Constantine College Wi-Fi design

Background

Constantine College is a 600 room student residence forming part of the University of York Campus East. Wireless and 100Mb wired network access is provided to all study bedrooms using HP Procurve 2620 switches and Aruba access points. The vast majority of wired ports go unused with most devices connecting to the eduroam Wi-Fi network. Throughout the buildings the APs were wall mounted and primarily cited in the corridors with additional APs in some shared kitchens. Aruba ARM was used to automatically manage AP channel and power settings.

Figure 1 - Satellite view of Constantine College

The IT Services network team had received relatively small numbers of complaints regarding Wi-Fi performance. These were dealt with on a case by case basis with various remediation strategies attempted including: changing AP TX power levels, resetting the network configuration on the client device, upgrading of Wi-Fi chipset drivers where possible. In many cases IT staff found making a small change resolved the complaint, or on attending the student's room no issue was observed.

Ultimately it became clear there was a high level of dissatisfaction with the network performance. This was all discussed on facebook groups and few, if any, of those experiencing problems reported the issue. Students' accommodation costs included an itemized line for network services, refunds were demanded and the university's CIO became involved. With the network clearly failing to meet requirements a full assessment of the design and performance was commissioned.

Diagnosing problems with the existing network

I found there were no indications of any issue with the wired LAN, and all tests showed this deployment to be performing as expected.

The location of the AP-135s presented numerous problems. Inappropriate mounting meant units with a down-tilt omni antenna, designed to mounted on the ceiling were instead placed on the wall. This resulted in an inappropriate antenna pattern often creating a coverage hole in rooms behind the AP and increasing the amount of RF bleed between floors.

Excessive inter-floor coverage and siting the APs in corridors resulted in minimal signal attenuation between APs. The radio resource management then reduced AP TX power to the lowest configured levels on 2.4GHz. Despite this, with multiple APs in a building all being RF neighbours on 2.4GHz, and to a lesser extent 5GHz, channel contention was a significant problem leading to deterioration of the network performance at busy times.

The ensuite washrooms of the study bedrooms were fabricated off site as a drop-in 'pod' and caused higher RF attenuation than the rest of the building construction. This was not taken into consideration and on some floors corridor APs were centred on the washrooms.

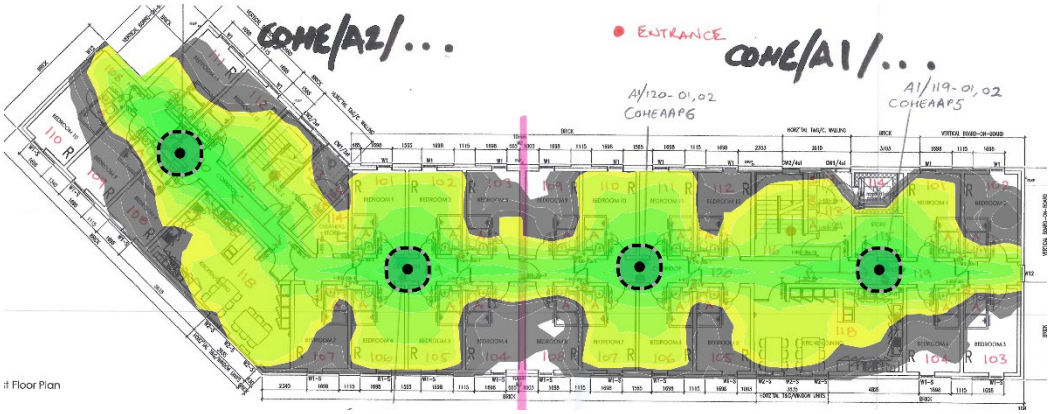

Figure 2- Predictive model of original design at 5GHz

Figure 2 shows an example predictive survey of the original design at 5GHz created after I'd taken wall attenuation measurements and noted the power output settings of the APs. This pattern of poor coverage was found to closely match the users' experience.

The flawed design was the result of institutional habit – placing APs on walls dated from using models with external or adjustable antennas. Placement in corridors had long been standard practice and in student accommodation it was deemed preferable not to require access to study bedrooms for maintenance.

This design initially appeared to perform adequately but it's likely previous residents having problems with Wi-Fi connected to the wired network in their room. As the wired NIC became less common in many laptops, the poor Wi-Fi performance would become a greater challenge.

Almost to ensure clients had the worst possible experience, band steering was enabled on the network which would attempt to identify 5GHz capable clients associated on 2.4GHz and move them to 5GHz. This resulted in devices repeatedly being kicked off a marginal but working connection.

A new design

My redesign focussed on 5GHz coverage providing -67dB RSSI reported by the reference device (iPhone 5) in the work and rest areas of the study bedrooms and shared kitchens as shown by the areas in green on figure 3. Capacity requirements were vague but based on traffic in student residences across the campus, a relatively modest 5Mb/s sustained throughput would meet student expectations.

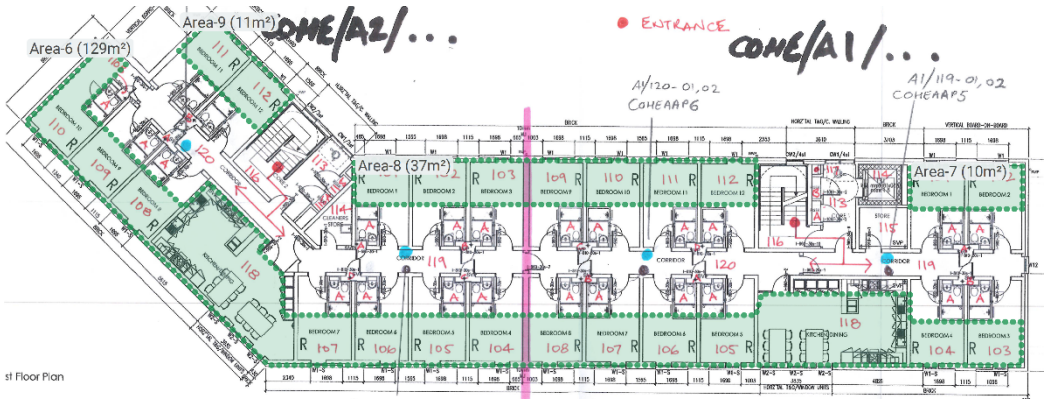

Figure 3 - Required coverage areas

I moved all APs to the study bedrooms, putting the AP closer to the users and making better use of the attenuation offered by the building materials for channel reuse.

With each room having a double network outlet no additional cabling was necessary and wall plate / hospitality APs could be installed with minimal disruption. This placed the AP at desk height avoiding potential RF attenuation from furniture.

Measurements of the walls between rooms showed these to be 5dB at 5GHz meaning RF passes better between rooms than from the corridors to the rooms in many cases.

Figure 4 shows the AP layout of the new design. In this predictive model I kept power levels low in order to ensure the coverage map produced was conservative.

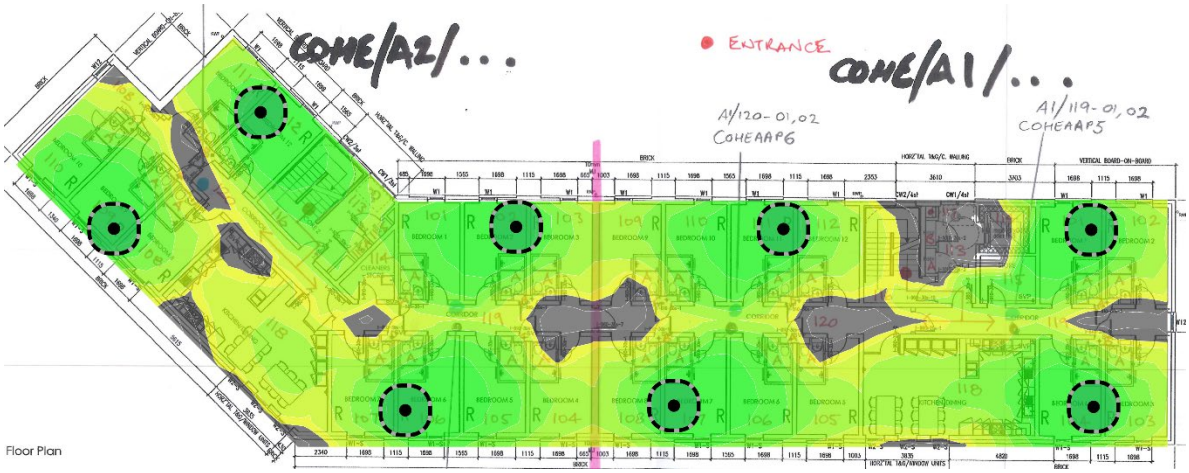

Figure 4 - New design 5GHz signal strength model

Roaming was not a factor in this design so secondary coverage was not considered. As a result, in many areas the failure of an AP would result in a coverage hole until repaired, which was considered acceptable.

Whilst my design close to doubled the number of APs deployed, by taking advantage of the building attenuation to reduce cell sizes it was possible to reduce channel contention whilst increasing network capacity.

High SNR allowed for consistently high data-rates to be achieved and reduced channel contention increases access to airtime.

The above design, tested and ultimately deployed without modification, resulted in a transformed network experience for residents of the college. The only problem this presented to the campus network team was an expectation the same design would then be deployed in all other residences.