Case Study Evaluation: Using 5GHz and 802.11ac in congested 2.4GHz airspaces

By Pranay Pancholi, Loughborough University, September 2014

Background

Loughborough University is one of the country's leading Universities. It spans over 437 acres of land, making it the largest single site University in the United Kingdom. Loughborough University boasts internationally acclaimed research, excellence in teaching, strong links with industry and unrivalled sporting achievements, helping to secure its naming by The Times Good University Guide 2014, as University of the Year for Sport. Loughborough University has over 2200 wireless Access Points (AP) installed on campus and various off-campus sites to support and deliver a comprehensive, reliable and leading edge wireless network. In supporting the requirements and needs of users in various research departments, IT Services is consulted about various topics and offers advice on specialised requirements.

1. Introduction

This case study focuses on a request from academic departments to assist with final year student assessment and viva demonstrations. This is achieved by moving away from the use of privately created wireless networks within the local department and instead using University infrastructure and hardware.

2. Description of Work

The School of Electronic, Electrical and Systems Engineering department at Loughborough University contacted IT Services to discuss various options to provide infrastructure and hardware, to help overcome wireless connectivity obstacles during student assessment and viva demonstrations. Students are set a specific physical task to solve, with a number of custom-made robots to accomplish the task. The students are tasked to develop and demonstrate a bomb disposal system with the use of robots that should be capable of moving between two points - a base and target location - multiple times. Robots must carry out these tasks:

- Follow a marked route
- Lift items
- Retrieve items
- Monitor visual feeds

The robots can be operated remotely. Some of the student groups may build a robotic system that requires communicating wirelessly over a wireless network. These devices cannot connect and authenticate using eduroam, therefore a privately created network using a pre-shared key was set up. Previously, two TP-Link Wireless N Access Points were configured to serve as a private network operating in 2.4GHz mode at a maximum bandwidth of 150mbps.

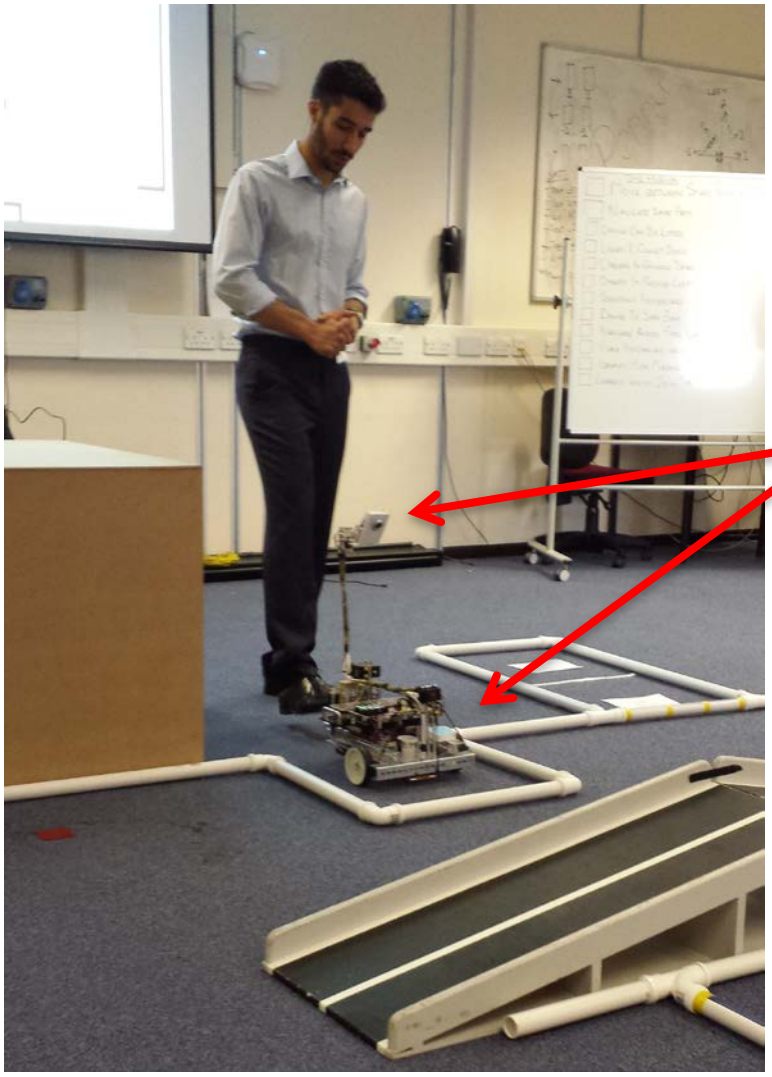
A specific netblock of 16 pre-allocated IP addresses was provided to various student groups, ensuring that it did not conflict with the other groups whose assessments are conducted simultaneously.

The two APs were put into two separate rooms next door to each other, on channels 1 and 6. Lastly, Go Pro wireless cameras are used within the demonstrations to enable live HD video of the robots' activity to be streamed to multiple iPads.

3. Findings

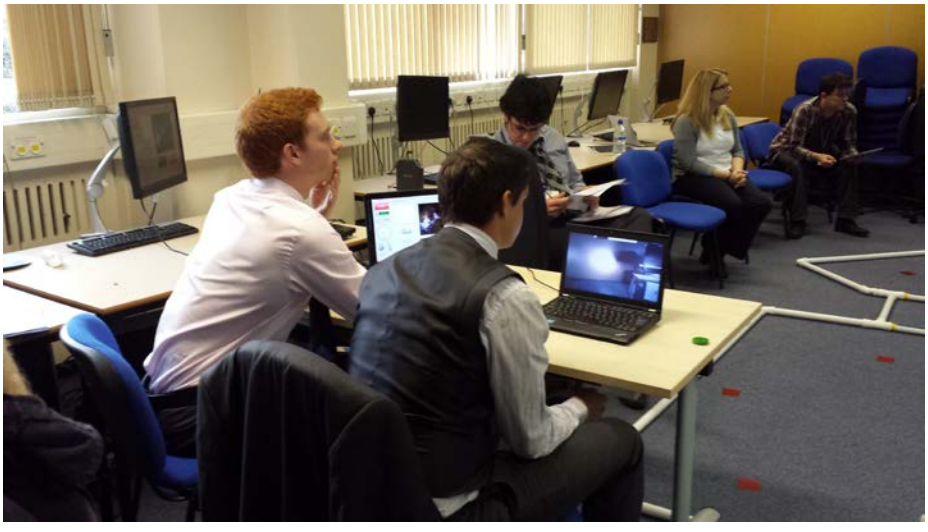
IT Services had the opportunity to sit in and observe whilst various student assessment demonstrations were taking place. As part of the observation, we decided to run various wireless scanning tools such as a spectrum analyzer called Chanalyzer with a Wi-Spy DBx dongle. This is used for scanning RF signals and is able to identify interferences from non Wi-Fi activities. A Fluke AirCheck was also used. Wi-Fi Explorer for Mac OS X was also running; this is able to scan, monitor and identify conflicts on nearby wireless networks.

A standard configuration for a group's assessment featured a radio controlled robot, controlled remotely by a wireless TP-Link TL-WR702N Nano router in client mode, which would connect to a pre-configured router with an allocated static IP Address. A wireless camera was used to provide a live visual feed from the robots. Robots are controlled remotely often by using Microsoft Xbox games controllers. A typical configuration of a robot can be seen below.



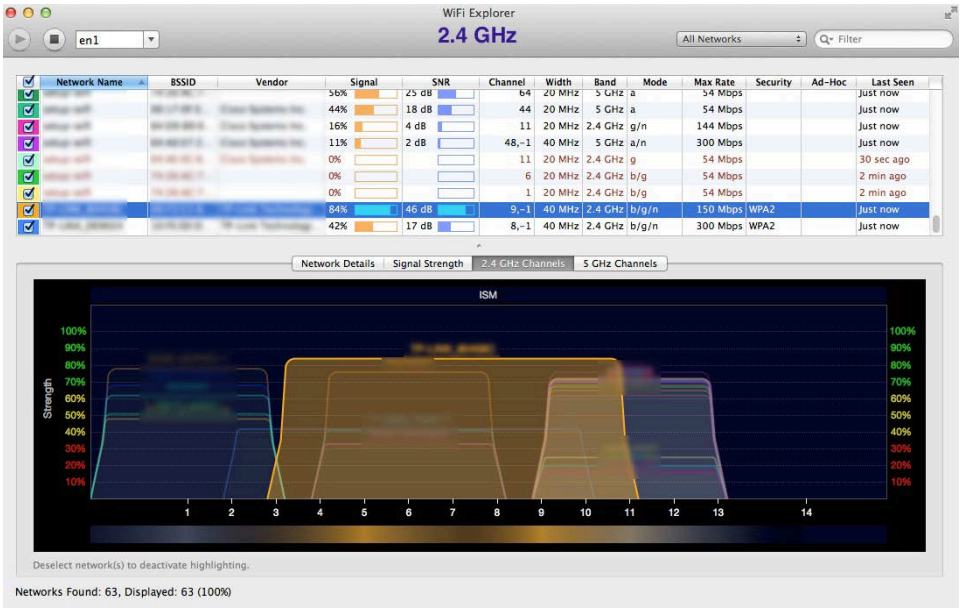
Robot with wireless camera with a TP-Link Nano router to send video streams from robot to remote computer.

The live video feeds from the camera placed on the robots are then viewed remotely on laptops as seen below.

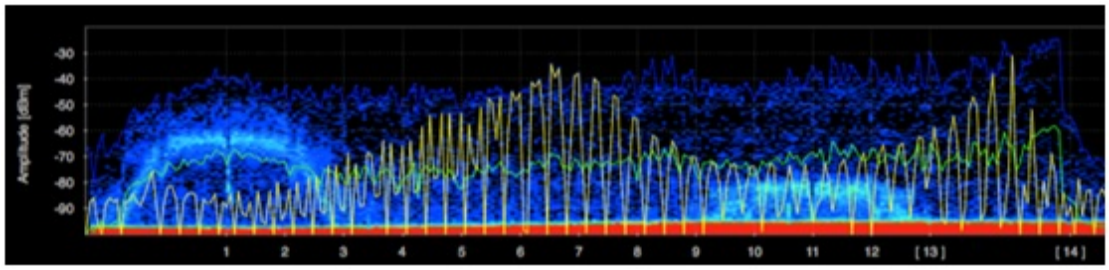


A short video of groups controlling the robots can be viewed here: https://community.ja.net/videos/controlling-robots-congested-airspace

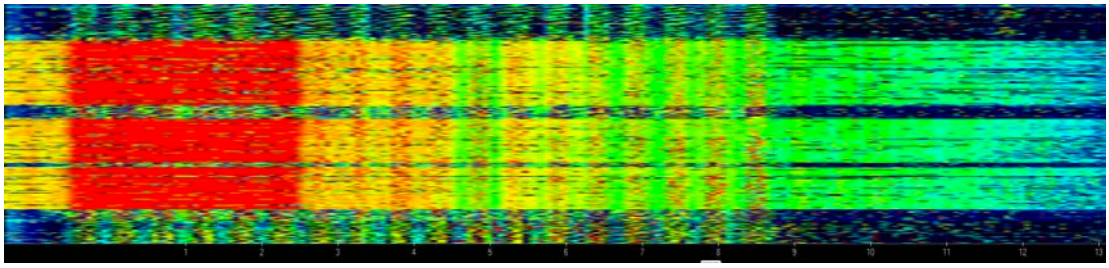
During the live demonstrations we discovered that using the 2.4GHz air space is not recommended due to AP overcrowding across all of the channels. This is shown below using WiFi Explorer for OS X. As well as the standard University wireless networks APs, there were various other unknown APs also shown on the list; some of these overlapping channels are shown below. As Go Pro cameras were used to create an Ad-Hoc connection to iPads to be able to view the visual feeds, this added another 4 devices within the already congested 2.4Ghz spectrum as seen below.



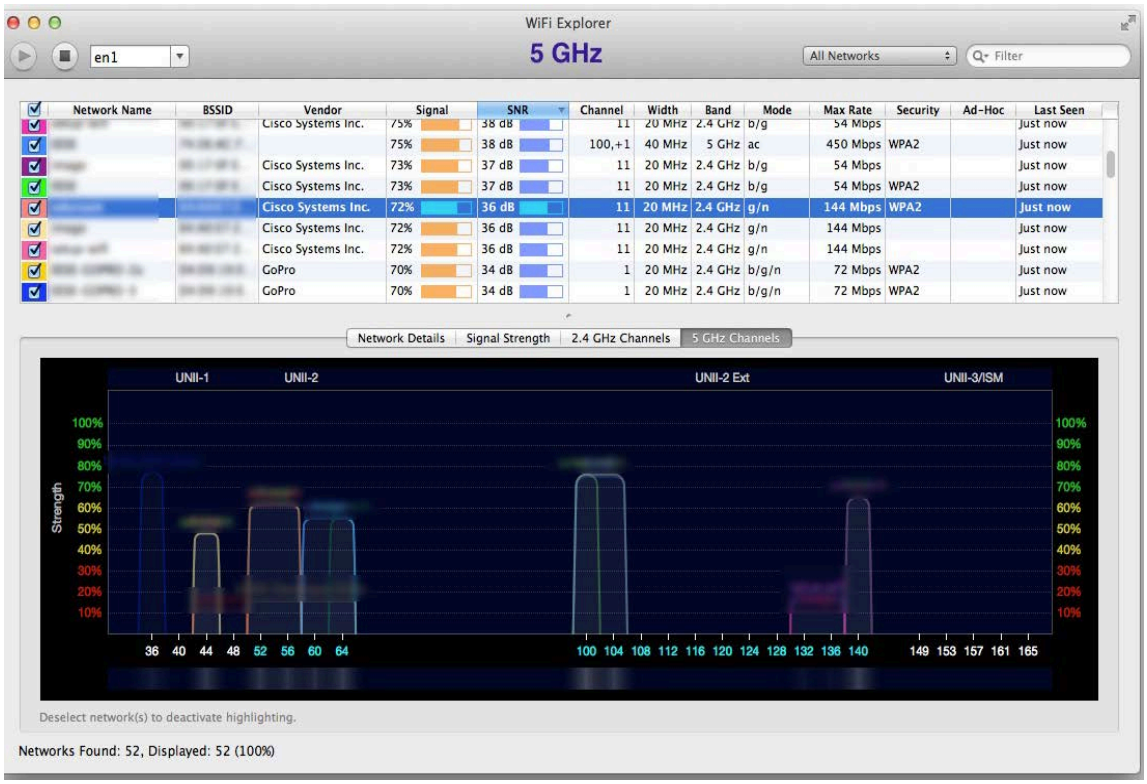
We used Chanalyzer to spectrum-analyse the area whilst the demonstrations were taking place. Whilst running the application we could idenfity non Wi-Fi emitting sources that were causing interference, leading to dropouts during the assesments. The source of interference was high and was caused by another group's live visual feeds.



The waterfall view in Chanalyzer showed the interference appearing in short bursts.



Whilst monitoring the 5GHz spectrum using Wi-Fi Explorer we could easily identify that it was not heavily utilized, as seen below.



To provide more of a resilient workable solution, improving robustness of the service to help minimise impact of any future interference and eliminating the number of frequent dropouts, it was decided that all future demonstrations should use 5GHz with supported 802.11ac support.

To provide infrastructure it was decided that the department should purchase 3 x Cisco Aironet 3702i 802.11ac APs to meet demand for critical wireless needs. These were installed into each of the demonstration rooms. Each of the APs received their uplink from a gigabit switch. The existing solution that involved using TP-Link routers was removed. A new private wireless network with a new SSID was created and only applied to the three Cisco 3702i APs with use of a pre-shared key.

It was strongly advised for future demonstrations that student groups should use newly installed hardware that supports 5GHz with 802.11ac in conjunction with their robots; this will by then replace any pre-existing 2.4GHz routers. As there are many existing nearby APs feeding other rooms of the building it was decided to have their transmit power levels decreased to stop any wireless signals penetrating into the demonstration rooms, helping ease spectrum congestion.

Once the new infrastructure and hardware had been installed we were able to sit in to another demonstration with students using the new infrastructure and another group wishing to configure their own. During the demonstrations we found that groups connected to the new infrastructure hardware saw no problems with respect to connectivity, dropouts, interference, lag and latency. A post spectrum analysis found no interfering sources whilst using 5GHz.

4. Summary

From our findings in this scenario, where client devices that are operating in an overly congested 2.4GHz spectrum and wish to move to the 5GHz spectrum, we believe that the following should be undertaken prior to any changes:

- Spectrum Analysis of areas concerned during real use to check for any interferences caused by non Wi-Fi emitting devices.
- Wi-Fi scan or survey area for any nearby APs that may be affecting the same channel numbers.
- Decrease power levels on any nearby APs to avoid signal penetration into potentially affected rooms.
- If installing 5GHz supported APs with 802.11ac, ensure client devices can also support connections at 5Ghz with 802.11ac.

This evaluation has only focused on the scenario as explained in the description of work. Other situations under different circumstances may require alternative solutions.

5. Contact

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