

Project 3: Collection and Analysis of Wireless Signals

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Abstract—A route around campus was taken on foot in order to sample cell phone, GPS, and WiFi signals. An Android smartphone with the RF Signal Tracker app was used to sample and store the various data associated with each type of wireless signal. Analysis was then performed on signal strength over time and location for each type of signal. Additionally, wireless network SSID and BSSID characteristics were correlated against location on the Texas State University San Marcos campus.

I. SAMPLING METHODOLOGY AND ROUTE

THIS project makes use of an app titled “RF Signal Tracker” by developer Ken Hunt in the Google Play app store for Android smart phones. The particular device utilized was a Samsung Galaxy S Relay 4G, model string SGH-T699. A path was walked around campus, with this device running this app, to sample cellular signals, GPS signals, and WiFi signals at regular intervals and store the results in a CSV file. Analysis was then performed on the data.

The route is detailed in figure 1 as the red line over the Google Maps Satellite image. The path started at the RFM building, and ended at the commuter parking lot near the soccer fields. The entire path was walked at approximately the same speed, with only one stop for a traffic light. *Due to this fact, the relationship between time and location is relatively linear with only minor phase shifts.* Given this relationship, the data in this report is plotted against time, with the understanding that the position of the sampler when x percent of the data has been plotted roughly corresponds to x percent of the path having been travelled.

II. DATA

The data is kept in two principal csv files on a git repository located at the following URLs:

- Cell and GPS data: https://raw.githubusercontent.com/aggrokater/ee4372-comm-networks/master/project-3-wireless-signal-sampling/cell-data/export_140321144244.csv
- WiFi data: https://raw.githubusercontent.com/aggrokater/ee4372-comm-networks/master/project-3-wireless-signal-sampling/wifi-data/wifi_140403220558.csv

The data collected Cell and GPS data every 5 to 6 seconds, and WiFi data every 7 or 8 seconds. It is important to note that it appears as if the sampling software was unable to keep up with the polling requests for at least the first minute for the WiFi data. There are multiple sets of WiFi data that have the same timestamp, but different GPS coordinates during this first minute. The overall trends gleaned from the data, however, do not suffer unnecessarily from this glitch.

Numerous gnuplot scripts were utilized to plot this data in different ways. Along the way, various “helper” CSVs were generated to ease plotting with gnuplot. These helper CSVs may all be found in the repository, as can the gnuplot scripts. The main url for the repository is below:

- <https://github.com/aggrokater/ee4372-comm-networks/tree/master/project-3-wireless-signal-sampling>

III. CELLULAR DATA ANALYSIS

The Received Signal Strength Indication (RSSI, units dBm) of the cellular signal was plotted over time, as was the class of signal (regular 2G vs data 3G/4G). The results can be found in figure 2. It can be seen that the signal strength correlates with the presence of buildings: the more buildings there are, the lower the signal strength tends to be.

As well, mobile data transfer over time was also plotted in figure 3. In particular, take note that mobile data transfer only occurred when there was an HSPA+ (3G/4G) signal to the cellular handset. Throughput of the data connection was not investigated for this report.

The code for these plots can be found in the repo mentioned in the Data section of this report.

IV. WiFi DATA ANALYSIS

A first impression of the WiFi data leads to the conclusion that the WiFi spectrum is quite crowded around Texas State. Figure 4 showcases over 100 unique SSIDs that were sampled on the route. 65 of these were “unknown” signals that were broadcasting a BSSID on the WiFi spectrum, but did not supply SSIDs. It is suspected that these were WiFi signals from personal devices such as mobile phones and laptops that were not acting as access points.

Eliminating the unknowns from the plot, as in Figure 5, still shows a relatively crowded spectrum, but more trends are evident without the noise of the unknowns. The solid blue triangle line in particular is the “TexasStateWPA” SSID that most students, faculty, and other staff utilize to connect to the Texas State network. Between the 30 minute and 32 minute marks, there is relatively little SSID detection. This corresponds to the walk away from RFM, over the bridge, and toward the main campus. From the 32 minute to 37 minute marks, there is more SSID detection that corresponds with the Nursing and Student Center buildings, followed by several dorm rooms. From the 37 minute to 39 minute mark, the walk along Sessom Drive toward the Rec center has lower SSID detection. Upon walking along the Rec Center and toward the athletic dorms, SSID detection rises again until the sampler reaches the parking lot.

The TexasStateWPA and TexasStateUniversity networks are plotted in Figure 6. Not revealed by the plot, however, is that this WiFi network is supplied by numerous independent devices. As the sampler walks out of range of one access point, the connection gets handed off to another access point. This is evident in the logs, as the SSID stays the same – TexasStateWPA– while the BSSID that identifies the unique hardware supply the SSID changes.

Figure 7 is provided to illustrate the presence of two other “official” Texas State wireless SSIDs. The “Comanche at Student Center” SSID is found near the student center between the 33 and 35 minute marks. During this particular segment of the path, the SSID of a Bobcat Tram was also briefly detected (two samples): “BobcatTram7”. It is suspected that this signal was associated with a moving Bobcat Tram as it either arrived or departed from the Student Center pick-up/drop-off zone.

Figure 8 shows the signal strength of various SSIDs associated with HP printing devices. Three distinct clusters are evident. The first is around the 29 minute mark. Numerous HP printing devices are detected and are likely originated in the RFM building. Crossing the bridge, many more printing devices are detected, presumably from the Nursing and Student Center buildings as well as the nearby dorm rooms. These types of SSIDs drop off afterward until the sampler nears the athletic dorms near the rec center and commuter parking lot, where some brief SSID detection again occurs.

Finally, Figure 9 plots the unknown WiFi signals by themselves. They appear to occur relatively uniformly throughout the sampling path. It is suspected that these correspond to WiFi clients, rather than access points.

V. CONCLUSION

The most pressing conclusion that may be drawn from this project is that the uniqueness of the SSID/BSSID combo can be used to develop a highly indentifiable heatscore for any given individual or network. As well, the “wireless landscape,” so-to-speak, also gives rise to a very detailed and unique heatmap of a particular area. The uniqueness of all this data lends itself very well to gleaning trends about the inhabitants of the area that they might not be genuinely aware they are broadcasting.

Everything goes somewhere, and whoever goes everywhere holds quite a bit of valuable data. *cough* GOOGLE *cough*

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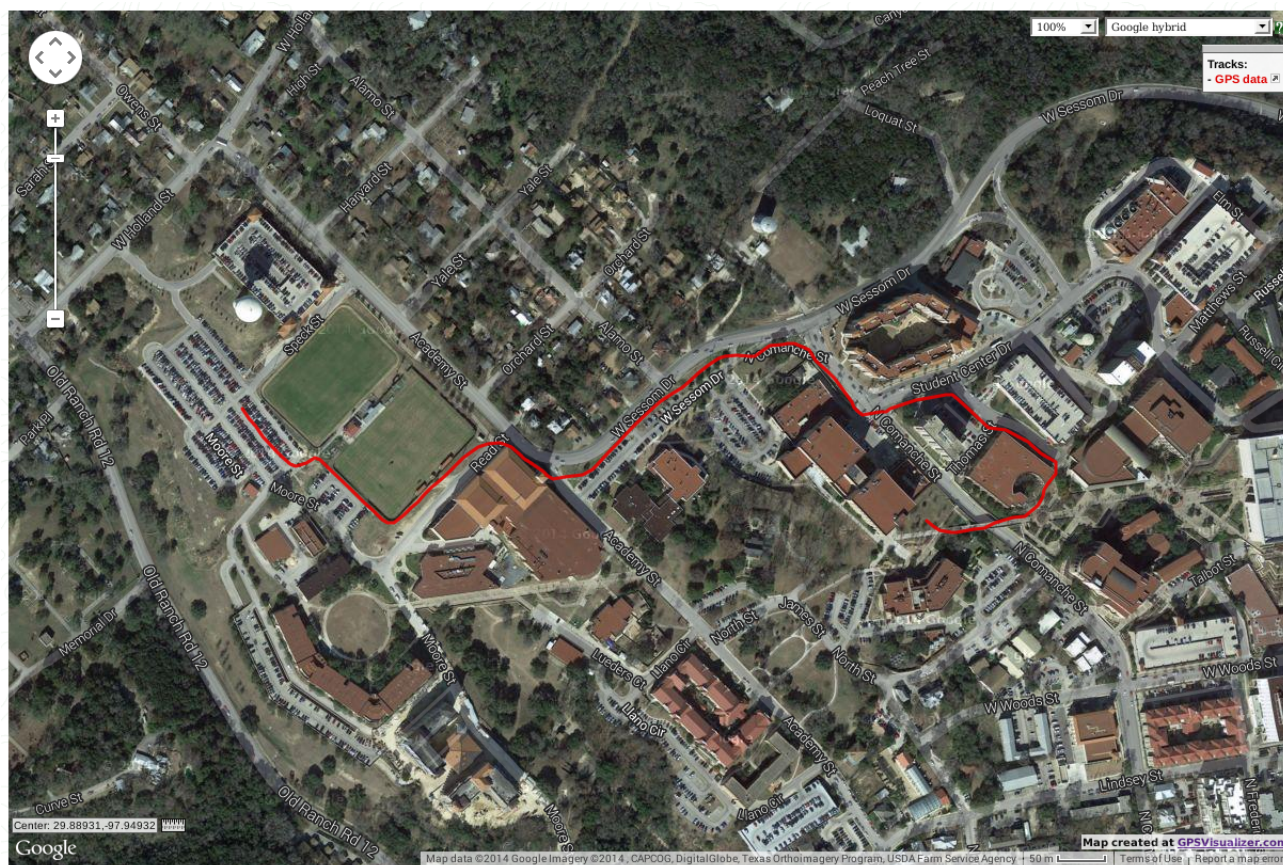


Fig. 1: Path Taken Around Campus

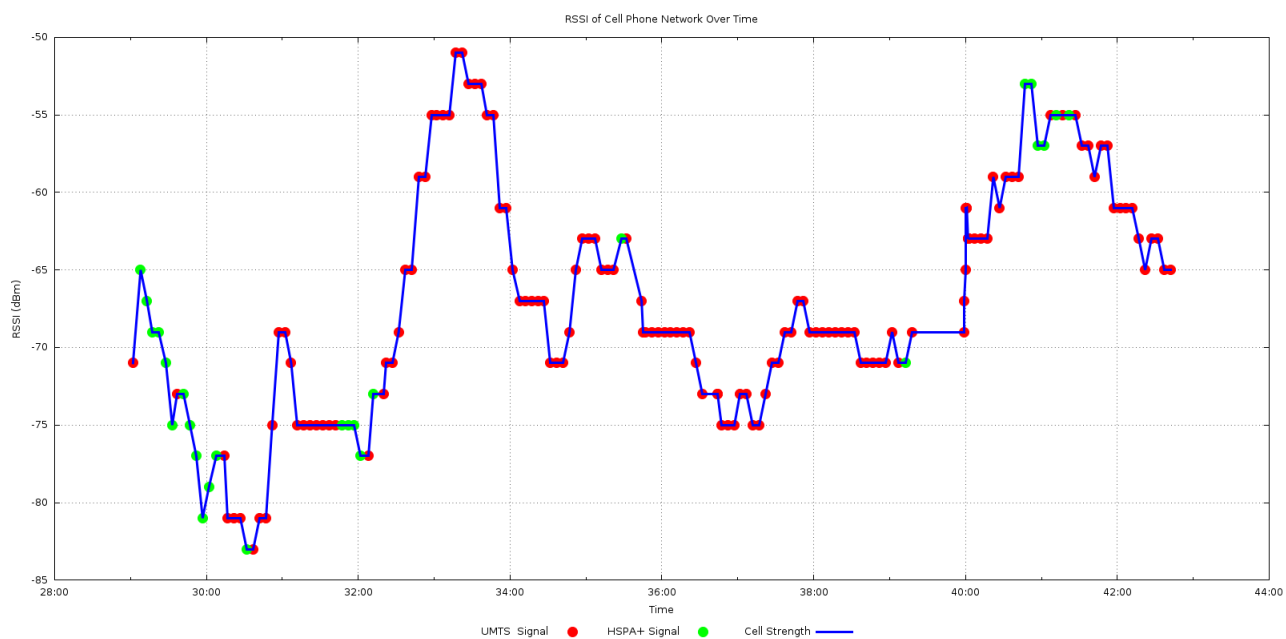


Fig. 2: RSSI of Cellular Signal Over Time

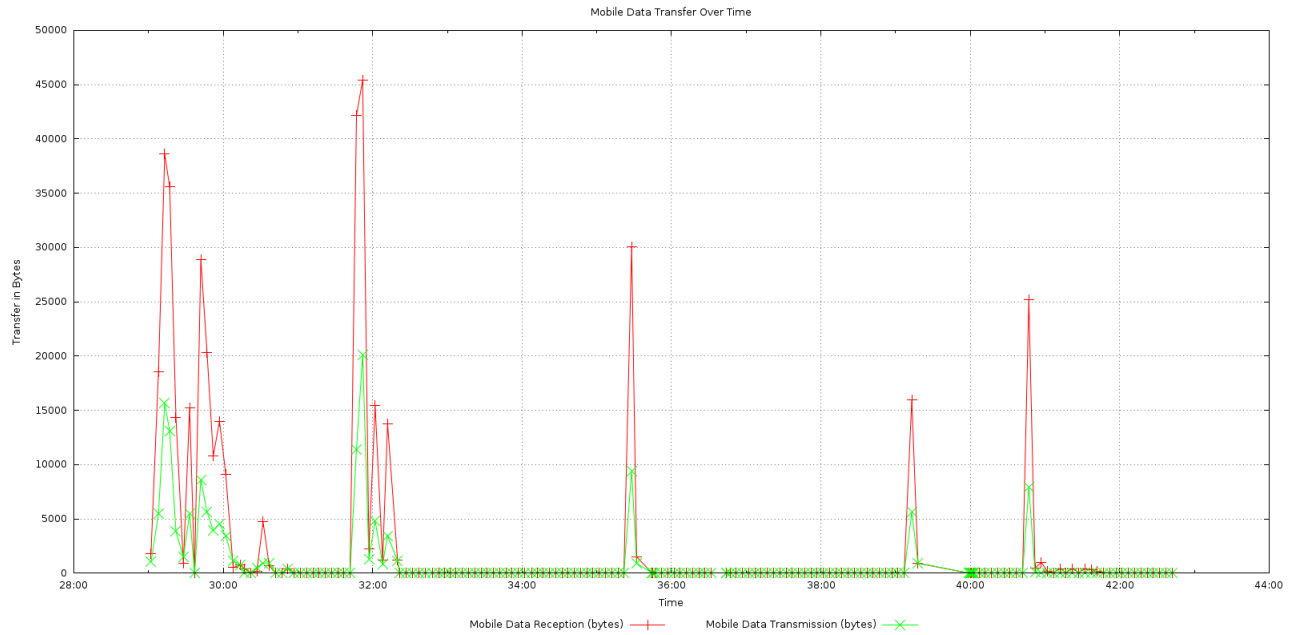


Fig. 3: Mobile Data Transfer Over Time

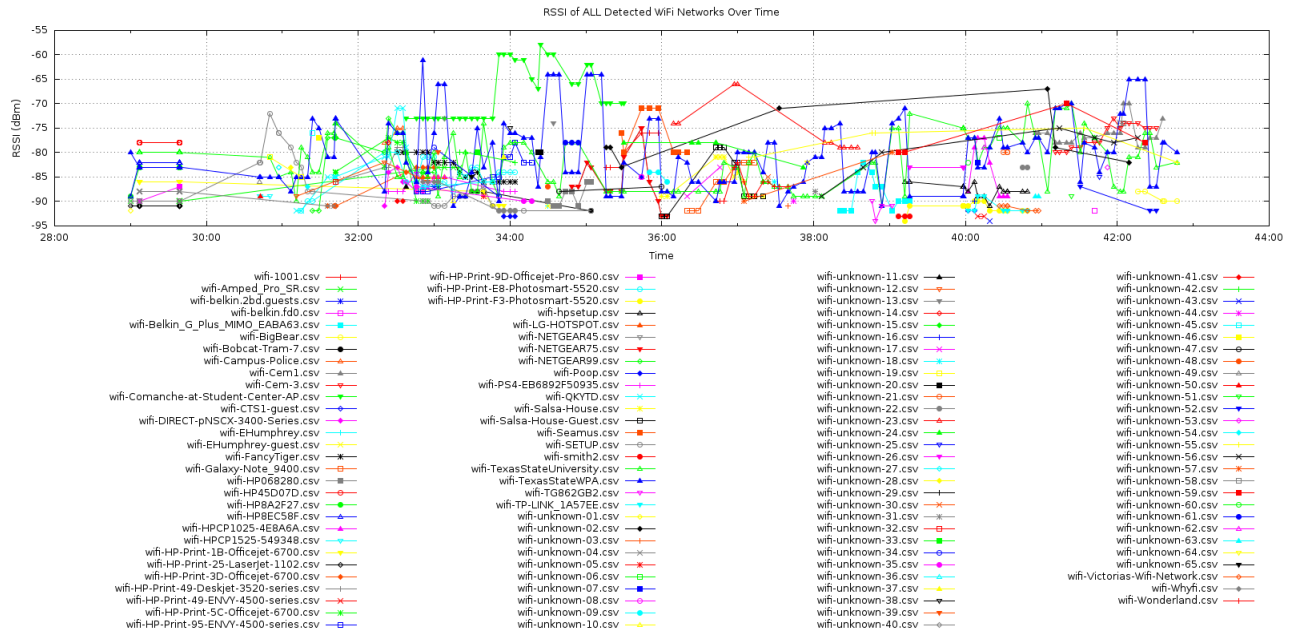


Fig. 4: ALL WiFi SSIDs

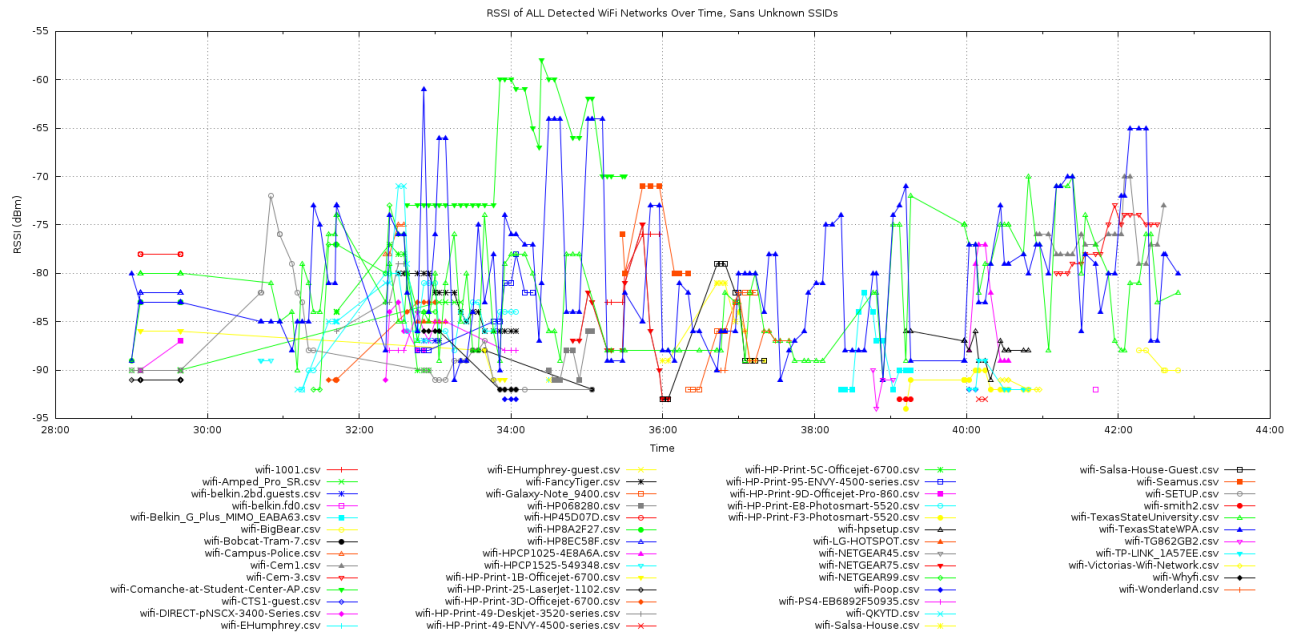


Fig. 5: All WiFi SSIDs Except Unknowns

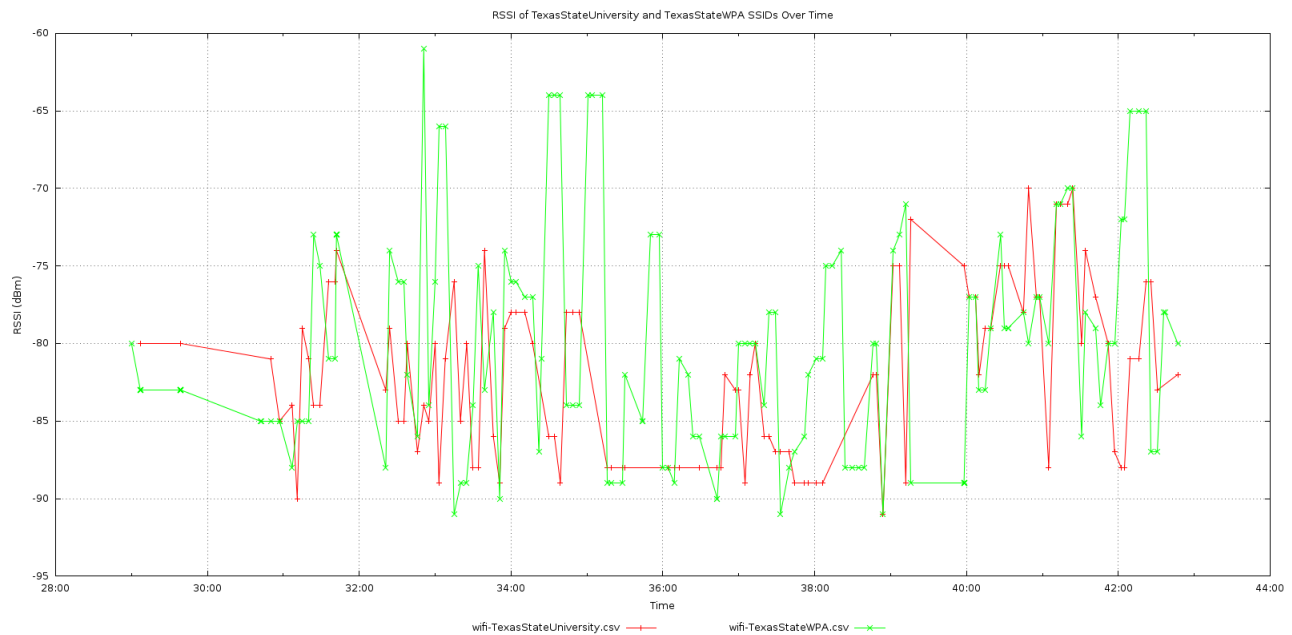


Fig. 6: Texas State Wireless Network (TexasStateWPA and TexasStateUniversity)

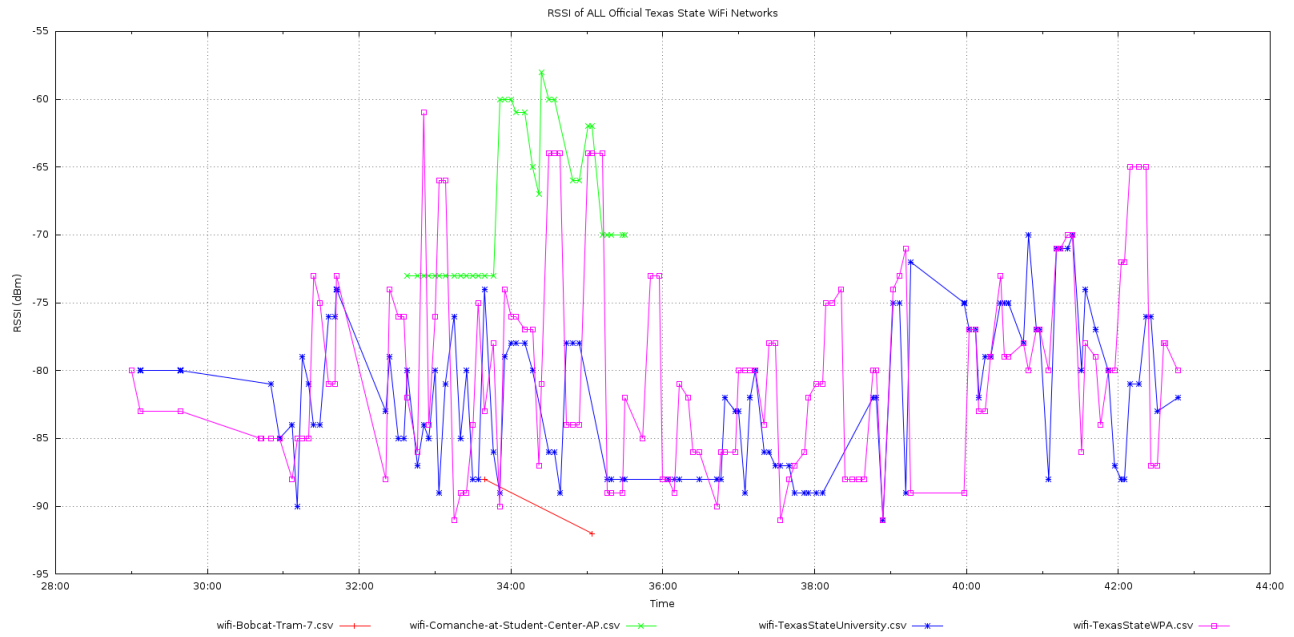


Fig. 7: All “official” Texas State Wireless SSIDs

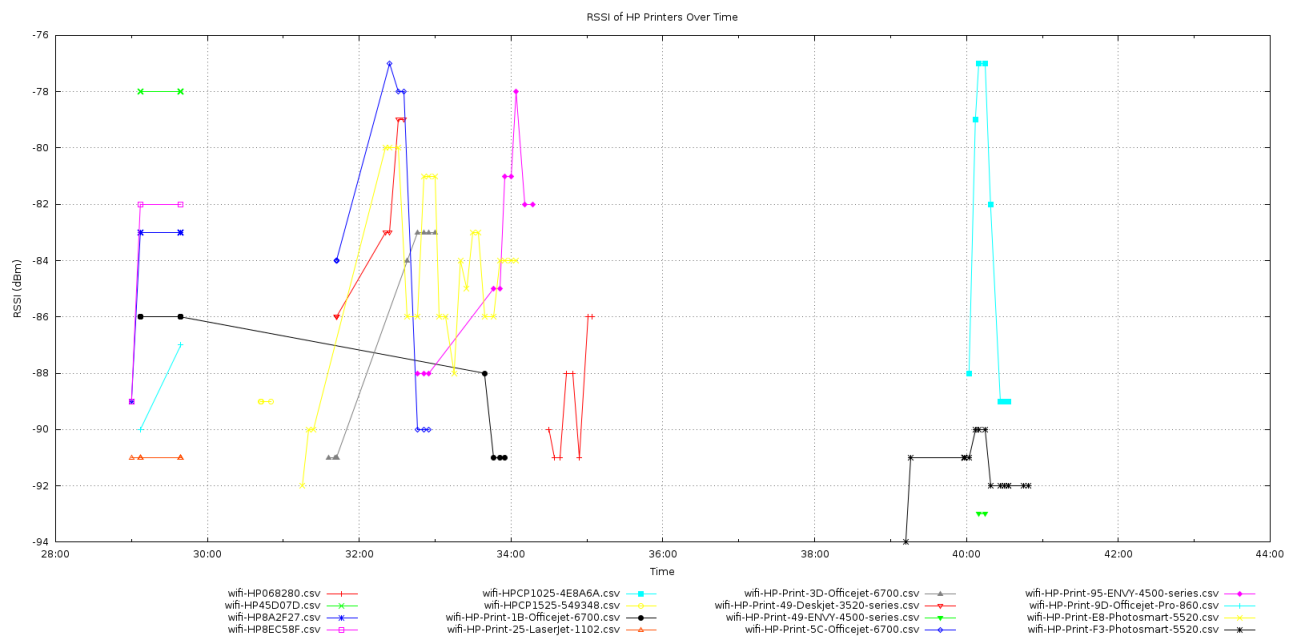


Fig. 8: WiFi Printing Devices

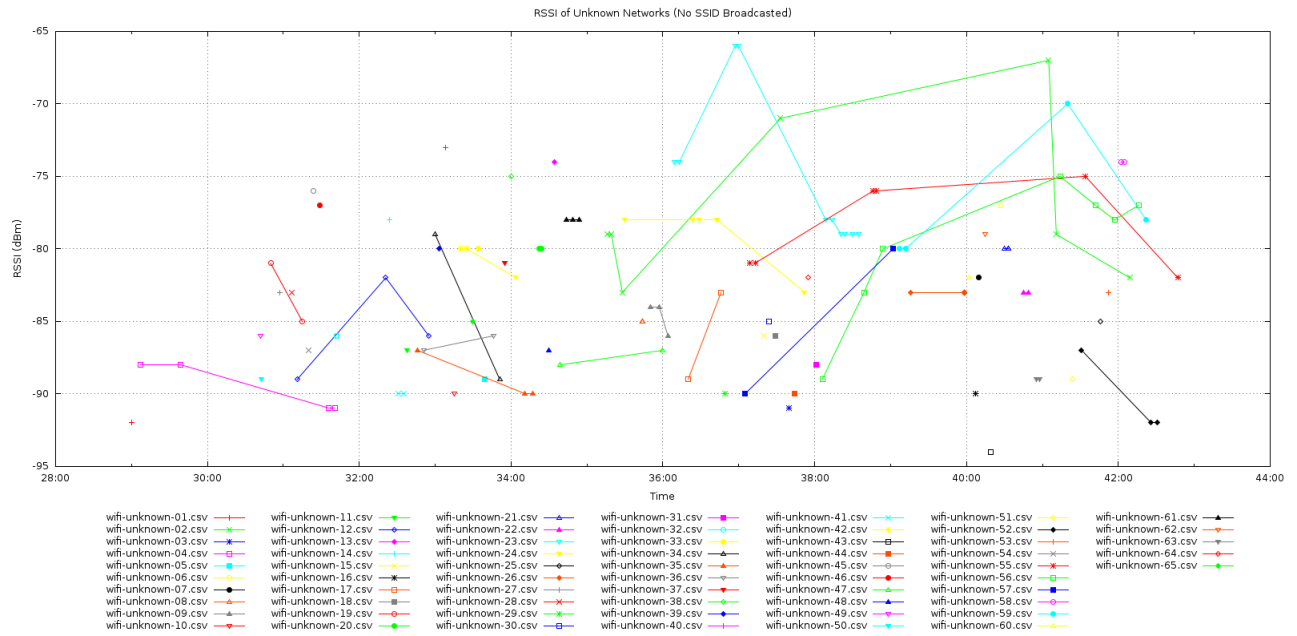


Fig. 9: WiFi Signals With No SSID (Unknowns)