Pi Based Signal Activity Monitor

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Introduction

The project consisted of the research, design, implementation and results analysis of a wireless probe system that could effectively provide insights into the 'busyness' of a given area by monitoring openly available 802.11 Wi-Fi traffic. Initial results prove a clear correlation in the number of unique MAC addresses recorded and the number of people in an area, opening up exciting future possibilities for the deployment of such a system in a university setting.

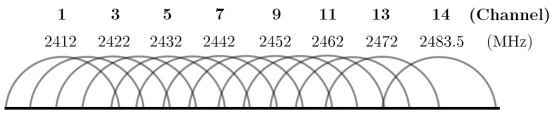
What is Wi-Fi?

Wireless local area network (WLAN) technology based on the IEEE 802.11 Standard.

IEEE 802.11 defines a range of protocols, commonly used ones are 802.11b/g/n. These operate on 2.4GHz (b/g/n) and 5GHz (n only) frequencies.

The 2.4GHz frequency, which was focused on for this research, is split into 14 channels.

Communication is sent in the form of a WLAN packet, which contains a 802.11 frame. When a device sends a packet, a specific channel is used, devices that are listening for WLAN packets will only receive packets that are sent on the channel that it is listening to.



Probe Requests

A probe request is a type of frame (specifically wlan.fc.type_subtype eq 4) sent by client devices using active discovery mode, such as smartphones and laptops, to wireless access points (APs). Probe requests are used by devices to see if there are any known APs that they can connect to. Devices send requests and await a probe response from the access point.

Client devices in active discovery mode may send out many hundreds of such requests throughout the day, in order to connect to Wi-Fi access points quickly and maintain connectivity [1]. Whilst many Wi-Fi communications are encrypted, probe requests are available for any network interface in monitor mode to inspect.

System

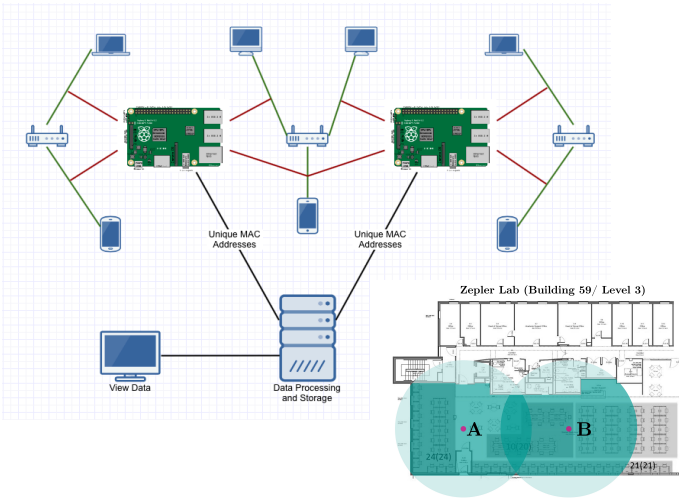
Consisting of two components, client wireless probes and server, the system collects, processes and stores the source MAC address plus other metadata from probe request frames that have been captured.

The client probes are Raspberry Pi 2 computers that run Python scripts. A hi-gain TP-LINK TL-WN722N is put into monitor mode and it's operating channel is continually changed to cover the entire 2.4GHz spectrum. A separate thread then captures and stores frames of the probe request type, attempting to send the results to the Google App Engine based server every 15 minutes.

The server processes results, only retaining the result with the highest signal for each unique MAC address in each time period – enabling the use of multiple wireless probes. Results are stored and can be accessed through a simple web interface at http://jawsfi-soton.appspot.com/.

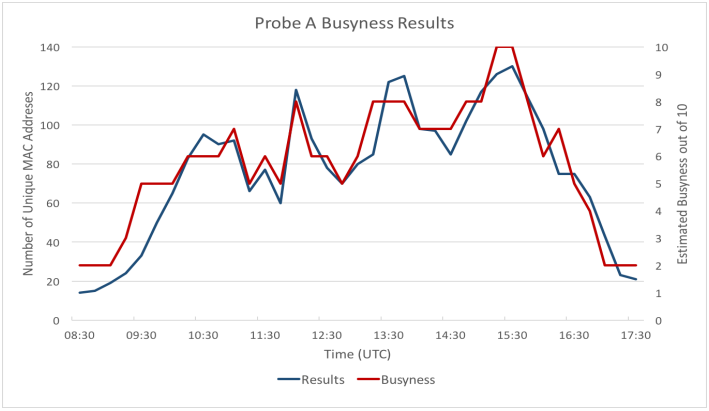
By monitoring the number of unique MAC addresses making probe requests in a given area, the system is able to provide an insight into how busy an area is due to the correlation between unique MAC addresses and number of people present.

System Architecture Diagram



Results

In order to evaluate if the system could effectively measure the busyness of an area a test was conducted over the course of a working day. Two probes were placed in the ECS labs and switched on to monitor probe requests and send the results to the server. Additionally, recordings were made to estimate the actual busyness of the area each probe was in, out of 10. A graph was produced plotting the number of unique MAC addresses detected over the course of the day, along with the actual busyness of the same area. The initial results show a clear correlation between the busyness recorded by the system and the number of people present – confirming the effectiveness of the system.



Usage

The majority of users are unaware that their mobile device may be transmitting probe requests that can reveal information about their presence and whereabouts. There are several commercial solutions available that provide analytics for public locations that utilise open probe requests. With additional work, the system produced could easily be used in the university to provide students with live estimates of how busy workspace environments are.

References

[1] Freudiger, J., "How talkative is your mobile device?: an experimental study of Wi-Fi probe requests" in Processings of the 8th ACM Confrence on Security & Privacy in Wireless and Mobile Networks., WiSec '15., New York., NY, 2015.

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