2011 Taste of Research Summer Scholarship Program

Experimentally Determining Differences in RSSI Readings Between Different Wi-Fi Chipsets

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Research Theme: Digital Future

Background

There are many difficulties with using GPS for location indoors and in urban canyons. Wi-Fi fingerprinting techniques has been widely accepted as an alternative. Fingerprinting involves recording the signal strengths (RSSI) of Access Points (APs) at reference points into a database which is then queried by a user to provide their location.

For this system to work well, the RSSI reported by the user should match well with that of the RSSI recorded in the training phase. Many existing algorithms assume that all devices perform similarly or only have an offset.

Aim

To experimentally investigate how a wide variety of different Wi-Fi based devices report their RSSI in both an indoor and outdoor environment so that we can understand the limitations in accuracy of a Wi-Fi Fingerprinting Location System.

Testing Methodology

• A variety of devices (Laptops, USB Wireless Cards and Mobile Phones) were tested (see Figure 1).
• A dual band (2.4Ghz and 5Ghz) Belkin Play Wireless N AP was set up at a fixed position.
• The device under testing was placed on top of the bin at the same height as the AP.
• The RSSI of the AP on all channels was logged.
• Every 5 minutes, the trolley was moved to one of 15 distances from the AP (ranging from 0.3m to 35m).
• The testing was conducted indoors and outdoors (See Figure 2 and 3).

Why are there RSSI differences?

• Differences in the design of the Wi-Fi device, antenna, number of antennas, chipset, RF Front-end design and drivers.
• Wi-Fi devices do not give absolute signal strength readings. Signal strength reported is an indicator only.
• Manufacturers are free to choose how their device behaves – there is no standard.

Figure 1. Some of the devices used in testing

Figure 2. Indoor Testing

Figure 3. Outdoor Testing

Results

• Significant differences were found in mean RSSIs (see Figure 4).
• Some cards were unable to report useful RSSIs.
• Temporal patterns were found in the RSSIs from some cards (see Figure 5).
• Variances in RSSI were lower in the 5Ghz band compared to the 2.4Ghz band (see Figure 6).
• Different generations of chipsets from the same vendor exhibited significant differences in their RSSIs.
• Certain cards appear to report certain values of RSSI which are not correlated with the true signal strength.

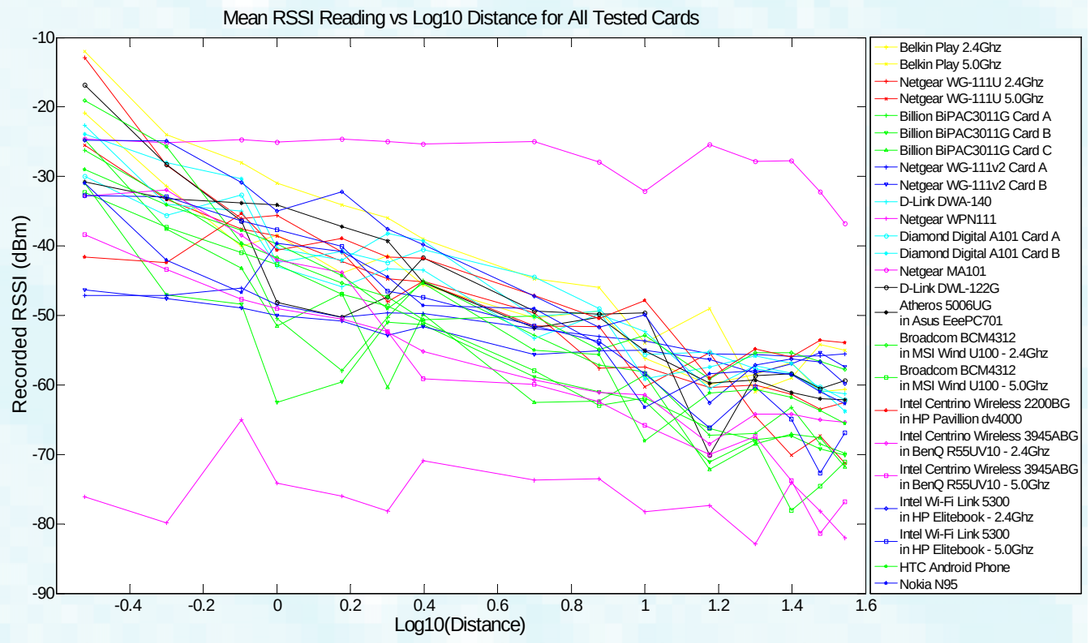
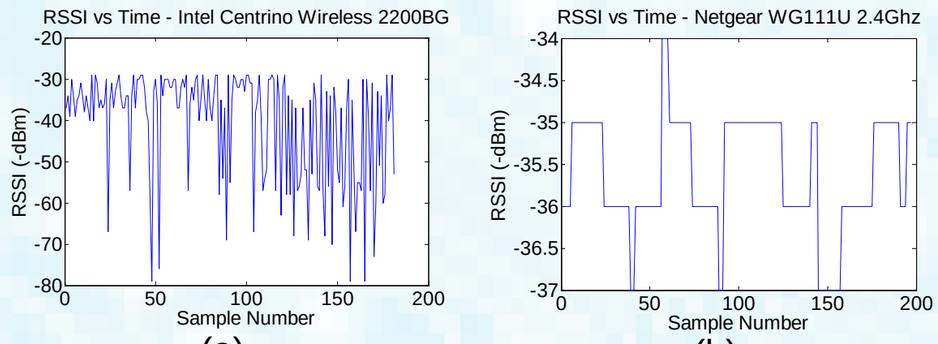
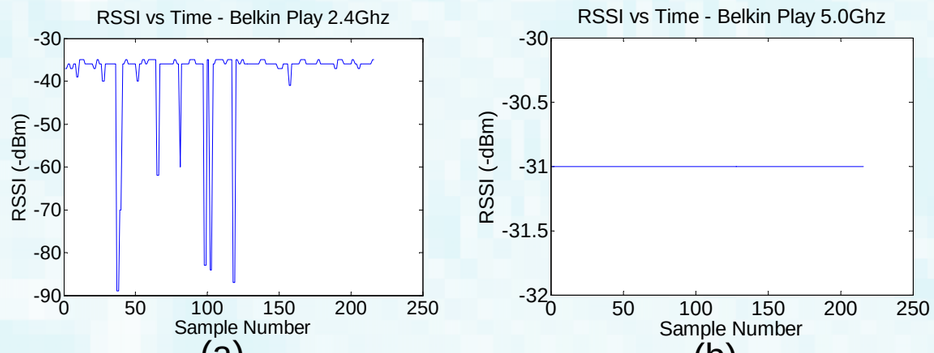


Figure 4. Mean RSSI Trends for Outdoor Testing



(a) (b)

Figure 5. Temporal RSSI Trends for Outdoor Testing at 1m



(a) (b)

Figure 6. Temporal RSSI Trends for Outdoor Testing at 1m – 2.4Ghz band in (a), 5.0Ghz band in (b)

Conclusion

It was found that there are significant differences in the RSSI values reported from different devices. These differences will limit the accuracy of a fingerprinting based Wi-Fi positioning system. Some chipsets were found to be incompatible with fingerprinting due to incorrect RSSI readings, limiting their accuracy to that of Cell ID algorithms. An improvement in accuracy can be had if the chipsets used for location and training are limited.

It was also found that the 5Ghz band provides a much more stable signal – its use may improve the accuracy of a fingerprinting based positioning system.

If many devices are to be used in a fingerprinting system, it is essential that calibration be performed.

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