Unwire Portland

Proof of Concept Network Testing

Report of Findings

The Performance Criteria

Uptown Services has evaluated the Proof Of Concept (POC) network in Portland, OR based on the city's testing criteria in the Proof Of Concept Network Testing RFP and subsequent instructions from the city to precisely define the criteria to be used to calculate the coverage. The testing criteria requires the tester to evaluate three areas of network performance:

1. Throughput
   - Requirement IA: The availability of a 1 Mbps downstream/256 Kbps upstream connection in a stationery position
   - Requirement IB: The maximum number of supported 1 Mbps downstream/256 Kbps upstream connections for a single 802.11 access point
2. Availability
   - Requirement IIA: The network's ability to provide a connection (64 Kbps upstream and downstream) 99% of time
   - Requirement IIB: The network's ability to deliver packets between an end user device and the MetroFi Point of Presence (POP) in less than or equal to 100 milliseconds
   - Requirement IIC: The network's ability to deliver at least one full speed connection (1Mbps downstream/256 upstream) at a distance of up to 250 feet from an access point
   - Requirement IID: The network's ability to provide a connection to at least 90% of the outdoor POC area
3. Security
   - Requirement IIIA: The network's ability to support 802.11i
   - Requirement IIIB: The network's ability to support multiple SSIDs, including non-broadcast SSIDs

The testing criteria also requires the tester to evaluate the network's ability to meet the performance requirements within the Throughput and Availability categories listed above both without a signal booster and with MetroFi's recommended signal booster. After the RFP was released but before the testing was started, the recommended signal booster was changed to the Ruckus Metroflex.

Testing Methodology

Five types of testing were done to gather the data necessary to evaluate the network based on all the criteria: Extended Availability Testing, Coverage Testing, Service Set and Security Testing, Connection Limit Testing, and Signal Booster Testing. The following subsections report the methods used for of each of the individual tests.

Preparation for the initial testing of the network began February 5, 2007 and the actual testing began February 7, 2007. The initial Coverage Testing, Connection Limit Testing, Service Set and Security Testing, and Signal Booster Testing were completed by February 14, 2007. The Extended Availability Testing was started on February 7, 2007 and continued through March 28, 2007. The peak throughput of 6 Access Points (APs) and the signal levels surrounding 25 APs were retested on April 3 & 4, 2007. The Coverage Testing, Connection Limit Testing, Service Set and Security Testing, and most of the Signal Booster Testing were done between the hours of 2:00 AM and 8:00 AM when the load on the network from other users would be minimal.

Uptown Services' proprietary evaluation software was used in all of the testing to conduct the individual tests and to log the test results along with the Wifi and GPS parameters. The evaluation software is a multithreaded Windows application that uses standard Internet protocols to perform three types of tests simultaneously and repetitively. The first is a Ping test that sends an ICMP Echo request (commonly known as a ping) and measures the time it takes to receive the response. The second is a downstream throughput test that uses the HTTP protocol to get a file from a web server and measures the time it takes to receive the file. The third is an upstream throughput test that uses the FTP protocol to send a file to an FTP server and measures the time it takes to send the file. The software can be configured to use different hosts, timeout periods, and repetition rates for each test.

The results from all of the tests were saved in log files for further analysis and reporting. Following the completion of the initial testing, and again following the completion of the retesting, the data was extracted from the log files and analyzed extensively to determine the results of each of the tests.

Extended Availability Testing

The Extended Availability Testing involved placing a wireless equipped laptop in a location provided by the City that was safe, had power available to it, and was within reach of an access point. The laptop was configured to run the evaluation software continuously, log the results, and automatically upload the logs to a server for evaluation.

The evaluation software was configured to normally ping two different hosts 12 times per minute, download a test file using HTTP about every 40 seconds, and upload a test file using FTP about every 40 seconds. The timeouts and retries built into the upload and download protocols can cause there to be more time between tests for the upstream and downstream tests when they have problems getting packets through. The server used for the first pinger, the downstream test, and the upstream test was the MetroFi admin server. The server used for the second pinger was Portland State's web server (www.pdx.edu). The second pinger was only intended as a backup to help troubleshoot any problems that might arise.

Analysis of the logs from the Extended Availability Test involved looking at the results of all the tests performed during each minute of the testing. To determine the Downstream Availability, a minute was considered tested if there was at least one downstream throughput test during that minute and it was considered failed if the average throughput of all the downstream tests completed during that minute was less than 64 Kbps. Likewise, to determine the Upstream Availability, a minute was considered tested if there was at least one upstream throughput test during that minute and it was considered failed if the average throughput of all the upstream tests completed during that minute was less than 64 Kbps. To determine the Combined Throughput Availability, a minute was considered tested if there was at least one upstream or downstream throughput test during that minute and it was considered failed if either the upstream or downstream average throughput during that minute was less than 64 Kbps. To determine the Ping Time Availability, a minute was considered tested if there was at least 6 pings attempted with the first pinger during that minute and it was considered failed if the average ping time of all the pings attempted with the first pinger during that minute was more than 200 ms. In calculating the average ping time, a value of 1000 ms was used for any ping test that timed out. In all the cases the availability is defined as one minus the number of failed minutes divided by the number of minutes tested (i.e., 1 – (failed minutes / tested minutes)).

Coverage Testing

The initial Coverage Testing involved driving all the publicly accessible roads in the entire POC while continuously testing the public access network (SSID = MetroFi-Free). This testing was done using our evaluation software running on a Toshiba laptop mounted in the vehicle and using a Proxim Orinoco Gold Wifi card with a 5.5 dBi antenna mounted on the roof of the vehicle. This configuration generated an Effective Isotropic Radiated Power (EIRP) of 23 dBm (200 mW). The vehicle was also equipped with a Garmin eTrex GPS receiver to determine the vehicle's position throughout the coverage testing.

The evaluation software was set to ping 2 hosts once per second. The first host was a server on MetroFi's internal network and the second host was Portland State's web server (www.pdx.edu). The evaluation software was also set to use HTTP to download a file from MetroFi's server every 10 seconds and to use FTP to upload a file to the server every 10 seconds. The results for the ping tests include a status that indicates if the ping completed normally or not; the time in milliseconds (ms) that it took for the ping message to reach the host and return; and both the URL and the IP Address of the host. The results for the download and upload tests include a status that indicates if the test completed normally or not; the throughput in kilobits per second (Kbps) calculated as the size of the file divided by the time it took to transfer it; the size of the file; and the URL of the file transferred.

The evaluation software records the results for each test, and the GPS and Wifi parameters at the time of each test, into a test log file for later evaluation. The GPS parameters include a status that indicates if the GPS is working normally or not; the latitude and longitude; the speed; the heading; and the UTC date and time of the latest position fix. The Wifi parameters include a status that indicates if the Wifi device is working normally or not; the Receive Signal Strength Indicator (RSSI) reported by the Wifi device; the SSID of the network it is connected to; and the MAC Address of the AP it is associated with.

The test results from the coverage test logs were sorted into sets based on the location where the test was performed as indicated by the GPS. The city defined the outdoor POC area to be tested as those locations that are within 500 feet of any one of the APs that make up the POC network. Tests that took place outside the POC area were removed from the set of tests for the POC area. Tests where the GPS did not report a valid position fix were also removed from the POC set. Since we could not assure that the Wifi connection manager was always associated with the strongest AP, those tests that were associated with an AP that was not the closest AP were also removed from the POC set.

The test results remaining in the POC set were analyzed geographically and statistically to determine the average receive signal level, average upstream and downstream throughput, upstream and downstream throughput test failure rates, average network latency, and packet loss rate for each 100 foot square within the POC that was tested. For each performance measure we established a scale where green indicates a passing value, yellow indicates a marginal value, red indicates a failing value, and black indicates complete failure (e.g., no signal detected).

To determine if each AP met the downstream throughput requirement of at least 1 megabit per second (Mbps) and the upstream throughput requirement of at least 256 kilobits per second (Kbps), the best throughput measured for each AP was extracted from the test results remaining in the POC set. To determine the performance at a distance of up to 250 feet of an access point, the distance to the nearest access point was determined for each test measurement and those measurements within 250 feet of an access point were analyzed statistically.

After reviewing the initial test results, and after MetroFi made some improvements, the signal levels around 25 of the APs were measured again during the retesting effort. At that time the NetStumbler software application was used to record the data since only the signal levels needed to be measured during this part of the retesting. Otherwise the test setup was the same as during the initial testing. The retest results were analyzed geographically and statistically in the same way as the initial test results. The initial test results for the retested 25 APs were replaced with the retest results and then the coverage was recalculated.

The retesting also included re-measuring the best upstream and downstream throughput for the six APs that had previously failed to meet the downstream throughput requirement of at least 1 Mbps. Two of these APs had also failed to meet the upstream throughput requirement of at least 256 Kbps. The test setup and equipment used were the same as what was used during the initial testing.

Service Set and Security Testing

The purpose of the Service Set and Security Testing is to verify the ability of the network to support a second SSID that supports WPA2 security. The POC Network includes a second SSID (MetroFi-Premium) that requires users to authenticate using the WPA2 security protocol satisfying the requirements of 802.11i. Testing this capability involved configuring the test device to access the “MetroFi-Premium” network, driving to within range of at least 10 APs and verifying that a good connection is established at each AP.

The test laptop with the evaluation software and the Ruckus Metroflex configured for access to the MetroFi-Premium network were driven around in the POC and connections were made to a number of APs.

Connection Limit Testing

The purpose of the Connection Limit Testing is to measure the performance of a single Access Point (AP) with up to 15 laptops using it at the same time. This involved loading the evaluation software onto 15 laptops equipped with built-in wireless adapters, taking them to a spot close to an AP, then starting them up, one-at-a-time, with them all recording the results of their tests. This testing was scheduled for the middle of the night to minimize the possibility that other users might be connected to the AP being tested.

The laptops were prepared before taking them to the test site by synchronized their system clocks with an Internet Time Server, verifying they were running properly and connecting to the network. Then they were loaded into the car and driven to a parking lot at NE 10th Av and Weidler St where there is an AP (MAC address = 00-0A-DB-01-E8-40) about 20 feet from the car with a clear path to the AP. The testing was started at about 2:20 AM and was completed about 3:30 AM.

The laptops were arranged in the back of the car and then started up, one-at-a-time, while verifying that Windows booted successfully, the wireless connection manager connected to the MetroFi-Free network and the correct AP, the evaluation software properly and the tests were running. The evaluation software was set to ping 2 hosts once per second, download the 200KB test file from the HTTP server once each 10 seconds, and upload the 100KB test file to the FTP server once each 10 seconds. The picture in Figure 1 shows the laptops in the back of the test vehicle.

The data from the test logs was analyzed to determine how the performance changed as more laptops were connected to the network and then as they were disconnected. The downstream and upstream performance results are shown in two charts in the results section of this report. Since we do not actually know if another user is connected to the AP being tested, the Qty Of PCs Online on the charts is the number of testing laptops that have been started and are running the test software. The Aggregate Throughput is the sum of the number of bytes transferred by all of the laptops combined during each minute of the test, times 8 bits/byte, divided by 60 seconds/minute, divided by 1000 bits/kilobit to give Kilobits per second (Kbps).

Figure 1 – Connection Limit Testing Configuration

Signal Booster Testing

The Signal Booster Testing involved testing the signal booster recommended by MetroFi (the Ruckus Metroflex) while driving in roughly a straight line away from an AP located along the edge of the POC and comparing its performance to that of the standard test setup used for the coverage testing (the Proxim Orinoco Gold Wifi card with an external 5.5 dBi antenna). The tests included using the evaluation software to measure and record the performance data and using the GPS Receiver to determine the position of each test. The Effective Isotropic Radiated Power (EIRP) for both the Proxim Orinoco Gold Wifi card with an external 5.5 dBi antenna and the Ruckus Metroflex is 23 dBm (200 mW).

To eliminate the potential problem of the metal body of the car causing variations in the test results depending on the orientation of the car to the AP while still protecting the signal booster from the rain, the booster was placed in a plastic box mounted on the roof of the car. The power and signal cables ran through the sunroof to the laptop mounted inside the car. The pictures below show this test setup. The picture in Figure 2 shows the booster secured in the box with the lid off before it was placed on the roof of the car. The picture in Figure 3shows the box on the top of the car with the cables running down to the laptop.

Figure 2 – Signal Booster Testing Configuration

Figure 3 – Signal Booster Testing Configuration

Testing while driving in a straight line away from the AP allows comparison of the performance of the booster with a relatively clear line of sight to the AP but does not check how well it deals with things interfering with the line of sight such as buildings and trees. To compare the ability of the booster to deal with interference, as compared to the external antenna, testing was also done while driving around the 3 blocks closest to the AP on either side of the straight-line route. This put the buildings and trees in those blocks between the AP and the test device. The performance with interference was analyzed separately from the straight-line results.

The Signal Booster Testing was done starting at the AP at the corner of SE Glisan and 28th Av and driving east along Glisan to Glisan Circle about 3500 feet to the east. The test route was driven using the external antenna and then using the Ruckus Metroflex signal booster.

Throughput Results

Requirement IA: The availability of a 1 Mbps downstream/256 Kbps upstream connection in a stationery position

Table 1 below shows the best downstream and best upstream throughput measured for each AP during the initial coverage testing. The table is sorted in ascending order of throughput so the worst performing APs are at the top of the table. During the initial coverage testing, six APs failed the downstream throughput and two of those APs also failed the upstream throughput. These six APs were re-tested and the retest results are shown in Table 2 below. With the retesting, Uptown Services found that 99% (69 of 70) of access points (APs) provided at least 1 Mbps of downstream connectivity and 100% (all 70) of APs provided at least 256 Kbps of upstream connectivity.

Table 1 – Individual Access Point Throughput Test Results

Best Measured Throughput For Each AP (during the Initial Testing)

Location	MAC	Downstream Best (Kbps)	Upstream Best (Kbps)
SW 3RD/SW JEFFERSON	00-0A-DB-03-28-40	0	0
SE BELMONT/SE 20TH	00-0A-DB-01-CE-00	107	166
SW 4TH/SW MORRISON	00-0A-DB-01-B5-C0	568	525
SW TAYLOR/SW BROADWAY	00-0A-DB-01-9D-80	773	511
NE COUCH ST/NE 24TH AVE	00-0A-DB-01-EA-80	874	701
SW 10TH/SW TAYLOR	00-0A-DB-01-9F-40	999	600
SW 11TH/SW YAMHILL	00-0A-DB-01-91-40	1,098	747
SE 13TH/SE OAK	00-0A-DB-01-9E-E0	1,359	999
SW BROADWAY/SW WASHINGTON	00-0A-DB-03-7B-C0	1,416	1,114
NE 13TH AVE/NE HOLLADAY ST	00-0A-DB-01-E7-C0	1,426	1,282
NE GLISAN/NE 17TH	00-0A-DB-01-74-E0	1,583	801
SW PINE/SW 5TH	00-0A-DB-01-ED-A0	1,611	1,007
NE COUCH/NE 9TH	00-0A-DB-01-C5-00	1,684	1,409
SW 11TH/SW WASHINGTON	00-0A-DB-01-B4-20	1,872	1,134
SW BROADWAY/SW OAK	00-0A-DB-01-AE-20	1,952	1,049
SW BROADWAY/SW YAMHILL	00-0A-DB-03-7B-80	1,955	1,099
SW PINE/SW 2ND	00-0A-DB-03-C3-A0	2,003	1,053
SW 4TH/SW OAK	00-0A-DB-01-9E-C0	2,033	1,381
NE WEILDER/NE 10TH AVE	00-0A-DB-01-E8-40	2,076	1,016
SE YAMHILL ST/SE 26TH AVE	00-0A-DB-03-4C-E0	2,086	1,045
SE TAYLOR/SE 10TH	00-0A-DB-01-C7-20	2,089	977
NE 20TH AVE/NE FLANDERS ST	00-0A-DB-03-7B-40	2,092	1,180
NE GLISAN/NE 28TH AVE	00-0A-DB-01-D8-40	2,113	977
SE 24TH AVE/SE PINE ST	00-0A-DB-03-5E-20	2,165	1,134
NE IRVING ST/NE 20TH AVE	00-0A-DB-03-81-A0	2,179	1,047
SE PINE/SE 17TH	00-0A-DB-01-98-00	2,205	955
SW MADISON/BROADWAY	00-0A-DB-03-48-80	2,215	1,163
SE HAWTHORNE/SE 23RD	00-0A-DB-01-C6-40	2,238	1,178

Best Measured Throughput For Each AP (during the Initial Testing)

Location	MAC	Downstream Best (Kbps)	Upstream Best (Kbps)
SE HAWTHORNE/SE 16TH	00-0A-DB-03-C6-60	2,286	947
NE GRAND AVE/NE WEILDER	00-0A-DB-01-F1-80	2,332	1,172
SE 20TH/E BURNSIDE	00-0A-DB-03-49-20	2,398	1,612
SW BROADWAY/SW CLAY	00-0A-DB-01-E8-20	2,453	1,262
SE SANDY AVE/SE 9TH	00-0A-DB-03-C0-40	2,460	1,354
SE HAWTHORNE/SE 10TH	00-0A-DB-03-47-40	2,531	1,121
SE WATER/SE MAIN	00-0A-DB-03-46-40	2,558	1,090
SE 26TH AVE/SE WASHINGTON	00-0A-DB-01-91-20	2,635	1,223
SW ALDER/SW 10TH	00-0A-DB-01-86-00	2,636	1,385
SE BELMONT/SE 7TH	00-0A-DB-01-9A-E0	2,657	913
NE GLISAN ST/NE 24TH AVE	00-0A-DB-01-A5-80	2,659	1,163
SW MARKET/SW 3RD	00-0A-DB-01-C9-E0	2,722	1,289
SW 4TH/SW MADISON	00-0A-DB-03-82-40	2,726	1,512
SE GRAND AVE/SE HAWTHORNE	00-0A-DB-01-9C-80	2,748	1,067
NE 15TH AVE/NE HALSEY ST	00-0A-DB-01-EE-80	2,751	1,204
SE 14TH/SE MAIN	00-0A-DB-03-7C-E0	2,874	1,587
SW 3RD/SW TAYLOR	00-0A-DB-01-AA-60	2,888	1,670
NE GRAND AVE/NE MULTNOMAH ST	00-0A-DB-03-7F-A0	2,907	1,748
SE 17TH/SE ALDER	00-0A-DB-03-80-60	2,912	1,358
NE HOLLADAY ST/NE 3RD AVE	00-0A-DB-01-C5-80	2,924	1,582
SE 26TH/SE MAIN	00-0A-DB-03-C4-C0	2,999	1,807
SE ANKENY ST/SE 7TH AVE	00-0A-DB-01-C7-A0	3,002	1,789
SE 12TH/SE ANKENY	00-0A-DB-01-A7-20	3,043	1,565
SE MLK BLVD/SE TAYLOR	00-0A-DB-01-92-E0	3,116	1,351
SW BROADWAY/SW MORRISON	00-0A-DB-03-49-40	3,142	1,292
SW BURNSIDE/SW 13TH	00-0A-DB-01-E8-80	3,178	1,435
NE MULTNOMAH/NE 16TH	00-0A-DB-03-47-C0	3,244	1,145
NE DAVIS/NE SANDY	00-0A-DB-01-C6-00	3,248	1,481
SE 20TH/SE MAIN	00-0A-DB-03-7C-C0	3,397	1,400
NE HOLLADAY ST/NE 7TH AVE	00-0A-DB-01-90-00	3,491	1,525
SE BELMONT/SE 12TH	00-0A-DB-01-93-00	3,575	2,373
NE GRAND AVE/NE OREGON ST	00-0A-DB-01-CC-00	3,809	2,119
SE 23RD/SE TAYLOR	00-0A-DB-03-59-A0	4,099	2,330
NE MULTNOMAH/NE 9TH	00-0A-DB-03-34-20	4,196	2,333
SE STARK ST/SE SANDY	00-0A-DB-01-8F-60	4,228	2,204
SW STARKS/SW 10TH	00-0A-DB-01-A0-60	4,325	1,901
SE MLK BLVD/SE STARK ST	00-0A-DB-01-9E-40	4,413	2,142
SE WATER/SE BELMONT	00-0A-DB-01-98-60	4,654	2,216
SW 3RD/SW WASHINGTON	00-0A-DB-01-9D-A0	4,767	2,611
SE MAIN ST/SE 6TH AVE	00-0A-DB-03-32-60	4,898	2,345
SE 20TH/SE STARK	00-0A-DB-03-41-00	5,018	2,183
NE COUCH ST/NE MLK BLVD	00-0A-DB-03-81-E0	5,545	2,597

Table 2 – Individual Access Point Throughput Retest Results

Best Measured Throughput For Each AP (during the Retesting)

Location	MAC	Downstream Best (Kbps)	Upstream Best (Kbps)
SW TAYLOR/SW BROADWAY	00-0A-DB-01-9D-80	2,888	1,137
SW 10TH/SW TAYLOR	00-0A-DB-01-9F-40	3,146	1,139
SW 4TH/SW MORRISON	00-0A-DB-01-B5-C0	1,858	1,079
SE BELMONT/SE 20TH	00-0A-DB-01-BB-60	1,486	718
NE COUCH ST/NE 24TH AVE	00-0A-DB-01-EA-80	769	406
SW 3RD/SW JEFFERSON	00-0A-DB-03-28-40	1,899	1,201

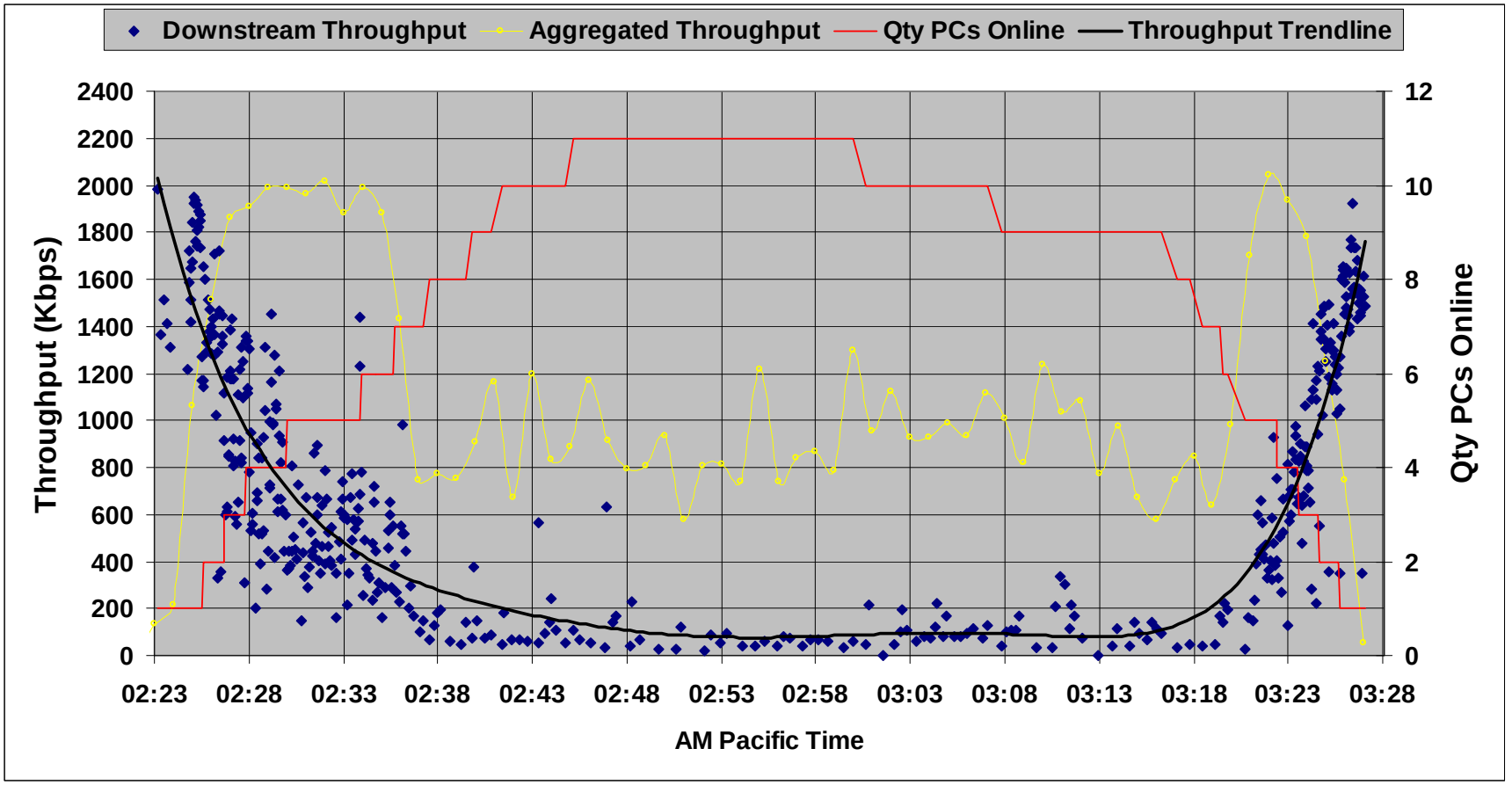
Requirement IB: The maximum number of supported 1 Mbps downstream/256 Kbps upstream connections for a single 802.11 access point

During the Connection Limit Testing, the first 10 laptops started, connected, and ran fine although it was apparent that, by the time the 10th laptop was started, it took a little longer for each one to connect, the throughput was lower, and there were more ping failures. The 11th laptop started but initially could not connect to the network even though the connection manager reported it had excellent signal strength. On the second or third try it did connect and the evaluation software ran fine. The 12th laptop started but could not connect to the network although the connection manager again reported it had excellent signal strength. The connection manager was directed to try again several times without success. Next the 13th, 14th, and 15th laptops were tried, one-at-a-time, and they also could not connect after several tries each. After several minutes, the laptops were shut down, one-at-a-time, until they were all shut down.

Charts 1 and 2 below show how the downstream and upstream throughput changed as the number of testing laptops online changed. The downstream throughput of the first laptop averaged 1556 Kbps when it was the only laptop online, fell to 91 Kbps when 11 laptops were online, and then climbed back up as the other laptops were turned off. The upstream throughput of the first laptop averaged 536 Kbps when it was the only laptop online, fell to 62 Kbps when 11 laptops were online, and then climbed back up as the other laptops were turned off. The Connection Limit Testing showed that MetroFi's POC network supports two 1 Mbps downstream connections and one 256 Kbps upstream connection simultaneously on a single 802.11 access point.

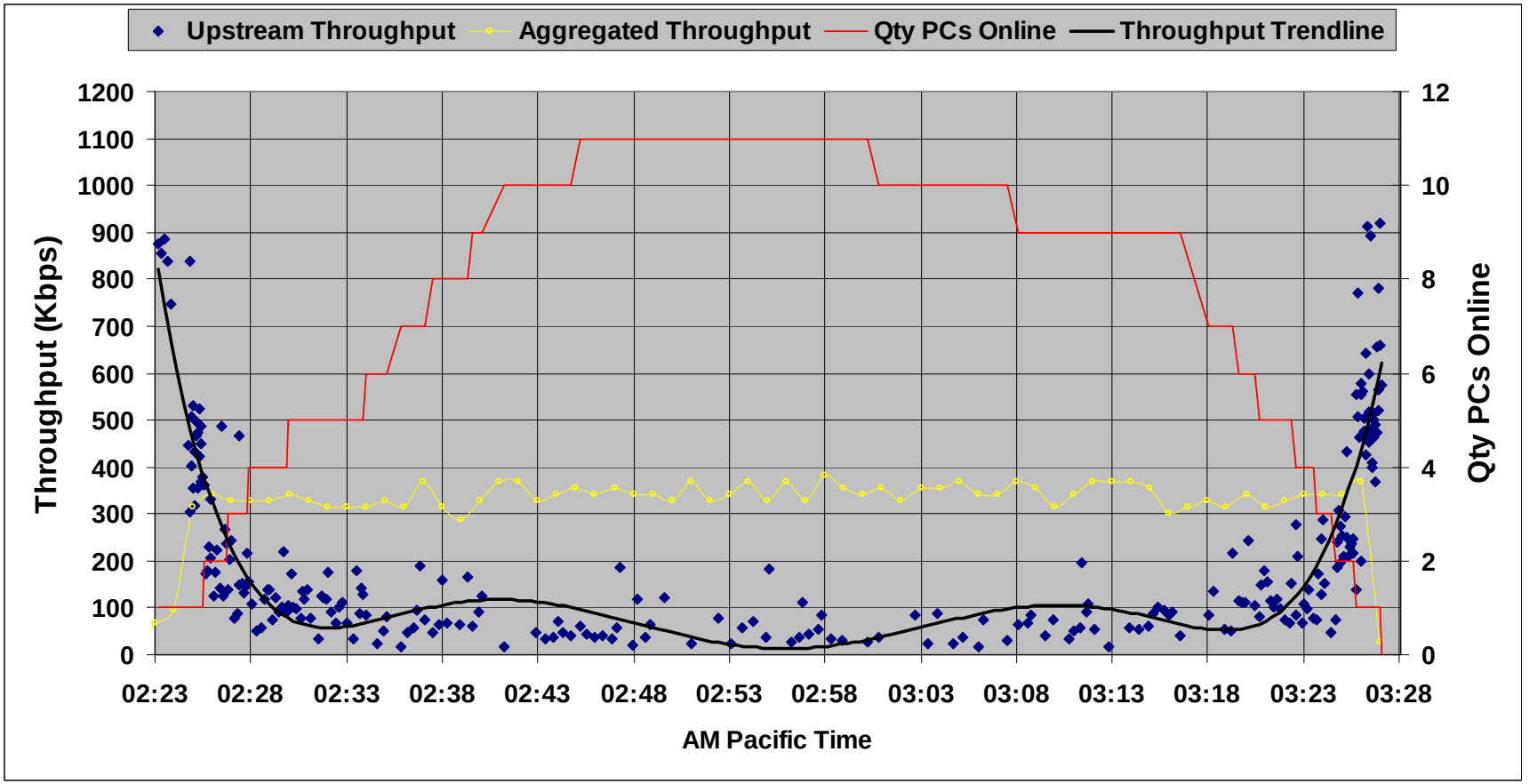
The downstream Aggregate Throughput climbed to about 2000 Kbps with 4 laptops online and remained fairly steady until about the time the 7th laptop was brought online and it dropped to about 800 Kbps. It remained between about 600 Kbps and 1300 Kbps until about the time the 6th laptop was shut down. Then it climbed back up to about 2000 Kbps before dropping as the number of laptops online fell below 4 causing the demand to drop. The upstream Aggregate Throughput climbed to about 330 Kbps with 2 laptops online and remained fairly steady throughout the test until about the time the 2nd laptop was shut down causing the demand to drop.

Chart 1 – Downstream Connection Limit Test Results



Each blue diamond is a throughput measurement by the first laptop. The black line is a "best-fit" trend line through the blue diamonds based on a 6th order polynomial curve. The yellow line is the total aggregated throughput of all of the laptops together for each minute throughout the testing. The red line is the number of laptops connected to the network and performing tests through the period of the testing.

Chart 2 – Upstream Connection Limit Test Results



Each blue diamond is a throughput measurement by the first laptop. The black line is a "best-fit" trend line through the blue diamonds based on a 6th order polynomial curve. The yellow line is the total aggregated throughput of all of the laptops together for each minute throughout the testing. The red line is the number of laptops connected to the network and performing tests through the period of the testing.

Availability Results

Requirement IIA: The network's ability to provide a connection (64 Kbps upstream and downstream) 99% of time

Initially there were problems getting the Extended Availability Test to run continuously. There were problems with the stability of the software, the hardware, and the connection to the network. The problems were troubleshot and repaired and then the test was run successfully for 711 hours (about 30 days).

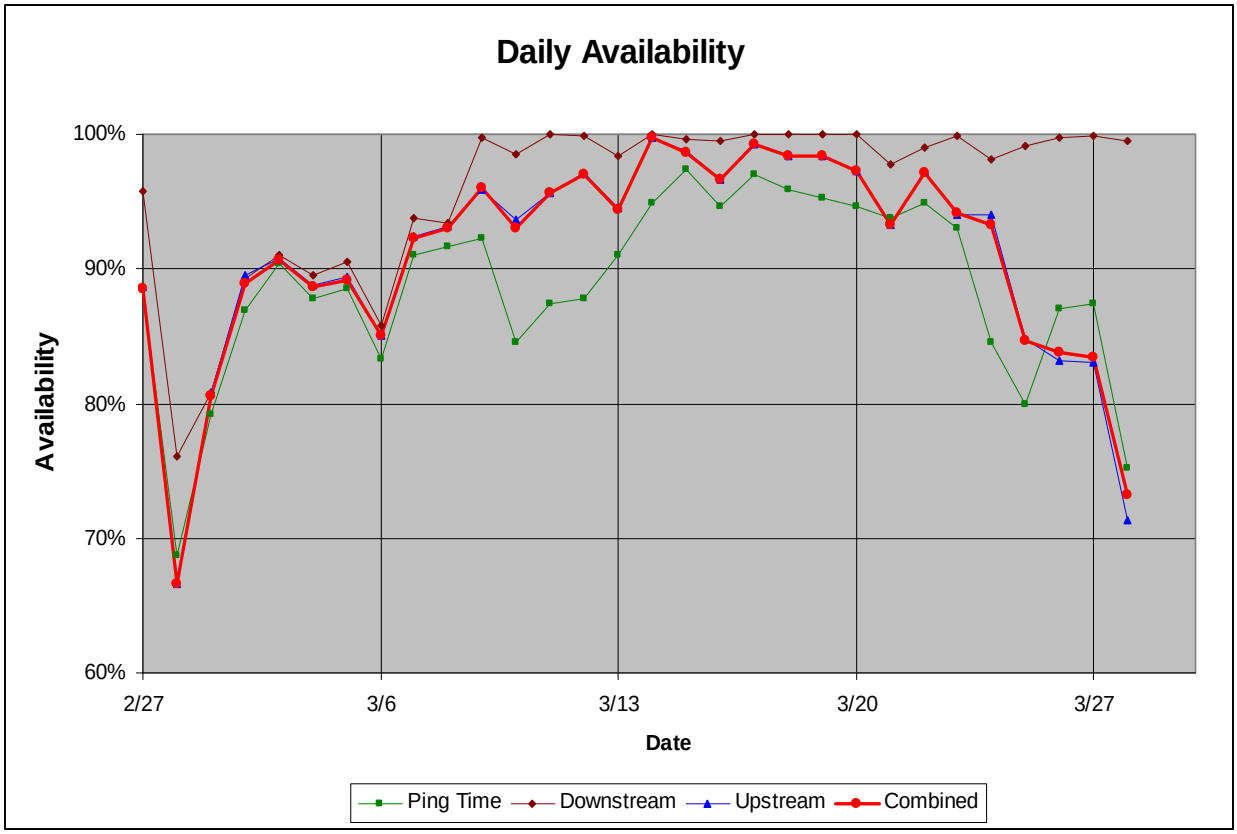
The results of the Extended Availability Testing show that the network provides a connection (of at least 64 Kbps upstream and downstream) 91% of the time (38773 of 42587 minutes tested). The average downstream throughput for these tests was 1336 Kbps and the average upstream throughput was 669 Kbps. The downstream throughput exceeded 1 Mbps in 63% of the tests and exceeded 256 Kbps in 92% of the tests. The upstream throughput exceeded 1 Mbps in 28% of the tests and exceeded 256 Kbps in 74% of the tests.

Table 3 shows the throughput availability statistics based on the results of the Extended Availability Testing done over the period of about 30 days. Chart 3 shows how the availability varied over the 30 days of the Extended Availability Test. An hour-by-hour breakdown of the availability is in Appendix I.

Table 3 –Extended Availability Testing Throughput Results

91%	Combined Throughput Availability
3814	Number of minutes where Upstream or Downstream Throughput failed
42587	Number of minutes where Upstream or Downstream Throughput was tested
96%	Downstream Throughput Availability
1782	Number of minutes where average Downstream Throughput was less than 64 Kbps
42576	Number of minutes where Downstream Throughput was tested
91%	Upstream Throughput Availability
3732	Number of minutes where average Upstream Throughput was less than 64 Kbps
42096	Number of minutes where Upstream Throughput was tested
1336	Average downstream throughput
63%	% of tests where downstream throughput exceeded 1 Mbps
92%	% of tests where downstream throughput exceeded 256 Kbps
669	Average upstream throughput
28%	% of tests where upstream throughput exceeded 1 Mbps
74%	% of tests where upstream throughput exceeded 256 Kbps

Chart 3 – Daily Availability Results



Requirement IIB: The network's ability to deliver packets between an end user device and the MetroFi Point of Presence (POP) in less than or equal to 100 milliseconds

The results of the Extended Availability Testing show that the network has the ability to deliver packets between Uptown Services' client device and the MetroFi Point of Presence (POP) in less than or equal to 100 milliseconds (i.e., a round trip ping time less than or equal to 200 ms) 89% of the time (37846 of 42610 minutes tested). These results are shown in Table 4 below.

Table 4 – Extended Availability Testing Ping Time Results

89%	Ping Time Availability
4764	Number of minutes where the average Ping Time was over 200 ms
42610	Number of minutes where at least 6 Ping Tests were tried

Requirement IIC: The network's ability to deliver at least one full speed connection (1Mbps downstream/256 upstream) at a distance of up to 250 feet from an access point

Analysis of the results of the throughput tests that were performed within 250 feet of an AP during the initial Coverage Testing shows that 92% (58 of 63) of the APs where at least two downstream and two upstream tests were performed delivered at least one full speed connection (1Mbps downstream/256 upstream). 74% (539of 730) of the downstream throughput tests met the downstream throughput requirement of 1 Mbps. 84% (517 of 614) of the upstream throughput tests met the upstream throughput requirement of 256 Kbps.

Requirement IID: The network's ability to provide a connection to at least 90% of the outdoor POC area

Analysis of the results the initial Coverage Testing combined with the results of the retesting of signal strength in the vicinity of 25 APs shows that the network provided an average signal strength meeting the City's minimum requirement of –79 dBm in 95% of the (2032 of 2147) locations in the POC area where an outdoor test for signal level was done within 500 ft of an AP.

The Combined Signal Strength Test Results in Table 5 below show the breakdown of 100 foot squares by average signal level for the combined initial and retest results. The GIS plots in Appendix II include the combined average signal levels overlaid on a map of the POC area.

Table 5 – Combined Signal Strength Test Results (Initial and Retest)

Plot	Range	Qty Sqs	Actual Min	Actual Max	Avg Sig	Min Tsts / Sq	Max Tsts / Sq	Avg Tsts / Sq	% Of All Sqs
0	No Signal Detected	56	-100.0	-94.2	-99.6	1	106	10.9	3%
1	-80 to -99 dBm	59	-93.9	-80.0	-85.3	1	159	16.2	3%
3	-60 to -79 dBm	883	-79.9	-60.0	-68.1	1	270	12.4	41%
5	-59 dBm & above	1149	-59.9	-31.0	-49.3	1	429	16.3	54%
		2147	Total Sqs						

The Initial Coverage Testing Statistics for the POC area in Table 6 below are calculated from the results from the results from the Initial Coverage Testing alone (i.e., they do not include results from the retesting). These statistics are based on averages for each 100-foot square that was tested. The city defined coverage to mean the percentage of the area where the signal level is at least -79 dBm so %Coverage is the percentage of the squares tested that had average signal level of at least -79 dBm. The Average Network Latency is calculated in 2 ways. The first calculation averages the ping time of only the pings that did not time out. The second calculation uses 1000 ms for the pings that timed out and calculates the overall average including the timeouts. The average downstream and upstream throughput values are the average of the average downstream and upstream throughput values for all of the 100-foot squares tested. The average packet loss is the average of the ping loss values for all of the 100-foot squares tested. The average downstream and upstream file loss values are the average of the downstream and upstream file loss values for all of the 100-foot squares tested.

Table 6 –Initial Coverage Testing Statistics

Overall Statistic	Value	Units	Notes
%Coverage	84%		Covered means RSSI is >= -79 dBm
AvgLatency1	296	ms	Avg of only the pings that did not time out
AvgLatency2	390	ms	Avg of all pings treating a timeout as 1000 ms
AvgDwnstrmThroughput	1154	Kbits/sec	
AvgUpstrmThroughput	573	Kbits/sec	
AvgPktLoss	30%		
AvgDwnstrmFileLoss	20%		
AvgUpstrmFileLoss	24%		

Tables 7 through 13 below show the number of 100 foot squares in each range for each of the performance measures from the results of the Initial Coverage Testing. The GIS plots in Appendix II show the results for each performance measure overlaid on a map of the POC area.

The Initial Signal Strength Test Results in Table 7 show the received signal strength indication (RSSI) reported by the Wifi card. The value for each 100-foot square is the average for the tests within that square. Squares where the Wifi card reported no signal was being detected are plotted separately.

Table 7 – Initial Signal Strength Test Results

Plot	Range	Qty Sqs	Actual Min	Actual Max	Avg Sig	Min Tsts / Sq	Max Tsts / Sq	Avg Tsts / Sq	% Of All Sqs
0	No Signal Detected	193	-100.0	-100.0	-100.0	1	85	10.4	9%
1	-80 to -99 dBm	139	-99.4	-79.1	-86.0	1	303	23.4	7%
3	-60 to -79 dBm	729	-79.0	-60.0	-68.6	1	359	17.5	35%
5	-59 dBm & above	998	-59.9	-33.2	-48.7	1	429	23.0	48%
		2059	Total Sqs						

The Packet Loss Test Results in Table 8 show the percentage of ping tests to MetroFi's ping host within each 100-foot square that did not receive a response within the 1-second timeout period.

Table 8 – Packet Loss Test Results

Plot	Range	Qty Sqs	Actual Min	Actual Max	Avg Packet Loss Rate	Min Tsts / Sq	Max Tsts / Sq	Avg Tsts / Sq	% Of All Sqs
0	100% Pkts Lost	439	100.0%	100.0%	100%	1	63	4.6	21%
1	51% to 99%	102	55.6%	97.8%	72%	3	138	11.8	5%
3	11% to 50%	347	10.5%	50.0%	30%	2	73	9.8	17%
5	<=10% Pkts Lost	1163	0.0%	10.0%	0%	1	195	10.4	57%
		2051	Total Sqs						

The Ping Time Test Results in Table 9 show the time (in ms) that it takes for a ping test packet to reach MetroFi's ping host and return to the client PC. The value for each 100-foot square is the average for the tests within that square. Squares where the ping loss is 50% or higher are plotted separately since the ping time does not mean a great deal when more than half the packets are lost.

Table 9 – Ping Time Test Results

Plot	Range	Qty Sqs	Actual Min	Actual Max	Avg Packet Loss Rate	Min Tsts / Sq	Max Tsts / Sq	Avg Tsts / Sq	% Of All Sqs
0	>=50% Pkt Loss	608	9.0	1000.0	90%	1	138	5.8	30%
1	301 ms & above	171	302.5	795.8	26%	1	73	9.5	8%
3	101 to 300 ms	260	100.3	297.4	9%	1	122	10.8	13%
5	100 ms & below	1012	7.0	99.5	1%	1	195	10.6	49%
		2051	Total Sqs						

The Downstream File Loss Test Results in Table 10 show the percentage of attempts to retrieve a 200 Kbyte file from MetroFi's http host within each 100 foot square that were not successful in getting the file within the 20 second timeout period.

Table 10 – Downstream File Loss Test Results

Plot	Range	Qty Sqs	Actual Min	Actual Max	Avg File Loss Rate	Min Tsts / Sq	Max Tsts / Sq	Avg Tsts / Sq	% Of All Sqs
0	100% Tests Failed	173	100.0%	100.0%	100%	1	5	1.4	17%
1	51% to 99%	8	66.7%	83.3%	71%	3	14	5.4	1%
3	11% to 50%	60	11.1%	50.0%	41%	2	9	3.2	6%
5	<=10% Tsts Failed	793	0.0%	10.0%	0%	1	21	1.9	77%
		1034	Total Sqs						

The Downstream File Throughput Test Results in Table 11 show the downstream throughput (in kbits/s) for retrieving a file from MetroFi's http host to the client PC. The value for each 100-foot square is the average for the tests within that square. Squares where the file loss is 50% or higher are plotted separately since the throughput means little in that case.

Table 11 – Downstream File Throughput Test Results

Plot	Range	Qty Sqs	Actual Min	Actual Max	Avg File Loss Rate	Min Tsts / Sq	Max Tsts / Sq	Avg Tsts / Sq	% Of All Sqs
0	>50% Tests Failed	181	0.0	923.3	99%	1	14	1.6	18%
1	< 256 kbits/s	54	0.0	252.0	6%	1	5	1.4	5%
3	256 to 999 kbits/s	239	260.0	999.0	6%	1	13	1.8	23%
5	1000 kbits/s & over	560	1000.0	4654.0	1%	1	21	2.1	54%
		1034	Total Sqs						

The Upstream File Loss Test Results in Table 12 show the percentage of attempts to send a 100 Kbyte file to MetroFi's ftp host within each 100 foot square that were not successful in sending the file within the 20 second timeout period.

Table 12 – Upstream File Loss Test Results

Plot	Range	Qty Sqs	Actual Min	Actual Max	Avg File Loss Rate	Min Tsts / Sq	Max Tsts / Sq	Avg Tsts / Sq	% Of All Sqs
0	100% Tests Failed	177	100.0%	100.0%	100%	1	6	1.4	20%
1	51% to 99%	8	60.0%	75.0%	67%	3	13	4.6	1%
3	11% to 50%	75	12.5%	50.0%	39%	2	9	3.5	9%
5	<=10% Tsts Failed	618	0.0%	7.7%	0%	1	19	1.7	70%
		878	Total Sqs						

The Upstream File Throughput Test Results in Table 13 show the upstream throughput (in kbits/s) for sending a file to MetroFi's FTP host from the client PC. The value for each 100-foot square is the average for the tests within that square. Squares where the file loss is 50% or higher are plotted separately since the throughput does not mean a great deal in that case.

Table 13 – Upstream File Throughput Test Results

Plot	Range	Qty Sqs	Actual Min	Actual Max	Avg File Loss Rate	Min Tsts / Sq	Max Tsts / Sq	Avg Tsts / Sq	% Of All Sqs
0	>50% Tests Failed	185	0.0	667.3	99%	1	13	1.6	21%
1	< 64 kbits/s	35	8.0	59.0	10%	1	2	1.3	4%
3	64 to 255 kbits/s	68	68.0	255.0	2%	1	8	1.4	8%
5	256 kbits/s & over	590	260.5	2611.0	4%	1	19	2.0	67%
		878	Total Sqs						

Security Results

Requirement IIIA: The network's ability to support 802.11i; and

Requirement IIIB: The network's ability to support multiple SSIDs, including non-broadcast SSIDs

The POC Network supports 802.11i by requiring users to authenticate using the WPA2 security protocol in order to gain access to the second SSID supported by the network (MetroFi-Premium) so these two requirements were tested together. The network did not have a non-broadcast SSID enabled at the time Uptown Services did its testing so that requirement could not be tested.

Initially, all attempts to establish a connection to the MetroFi-Premium network were unsuccessful. Attempts were made with three different wifi devices and their connection managers. MetroFi was contacted to get help with the problem and they sent me a setup guide that they normally provide to customers of the MetroFi-Premium network. Following the directions in the setup guide, a connection to the AP was established but the connection to the network was not complete, the browser could not connect to any servers, and no ping tests were

successful. After further troubleshooting with the help of MetroFi, a functioning connection to the network was established. It is unknown what if anything MetroFi did on the network side to make the connection possible but it simply started working after one of the times the laptop was restarted.

A good connection with downstream throughput of at least 1000 Kbps was established at the 12 APs with the MAC addresses listed below. This confirmed that the network supports both 802.11i security and at least two SSIDs.

- 00:0A:DB:01:91:21
- 00:0A:DB:01:CC:01
- 00:0A:DB:03:49:21
- 00:0A:DB:01:9E:41
- 00:0A:DB:01:E7:C1
- 00:0A:DB:03:7C:C1
- 00:0A:DB:01:A7:21
- 00:0A:DB:01:EE:81
- 00:0A:DB:03:82:41
- 00:0A:DB:01:C6:41
- 00:0A:DB:03:41:01
- 00:0A:DB:03:C4:C1

Signal Booster Testing Results

The network's ability to meet the performance requirements within the Throughput and Availability categories listed above both without a signal booster and with MetroFi's recommended signal booster

Figures 4, 5 and 6 below are geographic plots of the performance in 20-foot squares of the Wifi card with the external antenna (labeled STD) compared to the Ruckus Metroflex signal booster (labeled RCKS). The performance measures shown are Ping Loss, Ping Time (a.k.a., latency), and Downstream Throughput. These figures show that the performance was slightly better with the external antenna at long distances with a clear line of sight to the AP and the performance was slightly better with the Ruckus when there were obstacles between the AP and the location of the test. Otherwise the performance of the two test configurations appears to be roughly the same.

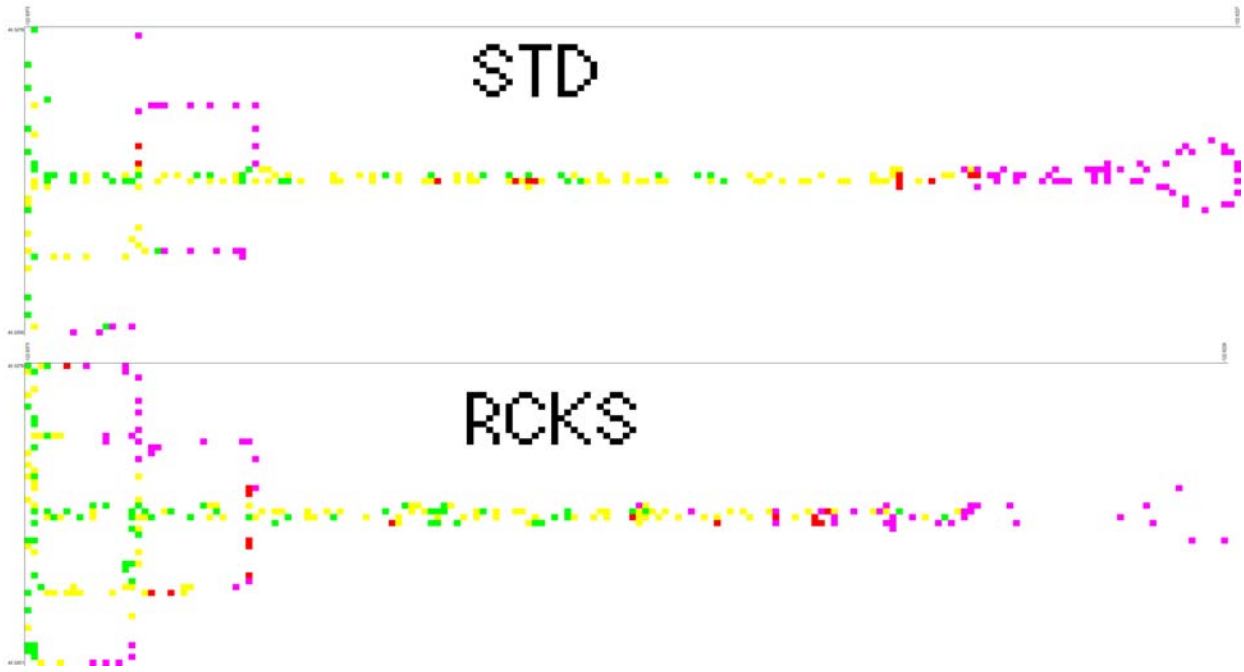
Figure 4 – Signal Booster Comparison Testing- P1 Ping Loss

Ping Loss Legend: Violet=100% loss; Red=51% to 99% loss; Yellow=11% to 50% loss; Green=10% or less loss.

Figure 5 – Signal Booster Comparison Testing - P1 Ping Time

Ping Time Legend: Violet => 50% packet loss; Red => 300 ms; Yellow = 101 to 300 ms; Green = 100 ms or less.

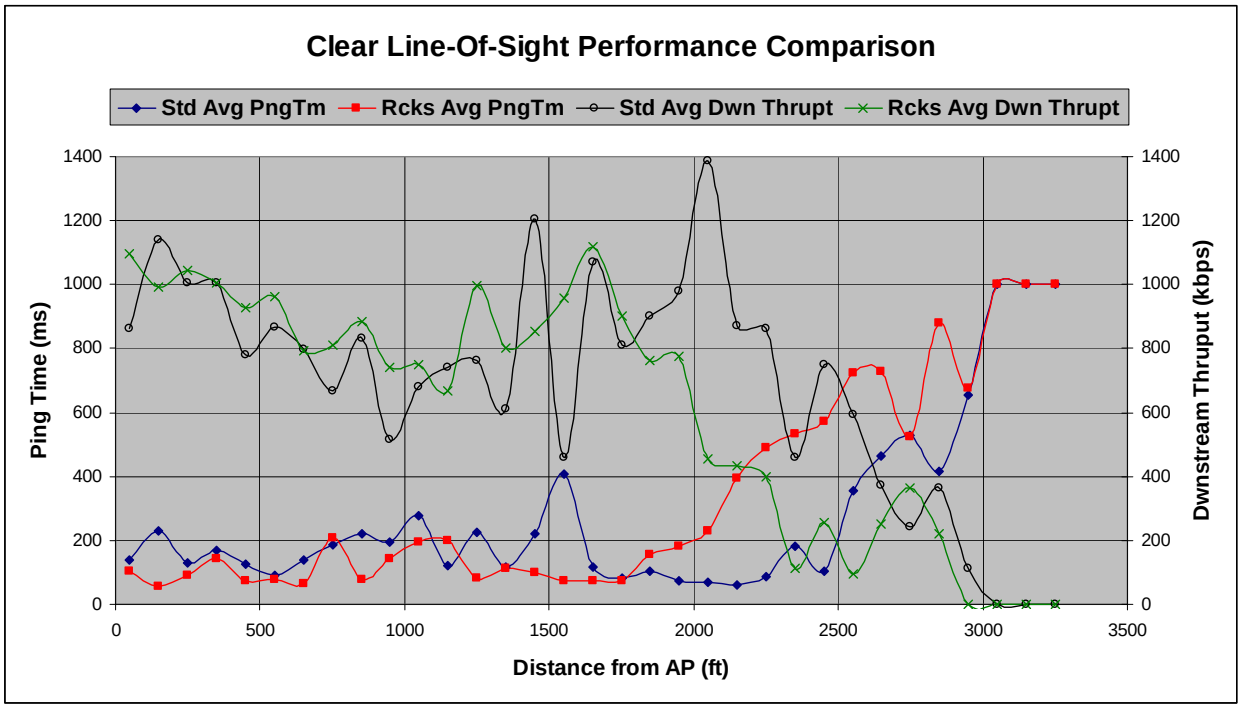
Figure 6 – Signal Booster Comparison Testing – Downstream Throughput



Downstream Throughput Legend: Violet =>50% tests failed; Red = <256 kbps; Yellow = 256 to 999 kbps; Green = 1000 kbps or more

Chart 4 shows a numerical comparison of the clear line-of-sight performance of the two test configurations as a function of the distance from the AP. For this chart, only the tests along Glisan were used. The tests were grouped in 100 ft intervals of the distance from the AP (i.e., 0 to 100ft, 100 to 200ft, etc.) for each configuration. Then the average ping time and the average downstream throughput for each group were calculated and plotted for both configurations. This chart also shows there is not much difference in performance between the two configurations.

Chart 4 – Clear Line of Sight Results for Signal Booster Testing



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Appendix I

Hour-By-Hour Availability

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
02/27/07 09:00	1	12	0	12	1	12	0	12
02/27/07 10:00	1	60	0	60	1	60	2	60
02/27/07 11:00	3	60	0	60	3	59	1	60
02/27/07 12:00	2	60	1	60	1	59	7	60
02/27/07 13:00	8	60	0	60	8	58	14	60
02/27/07 14:00	9	60	0	60	9	60	5	60
02/27/07 15:00	11	60	0	60	11	59	13	60
02/27/07 16:00	28	60	13	60	27	57	23	60
02/27/07 17:00	25	60	16	60	25	60	22	60
02/27/07 18:00	1	60	0	60	1	60	1	60
02/27/07 19:00	1	60	0	60	1	60	3	60
02/27/07 20:00	0	60	0	60	0	60	0	60
02/27/07 21:00	7	60	6	60	7	60	8	60
02/27/07 22:00	1	60	0	60	1	60	0	60
02/27/07 23:00	0	60	0	60	0	60	0	60
02/28/07 00:00	20	60	20	60	19	60	24	60
02/28/07 01:00	22	60	22	60	21	60	22	60
02/28/07 02:00	9	60	9	60	9	59	12	60
02/28/07 03:00	18	60	14	60	14	58	24	60
02/28/07 04:00	22	60	22	60	21	60	23	60
02/28/07 05:00	60	60	60	60	60	60	60	60
02/28/07 06:00	60	60	60	60	60	60	60	60
02/28/07 07:00	60	60	60	60	60	60	60	60
02/28/07 08:00	17	60	11	60	17	58	15	60
02/28/07 09:00	23	60	17	60	23	60	23	60
02/28/07 10:00	9	60	0	60	9	60	3	60
02/28/07 11:00	13	60	0	60	13	53	12	60
02/28/07 12:00	36	60	0	60	36	54	13	60
02/28/07 13:00	18	60	0	60	18	59	14	60
02/28/07 14:00	12	60	0	60	12	57	6	60
02/28/07 15:00	17	60	0	60	17	60	3	60
02/28/07 16:00	18	60	11	60	18	59	16	60
02/28/07 17:00	11	60	8	60	11	60	13	60
02/28/07 18:00	0	60	0	60	0	60	1	60
02/28/07 19:00	10	60	10	60	10	60	15	60
02/28/07 20:00	0	60	0	60	0	60	5	60
02/28/07 21:00	19	60	14	60	19	60	17	60
02/28/07 22:00	7	60	7	60	7	60	8	60
02/28/07 23:00	0	60	0	60	0	60	2	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/01/07 00:00	0	60	0	60	0	60	0	60
03/01/07 01:00	0	60	0	60	0	60	5	60
03/01/07 02:00	0	60	0	60	0	60	3	60
03/01/07 03:00	0	60	0	60	0	60	0	60
03/01/07 04:00	18	60	18	60	18	60	19	60
03/01/07 05:00	39	60	38	60	37	60	38	60
03/01/07 06:00	12	60	11	60	12	60	13	60
03/01/07 07:00	60	60	60	60	60	60	60	60
03/01/07 08:00	12	60	12	60	11	60	12	60
03/01/07 09:00	0	60	0	60	0	60	0	60
03/01/07 10:00	2	60	0	60	2	60	0	60
03/01/07 11:00	0	60	0	60	0	60	0	60
03/01/07 12:00	0	60	0	60	0	60	0	60
03/01/07 13:00	0	60	0	60	0	60	3	60
03/01/07 14:00	0	60	0	60	0	60	1	60
03/01/07 15:00	0	60	0	60	0	60	0	60
03/01/07 16:00	17	60	17	60	17	60	19	60
03/01/07 17:00	2	60	2	60	2	60	2	60
03/01/07 18:00	0	60	0	60	0	60	1	60
03/01/07 19:00	31	60	31	60	31	60	32	60
03/01/07 20:00	60	60	60	60	60	60	60	60
03/01/07 21:00	19	60	19	60	19	60	20	60
03/01/07 22:00	8	60	8	60	8	60	11	60
03/01/07 23:00	0	60	0	60	0	60	0	60
03/02/07 00:00	0	60	0	60	0	60	0	60
03/02/07 01:00	5	60	5	60	4	60	7	60
03/02/07 02:00	0	60	0	60	0	60	0	60
03/02/07 03:00	0	60	0	60	0	60	0	60
03/02/07 04:00	32	60	32	60	31	60	34	60
03/02/07 05:00	26	60	26	60	26	60	27	60
03/02/07 06:00	18	60	18	60	18	60	18	60
03/02/07 07:00	47	60	47	60	45	60	48	60
03/02/07 08:00	0	60	0	60	0	60	1	60
03/02/07 09:00	0	60	0	60	0	60	0	60
03/02/07 10:00	0	60	0	60	0	60	2	60
03/02/07 11:00	0	60	0	60	0	60	0	60
03/02/07 12:00	0	60	0	60	0	60	0	60
03/02/07 13:00	3	60	0	60	3	60	13	60
03/02/07 14:00	2	60	1	60	2	60	9	60
03/02/07 15:00	4	60	3	60	3	60	4	60
03/02/07 16:00	12	60	11	60	10	60	12	60
03/02/07 17:00	0	60	0	60	0	60	0	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/02/07 18:00	0	60	0	60	0	60	0	60
03/02/07 19:00	5	60	5	60	4	60	6	60
03/02/07 20:00	0	60	0	60	0	60	0	60
03/02/07 21:00	0	60	0	60	0	60	0	60
03/02/07 22:00	6	60	6	60	5	60	7	60
03/02/07 23:00	0	60	0	60	0	60	0	60
03/03/07 00:00	6	60	6	60	6	60	7	60
03/03/07 01:00	5	60	5	60	5	60	8	60
03/03/07 02:00	5	60	4	60	5	60	5	60
03/03/07 03:00	0	60	0	60	0	60	0	60
03/03/07 04:00	31	60	31	60	31	60	32	60
03/03/07 05:00	18	60	17	60	18	60	18	60
03/03/07 06:00	18	60	17	60	18	60	18	60
03/03/07 07:00	38	60	38	60	38	60	38	60
03/03/07 08:00	0	60	0	60	0	60	0	60
03/03/07 09:00	0	60	0	60	0	60	0	60
03/03/07 10:00	0	60	0	60	0	60	0	60
03/03/07 11:00	0	60	0	60	0	60	0	60
03/03/07 12:00	0	60	0	60	0	60	0	60
03/03/07 13:00	1	60	0	60	1	60	0	60
03/03/07 14:00	0	60	0	60	0	60	0	60
03/03/07 15:00	0	60	0	60	0	60	0	60
03/03/07 16:00	12	60	11	60	10	60	12	60
03/03/07 17:00	0	60	0	60	0	60	0	60
03/03/07 18:00	0	60	0	60	0	60	0	60
03/03/07 19:00	0	60	0	60	0	60	0	60
03/03/07 20:00	0	60	0	60	0	60	0	60
03/03/07 21:00	0	60	0	60	0	60	0	60
03/03/07 22:00	1	60	0	60	1	60	1	60
03/03/07 23:00	0	60	0	60	0	60	0	60
03/04/07 00:00	0	60	0	60	0	60	3	60
03/04/07 01:00	0	60	0	60	0	60	0	60
03/04/07 02:00	0	60	0	60	0	60	4	60
03/04/07 03:00	1	60	0	60	1	60	1	60
03/04/07 04:00	36	60	33	60	36	60	37	60
03/04/07 05:00	13	60	13	60	12	60	13	60
03/04/07 06:00	23	60	23	60	23	60	24	60
03/04/07 07:00	58	60	58	60	57	60	58	60
03/04/07 08:00	0	60	0	60	0	60	0	60
03/04/07 09:00	0	60	0	60	0	60	0	60
03/04/07 10:00	0	60	0	60	0	60	0	60
03/04/07 11:00	0	60	0	60	0	60	0	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/04/07 12:00	0	60	0	60	0	60	0	60
03/04/07 13:00	0	60	0	60	0	60	0	60
03/04/07 14:00	0	60	0	60	0	60	0	60
03/04/07 15:00	0	60	0	60	0	60	0	60
03/04/07 16:00	6	60	6	60	6	60	8	60
03/04/07 17:00	0	60	0	60	0	60	0	60
03/04/07 18:00	0	60	0	60	0	60	0	60
03/04/07 19:00	13	60	9	60	13	60	14	60
03/04/07 20:00	1	60	0	60	1	60	1	60
03/04/07 21:00	6	60	6	60	6	59	8	60
03/04/07 22:00	3	60	3	60	3	58	4	60
03/04/07 23:00	3	60	0	60	3	60	1	60
03/05/07 00:00	11	60	10	60	10	60	11	60
03/05/07 01:00	1	60	0	60	1	60	2	60
03/05/07 02:00	0	60	0	60	0	60	0	60
03/05/07 03:00	0	60	0	60	0	60	0	60
03/05/07 04:00	26	60	25	60	25	60	26	60
03/05/07 05:00	2	60	1	60	1	60	2	60
03/05/07 06:00	28	60	27	60	28	60	28	60
03/05/07 07:00	55	60	55	60	55	60	55	60
03/05/07 08:00	0	60	0	60	0	60	0	60
03/05/07 09:00	0	60	0	60	0	60	0	60
03/05/07 10:00	2	60	0	60	2	60	1	60
03/05/07 11:00	0	60	0	60	0	60	0	60
03/05/07 12:00	0	60	0	60	0	60	0	60
03/05/07 13:00	19	60	19	60	19	60	25	60
03/05/07 14:00	0	60	0	60	0	60	0	60
03/05/07 15:00	0	60	0	60	0	60	2	60
03/05/07 16:00	0	60	0	60	0	60	0	60
03/05/07 17:00	0	60	0	60	0	60	0	60
03/05/07 18:00	1	60	0	60	1	58	5	60
03/05/07 19:00	11	60	0	60	11	59	6	60
03/05/07 20:00	0	60	0	60	0	60	0	60
03/05/07 21:00	0	60	0	60	0	60	0	60
03/05/07 22:00	0	60	0	60	0	60	0	60
03/05/07 23:00	0	60	0	60	0	60	2	60
03/06/07 00:00	9	60	9	60	9	60	10	60
03/06/07 01:00	11	60	11	60	11	60	13	60
03/06/07 02:00	0	60	0	60	0	60	0	60
03/06/07 03:00	0	60	0	60	0	60	0	60
03/06/07 04:00	47	60	47	60	47	60	47	60
03/06/07 05:00	24	60	24	60	24	60	24	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/06/07 06:00	32	60	32	60	32	60	32	60
03/06/07 07:00	51	60	51	60	51	60	51	60
03/06/07 08:00	0	60	0	60	0	60	0	60
03/06/07 09:00	1	60	0	60	1	60	3	60
03/06/07 10:00	1	60	0	60	1	60	4	60
03/06/07 11:00	0	60	0	60	0	60	2	60
03/06/07 12:00	0	60	0	60	0	60	3	60
03/06/07 13:00	20	60	20	60	20	60	22	60
03/06/07 14:00	0	60	0	60	0	60	0	60
03/06/07 15:00	0	60	0	60	0	60	1	60
03/06/07 16:00	4	60	4	60	4	60	7	60
03/06/07 17:00	0	60	0	60	0	60	0	60
03/06/07 18:00	8	60	1	60	7	56	10	60
03/06/07 19:00	7	60	5	60	7	60	10	60
03/06/07 20:00	0	60	0	60	0	60	0	60
03/06/07 21:00	0	60	0	60	0	60	0	60
03/06/07 22:00	1	60	0	60	1	60	0	60
03/06/07 23:00	0	60	0	60	0	60	1	60
03/07/07 00:00	0	60	0	60	0	60	0	60
03/07/07 01:00	0	60	0	60	0	60	0	60
03/07/07 02:00	0	60	0	60	0	60	0	60
03/07/07 03:00	0	60	0	60	0	60	0	60
03/07/07 04:00	17	60	17	60	16	60	18	60
03/07/07 05:00	0	60	0	60	0	60	0	60
03/07/07 06:00	36	60	36	60	36	60	37	60
03/07/07 07:00	18	60	18	60	18	60	18	60
03/07/07 08:00	3	59	3	59	1	55	8	60
03/07/07 09:00	1	60	1	60	0	59	4	60
03/07/07 10:00	0	60	0	60	0	59	5	60
03/07/07 11:00	22	60	0	60	22	58	19	60
03/07/07 12:00	0	60	0	60	0	60	1	60
03/07/07 13:00	0	60	0	60	0	60	0	60
03/07/07 14:00	8	60	8	60	8	60	8	60
03/07/07 15:00	0	60	0	60	0	60	2	60
03/07/07 16:00	7	60	6	60	7	60	9	60
03/07/07 17:00	0	60	0	60	0	60	0	60
03/07/07 18:00	0	60	0	60	0	60	0	60
03/07/07 19:00	0	60	0	60	0	60	0	60
03/07/07 20:00	0	60	0	60	0	60	0	60
03/07/07 21:00	0	60	0	60	0	60	0	60
03/07/07 22:00	0	60	0	60	0	60	0	60
03/07/07 23:00	0	60	0	60	0	60	0	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/08/07 00:00	0	60	0	60	0	60	1	60
03/08/07 01:00	0	60	0	60	0	60	0	60
03/08/07 02:00	0	60	0	60	0	60	0	60
03/08/07 03:00	0	60	0	60	0	60	0	60
03/08/07 04:00	30	60	29	60	30	60	31	60
03/08/07 05:00	0	60	0	60	0	60	0	60
03/08/07 06:00	41	60	41	60	41	60	41	60
03/08/07 07:00	13	60	13	60	13	60	13	60
03/08/07 08:00	0	60	0	60	0	60	0	60
03/08/07 09:00	0	60	0	60	0	60	0	60
03/08/07 10:00	0	60	0	60	0	60	0	60
03/08/07 11:00	0	60	0	60	0	60	1	60
03/08/07 12:00	1	60	0	60	1	60	0	60
03/08/07 13:00	0	60	0	60	0	60	0	60
03/08/07 14:00	0	60	0	60	0	60	3	60
03/08/07 15:00	0	60	0	60	0	60	9	60
03/08/07 16:00	13	60	13	60	11	60	15	60
03/08/07 17:00	0	60	0	60	0	60	0	60
03/08/07 18:00	1	60	0	60	1	60	0	60
03/08/07 19:00	0	60	0	60	0	60	0	60
03/08/07 20:00	0	60	0	60	0	60	0	60
03/08/07 21:00	0	60	0	60	0	60	2	60
03/08/07 22:00	1	60	0	60	1	60	2	60
03/08/07 23:00	0	60	0	60	0	60	2	60
03/09/07 00:00	0	60	0	60	0	60	4	60
03/09/07 01:00	19	60	0	60	19	60	0	60
03/09/07 02:00	11	60	0	60	11	60	1	60
03/09/07 03:00	0	60	0	60	0	60	0	60
03/09/07 04:00	0	60	0	60	0	60	16	60
03/09/07 05:00	0	60	0	60	0	60	0	60
03/09/07 06:00	8	60	0	60	8	53	11	60
03/09/07 07:00	4	59	0	59	4	57	12	60
03/09/07 08:00	0	60	0	60	0	60	1	60
03/09/07 09:00	3	60	3	60	3	60	5	60
03/09/07 10:00	0	60	0	60	0	60	0	60
03/09/07 11:00	3	60	1	60	3	60	6	60
03/09/07 12:00	0	60	0	60	0	60	6	60
03/09/07 13:00	4	60	0	60	4	59	13	60
03/09/07 14:00	0	60	0	60	0	60	1	60
03/09/07 15:00	0	60	0	60	0	60	3	60
03/09/07 16:00	0	60	0	60	0	60	0	60
03/09/07 17:00	0	60	0	60	0	60	9	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/09/07 18:00	0	60	0	60	0	60	1	60
03/09/07 19:00	0	60	0	60	0	60	1	60
03/09/07 20:00	5	60	0	60	5	60	7	60
03/09/07 21:00	1	60	0	60	1	60	11	60
03/09/07 22:00	0	60	0	60	0	60	3	60
03/09/07 23:00	0	60	0	60	0	60	0	60
03/10/07 00:00	21	60	0	60	21	59	2	60
03/10/07 01:00	17	60	0	60	17	53	14	60
03/10/07 02:00	10	60	0	60	10	59	12	60
03/10/07 03:00	13	60	0	60	13	59	11	60
03/10/07 04:00	32	60	21	59	23	51	54	60
03/10/07 05:00	5	60	0	60	5	60	57	60
03/10/07 06:00	1	60	0	60	1	60	35	60
03/10/07 07:00	0	60	0	60	0	60	13	60
03/10/07 08:00	0	60	0	60	0	60	0	60
03/10/07 09:00	0	60	0	60	0	60	4	60
03/10/07 10:00	0	60	0	60	0	60	1	60
03/10/07 11:00	0	60	0	60	0	60	6	60
03/10/07 12:00	0	60	0	60	0	60	4	60
03/10/07 13:00	0	60	0	60	0	60	0	60
03/10/07 14:00	0	60	0	60	0	60	0	60
03/10/07 15:00	0	60	0	60	0	60	1	60
03/10/07 16:00	0	60	0	60	0	60	0	60
03/10/07 17:00	0	60	0	60	0	60	0	60
03/10/07 18:00	0	60	0	60	0	60	0	60
03/10/07 19:00	1	60	0	60	1	60	2	60
03/10/07 20:00	0	60	0	60	0	60	6	60
03/10/07 21:00	0	60	0	60	0	60	0	60
03/10/07 22:00	0	60	0	60	0	60	0	60
03/10/07 23:00	0	60	0	60	0	60	0	60
03/11/07 00:00	4	60	0	60	4	60	6	60
03/11/07 01:00	27	60	0	60	27	60	13	60
03/11/07 02:00	25	60	0	60	25	55	25	60
03/11/07 03:00	3	60	0	60	3	60	11	60
03/11/07 04:00	0	60	0	60	0	60	35	60
03/11/07 05:00	0	60	0	60	0	60	43	60
03/11/07 06:00	0	60	0	60	0	60	35	60
03/11/07 07:00	0	60	0	60	0	60	0	60
03/11/07 08:00	0	60	0	60	0	60	0	60
03/11/07 09:00	0	60	0	60	0	60	0	60
03/11/07 10:00	0	60	0	60	0	60	0	60
03/11/07 11:00	1	60	0	60	1	59	1	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/11/07 12:00	0	60	0	60	0	60	1	60
03/11/07 13:00	0	60	0	60	0	60	0	60
03/11/07 14:00	0	60	0	60	0	60	1	60
03/11/07 15:00	0	60	0	60	0	60	0	60
03/11/07 16:00	2	60	0	60	2	60	4	60
03/11/07 17:00	0	60	0	60	0	60	0	60
03/11/07 18:00	1	60	0	60	1	60	3	60
03/11/07 19:00	0	60	0	60	0	60	0	60
03/11/07 20:00	0	60	0	60	0	60	1	60
03/11/07 21:00	0	60	0	60	0	60	0	60
03/11/07 22:00	0	60	0	60	0	60	3	60
03/11/07 23:00	0	60	0	60	0	60	0	60
03/12/07 00:00	25	60	0	60	25	58	15	60
03/12/07 01:00	11	60	0	60	11	60	3	60
03/12/07 02:00	0	60	0	60	0	60	0	60
03/12/07 03:00	0	60	0	60	0	60	0	60
03/12/07 04:00	0	60	0	60	0	60	29	60
03/12/07 05:00	2	60	0	60	2	60	46	60
03/12/07 06:00	0	60	0	60	0	60	45	60
03/12/07 07:00	0	60	0	60	0	60	1	60
03/12/07 08:00	0	60	0	60	0	60	0	60
03/12/07 09:00	0	60	0	60	0	59	3	60
03/12/07 10:00	0	60	0	60	0	60	6	60
03/12/07 11:00	1	60	0	60	1	60	2	60
03/12/07 12:00	2	60	1	60	1	60	5	60
03/12/07 13:00	0	60	0	60	0	60	0	60
03/12/07 14:00	2	59	0	59	2	59	2	60
03/12/07 15:00	0	60	0	60	0	60	0	60
03/12/07 16:00	0	60	0	60	0	60	10	60
03/12/07 17:00	0	60	0	60	0	60	2	60
03/12/07 18:00	0	60	0	59	0	60	4	60
03/12/07 19:00	0	60	0	60	0	60	1	60
03/12/07 20:00	0	60	0	60	0	60	1	60
03/12/07 21:00	0	60	0	60	0	60	0	60
03/12/07 22:00	0	60	0	60	0	60	0	60
03/12/07 23:00	0	60	0	60	0	60	0	60
03/13/07 00:00	14	60	0	60	14	58	4	60
03/13/07 01:00	35	60	0	60	35	59	9	60
03/13/07 02:00	8	60	0	60	8	60	1	60
03/13/07 03:00	0	60	0	60	0	60	0	60
03/13/07 04:00	0	60	0	60	0	60	14	60
03/13/07 05:00	0	60	0	59	0	60	35	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/13/07 06:00	0	60	0	60	0	60	19	60
03/13/07 07:00	0	60	0	60	0	60	1	60
03/13/07 08:00	5	60	5	60	4	60	7	60
03/13/07 09:00	0	60	0	60	0	60	0	60
03/13/07 10:00	19	60	19	60	18	59	23	60
03/13/07 11:00	0	60	0	60	0	60	0	60
03/13/07 12:00	0	60	0	60	0	60	8	60
03/13/07 13:00	0	60	0	60	0	60	2	60
03/13/07 14:00	0	60	0	60	0	60	0	60
03/13/07 15:00	0	60	0	60	0	60	6	60
03/13/07 16:00	0	60	0	60	0	60	0	60
03/13/07 17:00	0	60	0	60	0	60	1	60
03/13/07 18:00	0	60	0	60	0	59	0	60
03/13/07 19:00	0	60	0	60	0	60	0	60
03/13/07 20:00	0	60	0	60	0	60	0	60
03/13/07 21:00	0	60	0	60	0	60	0	60
03/13/07 22:00	0	60	0	60	0	60	0	60
03/13/07 23:00	0	60	0	60	0	60	0	60
03/14/07 00:00	4	60	0	60	4	60	2	60
03/14/07 01:00	0	60	0	60	0	60	2	60
03/14/07 02:00	0	60	0	60	0	60	0	60
03/14/07 03:00	0	60	0	60	0	60	0	60
03/14/07 04:00	0	60	0	60	0	60	11	60
03/14/07 05:00	0	60	0	60	0	60	31	60
03/14/07 06:00	0	60	0	60	0	60	12	60
03/14/07 07:00	0	60	0	60	0	60	0	60
03/14/07 08:00	0	60	0	60	0	60	3	60
03/14/07 09:00	0	60	0	60	0	60	4	60
03/14/07 10:00	0	60	0	60	0	60	1	60
03/14/07 11:00	0	60	0	60	0	60	2	60
03/14/07 12:00	0	60	0	60	0	60	0	60
03/14/07 13:00	0	60	0	60	0	60	5	60
03/14/07 14:00	0	60	0	60	0	60	0	60
03/14/07 15:00	0	60	0	60	0	60	0	60
03/14/07 16:00	0	60	0	60	0	60	0	60
03/14/07 17:00	0	60	0	60	0	60	0	60
03/14/07 18:00	0	59	0	59	0	59	0	59
03/14/07 19:00	0	60	0	60	0	60	0	60
03/14/07 20:00	0	60	0	60	0	60	0	60
03/14/07 21:00	0	60	0	60	0	60	1	60
03/14/07 22:00	0	60	0	60	0	60	0	60
03/14/07 23:00	0	60	0	60	0	60	0	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/15/07 00:00	0	60	0	60	0	60	0	60
03/15/07 01:00	7	60	0	60	7	60	1	60
03/15/07 02:00	0	60	0	60	0	60	1	60
03/15/07 03:00	0	60	0	60	0	60	0	60
03/15/07 04:00	1	60	0	60	1	60	0	60
03/15/07 05:00	0	60	0	60	0	60	1	60
03/15/07 06:00	0	60	0	60	0	60	6	60
03/15/07 07:00	3	60	3	60	2	60	4	60
03/15/07 08:00	0	60	0	60	0	60	1	60
03/15/07 09:00	5	60	3	60	4	59	5	60
03/15/07 10:00	0	60	0	60	0	60	0	60
03/15/07 11:00	0	60	0	60	0	60	0	60
03/15/07 12:00	0	60	0	60	0	60	0	60
03/15/07 13:00	0	60	0	60	0	60	0	60
03/15/07 14:00	0	60	0	60	0	60	1	60
03/15/07 15:00	0	60	0	60	0	60	4	60
03/15/07 16:00	0	60	0	60	0	60	2	60
03/15/07 17:00	0	60	0	60	0	60	6	60
03/15/07 18:00	0	60	0	60	0	60	1	60
03/15/07 19:00	0	60	0	60	0	60	1	60
03/15/07 20:00	0	60	0	60	0	59	2	60
03/15/07 21:00	0	60	0	60	0	60	1	60
03/15/07 22:00	0	60	0	60	0	60	1	60
03/15/07 23:00	4	60	0	60	4	60	0	60
03/16/07 00:00	23	60	0	60	23	58	9	60
03/16/07 01:00	2	60	0	60	2	58	2	60
03/16/07 02:00	0	60	0	60	0	60	1	60
03/16/07 03:00	0	60	0	60	0	60	4	60
03/16/07 04:00	0	60	0	60	0	60	6	60
03/16/07 05:00	0	60	0	60	0	60	3	60
03/16/07 06:00	0	60	0	60	0	60	4	60
03/16/07 07:00	0	60	0	60	0	60	1	60
03/16/07 08:00	6	60	4	60	6	59	6	60
03/16/07 09:00	5	60	3	60	5	60	6	60
03/16/07 10:00	1	60	0	60	1	60	4	60
03/16/07 11:00	0	60	0	60	0	60	6	60
03/16/07 12:00	0	60	0	60	0	60	1	60
03/16/07 13:00	0	60	0	60	0	60	1	60
03/16/07 14:00	0	60	0	60	0	60	1	60
03/16/07 15:00	0	60	0	60	0	60	2	60
03/16/07 16:00	4	60	0	60	4	60	4	60
03/16/07 17:00	8	60	0	60	8	60	7	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/16/07 18:00	0	60	0	60	0	60	3	60
03/16/07 19:00	0	60	0	60	0	60	0	60
03/16/07 20:00	0	60	0	60	0	60	1	60
03/16/07 21:00	0	60	0	60	0	60	1	60
03/16/07 22:00	0	60	0	60	0	60	5	60
03/16/07 23:00	0	60	0	59	0	60	0	60
03/17/07 00:00	1	60	0	60	1	60	0	60
03/17/07 01:00	2	60	0	60	2	60	2	60
03/17/07 02:00	0	60	0	60	0	60	0	60
03/17/07 03:00	0	60	0	60	0	60	7	60
03/17/07 04:00	0	60	0	60	0	60	11	60
03/17/07 05:00	0	60	0	60	0	60	7	60
03/17/07 06:00	0	60	0	60	0	60	1	60
03/17/07 07:00	0	60	0	60	0	60	0	60
03/17/07 08:00	0	60	0	60	0	60	3	60
03/17/07 09:00	0	60	0	60	0	60	3	60
03/17/07 10:00	0	60	0	60	0	60	0	60
03/17/07 11:00	0	60	0	60	0	60	1	60
03/17/07 12:00	0	60	0	60	0	60	0	60
03/17/07 13:00	0	60	0	60	0	60	1	60
03/17/07 14:00	0	60	0	60	0	60	0	60
03/17/07 15:00	0	60	0	60	0	60	0	60
03/17/07 16:00	0	60	0	60	0	60	2	60
03/17/07 17:00	0	60	0	60	0	60	1	60
03/17/07 18:00	0	60	0	60	0	60	0	60
03/17/07 19:00	0	60	0	60	0	60	1	60
03/17/07 20:00	0	60	0	60	0	60	1	60
03/17/07 21:00	0	60	0	60	0	60	0	60
03/17/07 22:00	0	60	0	60	0	60	2	60
03/17/07 23:00	7	60	0	60	7	60	0	60
03/18/07 00:00	21	60	0	60	21	60	12	60
03/18/07 01:00	0	60	0	60	0	60	0	60
03/18/07 02:00	0	60	0	60	0	60	1	60
03/18/07 03:00	0	60	0	60	0	60	0	60
03/18/07 04:00	0	60	0	60	0	60	15	60
03/18/07 05:00	0	60	0	60	0	60	1	60
03/18/07 06:00	0	60	0	60	0	60	16	60
03/18/07 07:00	0	60	0	60	0	60	0	60
03/18/07 08:00	0	60	0	60	0	60	4	60
03/18/07 09:00	0	60	0	60	0	60	1	60
03/18/07 10:00	0	60	0	60	0	60	0	60
03/18/07 11:00	0	60	0	60	0	60	0	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/18/07 12:00	0	60	0	60	0	60	0	60
03/18/07 13:00	0	60	0	60	0	60	0	60
03/18/07 14:00	0	60	0	60	0	60	0	60
03/18/07 15:00	0	60	0	60	0	60	0	60
03/18/07 16:00	0	60	0	60	0	60	0	60
03/18/07 17:00	0	60	0	60	0	60	0	60
03/18/07 18:00	0	60	0	60	0	60	1	60
03/18/07 19:00	1	60	0	60	1	60	0	60
03/18/07 20:00	0	60	0	60	0	60	2	60
03/18/07 21:00	1	60	0	60	1	60	5	60
03/18/07 22:00	0	60	0	60	0	60	0	60
03/18/07 23:00	1	60	0	60	1	60	1	60
03/19/07 00:00	5	60	0	60	5	60	11	60
03/19/07 01:00	14	60	0	60	14	60	15	60
03/19/07 02:00	1	60	0	60	1	60	1	60
03/19/07 03:00	0	60	0	60	0	60	1	60
03/19/07 04:00	0	60	0	60	0	60	3	60
03/19/07 05:00	0	60	0	60	0	60	1	60
03/19/07 06:00	0	60	0	60	0	60	12	60
03/19/07 07:00	0	60	0	60	0	60	0	60
03/19/07 08:00	0	60	0	60	0	60	1	60
03/19/07 09:00	0	60	0	60	0	60	3	60
03/19/07 10:00	0	60	0	60	0	60	6	60
03/19/07 11:00	0	60	0	60	0	60	1	60
03/19/07 12:00	1	60	0	60	1	60	2	60
03/19/07 13:00	0	60	0	60	0	60	0	60
03/19/07 14:00	0	60	0	60	0	60	2	60
03/19/07 15:00	0	60	0	60	0	60	2	60
03/19/07 16:00	0	60	0	60	0	60	1	60
03/19/07 17:00	0	60	0	60	0	60	1	60
03/19/07 18:00	0	60	0	60	0	60	0	60
03/19/07 19:00	0	60	0	60	0	60	0	60
03/19/07 20:00	0	60	0	60	0	60	3	60
03/19/07 21:00	0	60	0	60	0	60	2	60
03/19/07 22:00	0	60	0	60	0	60	1	60
03/19/07 23:00	3	60	0	60	3	60	0	60
03/20/07 00:00	19	60	0	60	19	60	5	60
03/20/07 01:00	15	60	0	60	15	59	0	60
03/20/07 02:00	1	60	0	60	1	60	0	60
03/20/07 03:00	0	60	0	60	0	60	12	60
03/20/07 04:00	0	60	0	60	0	60	0	60
03/20/07 05:00	0	60	0	60	0	60	6	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/20/07 06:00	0	60	0	60	0	60	33	60
03/20/07 07:00	3	60	0	60	3	60	2	60
03/20/07 08:00	0	60	0	60	0	60	0	60
03/20/07 09:00	0	60	0	60	0	59	1	60
03/20/07 10:00	0	60	0	60	0	60	0	60
03/20/07 11:00	0	60	0	60	0	60	2	60
03/20/07 12:00	0	60	0	60	0	60	1	60
03/20/07 13:00	0	60	0	60	0	60	0	60
03/20/07 14:00	0	60	0	60	0	60	3	60
03/20/07 15:00	1	60	0	60	1	60	1	60
03/20/07 16:00	0	60	0	60	0	60	1	60
03/20/07 17:00	0	60	0	60	0	60	0	60
03/20/07 18:00	0	60	0	60	0	60	1	60
03/20/07 19:00	0	60	0	60	0	60	0	60
03/20/07 20:00	0	60	0	60	0	60	0	60
03/20/07 21:00	0	60	0	60	0	59	7	60
03/20/07 22:00	0	60	0	60	0	60	1	60
03/20/07 23:00	1	60	0	60	1	60	2	60
03/21/07 00:00	36	60	1	60	36	50	17	60
03/21/07 01:00	4	60	0	60	4	60	0	60
03/21/07 02:00	1	60	0	60	1	60	0	60
03/21/07 03:00	0	60	0	60	0	60	0	60
03/21/07 04:00	9	60	9	60	9	60	11	60
03/21/07 05:00	15	60	15	60	14	60	17	60
03/21/07 06:00	0	60	0	60	0	60	10	60
03/21/07 07:00	0	60	0	60	0	60	0	60
03/21/07 08:00	2	60	1	60	2	60	6	60
03/21/07 09:00	0	60	0	60	0	60	2	60
03/21/07 10:00	1	60	0	60	1	59	0	60
03/21/07 11:00	0	60	0	60	0	60	0	60
03/21/07 12:00	0	60	0	60	0	60	0	60
03/21/07 13:00	1	60	0	60	1	60	3	60
03/21/07 14:00	0	60	0	60	0	60	3	60
03/21/07 15:00	7	60	7	60	7	60	8	60
03/21/07 16:00	1	60	0	60	1	60	0	60
03/21/07 17:00	0	60	0	60	0	60	0	60
03/21/07 18:00	0	60	0	60	0	60	0	60
03/21/07 19:00	0	60	0	60	0	60	0	60
03/21/07 20:00	0	60	0	60	0	60	0	60
03/21/07 21:00	0	60	0	60	0	60	1	60
03/21/07 22:00	0	60	0	60	0	60	0	60
03/21/07 23:00	20	60	0	60	20	47	12	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/22/07 00:00	22	60	1	60	21	32	26	60
03/22/07 01:00	0	60	0	60	0	60	0	60
03/22/07 02:00	0	60	0	60	0	60	1	60
03/22/07 03:00	0	60	0	60	0	60	0	60
03/22/07 04:00	0	60	0	60	0	60	5	60
03/22/07 05:00	0	60	0	60	0	60	0	60
03/22/07 06:00	0	60	0	60	0	60	7	60
03/22/07 07:00	3	60	3	59	3	60	4	60
03/22/07 08:00	3	60	2	60	3	60	5	60
03/22/07 09:00	2	60	0	60	2	60	0	60
03/22/07 10:00	0	60	0	60	0	60	1	60
03/22/07 11:00	1	60	0	60	1	60	1	60
03/22/07 12:00	0	60	0	60	0	60	0	60
03/22/07 13:00	6	60	6	60	6	60	8	60
03/22/07 14:00	0	60	0	60	0	60	0	60
03/22/07 15:00	0	60	0	60	0	60	1	60
03/22/07 16:00	2	60	2	59	1	59	6	60
03/22/07 17:00	0	60	0	60	0	60	0	60
03/22/07 18:00	0	60	0	60	0	60	1	60
03/22/07 19:00	0	60	0	60	0	60	0	60
03/22/07 20:00	0	60	0	60	0	60	0	60
03/22/07 21:00	2	60	0	60	2	59	5	60
03/22/07 22:00	0	60	0	60	0	60	2	60
03/22/07 23:00	0	60	0	60	0	60	1	60
03/23/07 00:00	22	60	0	60	22	37	40	60
03/23/07 01:00	18	60	0	60	18	58	1	60
03/23/07 02:00	0	60	0	60	0	60	0	60
03/23/07 03:00	0	60	0	60	0	60	0	60
03/23/07 04:00	0	60	0	60	0	60	9	60
03/23/07 05:00	0	60	0	60	0	60	0	60
03/23/07 06:00	0	60	0	60	0	60	0	60
03/23/07 07:00	0	60	0	60	0	60	0	60
03/23/07 08:00	0	60	0	60	0	60	0	60
03/23/07 09:00	1	60	0	60	1	60	0	60
03/23/07 10:00	0	60	0	60	0	60	1	60
03/23/07 11:00	0	60	0	60	0	60	1	60
03/23/07 12:00	0	60	0	60	0	60	6	60
03/23/07 13:00	1	60	0	60	1	60	1	60
03/23/07 14:00	2	60	0	60	2	60	0	60
03/23/07 15:00	2	60	0	60	2	60	3	60
03/23/07 16:00	0	60	0	60	0	60	2	60
03/23/07 17:00	0	60	0	60	0	60	1	60

Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/23/07 18:00	0	60	0	60	0	60	1	60
03/23/07 19:00	0	60	0	60	0	60	0	60
03/23/07 20:00	0	60	0	60	0	60	0	60
03/23/07 21:00	1	60	0	60	1	60	0	60
03/23/07 22:00	16	60	0	60	16	60	4	60
03/23/07 23:00	22	59	2	58	21	43	30	60
03/24/07 00:00	26	55	15	55	16	19	56	60
03/24/07 01:00	0	60	0	60	0	60	1	60
03/24/07 02:00	0	60	0	60	0	60	3	60
03/24/07 03:00	11	60	1	60	10	60	27	60
03/24/07 04:00	1	60	0	60	1	60	1	60
03/24/07 05:00	23	60	5	60	21	58	27	60
03/24/07 06:00	5	60	0	60	5	60	10	60
03/24/07 07:00	0	60	0	60	0	60	5	60
03/24/07 08:00	0	60	0	60	0	60	0	60
03/24/07 09:00	0	60	0	60	0	60	3	60
03/24/07 10:00	0	60	0	60	0	60	3	60
03/24/07 11:00	1	59	0	59	1	59	1	60
03/24/07 12:00	9	60	6	60	9	59	9	60
03/24/07 13:00	2	60	0	60	2	60	8	60
03/24/07 14:00	6	60	0	60	6	60	7	60
03/24/07 15:00	0	60	0	60	0	59	1	60
03/24/07 16:00	4	60	0	60	4	60	8	60
03/24/07 17:00	4	60	0	60	4	59	4	60
03/24/07 18:00	3	60	0	60	3	60	23	60
03/24/07 19:00	0	60	0	60	0	60	17	60
03/24/07 20:00	1	60	0	60	1	60	7	60
03/24/07 21:00	0	60	0	60	0	60	0	60
03/24/07 22:00	1	60	0	60	1	60	1	60
03/24/07 23:00	0	60	0	60	0	60	0	60
03/25/07 00:00	1	60	0	60	1	60	2	60
03/25/07 01:00	12	60	0	60	12	59	9	60
03/25/07 02:00	41	60	0	60	41	53	18	60
03/25/07 03:00	32	60	2	60	31	54	28	60
03/25/07 04:00	6	60	0	60	6	60	9	60
03/25/07 05:00	19	60	0	60	19	60	36	60
03/25/07 06:00	3	60	0	60	3	60	5	60
03/25/07 07:00	0	60	0	60	0	60	0	60
03/25/07 08:00	3	60	0	60	3	60	11	60
03/25/07 09:00	2	60	0	60	2	60	1	60
03/25/07 10:00	36	59	1	59	36	55	54	60
03/25/07 11:00	9	60	0	60	9	54	20	60

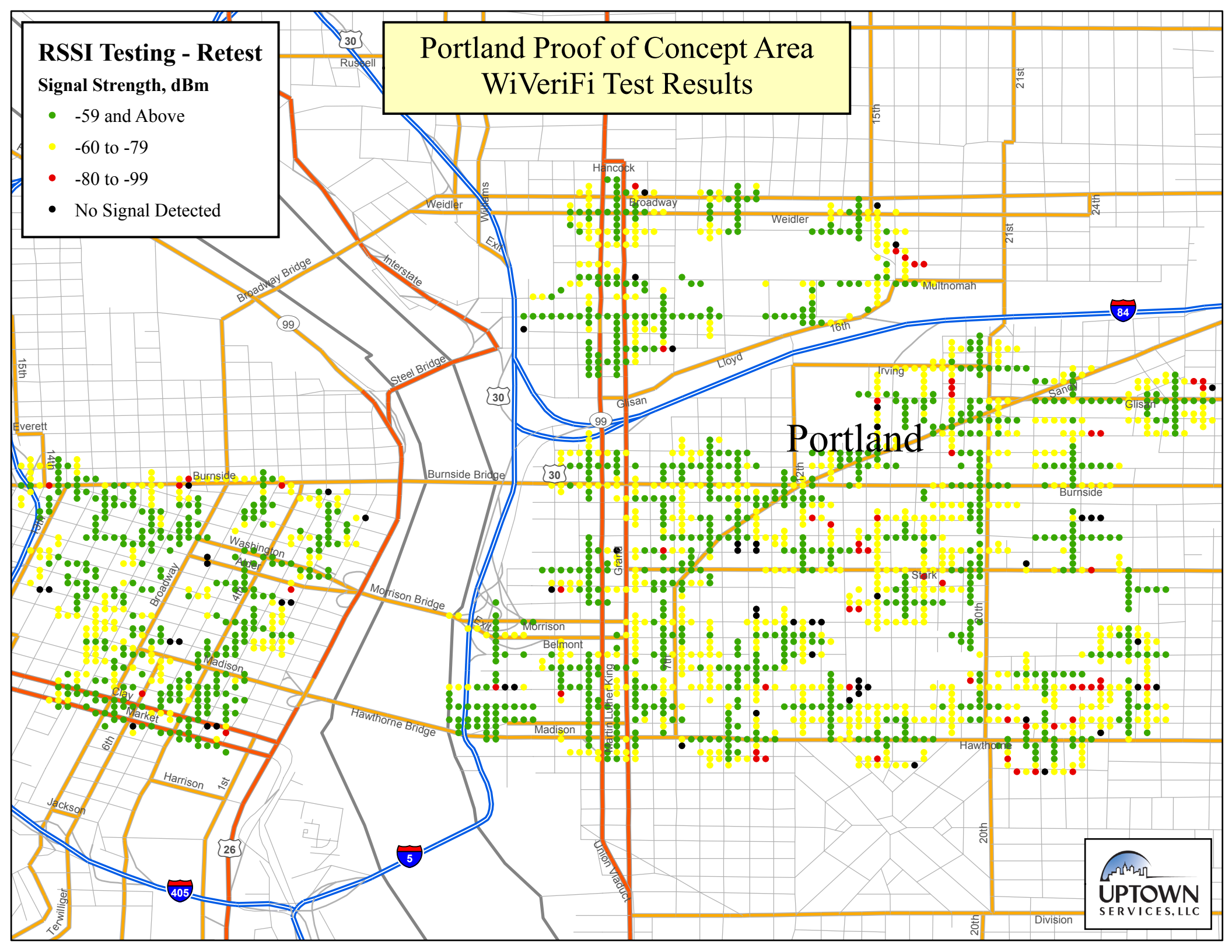
Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/25/07 12:00	1	60	0	60	1	60	1	60
03/25/07 13:00	0	60	0	60	0	60	1	60
03/25/07 14:00	0	60	0	60	0	60	3	60
03/25/07 15:00	2	60	0	60	2	59	4	60
03/25/07 16:00	1	60	0	60	1	60	0	60
03/25/07 17:00	1	60	0	60	1	59	6	60
03/25/07 18:00	1	60	0	60	1	60	7	60
03/25/07 19:00	1	60	0	60	1	60	3	60
03/25/07 20:00	16	60	0	60	16	60	10	60
03/25/07 21:00	7	60	0	60	7	60	10	60
03/25/07 22:00	19	53	10	51	11	39	42	60
03/25/07 23:00	7	60	0	60	7	57	9	60
03/26/07 00:00	28	57	4	57	25	34	43	60
03/26/07 01:00	27	58	0	58	27	31	37	60
03/26/07 02:00	3	60	0	60	3	53	9	60
03/26/07 03:00	4	60	0	60	4	60	3	60
03/26/07 04:00	4	60	0	60	4	60	4	60
03/26/07 05:00	5	60	0	60	5	60	17	60
03/26/07 06:00	1	60	0	60	1	60	0	60
03/26/07 07:00	4	60	0	60	4	60	2	60
03/26/07 08:00	10	60	0	60	10	58	9	60
03/26/07 09:00	5	60	0	60	5	60	2	60
03/26/07 10:00	16	60	0	60	16	58	0	60
03/26/07 11:00	8	60	0	60	8	58	2	60
03/26/07 12:00	21	60	0	60	21	59	17	60
03/26/07 13:00	14	60	0	60	14	59	10	60
03/26/07 14:00	7	60	0	60	7	60	6	60
03/26/07 15:00	14	60	0	60	14	58	13	60
03/26/07 16:00	6	60	0	60	6	60	2	60
03/26/07 17:00	5	60	0	60	5	60	0	60
03/26/07 18:00	4	60	0	60	4	60	1	60
03/26/07 19:00	4	60	0	60	4	59	5	60
03/26/07 20:00	1	60	0	60	1	60	2	60
03/26/07 21:00	0	60	0	60	0	60	1	60
03/26/07 22:00	0	60	0	59	0	60	0	60
03/26/07 23:00	42	60	0	60	42	57	1	60
03/27/07 00:00	54	60	0	60	54	57	9	60
03/27/07 01:00	12	60	0	60	12	57	1	60
03/27/07 02:00	0	60	0	60	0	60	0	60
03/27/07 03:00	20	60	0	60	20	60	34	60
03/27/07 04:00	2	60	0	60	2	60	24	60
03/27/07 05:00	0	60	0	60	0	60	4	60

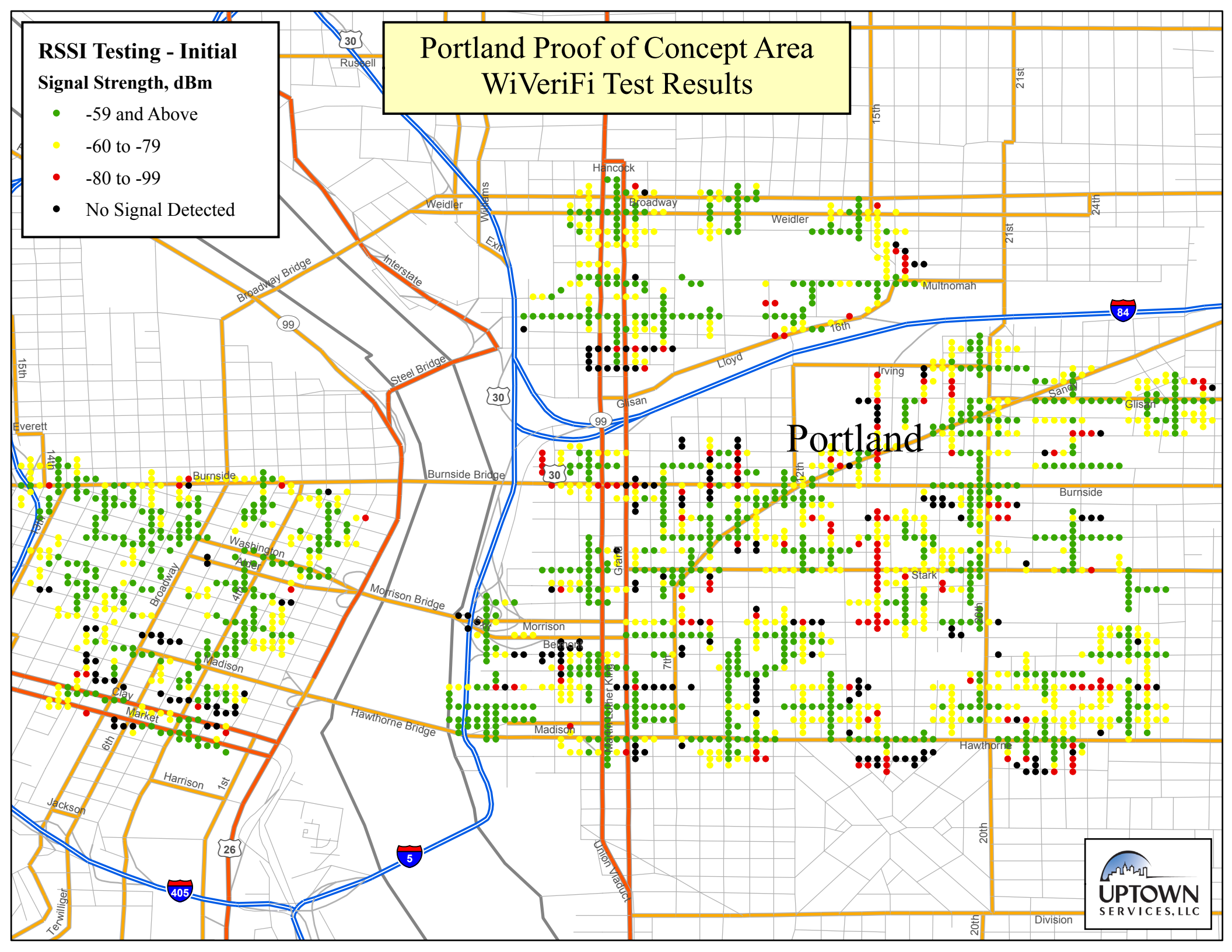
Hour	Combined Bad Minutes	Combined Total Minutes	Down stream Bad Minutes	Down stream Total Minutes	Up stream Bad Minutes	Up stream Total Minutes	Ping Time Bad Minutes	Ping Time Total Minutes
03/27/07 06:00	0	60	0	60	0	60	2	60
03/27/07 07:00	3	60	0	60	3	60	3	60
03/27/07 08:00	14	60	1	60	14	58	6	60
03/27/07 09:00	19	60	0	60	19	59	6	60
03/27/07 10:00	1	60	0	60	1	60	1	60
03/27/07 11:00	17	60	0	60	17	59	8	60
03/27/07 12:00	4	60	0	60	4	60	1	60
03/27/07 13:00	8	60	1	60	8	58	7	60
03/27/07 14:00	7	60	0	60	7	60	8	60
03/27/07 15:00	10	60	0	60	10	60	6	60
03/27/07 16:00	25	60	0	59	25	54	27	60
03/27/07 17:00	6	60	0	60	6	60	5	60
03/27/07 18:00	3	60	0	60	3	60	4	60
03/27/07 19:00	3	60	0	60	3	60	1	60
03/27/07 20:00	3	60	0	60	3	60	4	60
03/27/07 21:00	0	60	0	60	0	60	1	60
03/27/07 22:00	1	60	0	60	1	60	0	60
03/27/07 23:00	27	60	0	60	27	46	19	60
03/28/07 00:00	28	60	0	60	28	46	7	60
03/28/07 01:00	0	60	0	60	0	60	2	60
03/28/07 02:00	0	60	0	60	0	60	0	60
03/28/07 03:00	1	60	0	60	1	60	0	60
03/28/07 04:00	1	60	0	60	1	60	8	60
03/28/07 05:00	0	60	0	60	0	60	1	60
03/28/07 06:00	1	60	0	60	1	60	1	60
03/28/07 07:00	11	60	1	60	10	59	4	60
03/28/07 08:00	20	60	0	60	20	59	23	60
03/28/07 09:00	26	60	0	60	26	60	20	60
03/28/07 10:00	20	60	0	60	20	53	17	60
03/28/07 11:00	18	60	0	60	18	56	8	60
03/28/07 12:00	12	60	0	60	12	59	6	60
03/28/07 13:00	19	60	0	60	19	57	19	60
03/28/07 14:00	6	60	0	60	6	56	18	60
03/28/07 15:00	12	60	1	60	12	57	25	60
03/28/07 16:00	31	60	3	60	30	37	37	60
03/28/07 17:00	5	60	1	60	4	60	2	60
03/28/07 18:00	30	60	0	60	30	57	18	60
03/28/07 19:00	33	60	1	60	32	35	39	60
03/28/07 20:00	33	60	0	60	33	45	26	60
03/28/07 21:00	34	60	0	60	34	58	29	60
03/28/07 22:00	30	60	0	60	30	60	17	60
03/28/07 23:00	14	59	0	59	14	58	30	59

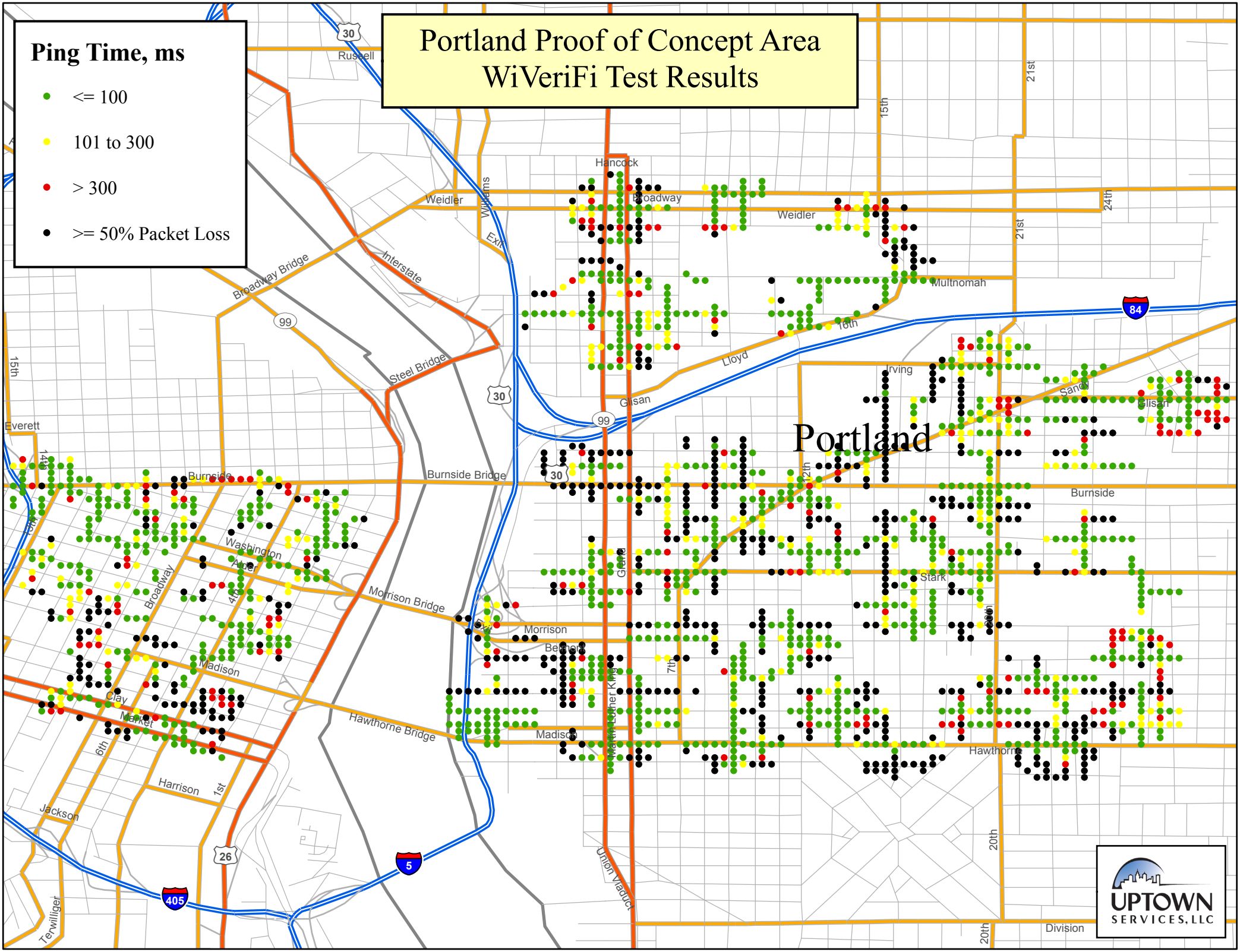
Appendix II

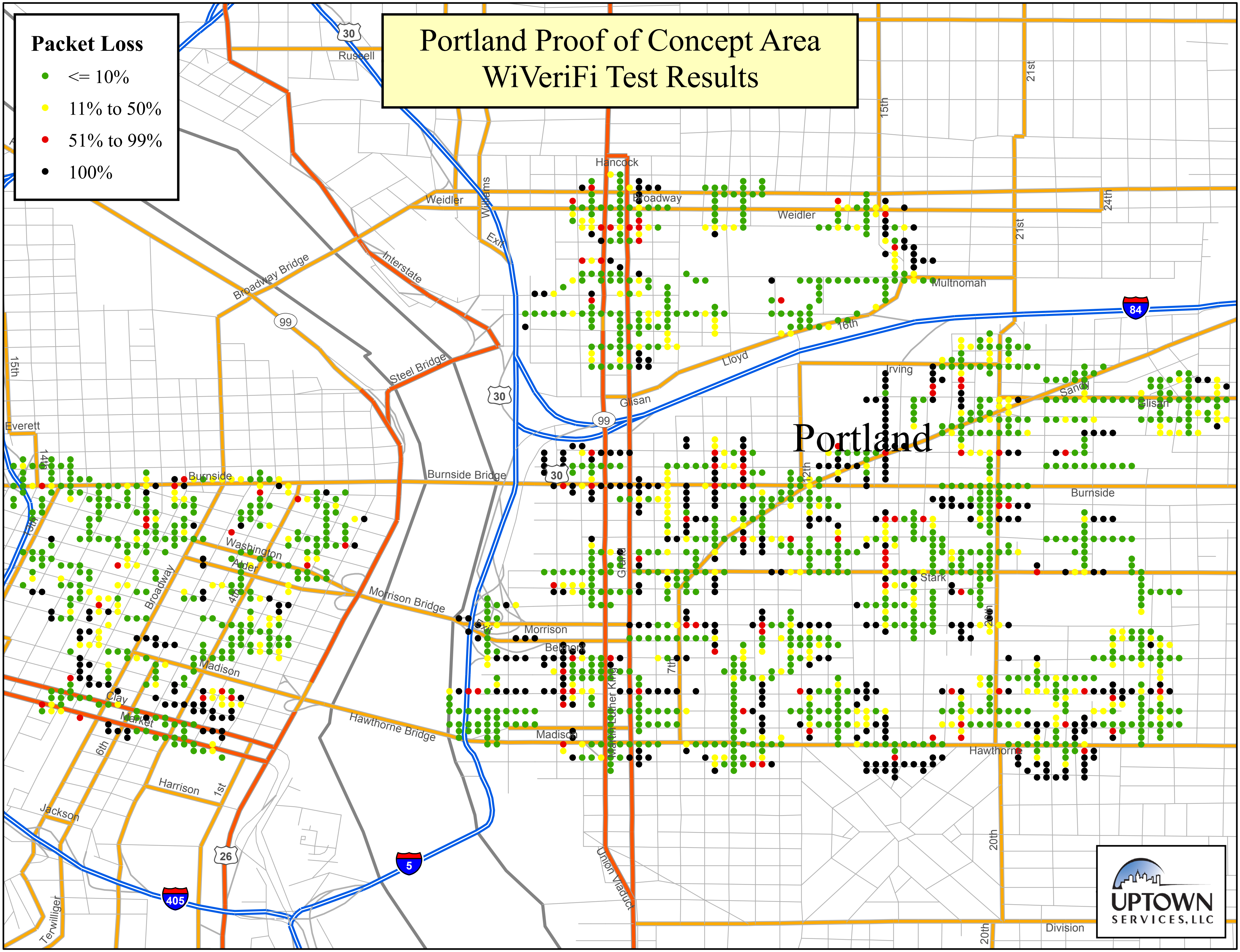
GIS Plots of Performance

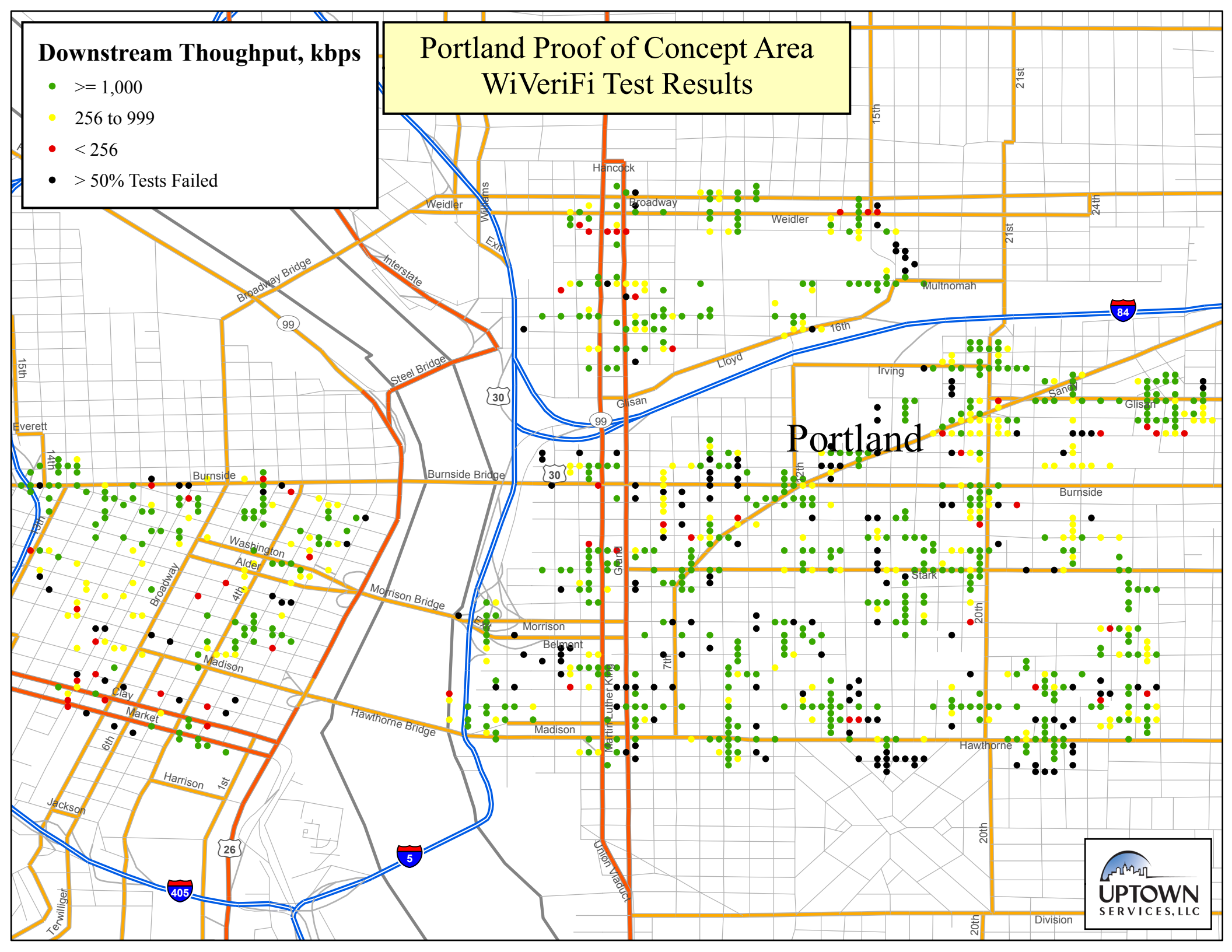
1. Signal Strength – Retest Combined with Initial Tests
2. Signal Strength – Initial Tests
3. Ping Time
4. Packet Loss
5. Downstream Throughput
6. Downstream File Loss
7. Upstream Throughput
8. Upstream File Loss
9. Plot of Test Vehicle Speed


RSSI Testing - Retest
Signal Strength, dBm
-59 and Above
-60 to -79
-80 to -99
No Signal Detected
Portland Proof of Concept Area
WiVeriFi Test Results
Portland
Russell
Weidler
Hancock
Broadway
Multnomah
Irving
Glisan
Lloyd
Burnside
Burnside Bridge
Steel Bridge
Broadway Bridge
Interstate
Williams
Exit
Everett
Washington
Ankeny
Morrison Bridge
Morrison
Belmont
Madison
Hawthorne Bridge
Hawthorne
Stark
Grant
Martin Luther King
Union Viaduct
Division
Harrison
Jackson
Terwilliger
Clay
Market
15th
16th
21st
24th
20th
14th
12th
7th
6th
4th
1st
Sandy
99
30
84
26
5
405
UPTOWN
SERVICES, LLC


RSSI Testing - Initial
Signal Strength, dBm
-59 and Above
-60 to -79
-80 to -99
No Signal Detected
Portland Proof of Concept Area
WiVeriFi Test Results
Portland
Russell
Hancock
Broadway
Weidler
Multnomah
Irving
Glisan
Lloyd
16th
21st
24th
15th
Williams
Interstate
Broadway Bridge
Steel Bridge
Burnside Bridge
Morrison Bridge
Hawthorne Bridge
Burnside
Everett
Washington
Alder
Morrison
Madison
Clay
Market
Harrison
Jackson
Terwilliger
Grant
Stark
Hawthorne
Division
Union Viaduct
Martin Luther King
Broadway
4th
6th
1st
7th
12th
20th
14th
Exit
99
30
84
26
5
405
UPTOWN
SERVICES, LLC


Ping Time, ms
<= 100
101 to 300
> 300
>= 50% Packet Loss
Portland Proof of Concept Area
WiVeriFi Test Results
Portland
Russell
Hancock
Broadway
Weidler
Williams
Interstate
Broadway Bridge
Steel Bridge
Burnside Bridge
Morrison Bridge
Hawthorne Bridge
Lloyd
Irving
Multnomah
Burnside
Stark
Morrison
Madison
Harrison
Jackson
Clay
Market
Everett
Gisan
Glisan
Division
Hawthorne
Union Viaduct
Martin Luther King
Terwilliger
15th
21st
24th
16th
12th
7th
6th
4th
1st
20th
99
30
84
26
5
405
UPTOWN
SERVICES, LLC


Portland Proof of Concept Area
WiVeriFi Test Results
Packet Loss
<= 10%
11% to 50%
51% to 99%
100%
Portland
Hancock
Broadway
Weidler
Multnomah
Lloyd
16th
15th
21st
24th
Irving
Sandy
Glisan
Everett
Burnside
Burnside Bridge
Broadway Bridge
Steel Bridge
Interstate
Williams
Russell
Washington
Alder
Morrison Bridge
Morrison
Belmont
Madison
Hawthorne Bridge
Hawthorne
Stark
Grand
Martin Luther King
7th
12th
20th
Clay
Market
Harrison
Jackson
1st
4th
6th
14th
Terwilliger
Union Viaduct
Division
Exit
30
99
84
5
405
26
UPTOWN
SERVICES, LLC


Downstream Thoughput, kbps
>= 1,000
256 to 999
< 256
> 50% Tests Failed
Portland Proof of Concept Area
WiVeriFi Test Results
Portland
Hancock
Broadway
Weidler
Multnomah
Irving
Glisan
Burnside
Stark
Morrison
Belmont
Madison
Hawthorne
Division
Everett
Lloyd
Sandy
Williams
Interstate
Broadway Bridge
Steel Bridge
Burnside Bridge
Morrison Bridge
Hawthorne Bridge
Union Viaduct
Martin Luther King
Grand
Washington
Alder
Clay
Market
Harrison
Jackson
Terwilliger
15th
21st
24th
16th
14th
12th
20th
7th
6th
4th
1st
99
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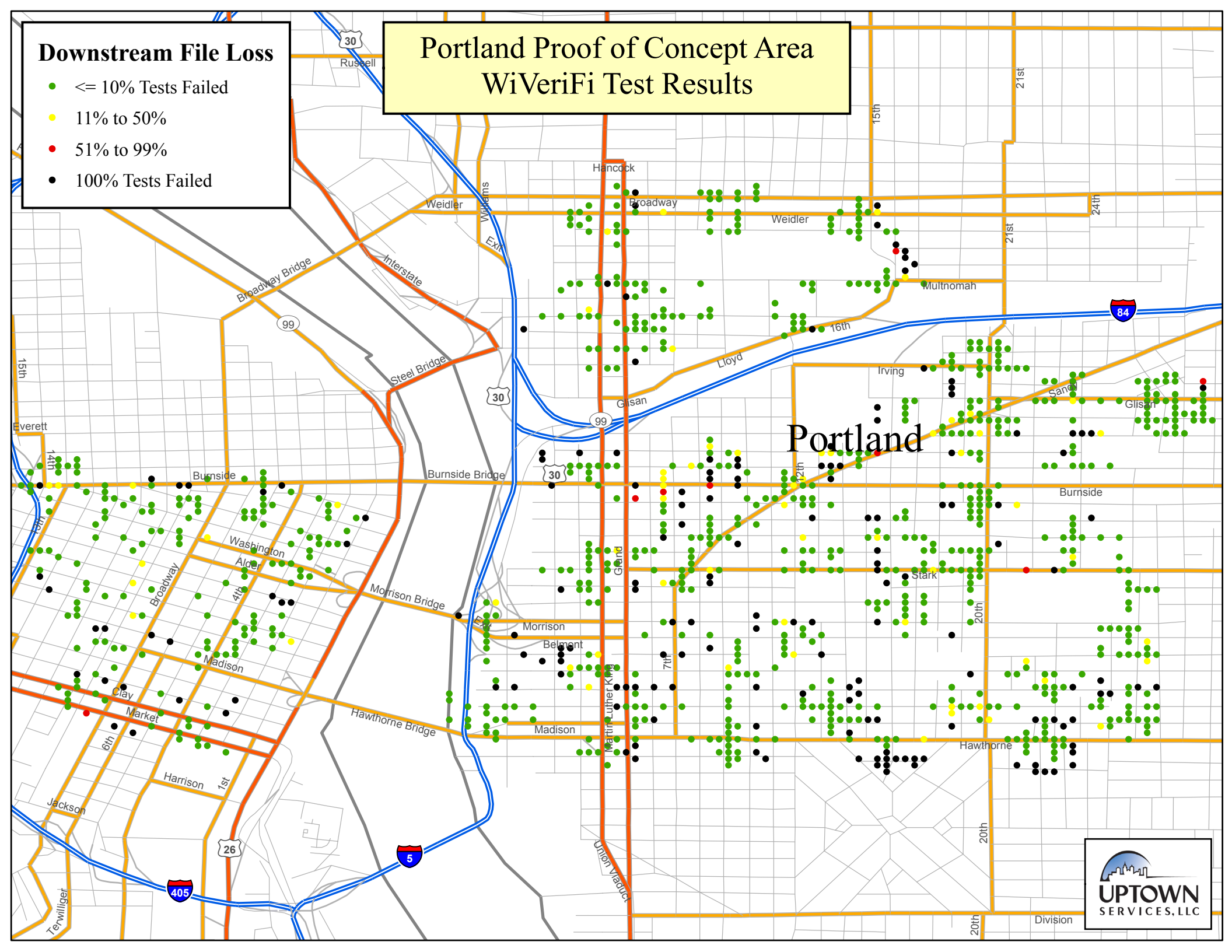
84
26
5
405
UPTOWN
SERVICES, LLC


Downstream File Loss
<= 10% Tests Failed
11% to 50%
51% to 99%
100% Tests Failed
Portland Proof of Concept Area
WiVeriFi Test Results
Portland
Russell
Hancock
Broadway
Weidler
Williams
Interstate
Broadway Bridge
Steel Bridge
Burnside Bridge
Morrison Bridge
Hawthorne Bridge
Multnomah
Irving
Glisan
Lloyd
Burnside
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21st
24th
16th
20th
14th
12th
7th
6th
4th
1st
Broadway
99
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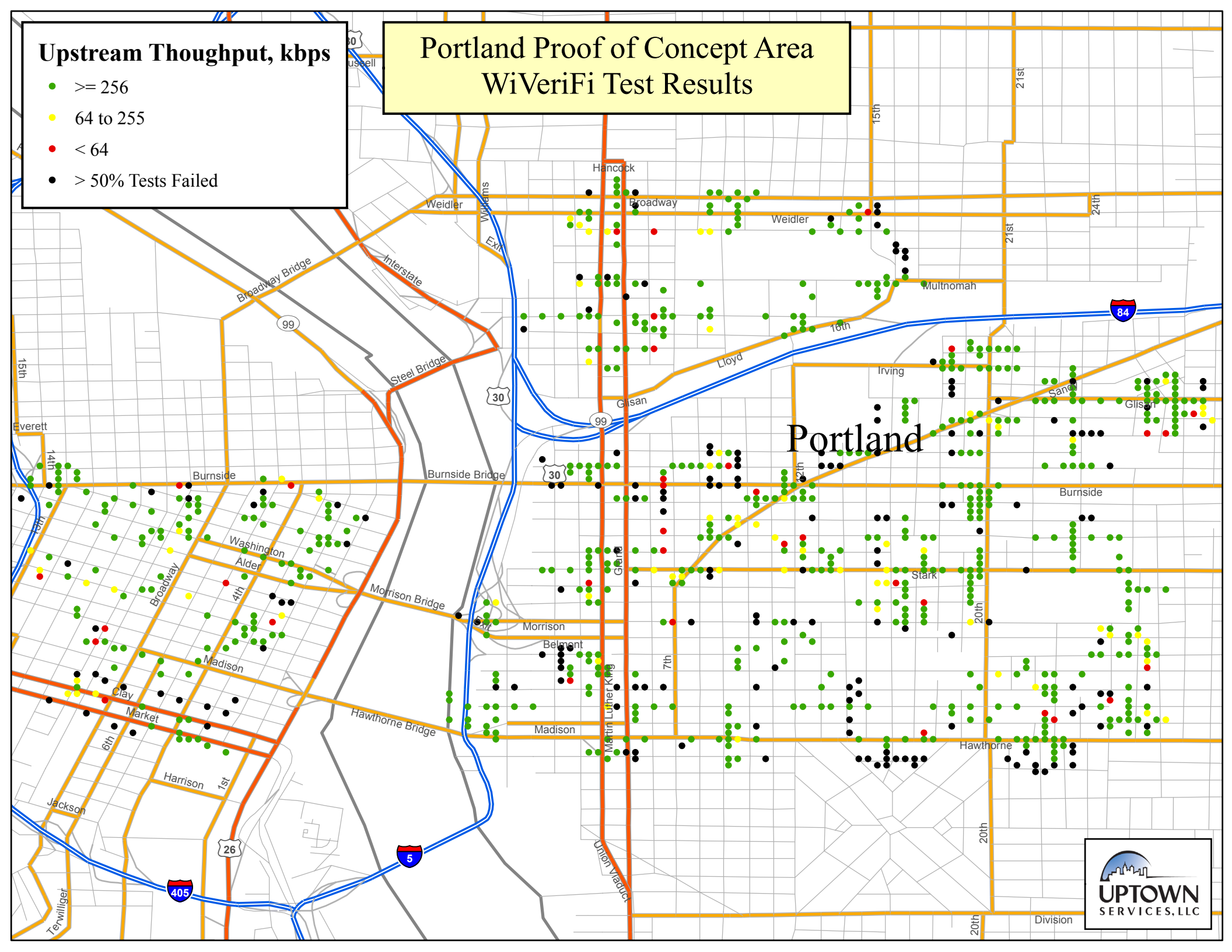
405
UPTOWN
SERVICES, LLC


Upstream Thoughput, kbps
>= 256
64 to 255
< 64
> 50% Tests Failed
Portland Proof of Concept Area
WiVeriFi Test Results
Portland
Broadway Bridge
Steel Bridge
Burnside Bridge
Morrison Bridge
Hawthorne Bridge
Interstate
Weidler
Broadway
Burnside
Everett
Hancock
Multnomah
Irving
Glisan
Lloyd
Stark
Morrison
Belmont
Madison
Hawthorne
Division
Washington
Alder
Clay
Market
Harrison
Jackson
Terwilliger
Martin Luther King
Union Viaduct
Williams
Vancouver
Grand
Sandy
15th
16th
20th
21st
24th
14th
12th
7th
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4th
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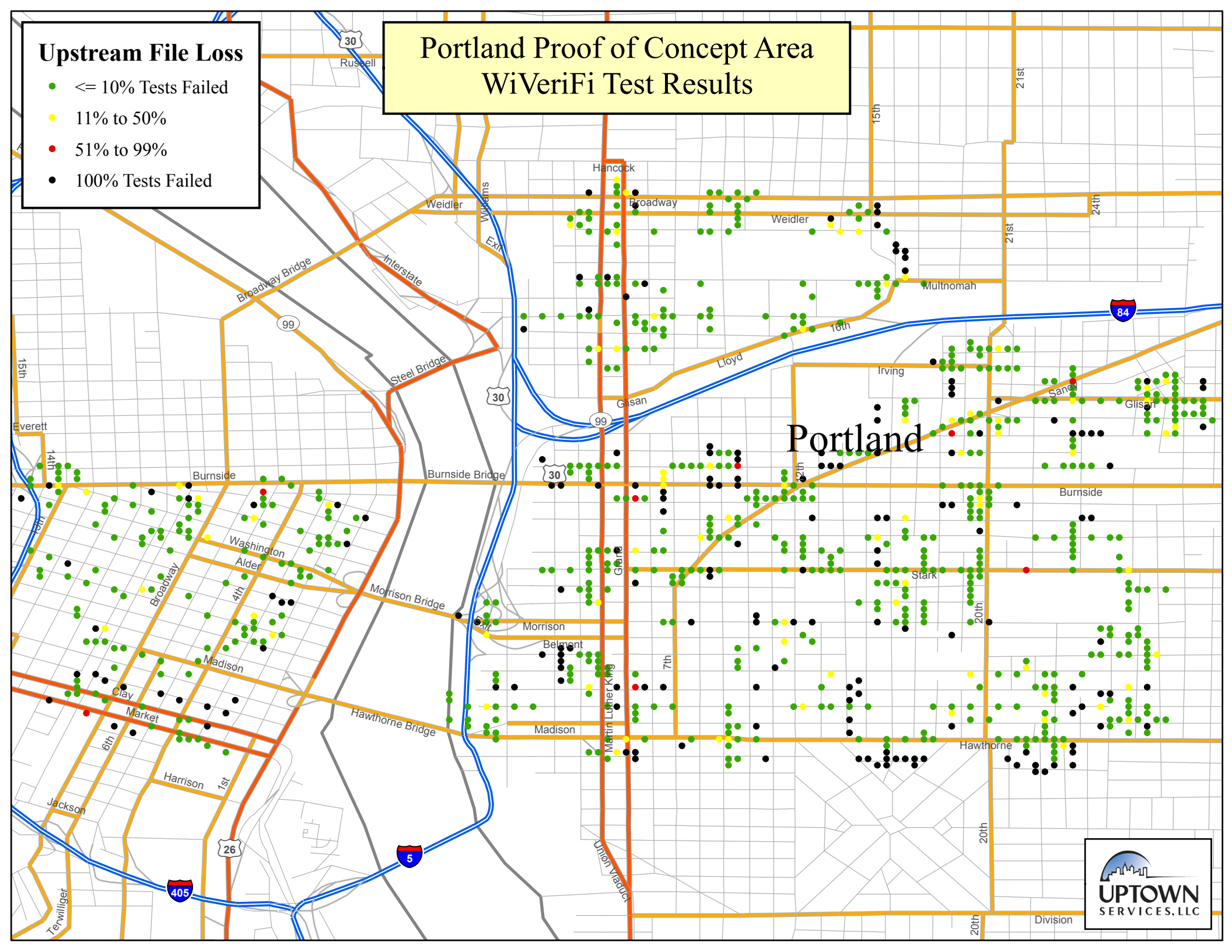
UPTOWN
SERVICES, LLC


Upstream File Loss
<= 10% Tests Failed
11% to 50%
51% to 99%
100% Tests Failed
Portland Proof of Concept Area
WiVeriFi Test Results
Portland
Russell
Weidler
Broadway
Hancock
Williams
Interstate
Broadway Bridge
Steel Bridge
Burnside Bridge
Morrison Bridge
Hawthorne Bridge
Lloyd
Irving
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15th
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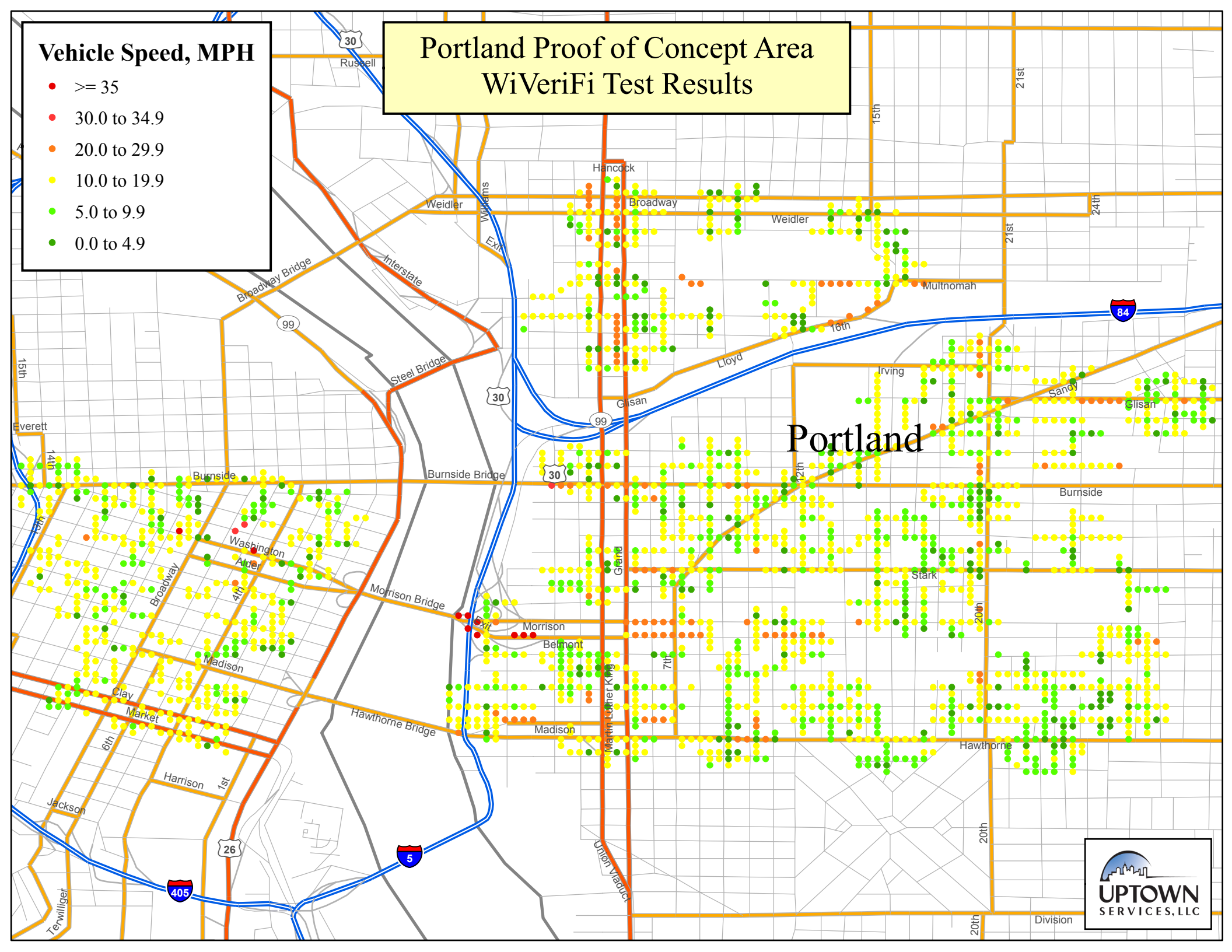
UPTOWN
SERVICES, LLC


Vehicle Speed, MPH
>= 35
30.0 to 34.9
20.0 to 29.9
10.0 to 19.9
5.0 to 9.9
0.0 to 4.9
Portland Proof of Concept Area
WiVeriFi Test Results
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Russell
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Hancock
Broadway
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Interstate
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Morrison Bridge
Hawthorne Bridge
Lloyd
Multnomah
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Sandy
Glisan
Burnside
Stark
Morrison
Belmont
Madison
Hawthorne
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Everett
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