



# Understanding the True Performance Characteristics of Mobile WiMAX in a Commercial Network

December 3, 2009

# A quick introduction to Signals Research Group, LLC.

- Signals Research Group, LLC offers thought-leading field research and proprietary consulting services on the wireless telecommunications industry.
- Our flagship research product, a research newsletter entitled “Signals Ahead,” includes more than 70 corporate subscribers on five continents across the entire wireless ecosystem.



# Mobile WiMAX Drive Test Background

- In July 2009 we conducted an independent performance benchmark test of Mobile WiMAX.
- The tests leveraged Clearwire's network in Portland, Oregon.
- Clearwire provided us access to its network and provided some of the devices that we tested.
- Intel provided us with access to a server for our throughput tests as well as some of the devices that we tested.
- Intel and Clearwire did not participate in our network testing nor did they have any influence on where we did our testing.

*Clearwire Coverage in the Portland Area*



Source: Clearwire



# Mobile WiMAX Drive Test Methodology

- We used sophisticated drive test tools to capture and analyze the data.
  - Rohde&Schwarz (R&S) TSMW Universal Radio Network Analyzer
  - R&S ROMES drive test software and engineering support
  - Intel FiDO (Field Deployment Optimization) drive test tool
- We tested five devices during our four day stay in Portland.
  - simultaneous downlink and uplink
- All test results were recorded and reported unless the file was corrupted.

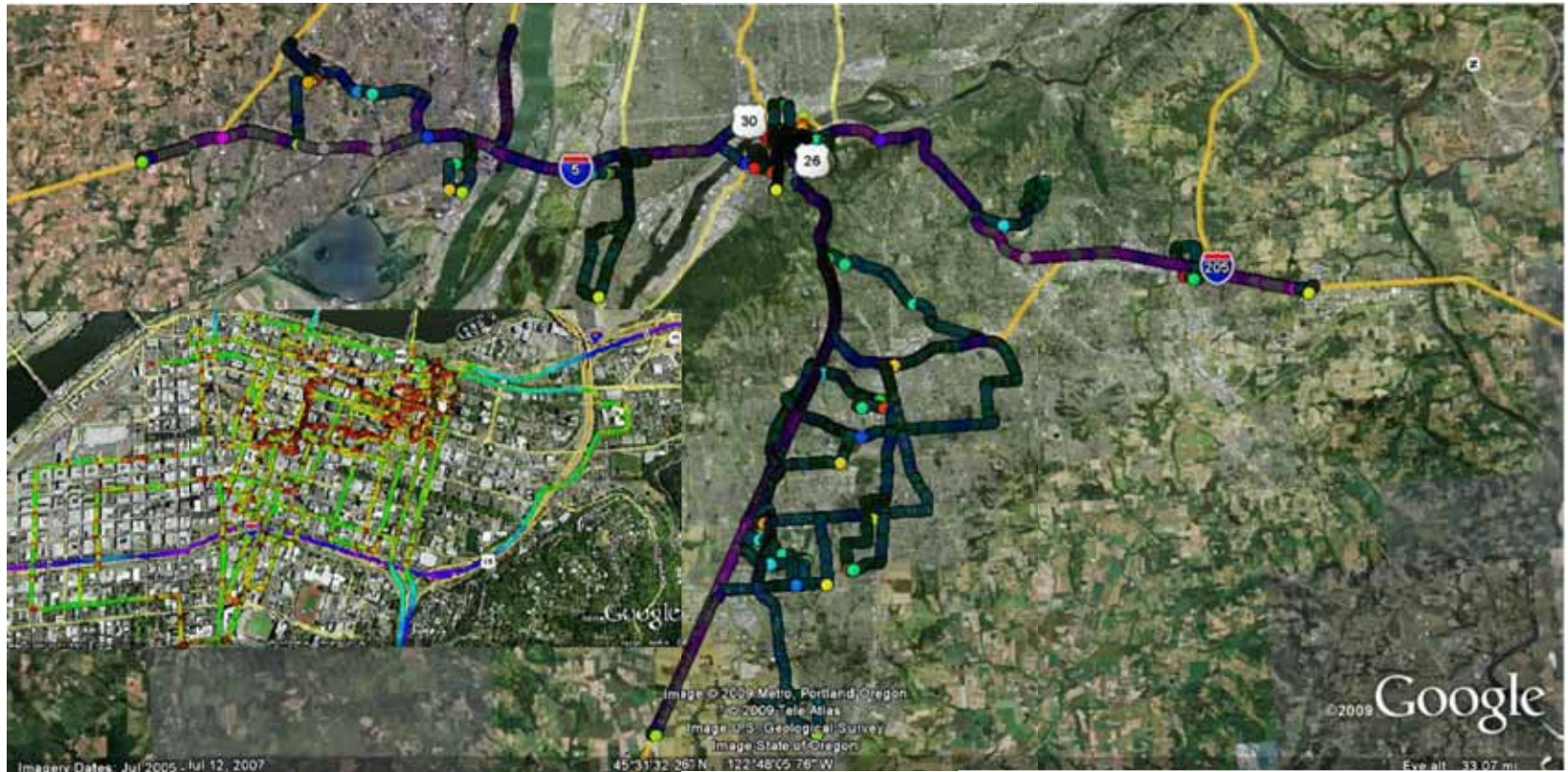
| Manufacturer    | Model           | Form Factor         | Chipset                              | Status                  | Features                                       |
|-----------------|-----------------|---------------------|--------------------------------------|-------------------------|--|
| Motorola        | USBw 100        | USB dongle          | Beceem BCS200                        | non-commercial firmware | MIMO A/B; 2.3GHz/2.5GHz                        |
| Ubee            | N.A.            | USB dongle          | Beceem BCS250                        | non-commercial hardware | UL transmit diversity; MIMO A/B; 2.3GHz/2.5GHz |
| Franklin        | U300            | USB dongle          | Beceem BCS200                        | non-commercial firmware | EV-DO; MIMO A/B 2.3GHz/2.5GHz                  |
| Fujitsu-Siemens | Lifetbook P8020 | Notebook (embedded) | Next Generation embedded Intel WiMAX | non-commercial hardware | MIMO A/B; 2.3GHz/2.5GHz/3.5GHz                 |
| 2go Convertible | Classmate       | Netbook (embedded)  | Intel Echo Peak                      | commercial              | MIMO A/B; 2.3GHz/2.5GHz                        |

Source: Signals Research Group, LLC

# Mobile WiMAX Drive Test Methodology (cont'd)

*"Oh the places we did go!"*

*Geo plot of all test routes with speed (mph)*



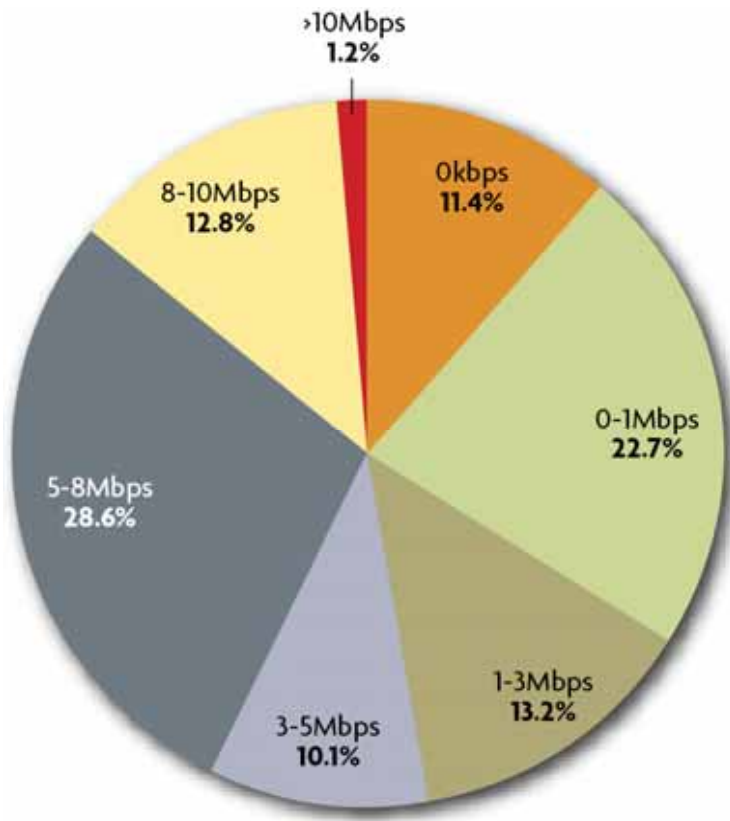
- During our tests we transferred ~46.3GB of data.
  - Mobile - 30.7GB; Pedestrian – 14.6GB
- We drove 420 miles over the course of a 4 day period.



# Mobile WiMAX Drive Test – downtown Portland mid afternoon

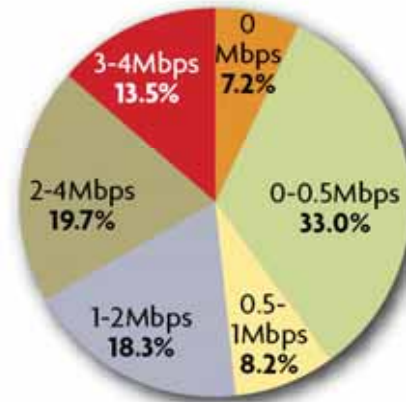
## Test Scenario 21 KPIs

### Distribution of DL/UL Data Rates and MIMO Matrix A/B

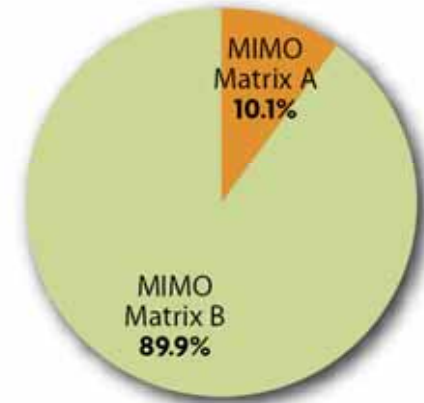


Total Transfer = 995.4MB  
Avg Speed = 6.8Mph  
Adj Avg DL = 4.4Mbps

Adj Avg UL = 1.4Mbps  
Max DL = 10.8Mbps  
Max UL = 3.9Mbps



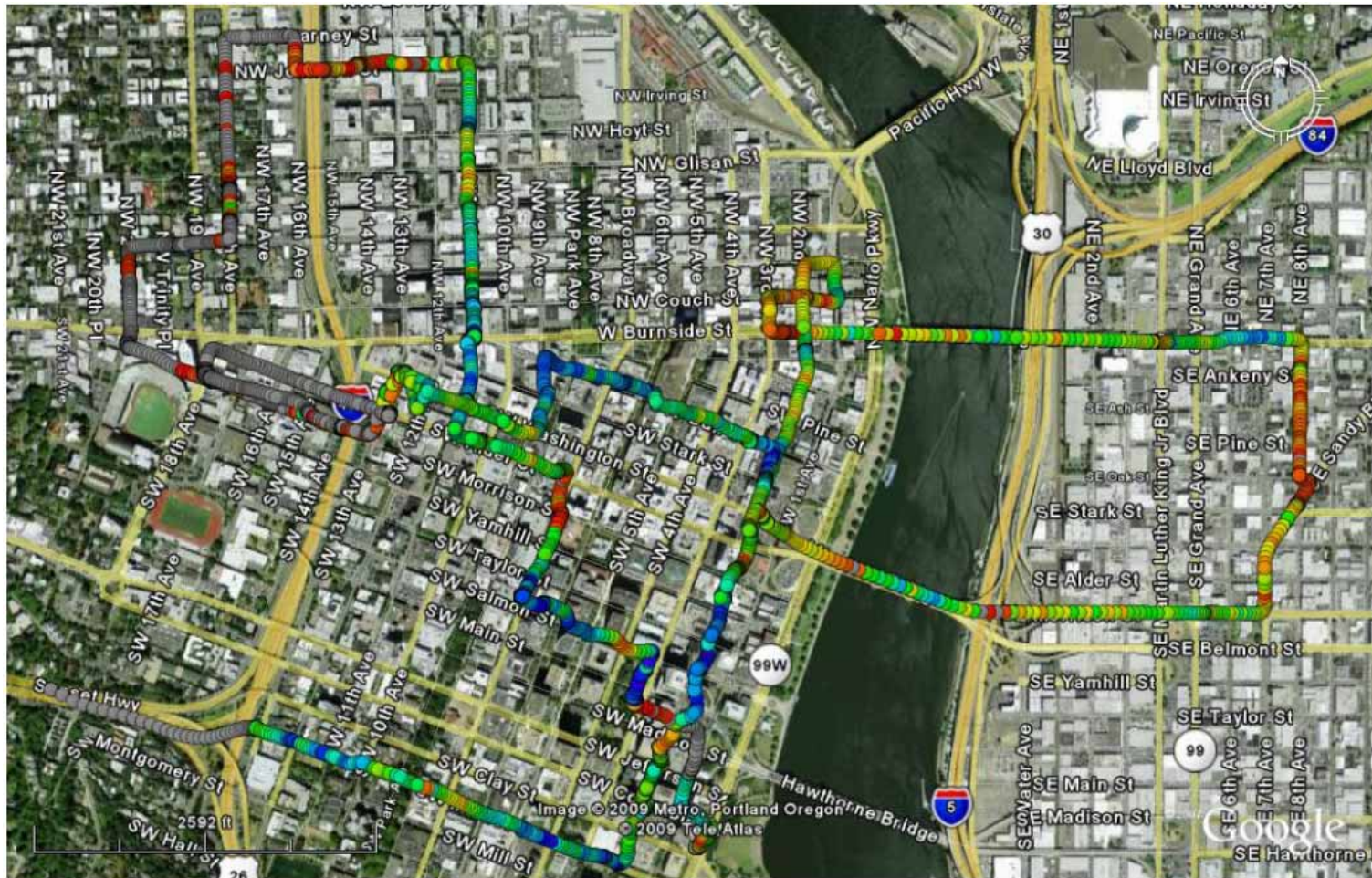
UL Throughput



Source: Signals Research Group, LLC

# Mobile WiMAX Drive Test – downtown Portland mid afternoon

**Portland Vehicular Mode**  
**Geo plot of DL Data Rates (Test Scenario 21)**



DL Throughput (Mbps)

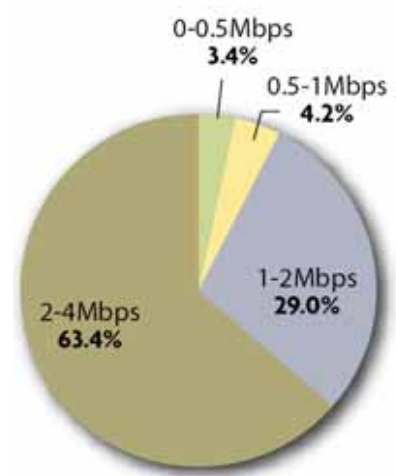
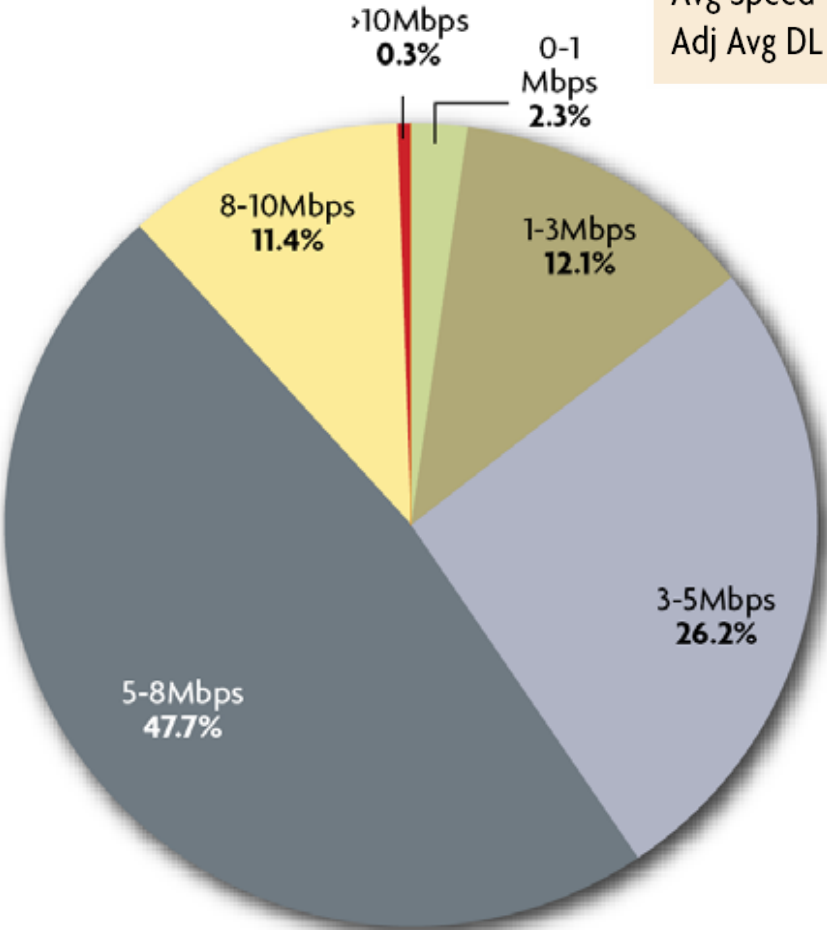
|        |       |       |       |       |
|--------|-------|-------|-------|-------|
| 12,000 | 9,500 | 7,000 | 4,500 | 2,000 |
| 11,500 | 9,000 | 6,500 | 4,000 | 1,500 |
| 11,000 | 8,500 | 6,000 | 3,500 | 1,000 |
| 10,500 | 8,000 | 5,500 | 3,000 | 500   |
| 10,000 | 7,500 | 5,000 | 2,500 |       |

Source: Signals Research Group, LLC

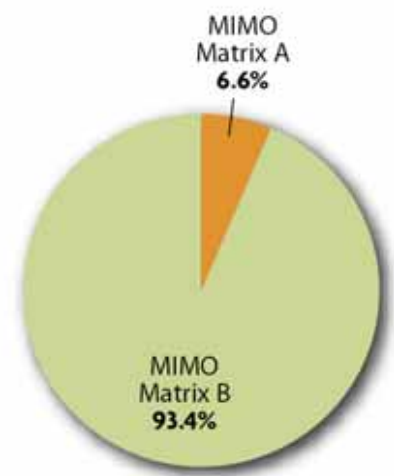
# Mobile WiMAX Pedestrian Test – downtown Portland early evening

## Test Scenarios 14-15 KPIs Distribution of DL/UL Data Rates and MIMO Matrix A/B

|                            |                      |
|----------------------------|----------------------|
| Total Transfer = 1,728.5MB | Adj Avg UL = 2.4Mbps |
| Avg Speed = 2.8Mph         | Max DL = 10.2Mbps    |
| Adj Avg DL = 5.4Mbps       | Max UL = 2.4Mbps     |



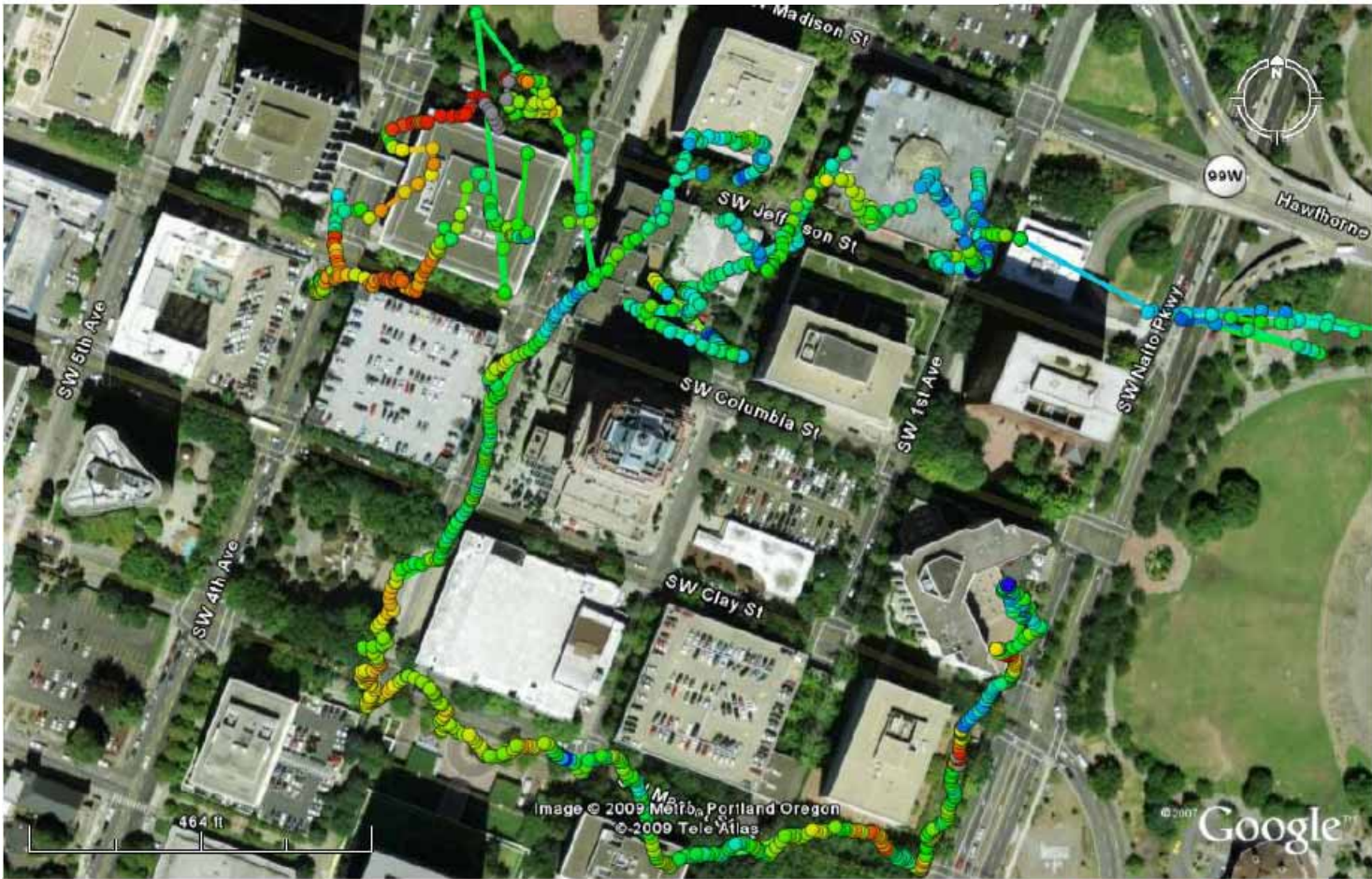
UL Throughput



Source: Signals Research Group, LLC

# Mobile WiMAX Pedestrian Test – downtown Portland early evening

**Downtown Portland Pedestrian Mode**  
 Geo plot of DL Data Rates (Test Scenario 14-15)



Source: Signals Research Group, LLC

| DL Throughput (Mbps) |       |       |       |       |
|----------------------|-------|-------|-------|-------|
| 12,000               | 9,500 | 7,000 | 4,500 | 2,000 |
| 11,500               | 9,000 | 6,500 | 4,000 | 1,500 |
| 11,000               | 8,500 | 6,000 | 3,500 | 1,000 |
| 10,500               | 8,000 | 5,500 | 3,000 | 500   |
| 10,000               | 7,500 | 5,000 | 2,500 |       |

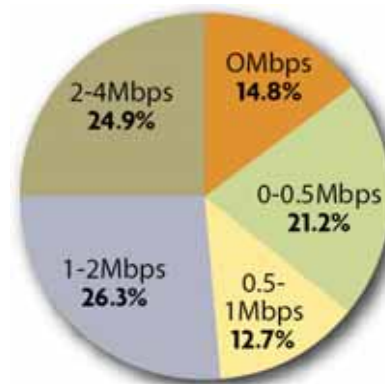
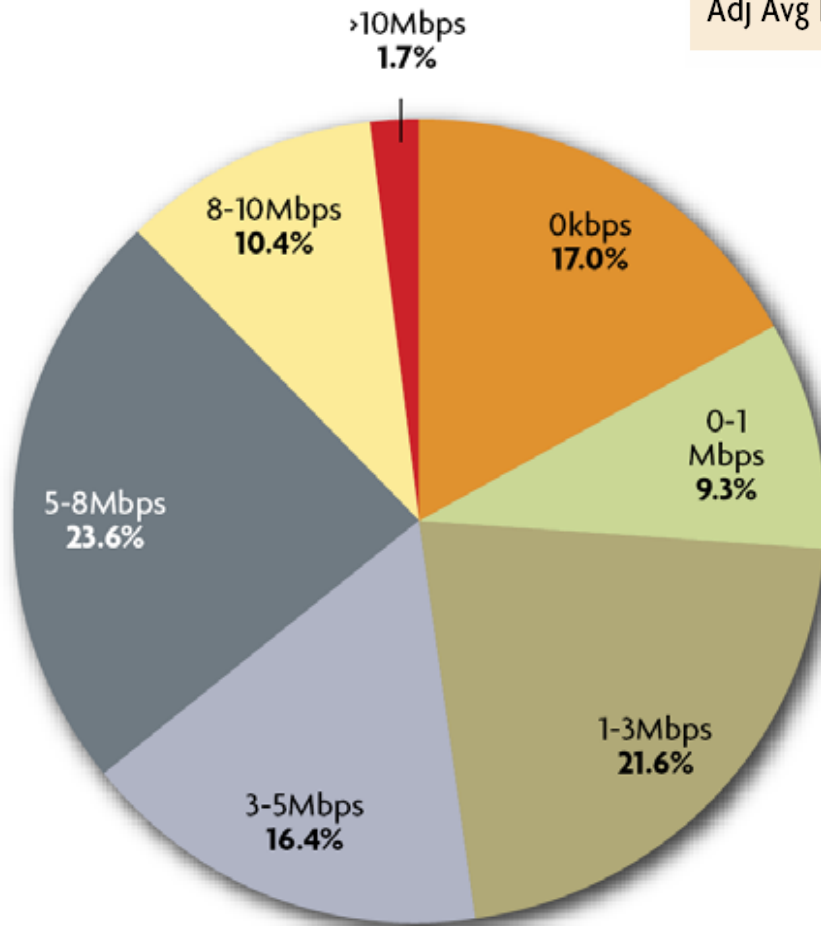
# Mobile WiMAX Drive Test – Hillsboro mid afternoon

## Test Scenario 18 KPIs

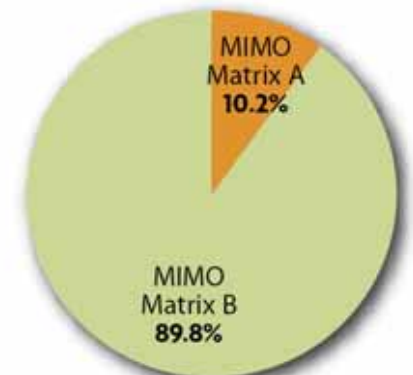
### Distribution of DL/UL Data Rates and MIMO Matrix A/B

Total Transfer = 1,851.5MB  
Avg Speed = 19.7Mph  
Adj Avg DL = 4.5Mbps

Adj Avg UL = 1.4Mbps  
Max DL = 11.1Mbps  
Max UL = 3.9Mbps



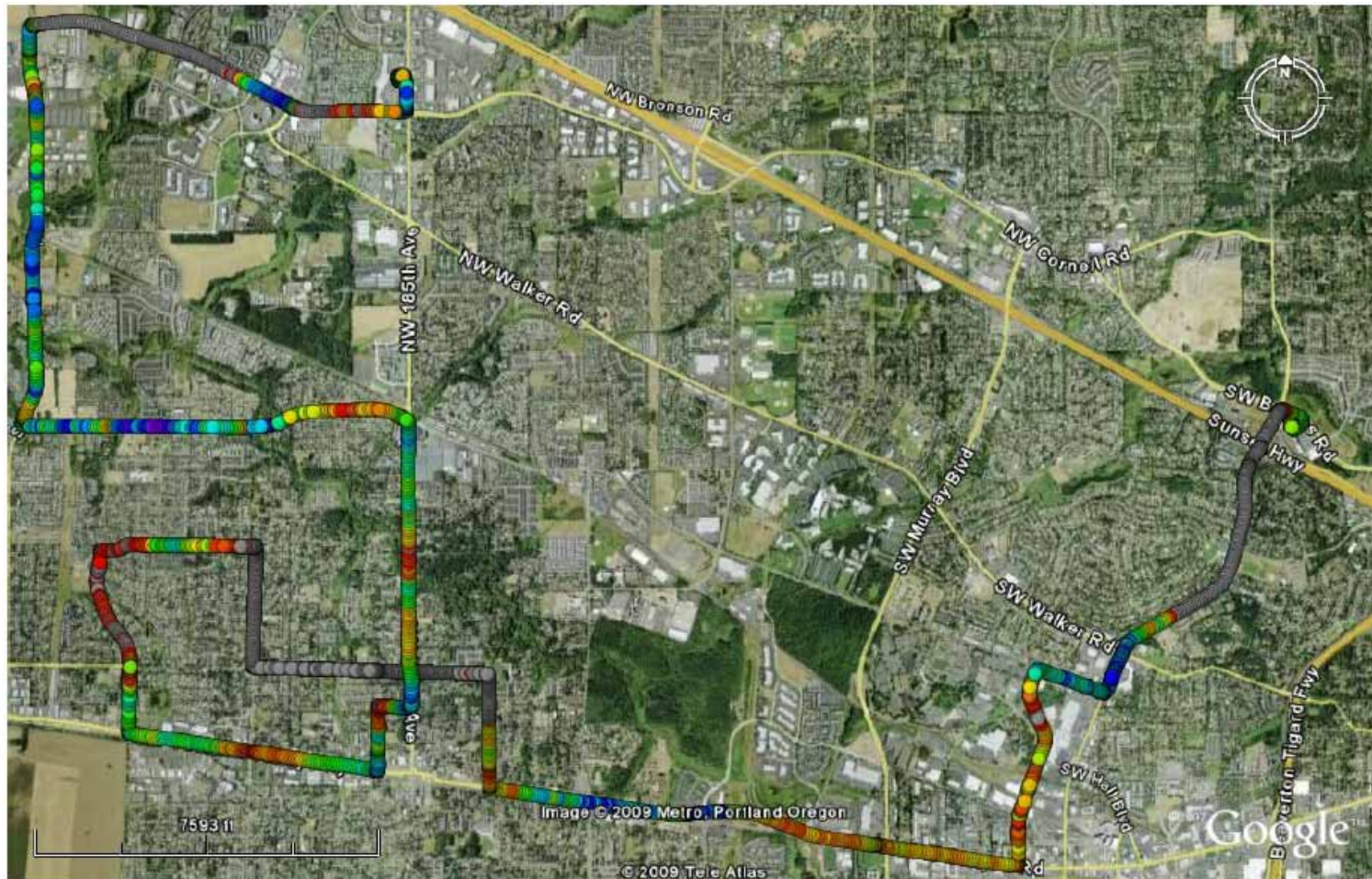
UL Throughput



Source: Signals Research Group, LLC

# Mobile WiMAX Drive Test – Hillsboro mid afternoon

**Hillsboro Vehicular Mode**  
Geo plot of DL Data Rates (Test Scenario 18)

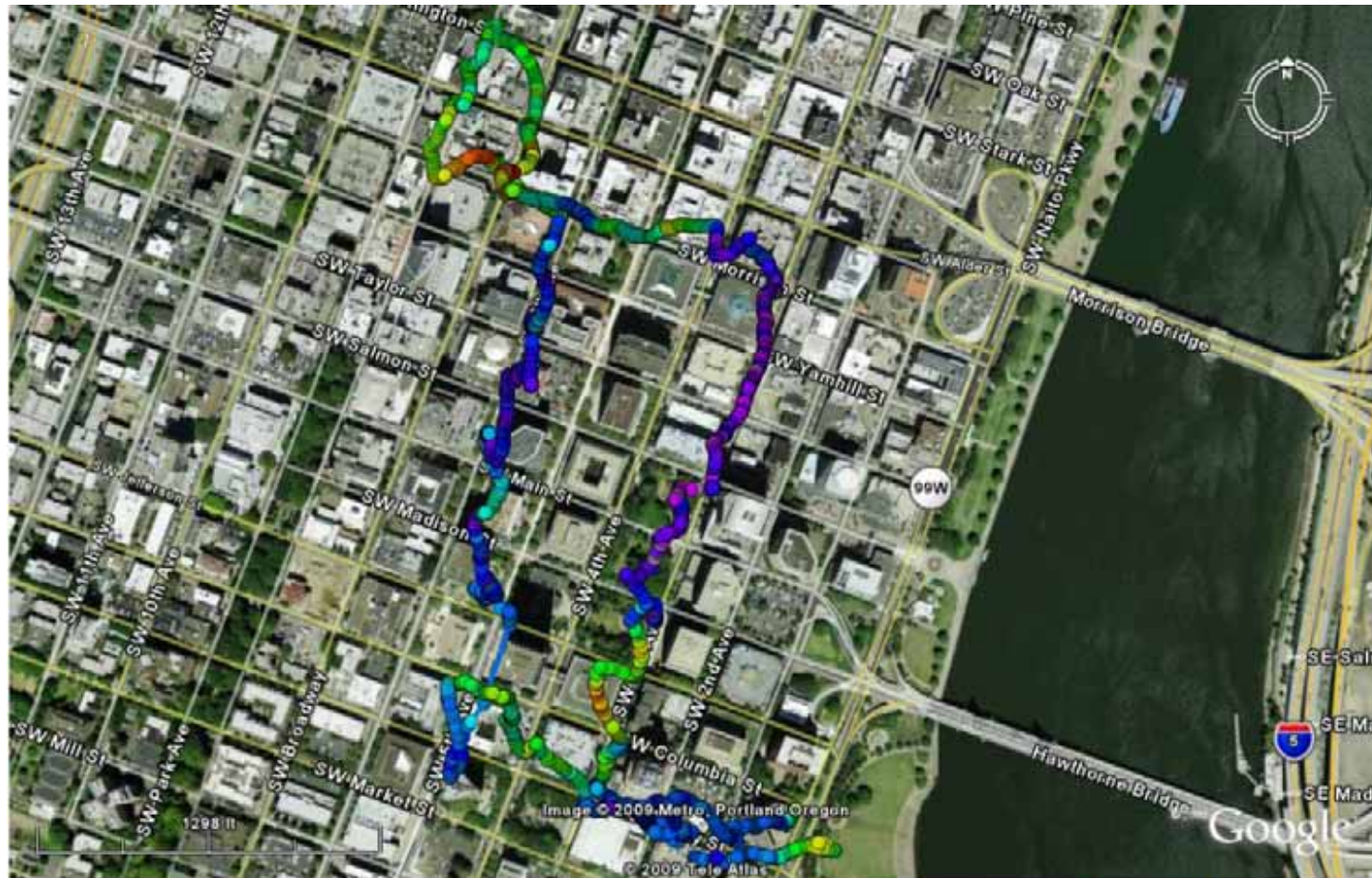


| DL Throughput (Mbps) |       |       |       |       |
|----------------------|-------|-------|-------|-------|
| 12,000               | 9,500 | 7,000 | 4,500 | 2,000 |
| 11,500               | 9,000 | 6,500 | 4,000 | 1,500 |
| 11,000               | 8,500 | 6,000 | 3,500 | 1,000 |
| 10,500               | 8,000 | 5,500 | 3,000 | 500   |
| 10,000               | 7,500 | 5,000 | 2,500 |       |

# Mobile WiMAX Pedestrian Test – downtown Portland morning (two devices)

## Portland Pedestrian Mode

Geo plot of Total Throughput for 2 Devices (Test Scenario 37)



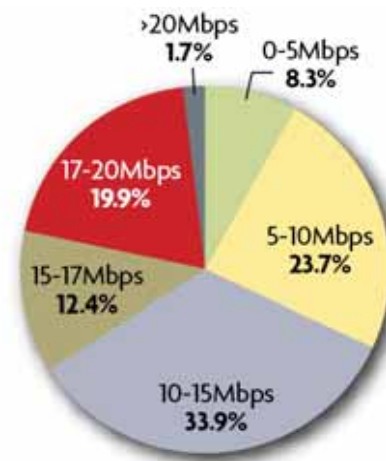
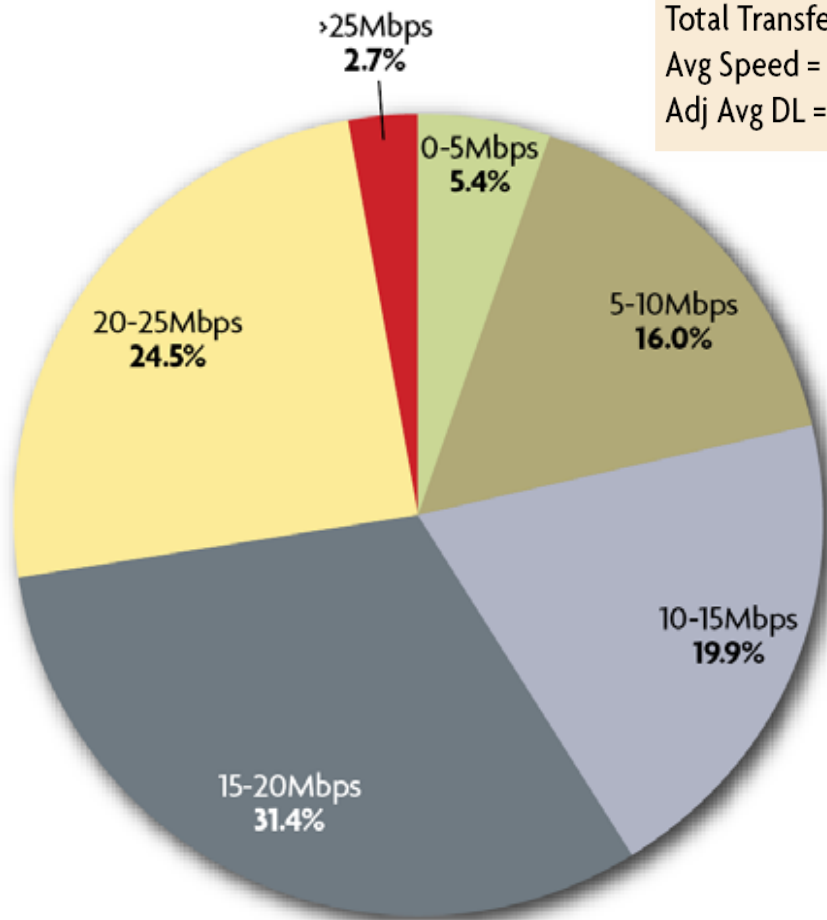
Source: Signals Research Group, LLC



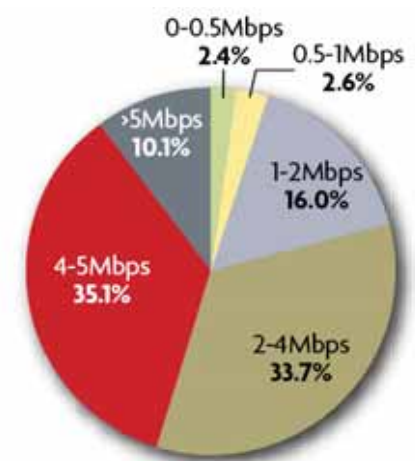
# Mobile WiMAX Pedestrian Test – downtown Portland morning (two devices)

## Distribution of Total Throughput and DL/UL Data Rates for Two Devices

|                            |                      |
|----------------------------|----------------------|
| Total Transfer = 4,421.9MB | Adj Avg UL = 3.5Mbps |
| Avg Speed = 2.4Mph         | Max DL = 21.1Mbps    |
| Adj Avg DL = 12.5Mbps      | Max UL = 7.1Mbps     |



Total DL Throughput



Total UL Throughput

Source: Signals Research Group, LLC

# Conclusions

- Average adjusted DL data rates were 3.8Mbps while the average adjusted UL data rates were 1.7Mbps.
  - Unadjusted average rates were 3.4Mbps and 1.6Mbps, respectively
  - DL peak = 18.1Mbps; UL peak = 7Mbps
  - Maximum combined DL/UL throughput across multiple devices = 27.8Mbps
- Coverage was excellent in urban areas to very good outside of the CBD.
  - In-building coverage was also better than we expected
  - Overall, coverage is not where we would like it to be nor is it close to typical cellular coverage
  - Additional cell sites are being deployed which could address the problem
- Results may not be indicative of a typical WiMAX network that can't deploy an N=6/N=3 frequency reuse scheme.

# Conclusions

- The availability of MIMO A/B and higher order modulation schemes (e.g., 64QAM) was very impressive.
  - Likely due to high CINR and the conservative frequency reuse scheme
  - Co-channel interference still existed in a number of areas (not presented)
- Performance differences with HSPA+ and LTE will be interesting to follow.
  - HSPA+ test results are largely in line with these results
  - LTE performance remains an unknown
    - Wider channel allocations (up to 2x10MHz versus 1x10MHz)
    - 700MHz/1700MHz versus 2500MHz
    - N=1 or FFR frequency reuse versus N=3/N=6
- Most broadband wireless data users don't care about spectrum utilization or network efficiency – they only care about coverage, price, and performance.
  - Longer-term implications of spectrum resources/utilization still exist

The logo for Signals Research Group features the word "SiGNALS" in a bold, black, sans-serif font. Above the letter "i" are four concentric, orange, semi-circular lines that resemble a signal or Wi-Fi icon. Below "SiGNALS" is the text "Research Group" in a smaller, orange, sans-serif font.

**SiGNALS**  
Research Group

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