TruePosition Test Report

TruePosition (Network-Based)

Phase II E-911 Location Technology Trial

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1. Introduction

In an effort to prepare for compliance with Federal Communications Commission Docket #94-102 regarding Phase II Enhanced 9-1-1, AT&T Wireless is endeavoring to review and consider all potential technical options. In some cases, lab testing and/or field trials are being conducted to allow AWS technical teams to learn more about the various technologies and determine whether they can both meet the Commission mandate and AWS' own internal standards for customer service and network quality.

TruePosition, a network-based Phase II technology vendor, was selected for a field trial in the Redmond, WA area. The vendor installed a Mobile Station (MS) location system in seven cell sites intended to provide latitude-longitude locating information of signals of interest accessing a control channel on the AWS wireless system.

In order to demonstrate compliance with the FCC mandate, network-based technology solutions are required to provide an accuracy of 100 meters 67% of the time and 300 meters 95% of the time.

The testing focused on accessing the accuracy requirements. This document provides the test results from the performance and operation of this trial.

1.1. Trial Objectives

The objective of this trial was to get a basic understanding of the capabilities of the TruePosition technology. The major emphasis for the tests are:

- Learn the issues associated with the installation process
- Understand the initial configuration and optimization issues
- Understand the limitations of the coverage
- Understand the accuracy of the covered areas
- Estimate the manpower requirements for maintenance and operation

No network element testing or system load testing was accomplished (or was intended) other than the functionality of those network elements necessary for the calculation of mobile position.

1.1.1. Trial Area Demonstration

TruePosition and AWS teams met to determine an appropriate coverage area in which to conduct the trial with the following goals: The TruePosition and AWS teams met to determine an appropriate coverage area in which to conduct the trial, with the following goals:

- A number of cell sites large enough to yield meaningful test results and meet trial objectives, but small enough to be manageable for a relatively small technical team
- A wireless environment representative of most areas covered by the AWS network nationwide (but not an abnormally challenging RF environment)
- Geographically located close to AWS' technical team headquarters and lab facilities

The two teams jointly agreed to conduct the trial utilizing seven cell sites in the Redmond, WA area. The sites were mainly sectorized (one omni-directional site) 850 MHz, IS-136 and analog, relatively low power base stations in a mature (fully build-out) wireless environment, including two rooftop installations and five monopoles (approximate height 120 ft.).

2. Test Philosophy

The main object of the testing is to determine the accuracy of the TruePosition system. Currently, the FCC has not mandated how or if the accuracy will be tested. For the purposes of this trial, AWS addresses accuracy testing via methodologies:

- Define a set of known test points and perform a number of tests from those points
- Drive the area in question using a known reference such as a DGPS receiver.

There are advantages and disadvantages of both philosophies. Testing at a known location is simpler to test and it is easier to calculate results. A disadvantage of testing at a known location is that the testing does not cover all areas well and it does not constitute a variety of real life environments.

Drive testing covers the test area and constitutes more of a real life environment but it is more complicated to calculate results. Both test philosophies were performed.

3. Test Set-Up

The test set-up was composed of the following equipment:

- TEMS software
- TEMS Ericsson KH688 mobile
- Garmin GPS III Plus
- GBR 21 Differential GPS receiver
- Motorola Microtac mobile (analog only)
- Nokia 6160 mobile

The equipment was mounted inside the vehicle except for the GPS and Differential GPS antenna. The mobiles were located above the dash inside the vehicle. The TEMS software was set to make a call every ten seconds. The other mobiles were manually dialed. Three variations of tests were performed:

- Stationary tests using the TEMS, Nokia and Motorola mobiles (two digital, one analog)
- Drive tests using the TEMS mobile
- Indoor tests using Nokia 6160

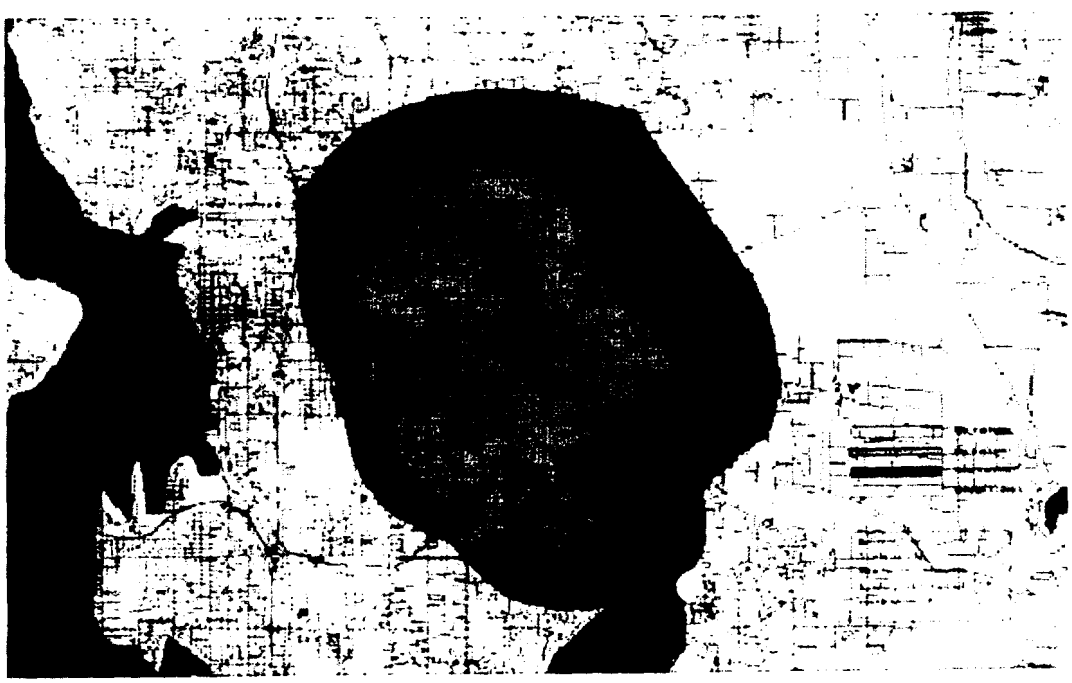
TruePositions published coverage area for the test area is shown in Figure 1. The drive tests were designed to cover this area. The predicted coverage is based upon simulation results, where:

• Green area has average expected location accuracy of less than or equal to 100 m.

• Blue has expected location accuracy of more than or equal to 100 m.

• White has average expected location accuracy more than 1000 m.

Figure 1. Predicted Coverage Based on TruePosition Simulation Results



Note: TruePosition calculated high confidence areas of locations based upon RF simulation tools. These tools used terrain data and cell site locations to determine the high confidence areas. All tests were performed inside TruePosition's confidence areas with separate drives performed to distinguish differences.

The following test cases were performed:

- Known test points (South area)
- Known test points plus drive tests (South area)

- Drive test (South area)
- Drive test (North area)
- In-building test

4. Test Issues

The following are issues that arose during the trial.

4.1. Site Connectivity

Initially, there were a number of connectivity issues that slowed the process of installing the TruePosition equipment both into the sites and into lab. Below is a summary of the hurdles that were addressed:

- DS0 at the cell site – There is no easy way to get a DS0 from the cell site T1s that were already installed (other than a Frame Relay connection).
- Local interconnect set-up – GTE was slow in getting T1 connectivity to each site.
- TruePosition interconnect design – The TruePosition design did not accommodate different interconnection options, i.e., no CSU/ DSU functionality, Frame Relay, Ethernet or IP support.

4.2. RF Connectivity

The cell sites were surveyed to use the available multicoupler ports on the Ericsson base station equipment. These ports are considered the most accessible ports on the Ericsson base stations, i.e., most sites have an available multicoupler port. During the trial it was determined that these ports did not have enough gain to meet the TruePosition receiver requirements (gain = +5.5 dB). TruePosition reconnected to the high gain ports where available (these ports are typically reserved for additional cabinets). Also, TruePosition changed their receiver hardware to compensate for lower gain.

4.3. RF Design

TruePosition used a number of GDOP plots to indicate the coverage of their system. The initial plot did not take terrain into account. The subsequent plots included terrain data, but TruePosition has raised questions regarding the accuracy of that data.

4.4. Beta Equipment

Since the TruePosition equipment used for the trial was still inBeta, there were continual updates being made. In fact, during the two-week trial, TruePosition implemented at least one new software update and one new hardware update that did not get into the test. During the few months TruePosition had installed hardware, there were four major software revisions and two major hardware revisions.

4.5. RF Environment

TruePosition indicated its belief that the RF environment in the test area was "very rough," indicated by measured interference at some sites which showed significant interference from transmitters such as Nextel, and has noted that the terrain in the Redmond area is not conducive to good accuracy measurements. However, there is no evidence that the Redmond area wireless system is more problematic than any other mature wireless network, and the FCC do not allow for reduced accuracy performance based on terrain.

4.6. Control Channel

Although a majority of the calls were located, it was noted that a small percentage (~ 5%) were unable to get a location. Also, a number of the calls were located but the confidence level of the calls was low.

4.7. Equipment Maintenance

The AWS technical team's general impression about maintenance was the equipment was very unstable and challenging to maintain. Component outages appeared extremely common and replacement of several of the TLPs and a number of SCSs was necessary.

4.8. Equipment Installs

The cell site installations went fairly smooth. Installations proceeded at about two a day (utilizing one AWS technician and two TruePosition personnel). The install involved mounting hardware into the racks, mounting an outdoor GPS antenna, and connecting to the RF receive ports, power and T1. One RF connection was installed improperly and later fixed.

4.9. Conclusions

Test results are summarized in Table 1below.

Table 1. Summary of Test Results

Test Case	67% (FCC requirement 100 m)	95% (FCC requirement 300 m)
Known test points	266	810
Drive plus known test points	286	833
Drive test (south area)	318	965
Drive test (North area)	371	1226
In-building test	299	448

The following conclusions have been drawn from the trial results:

- The trial area represented a typical real-world operating environment representative of AWS' national network.
- The technology tested in this trial failed to meet FCC accuracy requirements for a network-based location system.
- The technology, when tested was in Beta stage, required a high level of maintenance, tuning and optimization. Reliability in a larger scale implementation and system stability overall appear to be major issues.
- The TruePosition and AWS trial teams, despite cooperative efforts over a period of weeks, were unable to determine short-term fixes to substantially improve accuracy performance.

Exhibit D

Grayson E-911 Trial Technical Summary

E-911 Location Technology Trial

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1. Overview

1.1. Introduction

In an effort to prepare for compliance with Federal Communications Commission Docket #94-102 regarding Phase II Enhanced 911, AT&T Wireless is endeavoring to review and consider all potential technical options. In some cases, lab testing and/or field trials are being conducted to allow AWS technical teams to learn more about the various available technologies and determine whether they meet the FCC's mandate and AWS' internal standards for customer service and network quality.

Grayson Wireless, a network-based Phase II technology vendor, was selected for a field trial in the Redmond, WA area. Grayson's network-based solution is called Geometrix. The vendor (Grayson) installed pre-production Wireless Location Sensor (WLS) devices in seven Redmond area cell sites.

Grayson's WLS provides Time Distance of Arrival (TDOA) measurements on TDMA and AMPS voice channels. The TDOA measurements are processed by Grayson's Geolocation Control System (GCS) to determine the latitude and longitude of the desired mobile. The GCS for this trial was located in the lab area at AWS' Redmond Town Center Building 2.

In order to comply with the FCC mandate, network-based technology solutions are required to provide a location accuracy of 100 meters 67% of the time and 300 meters 95% of the time.

AWS testing focused on accessing the accuracy and functionality of the Position Determining Equipment (PDE).

1.2. Trial Objectives

The objective of this trial was to get a basic understanding of the capabilities of Grayson's Geometrix technology. The major emphasis

of the tests were to understand:

- The WLS and GCS installation process
- Initial configuration and optimization
- Coverage and accuracy limitations
- How to estimate the manpower requirements for installation

No network element or system load testing was intendedfor this trial, other than the functionality of those network elements necessary for the calculation of mobile position.

2. Summary Analysis

2.1. Test Environment

2.1.1. Trial Area

The first PDE trial was with True-Position. True-Position and AWS teams met to determine an appropriate coverage area in which to conduct the trial with the following goals:

- A number of cell sites large enough to yield meaningful test results and meet trial objectives, but small enough to be manageable for a relatively small technical team.
- A wireless environment representative of most areas covered by the AWS network nationwide (but not an abnormally challenging RF environment).
- A test bed located near the AWS' technical team headquarters and lab facilities.

The two teams jointly agreed to conduct the trial utilizing seven cell sites in the Redmond, WA area. The sites were mainly sectorized (one.omni-directional site) 850 MHz, IS-136 and analog, relatively low power base stations in a mature (fully built-out) wireless

environment, including two rooftop installations and five monopoles (approximate height 120 ft.).

For consistency in comparing test results, the Grayson trial used the same sites as the True-Position trial.

2.1.2. Test Philosophy

The main object of the testing was to determine the accuracy of Grayson's Geometrix System. Currently (in), the FCC has only suggests how accuracy measurements will be tested and reported.

For the purposes of this trial, AWS addresses accuracy testing via the following methodologies:

- Define a set of known test points and perform a number of tests from those points.

- Drive the area in question using a known reference such as a D-GPS receiver.

Both test philosophies were performed for the Grayson Trial in Redmond.

3. Testing Issues

- This trial was conducted with pre-production two channel TDOA WLS units (TDOA-2). The pre-production hardware only supports 850 MHz at this time.

- The seven Redmond area sites used for the Grayson trial were legacy sites from the previous True-Position Trial. No coverage or drive test information for the Redmond area was supplied to Grayson for analysis with their modeling tool. As a result, some areas driven were outside the Geometrix service area. This will not be a problem in Denver because of the market design procedure detailed in Section 4.

- There is no portable test platform available at this time to conduct in-building and walking location testing.

• Grayson WLS and GCS equipment downtime because of the following:

– V.35 software driver problems at all sites that required a T-1to Ethernet router (Lucent Pipeline) to be installed at each site. This problem will be corrected prior to Denver trial.

– Interconnect failure (T-1) at Bridal Trials. GTE repaired T-1 the next day.

– GPS antenna failure at DT Redmond. Grayson replaced the antenna the same day.

– Incorrect framing out of Lab DACS. Delayed start of testing by one to two weeks.

– Several resets of the GCS (Sparq Work Station) were required because of a failure to reboot after new software was uploaded. This problem has not returned, Grayson indicated that the lock-ups were because of mistakes on its end.

4. Conclusions

Overall test results are summarized in Table 1.

Table 1 Summary of Results

Test Case	67% (FCC requirement of within 100 meters)	95% (FCC requirement of within 300 meters)
TDMA Stationary	164	258
AMPS Stationary	211	330
West Redmond TDMA Drive	245	474
North Redmond TDMA Drive	424	771
West Redmond TDMA Drive	570	1012
North Redmond TDMA Drive	855	1624

The following conclusions have been drawn from the trial results:

- The trial area represented a typical real-world operating environment representative of AWS' national network.

- The technology tested in this trial failed to meet current FCC accuracy requirements for a network-based location system.

- The technology tested in this trial was in Beta stage; accuracy improvements expected with future enhancements merit further testing.

- The current equipment deployed in the Redmond Trial did not meet the current FCC accuracy requirements. However, accuracy improvements are expected with future enhancements like TDOA-4

and AOA WLS hardware. AWS should proceed with the Denver Trial using pre-production TDOA-2, 4, and AOA.

Exhibit E

Grayson E-911 Trial (Urban Denver, CO): Technical Summary

Phase 2: E-911 Location Technology Trial

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1. Purpose

This document provides a TDG technical summary of the testing efforts and analysis that has been done regarding the E911 Grayson Position Determining Equipment (PDE) trial in Denver, Colorado.

2. Overview

2.1. Introduction

In an effort to prepare for compliance with Federal Communications Commission (FCC) docket #94-102 regarding Phase II Enhanced 911, AT&T Wireless is endeavoring to review and consider all potential technical options. In some cases, lab testing and/or field trials are being conducted to allow AWS technical teams to learn more about the various technologies in order to determine whether they meet the FCC mandate and AWS internal standards for customer service and network quality.

In 2000, Grayson Wireless, a network-based location technology vendor, was selected as a finalist in an RFP process. Grayson's Geometrix product comprises two pieces of hardware: a Wireless Location Sensor (WLS) that provides Time Distance of Arrival (TDOA) measurements on TDMA and AMPS voice channels, and a Geolocation Control System (GCS). The TDOA measurements made by the WLS are processed by Grayson's GCS to determine the latitude and longitude of the desired mobile.

In order to demonstrate compliance with the FCC mandate, network-based technology solutions are required to provide an accuracy of 100 meters for 67% of the calls and 300 meters for 95% of the calls.

The testing focused on assessing the accuracy and functionality of the Position Determining Equipment (PDE).