



10.2.2 Geolocation Justification Report

10.2.2.1 Overview of Geolocation system

All HPE ARUBA NETWORKING Standard Power Access Points (6SD) contain an integrated Global Navigation Satellite System (GNSS) receiver and antenna. This allows for automatic and secure determination of geolocation for any individual access point in the WGS84 coordinate system. Multiple samples of the GNSS determined location are recorded and analyzed to calculate location uncertainty with a confidence level of 95%. The location of each 6SD is securely conveyed to the AFC System in each Available Spectrum Inquiry Request.

All HPE ARUBA NETWORKING Standard Power Access Points (6SD) are also able to determine ranges (in meters) between access points using out-of-band (OOB) radio communications in Part 15 granted bands that do not have an AFC requirement, such as within the 2.4 GHz unlicensed or 5 GHz UNII bands. These additional OOB measurements between access points are utilized to automatically and securely provide the geolocation and location uncertainty with a confidence level of 95% for those access points that are unable to directly obtain a GNSS fix, but are within the same network deployment.

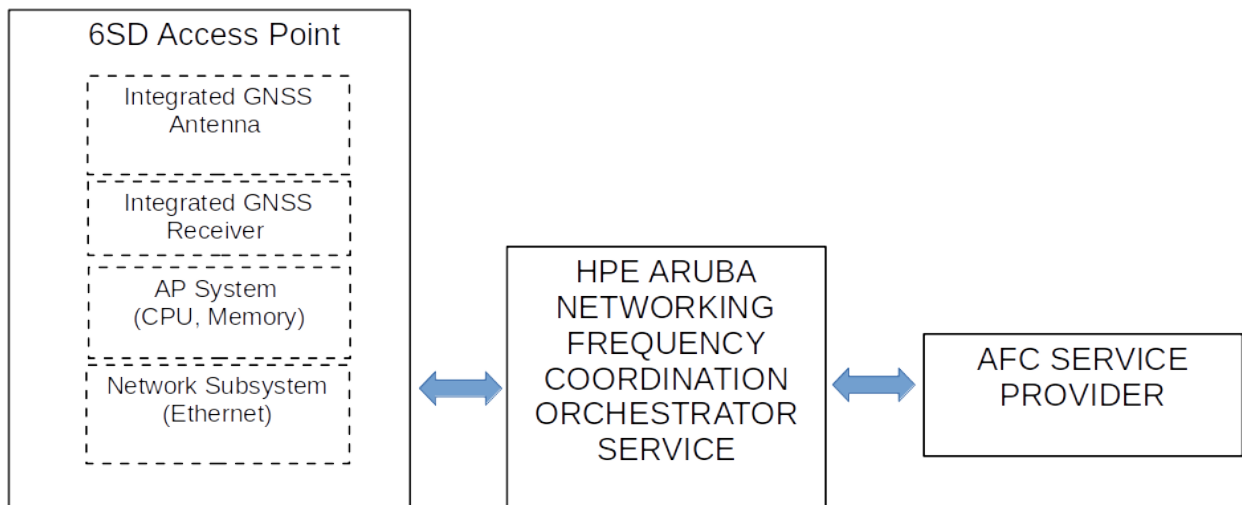


Figure 1: Block Diagram of HPE Aruba Networking Geolocation System

As of March 2024, all HPE Aruba Networking Standard Power Access Points (6SD) have an integrated GNSS Receiver Chipset identified as follows:

Manufacturer: UBLOX

Models: UBX-F10150-KB-TM or UBX-M9140-KB-C1100A

And one of the following omnidirectional GNSS antenna models is integrated internal to the access point as indicated in Figure 1:

Manufacturer, peak gain: Sercomm, 3.3 dBi or Amphenol, 6.3 dBi



10.2.2.2 Determination of location and uncertainty with 95% confidence level

The 6SD contains a software object named “location” in its internal memory with the following structure:

```
"location":|
{
  "elevation":
  {
    "height":3.65,
    "heightType":"AGL",
    "verticalUncertainty":4
  },
  "ellipse":
  {
    "center":
    {
      "latitude":37.47589111328125,
      "longitude":-121.92378997802734
    },
    "majorAxis":14,
    "minorAxis":5,
    "orientation":136.40645722350624
  }
}
```

FIGURE 2: 6SD Example 6SD Location Data Object

The location object data elements are further described as follows:

elevation:

height: in meters, must be entered by user or 6 GHz operations will not be enabled (no default value is pre-populated)

heightType: AGL indicates “Above Ground Level”, or may also be specified by user as “AMSL” for Above Mean Sea Level.

verticalUncertainty: in meters, must be entered by user

ellipse:

center: Latitude and Longitude, in degrees and decimal degrees, taken as the mean value from the most recently available dataset of 30, 60, 90 or 100 GNSS fix results obtained at a sample rate of once per 10 seconds as detailed in the following section.

major axis: The major axis, in meters, of the 95% confidence uncertainty ellipse

minor axis: The minor axis, in meters, of the 95% confidence uncertainty ellipse

orientation: The orientation of the major axis, in degrees and decimal degrees, relative to true north

Once populated, the above location data object is available to be communicated by the access point (6SD) to the HPE Aruba Frequency Coordination Orchestration (FCO) service. The following Figure 3 describes the flow of the location data object from the access point to the HPE Aruba FCO service, and to the FCC Approved AFC Service.

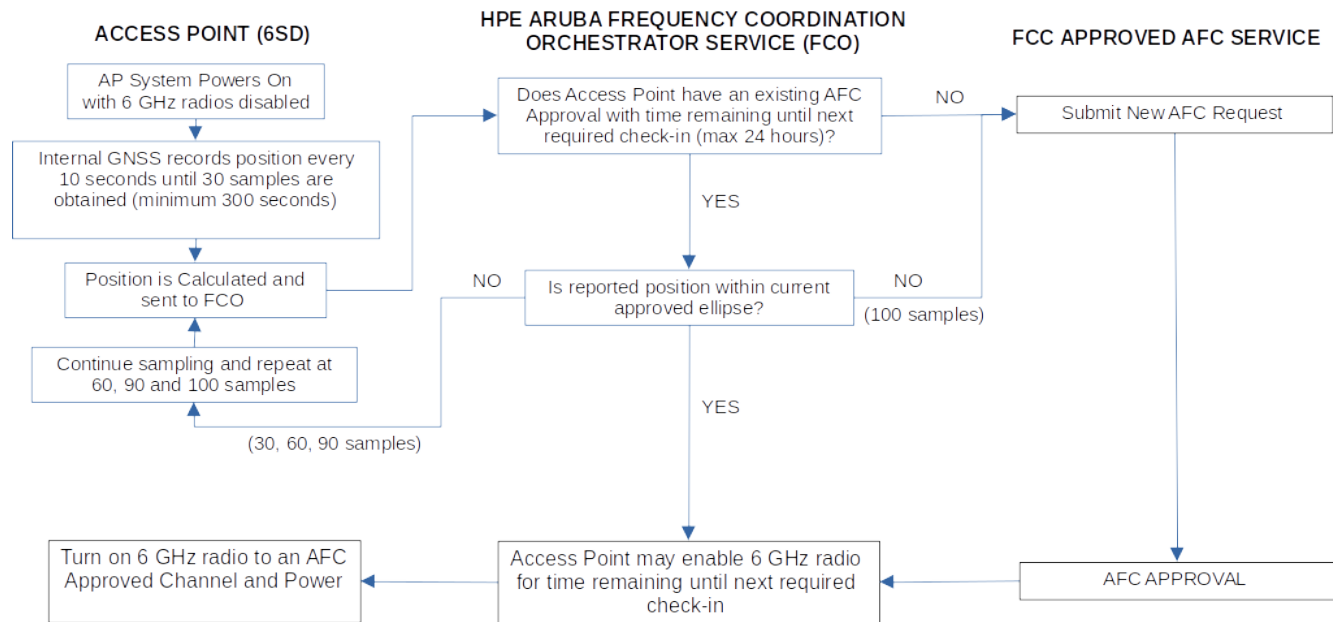


FIGURE 3: Flow of Location Data to FCO and AFC

A description of the flow on initial boot or after power failure is as follows:

1. When an AP reboots, the first location message is sent to the HPE Aruba FCO service when the AP has collected 30 samples of a valid fix from the GNSS. This requires a minimum sample window of 300 seconds elapsed from the first GNSS fix, with the fix sampled every 10 seconds for inclusion in the location data object (see Figure 2).
2. If the current location center is within the ellipse of a valid AFC Approval with time remaining until the next required check-in, Aruba's FCO will authorize 6 GHz operation for the duration of the time remaining on the current valid approval (i.e. remainder of 24 hours before next mandatory check-in with the FCC Approval AFC Service).
3. If the current location center is not within the ellipse of the current approval at 30 samples, the 6SD will retry the request at the following intervals
 - a. when 60 Samples are available to include in the calculations for the location center element. This represents 600 seconds elapsed since the first fix, at a rate of 1 sample/10 seconds.
 - b. when 90 samples are available (900 seconds)
 - c. when 100 samples are available (1000 seconds)
4. At 100 samples, if the calculated location center is not still within the approved ellipse, the previous approval will be considered invalid and a new AFC request will be submitted to the FCC Approved AFC Service including all elements of the location data object.

The determination of the 95% confidence ellipse values (major axis and minor axis, in meters) is determined using the most recent 100 samples prior to any request submitted to the FCC Approved AFC Service.



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The uncertainty calculation assumes a Chi-Square distribution with 2 degrees of freedom ($s=5.991$ for 95% confidence interval) governed by the following relationship for an axis aligned ellipse:

$$\left(\frac{x}{\sigma_x}\right)^2 + \left(\frac{y}{\sigma_y}\right)^2 = 5.991 \quad [1]$$

where x and y are the 2-Dimensional deviations, in meters, from the mean location, and σ_x and σ_y are the standard deviations of the x and y error populations.

The resulting major and minor axis lengths are then determined to be equal to

Major axis 95% confidence uncertainty length:

$$2\sigma_x\sqrt{5.991} \quad [2]$$

Minor axis 95% confidence uncertainty length:

$$2\sigma_y\sqrt{5.991} \quad [3]$$

The 6SD will not initiate any operations in any band requiring AFC authorization without having first automatically determined its location and location uncertainty with 95% confidence. When a location fix is not available from its integrated GNSS receiver, the 6SD will automatically seek to determine its location and location uncertainty using out-of-band (OOB) radio measurements in other Part 15 granted bands (e.g., 2.4 GHz and 5 GHz bands)

Automatic location determination based on out-of-band (OOB) measurements requires at least one other 6SD in the same network deployment to have established its location and location uncertainty using the GNSS methods described above.

A 6SD for which location measurements are not available from the integrated GNSS receiver will automatically determine its range in meters to one or more 6SD access points of previously determined location and uncertainty by one of two OOB methods:

Method 1: OOB Path Loss Determination between access points

Method 2: OOB 802.11 Based Fine Timing Measurement (FTM) between access points

Each of these methods results in a single value (distance in meters) which is added to both the major and minor axis values of the original access point uncertainty ellipse.

In the case of Path Loss Determination, Path Loss is converted to a distance between access points assuming free space propagation, which represents the worst case (largest possible) distance. The original (known) AP location is then used as the new AP location, and the original AP uncertainty ellipse, both major and minor axis values, is increased by the AP-AP determined distance.

For the case of 802.11 Based Fine Timing Measurement between access points, the distance between access points is determined by conversion of round trip time (RTT), in picoseconds, between access



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points assuming free space velocity. The original (known) AP location is then used as the new AP location, and the original AP uncertainty ellipse, both major and minor axis values, is increased by the AP-AP determined distance.

Since first shipping in 2021, Aruba customers have now deployed approximately 1.4 million access points (2.4 and 5 GHz) with integrated GPS capability. These access points are in service in the following markets:

Type	AP Count
Education (Hi-Ed)	229,121
Education (K-12)	320,268
Financial	50,085
Government	146,862
Healthcare	94,919
High Tech	67,944
Hospitality	55,703
Industrial Enterprise	75,503
Other/unknown	201,486
Retail	54,474
SP & Telecom	<u>74,974</u>
Grand Total	1,371,339

Within the above AP populations, approximately 1%, or 14,000 of these access points are models designed for installation in outdoor environments.

A GPS receiver is generally understood to be operate best in outdoor environments with a clear view of the sky. The accuracy of the USA based GPS system and factors that influence a receiver's accuracy are described at the following US Government maintained website:

<https://www.gps.gov/systems/gps/performance/accuracy/>

In HPE Aruba's GPS implementation, as with any GPS enabled device, there are three potential operating conditions, described as follows:

1. High Quality Fix: This is when a positional fix is calculated by the GPS receiver based on signals from multiple satellites at high signal to noise ratios. This will typically be obtained in outdoor environments with a clear view of the sky overhead, and few sources of multipath nearby.
2. Fix obtained of general (unknown) quality: This is the more general case of condition #1. In this case the receiver obtains signals from a sufficient number of satellites to calculate a position, but the



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absolute accuracy of the GPS fix at any given location and time is not known due to the variety of potential impairments that could be present (described at the [gps.gov](https://www.gps.gov) link above).

3. No fix obtained: In this condition the GPS receiver does not have enough satellites in view, or the signals are of such low quality that the receiver can not calculate and report a position.

The detailed algorithms for how GPS receivers use available satellite signals to obtain a fix and factors that influence the quality of the resulting location determination is beyond the scope of this submission.

However, when faced with the challenge to determine a location automatically, it is generally accepted that there is no better determination of an arbitrary true location than can be provided by a GPS receiver operating under the first condition stated above (high quality fix).

More generally, for any GPS receiver that has obtained a fix (condition 2: fix quality unknown), an expression of the positional uncertainty can be determined by a Type A uncertainty evaluation. This is achieved through repeated sampling, calculation and reporting of the fix location and applied statistical techniques.

For reference, NIST Technical Note 1297 (reference: <https://www.nist.gov/pml/nist-technical-note-1297/nist-tn-1297-3-type-evaluation-standard-uncertainty>) provides the following definition of a Type A uncertainty evaluation:

“A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. Examples are calculating the standard deviation of the mean of a series of independent observations”

For reporting of position and uncertainty to the AFC operator, the Aruba GPS position system utilizes a Type A (95% confidence) uncertainty determination, which is described as follows:

- For any Aruba access point that obtains a fix, the fix is sampled and recorded 100 times at an interval of 10 seconds.
- Upon collection of 100 samples the best known position (lat, lon) is calculated and reported as the 100 sample mean (lat, lon)
- The standard deviations in latitude and longitude are then also calculated from the population of 100 samples
- As described above by equations [1] through [3], the resulting 100 sample standard deviations in latitude and longitude are then combined and expanded for a 95% confidence interval. This is an area that is an ellipse, and represents the individual access point's Type A determined region corresponding to a 95% confidence interval.

It is noted that the absolute accuracy of the position and uncertainty determined by repeated measurement for a GPS receiver operating with impairments (condition #2) will never exceed (be better than) the same receiver operating with a clear view of sky (condition #1).



Appendix A to this report provides data and evaluation for a group of access points operating in condition #1 (or nearest approximation). This group of access points is likely representative of the best case absolute accuracy and lowest uncertainty that can be achieved by our system.

Appendix B to this report summarizes data and evaluation for groups of access points with various impairments. Some of this data was obtained from customer installations and therefore only the uncertainty results are provided for comparison to the results of Appendix A. (true locations are redacted)

We believe that the above described methods are in compliance with the Part 15 requirement to automatically determine the location and report the location with 95% confidence.

More specifically, given that the baseline accuracy of the USA GPS system is likely not in question (when operating in condition 1) , we believe it is appropriate to utilize a Type A evaluation for the more general case (operating condition 2) to individually determine an expression of uncertainty at 95% confidence interval for each access point.

The resulting expression of 95% confidence is an area of ellipse, which the selected AFC system provider is fully prepared to interpret and understand.

10.2.2.4 Security Features, how do we prevent bypassing AFC?

In general, HPE Aruba APs have no capability to configure or operate any radios until all the following steps complete successfully:

- The Linux operating system on the AP has to boot up.
- All the AP applications have to start successfully.
- A specific AP application (sapd) must be started to contact an Aruba controller or secure HPE servers to download the full configuration for the AP. The messages between the AP and the controller running ArubaOS are protected by checksums. This configuration includes the regulatory domain, which cannot be changed on a US restricted controller or access point.
- The regulatory domain is programmed into the AP's radio driver. From this point on, the radio can only use radio resources allowed by the US regulatory domain. No application layer misbehavior can later change this.
- The Aruba AP must stay in continuous contact with its controller or secure HPE servers using an Aruba proprietary protocol. The radios will turn off and the AP will reboot itself promptly if communication is interrupted with the controller and the above process will restart.
- There is also a hardware watchdog mechanism on the AP that guarantees that the AP will reboot in the event that APs applications cannot run normally.
- No user controls are present in ArubaOS at any time that will allow an AP to operate outside of the US based regulatory conditions. This includes channels, power settings, modulations, and additional requirements for DFS and TPC as applicable.



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In addition, the following details are provided for reference as part of the KDB 8594280 D02 UNII security requirements with respect to software change management:

- The ArubaOS image and Downloadable Regulatory Table (DRT) files are downloaded from arubanetworks.com to a local file server via https and then into the controller (or APs, for controllerless installations) via ftp, scp or https.
- The integrity and the authenticity of the image files are secured by using a digital signature that is signed at Aruba and verified on the controller (or AP) before installation.
- The ArubaOS files are digitally signed (using x509 certificates). The chain of trust leads back to the root certification authority that resides at Aruba Networks.
- The Aruba controllers (and APs) have the Aruba root-CA certificate factory-installed. This will be used to verify that the images did indeed originate from Aruba.
- Before installation of the image files, the devices acting as a controller will verify the signature and reject the images files if they cannot be authenticated.

In addition to the above standard security measures, there are no controls available to the user in the CLI or GUI that would allow a user to make changes to how the AFC system operates.

10.2.2.5 Details of how height is determined and/or entered

Elevation is measured and manually entered by the installer or operator. The height may be specified by the user as the 6SD antenna height above ground level (AGL) or above mean sea level (AMSL) in meters.

There is no pre-populated default value, and if no value is input at time of installation, then the 6 GHz radio will not be enabled.

10.2.3 Power Failure

At initial boot, including after power failure, the 6SD will follow the procedures described in section 10.2.2. above



APPENDIX A: RESULTS AND EXAMPLE CALCULATIONS

ACCESS POINTS WITH HIGH QUALITY GPS FIX



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A.1 Introduction

This appendix provides example calculations and data for access points operating with a clear view of the sky.

A.2 Example Measurements

Figure A-1 and Table A-1 shows 100 samples of the GPS determined location for an outdoor access point with clear view of the sky. For reference a 3m diameter circle is drawn around the 100 sample locations and the center point (mean location) is labeled.

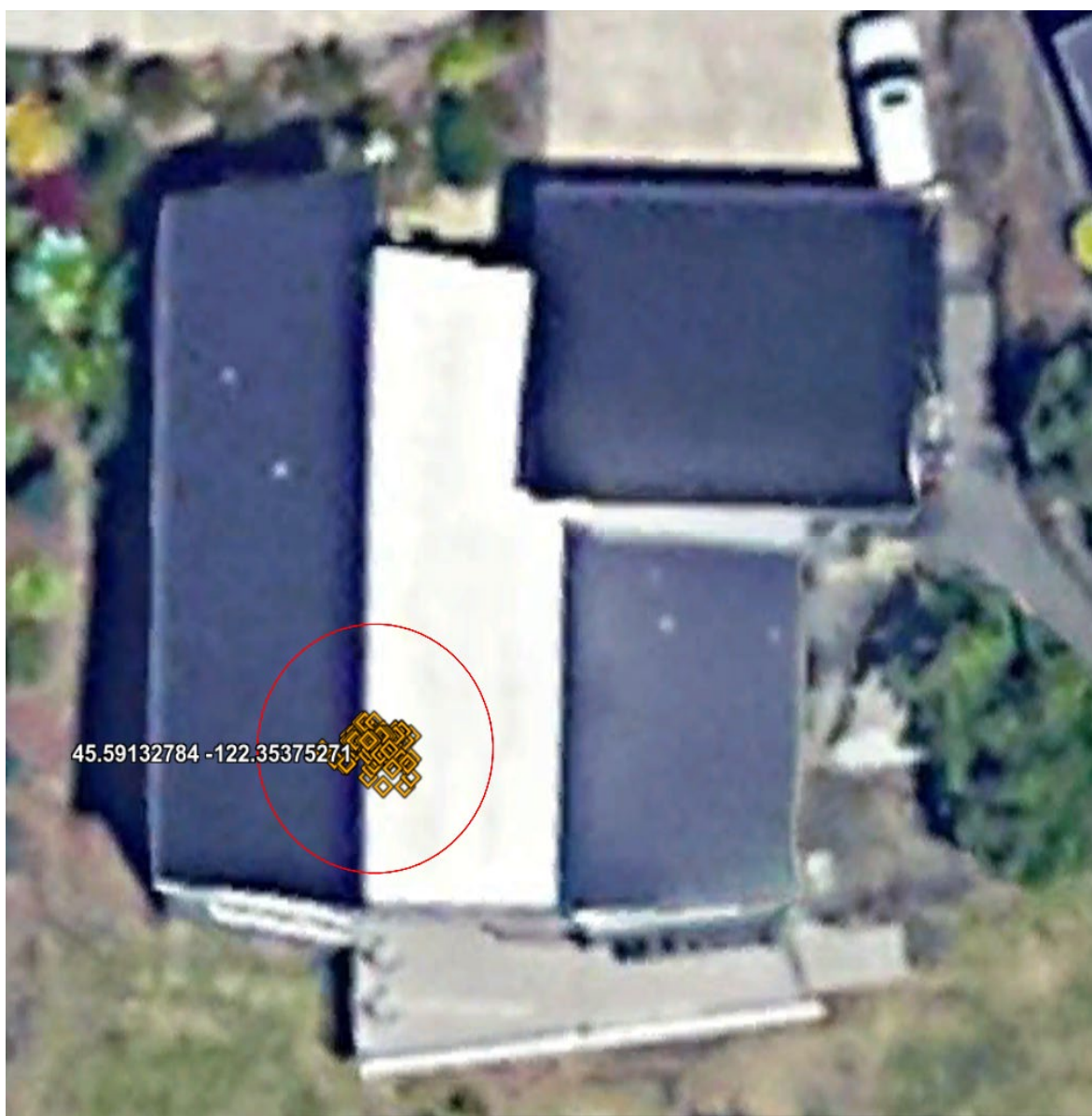


FIGURE A-1
GPS Data, 100 Samples taken at 10 second intervals



Lat	Lon	Lat	Lon	Lat	Lon	Lat	Lon	Lat	Lon
45.590000	-122.353747	45.590000	-122.353755	45.590000	-122.353760	45.590000	-122.353766	45.590000	-122.353753
45.591324	-122.353742	45.591329	-122.353754	45.591330	-122.353759	45.591324	-122.353763	45.591328	-122.353753
45.591325	-122.353744	45.591330	-122.353751	45.591331	-122.353759	45.591324	-122.353762	45.591327	-122.353754
45.591324	-122.353743	45.591330	-122.353750	45.591331	-122.353756	45.591326	-122.353760	45.591329	-122.353753
45.591325	-122.353741	45.591330	-122.353749	45.591329	-122.353754	45.591327	-122.353753	45.591330	-122.353758
45.591327	-122.353748	45.591331	-122.353750	45.591328	-122.353755	45.591328	-122.353747	45.591329	-122.353761
45.591326	-122.353751	45.591333	-122.353753	45.591331	-122.353755	45.591329	-122.353743	45.591328	-122.353760
45.591326	-122.353749	45.591333	-122.353756	45.591331	-122.353753	45.591330	-122.353741	45.591329	-122.353761
45.591326	-122.353749	45.591333	-122.353757	45.591330	-122.353746	45.591330	-122.353746	45.591330	-122.353761
45.591329	-122.353755	45.591332	-122.353756	45.591331	-122.353744	45.591329	-122.353747	45.591330	-122.353755
45.591329	-122.353754	45.591331	-122.353755	45.591331	-122.353746	45.591327	-122.353748	45.591330	-122.353755
45.591327	-122.353754	45.591331	-122.353753	45.591331	-122.353746	45.591327	-122.353752	45.591331	-122.353757
45.591326	-122.353755	45.591329	-122.353756	45.591327	-122.353747	45.591328	-122.353756	45.591331	-122.353755
45.591324	-122.353753	45.591329	-122.353759	45.591325	-122.353745	45.591329	-122.353754	45.591331	-122.353754
45.591323	-122.353754	45.591328	-122.353757	45.591321	-122.353741	45.591329	-122.353756	45.591330	-122.353749
45.591325	-122.353753	45.591327	-122.353753	45.591319	-122.353743	45.591329	-122.353759	45.591330	-122.353746
45.591326	-122.353749	45.591326	-122.353752	45.591319	-122.353750	45.591328	-122.353757	45.591331	-122.353744
45.591327	-122.353752	45.591325	-122.353748	45.591321	-122.353755	45.591327	-122.353759	45.591328	-122.353746
45.591328	-122.353754	45.591327	-122.353750	45.591324	-122.353762	45.591327	-122.353759	45.591325	-122.353748
45.591327	-122.353754	45.591329	-122.353758	45.591327	-122.353770	45.591328	-122.353757	45.591325	-122.353744

TABLE A-1: GPS Data Measured Every 10 seconds (100 samples)

A.3 Example Calculations

The resulting mean latitude and mean longitude is obtained from the 100 samples shown in Figure 1 and listed in Table 1 can be calculated as follows

$$\text{Latitude} = \Sigma(\text{lat})/100 = 45.5913278$$

$$\text{Longitude} = \Sigma(\text{lon})/100 = -122.3537527$$

Equations [1] – [3] of section 10.2.2.2 above can then be applied to the data to determine the ellipse corresponding to a 95% confidence interval. Note that the equations as stated in 10.2.2.2 are for the special case of an axis aligned ellipse. In general, we do not assume the ellipse is axis aligned, or that the earth is perfectly spherical, therefore it is necessary to do some translation to form an independent coordinate system for application of the 95% (chi-squared) relationship of equation [1]. This proceeds as follows:

First, the following python library is used to calculate the distance and bearing between two points whose coordinates are latitude and longitude.

<https://geographiclib.sourceforge.io/html/python/geodesics.html>

Due to the ellipsoidal shape of the earth, attempting to use spherical coordinates based method results in a slight error. This library builds on the Vincenty formula for calculating distances between two points on an ellipsoid and further handles some corner cases. The details of the algorithm are beyond the scope of this document.

We use the above library to convert the latitude and longitude coordinates to a cartesian coordinate system of X and Y with the Y axis pointing due north and the origin chosen as the first sample in the list of latitude and longitude coordinates.



We then calculate the error ellipse for this cartesian coordinate system of points as follows.

Stage 1: Calculate the eigen values and eigen vectors of the coordinates.

This is necessary to obtain the orientation of the error ellipse. To achieve this we first calculate the covariance matrix for the set of coordinates. For x and y coordinates it looks as follows.

$$A = \begin{bmatrix} var(x) & cov(x, y) \\ cov(x, y) & var(y) \end{bmatrix}$$

Where

$$Cov(xn, yn) = \frac{\sum_1^n (x_i - \mu_x)(y_i - \mu_y)}{n}$$

In our example it results in the following values

$$A = \begin{bmatrix} 0.20952014 & -0.02412236 \\ -0.02412236 & 0.10025016 \end{bmatrix}$$

Then we extract the eigen values and eigen vectors

$$(A - \lambda \cdot I) \cdot v = 0$$

In our example this leads to

$$\lambda = [0.214608430.09516187] \text{ and } v = \begin{bmatrix} 0.97846875 & 0.20639501 \\ -0.20639501 & 0.97846875 \end{bmatrix}$$

Stage 2: Calculate the ellipse orientation and dimensions.

The larger lambda value corresponds to the major axis and the angle is determined from the corresponding eigen vector in v . Since our Y axis oriented due north we can obtain the bearing of the ellipse by calculating the angle of the larger eigen vector with the Y axis.

From equation [1], we can now obtain the values of σ_x and σ_y to be

$$\begin{aligned} \sigma_x &= \max(\lambda) \\ \text{and} \\ \sigma_y &= \min(\lambda) \end{aligned}$$

Our ellipse dimensions can thus be calculated as below.

$$ellipsemajoraxis(width) = 2 * \sigma_x * \sqrt{5.991}$$

$$ellipsemin \in axis(height) = 2 * \sigma_y * \sqrt{5.991}$$



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In our example this comes to 2.26779m width and 1.51011m height. From the center location this may also be expressed as ± 1.14 m width and ± 0.75 m height.

For comparison purposes, it is also useful to calculate the area of the uncertainty ellipse, which is given by the formula

$$Area = \frac{\pi * Major}{2} * \frac{Minor}{2} = 2.69m^2$$



A.4 Additional Example

The following figure shows the reported locations and uncertainty ellipses by the methods of section A.2 and A.3 above for a group of 7 access points mounted outdoors on a single story light industrial building in a business park.

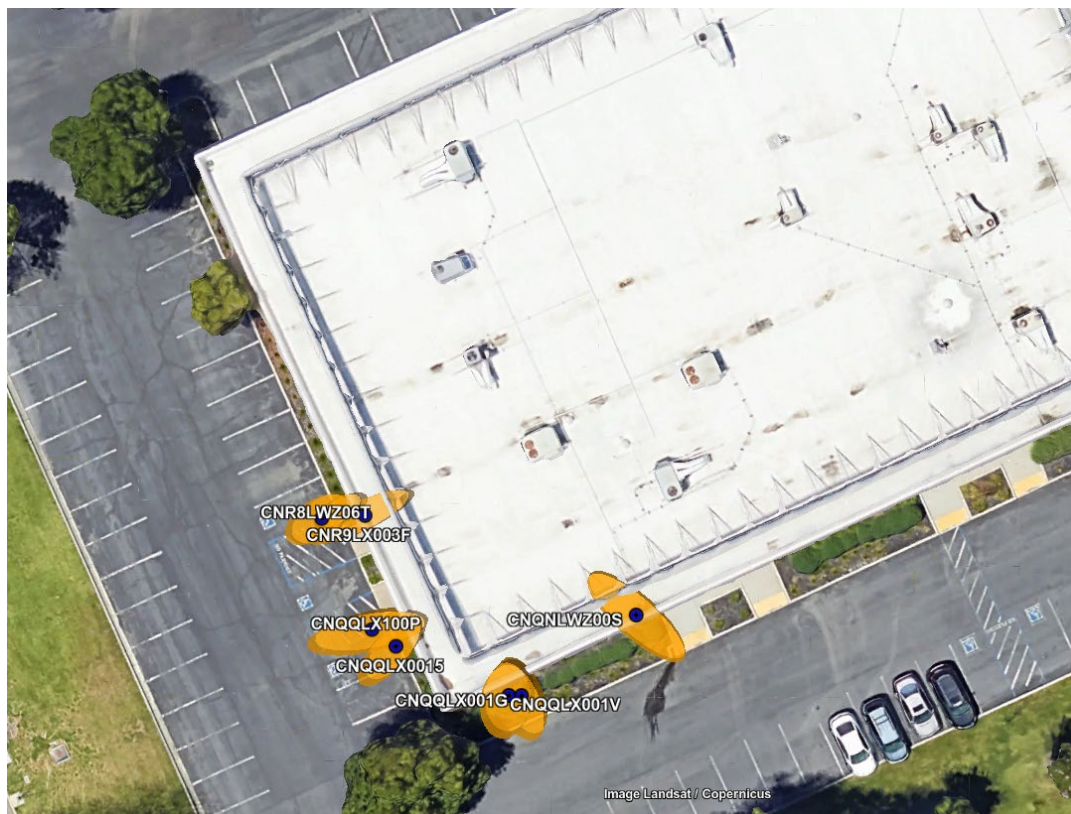


FIGURE A-2: Outdoor Access Points (qty:7)
100 Sample Mean Locations and 95% Confidence Uncertainty Ellipses

AP Name	100 Samples		Uncertainty Ellipse (Type A, 95% Confidence)		
	Mean	Mean	Major Axis (m)	Minor Axis (m)	Ellipse Area (m2)
	Lat	Lon			
CNR8LWZ06T	-121.924000	37.476030	4.91	2.67	10.30
CNR9LX003F	-121.923965	37.476032	7.69	1.99	11.99
CNQQLX100P	-121.923960	37.475960	8.24	2.60	16.80
CNQQLX0015	-121.923940	37.475950	5.86	2.38	10.96
CNQQLX001G	-121.923840	37.475920	5.67	2.80	12.49
CNQQLX001V	-121.923850	37.475920	5.02	3.45	13.59
CNQNLWZ00S	-121.923750	37.475970	8.66	2.74	18.61
Group Summary			Major Axis (m)	Minor Axis (m)	
Average (m)			±3.29	±1.33	
Mean Ellipse Area (m ²)					13.53

TABLE A-2
SUMMARY OF SEVEN OUTDOOR ACCESS POINTS



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A.5 Discussion

The results shown above represent the typical performance of HPE Aruba access points mounted outdoors with a clear view of the sky.



APPENDIX B: RESULTS AND EXAMPLE CALCULATIONS
ACCESS POINTS WITH GENERAL (UNKNOWN) QUALITY GPS FIX



B.1 Introduction

This appendix provides data representative of access points operating with various impairments. Due to use of customer locations, only uncertainty summaries are provided.

B.2 Twelve Story Building

The access points described in this section are installed in a customer's twelve story building (qty:88). In this example, no access point has a totally clear view of the sky as the installation is indoors on all levels (Floors 0 - 11). The following Figure B-1 shows the access point GPS determined locations as the 100 point mean for each location calculated by the methods described in Appendix A.1. For reference, the large bounding circle is 500m radius from the building center, and the smaller overlapping circles are 100m radius from the building corners.

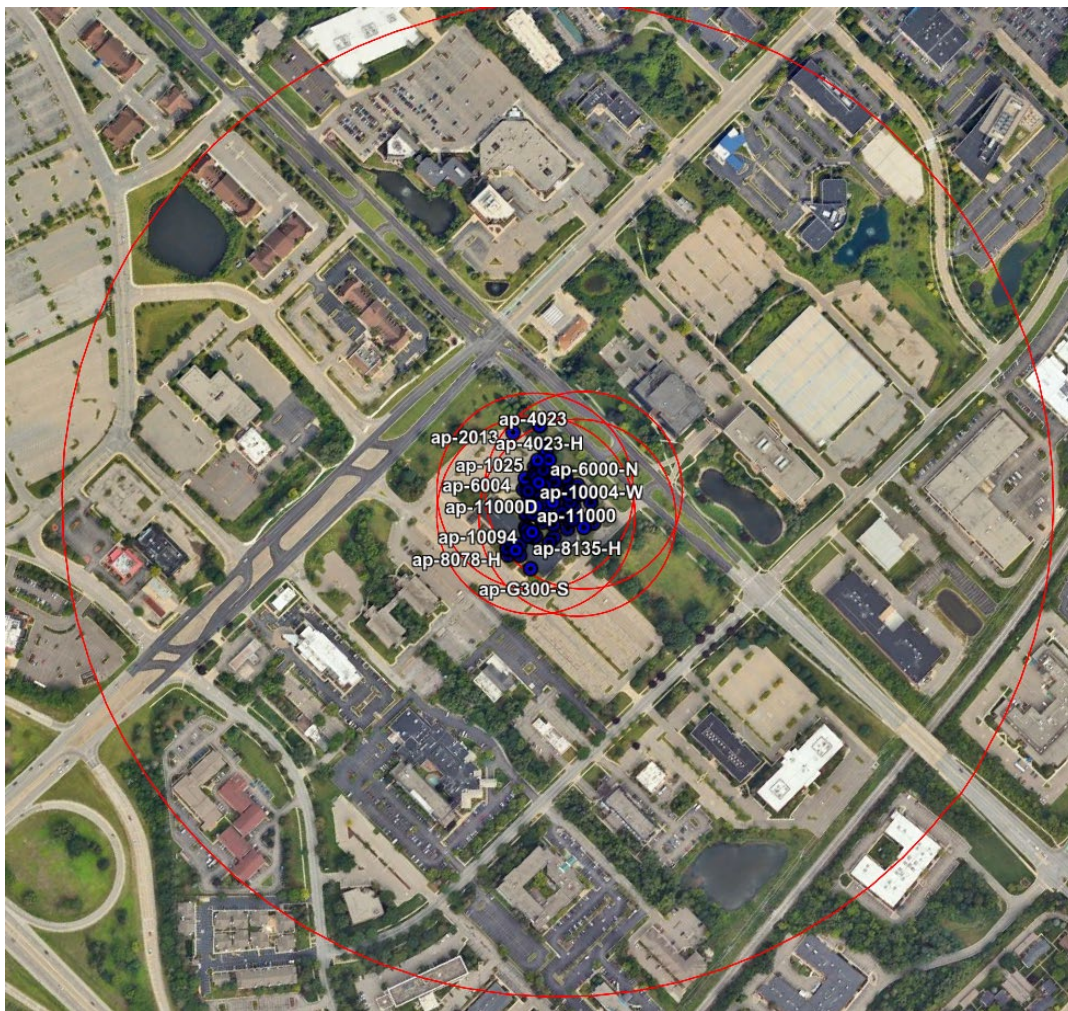


Figure B-1: Quantity 88 indoor access points, 100 sample mean for each location

The following Figure B-2 shows the 100 sample determined 95% confidence uncertainty ellipses (quantity 88) with the same 500m radius reference circle.

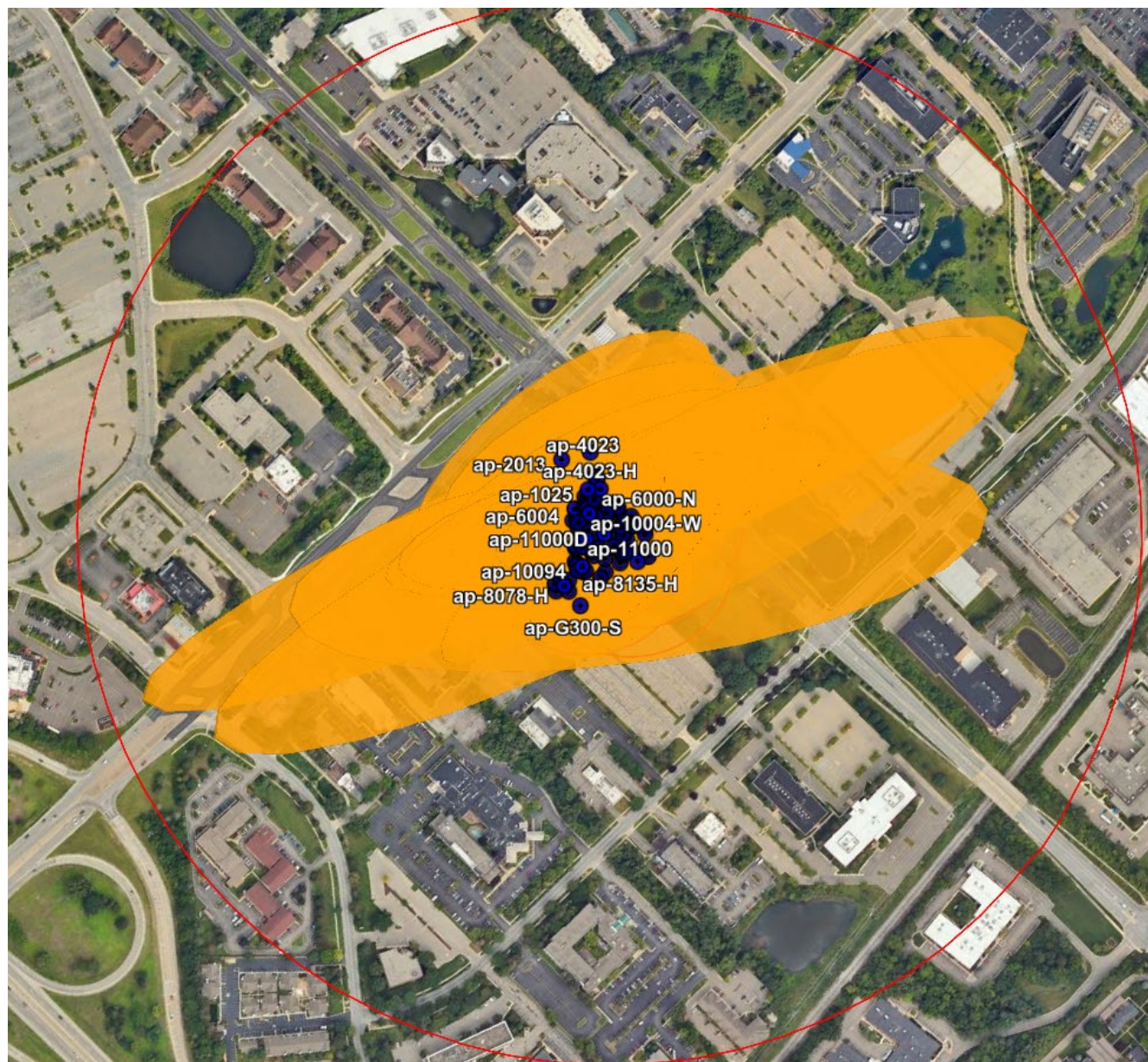


Figure B-2: Uncertainty Ellipses (95% Confidence), qty:88 Access Points

The following Table B-1 provides quantitative information on the 95% confidence uncertainty ellipses:

AP Name	Floor	Uncertainty Ellipse (Type A, 95% Confidence)			Ellipse Area (m ²)
		Major Axis (m)	Minor Axis (m)		
ap-11000	11	77.91	42.72		2,613.99
ap-11000D	11	29.63	23.77		553.33
ap-11000B	11	30.72	20.16		486.40
ap-10052-H	10	231.34	87.57		15,912.04
ap-10004-E	10	170.29	52.67		7,044.73
ap-10020-W	10	134.46	45.37		4,791.54



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ap-10004-W	10	107.77	49.34	4,176.50
ap-10002B	10	123.74	40.78	3,963.34
ap-10020-E	10	65.20	56.84	2,910.73
ap-10094	10	61.51	42.74	2,064.75
ap-9133-H	9	427.20	92.25	30,953.61
ap-9048-H	9	390.18	91.91	28,164.89
ap-9090-H	9	357.70	97.43	27,371.10
ap-9002	9	161.20	69.58	8,809.68
ap-9014	9	171.28	37.63	5,062.21
ap-9036	9	73.00	49.78	2,854.41
ap-8117M-H	8	821.98	170.12	109,827.18
ap-8135-H	8	653.81	188.09	96,585.25
ap-8000	8	259.02	64.32	13,085.15
ap-8078-H	8	142.55	75.13	8,411.82
ap-8034-H	8	110.14	57.11	4,940.28
ap-8016	8	97.19	30.82	2,352.56
ap-7119W-H	7	383.22	98.50	29,646.95
ap-7042	7	156.93	52.48	6,468.52
ap-7044-H	7	107.39	75.36	6,356.43
ap-7082	7	99.02	47.17	3,668.63
ap-7018	7	130.19	33.49	3,423.94
ap-7010-H	7	110.02	33.68	2,909.77
ap-6019	6	310.86	92.93	22,687.92
ap-6054	6	231.31	107.25	19,484.88
ap-6L11-H	6	147.64	62.95	7,299.59
ap-6000-N	6	132.78	56.17	5,857.88
ap-6004	6	134.74	33.63	3,559.35
ap-6094-H	6	89.52	32.02	2,251.47
ap-6042	6	69.63	28.37	1,551.66
ap-6000-S	6	74.77	24.09	1,414.44
ap-5117M-H	5	178.26	64.37	9,012.13
ap-5002	5	144.93	41.79	4,756.20
ap-5025-H	5	193.99	28.41	4,328.33
ap-5002-H	5	131.85	37.31	3,863.72
ap-5000-09-H	5	95.12	29.08	2,172.12
ap-5000-24-H	5	50.84	27.65	1,104.19
ap-5088	5	68.64	19.12	1,030.43
ap-4023	4	302.45	112.86	26,809.72
ap-4023-H	4	203.85	37.86	6,061.23
ap-4013-H	4	106.40	40.06	3,347.30
ap-4002	4	84.83	17.70	1,179.29
ap-4084	4	46.58	19.10	698.63
ap-3017	3	179.43	59.27	8,352.66
ap-3010-H	3	75.20	44.71	2,640.84
ap-3040-H	3	36.37	33.39	953.81
ap-3084	3	35.99	18.54	524.07
ap-2013	2	343.22	145.75	39,289.69



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ap-2052	2	171.61	55.22	7,442.58
ap-2036-H	2	122.68	67.73	6,526.39
ap-2002	2	125.88	44.33	4,382.94
ap-2028	2	37.60	25.51	753.23
ap-2082	2	33.63	16.83	444.61
ap-1025	1	341.77	146.59	39,349.10
ap-1S11-H	1	261.63	92.88	19,084.61
ap-1042-H	1	182.79	87.78	12,602.03
ap-1034	1	135.76	40.32	4,299.01
ap-1006-H	1	77.78	44.40	2,712.76
ap-1014	1	92.26	26.88	1,947.76
ap-1084	1	49.69	30.83	1,203.29
ap-1024-H	1	45.71	15.98	573.81
ap-G010	0	901.76	140.99	99,851.70
ap-G300-N	0	114.67	71.37	6,427.67
ap-G228	0	149.16	35.76	4,189.00
ap-G436-H	0	83.57	53.85	3,534.49
ap-G395-E	0	82.84	44.20	2,876.03
ap-G250H-H	0	79.64	44.19	2,764.12
ap-G048-S	0	72.93	45.83	2,625.26
ap-G008	0	77.87	39.16	2,394.91
ap-G332	0	63.83	35.92	1,800.51
ap-G048-E	0	60.56	36.01	1,712.49
ap-G405	0	52.74	40.99	1,697.78
ap-G418-H	0	65.79	32.84	1,696.87
ap-G015	0	66.32	30.44	1,585.45
ap-G250	0	55.47	30.75	1,339.71
ap-G395-C	0	39.84	32.46	1,015.72
ap-G455	0	33.62	32.56	859.95
ap-G388-H	0	38.12	25.11	751.90
ap-G300-S	0	42.09	22.66	748.98
ap-G028	0	46.73	16.15	592.89
ap-G024	0	38.46	15.37	464.38
ap-G395-W	0	21.45	15.15	255.30
ap-G050	0	21.45	11.17	188.06

Group Summary

Average
Group Mean Ellipse Area (m²)

Major Axis (m)
±74.1

Minor Axis (m)
±26.08

9,731.1



B.3 Example (Stadium Deployment)

Figure B-3 is an overview of an outdoor stadium deployment. In this example, there are 721 access points deployed in the bowl. No access point is expected to have a totally clear view of sky or be free from potential multipath interference. The stadium bowl (seating area) footprint is a circle of approximately 160m radius. In the figure below, for distance reference purposes the 160m footprint of the stadium is shown with an additional 100m drawn around the stadium (260m radius total circle),



FIGURE B-3: Stadium Footprint 160m radius +100m



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Figure B-4 shows the resulting position determination for 721 access points.

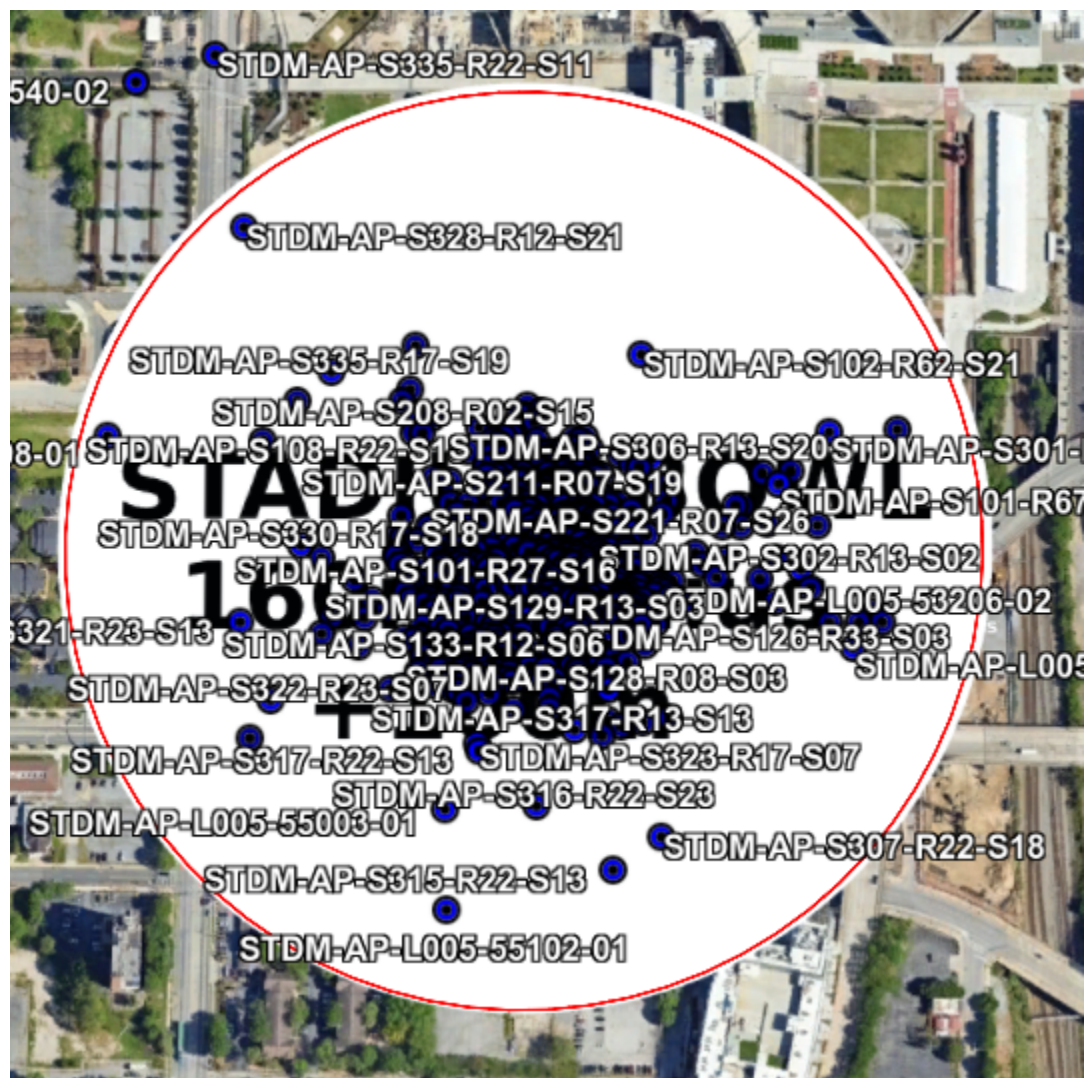


Figure B-4: GPS Determined Locations of 721 Access Points

Note that 2 access points appear “outside” the 100m additional radius, but one of these is actually deployed in the parking area shown in the NW corner of Figure B-4. The access point labeled STD-M-AP-S335-R22-S11 is located an additional 68m (168m total) beyond the stadium bowl footprint. (0.1% of total access points)

Figure B-5 shows the resulting 95% confidence uncertainty ellipses (721 total ellipses overlapping)

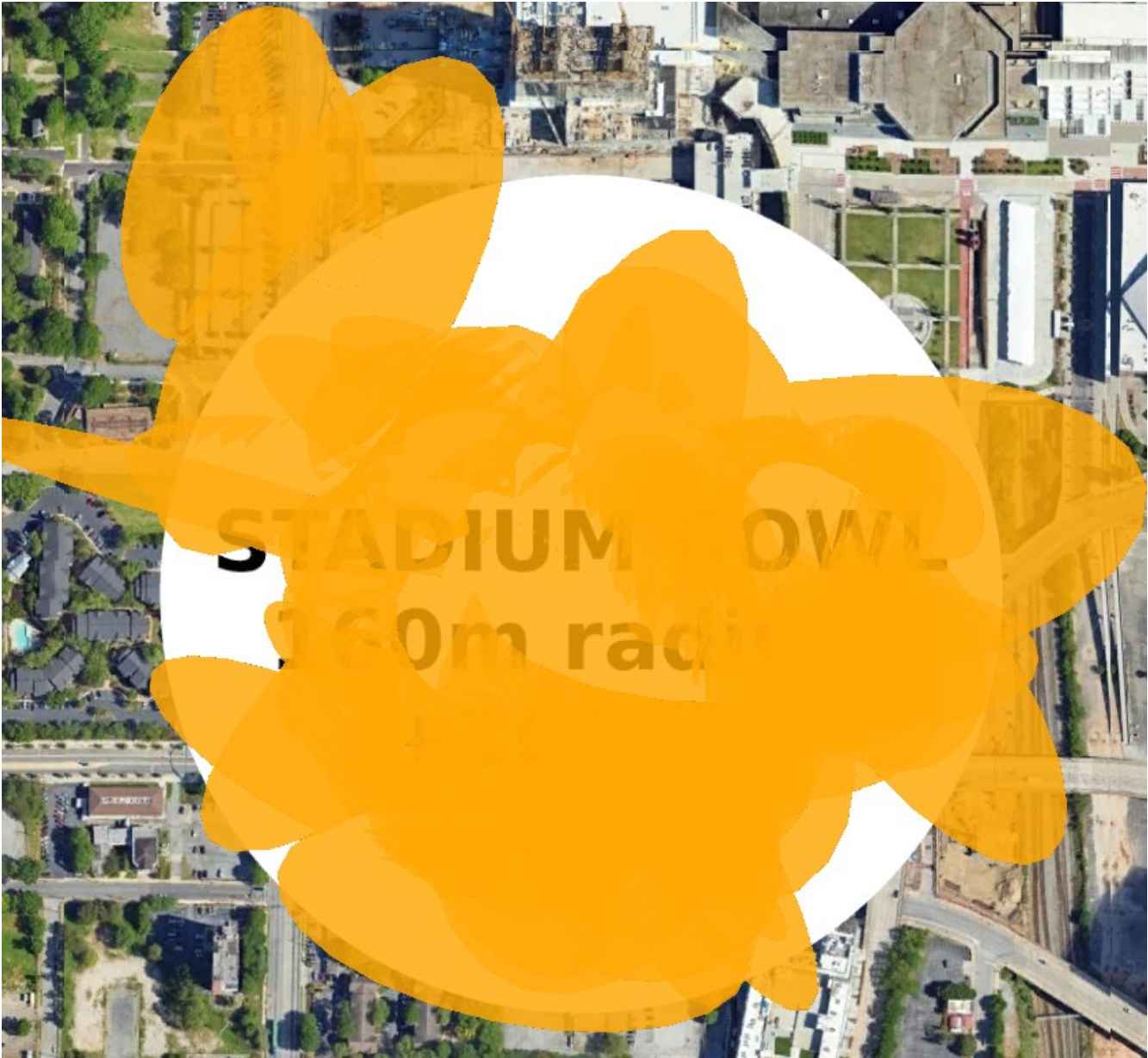


FIGURE B-5: Uncertainty Ellipses (95% Confidence) for 721 Access Points

Due to the quantity of Access Points, the ellipse data is provided in summary form only for this example deployment:

<u>Group Summary</u>			
<u>(Stadium</u>			
<u>Deployment</u>			
Average (m)	Major Axis (m)	Minor Axis (m)	
	±51.35	±26.5	
Group Mean Ellipse Area (m²)			4,282.3



B.5 Discussion

The results shown above show that the 95% confidence uncertainty due to impairments can be quantified for an individual access point as a Type A uncertainty based on 100 samples at 10 second intervals. The uncertainty ellipse based on this method will be submitted to the AFC system along with the 100 sample mean calculated position.