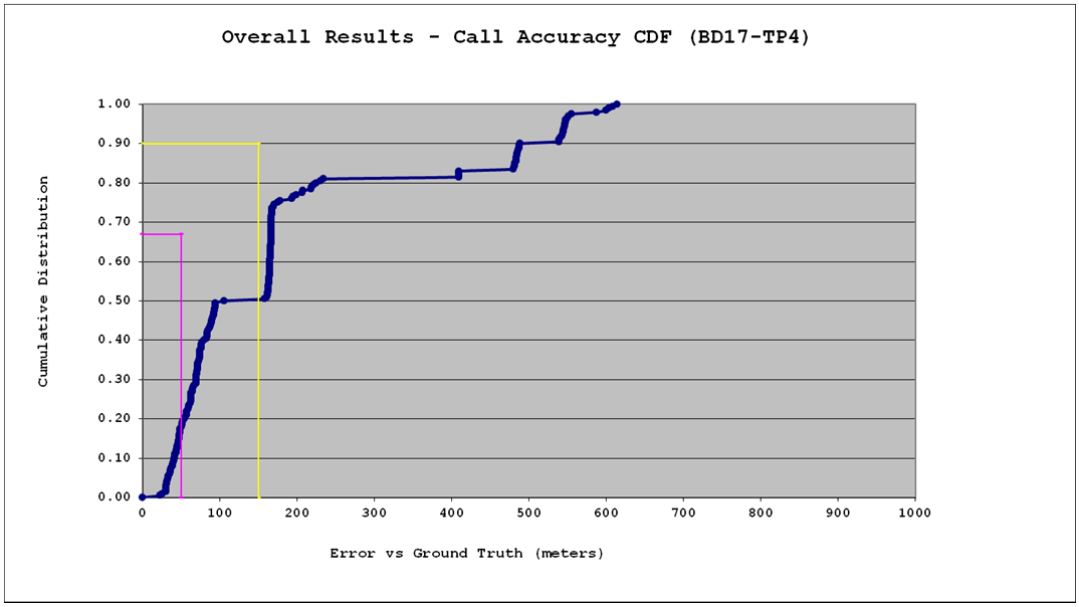
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD17_TP1	24.56	2.34	27.66	1.84
Polaris_BD17_TP2	21.52	7.37	27.91	1.36
Polaris_BD17_TP3	24.42	1.81	26.56	18.37
Polaris_BD17_TP4	24.63	1.52	27.90	19.48
Polaris_BD17_TP5	24.57	1.67	26.55	14.35

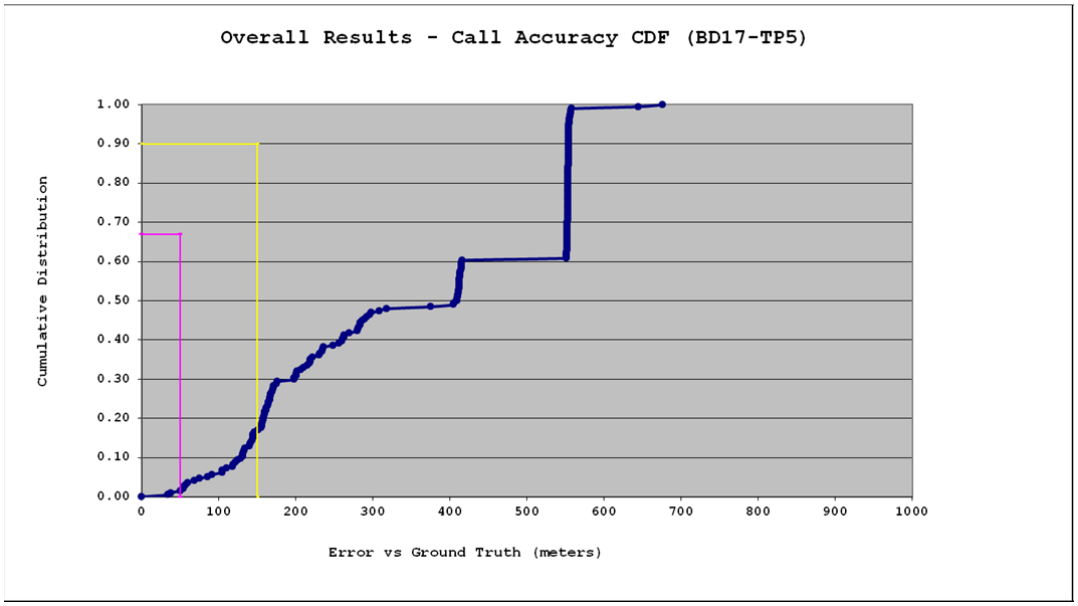
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD17_TP1	165	139	84.24%
Polaris_BD17_TP2	228	146	64.04%
Polaris_BD17_TP3	200	134	67.00%
Polaris_BD17_TP4	200	143	71.50%
Polaris_BD17_TP5	194	69	35.57%


Overall Results - Call Accuracy CDF (BD17-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)



6.3.2.3.4 Qualcomm per Test Point Results—BD17:

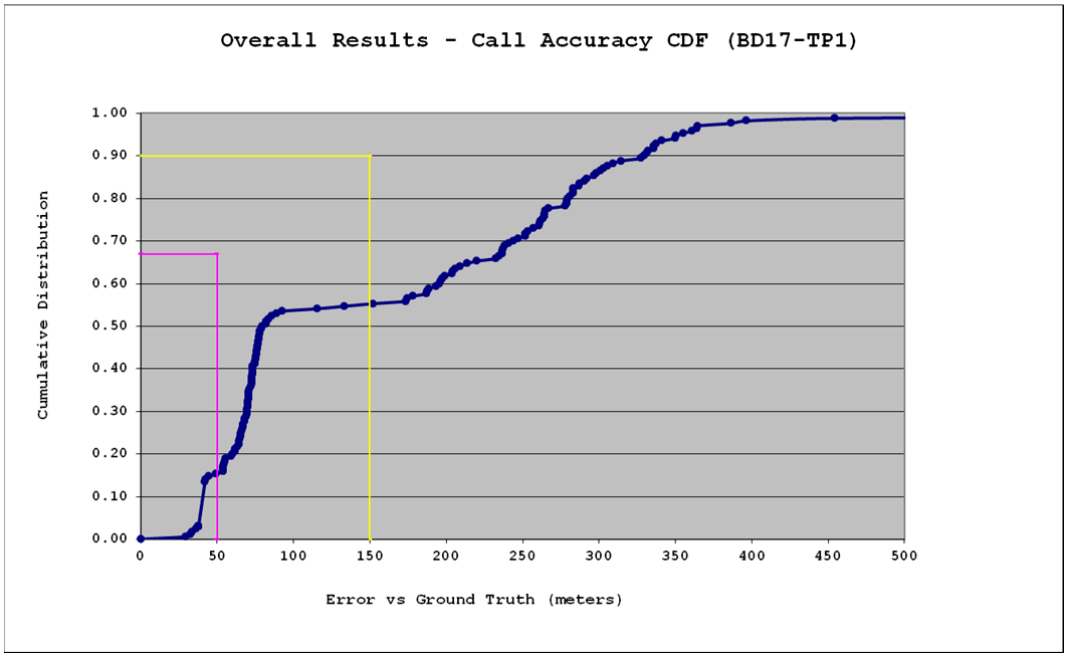
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD17_TP1	180	170	94.4%
Qualcomm_BD17_TP2	180	176	97.8%
Qualcomm_BD17_TP3	180	180	100.0%
Qualcomm_BD17_TP4	180	175	97.2%
Qualcomm_BD17_TP5	180	175	97.2%

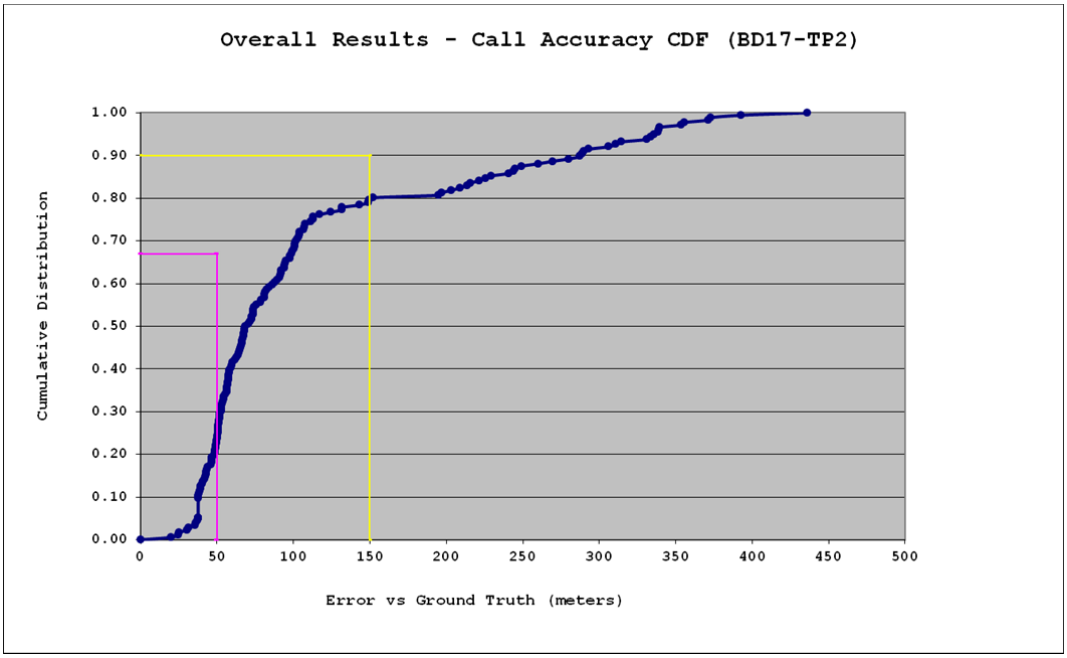
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD17_TP1	170	236.7	329.9	353.1	162.7	128.2	738.3	29.25
Qualcomm_BD17_TP2	176	99.1	288.1	336.6	111.8	95.8	436.0	19.95
Qualcomm_BD17_TP3	180	151.5	248.9	279.1	131.5	102.9	588.9	4.27
Qualcomm_BD17_TP4	175	155.4	287.1	338.0	131.8	145.3	977.1	12.13
Qualcomm_BD17_TP5	175	82.5	145.5	168.0	66.6	57.3	288.6	1.62

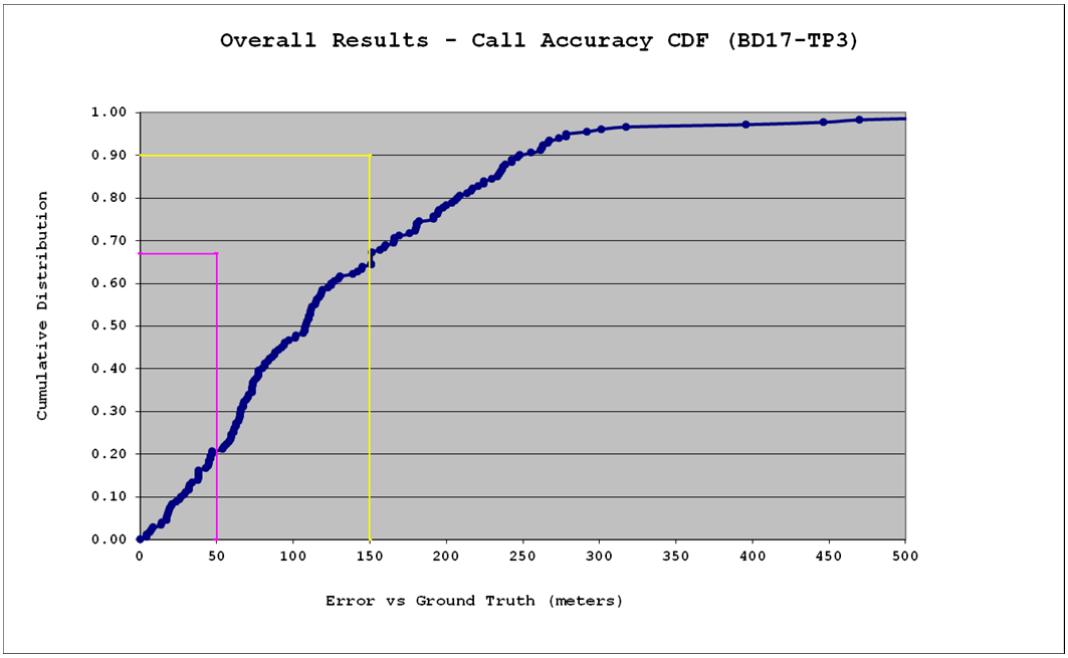
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD17_TP1	Number of Calls	18	93	15	0	13	2	29	0	170
	Percentage	10.6%	54.7%	8.8%	0.0%	7.6%	1.2%	17.1%	0.0%	100.0%
Qualcomm_BD17_TP2	Number of Calls	8	1	93	74	0	0	0	0	176
	Percentage	4.5%	0.6%	52.8%	42.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD17_TP3	Number of Calls	5	0	102	73	0	0	0	0	180
	Percentage	2.8%	0.0%	56.7%	40.6%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD17_TP4	Number of Calls	18	3	122	26	2	0	4	0	175
	Percentage	10.3%	1.7%	69.7%	14.9%	1.1%	0.0%	2.3%	0.0%	100.0%
Qualcomm_BD17_TP5	Number of Calls	8	0	21	146	0	0	0	0	175
	Percentage	4.6%	0.0%	12.0%	83.4%	0.0%	0.0%	0.0%	0.0%	100.0%

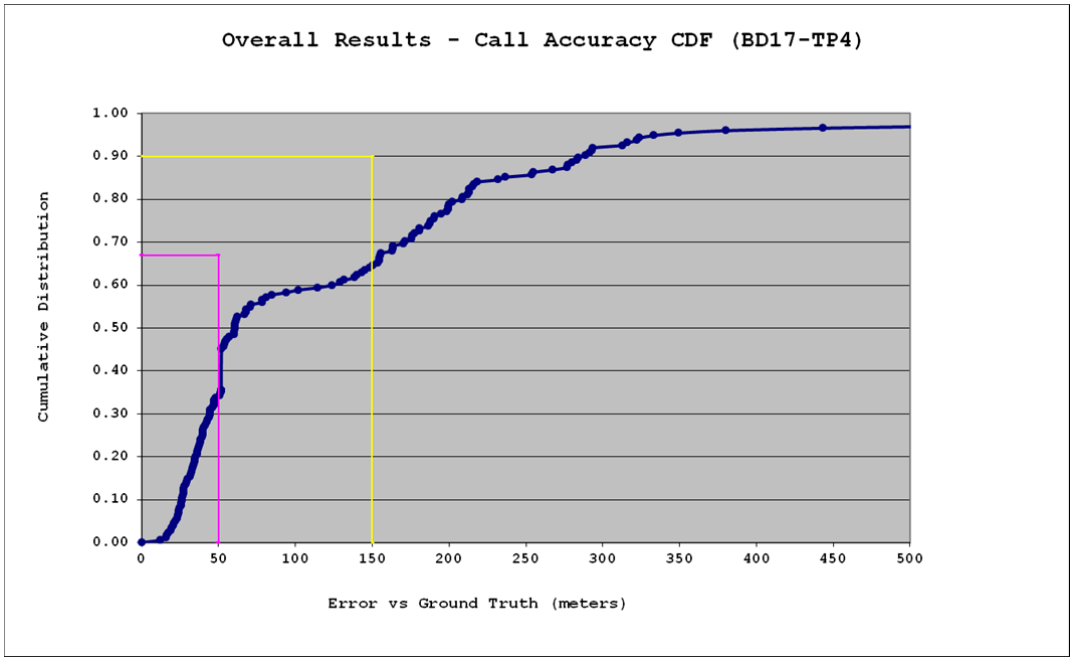
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD17_TP1	32.33	6.82	94.00	18.00
Qualcomm_BD17_TP2	25.79	6.18	66.00	17.00
Qualcomm_BD17_TP3	25.83	5.57	94.00	19.00
Qualcomm_BD17_TP4	27.93	9.50	94.00	18.00
Qualcomm_BD17_TP5	26.16	6.87	67.00	17.00

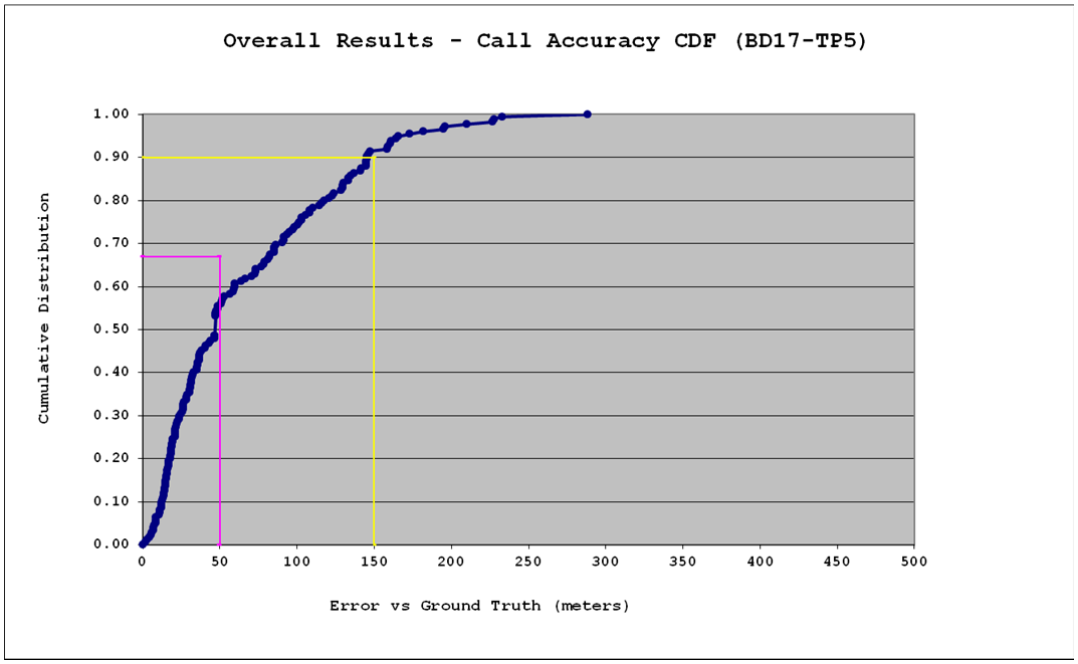
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD17_TP1	170	158	92.94%
Qualcomm_BD17_TP2	176	121	68.75%
Qualcomm_BD17_TP3	180	138	76.67%
Qualcomm_BD17_TP4	175	162	92.57%
Qualcomm_BD17_TP5	175	140	80.00%


Overall Results - Call Accuracy CDF (BD17-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD17-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B17_T3
B17_T1
B17_T2
B17_T5
B17_T4
Leavenworth St
Jones St
McAllister St
Market St
Stevenson St
Jessie St
Mission St
Minna St
Natoma St
Howard St
Mary St
Clementina St
Mint Plaza
Ringold St
Folsom St
Harriet St
Columbia Square
Sherman St
Langton St
7th St
8th St
Julia St
Angelos Alley
Rausch St
South of Market
©2013 Google

6.3.2.4 Building 18:

6.3.2.4.1 Building 18 Environment and Test Points:

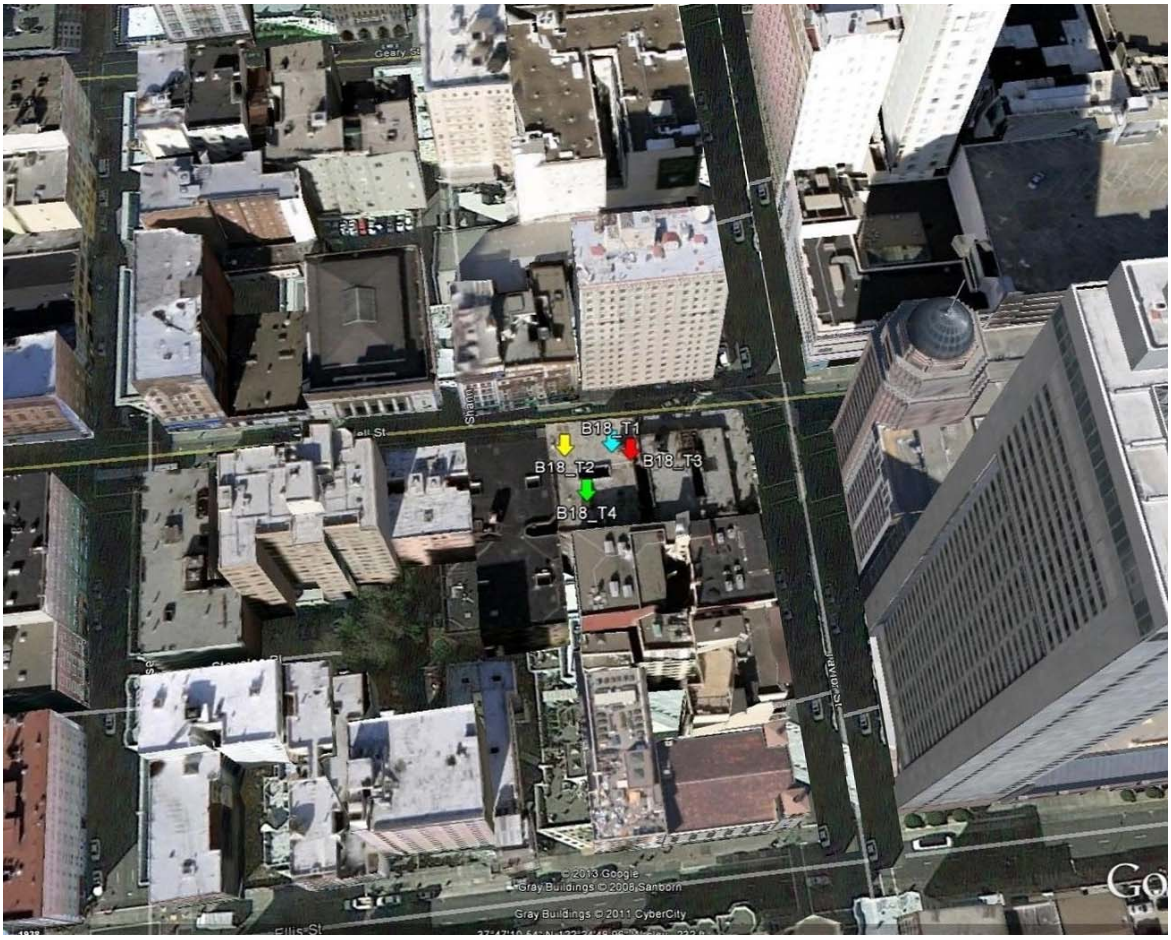
Building 18 is the Super 8 Motel building on O'Farrell Street, SF. It is a 5 story wood and plaster older construction with an external fire escape. No space exists between this building and its adjacent buildings. A couple of tall buildings are in the area.

TP1: In hotel lobby, not far from hotel entrance door

TP2: 2nd floor hallway near window/fire escape

TP3: Interior hallway, 3rd floor

TP4: Utility room overlooking air shaft



6.3.2.4.2 NextNav per Test Point Results—BD18:

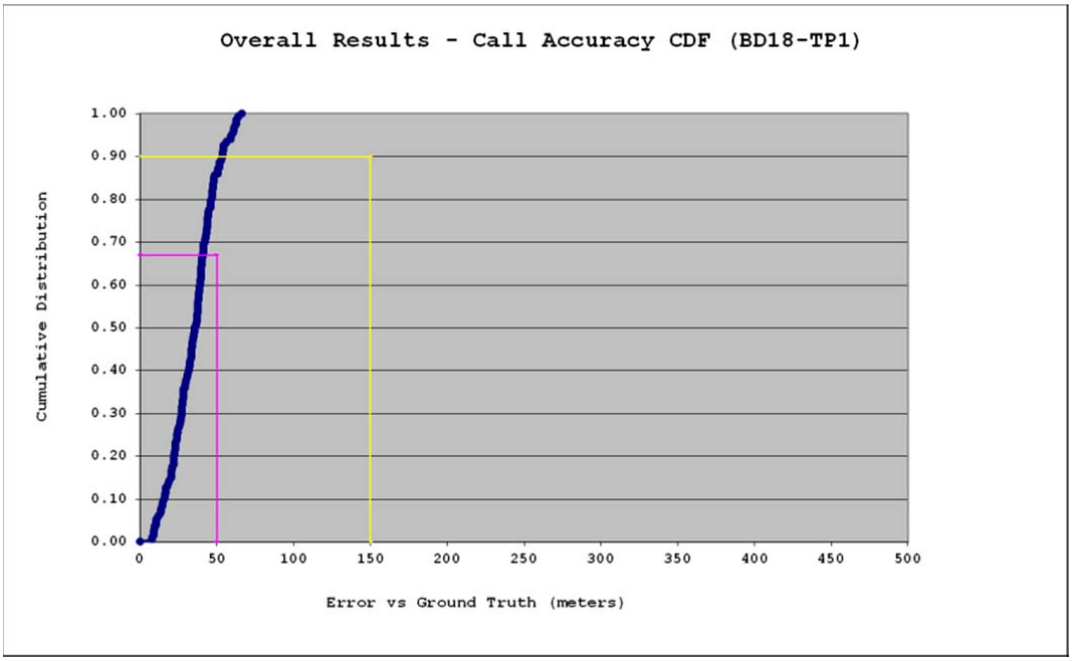
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD18_TP1	200	200	100.0%
NextNav_BD18_TP2	200	200	100.0%
NextNav_BD18_TP3	200	200	100.0%
NextNav_BD18_TP4	200	200	100.0%

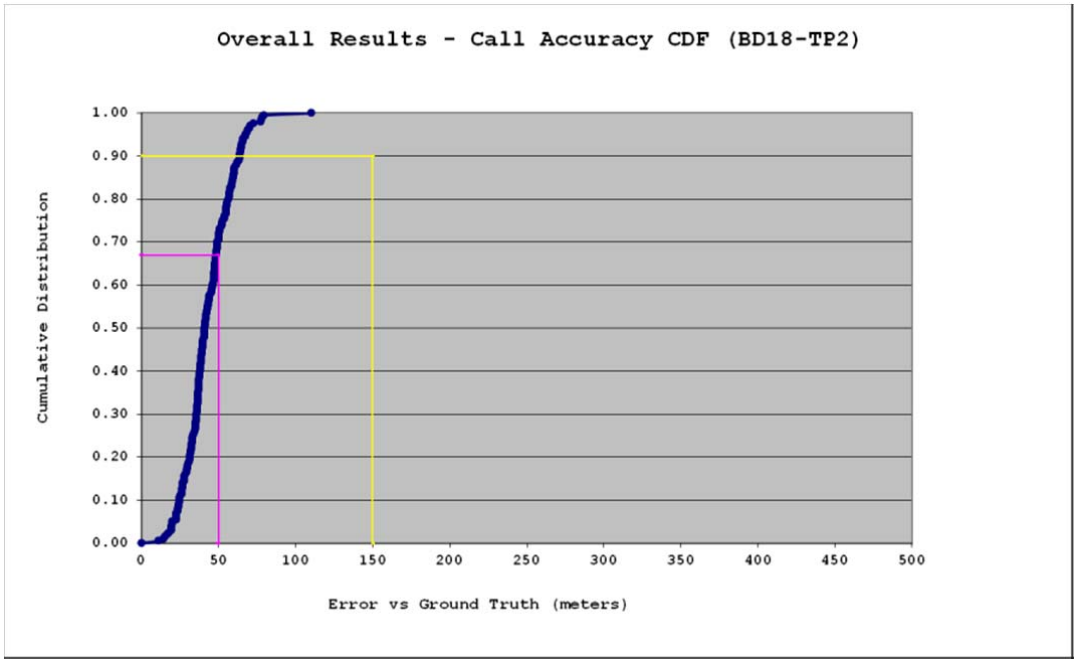
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD18_TP1	200	41.1	54.0	59.9	35.2	13.8	66.5	8.02
NextNav_BD18_TP2	200	48.7	64.1	67.7	43.6	14.9	110.2	11.43
NextNav_BD18_TP3	200	48.2	59.4	69.1	41.7	18.1	144.0	8.07
NextNav_BD18_TP4	200	65.0	76.8	81.5	61.9	10.8	86.5	26.37

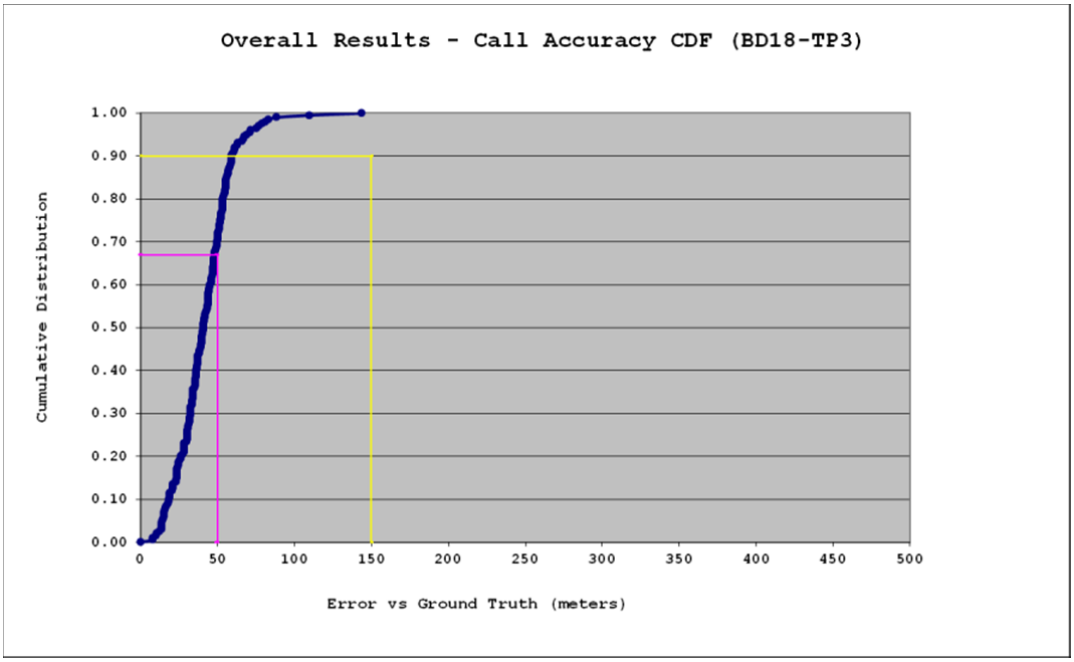
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD18_TP1	200	1.8	2.1	2.3	1.5	0.5	3.0	0.10
NextNav_BD18_TP2	200	2.3	2.6	2.8	2.1	0.5	3.2	0.63
NextNav_BD18_TP3	200	2.4	2.8	3.1	2.3	0.5	3.3	1.20
NextNav_BD18_TP4	200	2.5	2.8	3.0	2.3	0.4	3.8	1.01

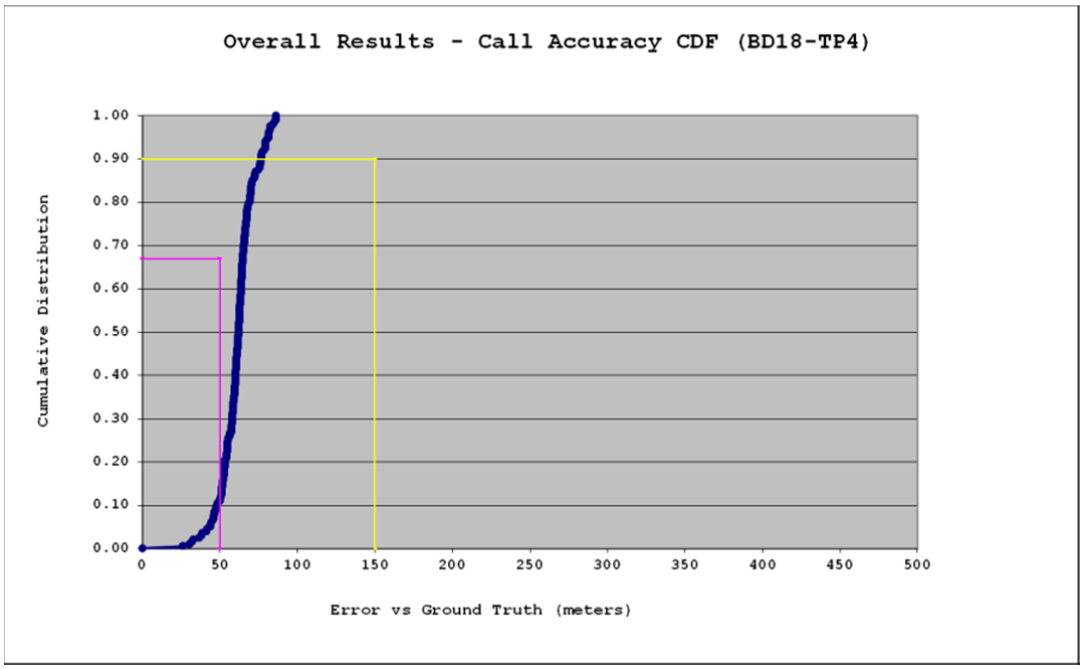
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD18_TP1	27.34	0.04	27.46	27.27
NextNav_BD18_TP2	27.37	0.50	32.34	27.27
NextNav_BD18_TP3	27.36	0.36	32.35	27.27
NextNav_BD18_TP4	27.36	0.36	32.44	27.27

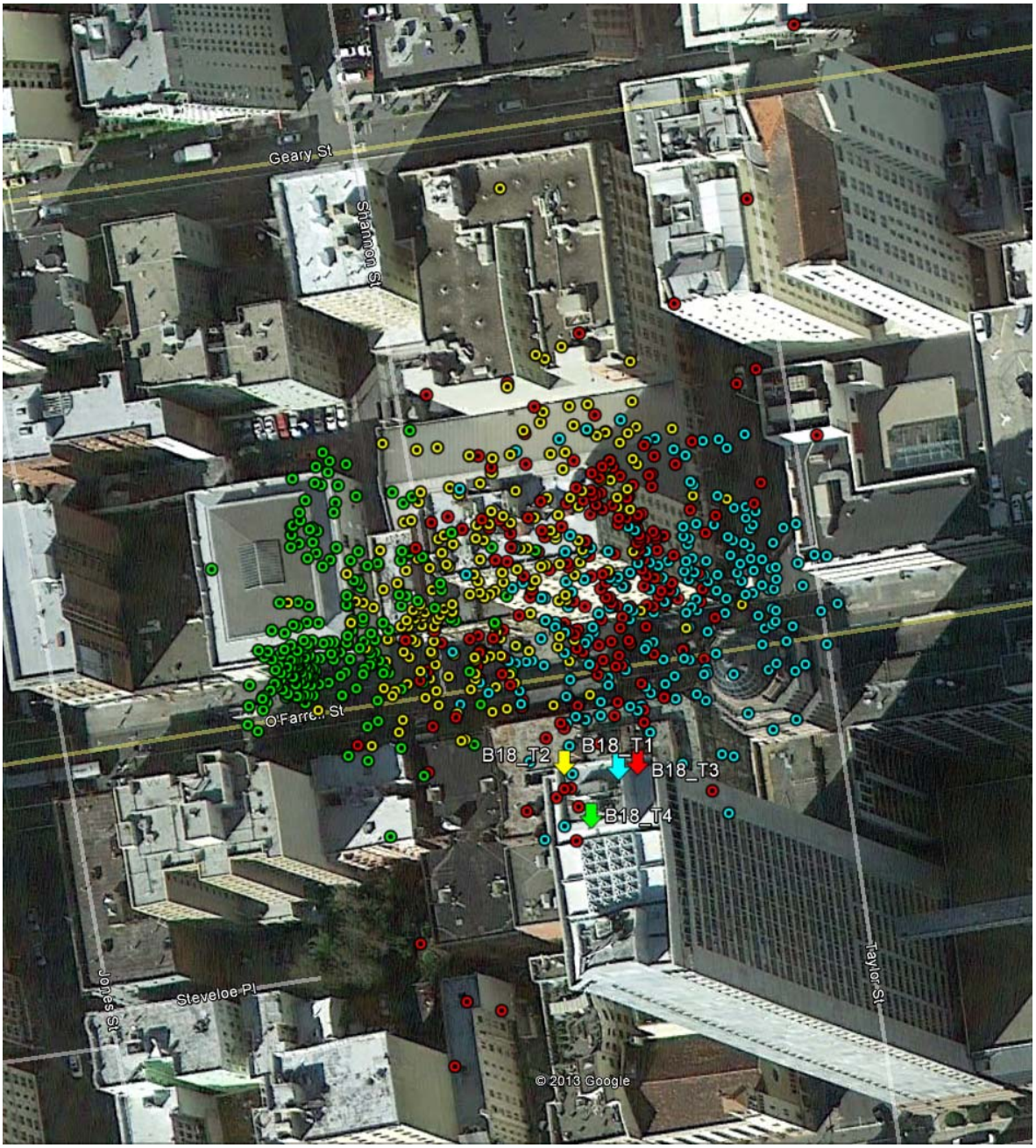
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD18_TP1	200	193	96.50%
NextNav_BD18_TP2	200	199	99.50%
NextNav_BD18_TP3	200	196	98.00%
NextNav_BD18_TP4	200	141	70.50%


Overall Results - Call Accuracy CDF (BD18-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Geary St
Shannon St
O'Farrell St
B18_T2
B18_T1
B18_T3
B18_T4
Steveloe Pl
Jones St
Taylor St
© 2013 Google

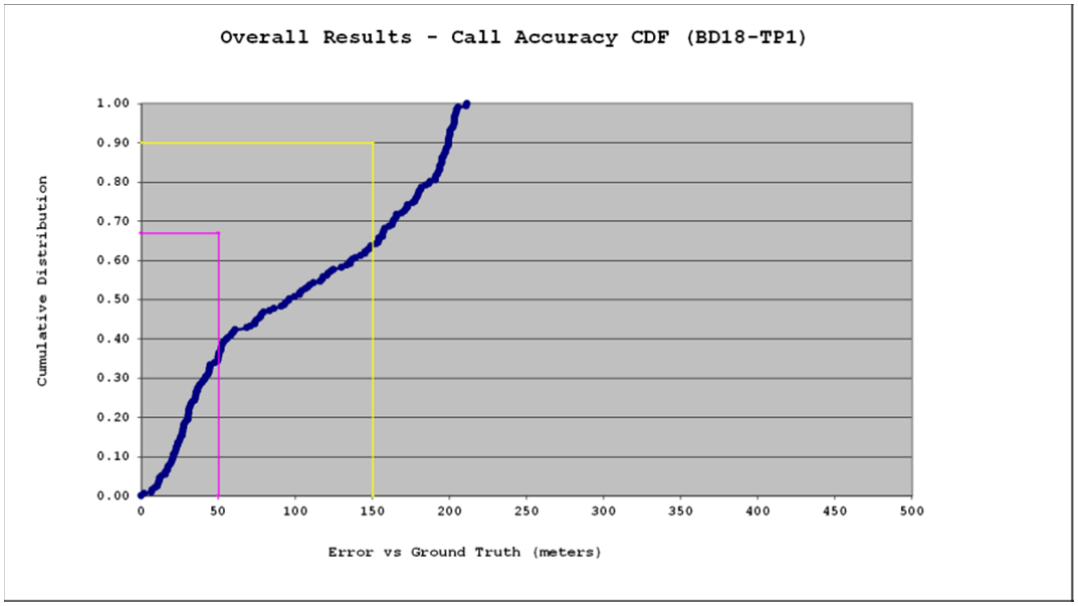
6.3.2.4.3 Polaris per Test Point Results—BD18:

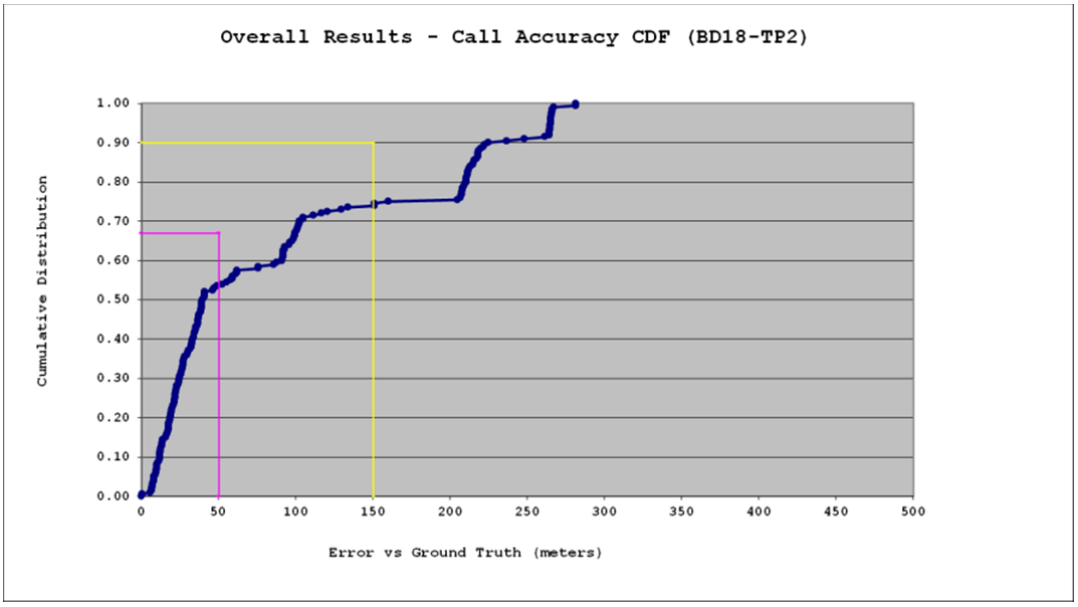
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD18_TP1	201	201	100.0%
Polaris_BD18_TP2	200	200	100.0%
Polaris_BD18_TP3	200	200	100.0%
Polaris_BD18_TP4	211	211	100.0%

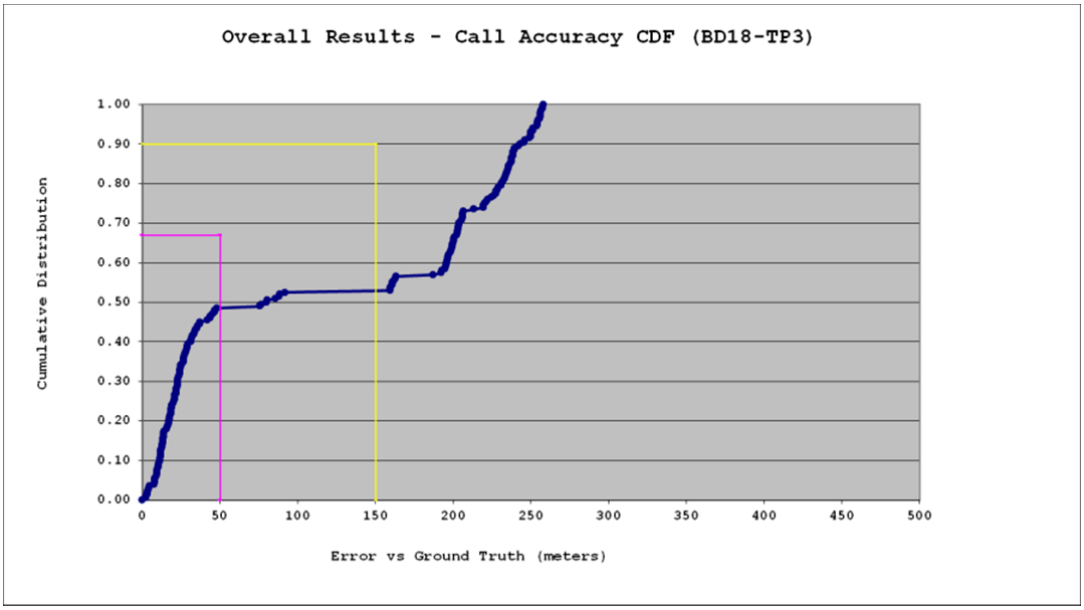
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD18_TP1	201	156.9	199.3	203.1	104.4	70.3	211.4	2.05
Polaris_BD18_TP2	200	99.8	225.7	264.9	91.5	89.0	281.4	0.39
Polaris_BD18_TP3	200	202.4	243.2	254.2	117.4	99.8	258.1	2.09
Polaris_BD18_TP4	211	206.4	468.5	717.9	247.9	378.4	3131.9	9.13

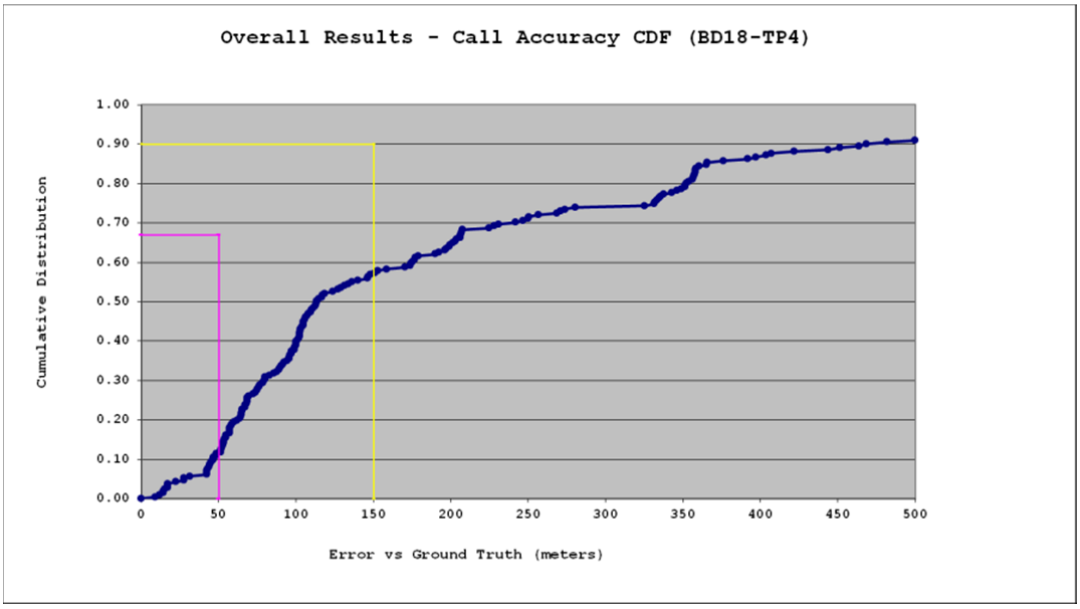
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD18_TP1	24.37	1.96	26.46	2.75
Polaris_BD18_TP2	24.75	1.07	26.88	19.31
Polaris_BD18_TP3	24.31	1.71	26.39	18.84
Polaris_BD18_TP4	22.68	6.24	29.32	1.58

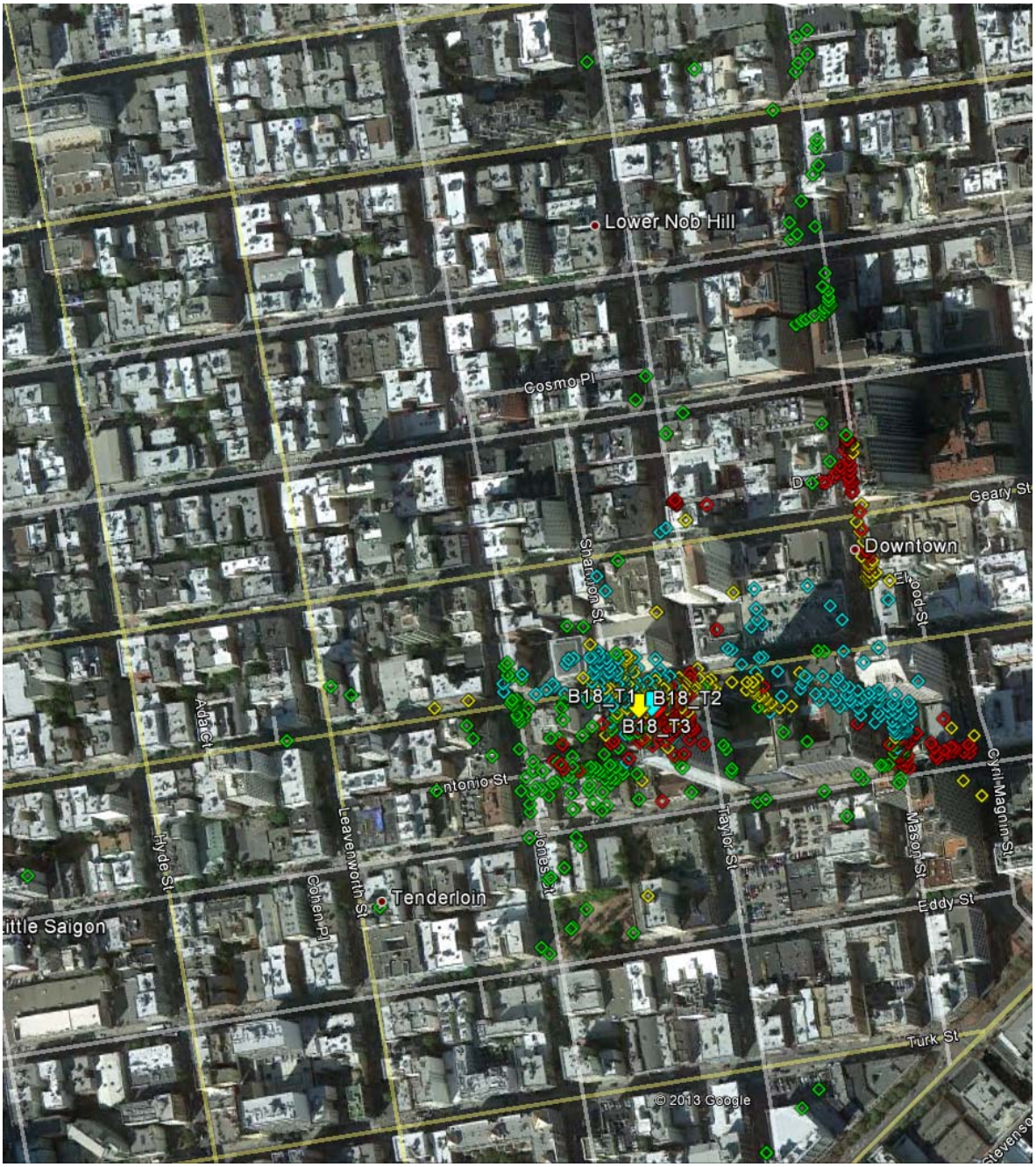
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD18_TP1	201	185	92.04%
Polaris_BD18_TP2	200	137	68.50%
Polaris_BD18_TP3	200	113	56.50%
Polaris_BD18_TP4	211	148	70.14%


Overall Results - Call Accuracy CDF (BD18-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Lower Nob Hill
Cosmo Pl
Geary St
Downtown
Taylor St
Mason St
Eddy St
Turk St
Tenderloin
Leavenworth St
Jones St
Hyde St
Cohen Pl
Ada Ct
B18_T1
B18_T2
B18_T3
© 2013 Google

6.3.2.4.4 Qualcomm per Test Point Results—BD18:

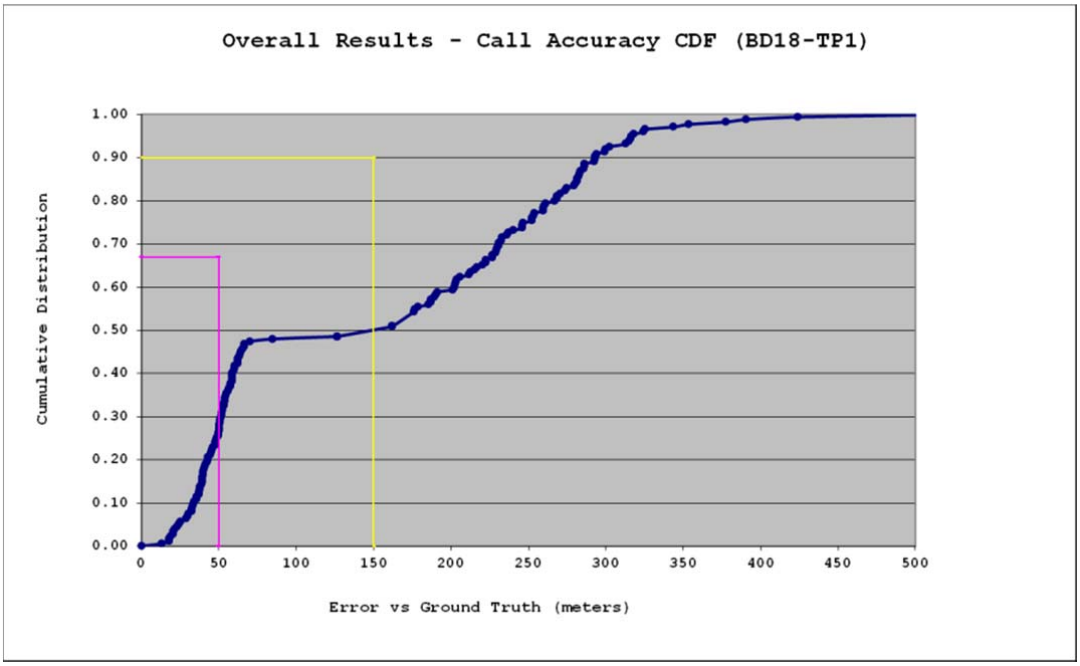
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD18_TP1	180	175	97.2%
Qualcomm_BD18_TP2	180	178	98.9%
Qualcomm_BD18_TP3	180	155	86.1%
Qualcomm_BD18_TP4	180	169	93.9%

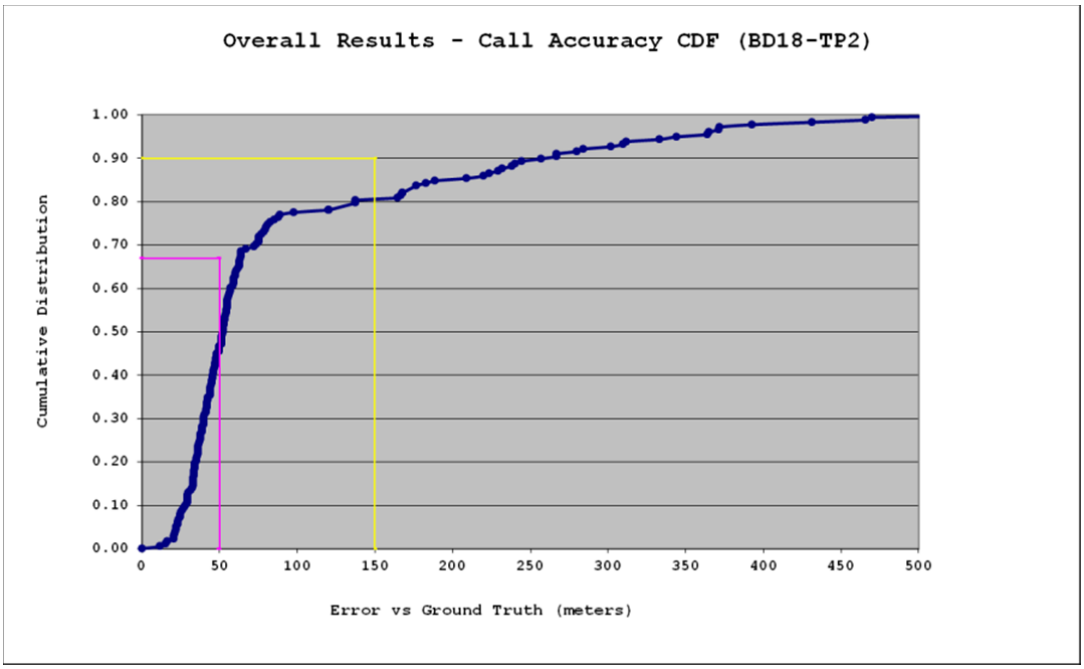
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD18_TP1	175	226.7	293.1	317.1	151.3	112.5	519.8	13.03
Qualcomm_BD18_TP2	178	63.7	259.9	347.1	96.0	105.8	575.8	11.90
Qualcomm_BD18_TP3	155	309.8	356.6	406.5	172.3	154.6	589.8	3.82
Qualcomm_BD18_TP4	169	238.5	334.1	398.3	158.6	138.7	622.7	10.29

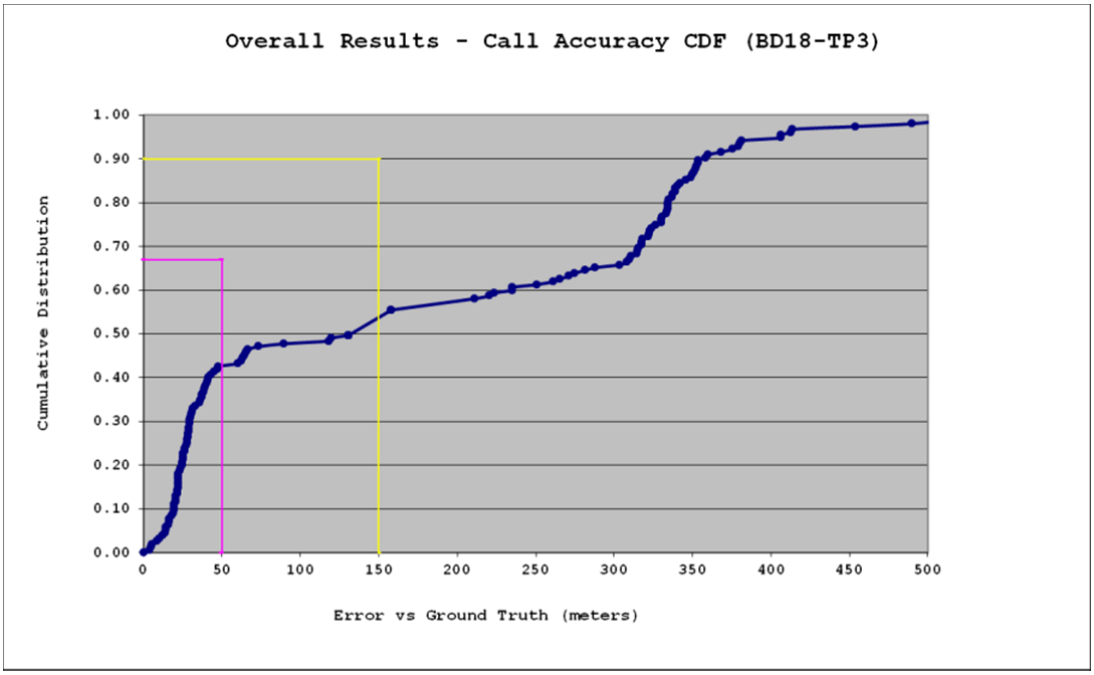
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD18_TP1	Number of Calls	10	9	146	8	0	0	2	0	175
	Percentage	5.7%	5.1%	83.4%	4.6%	0.0%	0.0%	1.1%	0.0%	100.0%
Qualcomm_BD18_TP2	Number of Calls	6	3	65	104	0	0	0	0	178
	Percentage	3.4%	1.7%	36.5%	58.4%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD18_TP3	Number of Calls	13	49	30	0	35	1	27	0	155
	Percentage	8.4%	31.6%	19.4%	0.0%	22.6%	0.6%	17.4%	0.0%	100.0%
Qualcomm_BD18_TP4	Number of Calls	9	6	144	10	0	0	0	0	169
	Percentage	5.3%	3.6%	85.2%	5.9%	0.0%	0.0%	0.0%	0.0%	100.0%

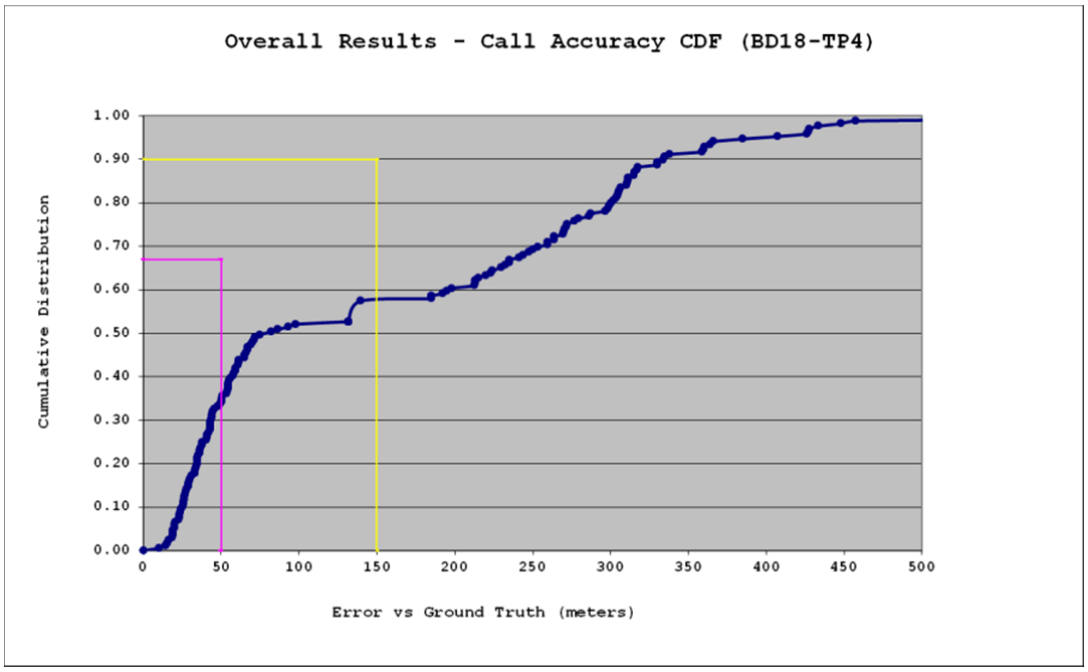
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD18_TP1	25.66	4.84	62.00	18.00
Qualcomm_BD18_TP2	24.47	1.59	27.00	16.00
Qualcomm_BD18_TP3	31.03	7.14	91.00	19.00
Qualcomm_BD18_TP4	25.89	4.24	46.00	18.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD18_TP1	175	173	98.86%
Qualcomm_BD18_TP2	178	144	80.90%
Qualcomm_BD18_TP3	155	154	99.35%
Qualcomm_BD18_TP4	169	163	96.45%


Overall Results - Call Accuracy CDF (BD18-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD18-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

6.3.2.5 Building 19:

6.3.2.5.1 Building 19 Environment and Test Points:

Building 19 is the 88 San Jose Condominium high rise Bldg (22 floors) in downtown San Jose located at 88 E. San Fernando Street, San Jose. Building is surrounded by much shorter buildings with tall buildings further away.

TP1: Deep inside building lobby

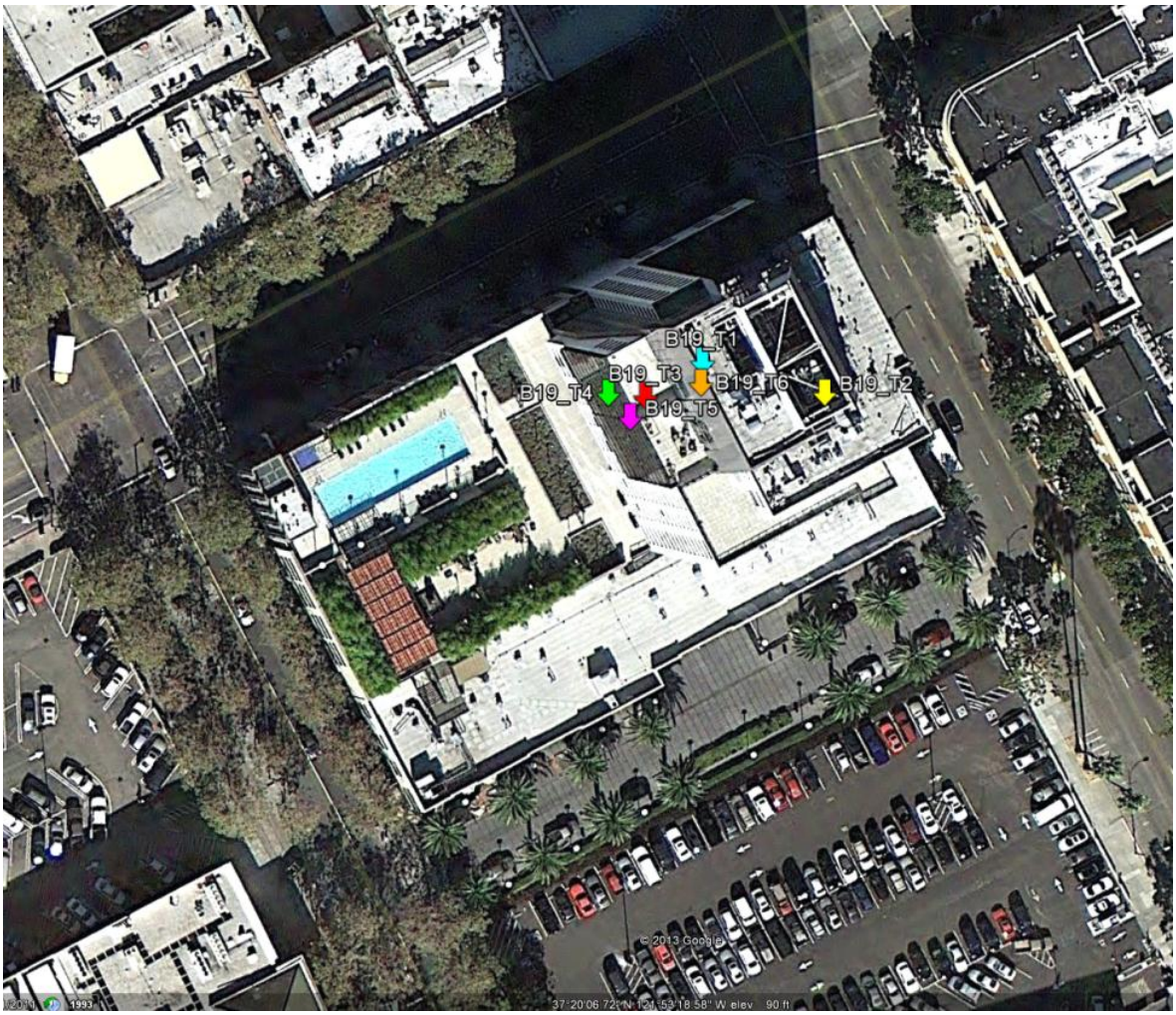
TP2: Corner of 2nd floor garage (exterior)

TP3: 5th floor stairwell

TP4: 5th floor common area (outside room)

TP5: 21 floor Observation room (with very large, 25 ft. tall window)

TP6: 10th floor hallway (interior)



6.3.2.5.2 NextNav per Test Point Results—BD19:

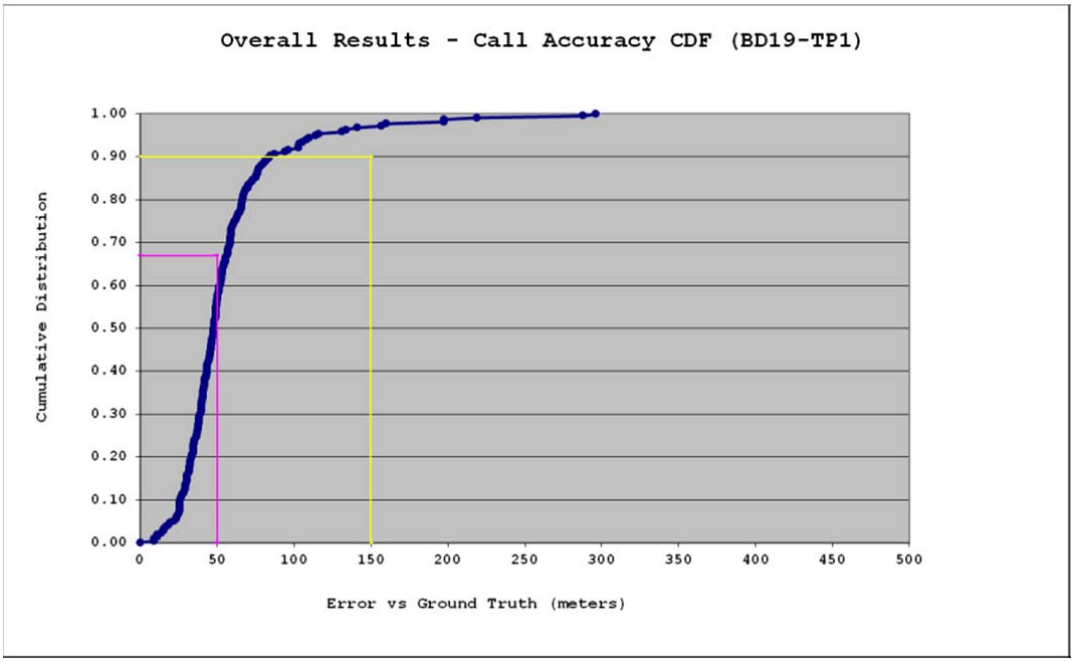
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD19_TP1	215	215	100.0%
NextNav_BD19_TP2	200	200	100.0%
NextNav_BD19_TP3	200	165	82.5%
NextNav_BD19_TP4	200	200	100.0%
NextNav_BD19_TP5	200	200	100.0%
NextNav_BD19_TP6	200	198	99.0%

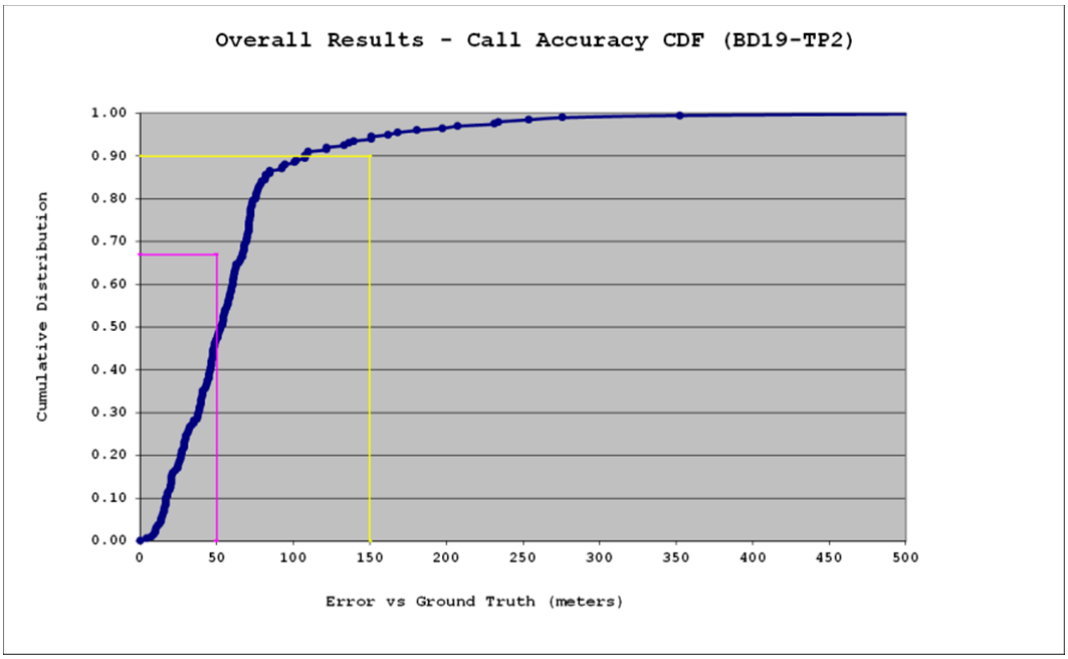
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD19_TP1	215	56.9	84.3	114.7	56.0	38.2	296.1	8.99
NextNav_BD19_TP2	200	67.4	107.9	162.1	63.9	60.2	562.6	4.25
NextNav_BD19_TP3	165	198.7	259.0	282.2	199.9	57.9	617.2	62.81
NextNav_BD19_TP4	200	33.8	43.5	50.0	33.8	30.1	305.8	6.01
NextNav_BD19_TP5	200	23.1	33.4	87.1	26.8	27.8	169.2	3.26
NextNav_BD19_TP6	198	98.4	129.1	144.1	81.9	48.3	332.8	2.81

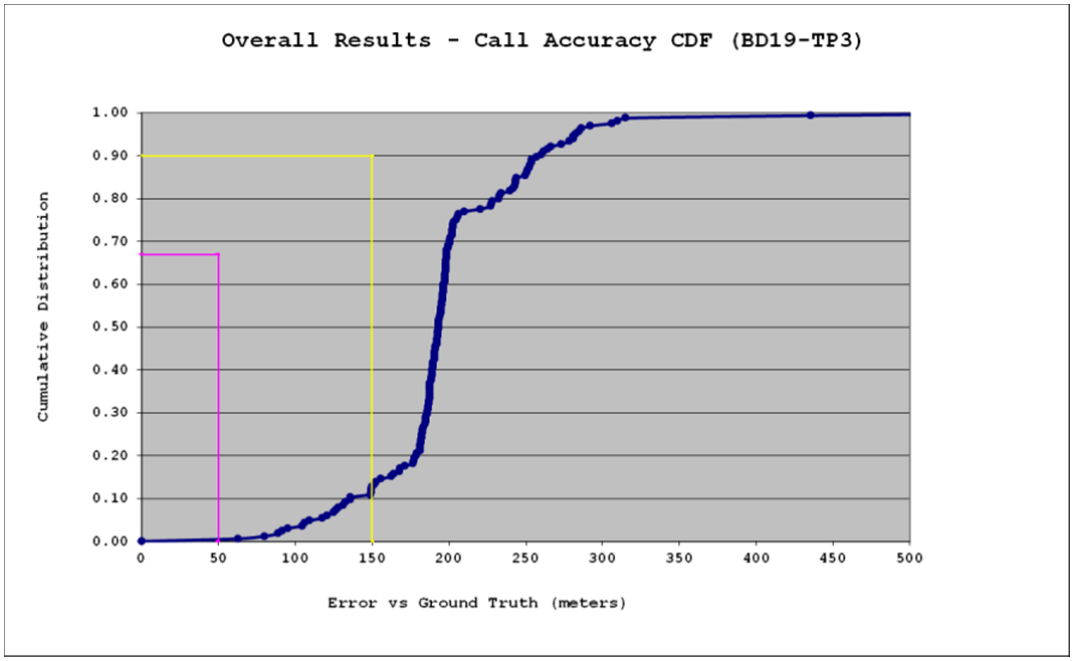
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD19_TP1	215	0.8	1.3	4.0	0.8	1.0	4.6	0.03
NextNav_BD19_TP2	200	2.1	2.3	2.5	1.9	0.3	2.7	1.10
NextNav_BD19_TP3	165	1.2	1.6	1.6	1.0	0.4	2.1	0.01
NextNav_BD19_TP4	200	1.1	1.3	1.4	0.9	0.4	2.1	0.01
NextNav_BD19_TP5	200	0.4	0.8	0.9	0.4	0.3	1.3	0.01
NextNav_BD19_TP6	198	0.6	0.9	1.2	0.5	0.3	1.4	0.02

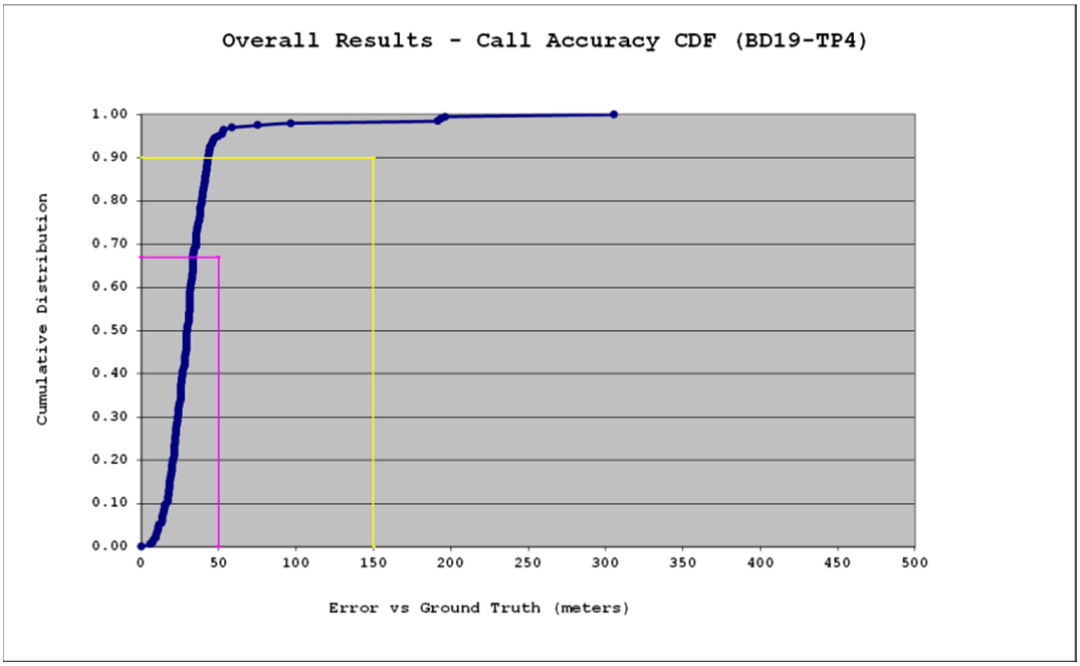
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD19_TP1	27.47	0.97	32.35	14.61
NextNav_BD19_TP2	27.53	0.21	27.98	27.00
NextNav_BD19_TP3	27.56	0.31	28.00	26.99
NextNav_BD19_TP4	27.49	0.37	32.30	26.40
NextNav_BD19_TP5	27.35	0.05	27.55	27.27
NextNav_BD19_TP6	27.66	0.55	32.59	26.95

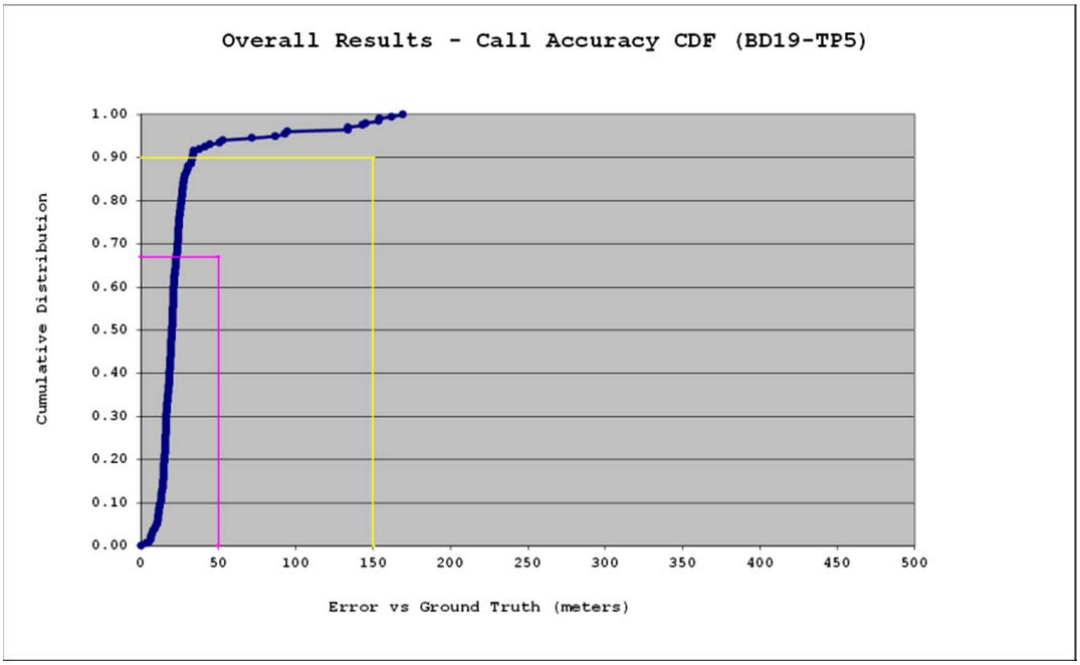
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD19_TP1	215	207	96.28%
NextNav_BD19_TP2	200	166	83.00%
NextNav_BD19_TP3	165	119	72.12%
NextNav_BD19_TP4	200	190	95.00%
NextNav_BD19_TP5	200	191	95.50%
NextNav_BD19_TP6	198	137	69.19%

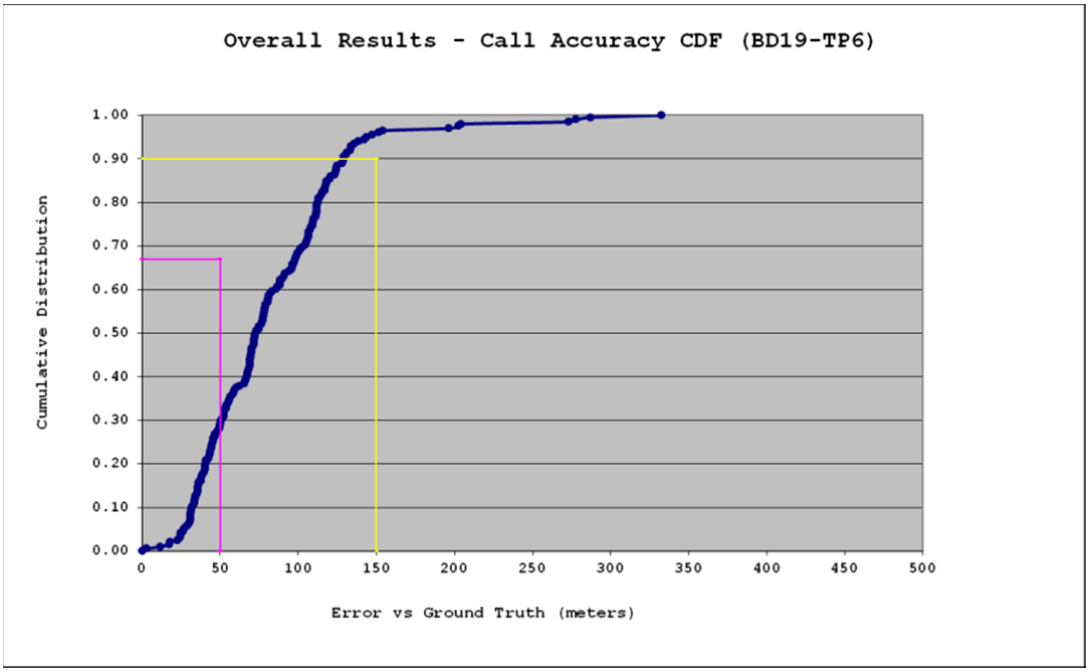

Overall Results - Call Accuracy CDF (BD19-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

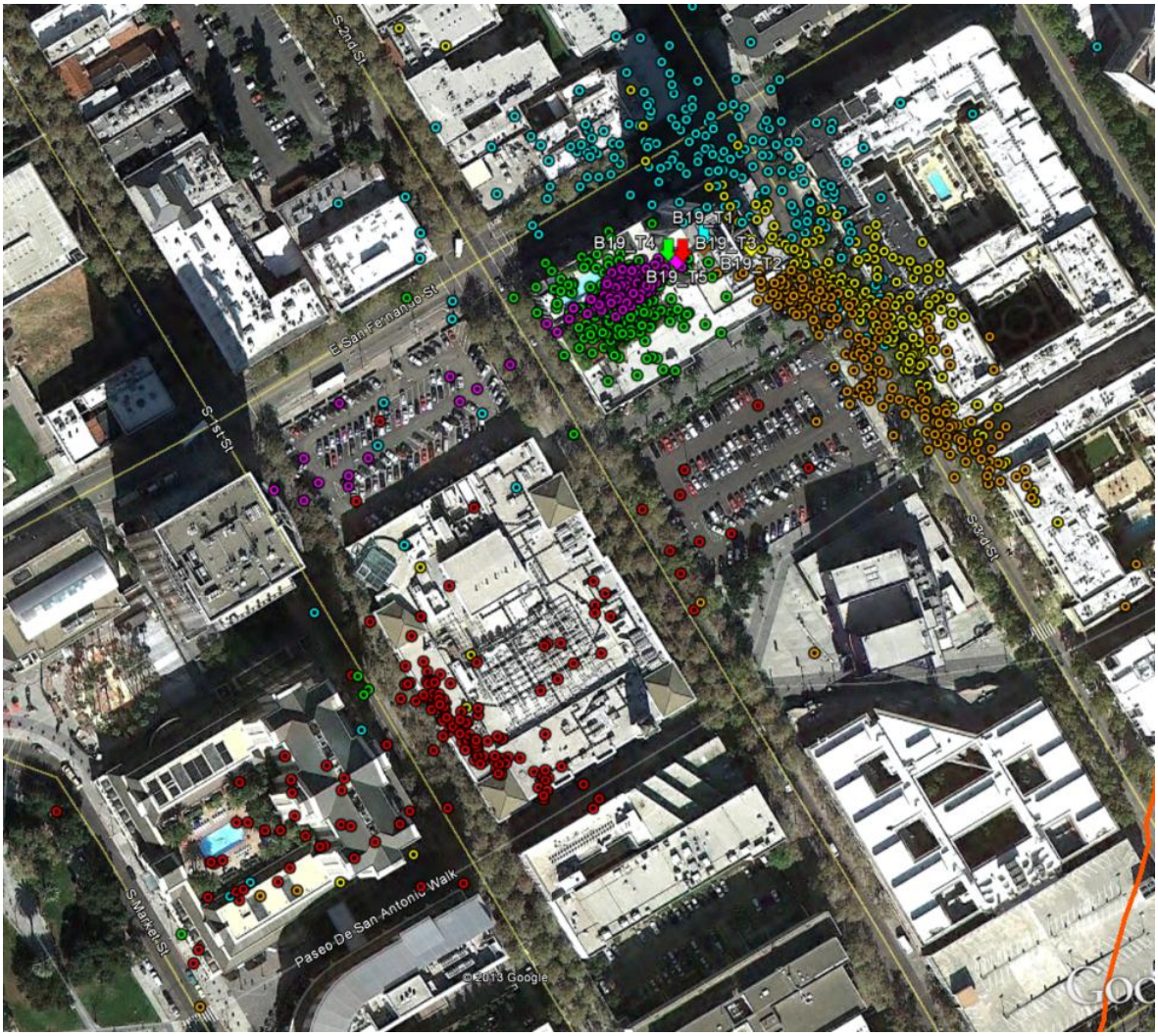

Overall Results - Call Accuracy CDF (BD19-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP6)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



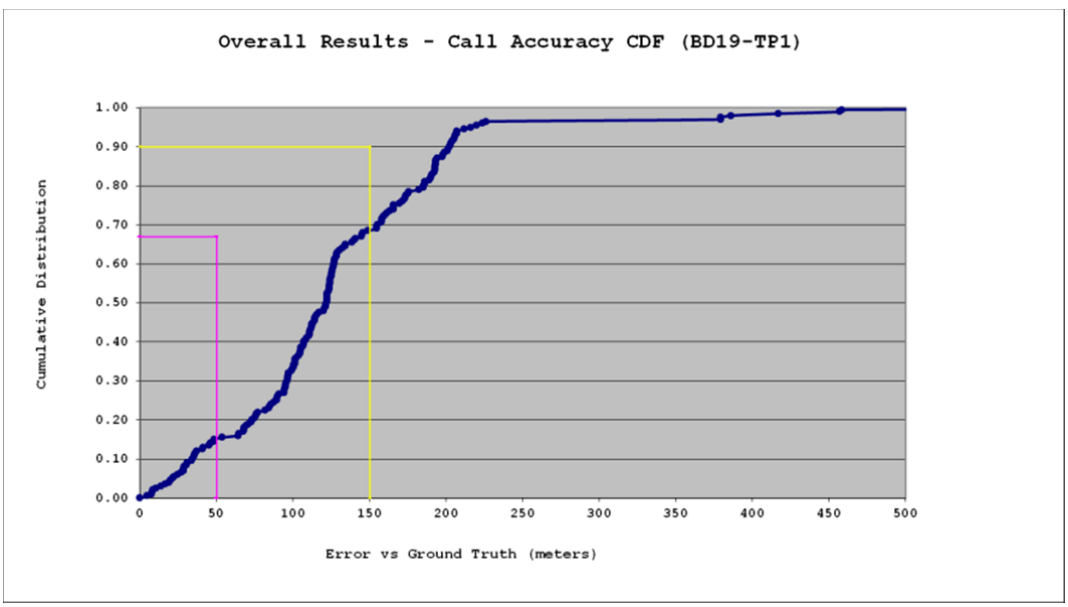
6.3.2.5.3 Polaris per Test Point Results—BD19:

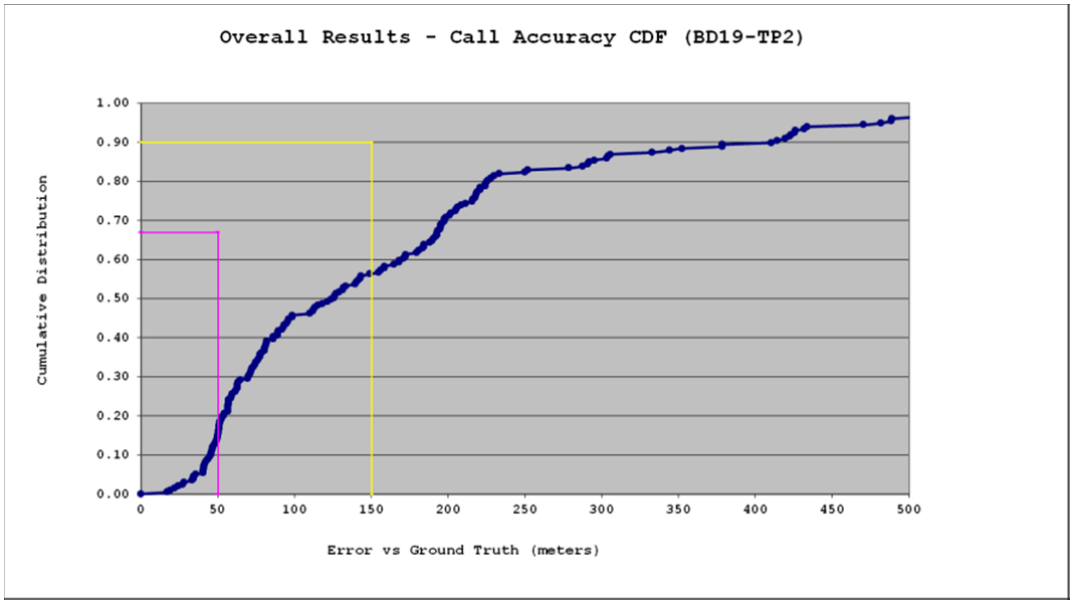
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD19_TP1	**200**	**200**	**100.0%**
Polaris_BD19_TP2	**199**	**199**	**100.0%**
Polaris_BD19_TP3	**100**	**100**	**100.0%**
Polaris_BD19_TP4	**200**	**200**	**100.0%**
Polaris_BD19_TP5	**200**	**200**	**100.0%**
Polaris_BD19_TP6	**136**	**135**	**99.3%**

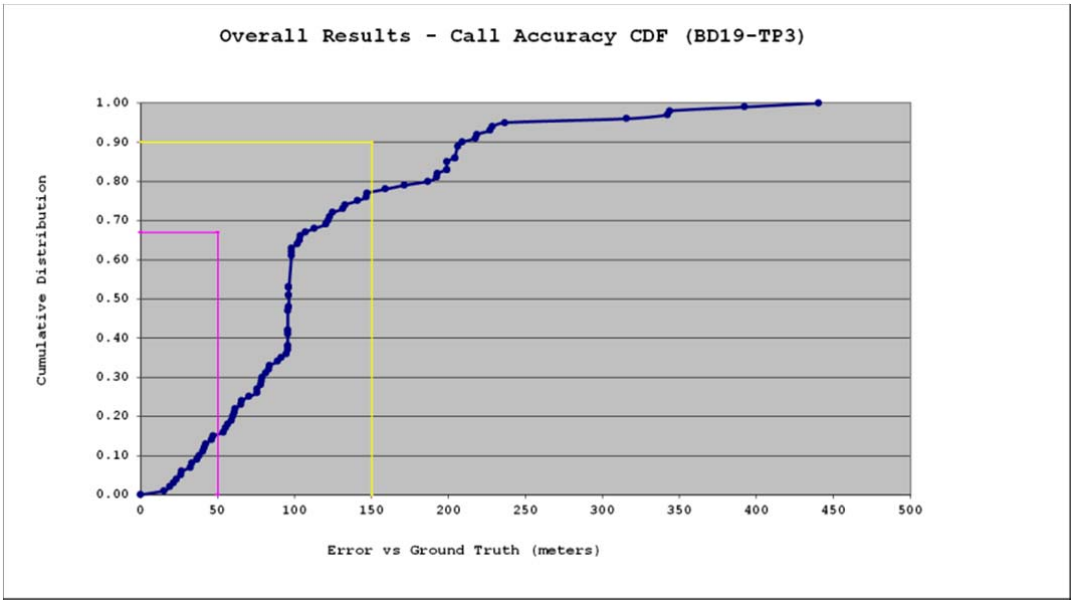
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD19_TP1	200	144.9	202.4	216.1	130.6	89.5	828.4	4.61
Polaris_BD19_TP2	199	193.2	410.9	482.5	172.5	160.1	849.3	16.83
Polaris_BD19_TP3	100	108.8	209.7	240.3	118.0	79.8	440.1	14.92
Polaris_BD19_TP4	200	170.1	323.7	346.1	156.6	88.3	400.0	18.30
Polaris_BD19_TP5	200	888.9	1032.8	1359.1	752.4	337.3	2727.6	140.31
Polaris_BD19_TP6	135	397.8	460.5	530.7	344.4	145.8	1138.1	49.26

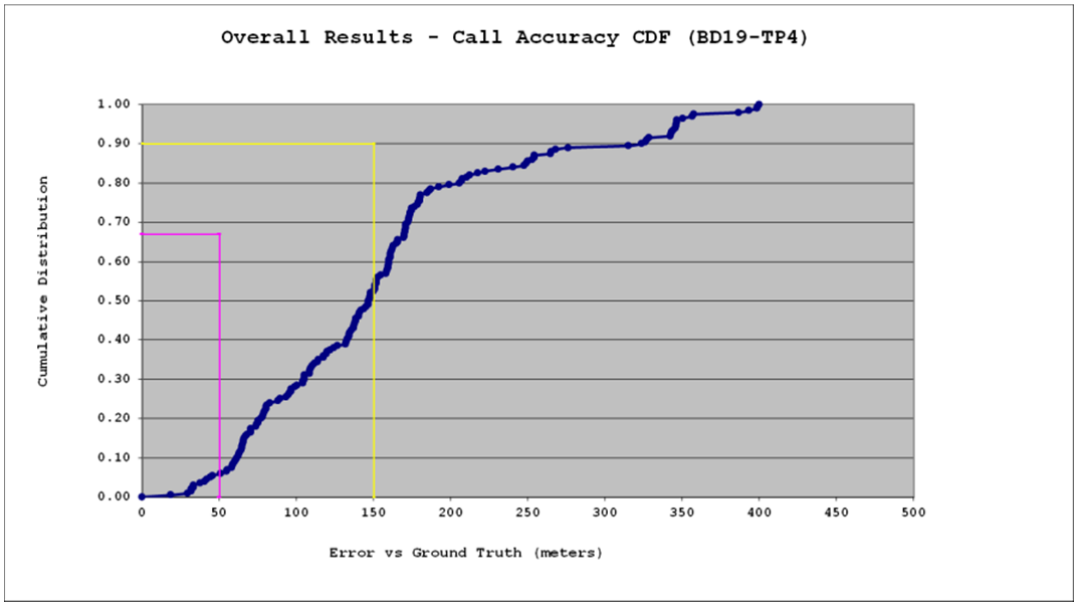
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD19_TP1	24.38	1.18	26.47	20.30
Polaris_BD19_TP2	23.51	2.10	26.39	16.72
Polaris_BD19_TP3	23.64	1.94	26.22	16.00
Polaris_BD19_TP4	24.14	1.65	26.15	18.77
Polaris_BD19_TP5	26.00	0.98	27.91	22.28
Polaris_BD19_TP6	23.59	3.67	28.76	4.69

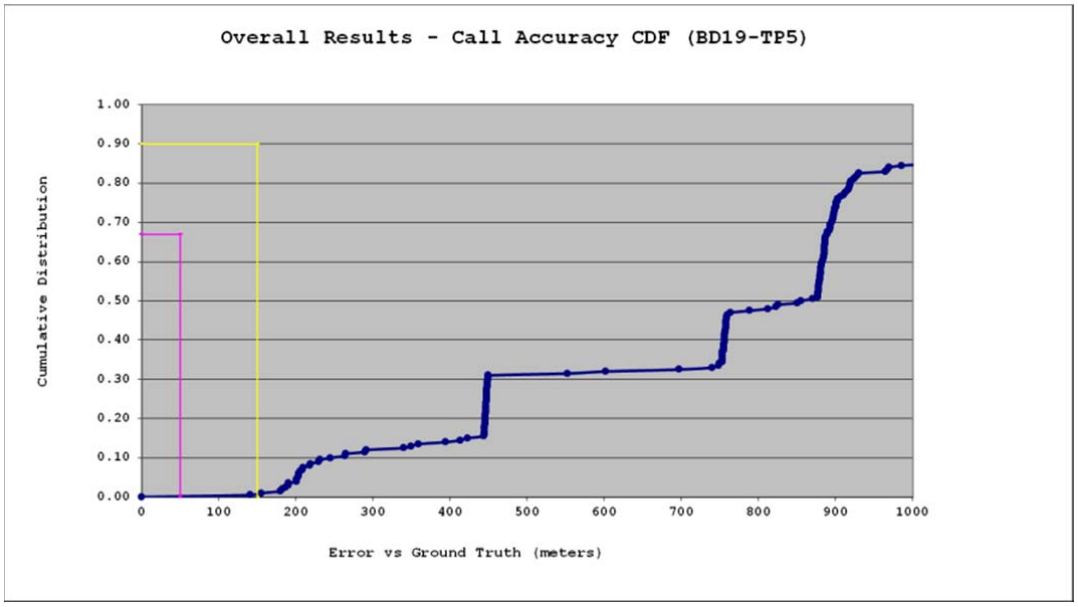
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD19_TP1	200	173	86.50%
Polaris_BD19_TP2	199	162	81.41%
Polaris_BD19_TP3	100	100	100.00%
Polaris_BD19_TP4	200	146	73.00%
Polaris_BD19_TP5	200	55	27.50%
Polaris_BD19_TP6	135	46	34.07%

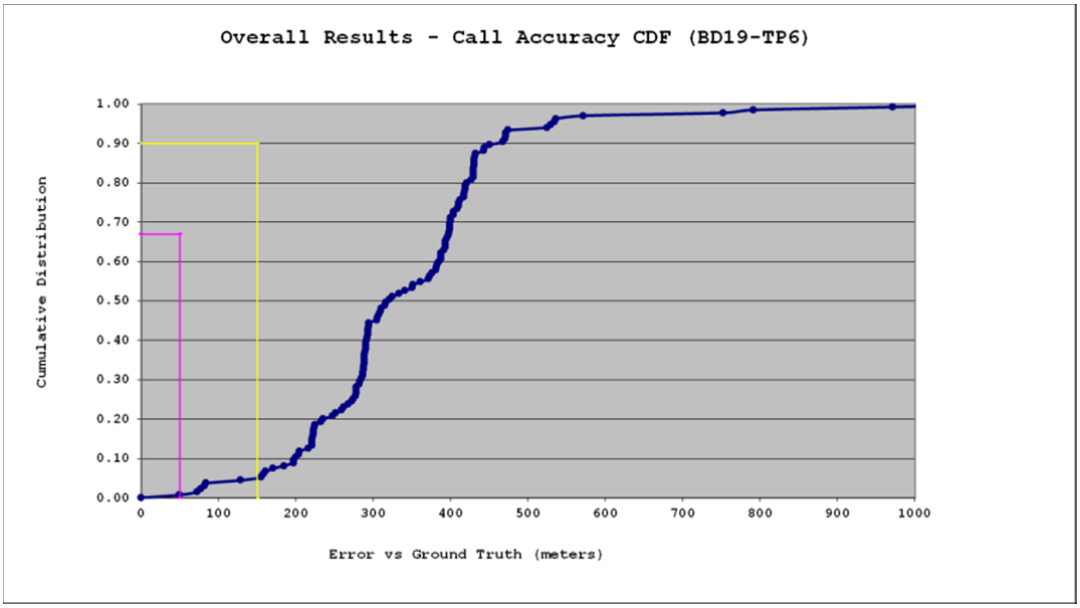


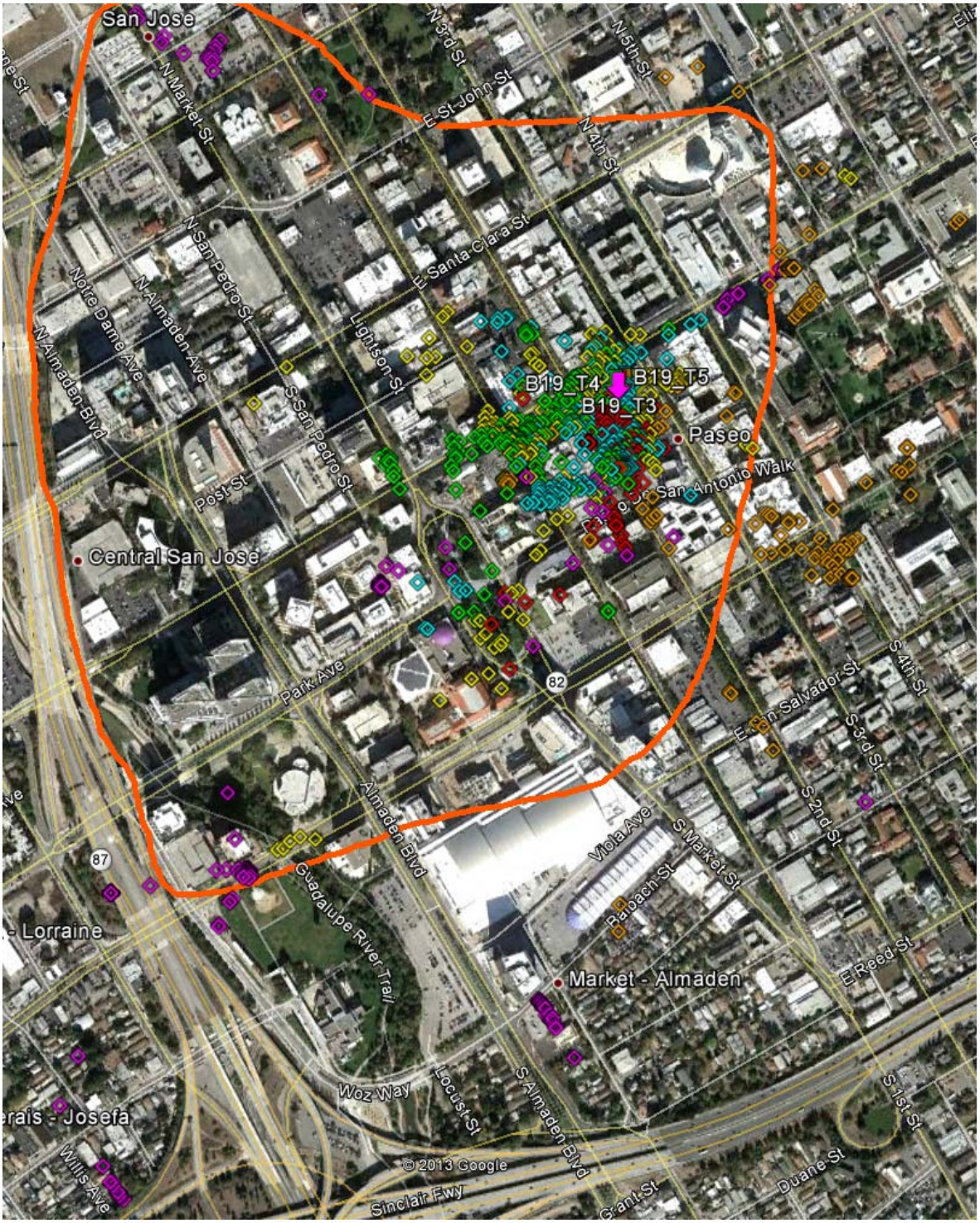

Overall Results - Call Accuracy CDF (BD19-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP6)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


San Jose
N Market St
E St John St
N 3rd St
N 5th St
N 4th St
E Santa Clara St
N San Pedro St
Notre Dame Ave
N Almaden Ave
N Almaden Blvd
Lightson St
S San Pedro St
Post St
B19_T4
B19_T5
B19_T3
Paseo
San Antonio Walk
Central San Jose
Park Ave
82
E San Salvador St
S 4th St
S 3rd St
S 2nd St
Almaden Blvd
Viola Ave
S Market St
Rabach St
Guadalupe River Trail
87
Lorraine
Market - Almaden
E Reed St
Woz Way
Locust St
S Almaden Blvd
S 1st St
Josefa
© 2013 Google
Sinclair Fwy
Grant St
Duane St
Willis Ave

6.3.2.5.4 Qualcomm per Test Point Results—BD19:

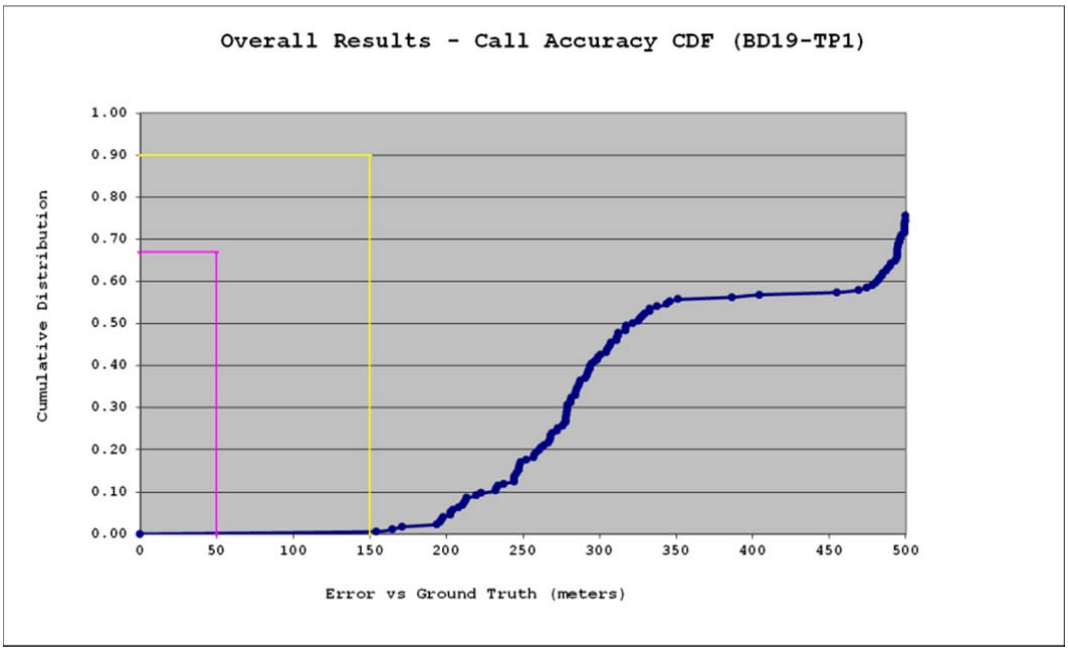
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD19_TP1	180	176	97.8%
Qualcomm_BD19_TP2	180	156	86.7%
Qualcomm_BD19_TP3	165	89	53.9%
Qualcomm_BD19_TP4	180	173	96.1%
Qualcomm_BD19_TP5	180	178	98.9%
Qualcomm_BD19_TP6	176	122	69.3%

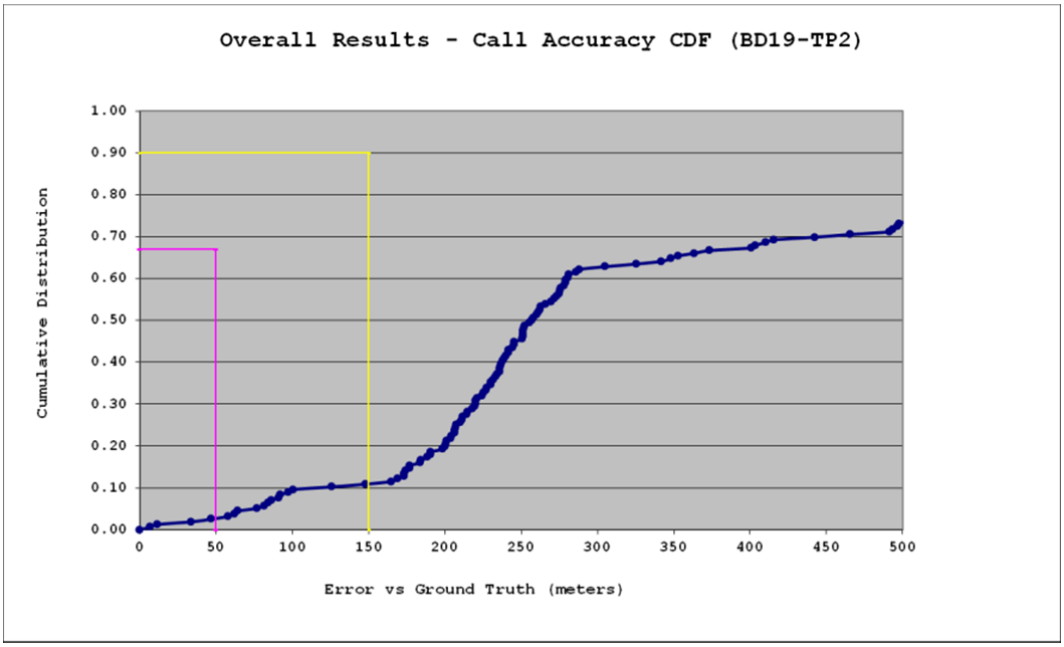
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD19_TP1	176	494.5	513.6	518.7	372.8	120.4	547.3	154.16
Qualcomm_BD19_TP2	156	396.7	555.5	559.9	315.3	160.0	722.9	6.62
Qualcomm_BD19_TP3	89	501.5	501.5	502.5	342.1	162.4	589.9	7.90
Qualcomm_BD19_TP4	173	485.7	499.3	514.2	358.0	139.7	586.2	89.58
Qualcomm_BD19_TP5	178	250.2	507.6	540.5	252.3	250.5	2403.4	9.18
Qualcomm_BD19_TP6	122	254.5	323.1	444.4	242.4	241.5	2405.1	33.41

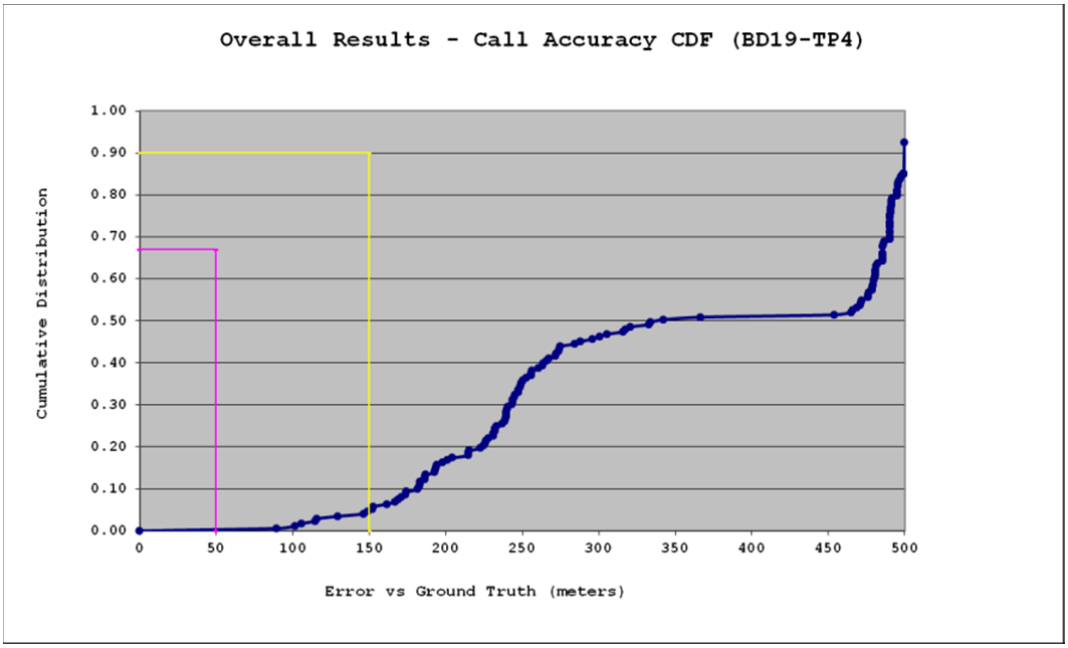
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD19_TP1	Number of Calls	5	94	1	0	72	0	4	0	176
	Percentage	2.8%	53.4%	0.6%	0.0%	40.9%	0.0%	2.3%	0.0%	100.0%
Qualcomm_BD19_TP2	Number of Calls	7	94	11	0	42	0	2	0	156
	Percentage	4.5%	60.3%	7.1%	0.0%	26.9%	0.0%	1.3%	0.0%	100.0%
Qualcomm_BD19_TP3	Number of Calls	30	39	0	0	13	4	3	0	89
	Percentage	33.7%	43.8%	0.0%	0.0%	14.6%	4.5%	3.4%	0.0%	100.0%
Qualcomm_BD19_TP4	Number of Calls	13	80	7	0	66	1	6	0	173
	Percentage	7.5%	46.2%	4.0%	0.0%	38.2%	0.6%	3.5%	0.0%	100.0%
Qualcomm_BD19_TP5	Number of Calls	10	9	113	27	4	0	15	0	178
	Percentage	5.6%	5.1%	63.5%	15.2%	2.2%	0.0%	8.4%	0.0%	100.0%
Qualcomm_BD19_TP6	Number of Calls	2	114	0	0	2	4	0	0	122
	Percentage	1.6%	93.4%	0.0%	0.0%	1.6%	3.3%	0.0%	0.0%	100.0%

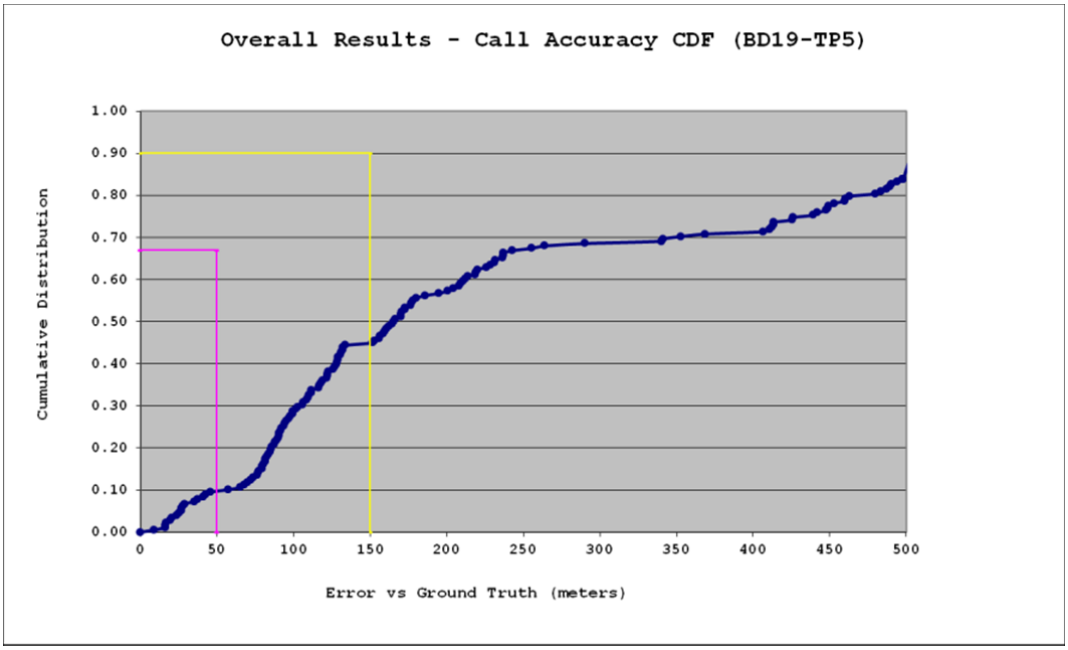
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD19_TP1	31.83	3.49	64.00	18.00
Qualcomm_BD19_TP2	32.63	8.09	92.00	19.00
Qualcomm_BD19_TP3	33.58	14.64	94.00	2.00
Qualcomm_BD19_TP4	31.55	4.80	49.00	15.00
Qualcomm_BD19_TP5	27.13	9.54	94.00	18.00
Qualcomm_BD19_TP6	34.30	7.48	56.00	15.00

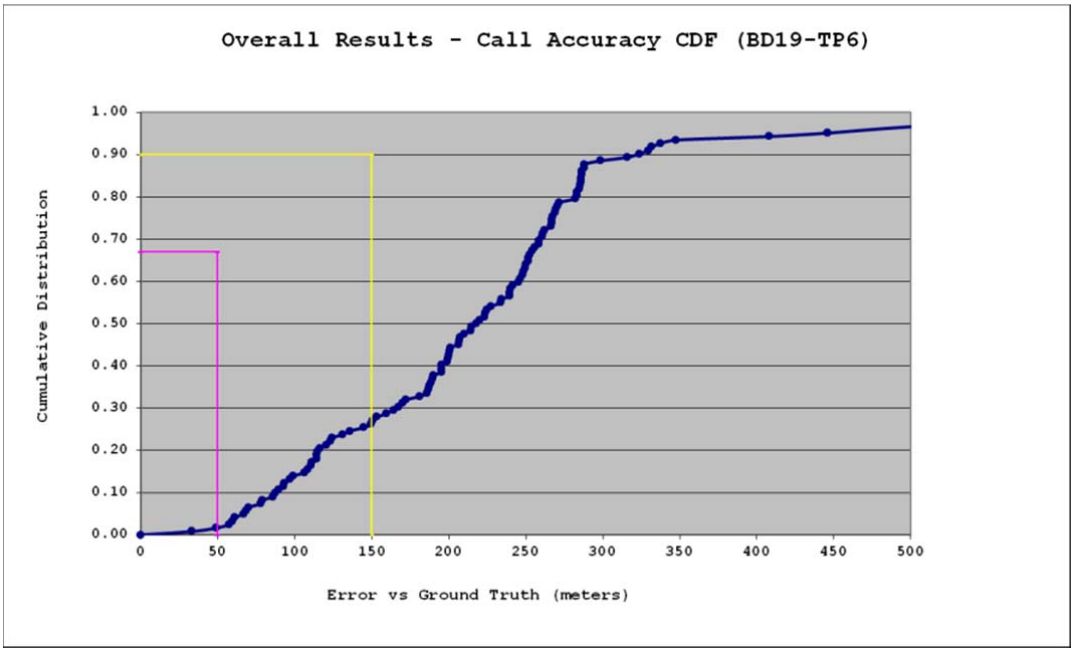
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD19_TP1	176	125	71.02%
Qualcomm_BD19_TP2	156	148	94.87%
Qualcomm_BD19_TP3	89	83	93.26%
Qualcomm_BD19_TP4	173	150	86.71%
Qualcomm_BD19_TP5	178	130	73.03%
Qualcomm_BD19_TP6	122	108	88.52%






Overall Results - Call Accuracy CDF (BD19-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD19-TP6)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


N 4th St
Sixth St
N 1st St
E Santa Clara St
S 3rd St
N Market St
W Santa Clara St
Fountain Alley
Lightson St
S 1st St
S San Pedro St
B19_T5
B19_T4
B19_T3
Paseo
Paseo De San Antonio Walk
E San Carlos St
S Market St
Park Ave
© 2013 Google
Salvador St

6.3.3 Suburban Buildings

6.3.3.1 Building 6:

6.3.3.1.1 Building 6 Environment and Test Points:

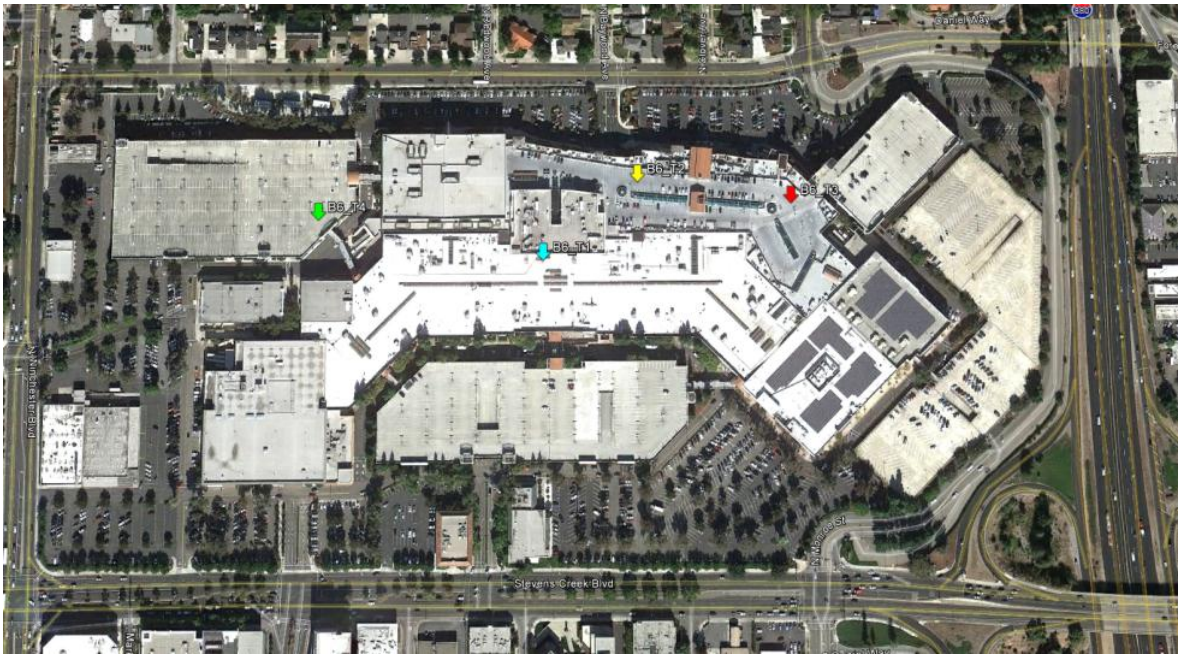
Building 6 is the Westfield Valley Fair Mall, in Santa Clara. It's the largest shopping mall in the area. It has typical 2-3 story suburban major mall construction.

TP1: In middle of first floor, open area away from atrium

TP2: First floor, interior of Forest Ave entrance

TP3: 2nd floor (upper level) near doors to parking structure C

TP4: Street level inside parking structure B



6.3.3.1.2 NextNav per Test Point Results—BD6:

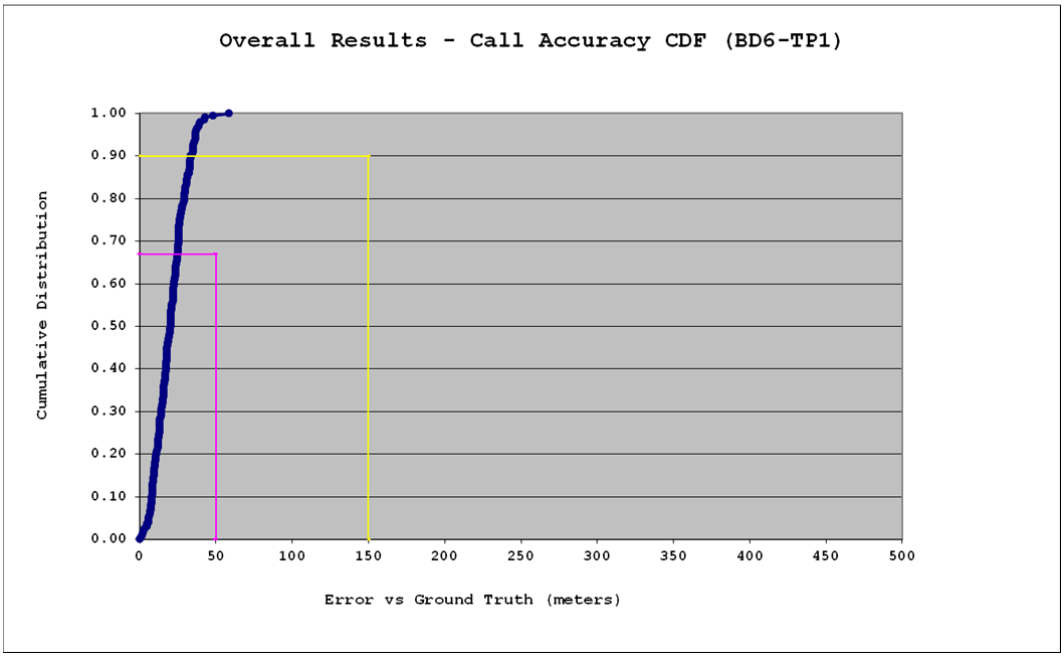
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD6_TP1	**200**	**200**	**100.0%**
NextNav_BD6_TP2	**225**	**225**	**100.0%**
NextNav_BD6_TP3	**200**	**200**	**100.0%**
NextNav_BD6_TP4	**200**	**200**	**100.0%**

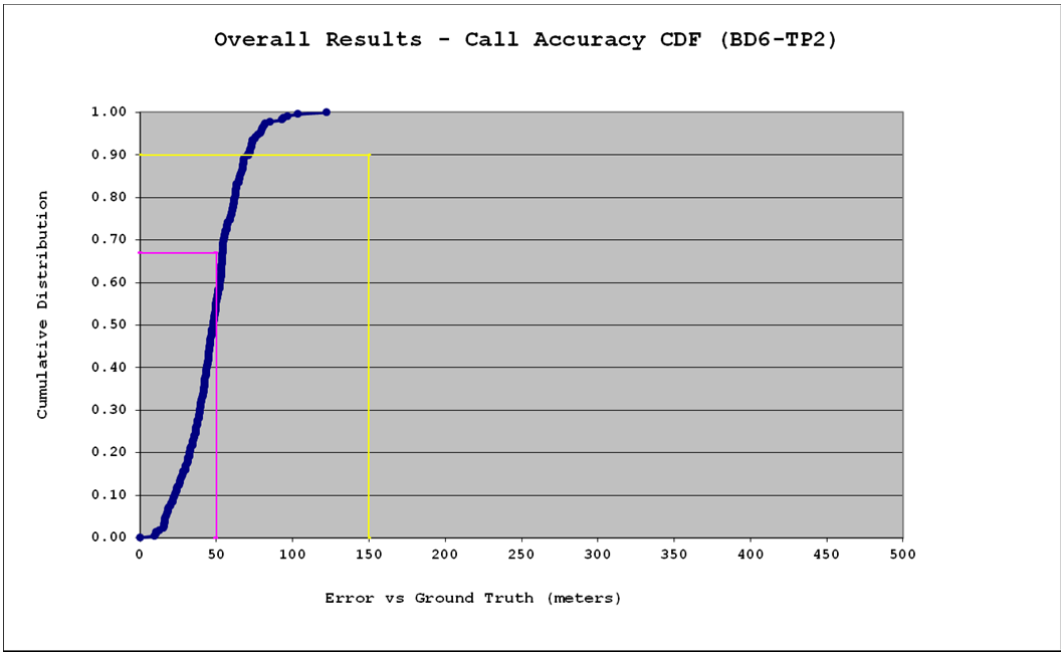
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD6_TP1	200	25.1	33.8	36.8	20.7	9.9	58.5	1.43
NextNav_BD6_TP2	225	54.3	71.3	78.8	48.2	18.4	122.3	9.57
NextNav_BD6_TP3	200	29.2	36.8	40.4	25.5	9.6	59.2	3.20
NextNav_BD6_TP4	200	35.4	45.8	49.8	32.7	10.0	65.2	5.22

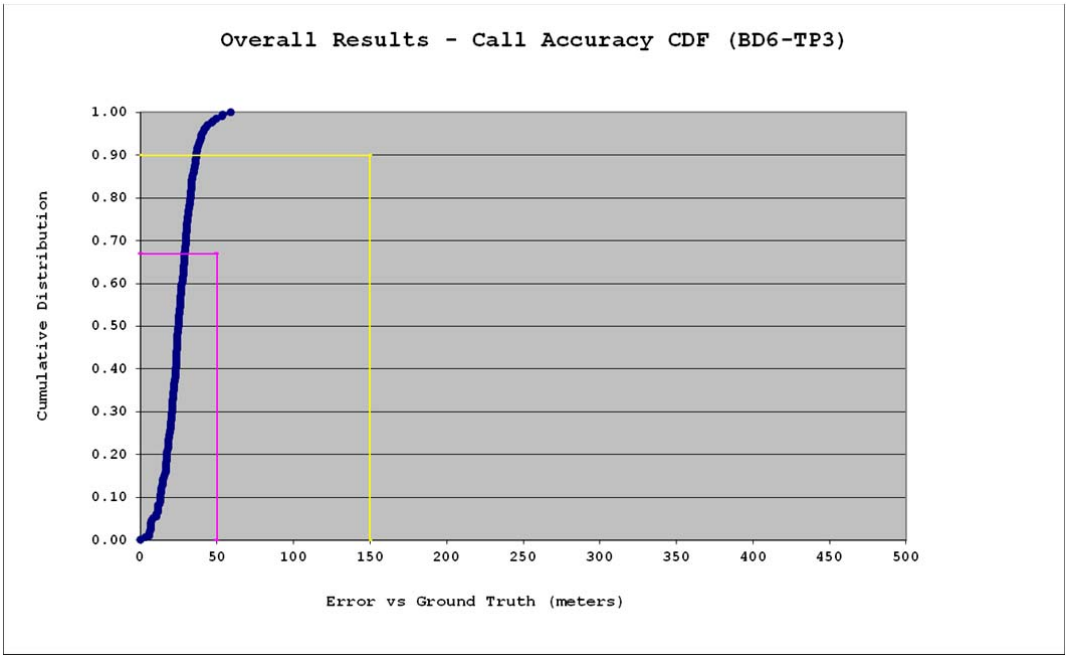
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD6_TP1	200	2.6	2.9	3.1	1.8	0.9	3.3	0.06
NextNav_BD6_TP2	225	2.6	3.1	3.1	1.8	0.9	3.6	0.29
NextNav_BD6_TP3	200	2.4	2.8	3.0	2.0	0.6	3.5	0.53
NextNav_BD6_TP4	200	2.1	2.4	2.4	2.0	0.3	2.8	1.00

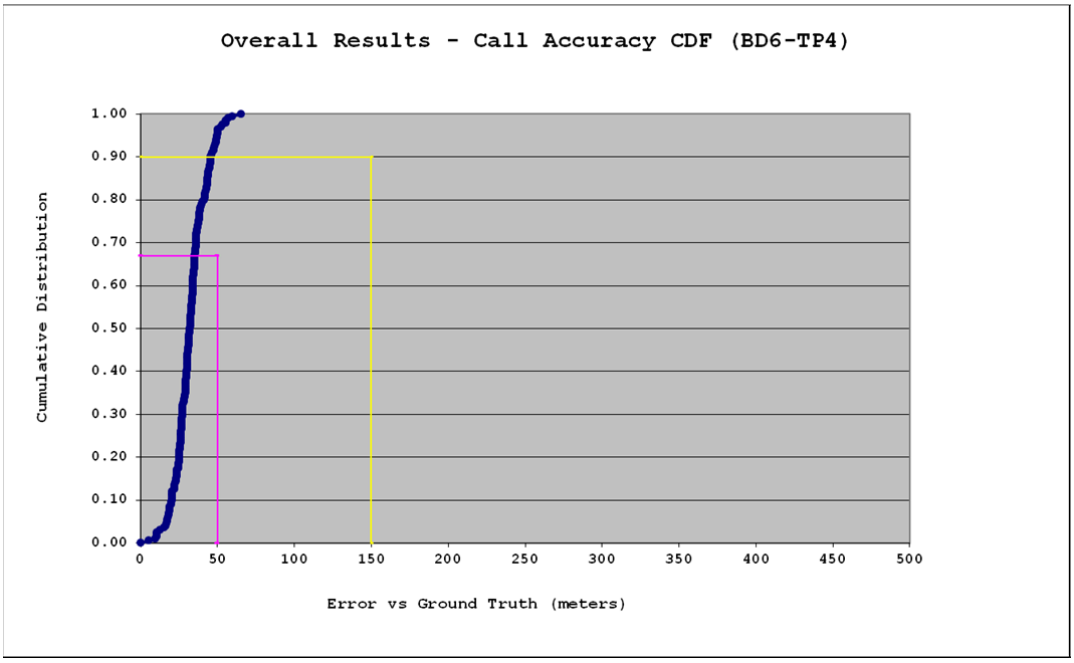
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD6_TP1	27.51	0.41	32.67	26.97
NextNav_BD6_TP2	27.38	0.67	32.36	20.37
NextNav_BD6_TP3	27.44	0.62	32.53	27.28
NextNav_BD6_TP4	27.34	0.06	27.68	27.27

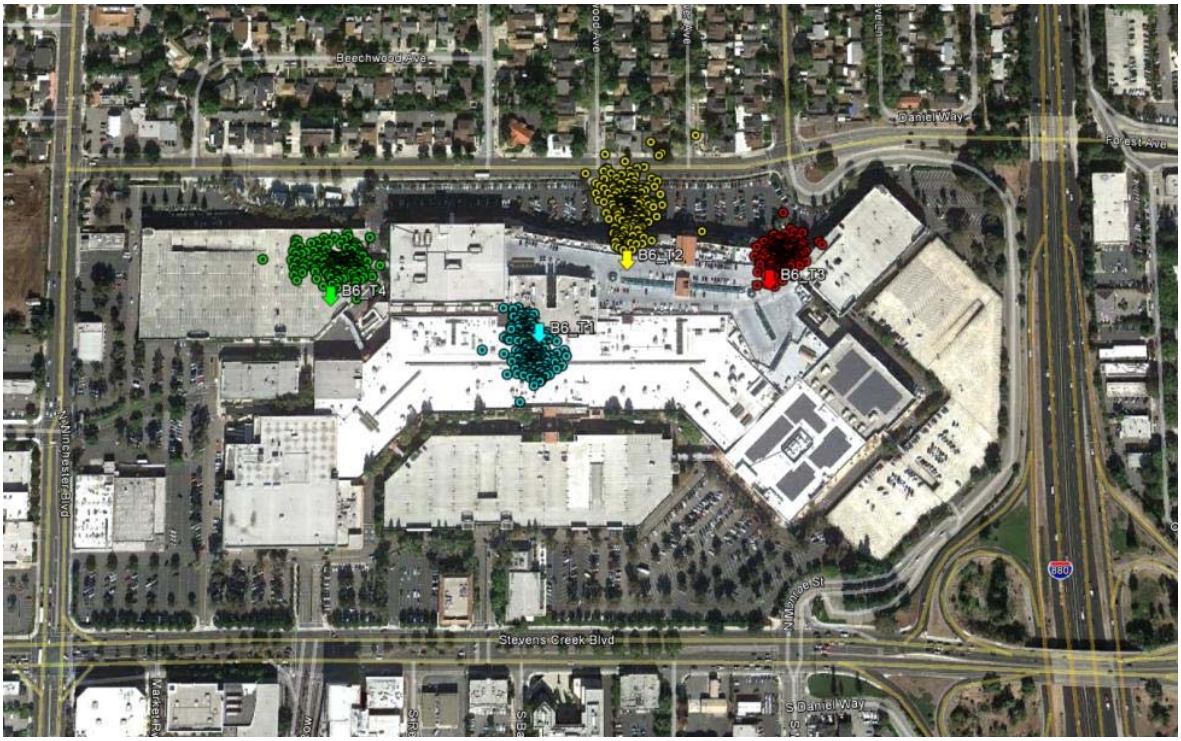
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD6_TP1	200	198	99.00%
NextNav_BD6_TP2	225	188	83.56%
NextNav_BD6_TP3	200	198	99.00%
NextNav_BD6_TP4	200	200	100.00%




Overall Results - Call Accuracy CDF (BD6-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD6-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD6-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Beechwood Ave
Daniel Way
Forest Ave
B6_T2
B6_T3
B6_T4
B6_T1
S Winchester Blvd
Stevens Creek Blvd
S Daniel Way
880

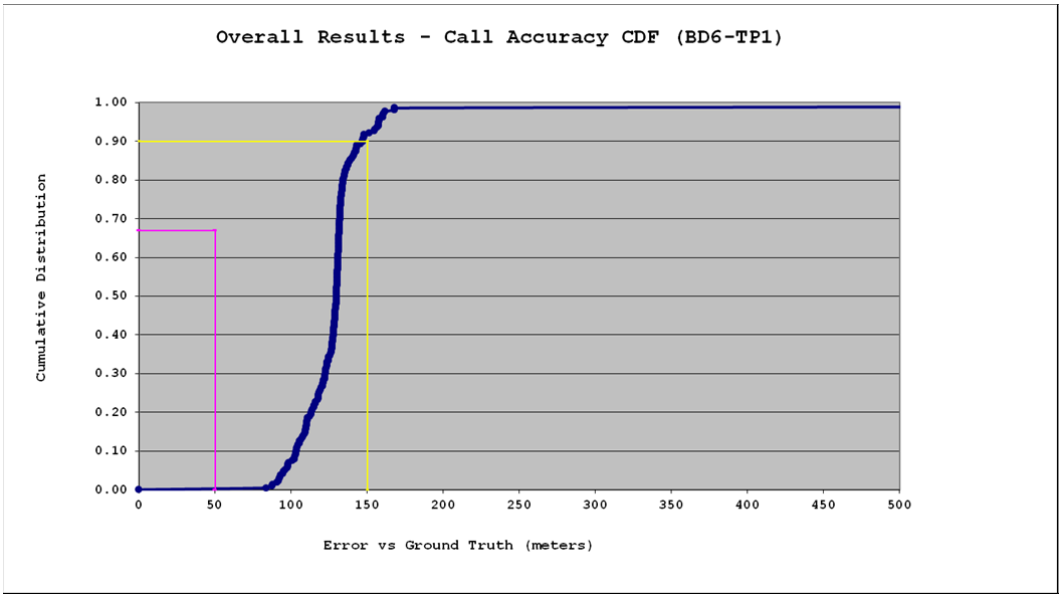
6.3.3.1.3 Polaris per Test Point Results—BD6:

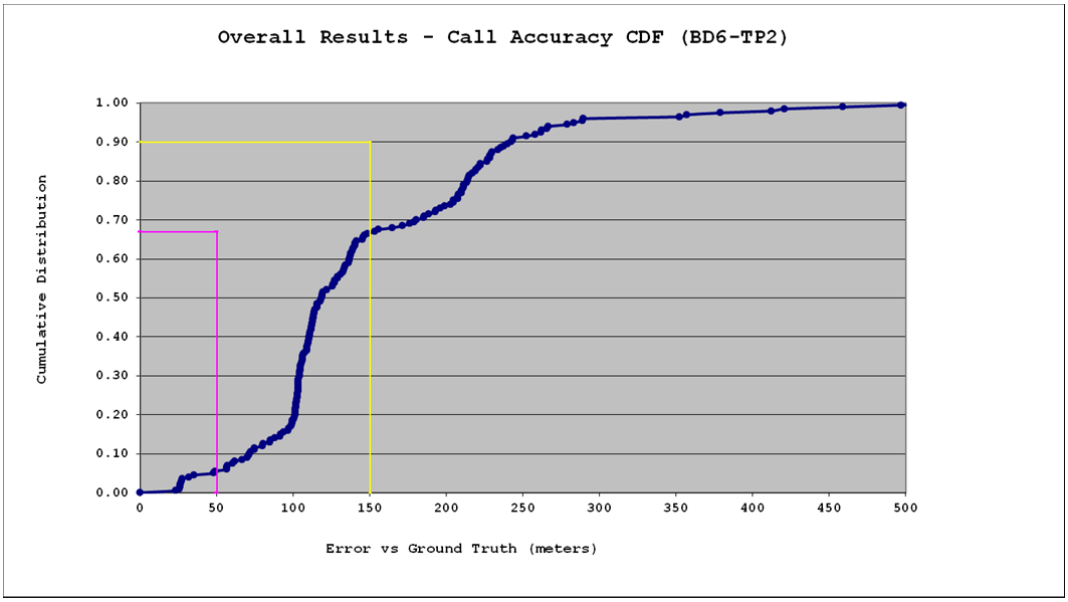
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD6_TP1	216	216	100.0%
Polaris_BD6_TP2	200	200	100.0%
Polaris_BD6_TP3	200	200	100.0%

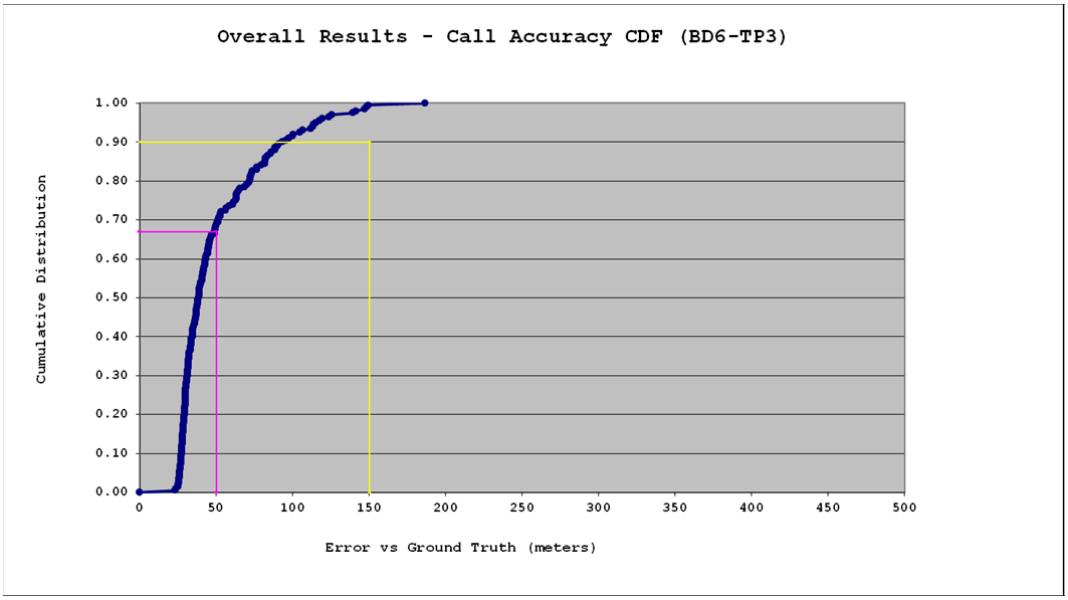
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD6_TP1	216	131.6	147.1	157.7	138.2	101.9	1089.1	83.54
Polaris_BD6_TP2	200	154.1	242.2	283.6	149.8	83.7	528.8	23.48
Polaris_BD6_TP3	200	49.1	93.6	115.4	50.7	30.1	186.8	23.21
Polaris_BD6_TP4	198	257.8	334.9	343.4	211.7	96.7	383.9	33.22

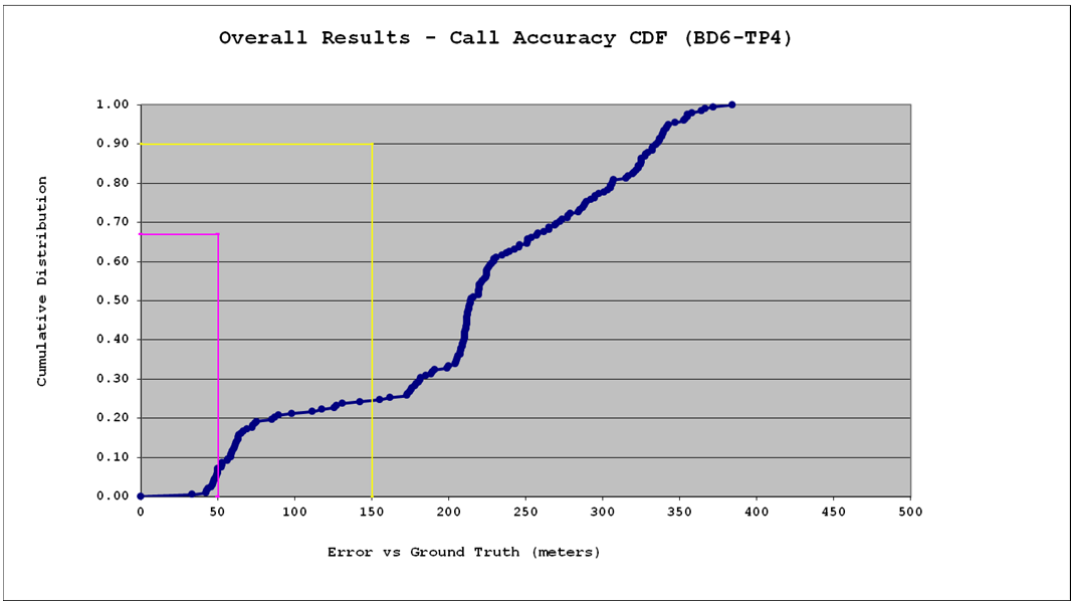
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD6_TP1	24.46	2.61	26.45	2.53
Polaris_BD6_TP2	24.35	1.78	26.12	7.51
Polaris_BD6_TP3	24.28	1.15	25.66	19.27
Polaris_BD6_TP4	24.72	1.12	26.21	19.87

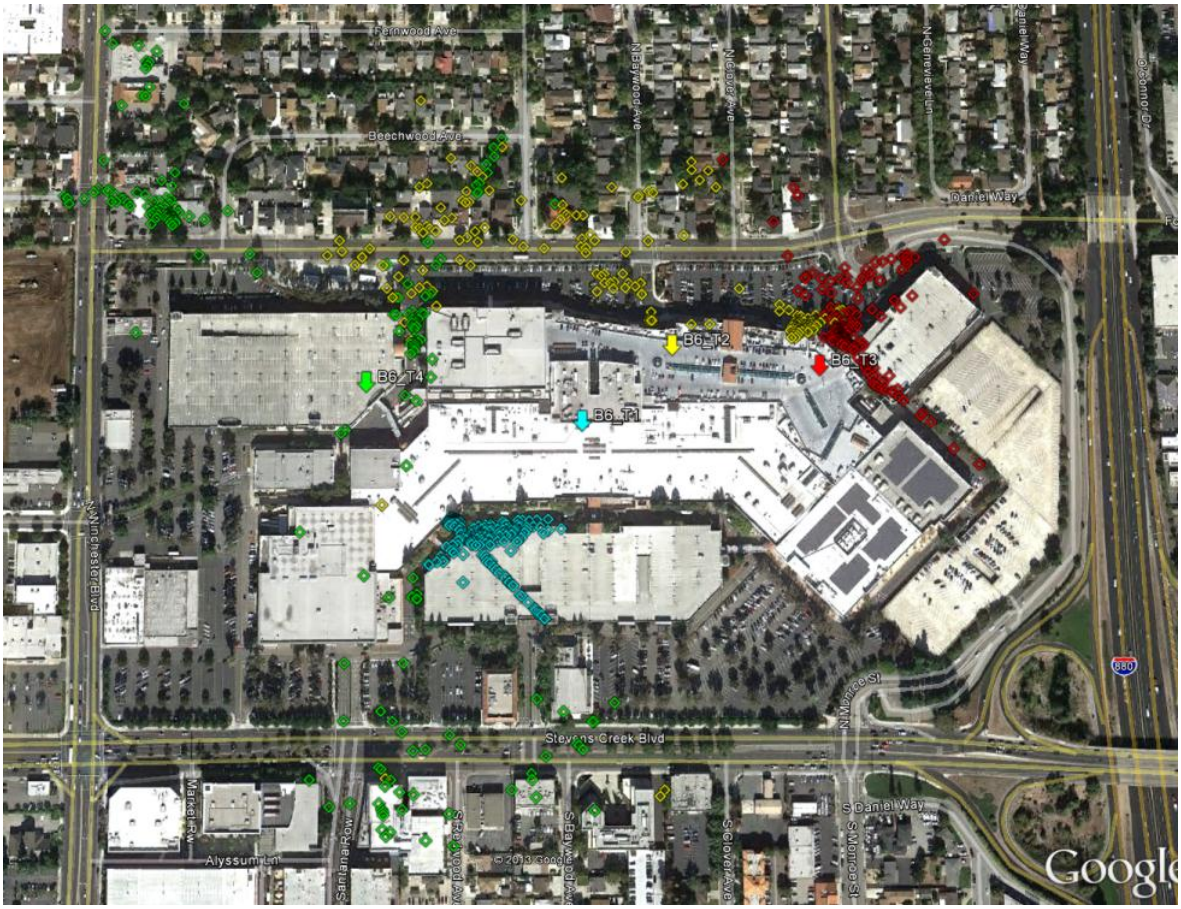
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD6_TP1	216	69	31.94%
Polaris_BD6_TP2	200	135	67.50%
Polaris_BD6_TP3	200	199	99.50%
Polaris_BD6_TP4	198	125	63.13%


Overall Results - Call Accuracy CDF (BD6-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD6-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD6-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD6-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



6.3.3.1.4 Qualcomm per Test Point Results—BD6:

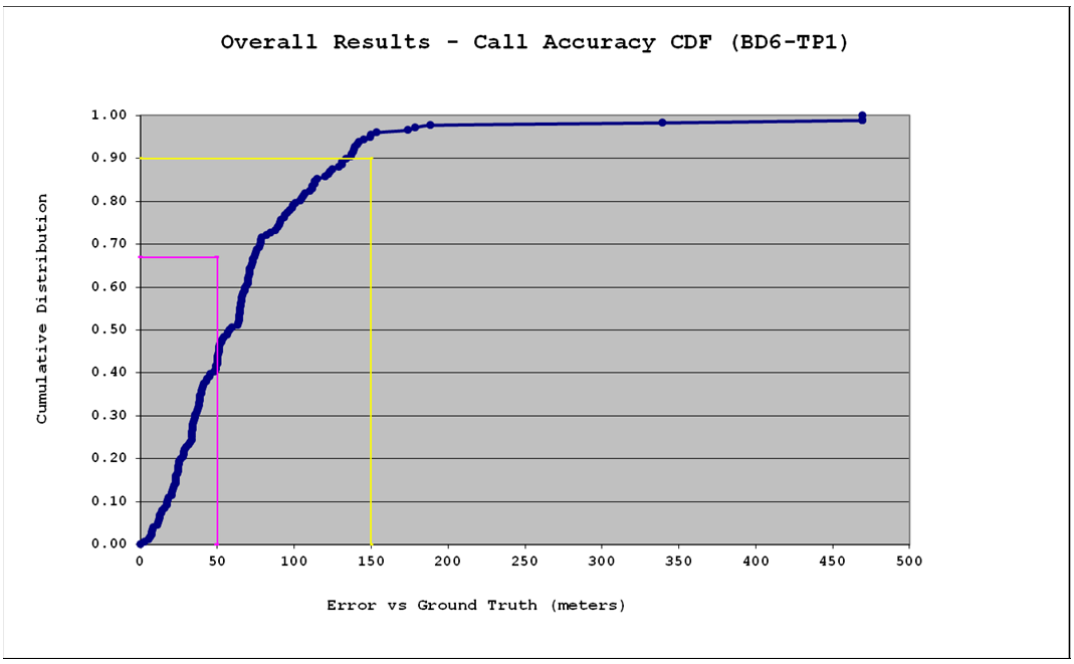
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD6_TP1	**180**	**176**	**97.8%**
Qualcomm_BD6_TP2	**180**	**175**	**97.2%**
Qualcomm_BD6_TP3	**200**	**176**	**88.0%**
Qualcomm_BD6_TP4	**200**	**199**	**99.5%**

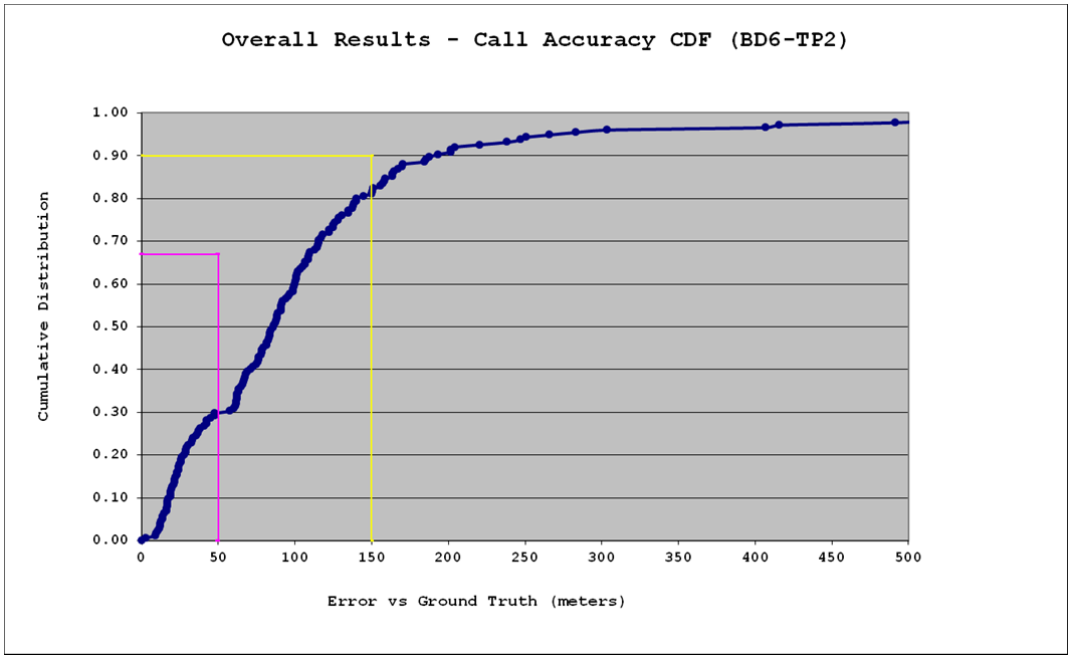
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD6_TP1	**176**	**74.6**	**135.6**	**149.8**	**72.4**	**69.4**	**469.3**	**2.90**
Qualcomm_BD6_TP2	**175**	**109.7**	**191.0**	**271.0**	**106.0**	**103.0**	**653.8**	**2.68**
Qualcomm_BD6_TP3	**176**	**149.8**	**418.9**	**551.1**	**156.3**	**151.0**	**561.9**	**11.51**
Qualcomm_BD6_TP4	**199**	**58.0**	**113.2**	**224.5**	**90.4**	**331.3**	**4639.4**	**3.58**

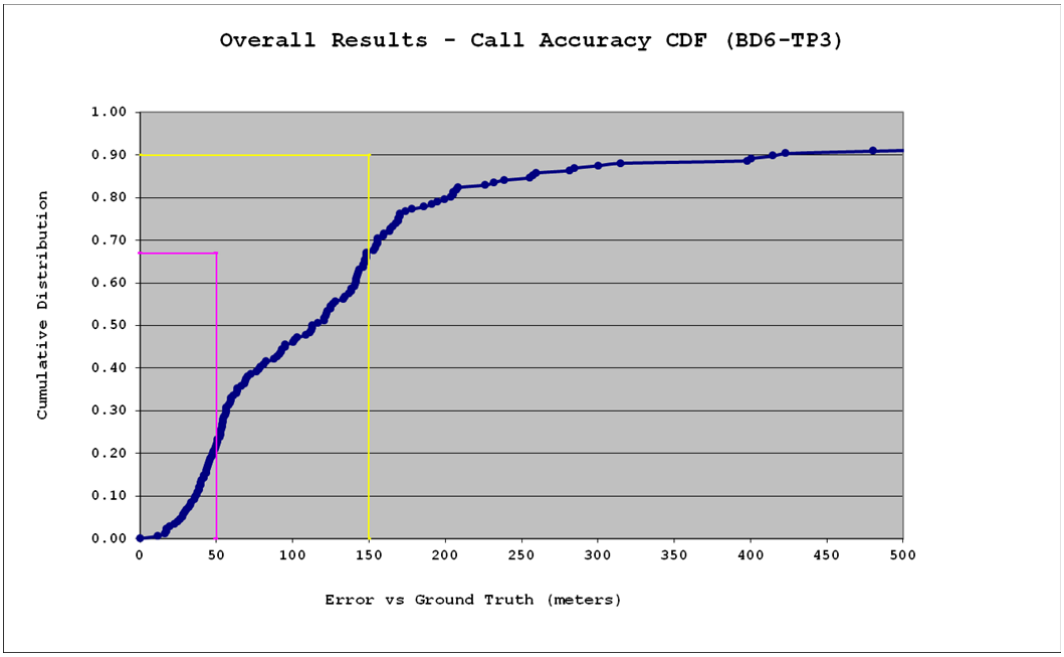
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD6_TP1	Number of Calls	3	2	93	44	11	2	21	0	176
	Percentage	1.7%	1.1%	52.8%	25.0%	6.3%	1.1%	11.9%	0.0%	100.0%
Qualcomm_BD6_TP2	Number of Calls	2	3	118	39	5	0	8	0	175
	Percentage	1.1%	1.7%	67.4%	22.3%	2.9%	0.0%	4.6%	0.0%	100.0%
Qualcomm_BD6_TP3	Number of Calls	16	19	113	11	5	0	12	0	176
	Percentage	9.1%	10.8%	64.2%	6.3%	2.8%	0.0%	6.8%	0.0%	100.0%
Qualcomm_BD6_TP4	Number of Calls	2	0	17	175	5	0	0	0	199
	Percentage	1.0%	0.0%	8.5%	87.9%	2.5%	0.0%	0.0%	0.0%	100.0%

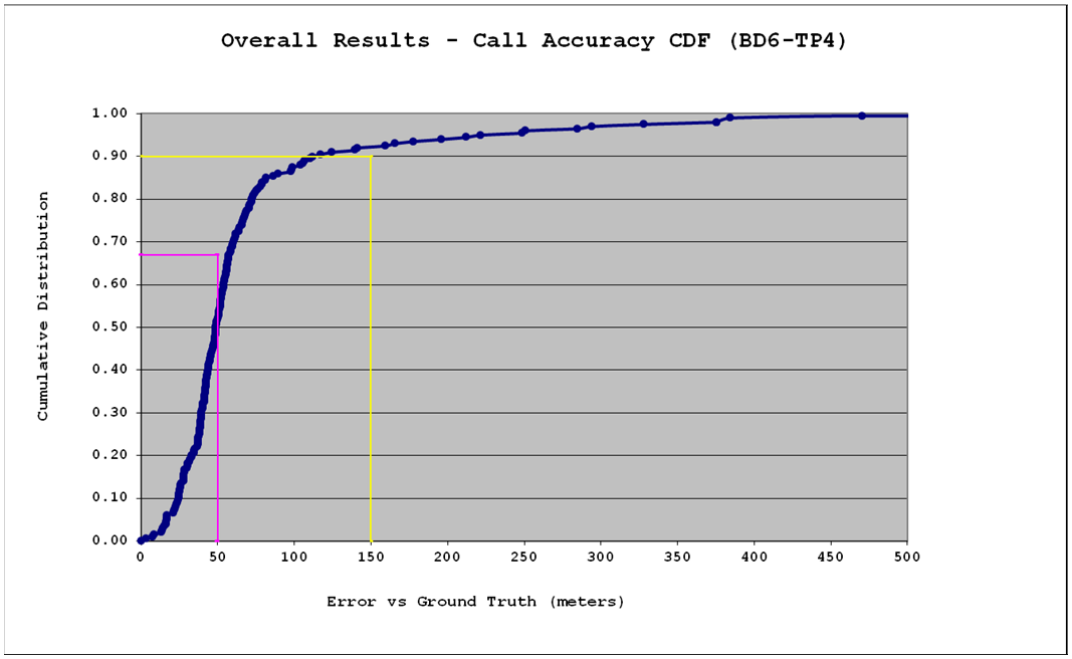
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD6_TP1	26.09	6.72	91.00	17.00
Qualcomm_BD6_TP2	25.33	3.22	50.00	18.00
Qualcomm_BD6_TP3	25.12	7.52	53.00	1.00
Qualcomm_BD6_TP4	24.56	2.16	43.00	17.00

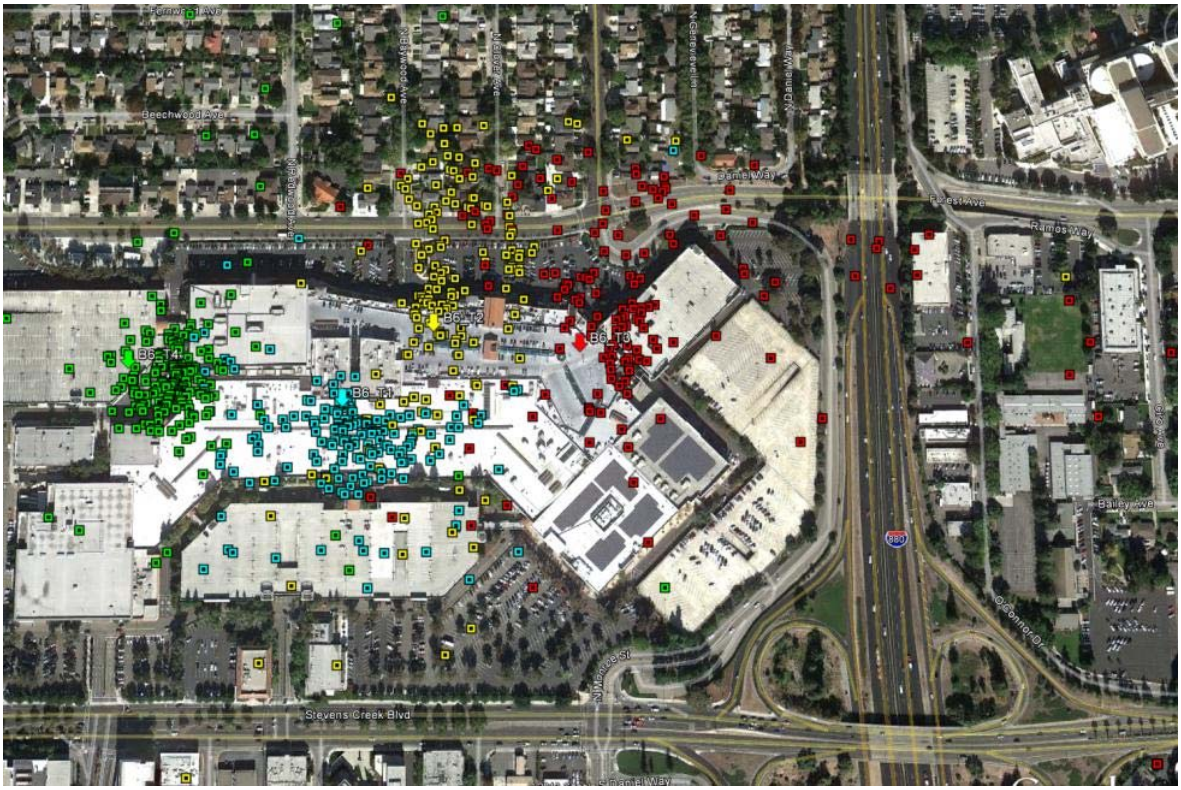
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD6_TP1	176	161	91.48%
Qualcomm_BD6_TP2	175	168	96.00%
Qualcomm_BD6_TP3	176	175	99.43%
Qualcomm_BD6_TP4	199	123	61.81%




Overall Results - Call Accuracy CDF (BD6-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD6-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)





6.3.3.2 Building 7:

6.3.3.2.1 Building 7 Environment and Test Points:

Building 7 is a 5 story modern glass and steel commercial building with an atrium in the middle. It has a 2 story parking structure in the back that is common with the hotel/conference center across the street (to the south).

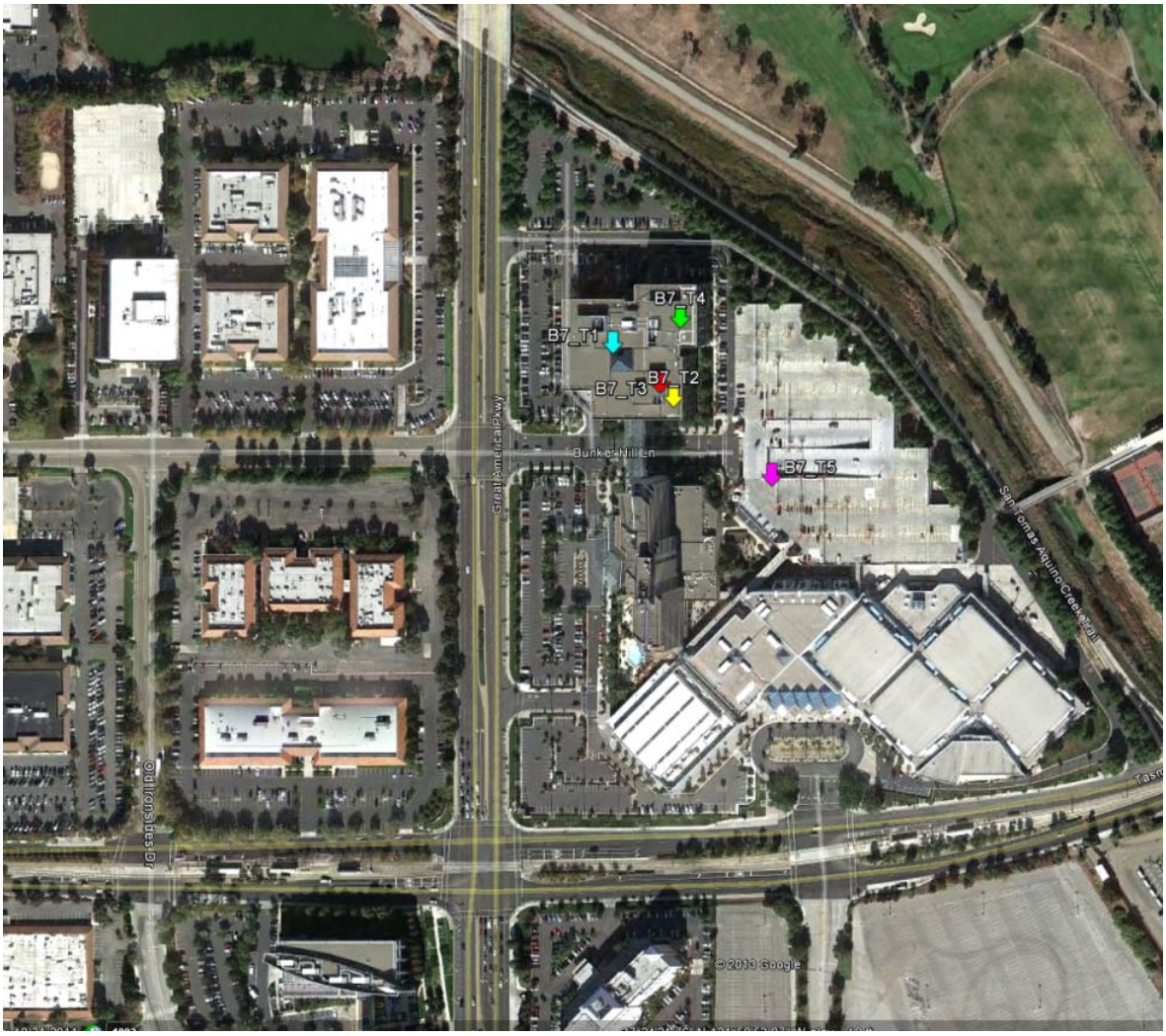
TP1: Inside building lobby, first floor, not directly under atrium

TP2: Interior hallway, 1st floor

TP3: Central hallway, 3rd floor, not directly under atrium

TP4: Interior hallway, 4th floor

TP 5: Inside 2-story parking structure behind the building, 1st floor



6.3.3.2.2 NextNav per Test Point Results—BD7:

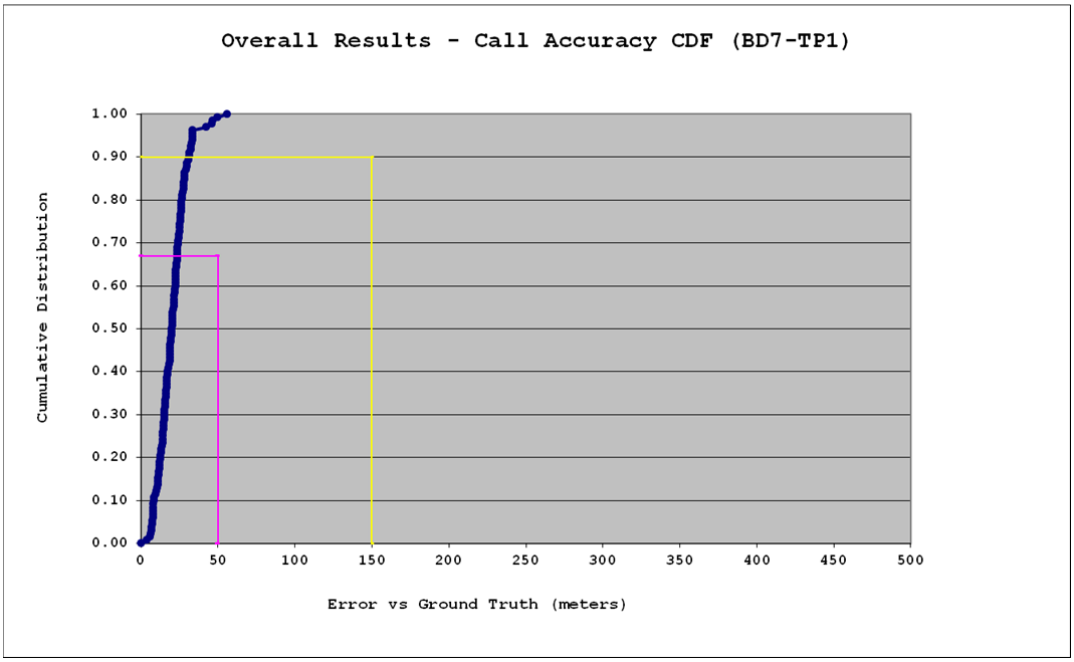
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD7_TP1	132	132	100.0%
NextNav_BD7_TP2	186	186	100.0%
NextNav_BD7_TP3	200	200	100.0%
NextNav_BD7_TP4	200	200	100.0%
NextNav_BD7_TP5	216	216	100.0%

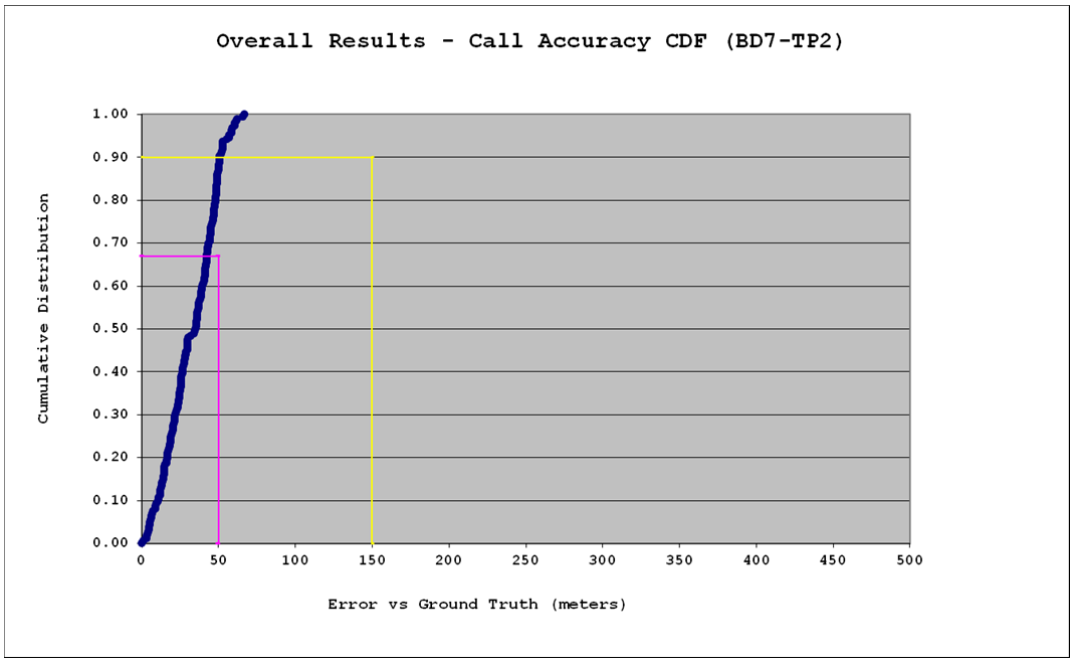
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD7_TP1	132	23.8	31.3	33.5	20.6	9.1	56.2	3.70
NextNav_BD7_TP2	186	42.7	50.9	57.2	32.8	16.0	66.9	1.35
NextNav_BD7_TP3	200	12.7	20.2	21.8	10.8	6.0	33.8	0.38
NextNav_BD7_TP4	200	25.5	32.0	33.8	21.2	8.2	39.4	3.31
NextNav_BD7_TP5	216	60.3	71.2	75.7	56.9	10.7	91.0	33.08

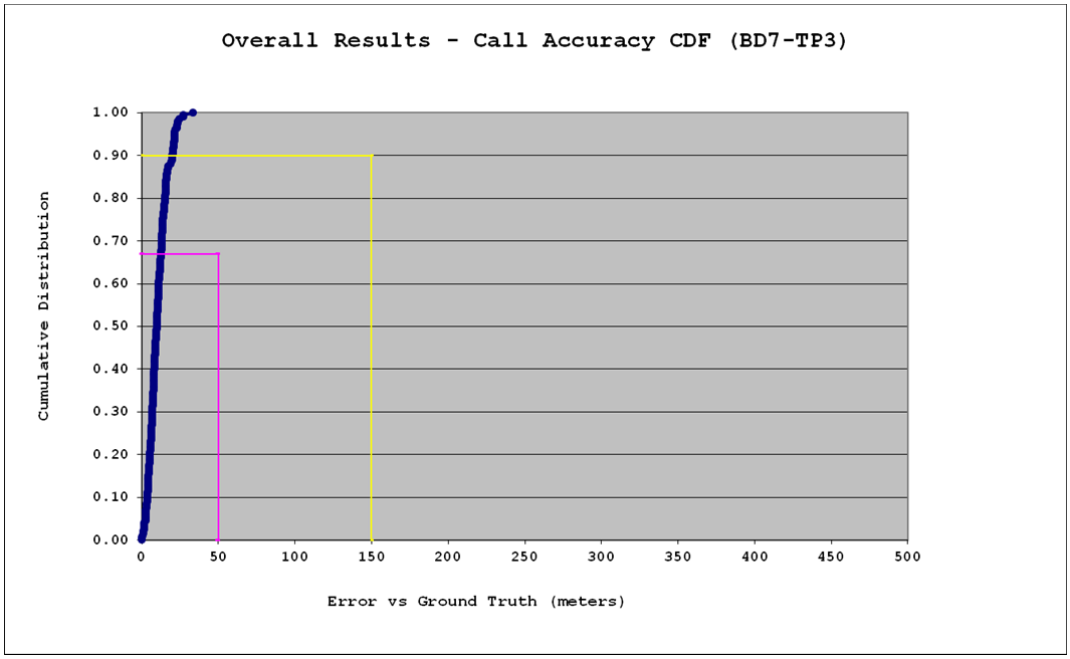
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD7_TP1	132	4.9	5.5	6.4	4.5	1.1	7.4	1.98
NextNav_BD7_TP2	186	4.7	5.1	5.3	3.8	1.0	5.7	1.98
NextNav_BD7_TP3	200	3.7	4.3	4.4	2.9	1.1	4.8	0.62
NextNav_BD7_TP4	200	4.4	5.0	5.3	3.8	1.0	6.1	1.81
NextNav_BD7_TP5	216	4.0	4.4	4.5	3.8	0.4	5.1	2.61

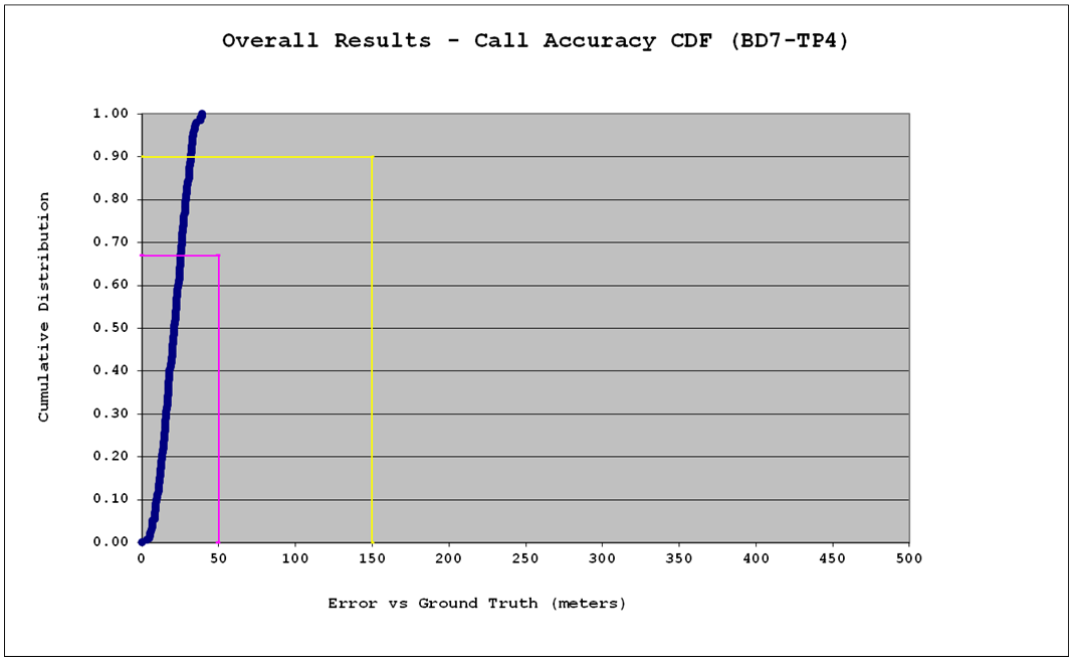
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD7_TP1	27.44	0.44	32.36	27.27
NextNav_BD7_TP2	27.39	0.52	32.42	27.27
NextNav_BD7_TP3	27.42	0.61	32.35	27.27
NextNav_BD7_TP4	27.33	0.04	27.59	27.27
NextNav_BD7_TP5	27.38	1.02	32.46	14.38

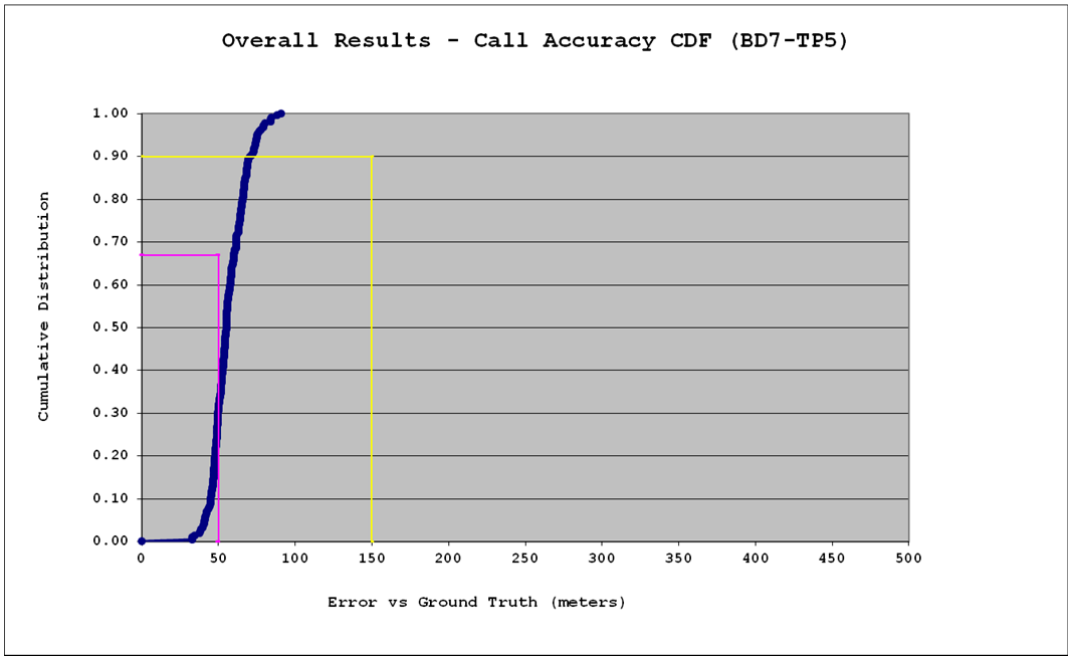
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD7_TP1	132	132	100.00%
NextNav_BD7_TP2	186	184	98.92%
NextNav_BD7_TP3	200	200	100.00%
NextNav_BD7_TP4	200	200	100.00%
NextNav_BD7_TP5	216	193	89.35%

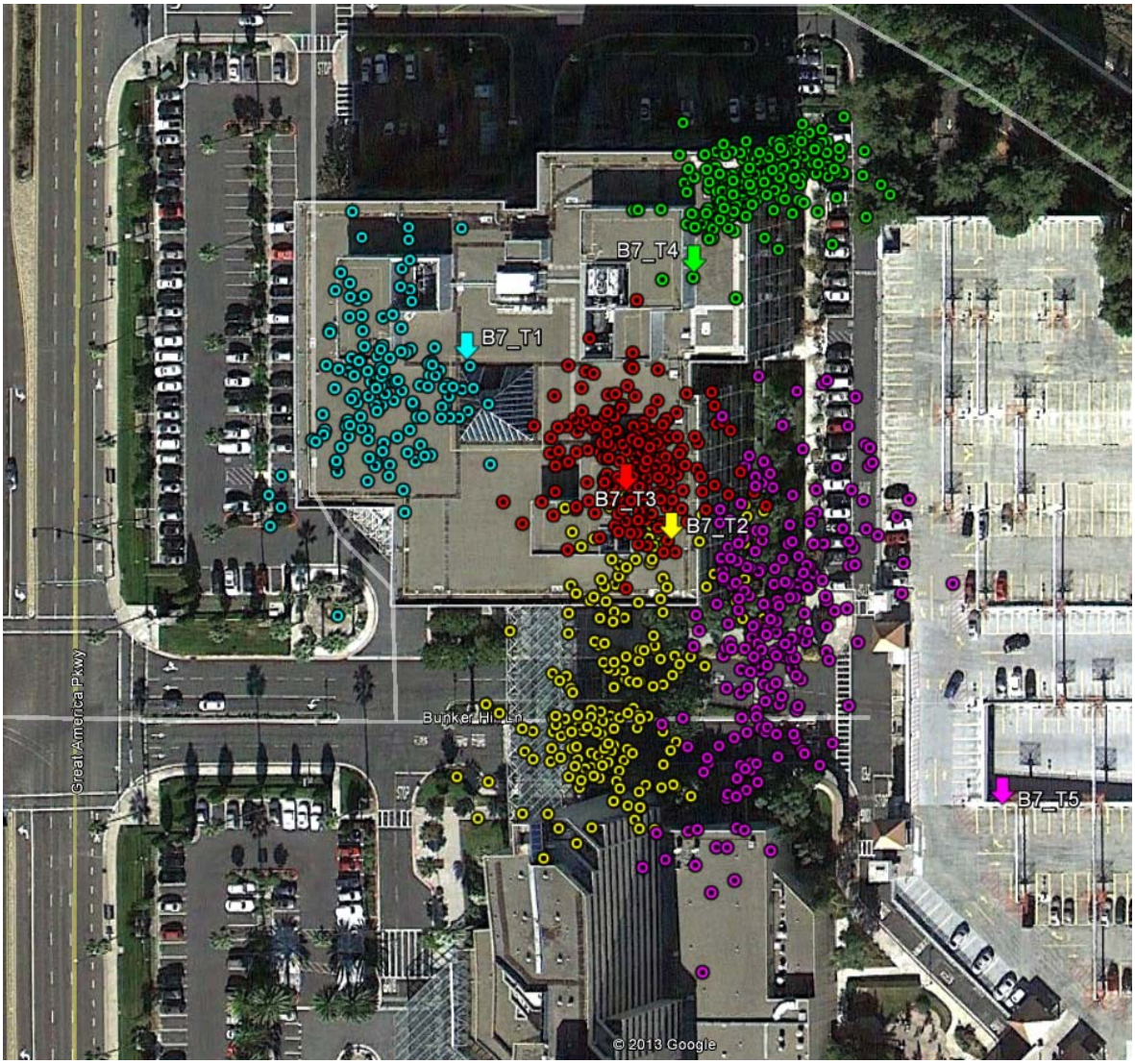

Overall Results - Call Accuracy CDF (BD7-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



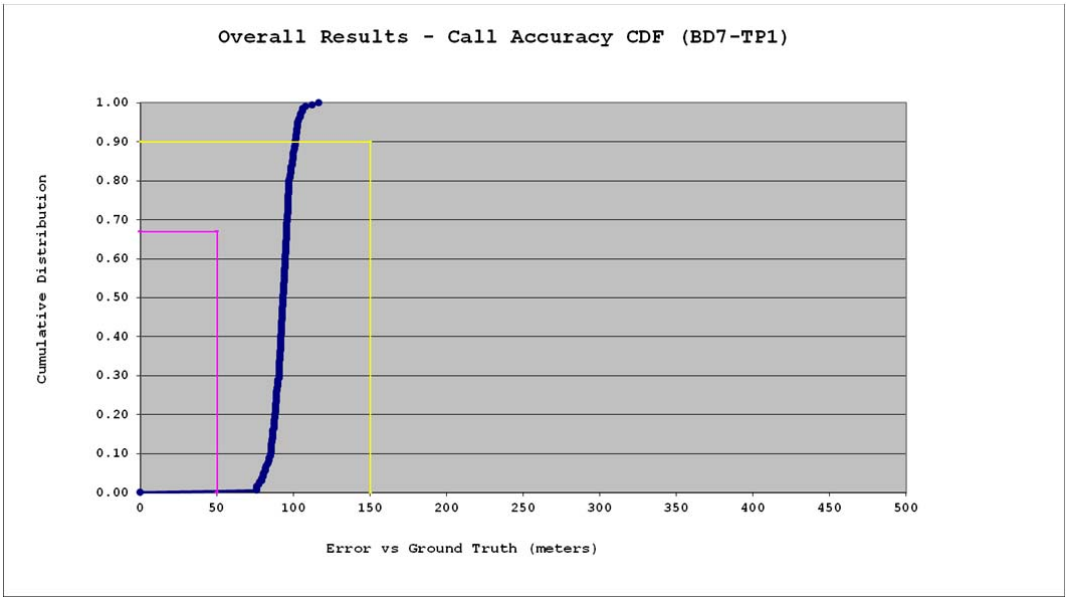
6.3.3.2.3 Polaris per Test Point Results—BD7:

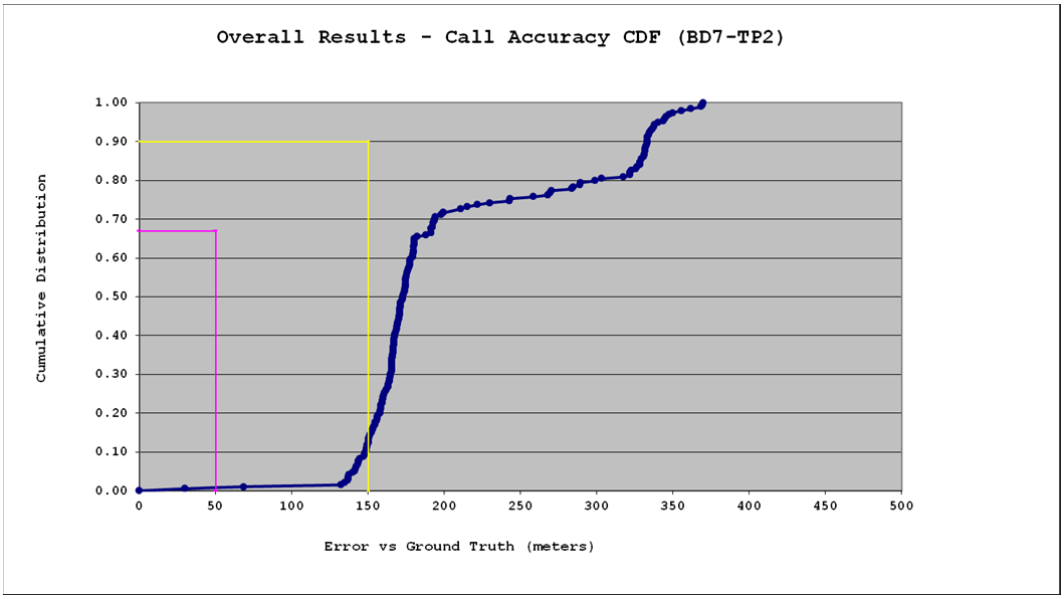
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD7_TP1	**194**	**194**	**100.0%**
Polaris_BD7_TP2	**196**	**194**	**99.0%**
Polaris_BD7_TP3	**200**	**200**	**100.0%**
Polaris_BD7_TP4	**102**	**102**	**100.0%**
Polaris_BD7_TP5	**199**	**198**	**99.5%**

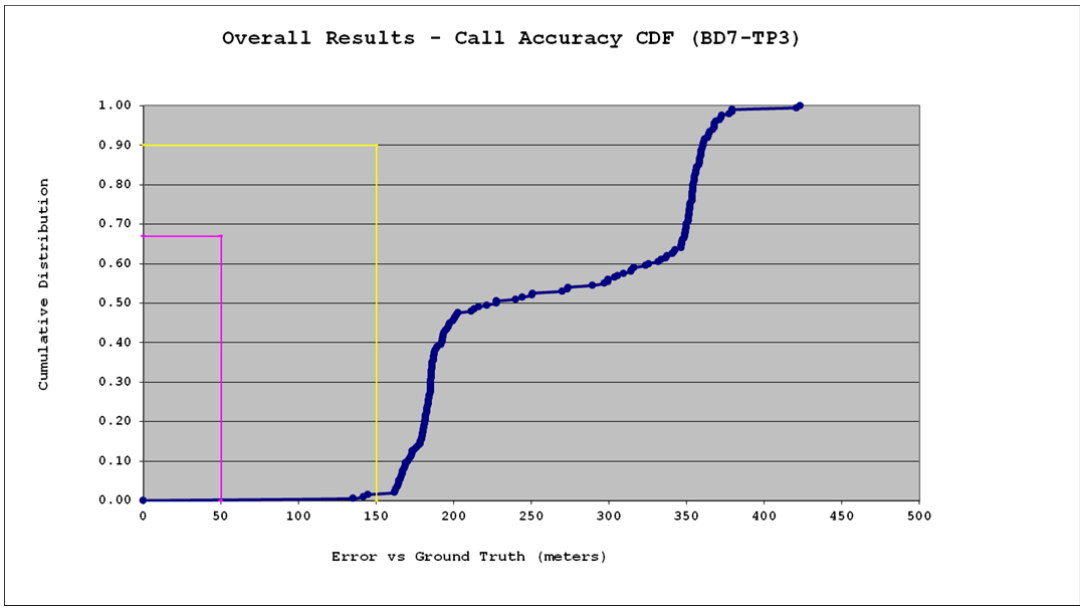
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD7_TP1	194	95.6	101.4	103.0	93.1	6.5	116.4	75.95
Polaris_BD7_TP2	194	191.2	333.2	341.5	206.2	72.8	369.9	30.07
Polaris_BD7_TP3	200	348.9	360.7	367.8	262.8	84.5	423.3	135.24
Polaris_BD7_TP4	102	490.6	571.5	801.9	432.5	159.5	822.4	60.59
Polaris_BD7_TP5	198	647.5	728.5	828.4	449.8	232.6	962.7	184.99

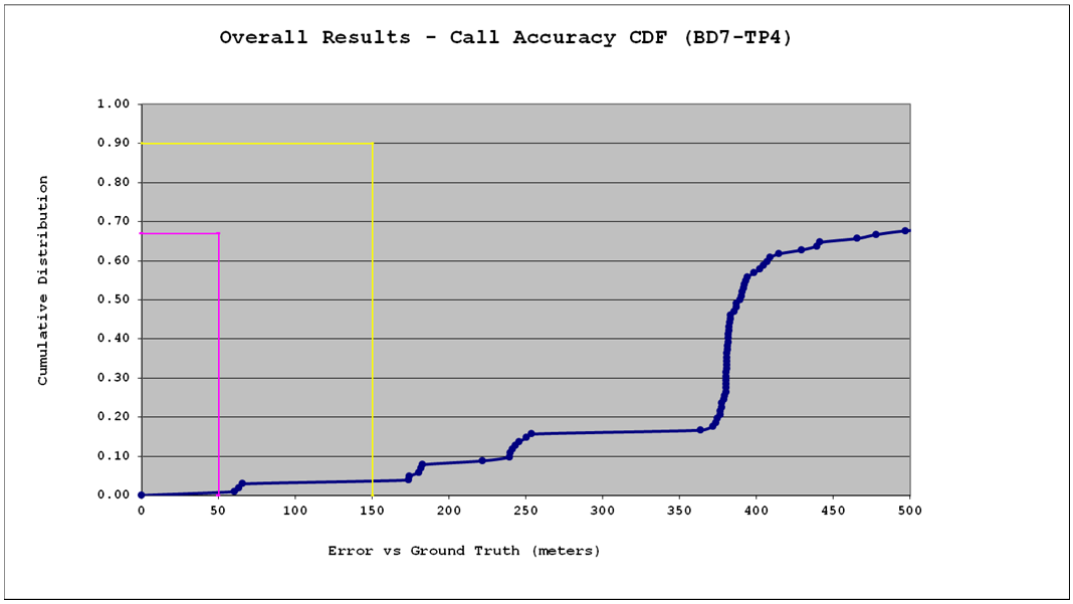
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD7_TP1	25.01	0.46	25.61	24.05
Polaris_BD7_TP2	25.02	0.48	26.11	23.68
Polaris_BD7_TP3	24.92	0.49	25.99	24.04
Polaris_BD7_TP4	24.73	1.06	26.11	20.28
Polaris_BD7_TP5	25.04	2.21	27.25	5.36

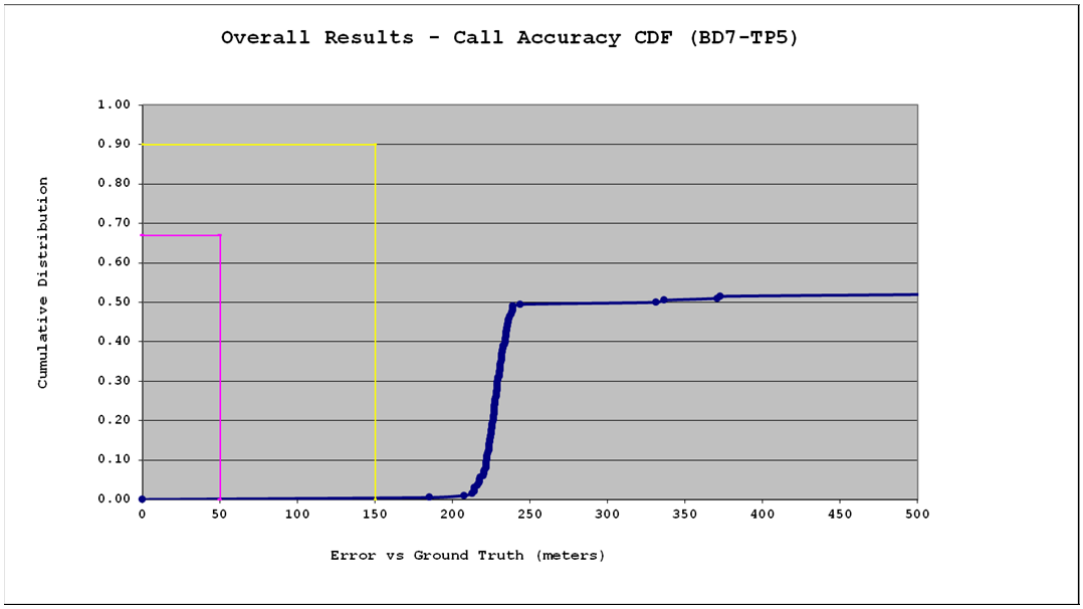
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD7_TP1	194	194	100.00%
Polaris_BD7_TP2	194	106	54.64%
Polaris_BD7_TP3	200	39	19.50%
Polaris_BD7_TP4	102	11	10.78%
Polaris_BD7_TP5	198	101	51.01%




Overall Results - Call Accuracy CDF (BD7-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

6.3.3.2.4 Qualcomm per Test Point Results—BD7:

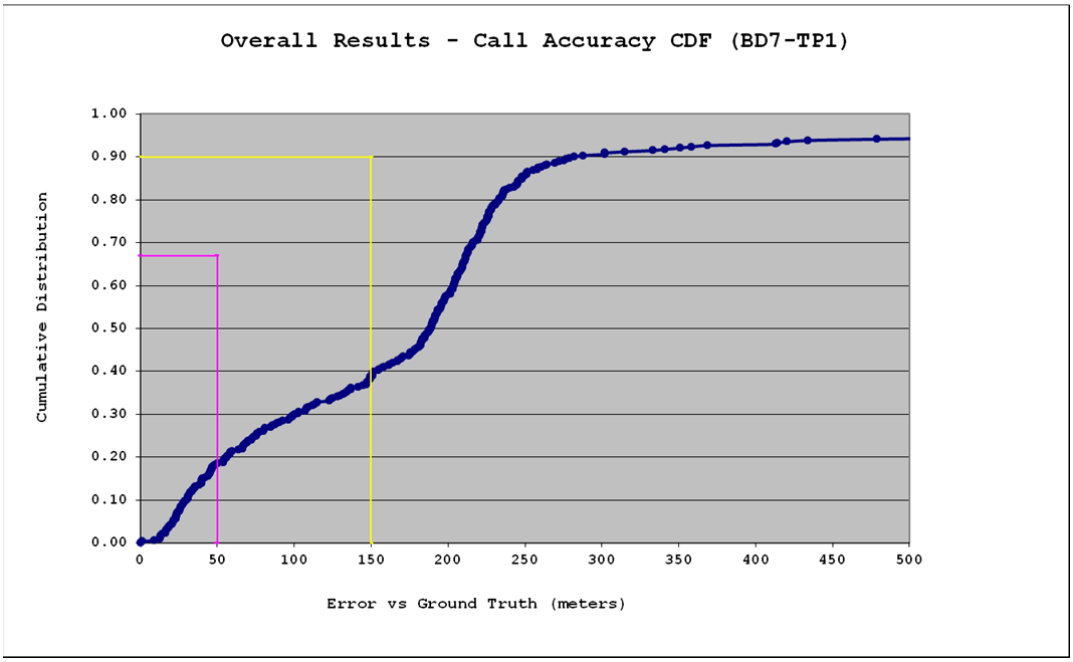
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD7_TP1	**400**	**341**	**85.3%**
Qualcomm_BD7_TP2	**400**	**383**	**95.8%**
Qualcomm_BD7_TP3	**401**	**209**	**52.1%**
Qualcomm_BD7_TP4	**308**	**295**	**95.8%**
Qualcomm_BD7_TP5	**180**	**179**	**99.4%**

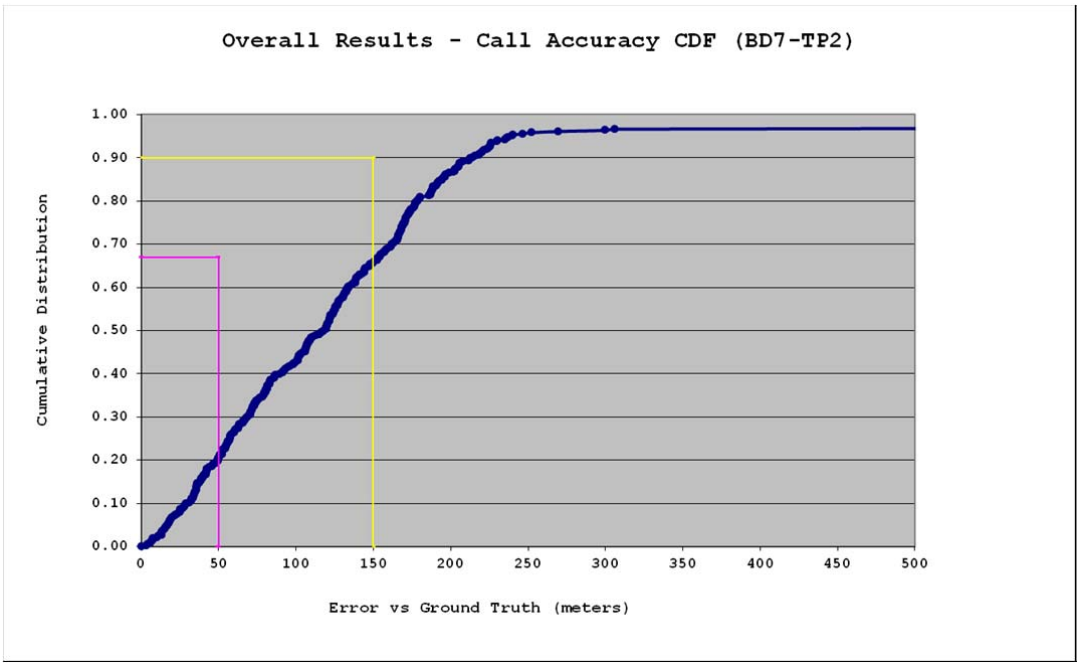
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD7_TP1	341	211.9	282.3	579.3	182.6	134.4	684.0	1.44
Qualcomm_BD7_TP2	383	153.9	214.0	239.6	130.8	113.7	703.1	3.32
Qualcomm_BD7_TP3	209	176.9	612.3	612.3	206.2	224.8	1665.3	3.75
Qualcomm_BD7_TP4	295	59.7	154.6	576.4	113.1	246.1	1464.1	3.20
Qualcomm_BD7_TP5	179	50.4	87.6	115.5	45.1	34.5	201.2	4.46

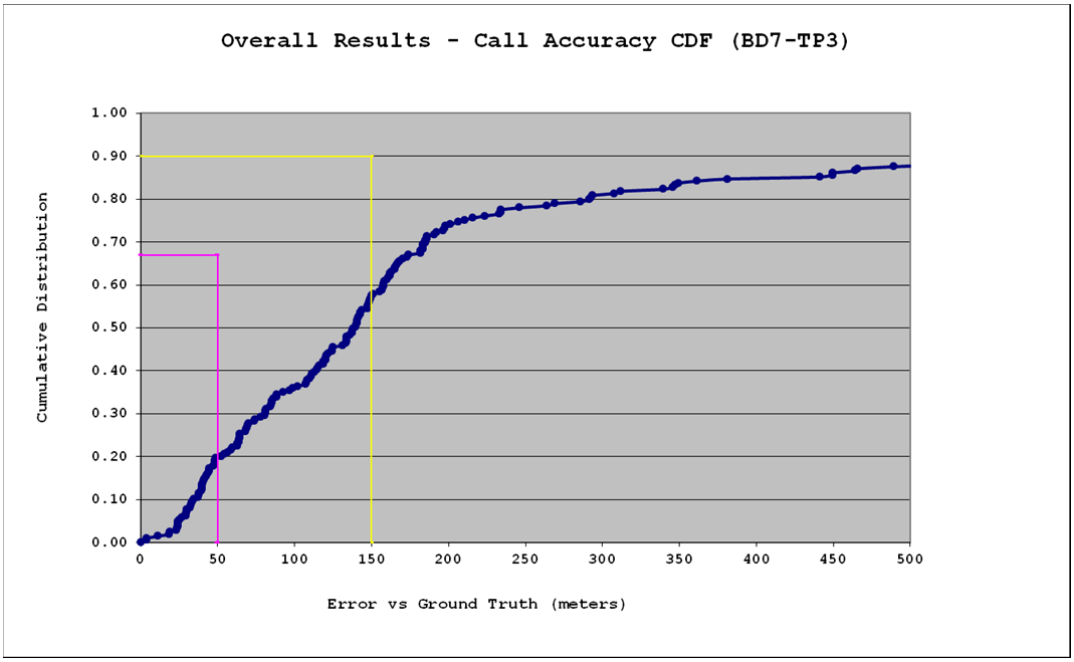
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD7_TP1	Number of Calls	15	45	252	21	1	0	7	0	341
	Percentage	4.4%	13.2%	73.9%	6.2%	0.3%	0.0%	2.1%	0.0%	100.0%
Qualcomm_BD7_TP2	Number of Calls	12	18	255	90	3	0	5	0	383
	Percentage	3.1%	4.7%	66.6%	23.5%	0.8%	0.0%	1.3%	0.0%	100.0%
Qualcomm_BD7_TP3	Number of Calls	19	54	98	0	21	0	17	0	209
	Percentage	9.1%	25.8%	46.9%	0.0%	10.0%	0.0%	8.1%	0.0%	100.0%
Qualcomm_BD7_TP4	Number of Calls	18	17	220	40	0	0	0	0	295
	Percentage	6.1%	5.8%	74.6%	13.6%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD7_TP5	Number of Calls	0	0	8	168	2	0	1	0	179
	Percentage	0.0%	0.0%	4.5%	93.9%	1.1%	0.0%	0.6%	0.0%	100.0%

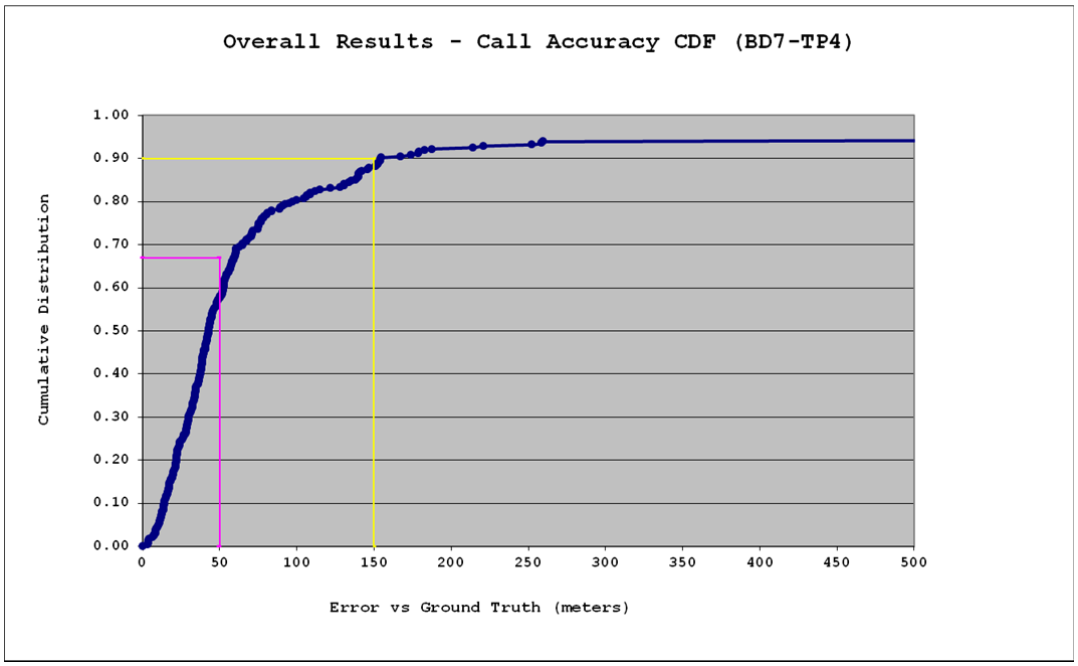
TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD7_TP1	23.17	4.70	33.00	2.00
Qualcomm_BD7_TP2	23.56	4.31	43.00	2.00
Qualcomm_BD7_TP3	23.94	7.43	47.00	1.00
Qualcomm_BD7_TP4	23.43	5.41	43.00	2.00
Qualcomm_BD7_TP5	24.21	1.23	31.00	17.00

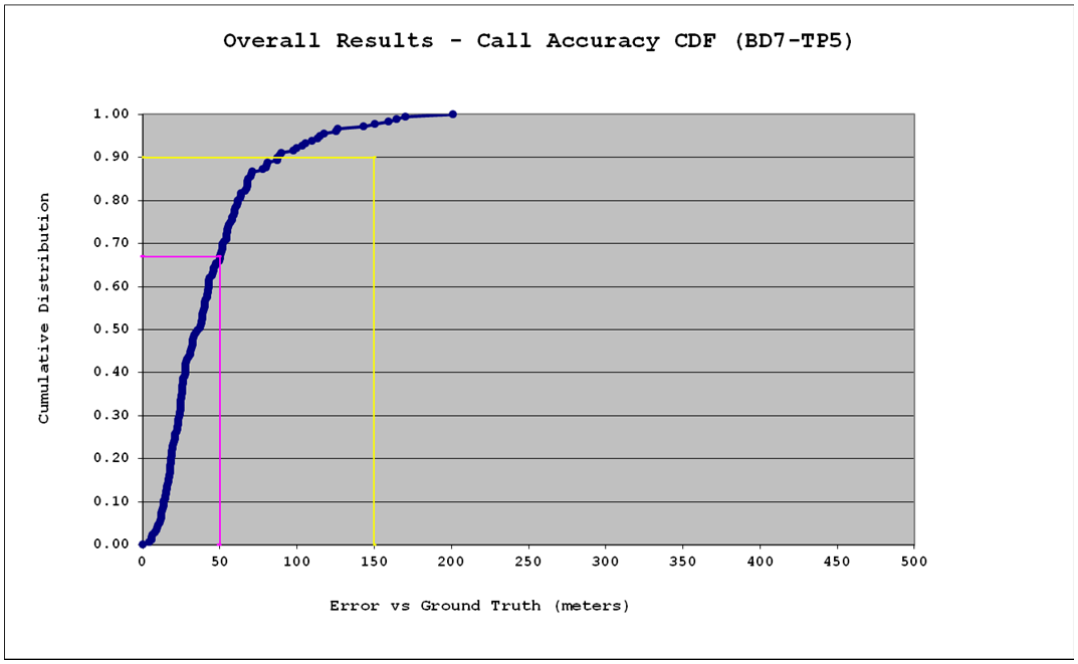
Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD7_TP1	341	216	63.34%
Qualcomm_BD7_TP2	383	293	76.50%
Qualcomm_BD7_TP3	209	188	89.95%
Qualcomm_BD7_TP4	295	284	96.27%
Qualcomm_BD7_TP5	179	124	69.27%

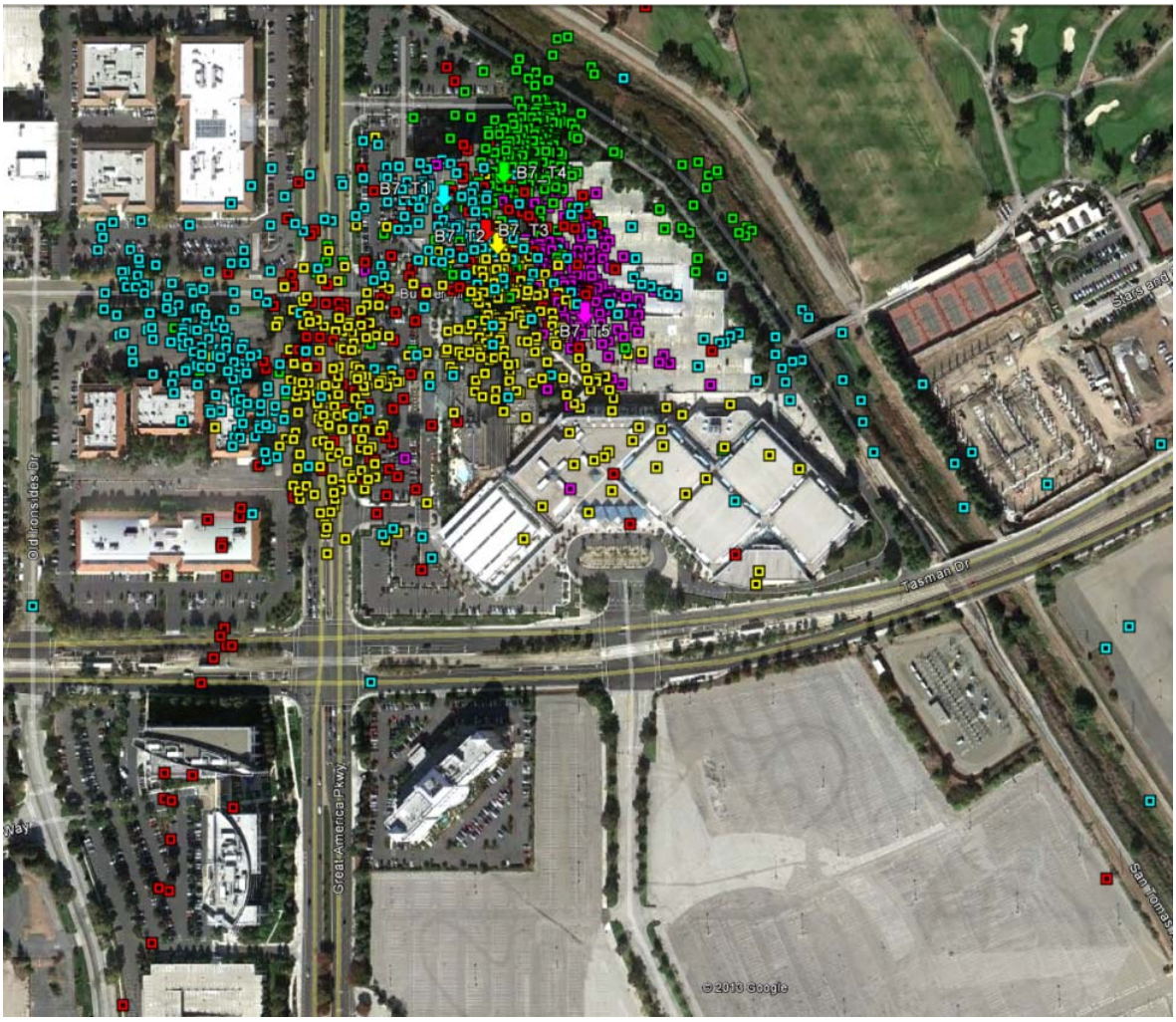

Overall Results - Call Accuracy CDF (BD7-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD7-TP5)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B7 T4
B7 T1
B7 T2
B7 T3
B7 T5
Old Ironsides Dr
Great America Pkwy
Tasman Dr
© 2013 Google

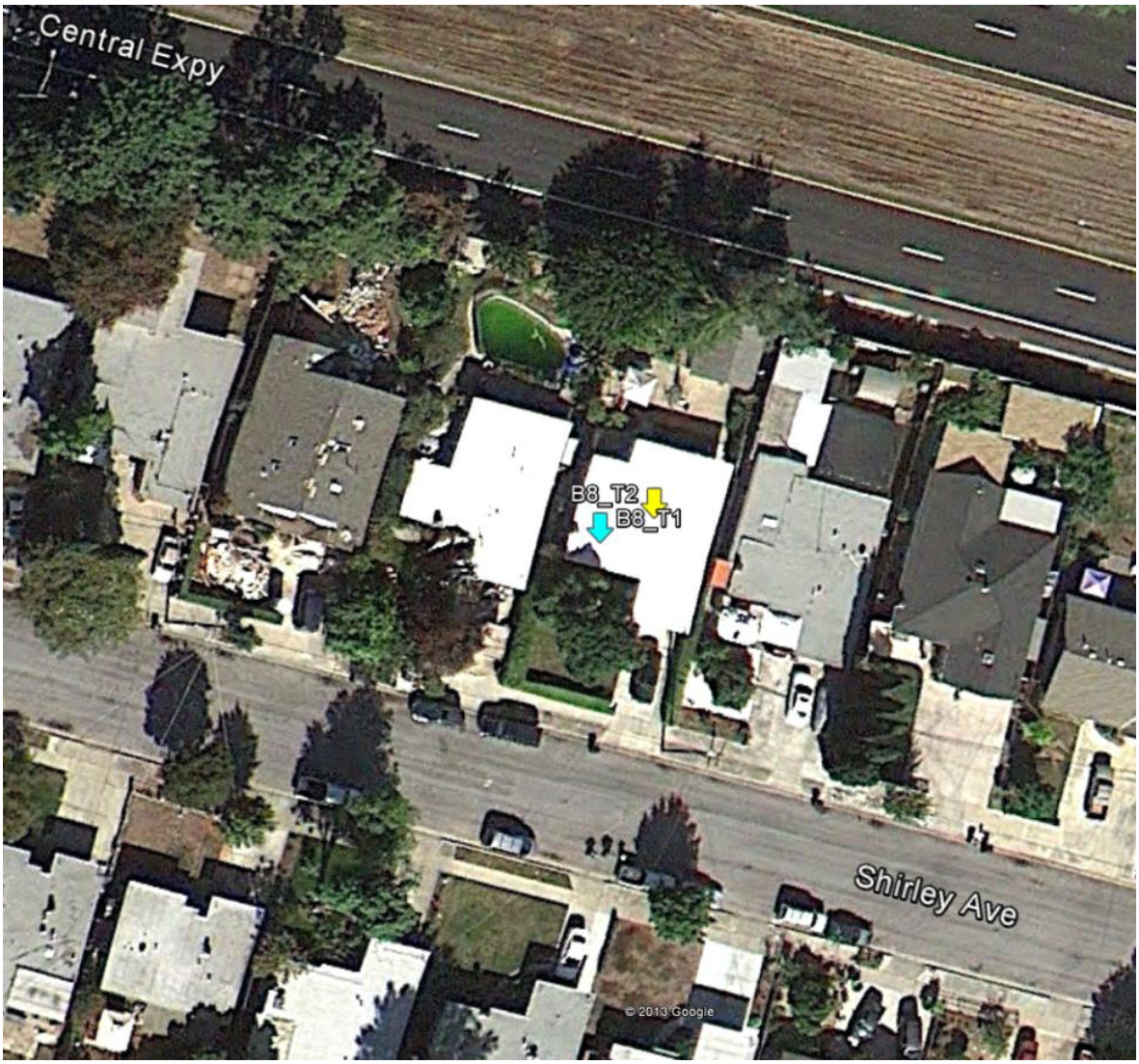
6.3.3.3 Building 8:

6.3.3.3.1 Building 8 Environment and Test Points:

Building 8 is a relatively small, one-story, single family home with typical wood construction seen across California. No high structures are present in this suburban neighborhood.

TP1: Living room

TP2: Hallway



6.3.3.3.2 NextNav per Test Point Results—BD8:

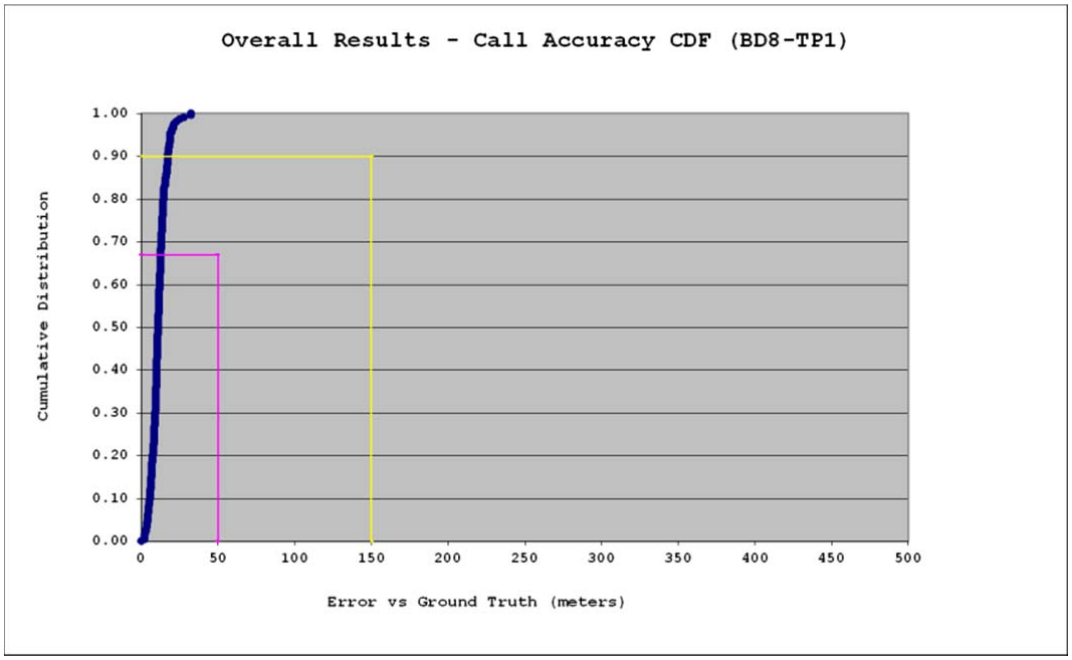
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD8_TP1	210	210	100.0%
NextNav_BD8_TP2	185	185	100.0%

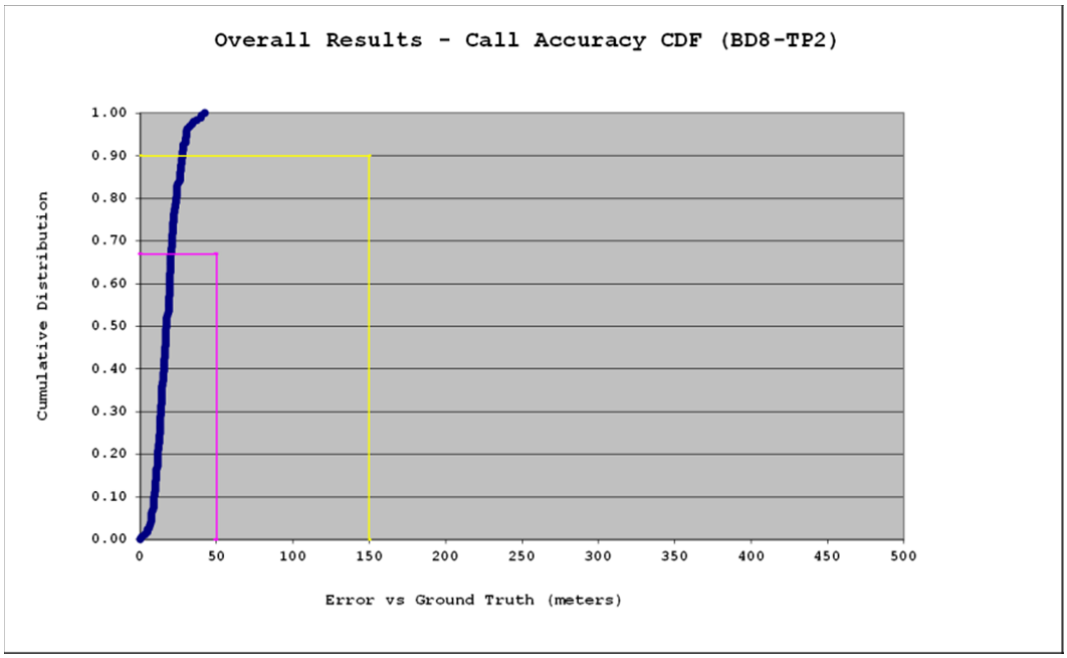
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD8_TP1	210	12.9	17.7	19.2	11.6	4.9	32.5	2.13
NextNav_BD8_TP2	185	20.4	27.7	30.5	18.2	7.4	42.5	1.28

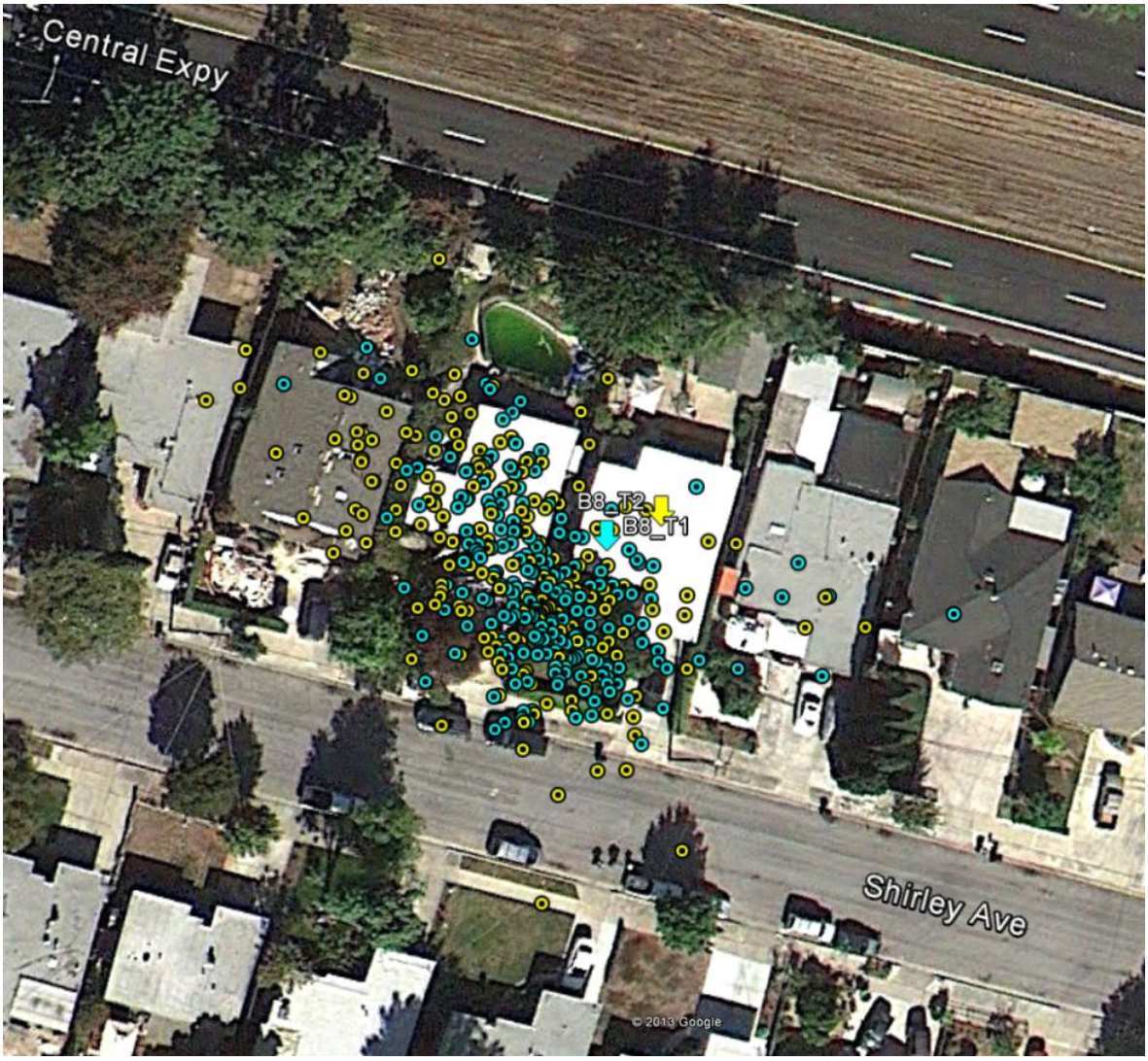
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD8_TP1	210	4.2	4.9	5.1	3.1	1.4	6.0	0.73
NextNav_BD8_TP2	185	4.9	5.4	5.5	3.0	2.0	5.7	0.39

TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD8_TP1	27.33	1.05	27.85	12.35
NextNav_BD8_TP2	27.48	0.17	27.90	26.97

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD8_TP1	210	210	100.00%
NextNav_BD8_TP2	185	185	100.00%


Overall Results - Call Accuracy CDF (BD8-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD8-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



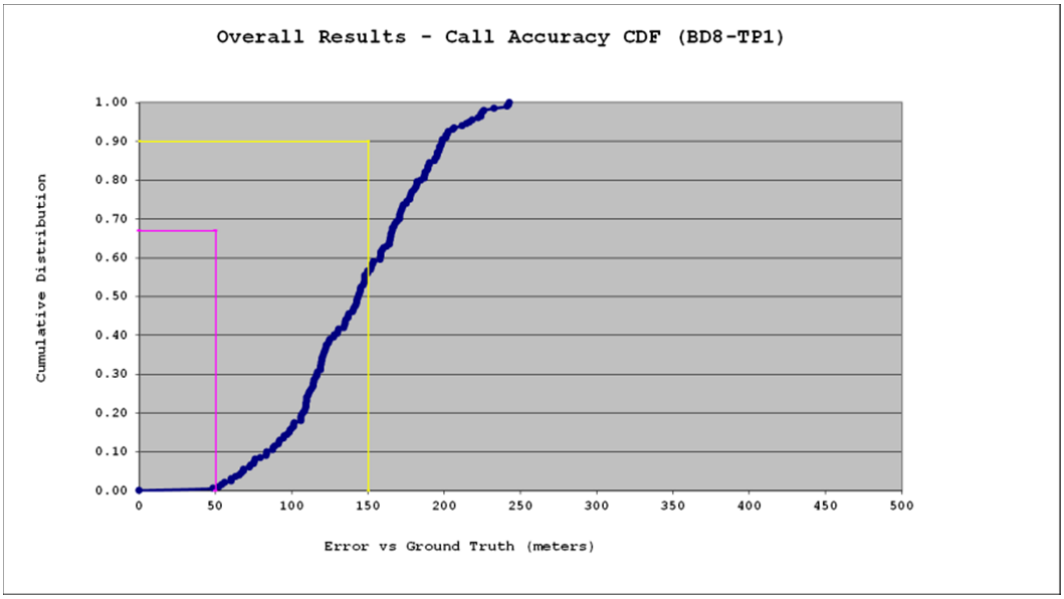
6.3.3.3.3 Polaris per Test Point Results—BD8:

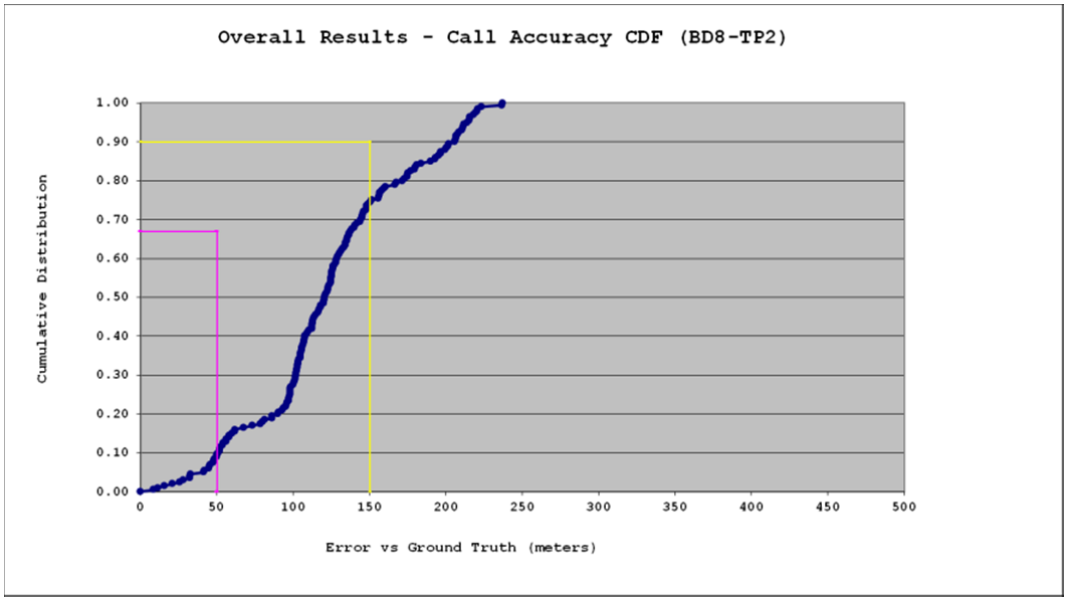
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD8_TP1	**200**	**200**	**100.0%**
Polaris_BD8_TP2	**200**	**200**	**100.0%**

Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD8_TP1	**200**	**166.1**	**199.0**	**216.5**	**144.0**	**44.0**	**242.8**	**48.27**
Polaris_BD8_TP2	**200**	**138.0**	**205.5**	**213.9**	**123.8**	**51.7**	**237.2**	**8.42**

TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD8_TP1	24.58	1.09	26.06	19.26
Polaris_BD8_TP2	24.67	1.09	26.12	19.73

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD8_TP1	200	172	86.00%
Polaris_BD8_TP2	200	185	92.50%





6.3.3.3.4 Qualcomm per Test Point Results—BD8:

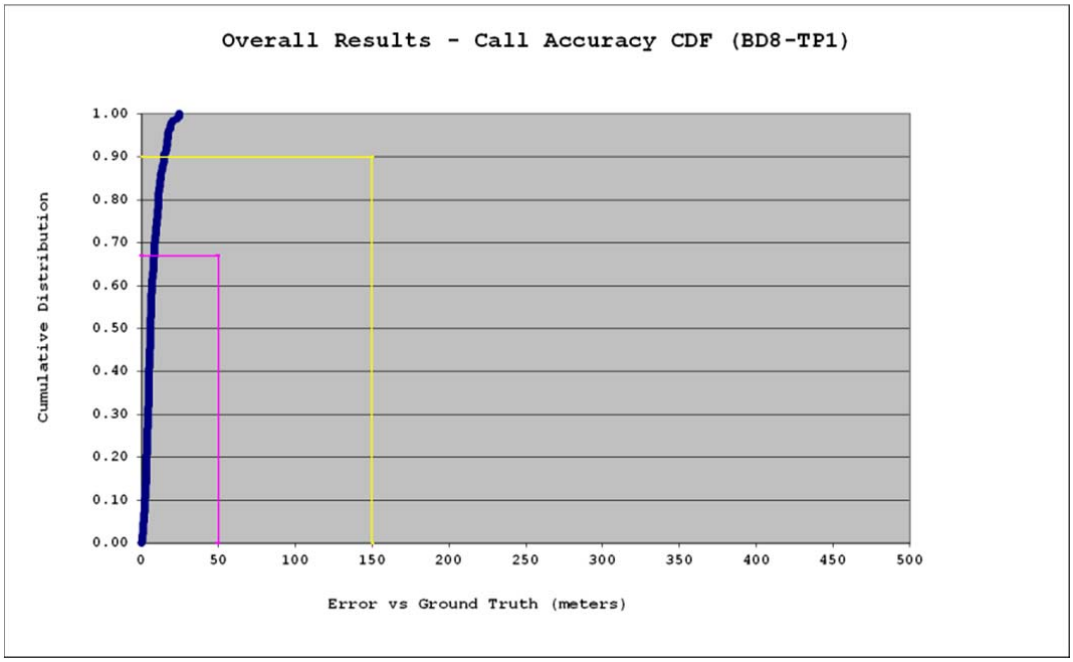
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD8_TP1	**179**	**178**	**99.4%**
Qualcomm_BD8_TP2	**180**	**180**	**100.0%**

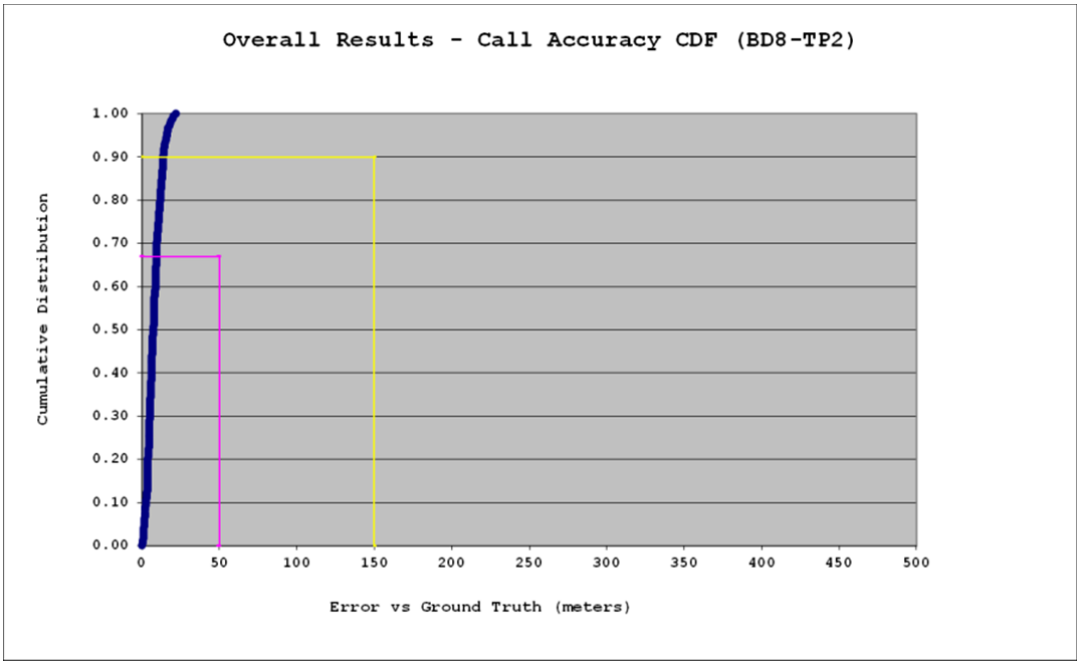
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD8_TP1	**178**	**8.3**	**14.7**	**17.4**	**7.6**	**5.0**	**24.8**	**0.66**
Qualcomm_BD8_TP2	**180**	**9.6**	**14.1**	**16.4**	**8.2**	**4.4**	**22.1**	**0.72**

PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD8_TP1	Number of Calls	0	0	0	178	0	0	0	0	178
	Percentage	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD8_TP2	Number of Calls	0	0	0	180	0	0	0	0	180
	Percentage	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%

TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD8_TP1	18.97	0.80	24.00	18.00
Qualcomm_BD8_TP2	19.38	1.53	25.00	18.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD8_TP1	178	169	94.94%
Qualcomm_BD8_TP2	180	179	99.44%




Overall Results - Call Accuracy CDF (BD8-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Central Expy
Shirley Ave
© 2013 Google

6.3.3.4 Building 9:

6.3.3.4.1 Building 9 Environment and Test Points:

Building 9 is the Santa Clara City Library. It is a sizeable 2-story suburban building of wood construction with good size windows and a significant amount of glass in its façade. The test points avoided the area near that façade of the building.

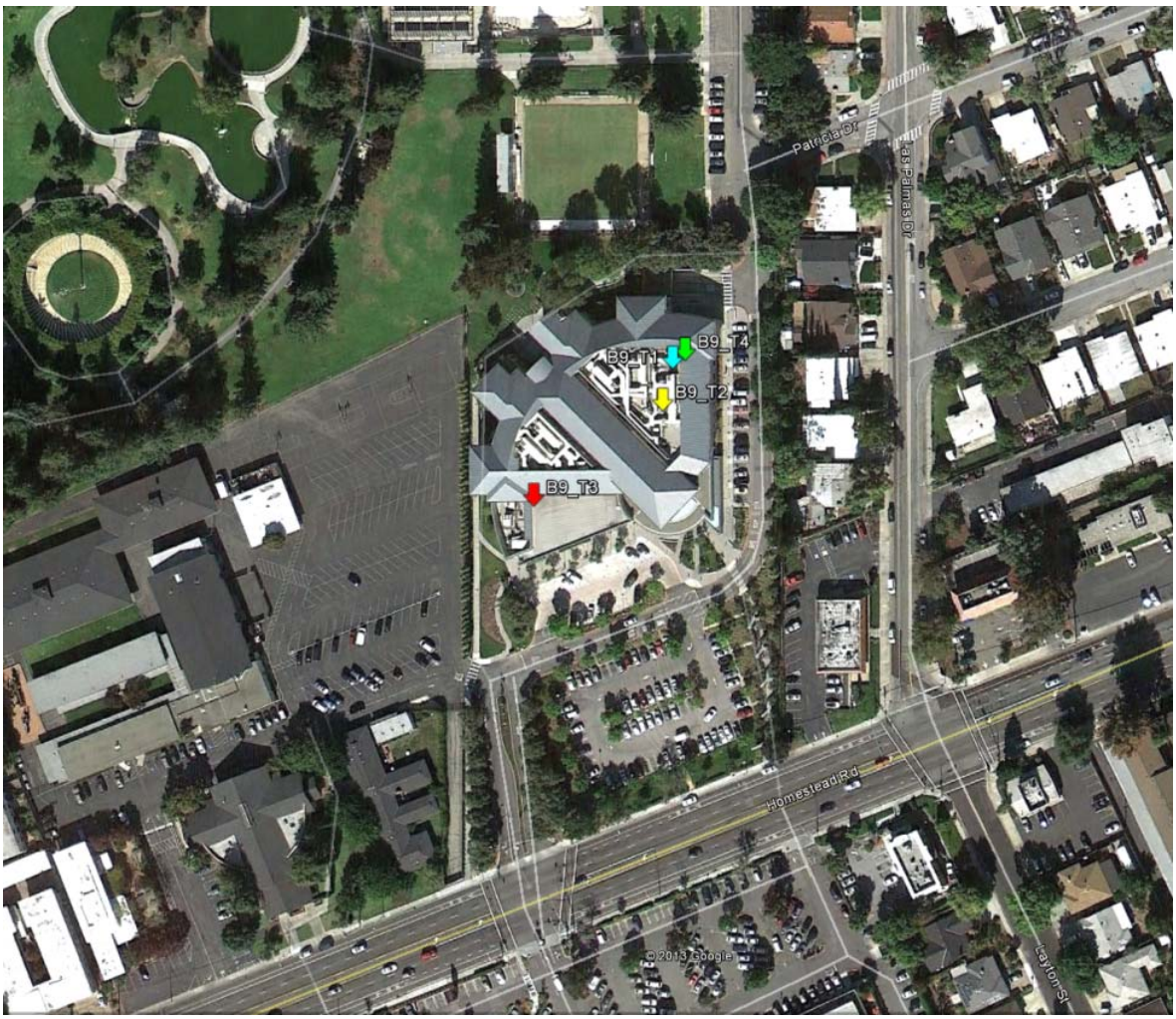
TP1: Interior corridor between offices, 1st floor

TP2: By employee elevator in parking garage, one level below main library hall.

TP3: Outside room with windows, 1st floor

TP4: Interior space near employee break room, 2nd (top) floor

During the analysis phase it was recognized that TP2 had severely unreliable signal reception that resulted in extremely low yield by all technologies under test. This point was therefore omitted from the statistical analysis of the data, and was the only test point among the entire set of 75 points where this was warranted.



6.3.3.4.2 NextNav per Test Point Results—BD9:

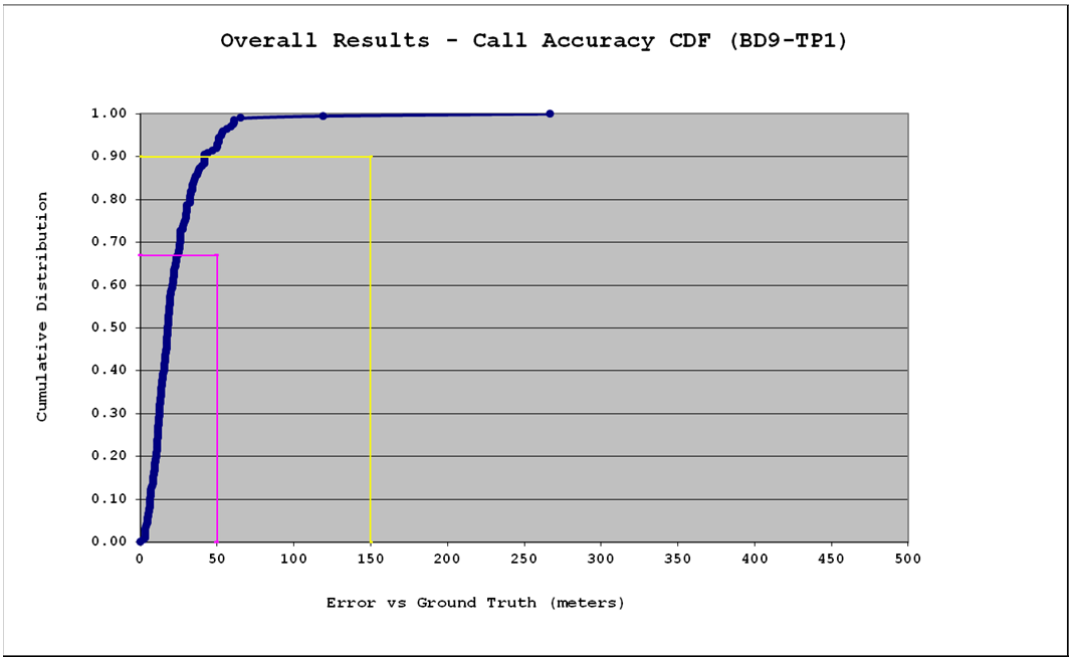
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD9_TP1	198	198	100.0%
NextNav_BD9_TP2			
NextNav_BD9_TP3	200	200	100.0%
NextNav_BD9_TP4	200	200	100.0%

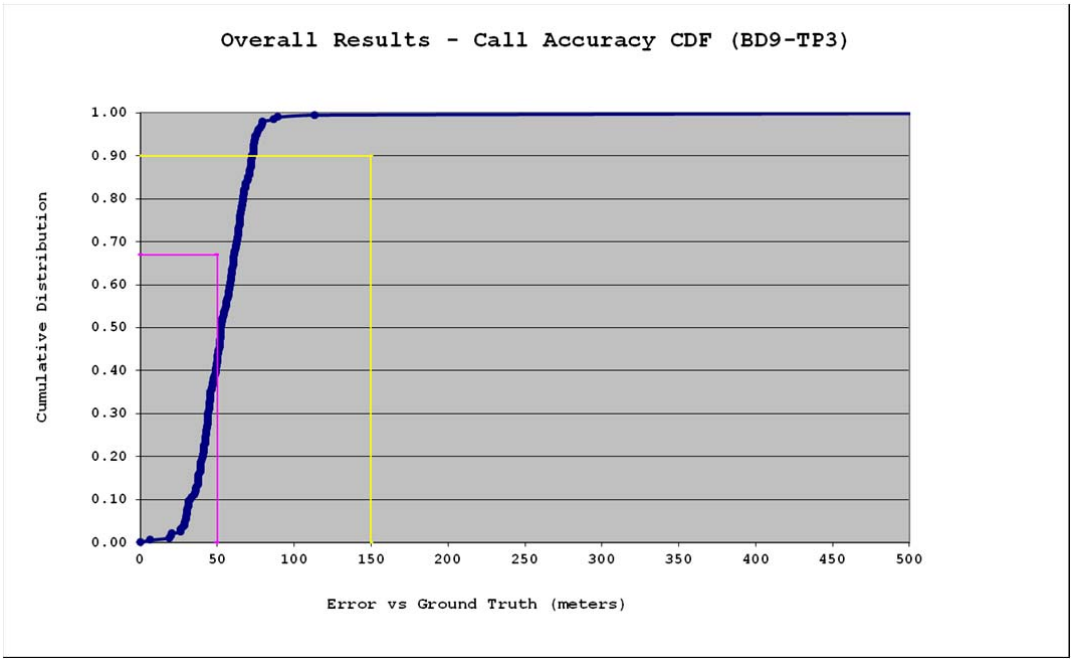
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD9_TP1	198	25.0	42.7	53.6	52.8	415.0	5854.2	2.38
NextNav_BD9_TP2								
NextNav_BD9_TP3	200	61.2	72.9	76.0	56.6	45.7	662.6	6.48
NextNav_BD9_TP4	200	23.9	32.3	34.7	19.4	9.8	58.7	1.13

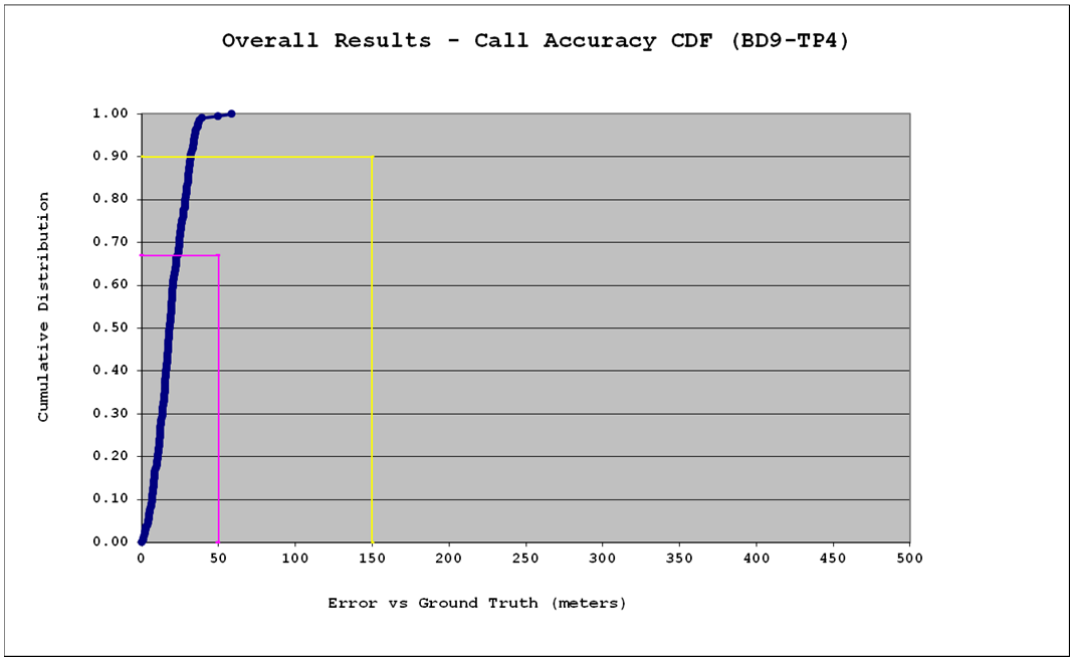
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD9_TP1	198	7.2	8.4	8.8	4.8	2.9	9.7	0.28
NextNav_BD9_TP2	0							
NextNav_BD9_TP3	200	5.2	5.7	5.8	4.6	0.9	6.7	2.96
NextNav_BD9_TP4	200	4.7	5.6	5.8	4.5	0.7	6.1	3.04

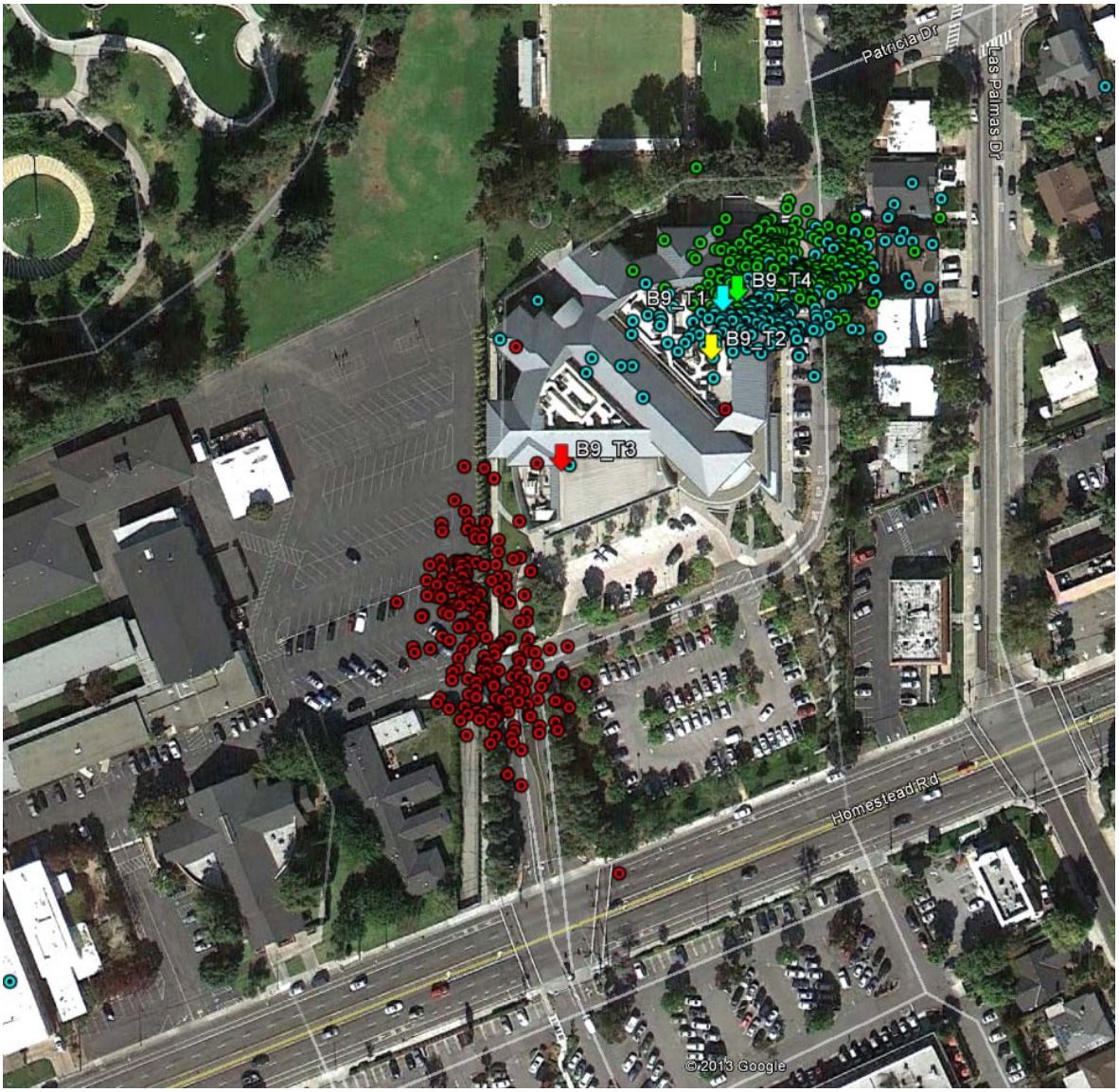
TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD9_TP1	27.46	0.19	27.93	26.98
NextNav_BD9_TP2				
NextNav_BD9_TP3	27.42	0.37	32.34	27.00
NextNav_BD9_TP4	27.36	0.36	32.34	27.27

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD9_TP1	198	192	96.97%
NextNav_BD9_TP2			
NextNav_BD9_TP3	200	152	76.00%
NextNav_BD9_TP4	200	200	100.00%


Overall Results - Call Accuracy CDF (BD9-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD9-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD9-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



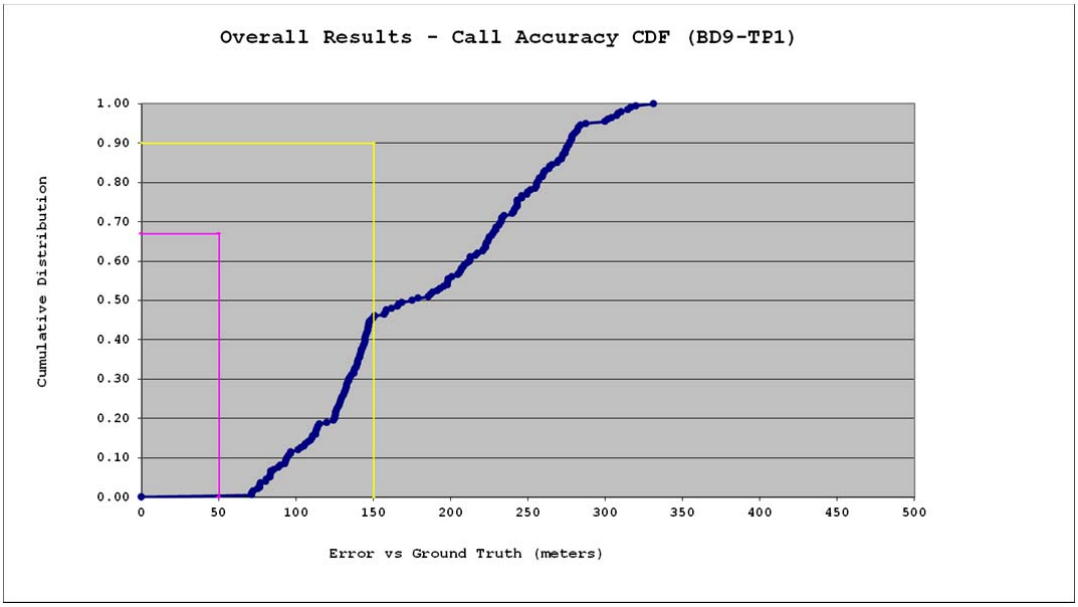
6.3.3.4.3 Polaris per Test Point Results—BD9:

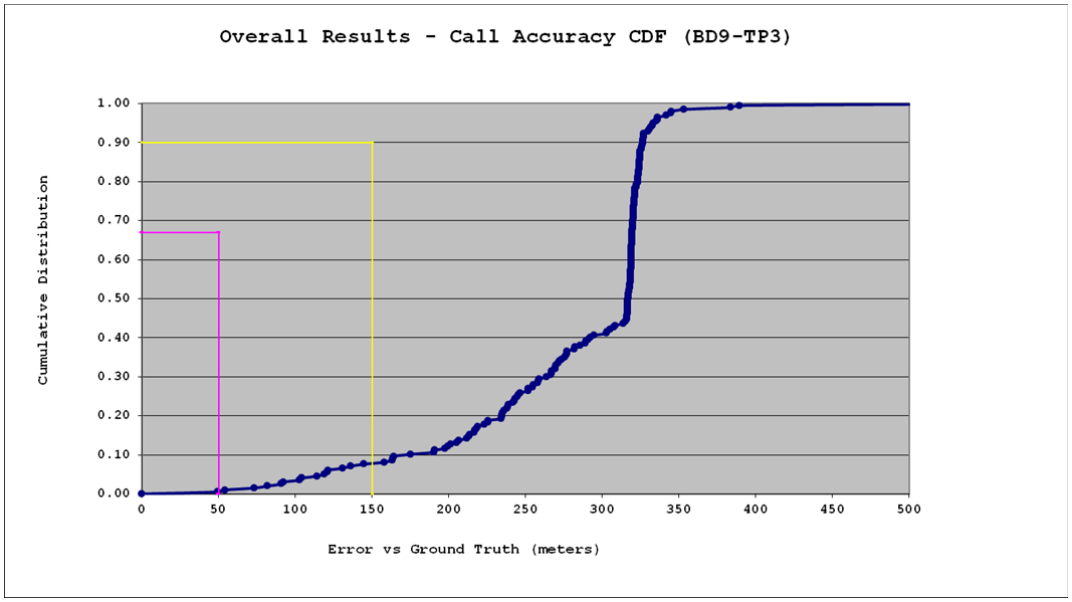
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD9_TP1	**200**	**200**	**100.0%**
Polaris_BD9_TP2			
Polaris_BD9_TP3	**198**	**197**	**99.5%**
Polaris_BD9_TP4	**199**	**199**	**100.0%**

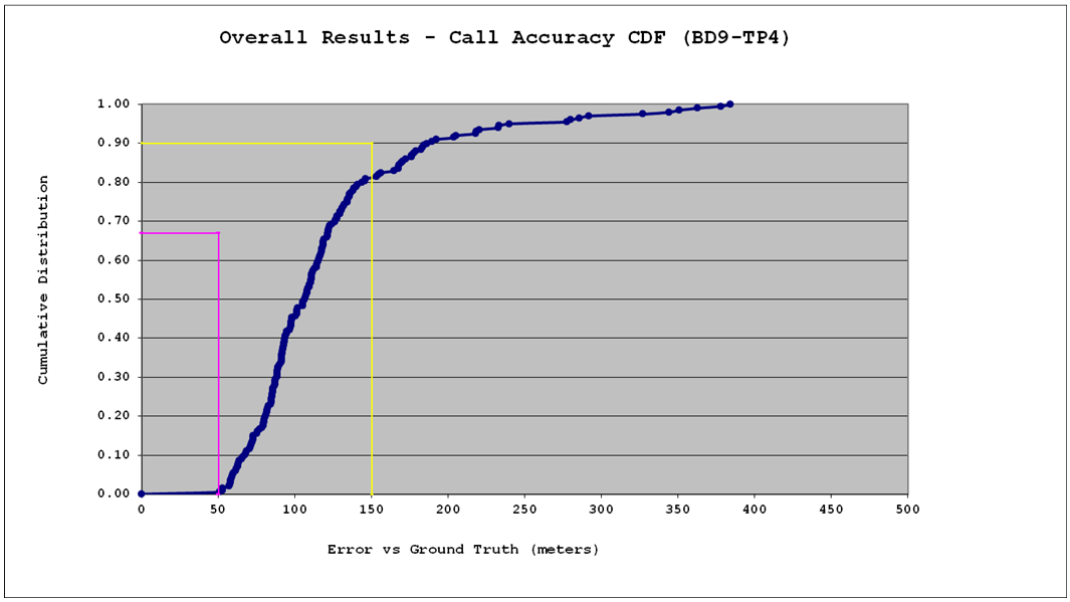
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD9_TP1	200	227.7	277.0	288.0	184.9	69.0	331.1	71.27
Polaris_BD9_TP2								
Polaris_BD9_TP3	197	319.5	326.3	333.4	280.2	71.1	595.4	49.19
Polaris_BD9_TP4	199	121.6	186.6	243.4	121.7	62.1	384.3	50.84

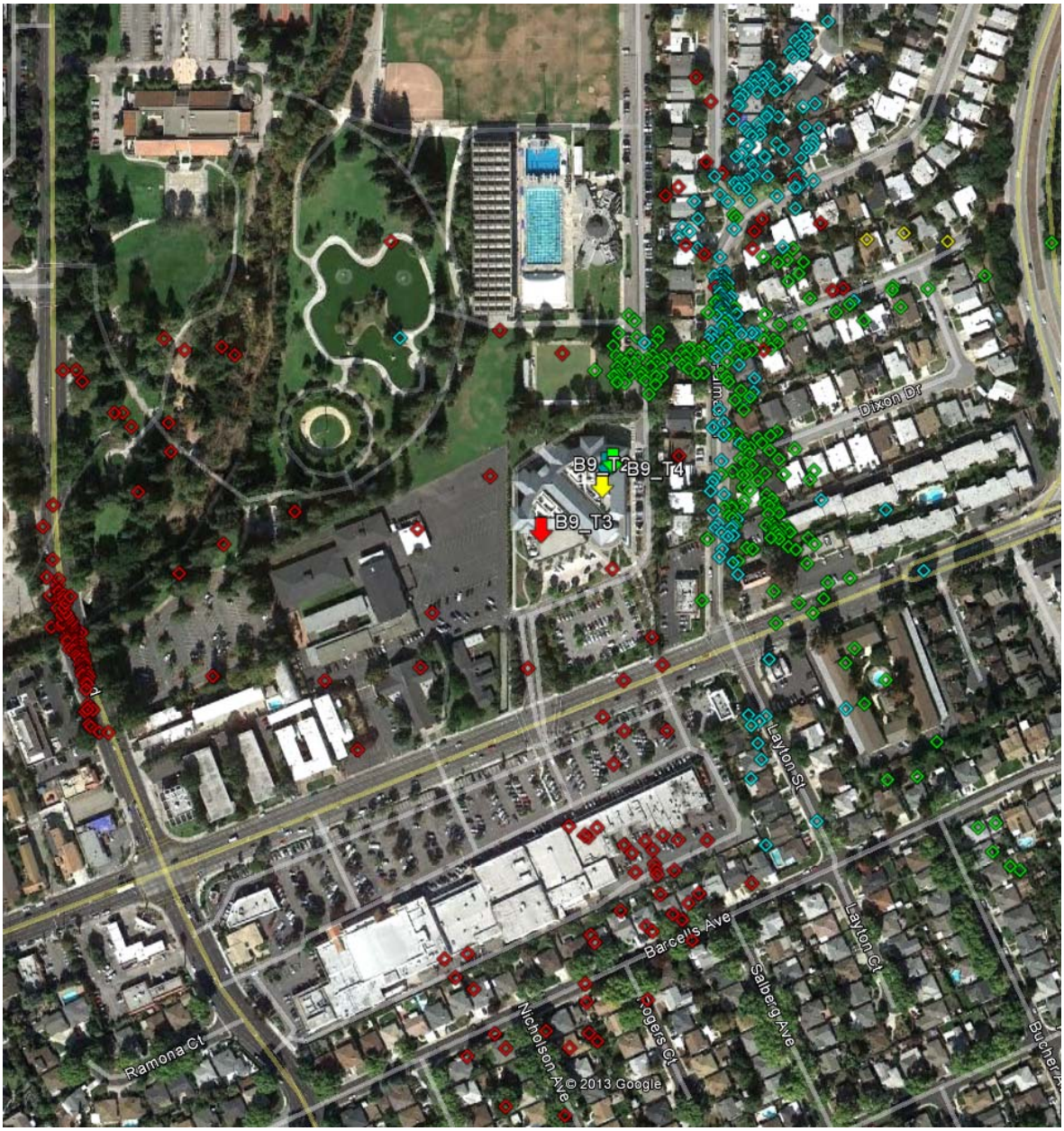
TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD9_TP1	24.72	0.93	26.11	22.16
Polaris_BD9_TP2				
Polaris_BD9_TP3	24.98	0.83	26.37	20.37
Polaris_BD9_TP4	24.94	0.76	26.22	22.17

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD9_TP1	200	164	82.00%
Polaris_BD9_TP2			
Polaris_BD9_TP3	197	98	49.75%
Polaris_BD9_TP4	199	190	95.48%




Overall Results - Call Accuracy CDF (BD9-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD9-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B9_T2
B9_T4
B9_T3
Dixon Dr
Layton St
Barcelis Ave
Layton Ct
Saberg Ave
Rogers Ct
Nicholson Ave
Ramona Ct
© 2013 Google

6.3.3.4.4 Qualcomm per Test Point Results—BD9:

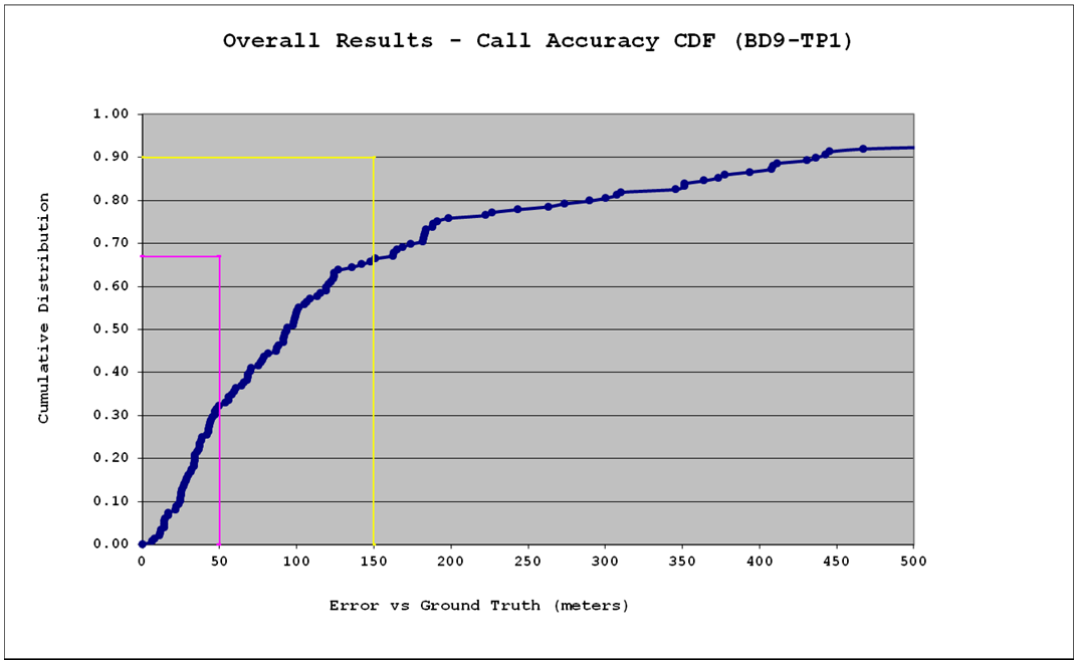
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD9_TP1	180	149	82.8%
Qualcomm_BD9_TP2			
Qualcomm_BD9_TP3	180	178	98.9%
Qualcomm_BD9_TP4	180	180	100.0%

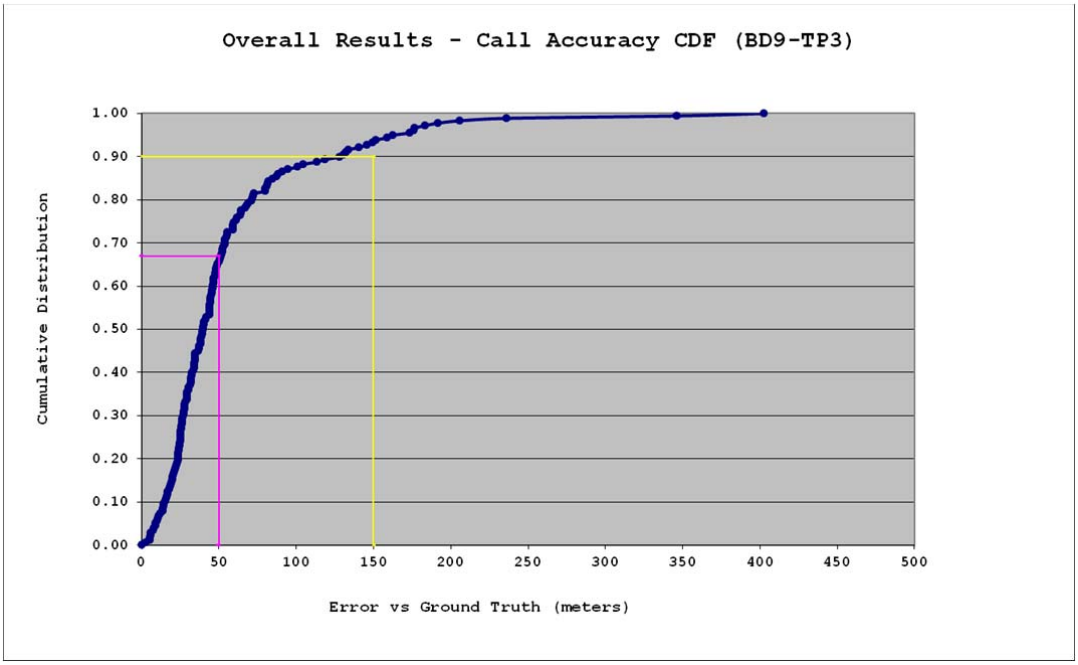
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD9_TP1	149	162.6	438.1	668.6	181.4	230.6	1311.5	6.64
Qualcomm_BD9_TP2								
Qualcomm_BD9_TP3	178	51.7	128.8	164.0	55.8	55.1	402.5	2.96
Qualcomm_BD9_TP4	180	54.1	155.4	190.7	81.1	306.4	4078.5	1.76

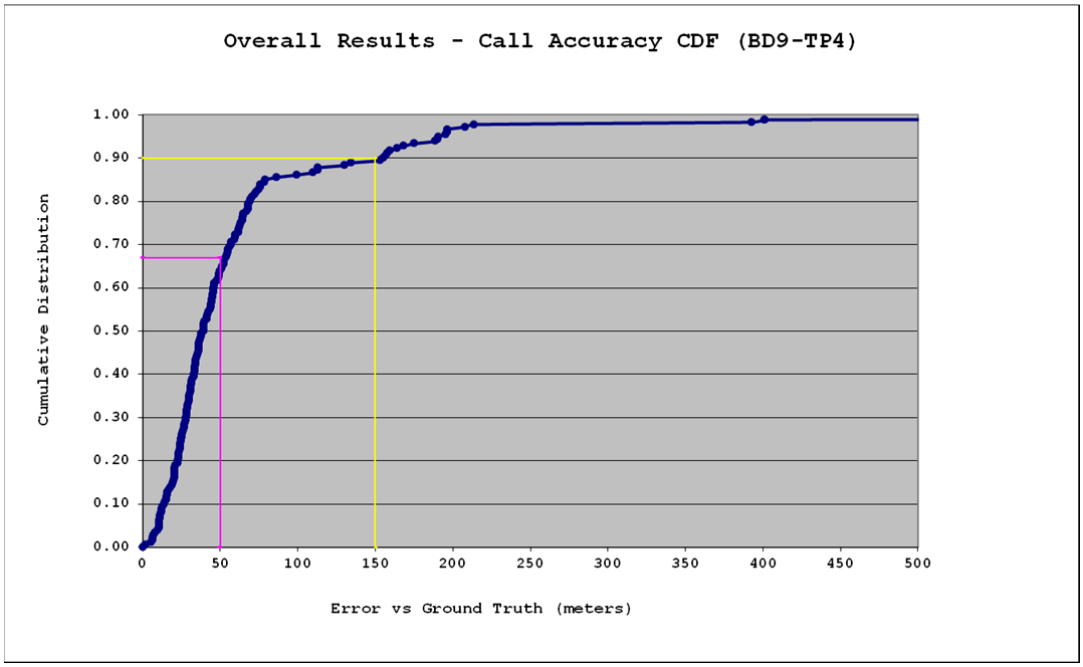
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD9_TP1	Number of Calls	2	14	123	9	1	0	0	0	149
	Percentage	1.3%	9.4%	82.6%	6.0%	0.7%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD9_TP2	Number of Calls									
	Percentage									
Qualcomm_BD9_TP3	Number of Calls	1	3	16	158	0	0	0	0	178
	Percentage	0.6%	1.7%	9.0%	88.8%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD9_TP4	Number of Calls	2	5	26	147	0	0	0	0	180
	Percentage	1.1%	2.8%	14.4%	81.7%	0.0%	0.0%	0.0%	0.0%	100.0%

TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD9_TP1	26.51	6.22	67.00	7.00
Qualcomm_BD9_TP2				
Qualcomm_BD9_TP3	25.17	3.29	50.00	18.00
Qualcomm_BD9_TP4	24.95	2.69	45.00	17.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD9_TP1	149	141	94.63%
Qualcomm_BD9_TP2			
Qualcomm_BD9_TP3	178	133	74.72%
Qualcomm_BD9_TP4	180	148	82.22%


Overall Results - Call Accuracy CDF (BD9-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD9-TP3)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD9-TP4)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

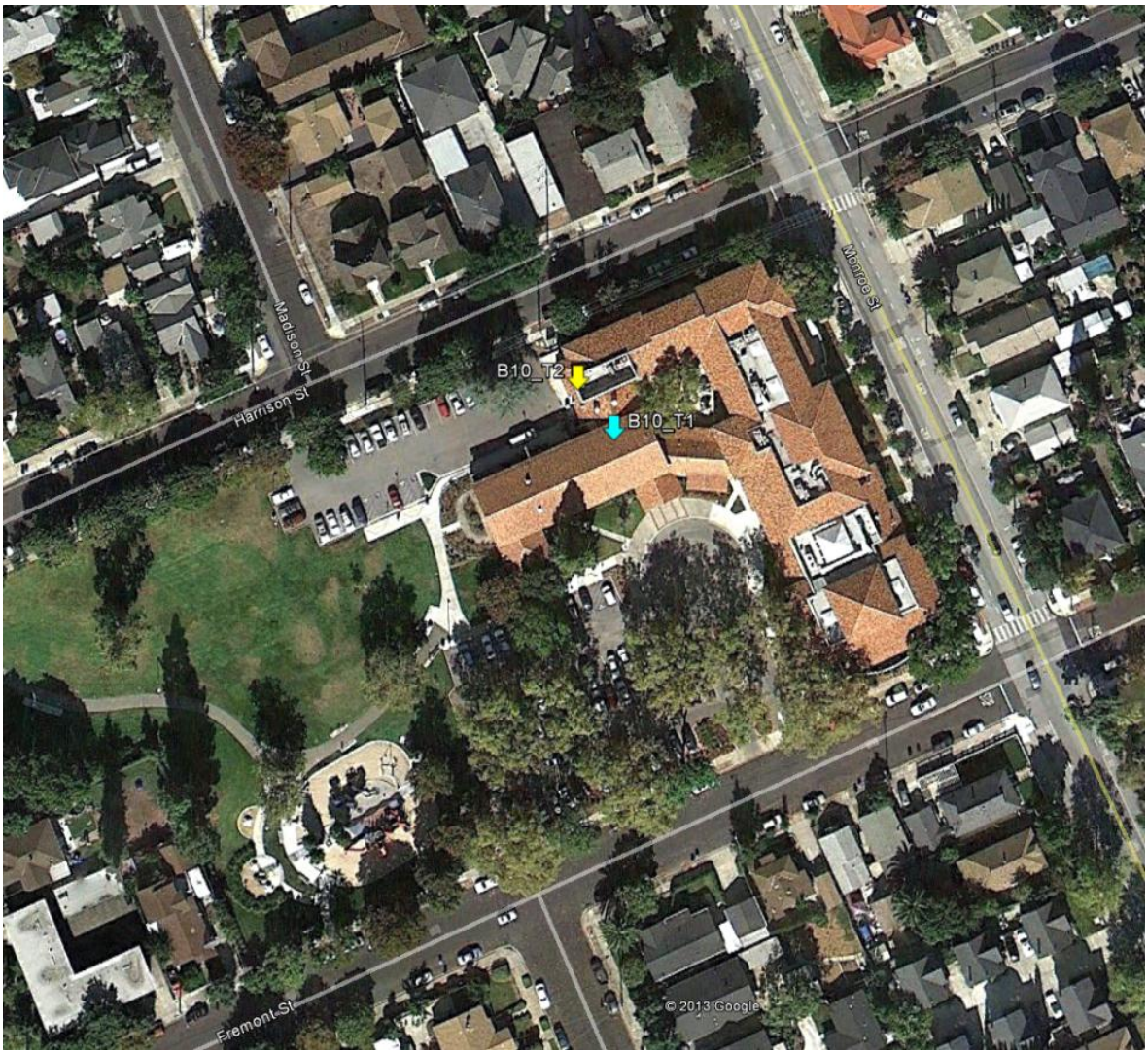
6.3.3.5 Building 10:

6.3.3.5.1 Building 10 Environment and Test Points:

Building 10 is the senior center building in Santa Clara. This a mostly 2 –story brick and plaster building with a tile roof.

TP1: Upper lobby (with glass wall to hall with many windows)

TP2: 1st floor stairwell near back entrance



6.3.3.5.2 NextNav per Test Point Results—BD10:

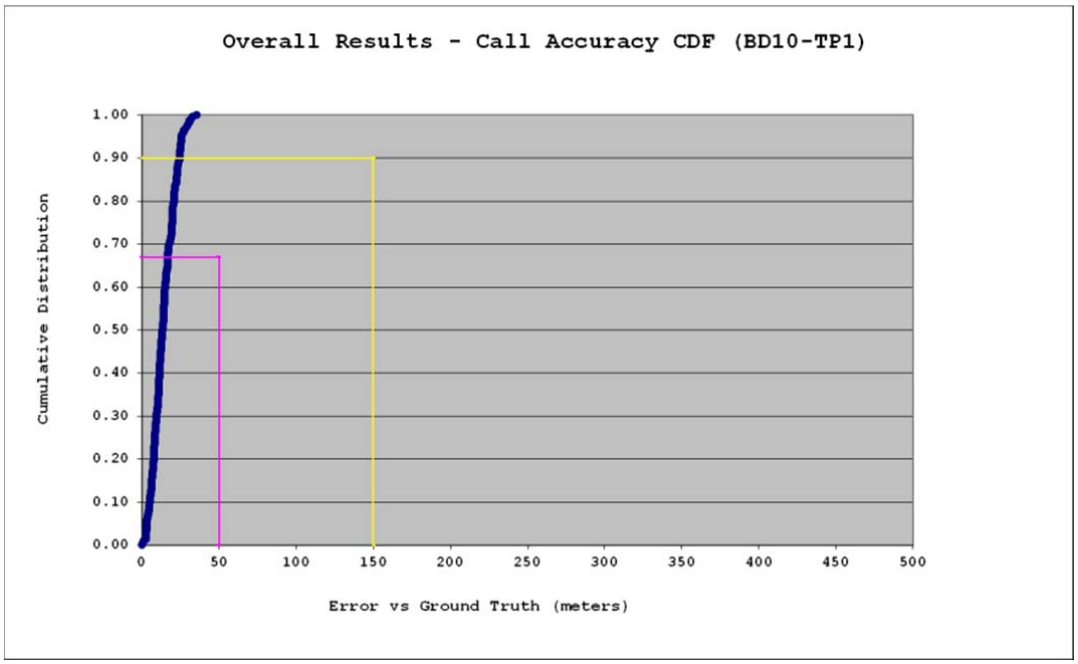
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD10_TP1	**223**	**223**	**100.0%**
NextNav_BD10_TP2	**200**	**200**	**100.0%**

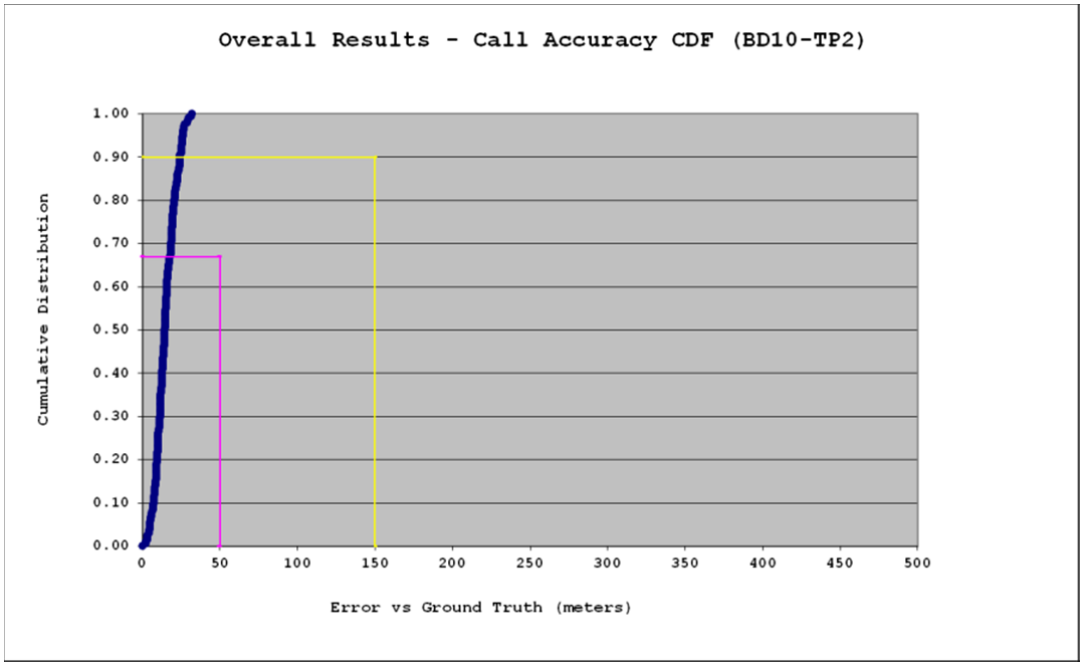
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD10_TP1	**223**	**16.9**	**24.5**	**26.0**	**14.3**	**7.2**	**35.6**	**0.48**
NextNav_BD10_TP2	**200**	**18.3**	**24.4**	**26.3**	**15.2**	**6.4**	**31.8**	**2.48**

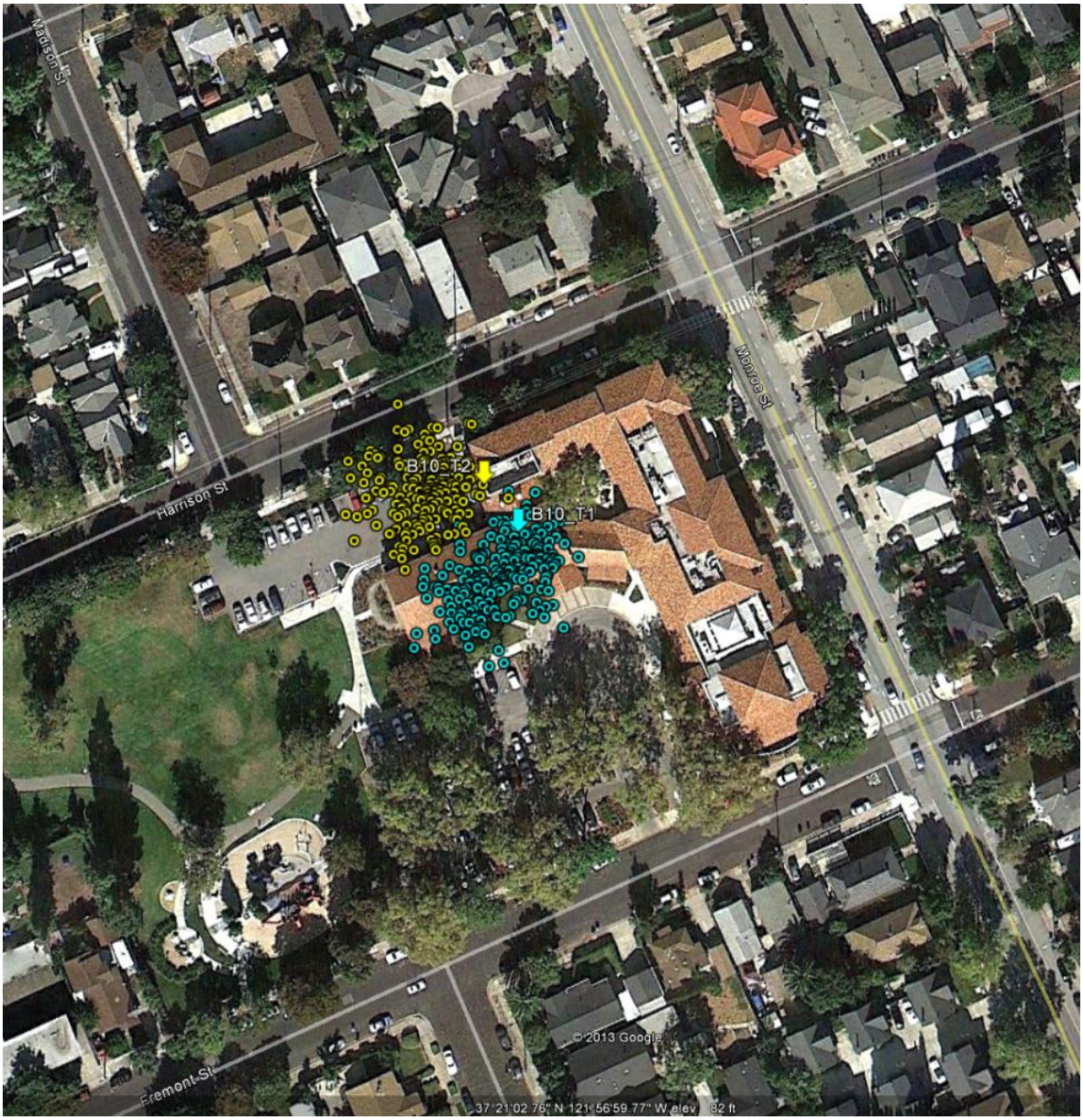
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD10_TP1	223	5.2	5.7	6.1	5.0	0.5	6.5	3.79
NextNav_BD10_TP2	200	5.2	5.6	5.7	4.9	0.5	6.7	3.20

TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD10_TP1	27.33	0.04	27.55	27.27
NextNav_BD10_TP2	27.40	0.50	32.34	27.27

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD10_TP1	223	223	100.00%
NextNav_BD10_TP2	200	200	100.00%




Overall Results - Call Accuracy CDF (BD10-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



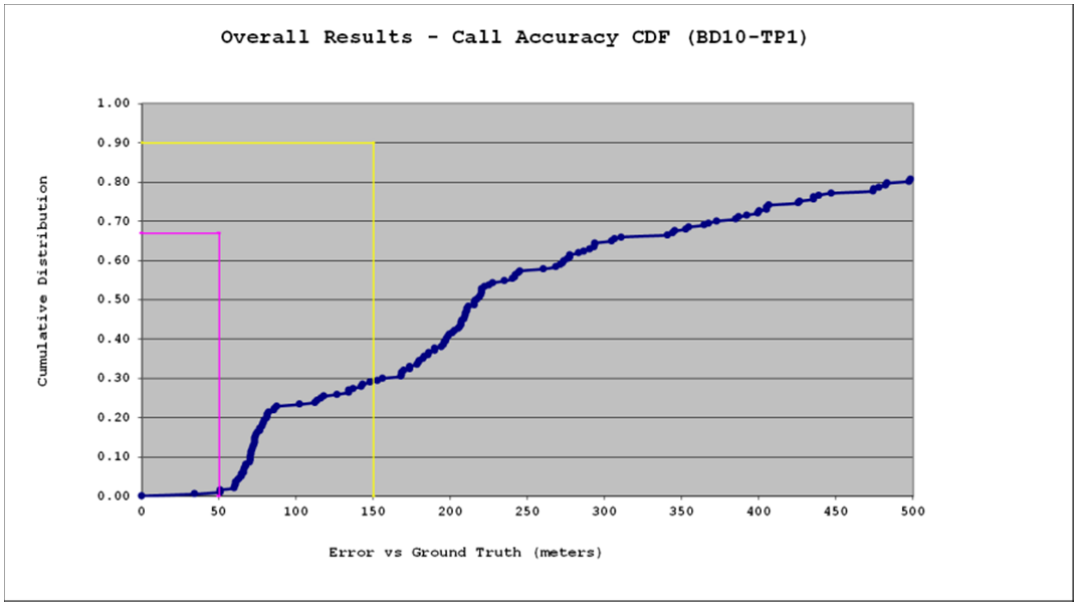
6.3.3.5.3 Polaris per Test Point Results—BD10:

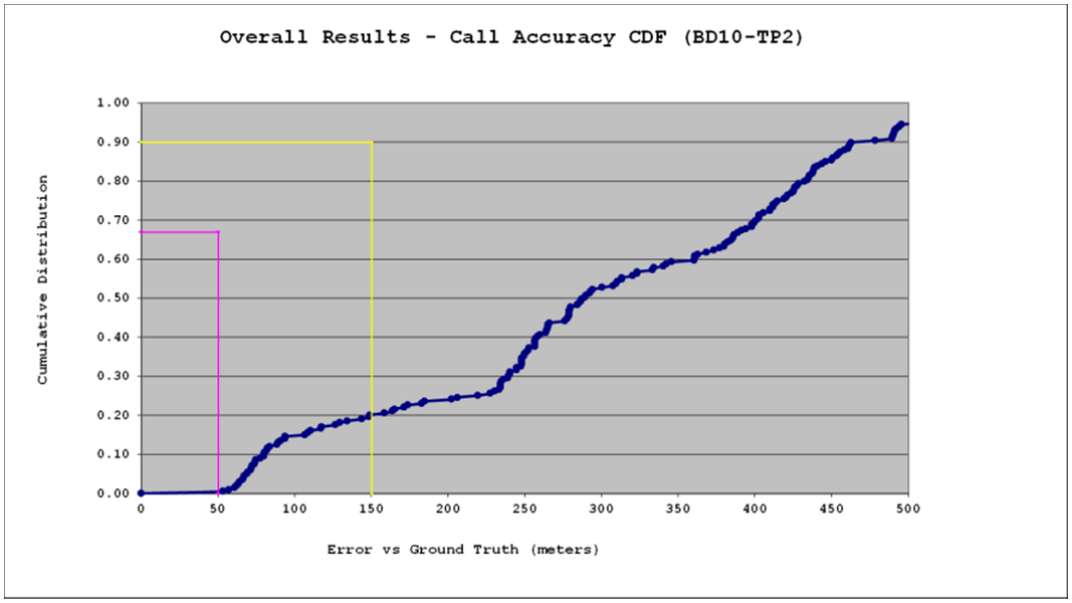
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD10_TP1	**198**	**197**	**99.5%**
Polaris_BD10_TP2	**200**	**199**	**99.5%**

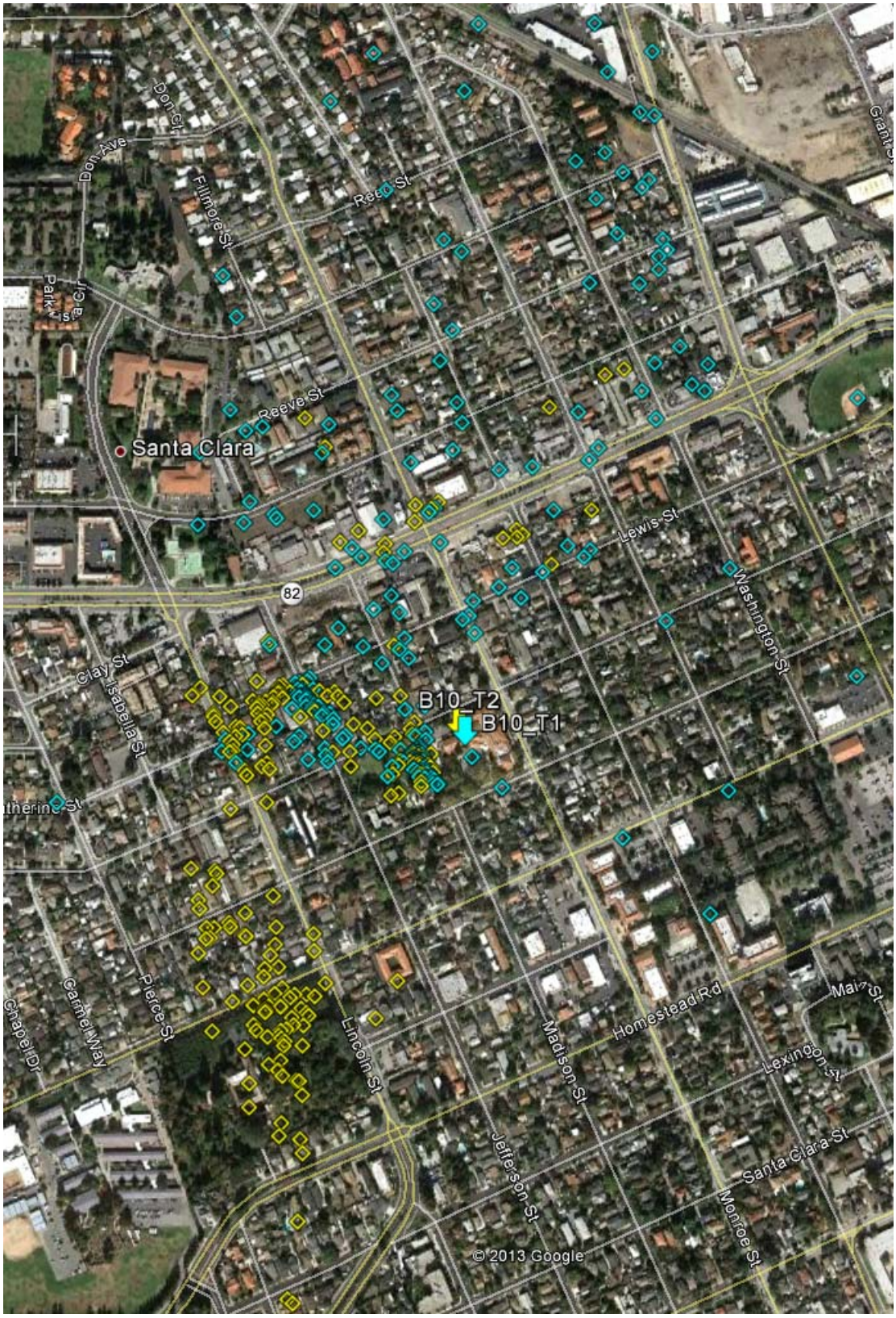
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD10_TP1	197	344.5	672.0	767.1	301.6	230.4	952.5	34.39
Polaris_BD10_TP2	199	390.5	465.9	505.6	302.0	146.4	748.3	53.30

TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD10_TP1	24.08	2.56	26.88	1.54
Polaris_BD10_TP2	25.22	1.01	27.11	21.18

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD10_TP1	197	166	84.26%
Polaris_BD10_TP2	199	152	76.38%




Overall Results - Call Accuracy CDF (BD10-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Santa Clara
B10_T2
B10_T1
Don Ave
Don Ct
Fillmore St
Reed St
Reeve St
Lewis St
Washington St
Clay St
Isabella St
Pierce St
Carmel Way
Chapel Dr
Lincoln St
Madison St
Jefferson St
Homestead Rd
Lexington St
Santa Clara St
Monroe St
Grant St
82
© 2013 Google

6.3.3.5.4 Qualcomm per Test Point Results—BD10:

Building 10 is City of Santa Clara Senior Center. It is mostly a two story masonry structure with a tile roof in a suburban, mostly residential neighborhood.

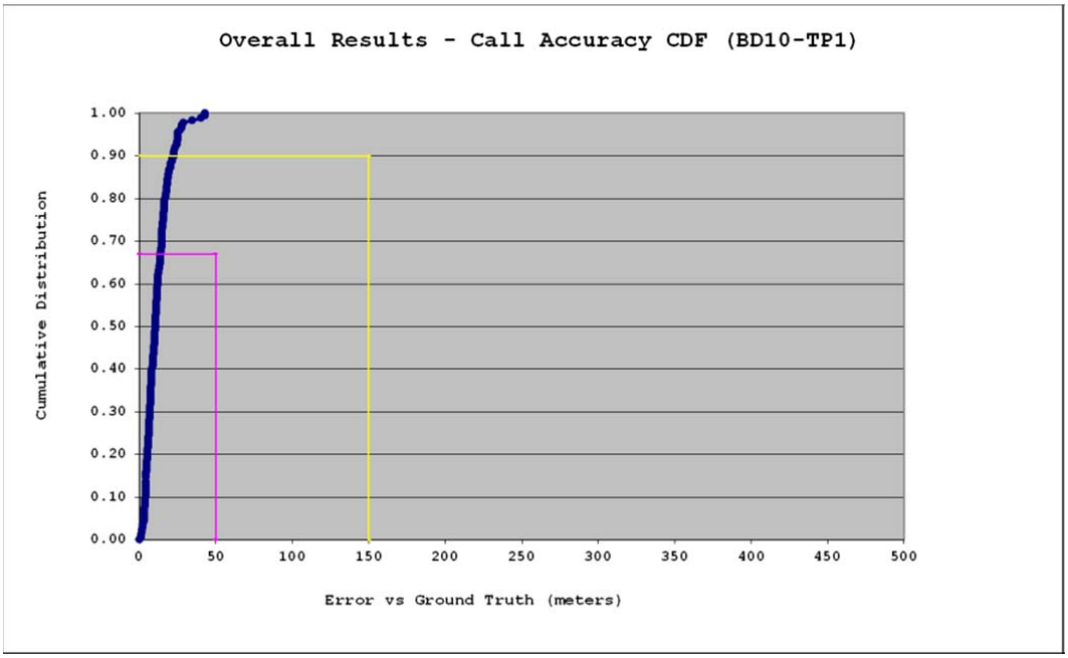
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD10_TP1	180	179	99.4%
Qualcomm_BD10_TP2	180	180	100.0%

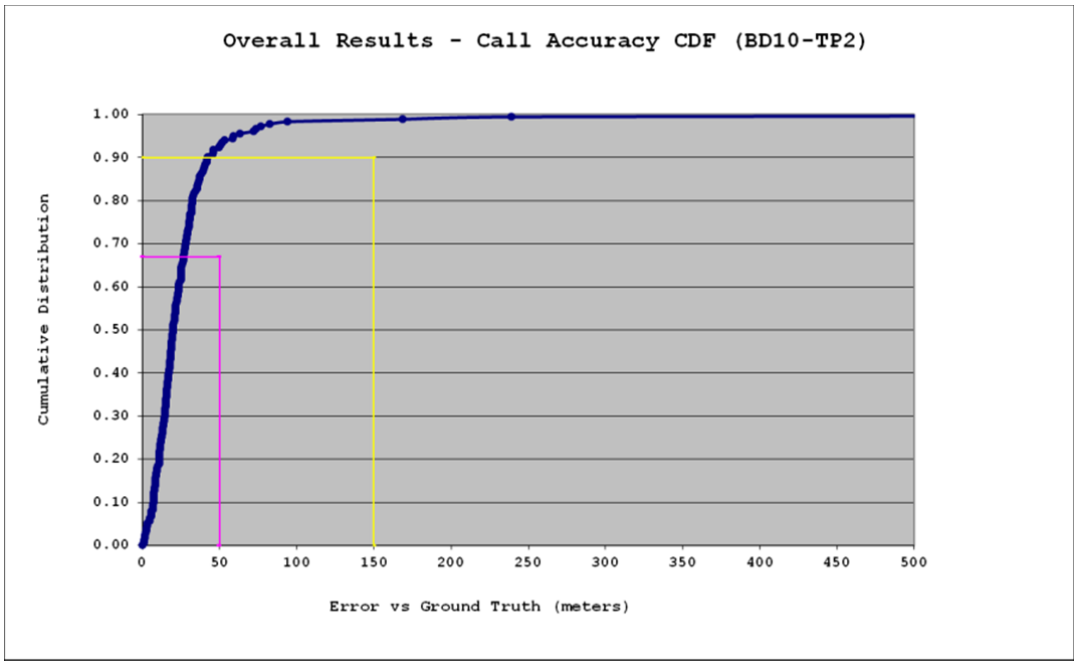
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD10_TP1	179	14.0	22.5	25.4	12.0	7.7	43.0	1.03
Qualcomm_BD10_TP2	180	27.0	42.6	59.5	32.5	100.4	1329.5	1.12

PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD10_TP1	Number of Calls	0	2	0	177	0	0	0	0	179
	Percentage	0.0%	1.1%	0.0%	98.9%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD10_TP2	Number of Calls	0	5	5	169	0	1	0	0	180
	Percentage	0.0%	2.8%	2.8%	93.9%	0.0%	0.6%	0.0%	0.0%	100.0%

TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD10_TP1	20.84	3.59	44.00	18.00
Qualcomm_BD10_TP2	24.33	1.56	31.00	17.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD10_TP1	179	167	93.30%
Qualcomm_BD10_TP2	180	160	88.89%


Overall Results - Call Accuracy CDF (BD10-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD10-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)

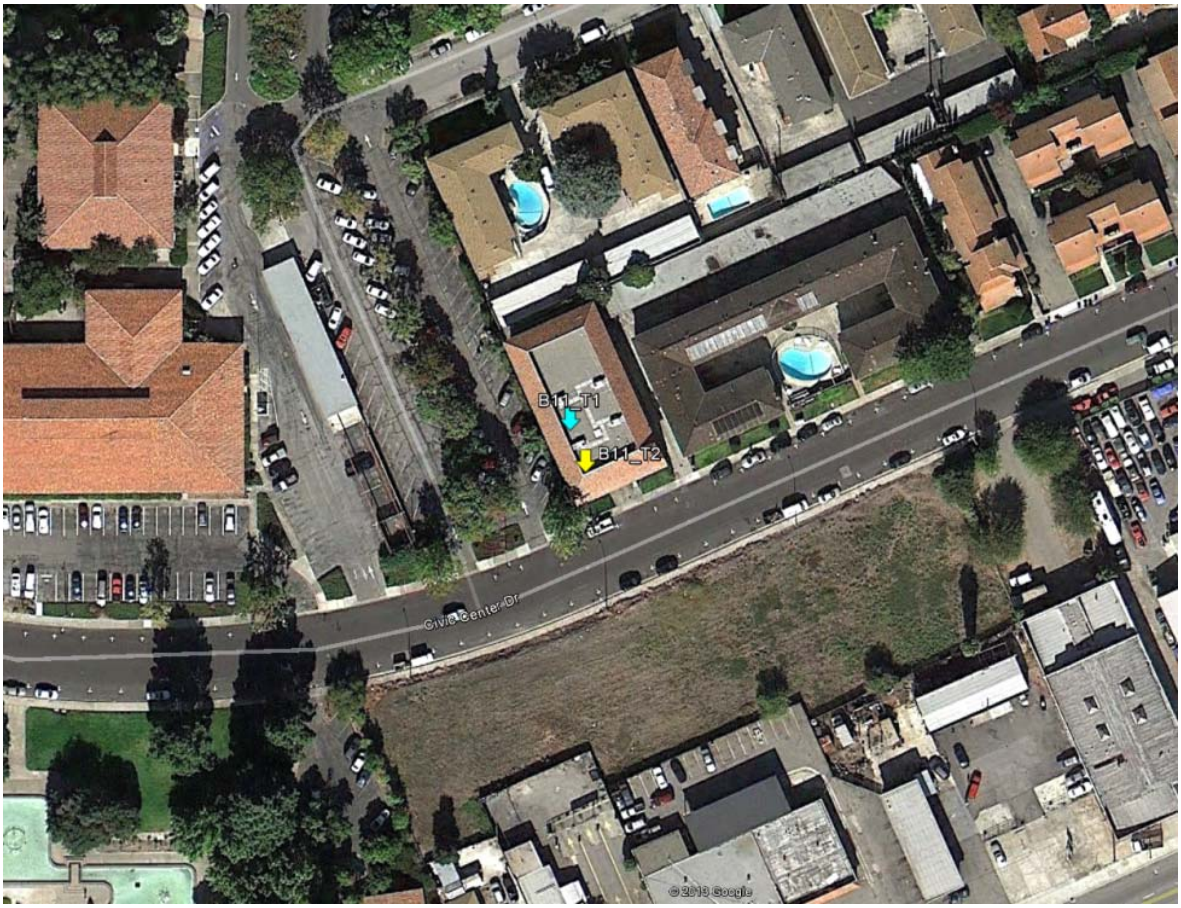
6.3.3.6 Building 11:

6.3.3.6.1 Building 11 Environment and Test Points:

Building 11 is 1405 Civic Center, Santa Clara, a 2 story apartment building that has been converted to city offices (including IT department). Typical light California construction with stucco and some brick veneer. 1st floor is mostly a garage space.

TP1: 2nd floor conference room, interior

TP2: 1st floor garage space



6.3.3.6.2 NextNav per Test Point Results—BD11:

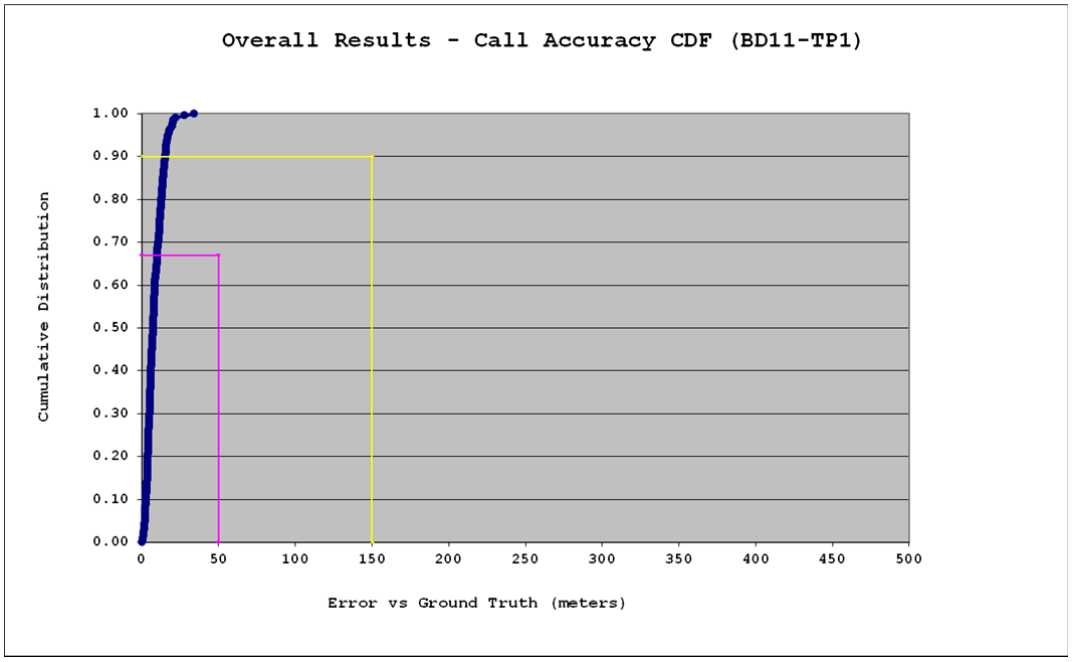
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD11_TP1	**206**	**206**	**100.0%**
NextNav_BD11_TP2	**200**	**200**	**100.0%**

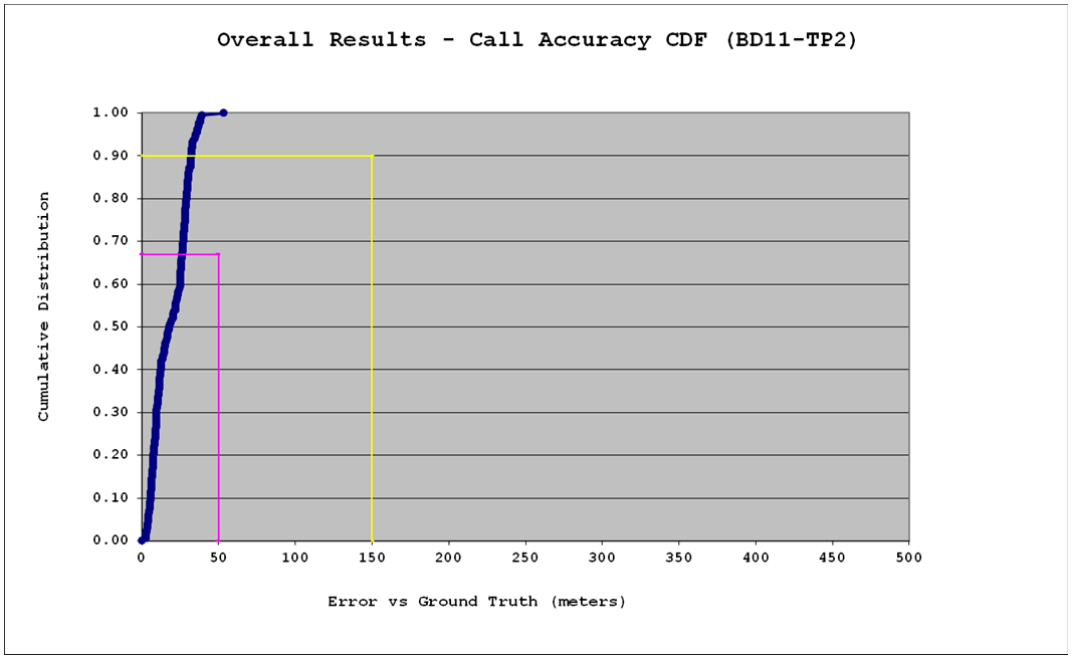
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD11_TP1	**206**	**10.3**	**15.4**	**17.2**	**8.6**	**5.2**	**34.0**	**0.54**
NextNav_BD11_TP2	**200**	**26.6**	**32.3**	**35.3**	**19.0**	**10.8**	**53.7**	**2.61**

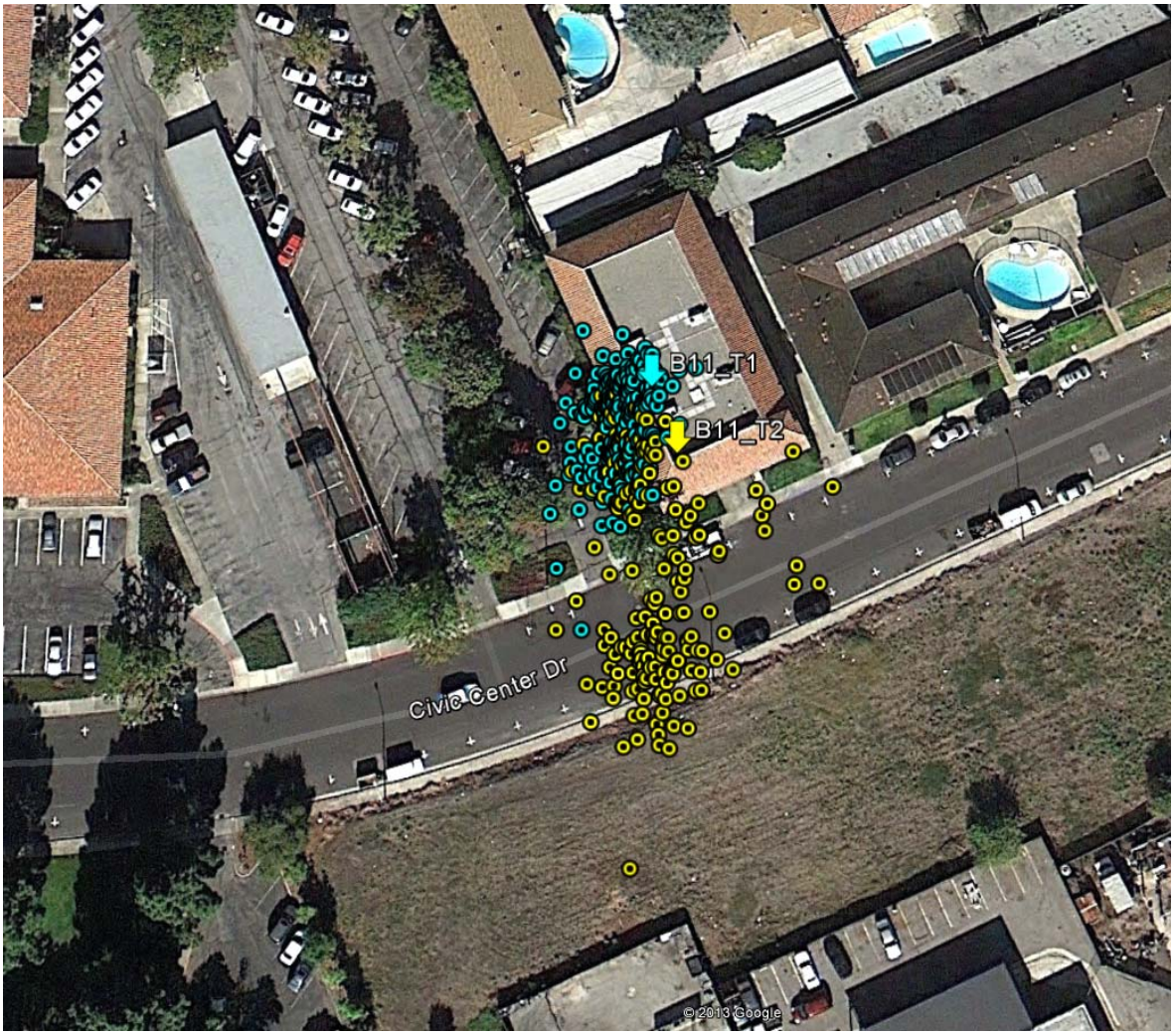
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD11_TP1	**206**	**5.1**	**5.6**	**5.7**	**4.8**	**0.6**	**6.1**	**3.29**
NextNav_BD11_TP2	**200**	**5.2**	**5.9**	**6.2**	**4.8**	**0.8**	**6.7**	**2.83**

TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD11_TP1	27.33	0.04	27.65	27.27
NextNav_BD11_TP2	27.34	0.36	32.34	26.33

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD11_TP1	206	206	100.00%
NextNav_BD11_TP2	200	199	99.50%




Overall Results - Call Accuracy CDF (BD11-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B11_T1
B11_T2
Civic Center Dr
© 2013 Google

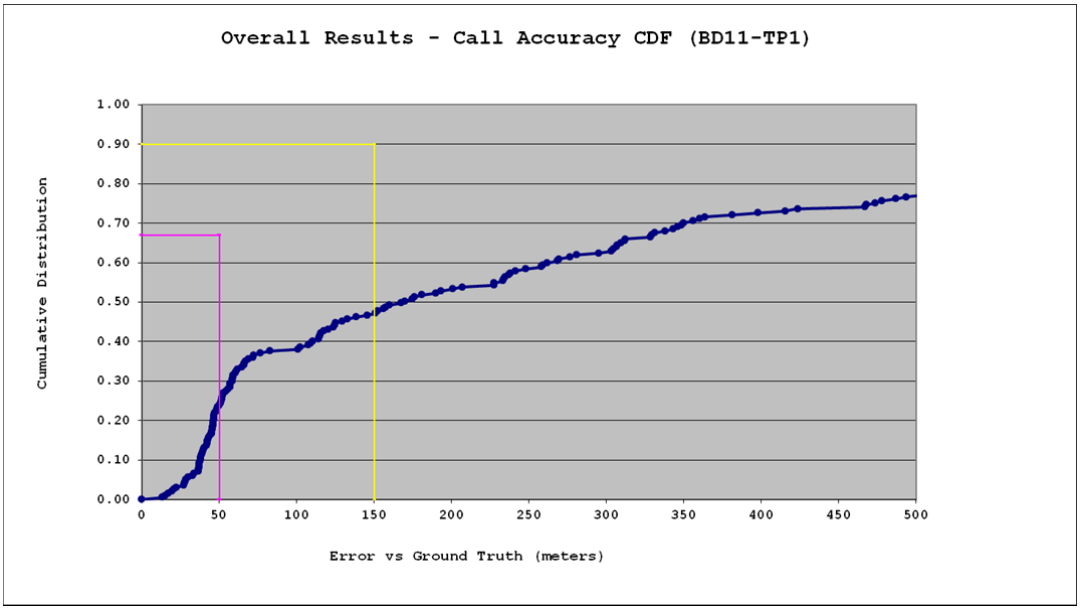
6.3.3.6.3 Polaris per Test Point Results—BD11:

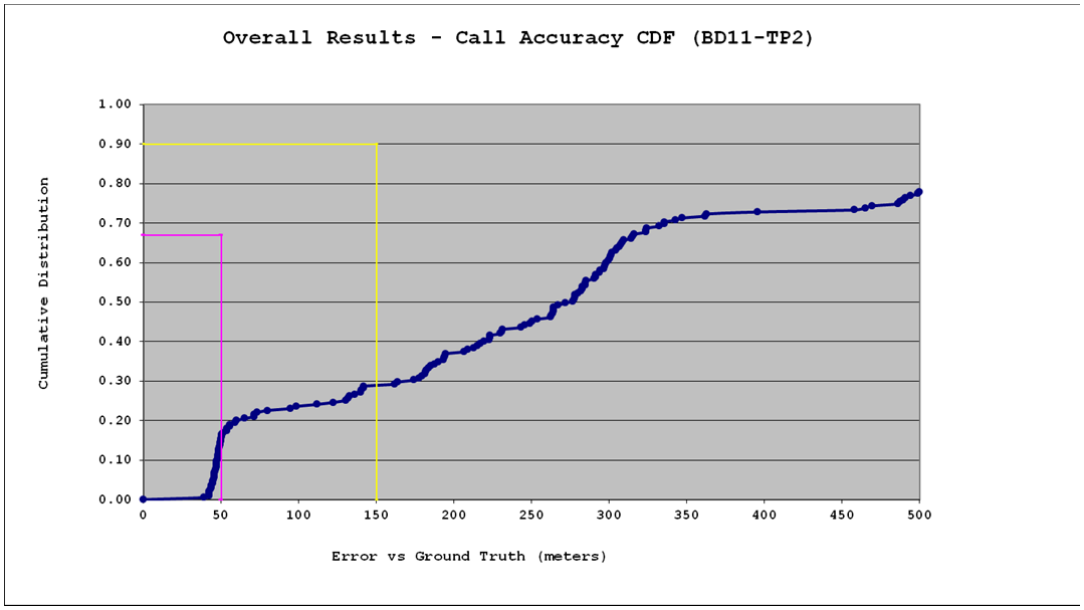
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD11_TP1	198	197	99.5%
Polaris_BD11_TP2	196	195	99.5%

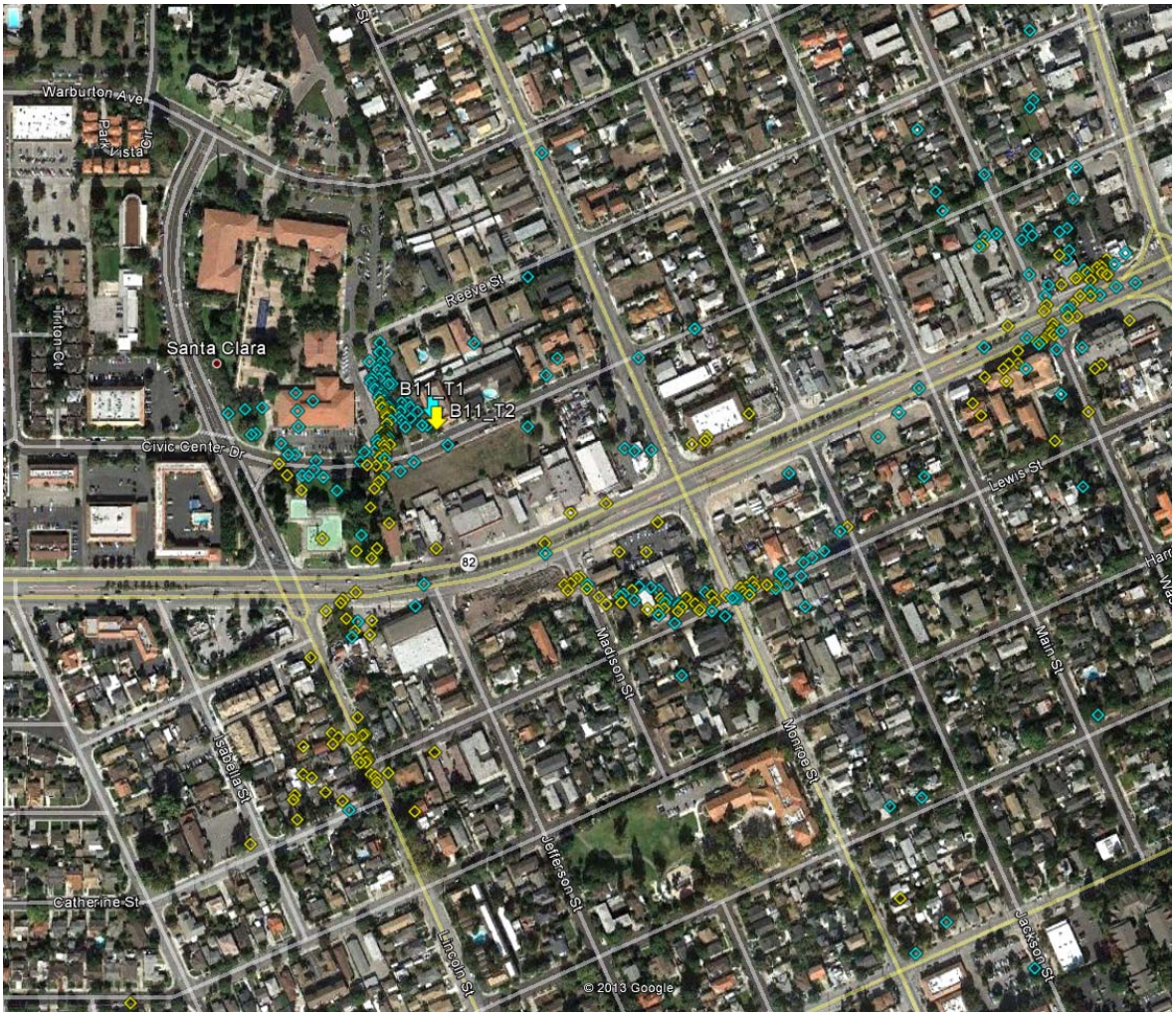
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD11_TP1	197	330.0	565.6	604.5	248.1	211.8	700.3	13.24
Polaris_BD11_TP2	195	316.2	562.8	582.0	284.9	187.6	828.2	39.15

TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD11_TP1	24.07	2.30	27.64	2.33
Polaris_BD11_TP2	24.62	0.96	27.12	20.67

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD11_TP1	197	193	97.97%
Polaris_BD11_TP2	195	163	83.59%




Overall Results - Call Accuracy CDF (BD11-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Warburton Ave
Park Vista Dr
Santa Clara
Reeve St
B11_T1
B11_T2
Civic Center Dr
Lewis St
Madison St
Monroe St
Main St
Jefferson St
Lincoln St
Jackson St
Catherine St
© 2013 Google

6.3.3.6.4 Qualcomm per Test Point Results—BD11:

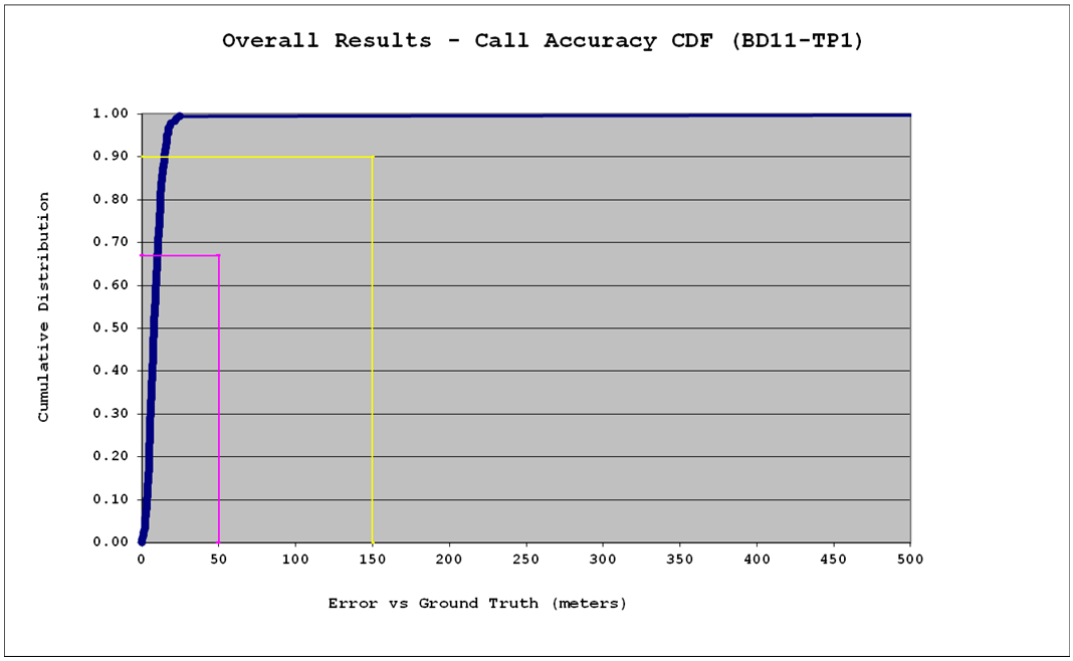
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD11_TP1	180	179	99.4%
Qualcomm_BD11_TP2	180	180	100.0%

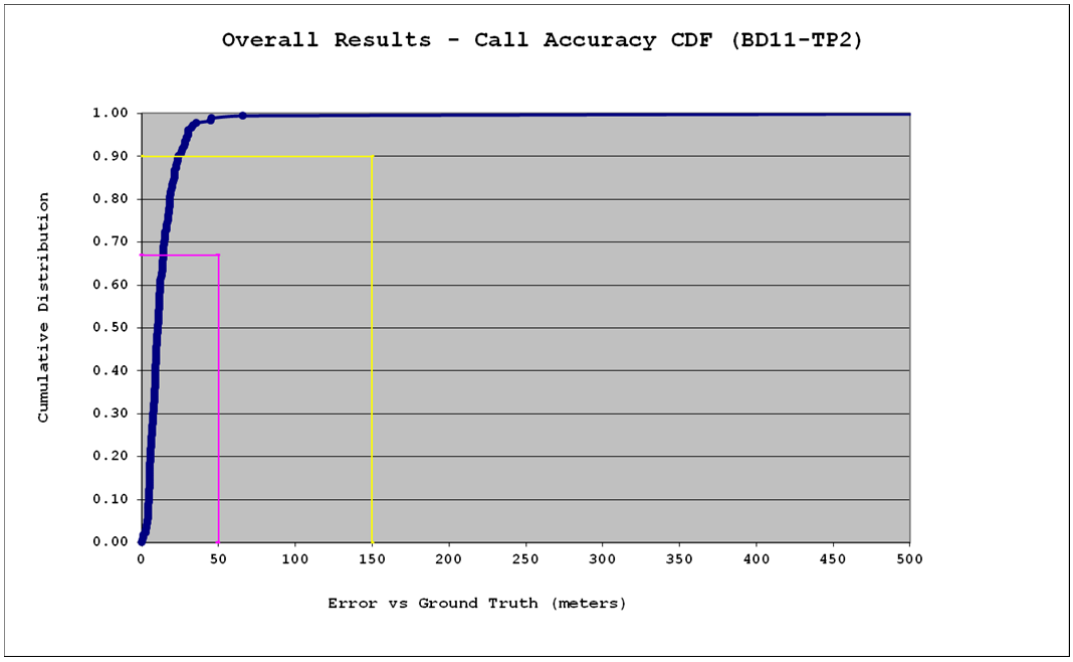
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD11_TP1	179	10.4	15.0	16.7	14.8	81.5	1097.1	0.23
Qualcomm_BD11_TP2	180	14.1	24.6	30.5	16.6	47.9	644.1	0.88

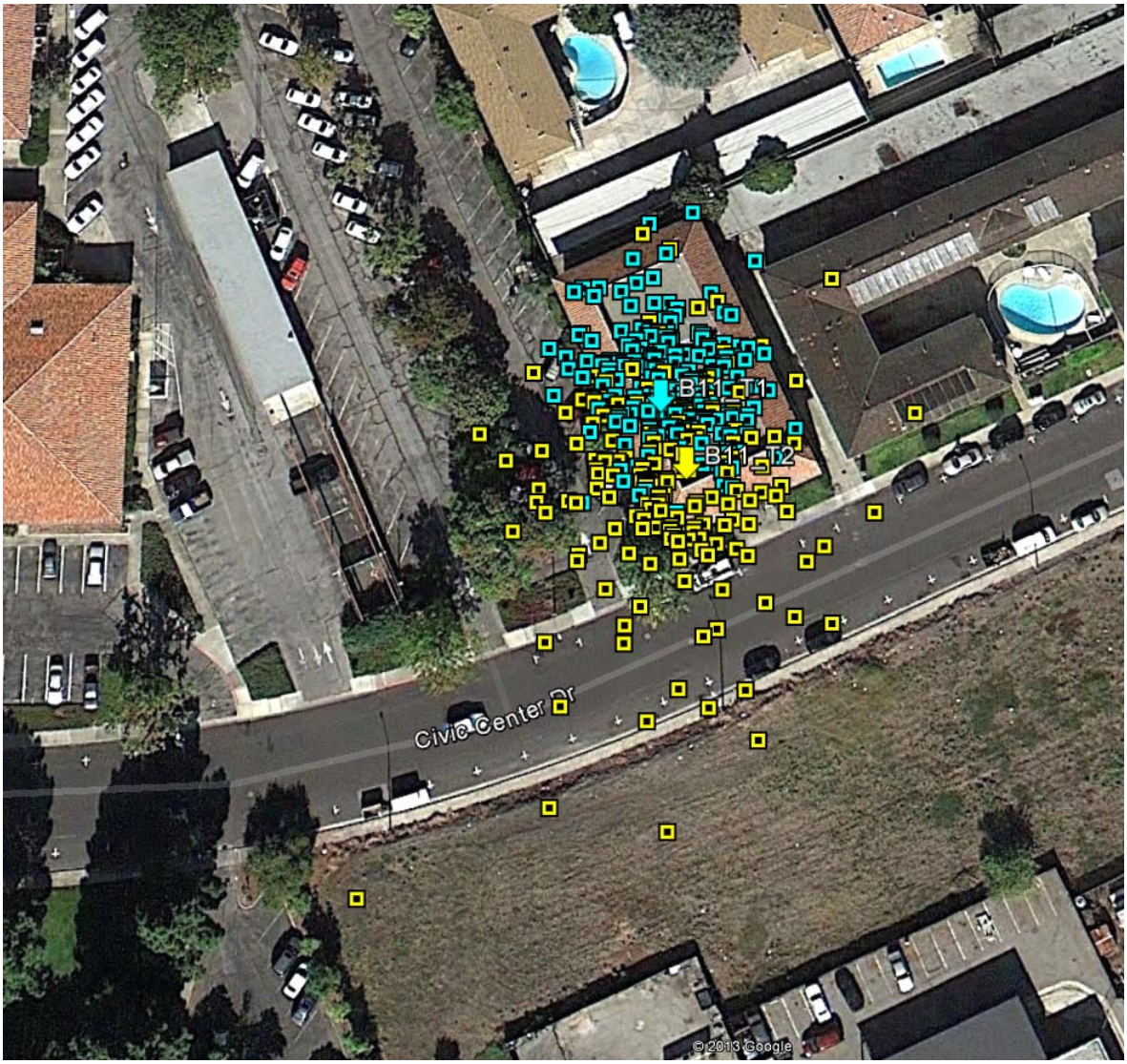
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD11_TP1	Number of Calls	0	0	0	178	0	1	0	0	179
	Percentage	0.0%	0.0%	0.0%	99.4%	0.0%	0.6%	0.0%	0.0%	100.0%
Qualcomm_BD11_TP2	Number of Calls	1	1	0	178	0	0	0	0	180
	Percentage	0.6%	0.6%	0.0%	98.9%	0.0%	0.0%	0.0%	0.0%	100.0%

TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD11_TP1	20.88	3.86	64.00	18.00
Qualcomm_BD11_TP2	23.84	2.22	43.00	17.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD11_TP1	179	173	96.65%
Qualcomm_BD11_TP2	180	171	95.00%


Overall Results - Call Accuracy CDF (BD11-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD11-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)



6.3.4 Rural Buildings

Identifying buildings in the rural polygon that was defined by the polygon sub-working group within CSRIC proved to be a major challenge. After considerable attempts at identifying buildings in that sparse rural area it was concluded that utilizing two buildings within the envelope of one large rural property was the most feasible approach within the strict lime limitations of the testing campaign.

6.3.4.1 Buildings 12 and 13:

6.3.4.1.1 Buildings 12 and 13 environment and test points:

The two buildings are shown in the figure below. Both are large riding stable buildings, with metal roofs, and considerable interior space allowing for the selection of test points reflecting distinct scenarios.

BD12 TP1: Storage room, metal and wood siding, small window

BD12 TP2: Stable hall, open space with metal roof and partially open air sides

BD13 TP1: Front room with big, tall windows

BD13 TP2: Stable hall, more surrounding metal and wood walls (further away from open air sides)

6.3.4.1.2 NextNav per Test Point Results—BD12:

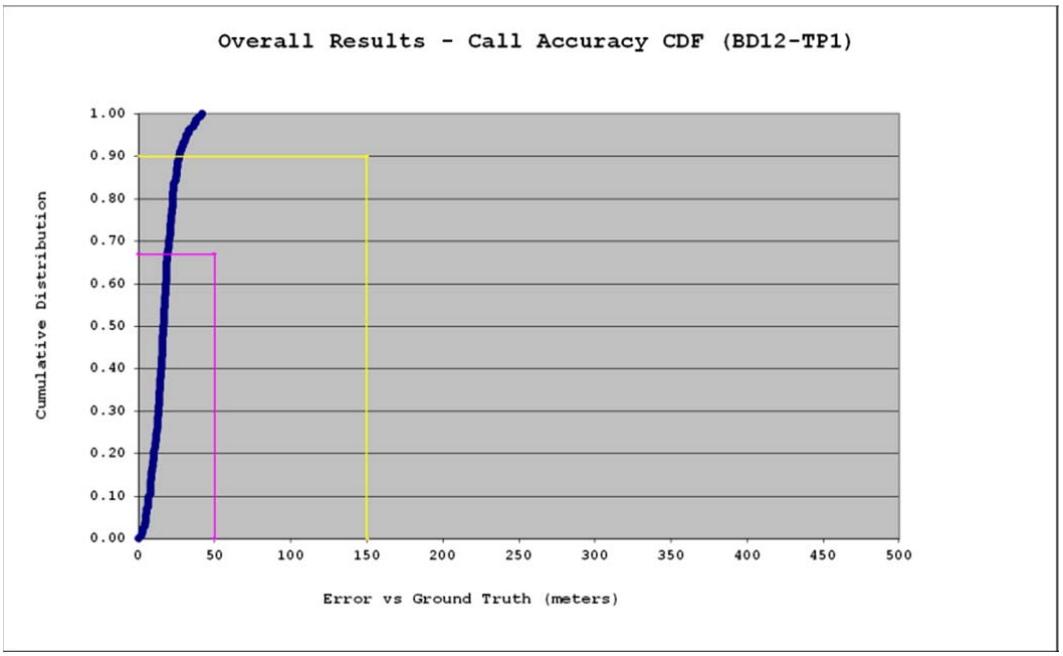
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD12_TP1	**200**	**200**	**100.0%**
NextNav_BD12_TP2	**243**	**243**	**100.0%**

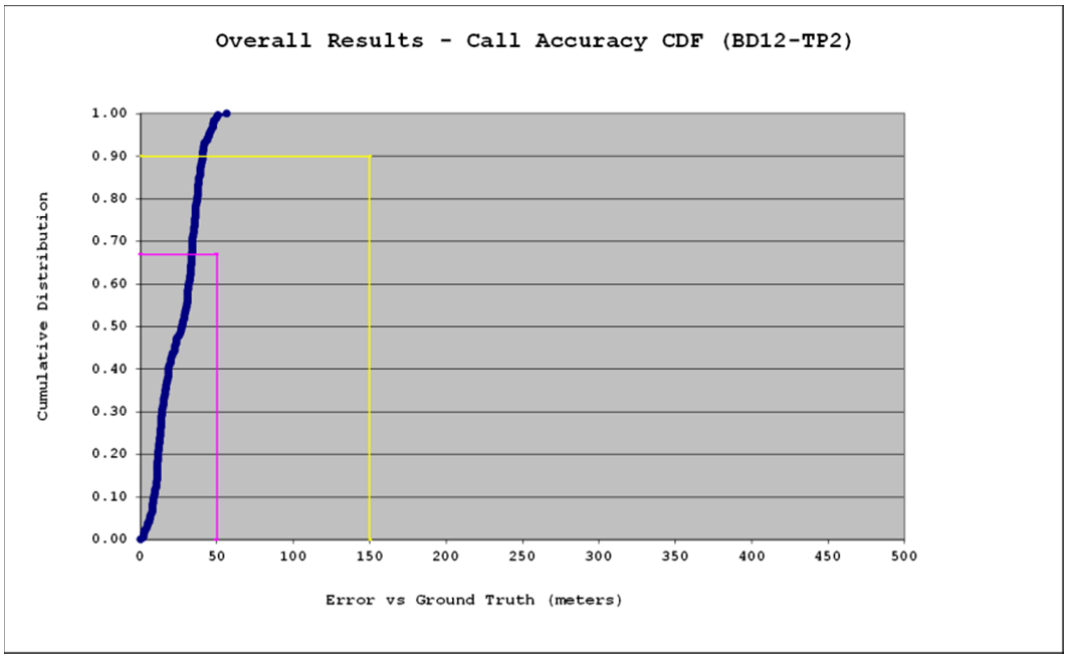
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD12_TP1	**200**	**19.2**	**27.0**	**31.8**	**17.2**	**7.9**	**41.9**	**1.94**
NextNav_BD12_TP2	**243**	**33.8**	**40.9**	**45.1**	**25.4**	**12.8**	**56.7**	**1.58**

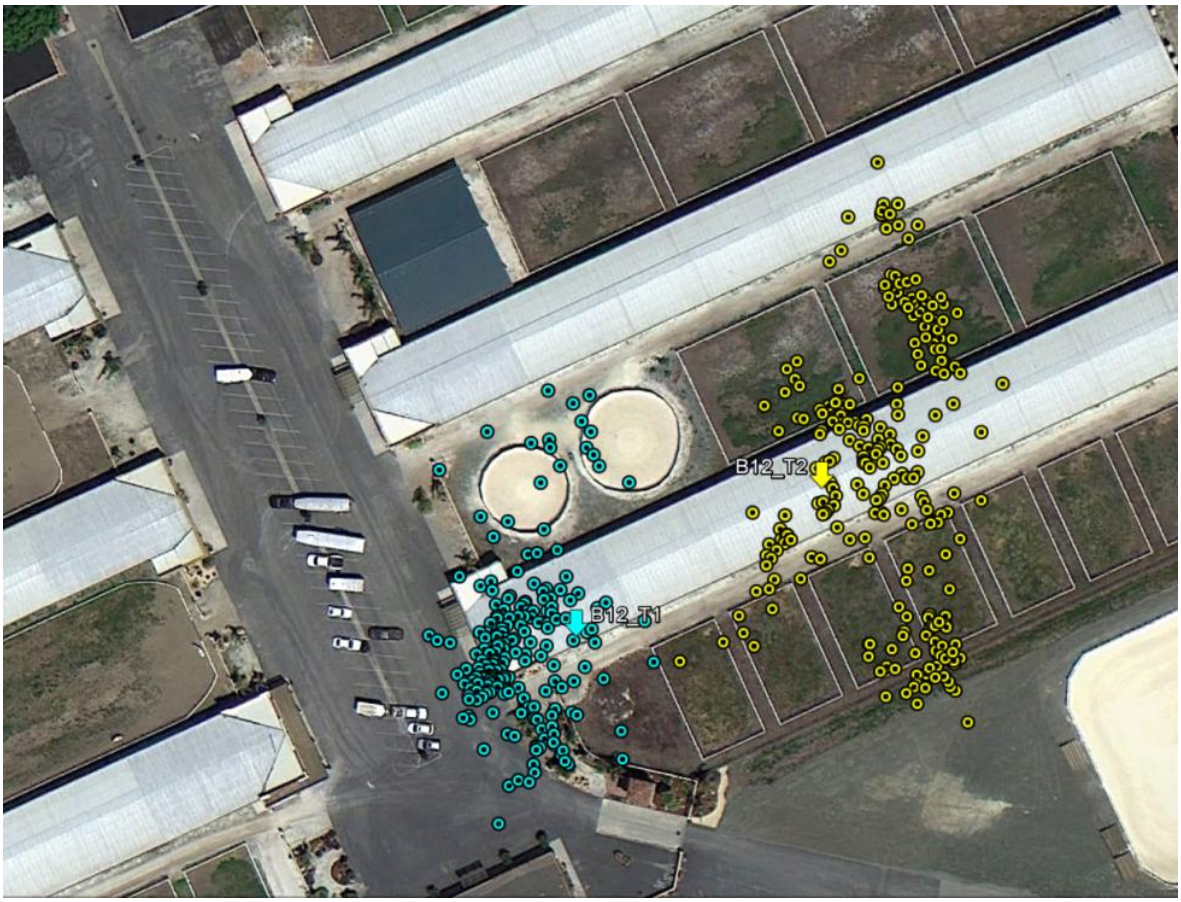
Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD12_TP1	**200**	**1.1**	**1.6**	**1.6**	**0.8**	**0.5**	**2.3**	**0.01**
NextNav_BD12_TP2	**243**	**0.5**	**0.8**	**0.9**	**0.4**	**0.3**	**1.3**	**0.01**

TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD12_TP1	27.59	0.20	27.96	26.99
NextNav_BD12_TP2	27.61	0.50	32.69	26.99

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD12_TP1	200	200	100.00%
NextNav_BD12_TP2	243	227	93.42%






B12_T2
B12_T1

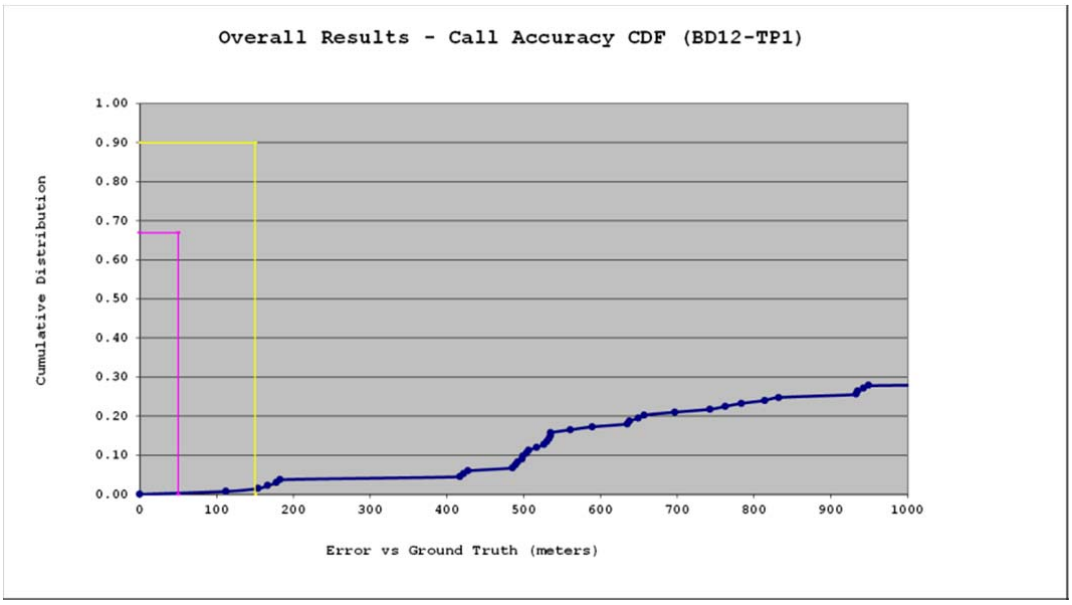
6.3.4.1.3 Polaris per Test Point Results—BD12:

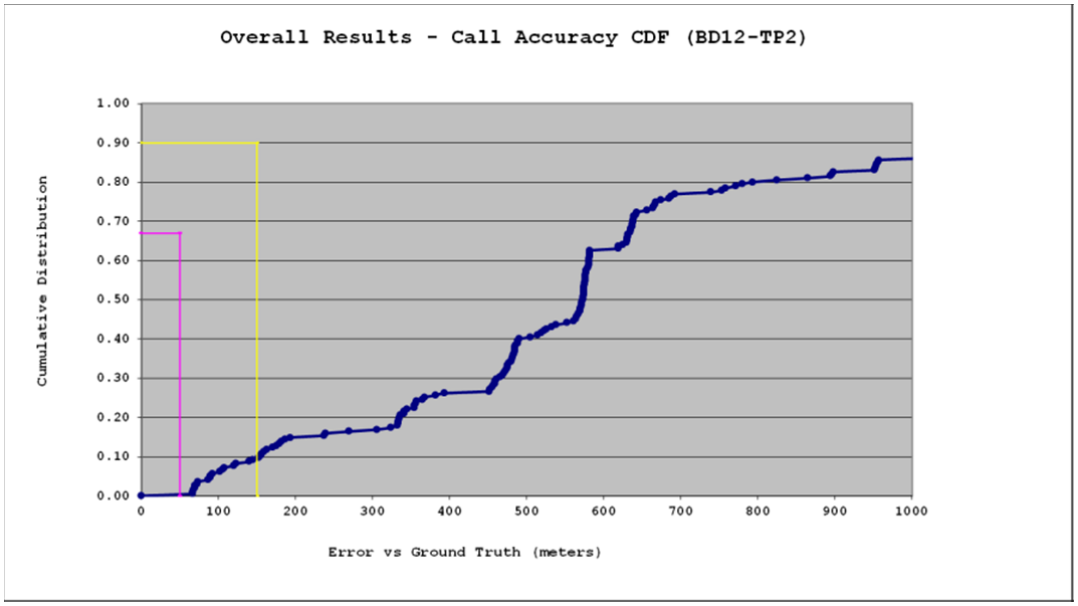
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD12_TP1	152	133	87.5%
Polaris_BD12_TP2	199	195	98.0%

Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD12_TP1	133	3033.6	3136.6	3145.0	2267.5	1149.1	5809.2	112.10
Polaris_BD12_TP2	195	634.2	1477.2	2946.4	744.1	768.9	4926.3	66.17

TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD12_TP1	21.54	7.49	26.02	1.23
Polaris_BD12_TP2	23.56	2.49	25.60	8.26

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD12_TP1	133	34	25.56%
Polaris_BD12_TP2	195	138	70.77%




Overall Results - Call Accuracy CDF (BD12-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


B12_T2
B12_T1

6.3.4.1.4 Qualcomm per Test Point Results—BD12:

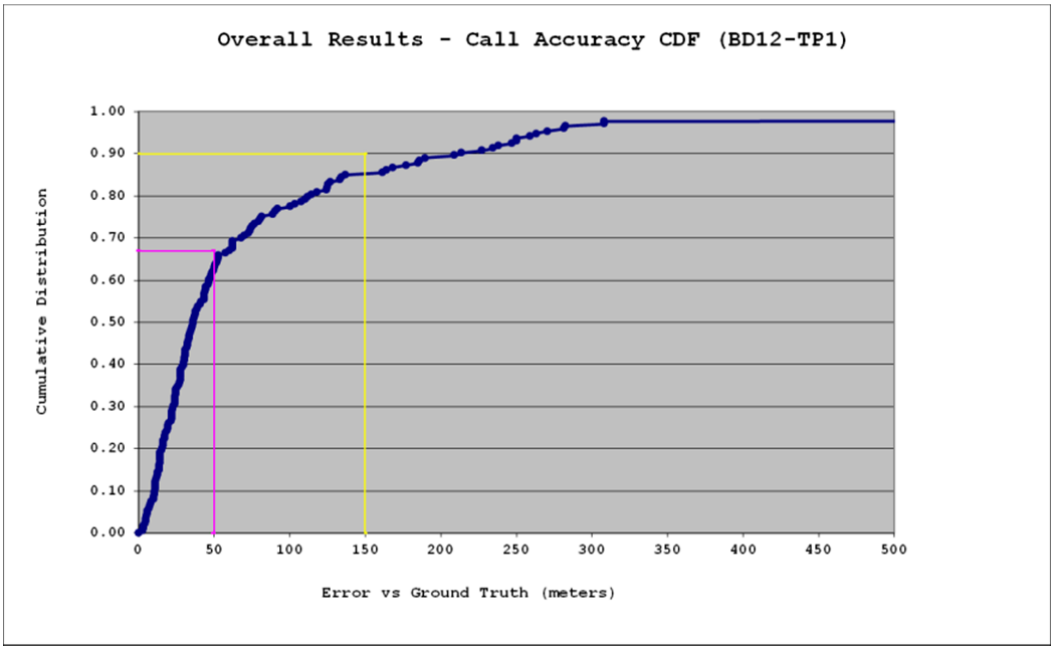
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD12_TP1	174	173	99.4%
Qualcomm_BD12_TP2	180	180	100.0%

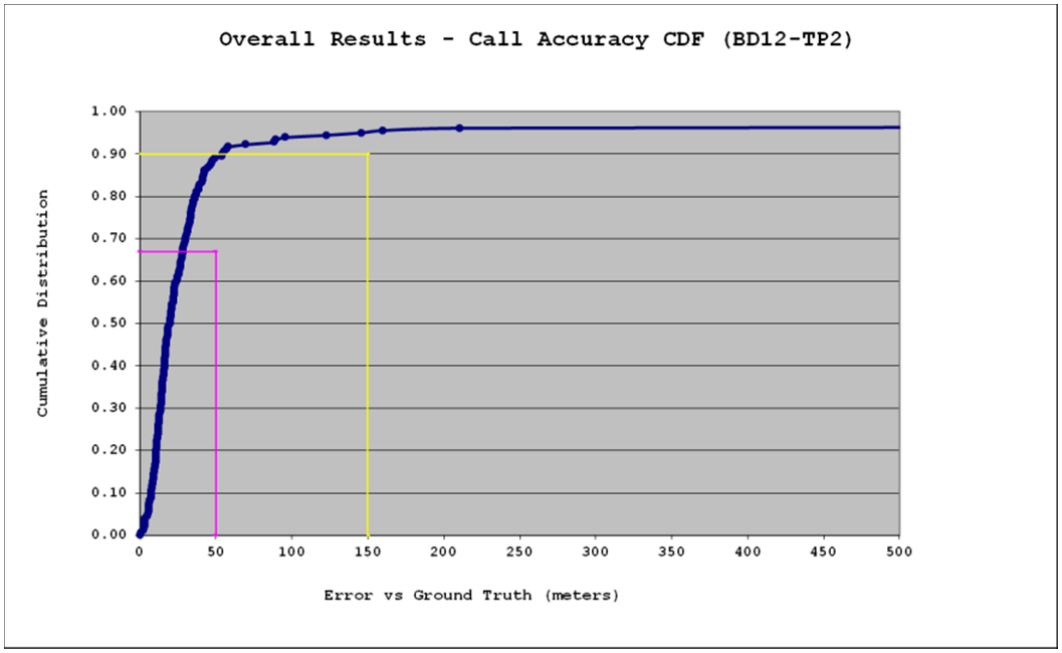
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD12_TP1	173	60.7	212.8	266.1	317.0	1859.9	18875.5	3.05
Qualcomm_BD12_TP2	180	28.6	54.8	146.3	430.5	2173.6	14465.2	1.00

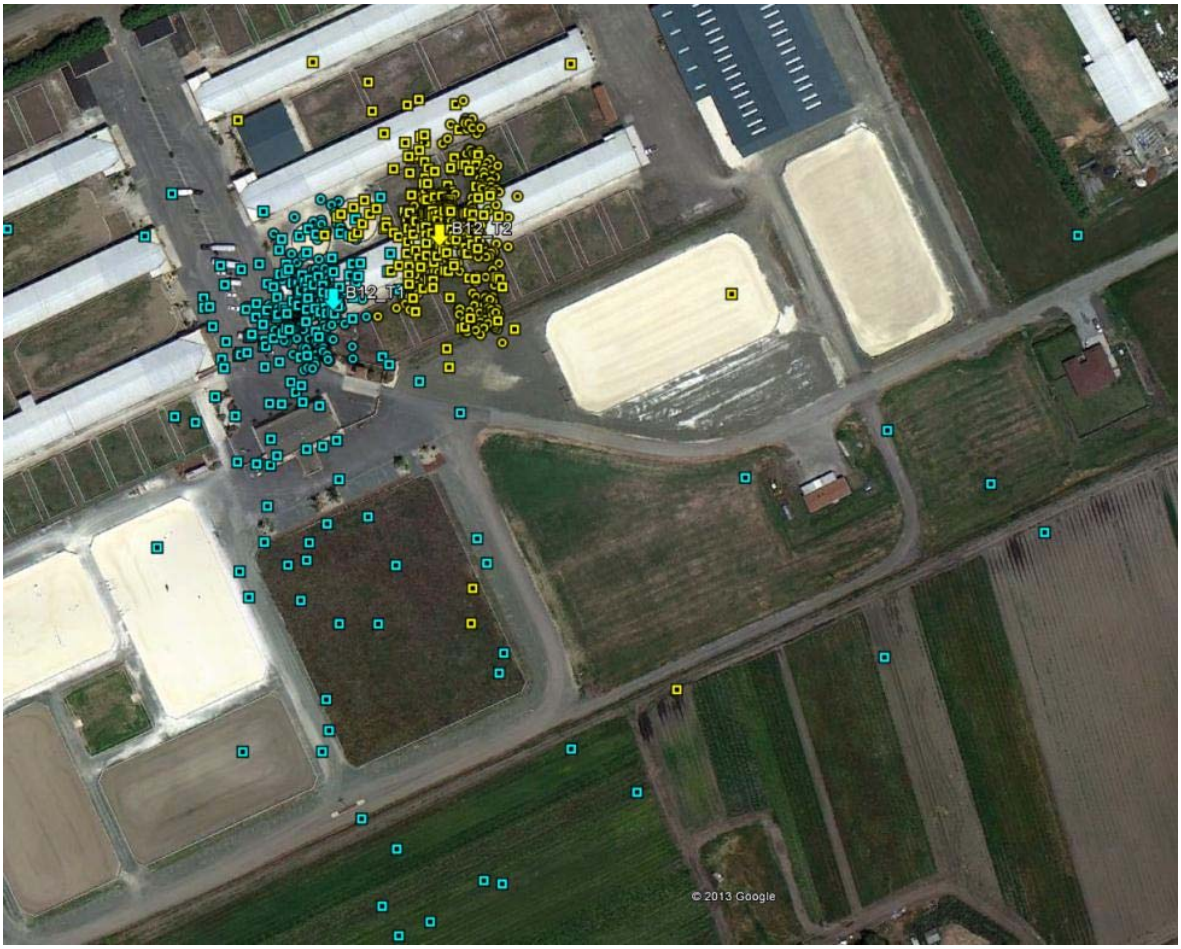
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD12_TP1	Number of Calls	1	8	50	113	0	0	1	0	173
	Percentage	0.6%	4.6%	28.9%	65.3%	0.0%	0.0%	0.6%	0.0%	100.0%
Qualcomm_BD12_TP2	Number of Calls	0	2	7	167	2	0	2	0	180
	Percentage	0.0%	1.1%	3.9%	92.8%	1.1%	0.0%	1.1%	0.0%	100.0%

TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD12_TP1	24.94	2.00	42.00	17.00
Qualcomm_BD12_TP2	24.22	1.61	28.00	18.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD12_TP1	173	141	81.50%
Qualcomm_BD12_TP2	180	154	85.56%




Overall Results - Call Accuracy CDF (BD12-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B12_T2
B12_T1
© 2013 Google

6.3.4.1.5 NextNav per Test Point Results—BD13:

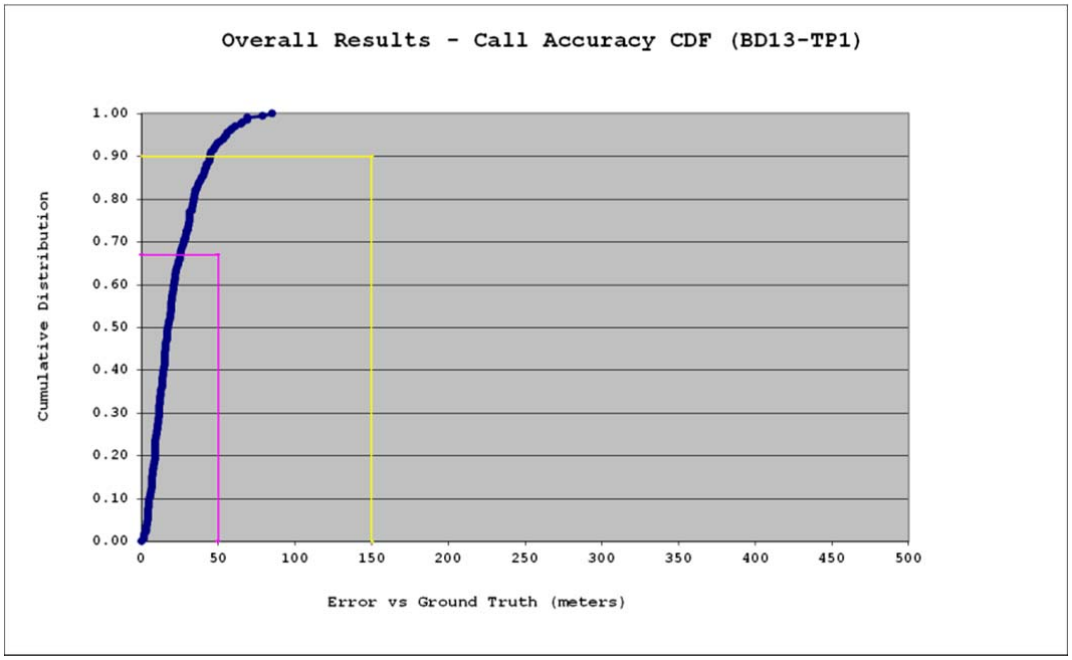
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
NextNav_BD13_TP1	200	200	100.0%
NextNav_BD13_TP2	200	177	88.5%

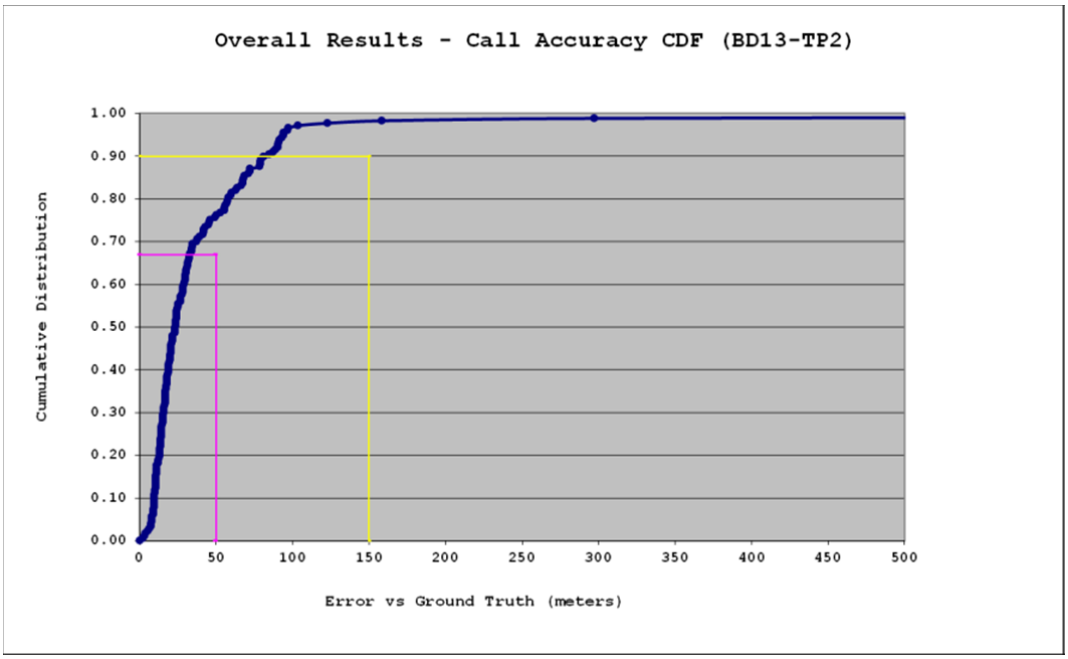
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD13_TP1	200	25.6	45.1	56.2	198.6	2491.4	35255.9	1.53
NextNav_BD13_TP2	177	33.2	82.6	94.1	47.1	116.9	1104.1	2.07

Vertical Distance Error (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
NextNav_BD13_TP1	200	0.6	1.0	1.0	0.5	0.3	1.6	0.01
NextNav_BD13_TP2	177	0.9	1.2	1.3	0.7	0.3	1.6	0.01

TTFF(Sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
NextNav_BD13_TP1	27.54	0.26	27.96	26.99
NextNav_BD13_TP2	27.50	0.29	27.98	26.96

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
NextNav_BD13_TP1	200	188	94.00%
NextNav_BD13_TP2	177	163	92.09%


Overall Results - Call Accuracy CDF (BD13-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD13-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B13_T2
B13_T1

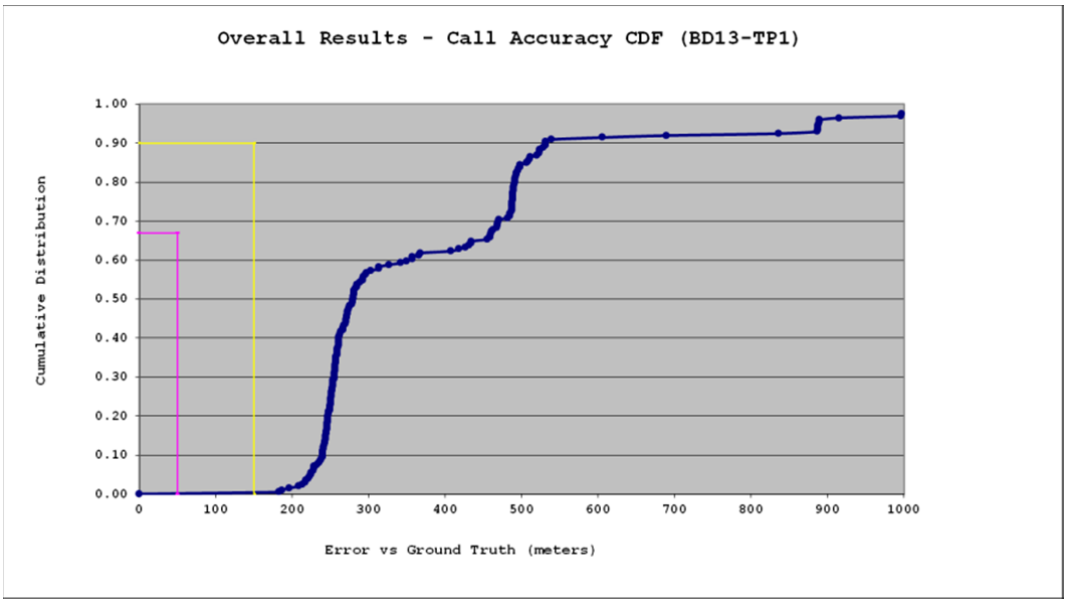
6.3.4.1.6 Polaris per Test Point Results—BD13:

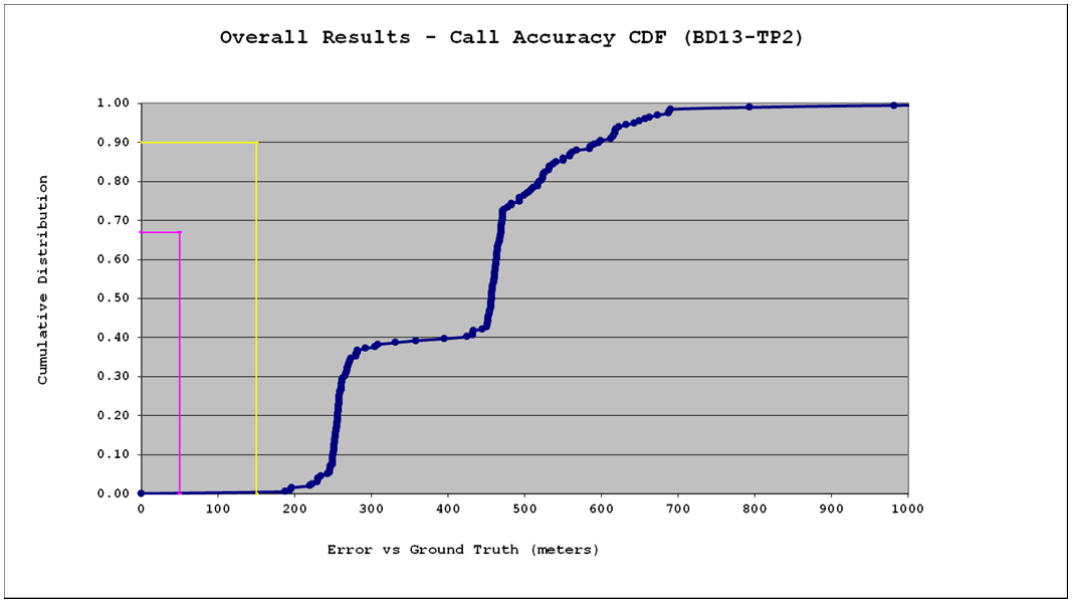
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Polaris_BD13_TP1	199	199	100.0%
Polaris_BD13_TP2	199	199	100.0%

Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Polaris_BD13_TP1	199	460.4	531.3	887.9	424.1	409.1	3232.0	182.74
Polaris_BD13_TP2	199	468.9	596.1	643.2	416.2	156.3	1356.6	187.64

TTFF (sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Polaris_BD13_TP1	23.46	2.33	25.59	5.84
Polaris_BD13_TP2	24.36	1.16	25.97	19.26

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Polaris_BD13_TP1	199	81	40.70%
Polaris_BD13_TP2	199	104	52.26%




Overall Results - Call Accuracy CDF (BD13-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
100
200
300
400
500
600
700
800
900
1000
Error vs Ground Truth (meters)


B13_T1
B13_T2
Fazle Lake Rd
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6.3.4.1.7 Qualcomm per Test Point Results—BD13:

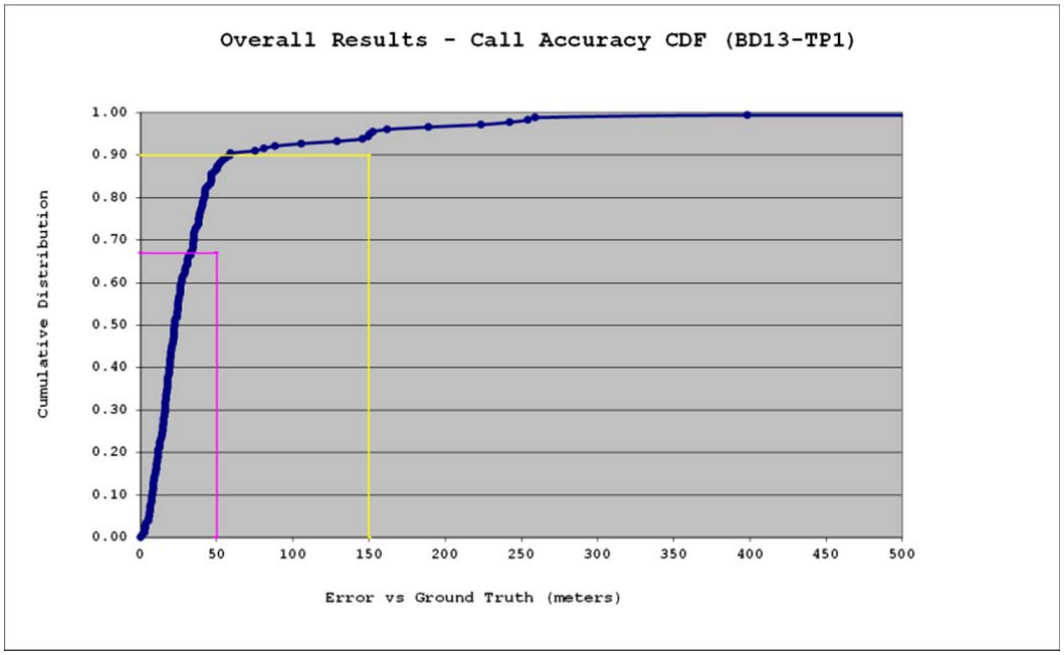
Number of Test Calls and Yield			
Test Point ID	Total Number of Test Calls Attempted	Total Number of Test Calls with Position Fix Received	Percentage of Test Calls with Fix Received (Yield)
Qualcomm_BD13_TP1	180	179	99.4%
Qualcomm_BD13_TP2	180	177	98.3%

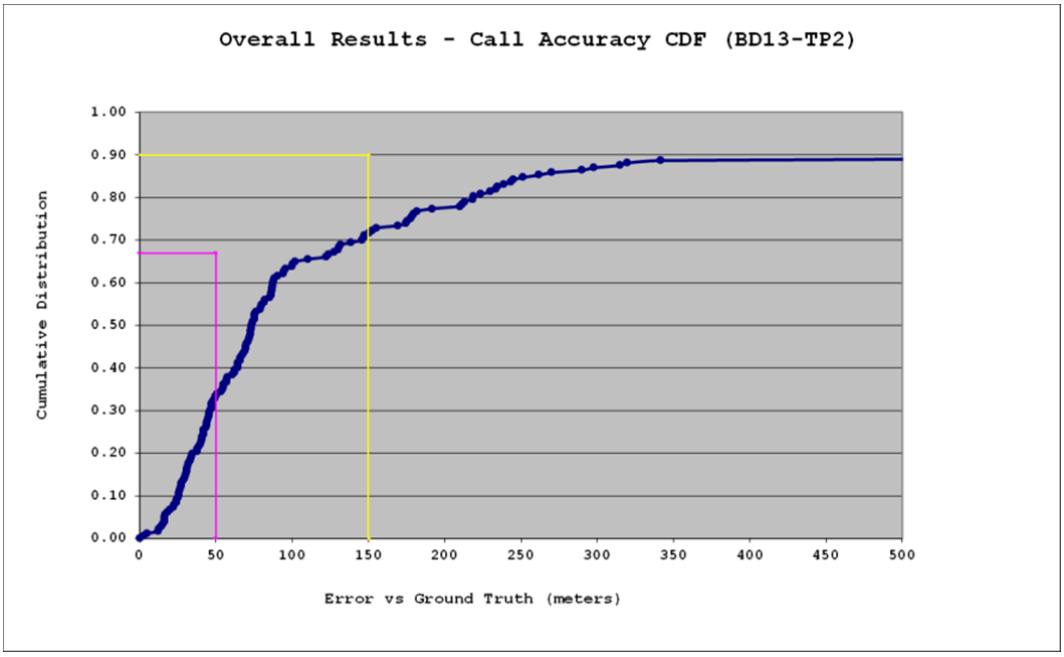
Horizontal Error Statistics (m)								
Test Point ID	Total Number of Calls	67th Percentile	90th Percentile	95th Percentile	Average Error	Standard Deviation	Max Error	Min Error
Qualcomm_BD13_TP1	179	33.5	58.9	151.0	108.9	958.3	12840.1	1.41
Qualcomm_BD13_TP2	177	127.2	902.9	15043.0	1705.5	5049.3	27782.4	2.96

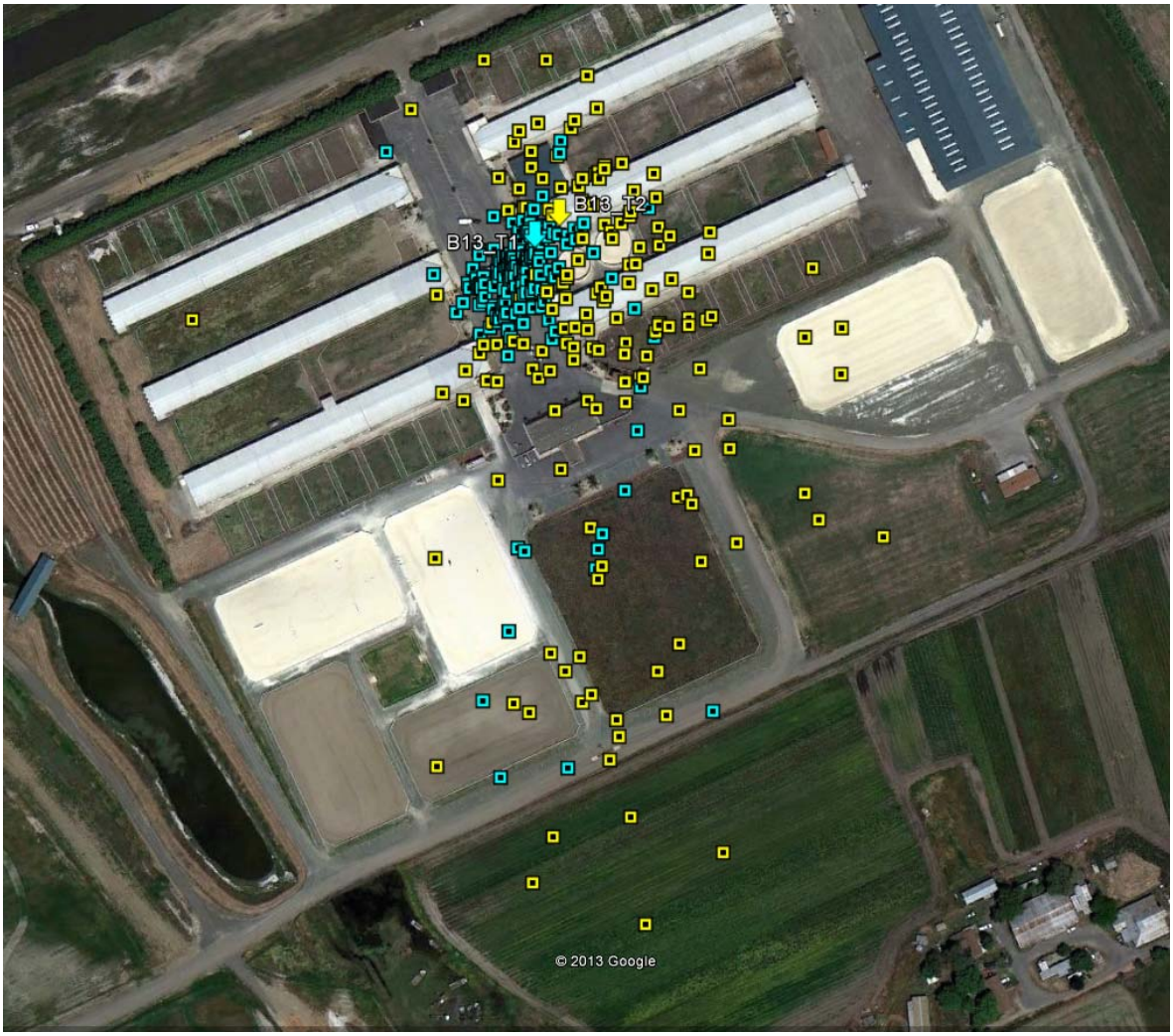
PDE Position Fix Type										
Test Point ID		Cell Sector	AFLT	Hybrid	GPS	Mixed Cell Sector	Safety Net	Mixed Mode	Invalid	Total
Qualcomm_BD13_TP1	Number of Calls	0	3	14	162	0	0	0	0	179
	Percentage	0.0%	1.7%	7.8%	90.5%	0.0%	0.0%	0.0%	0.0%	100.0%
Qualcomm_BD13_TP2	Number of Calls	7	10	88	69	0	0	3	0	177
	Percentage	4.0%	5.6%	49.7%	39.0%	0.0%	0.0%	1.7%	0.0%	100.0%

TTFF(sec)				
Test Point ID	Average Duration	Standard Deviation	Max Duration	Min Duration
Qualcomm_BD13_TP1	24.31	1.39	27.00	18.00
Qualcomm_BD13_TP2	26.08	4.89	49.00	19.00

Uncertainty			
Test Point ID	Total Test Calls	Number of calls with Error < Uncertainty	Percentage of calls Error < Uncertainty
Qualcomm_BD13_TP1	179	143	79.89%
Qualcomm_BD13_TP2	177	143	80.79%


Overall Results - Call Accuracy CDF (BD13-TP1)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


Overall Results - Call Accuracy CDF (BD13-TP2)
Cumulative Distribution
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
50
100
150
200
250
300
350
400
450
500
Error vs Ground Truth (meters)


B13_T2
B13_T1
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7 Summary Observations on the Test Results

7.1 Dense Urban Environment

The results for the dense urban buildings highlighted the challenges that satellite signals have in penetrating to those points that are in the interior of large buildings. Consequently, AGPS fall-back modes, such as AFLT, were experienced frequently. Accuracy degraded as expected when GPS fixes were not attained. While a surprising proportion of hybrid fixes were experienced, even at test points where one would not expect a satellite signal to penetrate, the quality of the hybrid fixes was in general significantly degraded compared to GPS fixes. Hence, in many dense urban test points (and in urban buildings as well) a significant amount of spread in location fixes was observed. This often extended over a number of city blocks. Few very poor fixes are seen in the dense urban case, perhaps because the high cell site densities (and consequently small cell radii) in the dense urban core create a reasonable lower bound on fall-back accuracy.

In contrast to the challenges that GPS signals face in the dense urban setting, RF finger printing experienced its best performance in the dense urban setting. This is probably a combination of a confined environment that could be extensively calibrated and many RF cell sites and handoff boundaries that could be leveraged in creating a good RF fingerprint map of the dense urban center.

The best observed performance in the dense urban setting was that of the dedicated terrestrial (beacon) location system—a new infrastructure. With this level of accurate location performance it is actually possible to discern some of the vagaries caused by multipath. Oftentimes, when the test point is floors below the roof and in an outside room with windows, the signal is forced to propagate from the handset out (or by reciprocity in) towards or from a building that is across the street or a few blocks away (if the space between it and the test point is open). The signal then propagates to (or from) the location infrastructure, whether terrestrial beacons or satellites. The result is that location fixes that may be relatively close in absolute distance (e.g., 40 m away) are often located in a building across the street, in a neighboring building, or even across a few blocks from the test point. (See for example, BD3_TP1, BD14_TP3 and BD15_TP4 for NextNav. This phenomenon will become even more obvious in the urban setting.)

7.2 Urban Environment

As mentioned above in Section 5.2.2, the specific test buildings used in the urban morphology were challenging, each in their own way. This is because each building represented more distinctly a building type and setting than the high rises of the dense urban environment.

The baseball stadium by the San Francisco Bay (BD4, AT&T Park) created a situation where AGPS fallback fixes could be very far away due to the very exposed RF propagation outside the structure in which the test points were located. This impacted points that were relatively deep inside the stadium building. The structure of the stadium also appears to have created challenges to RF fingerprinting at some test points.

The convention center created in some cases an environment that was deep indoors but with very strong cellular signal from cell sites inside the building (including a DAS). This situation was captured by two points of different depth (BD5_TP2 and BD5_TP3). This situation resulted in the beacon-based location system performing poorer than in most other test points, since attenuation to different directions in the outside world was particularly strong in those scenarios. AGPS and RF fingerprinting relied on the cell sites inside the structure to create adequate location fixes.

The US Court of Appeals Building (BD17) represented a classic older, heavy construction, but also had a very large atrium in its middle. Results varied depending heavily on the degree of distance from windows or the central atrium. Again, the phenomenon of apparent location in a building across the street is seen here (e.g., BD17_TP2 for both NextNav and Qualcomm, which was a test point inside a large court room

with windows in the direction of the building across the street). As one would expect, the degradation caused by being away from a window or atrium more significantly impacted the satellite based system than the terrestrial beacon based one. RF fingerprinting fixes appeared to cluster about the larger reflectors in this urban corner of San Francisco, which happened to be mostly across the streets from the target building.

The motel building (BD18) provided a very clear example of relatively good location fixes on the basis of absolute error distance but that are mostly in or around other buildings across the street (e.g., NextNav all four test points in BD18 .) This phenomenon is primarily caused by the physics of the problem. This case poignantly demonstrates the unique challenge with indoor location: absolute distances (like 50 or 150 m) which may have meant much in assessing outdoor performance mean less for the indoors, since emergency dispatch to the wrong building or even the wrong block could be easily encountered at 50 or 150 m. A location across the street is certainly better than one a few or many blocks away but it may still leave some human expectations unmet. RF fingerprinting for this building generates either fixes around the immediate vicinity of the building or clustered around major reflectors in the general area or along streets, presumably where calibration measurements were gathered.

Finally, the tall condominium building in urban downtown San Jose (BD19) demonstrated the mix of high rise construction causing direct signal attenuation, prominent distant reflectors, plus wide area cell site visibility. All combined to create relatively poor AGPS performance, uneven beacon system performance, and RF fingerprinting performance that degraded with the height of the test point.

All of the above factors related to each of the urban buildings, combined with a generally lower cell site density for fall back (than in dense urban), resulted ultimately in an aggregate urban performance that is slightly worse than the dense urban performance. Still, this overall performance is representative of the challenges of the big city with high structural density, whether it be San Francisco or a city in the Northeast or the Midwest.

7.3 Suburban Environment

The effect of smaller buildings with lighter construction and more spacing between buildings is immediately evident on the quality of the location fixes in the suburban environment. This is most clearly demonstrated in the case of individual houses or small apartment buildings. Outstanding GPS performance, almost as good as outdoors, can be achieved inside single story homes (see BD8). The majority of the GPS fixes fall inside the small home or its small lot. Almost as good a performance is achieved inside the upper floor of relatively small buildings with composite or tile roof material (see BD10_PT1, BD11_PT1). CDF's that are tightly packed at small error values (well below 50 m) signify this type of outstanding performance. Similarly outstanding performance is achieved on average by the beacon based location technology under similar circumstances. RF fingerprinting appears to suffers from performance degradation compared to more dense morphologies in the city. It is able to identify only the part of the neighborhood where the test calls originated, with spreads over a few to several blocks, and fixes that are frequently clustered or spread along roads where calibration was performed (e.g., BD8, BD9, BD10).

The AGPS performance predictably changes as the suburban buildings become bigger and higher. Test points that are not on the top floor have significantly more positioning error and spread about them as fall-back modes are more frequently the solution. The terrestrial beacon-based network continues to perform well in the larger suburban buildings (e.g., BD6, BD7). The phenomenon of positioning at the nearest building is only occasionally seen (basically when the propagation physics force it to happen, which is not common in the suburban environment). One example where this is seen is the parking structure (BD7_PT5) where the location signals are forced to tunnel through the garage entrance and bounce off the side of the adjacent building. Curiously, GPS appears to perform well in this specific scenario, perhaps because the parking structure had only 2 floors. RF finger printing shows some enhancement relative to the smaller suburban buildings, but still shows most of the location fixes along the roads, highways or reflecting buildings.

7.4 Rural Environment

As mentioned in Section 5.4.2, the building chosen for the rural environment where limited by what was accessible in the available time. Both buildings selected were large one story structures with metal roofs. Performance of AGPS reflected the effect of the metal roof and some metal siding in limiting the available number of satellite signals available for trilateration at certain test points. In these cases more hybrid fixes were experienced with a concomitant increase in the spread of the location fixes about the true location (e.g., BD13_TP2 and to a lesser extent BD12_TP1). In easier rural scenarios where metallic surfaces or multiple floors are not present, e.g., in a rural house, the expected performance would be very good similar to that seen in a suburban home, like BD8, or a small structure like BD11.

The performance of the beacon based network was less impacted by the metallic roof (since that roof had more impact on sky visibility rather than on side visibility towards terrestrial beacons). Consequently the performance was somewhat better than for AGPS. The performance of the beacon based network would of course depend on the density of its deployed beacons covering the rural area, which was sufficient in the case of the rural test polygon.

RF finger printing showed reduced performance relative to the suburban environment due to the large spacing between surveyed roads (where calibration is done) and the rural structures as well as the lower density of cell sites. The location fixes are spread along relatively long stretches of the rural roads.

8 Lessons Learned and Considerations for the Future

This section summarizes the lessons learned from TechnoCom's participation in the test bed as the independent test house. These lessons are presented from TechnoCom's perspective rather than more broadly from a CSRIC Working Group perspective. They are presented together with specific recommendations or suggestions aimed at for future test bed campaigns.

It should be kept in mind while reading these paragraphs that TechnoCom has been an active participant in CSRIC WG3. A number of the challenges cited below were easier to overcome because TechnoCom's project lead was an active member of CSRIC and of a number of its sub-working groups.

One of the biggest challenges to face CSRIC WG3 and TechnoCom was the very tight timeline in which the test bed Stage-1 had to be implemented, executed and its result reported. This is reflected in each of the following major areas where lessons have been learned and recommendations for the future are made.

8.1 Contractual and Project Setup

Setting up the contractual agreements for TechnoCom to serve as the independent test house was its first major challenge. Despite the remarkable efforts of WG3 in creating a common framework for the project, which encompassed a contractual template to be followed, a funding commitment beforehand from each participant, and a common technical statement of work, negotiating the actual contractual terms and contract language with each participating company was a major undertaking that consumed considerable energy and time.

Some of the smaller participating companies were agreeable to using the template with very little modification. That certainly helped expedite the process. Legal and contracts organizations in larger companies, however, varied in their willingness to adopt such a common template. At times, the template had to be abandoned for terms and conditions that are familiar to the contracting officers in those organizations. Often that was the only way to get an agreement signed in the available time frame. At other times, a hybrid of the common template and a company's traditional legal forms were created. Agreement in principle to the common template by the technical representative of a large company to CSRIC does not imply buy-in from contracts and legal departments. In most cases there was not enough time for that internal process in a larger company to take place. This meant that the test house had to expend the effort to negotiate terms similar in spirit to those in the common template agreement. That process was successful to varying degrees. Cancellation, indemnification, acceptance and payment were among the thorniest terms to reach formal agreement on. For example, the concept of an independent test house creating a report that is not necessarily subject to formal acceptance conditions by the client is alien to many contracting organizations at larger companies.

These contracting complexities meant that TechnoCom, because of its longstanding working relationship with most of the participants in Stage-1 and its intimate participation in CSRIC, agreed to verbal commitments when written language was an impediment to timely project launch and execution. Two factors were very helpful in this regard: (1) the acceptance by all that the SOW would be unchanged as a pre-condition for participation, and (2) the promise of up-front payment to the test house by the participants, although this sometimes did not get reflected in written agreements.

In a future test bed it is strongly recommended that enough time be allowed for a common legal agreement to be more formally accepted by all companies participating. This needs significantly more than 3 or 6 weeks and it needs to be started very early, immediately upon expression of interest to participate by the individual companies. The contracts or purchasing departments of companies must be active participants in this process. Companies would potentially be disqualified from participation in the test bed stage if they unduly delay the common agreement.

Related to the above issue is a company's commitment to participate and not to withdraw in mid-stream. The up-front payment condition is very helpful in guaranteeing no harm being imparted on the rest of the

participants. TechnoCom views this as a critical element for the ability of the test house to perform its duties without being unduly influenced by the potentially changing views within participating companies.

8.2 Test Planning

One of the most challenging aspects of Stage-1 of the indoor test bed has been the identification of buildings that meet the required technical selection criteria and which can be accessed for the purposes of testing within the tight time window of the test bed. Identifying possible buildings using satellite or aerial imagery, like with Google Earth, is an easier initial step than identifying a receptive point of contact in the ownership or management structure of that building. That particular step is the most difficult and most time consuming. It requires the proper introduction, preferably facilitated by local public safety officials, education on the objectives and the public benefits, continuous project management and coordination, and a willingness to accommodate the limitations and concerns of building management and/or its engineering staff, who have little bandwidth in their daily jobs to deal with this type of effort. Furthermore, the test house has to be able to accommodate the liability insurance requirements of the building, e.g., meet certain overage limits and add the building management or ownership to the beneficiaries of the insurance policy. In some cases a written access agreement is required and has to be developed, which takes additional time and effort. Despite all of these challenges, the eventual set of buildings selected in Stage-1 was excellent, which is a testimony to the dedication of all who participated in making the building selection and access process successful.

In a future test bed this aspect of the project should be handled in a more structured and formal approach than the strictly voluntary way used in Stage-1. Not only is a long lead time imperative, but also innovative approaches should be put in place to educate building managers and owners, and to incentivize them to permit access for testing, possibly on a periodic basis. One such idea would be a standing access agreement (possibly with a local wireless carrier) in which the building receives an honorarium or convenience fee, such as $500 or $1000 (depending on the size of building) for each day in which testing takes place.

8.3 Technology Readiness

The compressed project schedule, exacerbated by the lengthy collective decision making process to fund and participate in the project, and in some cases the lack of visibility of this effort within some participating organizations, resulted in somewhat inadequate time to: (1) fully validate the readiness of the technologies for testing in the field, (2) verify and refine their data collection configurations or system settings, and/or (3) fully establish and formally accept timely data and log handling processes. This resulted at times in field testing personnel or test house analysts supporting troubleshooting by the participating companies or supporting investigations into adjustments of test call settings that took place several days into the testing. Ideally, such engineering efforts should not be done during the formal period of testing but rather before it. Corralling all participants to be ready on all fronts at the same time under very tight time constraints is a daunting challenge. More time and a more formal go/no-go gate process needs to be followed in future comparative indoor test campaigns.

From a technical data perspective, exceptions to agreed-upon data formats that impact engineering assessment and analysis, such as absence of an accurate absolute time stamp or test device ID inside each log should be avoided.

8.4 Test Execution

Since access to test buildings is the most challenging aspect of project execution, the number of visits to each building should be minimized. Ideally no more than two visits would be needed: (1) initial visit and point selection, and (2) test call placement and formal surveying (if required at a new test point). However, achieving this objective requires the ability to coordinate well in advanced among multiple parties. Often this was not possible in Stage-1 because the buildings were not known well in advance. In fact, final agreement from some buildings was received one or two days only before the test team visit,

and that had to be a multi-team member visit to accomplish all the objectives of point identification, testing and surveying. In any case, project planners cannot and should not assume perfect efficiency in terms of trips to the market, time the field testers will be in the market, or cost of travel and accommodation. Many factors are simply beyond any one party's control.

From a technical perspective, although the SOW stated a minimum ground truth accuracy of better than 5 m, the benchmark and comparative nature of the test bed requires a more accurate ground truth determination. It is recommended that horizontal and vertical accuracy better than 1 meter be maintained at all test points, including any uncertainty in placing the test cart or fixture at the test point.

8.5 Project Scope

Although in theory a number of technologies exceeding 3 or 4 could be tested side by side in the test bed by employing a scalable test organization, in reality, the complexity of interactions among the participating companies, as well as the logistics, such as the physical dimensions of a non-obtrusive test cart or fixture make it very difficult for more than 4 technologies to be tested at the same time. It is recommended that the number of technologies included in a single test bed campaign be limited to 4.

The number of buildings selected for testing in Stage-1 was 19 and the number of test points within the buildings 75. Based on the variety of scenarios that were observed, the field experience with the buildings used, and the nature of the results obtained, this number of buildings was appropriate. More would be better but would make the project progressively more expensive and more difficult to execute in a timely manner. The ideal breakdown of a 19 or 20 building selection would include 6 dense urban, 6 urban, 5 or 6 suburban, and 2 rural buildings. The maximum recommended number of test points per building is 5 so as to perform the test call placement from all points in the building in one day.

Regardless of the exact number of buildings and test points, a large amount of test data is required to create statistically valid samples and to draw definitive conclusions from the indoor testing. It would be easy for a test house to under-estimate the amount of effort required for the data analysis and for generating a high quality report, containing varying degrees of detail, which benefits a wide range of stakeholders. Care should be taken to avoid such possibilities in the future.

8.6 Test Bed Region

The San Francisco Bay Area, despite being a relatively expensive place to perform testing, proved to be an outstanding environment to support the requirements of the indoor testing. It provided ample opportunity to create representative morphology polygons and to find potential candidate buildings to meet the technical requirements of the test plan. It also had an extensive travel infrastructure and a pervasive wireless coverage that made indoor testing more feasible.

8.7 Test Bed Continuity

Stage-1 of the test bed contained in the end only 3 technologies to test. With the complexity of the task at hand, this created a good learning opportunity for both CSRIC WG3 members and the test house. However, there are a number of technologies that are either in use for location based services (LBS) or that are emerging which should be evaluated for their potential to contribute to the improvement of indoor wireless E911.

Indoor wireless E911 is a critical public safety issue that will only increase in magnitude; it fully deserves the focus and continued forward momentum that a test bed stimulates.