A Whitepaper by Jon Foster

July 2019

Refreshing the Approach to WLAN Design

Executive Summary

This whitepaper describes the significant shortcomings with the industry standard methodology for designing 802.11 based wireless (Wi-Fi) networks (WLAN's), and the problems that these cause. It outlines some of the reasons why this is so, and suggests an alternative approach which removes many of these issues from the design process.

In short, these issues arise from:-

- Methods of data collection
- Work carried out by engineers without the required knowledge and experience
- Problems with supply chain business processes.

And they cause issues ranging from reduced network performance and a shorter network lifespan to, in the worst cases, a WLAN the cost of which is *vastly* inflated with many extra access points (APs) deployed than required, or simply not fit for purpose.

This paper then describes (at a high level) an alternative approach for designing Wi-Fi networks that should result in higher network performance and in many cases requires significantly fewer engineering resources to produce. Although more experienced and more highly qualified engineers are required to work using this method it should still provide a competitive advantage to those suppliers choosing to employ it.

Note that primarily this paper deals with WLAN design *outside the Comm's Room* – that is, it deals with identifying the required numbers for and mounting locations of wireless access points (APs) and not configuration of WLAN controllers and other service elements.

The target audience for this paper includes hands on WLAN designers (engineers/consultants), engineering managers, operations directors and perhaps most importantly, those procuring WLAN design services.

Note that the approach suggested here does not represent a "Methodology" which can be followed directly; such a work would be far beyond the scope of a whitepaper. Instead it provides ideas and examples to provide contrast to the prevailing standard.

A Whitepaper by Jon Foster

July 2019

“RF” Network Design

In this document I refer to “RF Network Design”. This is to distinguish the process from the process of “WLAN Design” which typically refers to the design and integration of WLAN equipment (controllers), AAA infrastructure monitoring solutions so on. This document and the processes described within are primarily concerned with understanding how many wireless access points should be deployed, what types should be used, where they are placed and how they should be configured for optimal operation. Typically this is referred to simply as a “Site Survey”.

The “RF” refers to “Radio Frequency”, however the processes described here actually involve a significantly wider scope than just elements of “RF” (Radio Frequency).

How Wireless Networks Are Currently Designed

Today the majority of wireless network are designed using either an “On-Site “or a “Predictive” RF survey (sometimes called a “Desktop survey”).

Whilst the exact details in how these processes are conducted will vary from company to company (and indeed, from engineer to engineer) the general principles are the same. This document focuses on the On-Site RF Survey, although many of the criticisms of the traditional on-site RF survey apply to desktop surveys equally, and relying on a desktop survey only (with no visit to site at all) is not engineering, it is simply guesswork.

The Traditional On-Site Survey

In the first of the traditional approaches to RF Network Design, an engineer (typically quite junior) is sent to visit the site where a new WLAN is required. Equipped with a laptop or tablet running a piece of specialised software installed on a laptop (commonly, “Ekahau Site Survey”, ESS). The engineer uses this software to record the strength of signals (RSSI) from Wi-Fi frames (“signals”) that are transmitted from an AP mounted on a tripod (sometimes this method is called an “AP on a Stick”, or “APoaS” Survey). The tripod is placed where the engineer thinks a sensible place to put an AP might be, and then they walk around the local area while software records signal strength of frames received from the AP. These transmissions get weaker as the engineer gets more distant or as obstacles between the AP and the survey engineer absorb or deflect the radio waves. In this way, the engineer is able to build up a map of the area covered by the AP at some RSSI value or greater. (This might be called the AP’s “Coverage”. The site survey software can display this data in heat maps, typically showing bright green representing strong RSSI and other colours showing progressive weaker signals.

Once the coverage from an AP has been measured, the engineer will move to another area outside the coverage area (cell), of the first AP and repeat the process, covering a different area until the entire floor plan has been covered, “complete coverage” having been achieved, as shown in the following example.

Figure 1 A floorplan showing complete RF coverage from a number of APs

Using this technique, an engineer can identify placements for between around 10 and 20 APs per day. It can often take 30 minutes or more to set up and completely map out a single AP location.

A report is then produced by the RF Survey software showing all the AP locations alongside heatmaps showing the level of coverage achieved. Sometimes heatmaps showing the coverage from individual APs is also shown. This gives the customer confidence that the new wireless network will work as the network is providing “coverage” with good signal strength everywhere. Often this report is accompanied by photographs of the AP mounting locations.

The need to map each AP Location.

Using this method, it is absolutely critical that the surveyor walks the location for each and every AP to be placed. Failure to do so will mean that the final report will have apparent gaps in coverage. Where the surveying engineer decides to place an AP in a different location the area must also be re-surveyed with the AP in the new location to avoid producing errors in the automated reporting, or missing AP heat maps.

Technical Evaluation of the Traditional Approach

Executive Summary

The standard approach as described above is critically flawed for a number of reasons: -

- The process rarely includes a sufficiently detailed requirements capture
- Mapping every inch of every AP's coverage area is incredibly labour intensive
- The data collected has hardly any relevance to modern WLAN requirements
- The engineers used to conduct the process are not suitably qualified to produce designs which fulfil more than basic signals strength requirements.
- The surrounding business processes are typically missing some critical elements which undermine the potential to achieve good outcomes yet further.

This section describes these shortcomings in some detail.

Insufficient Requirements Capture

At the beginning of the process the requirements for the new WLAN should be captured.

In almost all cases only lip service is taken to understanding what the customer's requirements are. Where requirements are specified, they are taken at face value with little detail and little or no critical evaluation.

For example, a customer may suggest that the new wireless network needs to support "voice" traffic. This is likely to simply be copied down and a few basic design criteria applied without further questioning or analysis. Engineering requirements for a network which needs to support a busy call centre over Wi-Fi will be very different from needing to support the occasional Skype call. Without extra information we cannot be sure that we're going to get the design right and are at risk of over or under engineering.

Similarly, the phrase "High Density" is used to describe how much wireless network capacity is required. Often this might be included in a design guide or RF Survey report. On its own the term High Density is meaningless and is open to subjective interpretation. We should be asking what High Density means. How many users must an AP support and how was this number arrived at? What is the wireless network going to be use for? What applications are going to be in use – both now and in the future? We should ask whether people be using wired connections too, or is the building going "wires free"?

All of these questions and many more should be asked. The answers will make a huge difference in the amount of network capacity required and the features which should be configured on the equipment once installed.

Figure 2 - Complete coverage, but with enough APs ... or too many?

To illustrate the point further, consider this example. The image to the right shows the coverage area (the coloured area) from a single AP within an open plan office.

This AP covers a large part of the office on its own. It is conceivable that coverage could be achieved with as few as 3 APs.

But, how many APs do we install? Is simply providing “coverage” enough? Maybe we need to install a few more? Or double the number?

Figure 3 - Coverage from a single AP

Without a detailed requirement capture we might miss the fact that perhaps this space is used to host events twice a year: - All the desks cleared away and hundreds of guests arrive, all requiring Wi-Fi access. Will the network be able to connect up all these devices in this scenario?

Without knowing detailed capacity requirements, we could easily install too few or too many APs.

Clearly, insufficient data capture will lead to significant risks and the possibility that solutions are over or under engineered – inevitably that the wrong number of APs will be deployed.

This criticism can apply to all types of WLAN design project, no matter what approach is used to collect RF data: - without a sufficient requirement capture, the rest of the design is just guesswork.

The Data Is Meaningless

Perhaps the largest issue with the standard approach is that the data collected is both almost completely irrelevant and completely insufficient to guarantee good network performance.

The author suggests that it only has value only to provide a false assurance to customers that their new network will work. Because they've seen the painted green heatmaps showing signal strength across their entire site is above some level, they have been informed represents "good coverage", and therefore the Wi-Fi will be good.

There are a number of reasons why this data is irrelevant and insufficient.

Firstly, let us consider what data is collected.

Per-AP Heat-Maps

As described above, most designs are now 'High Density' and driven by network capacity, not signal strength. Yet for the majority of RF surveys the only data that is collected is signal strength readings from an AP on a tripod in order to create a heatmap showing coverage for each AP and then aggregated RF readings for each entire floor of the site being surveyed.

Now, consider the coverage shown in the examples above. Clearly the AP shown covers a wide area. For a capacity-based design, the next AP is likely to be relatively close by – certainly well within the coverage cell for the first AP, and it will cover much the same area. And the same for the next AP, and so on. So what value is there in laboriously walking through the entire coverage area each time just to map it out?

In fact, this data is used erroneously by engineers to determine the next AP location. With little training, no knowledge of the capacity required and only an understanding of meeting a signal strength requirement the engineer will use this heat map of coverage to determine the *next* AP location. The engineer knows where coverage goes from one AP so can work out that the next AP should be put some distance further on, possibly to satisfy some immeasurable percentage of "coverage overlap".

The word *next* above is emphasised because it highlights that this second AP will have its position identified based on the position of the first when in fact these APs are utterly independent – the correct location of the second AP should be calculated based on a large number of other factors before signal strength is even considered – such as the requirement for adequate network capacity.

A note on cell sizes

There is one argument for creating heat maps for each AP. In theory, they do help identify where clients will "roam", however doing this correctly is a very advanced wireless design method, and the heat-maps need to be engineered for specific client devices. This is well beyond the skillset of the average Survey Engineer, and so is not a reason for creating Per-AP-Heat Maps.

A note on labour saving

A variant of this approach is not to walk the complete coverage area of each AP and to simply walk "forwards" across the floor of the building and survey areas yet to be covered by any AP. This saves a lot of time allows some kind of complete coverage map to be produced in lieu of a map of coverage for each AP. However now the engineer is literally only doing enough to "Paint the map green", and although this does allow an engineer to survey up to 50 APS a day the data produced is of very poor quality and will not support any analysis of metrics beyond simple coverage, including coverage from a secondary AP.

The Collecting device is nothing like actual WLAN clients

Another reason that the data collected by the standard approach has little value is that typically, the data collected in a Site Survey is done so by a specialised USB network adapter such as the (Proxim ORiNOCO 8494 adapter) rather than a client device which will actually be used on the WLAN. This adapter gives RSSI readings which can be significantly different to the majority of clients which will use the WLAN.

The below images demonstrate this. The first is the signal strength reading from a transmitter on Channel 1, reading at -63 dBm. The second is that same device, taken moments later but as seem by an iPhone SE, and it reads -74 dbm, a difference of 11dBm.

Radio	SSIDs	Tech.	Data Rt.	Ch.	Sig...
Sagemcom Broad...	BTHub4-576K	b g n	1-54M	1	-63

Figure 4 - RSSI taken from Ekahua Site Survey

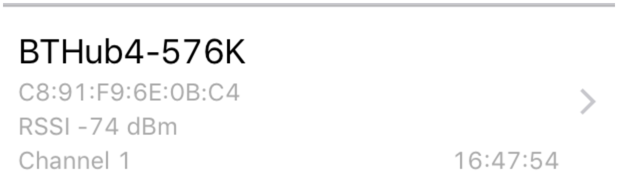

Figure 5 - The same transmitter, received by a smartphone.

This is not an outlining extreme example but is absolutely the norm for virtually every device which will connect to the WLAN.

Consider the implications of this. If a specification is agreed with a customer, say the ubiquitous -67 dBm or above, if it was tested with an iPhone SE or similar client, in this example it would fail that test and the supplier could be called in to rectify the situation. Even where sufficient caveats have been included in relevant contract documents the fact remains that any iPhones on that site will bring down the network performance and reduce available capacity.

Results from different Survey Network Cards models vary significantly

In 2017 Ekahau, manufacturer of leading site survey software *Ekahau Site Survey* changed their USB NIC-300 to a newer “SA-1” survey adapter based upon a different chipset. The readings from this adapter are reportedly up to 5 dBm different for the same received signal. Yet the majority of the industry simply moved from one adapter to the other without adapting to this change. This illustrates that the level of knowledge in the industry is poor enough that the difference in signal readings from one adapter to the other was not even considered despite the fact that any WLAN surveyed with one rather than the other would show with a signal strength 5 dBm better or worse!

Readings from **the same survey card** vary significantly

A further problem is introduced when a survey is conducted quickly or by inexperienced staff. Failure to collect enough data can significantly reduce the accuracy of the survey as RF signals received by this type of equipment vary in strength moment to moment.

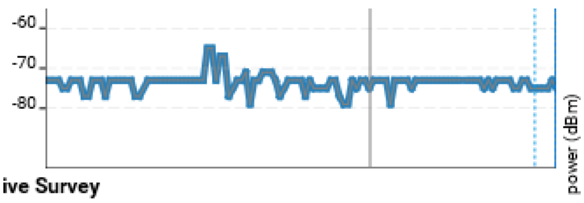

Figure 6 - RSSI (static source, receiver) changing over time

The image here shows RF signal from a static source changing over time – received by a static Ekahua NIC. You can see that the signal is changing by as much as around 15 dB, from as low as -80 to as high as -65.

Over time this will be averaged out, but if too few readings are taken then there is a risk that the results will not be representative, being either too high or too low. Therefore, care must be taken, and survey work should not be rushed to meet high “APs surveyed per day metrics”. Caution should be used when sending out an engineer who does not have a good understanding of the data being collected.

Mostly AP Power is set using Default “Auto power settings”.

If you are not yet convinced that the data collected by the average RF survey has little relevance then consider this:

During the RF Survey and engineer will have an AP set to transmit at a set power level for each radio. Changes to this power level will result in changes to the RSSI at any point in space – lower power will result in a smaller “cell size” and lower RSSI at any point in space. Higher power will create larger cells with larger RSSI.

But this power level is rarely reported in RF Survey reports and rarer still is it configured on WLAN equipment that actually goes into service.

The vast majority of installs instead rely on computer software (such as Cisco’s “RRM” and HPE Aruba’s “ARM”) to set AP power levels. If the default settings are used these can vary considerably, resulting in APs running with power levels vastly different from those used to create the heat maps on which the design was signed off. So even the most painstakingly accurate RF survey can immediately be rendered irrelevant the moment the network is made live, simply because the correct settings were never entered on the software controlling the APs.

Over Engineering for Safety

The above factors also help incentivise the designers to over deploy APs for safety sake. IF the only metric being measured is RSSI then it makes sense to ensure that RSSI is going to be well within the agreed limits – or risk having to re-visit site and repeat works. This could well result in extra APs deployed beyond those actually required.

This may not seem to be so big a sin until you consider the fact that with only a relatively small number of unique Wi-Fi channels to operate on, it is quite possible that these extra APs may re-use channels and not add any network capacity at all. The overheads incurred from their broadcasts might even be *detrimental* to performance.

Oops I did it again!

What happens if, during a site survey, the RF engineer realises they’ve made a mistake and they need to make a change right back at the beginning of the site? Perhaps they have realised that there is going to be a gap in coverage, or perhaps they have surveyed to the end of the building and the final AP location is just not quite able to cover that last room adequately. Are they going to go back to the start and do it all again, shuffling up APs and re-surveying? Or perhaps they could find some other locations for the last few APs in order to resolve the problem?

No, this is very unlikely. If AP locations are changed then to complete the coverage map properly they may have to re-survey each and every location. With easily 30 minutes required to do a single AP for a

Per-AP heat map there is no way that an enough engineering time is going to be available to re-do it. The answer is just to pop another AP in the small gap and the problem goes away.

This is hardly good design practice for an enterprise quality network (but given the alternatives, you can hardly blame the engineer). Placing APs with so little consideration makes a mockery of the whole process and costs the customer money.

Labour intensive

Having to walk the route through each AP location is very, very laborious. In order to ensure that the heat map is completely covered, the engineer must walk through the entire coverage area. Consider the room you're in now. Put an AP in the centre of it. Will that AP provide coverage to the room? In all but the largest rooms the answer is undoubtedly, 'yes'. Yet for the standard survey the engineer *still* has to walk the perimeter of the room and perhaps up and down the middle of the room too if it's large enough Failure to do this can leave gaps on the heat-map which may be questioned, despite the fact that there is an AP actually in the room.

The result of this is a relatively small number of (around 15) survey locations completed in one day.

For high density Wi-Fi deployments this can represent a very large resource and therefore commercial commitment for a relatively small area. Engineers have to waste time revising rooms and re-surveying, recording coverage for each AP. (I reluctantly admit that even the paint-it-green approach may be better than this huge waste of time and money).

Consider also that during this process, equipment needs to be powered 8 hours a day solid – multiple laptop batteries multiple survey AP batteries. This means that engineers need to be weighed down with multiple spares and often need to be very resourceful in hunting down places to charge laptop batteries whenever they get a spare minute.

Invasive

The process described above is unavoidably invasive. Even with low power settings a single AP will cover a large area when placed in an open environment or an environment where the majority of walls are partition walls. It is possible that where high capacity is required multiple APs will cover a single room. In order to map these effectively when creating per-ap heat maps the engineer may need to revisit the same room multiple times, once for each AP. In many environments this is very invasive -meetings have to be interrupted and in the worst cases a surveyor will be asked to return later – at the cost of a great deal of time. In some environments it is simply not feasible to conduct a survey in an area, or a lot of management overhead is expended in making arrangements – think busy hospitals, active teaching space, etc.

Reliance on automated reporting

Once the RF survey has been completed a report will need to be generated to show the results.

Quite often the only output a customer will receive is an automated report from the site survey software. Often this includes tens of pages of heatmaps with little or no explanation of what they mean. They do provide the illusion of value for money – as surely it must have taken a lot of work to produce such a lot of technical looking data, right?

The reality is that these reports hold little value beyond showing that some group of APs has indeed covered the area to some signal strength level. This ticks a single box in the "things which are required to design a WLAN" playbook but considering that these reports have hundreds of pages the majority is just filler.

In the worst cases these reports are actually simply wrong – containing very misleading information.

When a report is just composed of automated filler, what happens when someone needs to refer to the document to understand the design at some point in the future? What requirements was this network designed to fill, for example? Were any anomalies identified? Did the engineer have other concerns? What power settings were the APs on when the survey was conducted?

Hidden Sins

It is also possible to hide many sins behind a green heatmap.

I'd suggest that if you put enough APs into any area you will be able to provide a similar heatmap showing it's "all green", however good or poor the design is. You could double or triple the number of APs and show a green heat map. With this much over-engineering even a child could randomly plot spots on a map for AP locations and still achieve a green heatmap.

But clearly this does not equate to a well-engineered WLAN, providing the customer with value for money.

You can also tweak a heatmap to show green bits where in fact there is no coverage, or where an engineer did not actually survey by altering things like the 'accuracy level', or 'signal propagation assessment' value. The survey software will not interpret the lines on the map as walls or obstructions and is likely to paint coverage right over and beyond them in cases where the far side of such a wall has not been surveyed.

A note on "AP Resilience"

APs are often over deployed for another reason – adding "AP Resilience".

The argument goes that "50% resilient coverage" or "100% resilient coverage" should be deployed to ensure that if an AP fails that there is no gap in coverage. Although these measures are actually impossible to precisely measure, in practice this means that as many as double the required number of APs will be deployed somewhere in the building in case APs fail.

And that means double the number of cable runs, switch ports, AP licenses, etc.

Whilst it does make sense to eliminate single points of failure, nowhere else in the deployment of edge network infrastructure do we see this? Do we protect against network switch failure by deploying double the number of data ports everywhere and marking one for "backup"? No. Instead we have a robust process for reporting and resolving IT equipment failures in good time.

Although not generally published, I believe AP failure rates for enterprise class APs is probably somewhere around the 1% mark within any AP's lifetime.

So I'd suggest that rather than massively over provisioning APs to cater for some failure scenario we simply monitor their status and have a process in place to quickly resolve any outages.

No spectrum analysis

Spectrum Analysis is a technique which allows a suitably equipped engineer to 'see' what energy is present in a particular part of the radio spectrum, using a specialised tool called a Spectrum Analyser. A spectrum analyser allows an engineer to see how much non-wi-fi interference is in an area (such as that caused by a Microwave oven, baby monitor or microwave PIR sensor). With the right training an engineer can identify sources of interference and judge whether they will have an impact on the performance of a wireless network. In some cases, this can be tracked down to an exact source, in other situations it can simply be reported on as a 'heads up' to potential performance problems in the area.

The reality is that spectrum analysis rarely is conducted as part of the standard WLAN survey process. Customers rarely ask for it because they don't know what it is, and therefore it's very easy for a supplier to simply not include it, saving on the hassle of sending a suitably trained engineer to do the survey.

If this activity ISNT performed, then it leaves the risk that some interference will be present which will have a negative impact on future WLAN performance. Whilst in some cases this is unavoidable (say, the interference comes from a neighbouring building), it is still important to know that it's there prior to the network being installed.

It should be noted too, that the standard Survey Engineer is also likely to have no idea what spectrum analysis is, how to conduct it and how to interpret the data collected.

Lack of Wi-Fi interference analysis

Similarly, to the above, it is important to collect and analyse data relating to how much Wi-Fi interference there is in an area from competing Wi-Fi transmitters. if no analysis of Wi-Fi interference is completed whilst the site survey is conducted, then a customer could be blindsided to some very severe performance problems once a network is deployed – despite achieving wonderful levels of signal strength across every square inch of the site.

This is especially true in tenanted offices where your WLAN must compete with the neighbours.

A good piece of interference analysis should not just present data, but also include some narrative explaining what the impact is likely to be. Even if this does not enable a customer to fix the problem, at least when performance problems do appear due to Wi-Fi interference, they're not unexpected and the supplier isn't immediately in the frame for installing a faulty product.

And consider that it often takes a number of months for troubleshooting to play out before a supplier is called back in, and longer still before someone finally identifies this as the root cause of a problem.

Poor configuration

Without the proper understanding of the 802.11 protocol suite, client capabilities, capacity requirement and so on it is not possible to ensure that equipment (APs and WLAN controllers) are correctly configured.

Typically, this includes configuring very in-efficient settings such as "80 MHz wide channels" because on the surface of things it would seem logical and gives each client a very high data rate. Quote often this is simply an install time default and nobody knows to change it. This type of configuration setting is one of a number which needs consideration by a suitably trained engineer in order to make Wi-Fi operate efficiently.

In some cases where the survey engineer has suitable experience, set power levels for different APs can sometimes be considered and find their way into install time installation scripts, but this is rare (as described above.)

A summary Example

The pages above describe a *lot* of issues. The example below pulls these issues together to illustrate how they might work together to cause problems.

ACME Media Corporation has asked 5-Star Wireless to complete a wireless site survey for their corporate office building in London. The design needs to provide support for voice traffic and needs to be high density. The design will be based on either HPE Aruba or Cisco Systems hardware.

5-Star Wireless suggests that a coverage level of -67 dBm is required for voice support, with 30 users per AP. It will be designed by using an AP on a Stick site survey. A Wi-Fi survey is completed and the design is tested, signed off and installed.

3 months after the network is switched on ACME senior management become aware that users are complaining about poor Wi-Fi. RF Survey files are reviewed and it is found that coverage meets the specification agreed.

5-Star are called back and asked to conduct a follow up RF survey. This survey showed that coverage is *still* good, producing another set of “all green” heat maps. 5-Star are off the hook, having done ask asked by ACME, but the WLAN still does not work.

Here is a summary of some of the mistakes that led to this situation.

1) No requirements capture was completed. No analysis of what voice applications are in use was undertaken, no which devices were to be used. “High Density” was not unpicked to determine exactly who would be using the Wi-Fi for what.
2) The RF Survey engineer simply counted desks on the floorplan to determine AP numbers, assuming 4 users per desk. In many of these areas most users relied on wired connections and so 4 times as many APs were deployed in these areas than were required.
3) No analysis of interference was conducted and therefore nobody spotted that non-Wi-Fi interference was killing performance of the 2.4 GHz frequency band, or that the 5 GHz band was subject to issues created by poorly configured neighbouring Wi-Fi.
4) Default settings were used to configure the network, including 80 MHz wide channels and automatically assigned AP power levels. This lead to lots of co-channel interference and other issues, especially as users frequently connected to highly oversubscribed 2.4 GHz radios.
5) The large numbers of APs and random power levels were among factors that lead client device to make very poor decisions regarding ‘roaming’ from AP to AP as users moved around – including roaming to the 2.4 GHz radios.
6) No testing of Quality of Service was completed resulting in voice calls not being given priority over bulk data traffic.

But How Can This Happen?

How then, if the quality of work within the WLAN industry is so poor, why do suppliers get away with it? Surely if things were this bad there would be so many problems that suppliers would be called back to fix problems?

The answer is simple. The IEEE 802.11 (Wi-Fi) standard is designed to work in unlicensed frequency bands which are a “free for all” and therefore many protection mechanisms are built in to ensure that no matter what, data will get through in the end. As such, suppliers are unlikely to even be aware that their Wi-F designs could be sub-standard.

But just because it works, it does not mean it is working well. As load increases a poorly designed network becomes ever more at risk of a hard failure scenario where increasing retransmissions exponentially increase until it effectively grinds to a halt.

This is illustrated by the graph below.

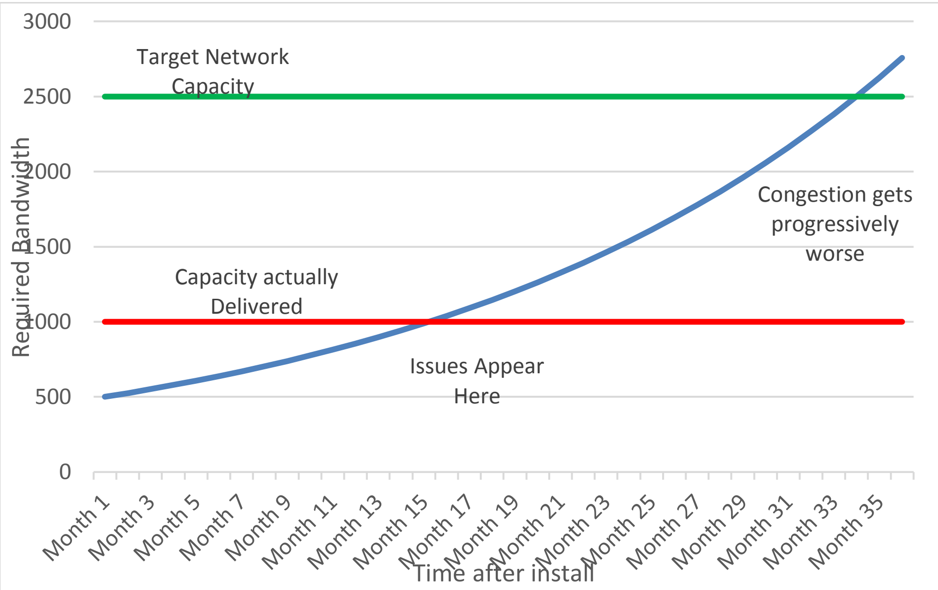

Figure 7 -Changing WLAN capacity requirements over time

The blue line represents actual demand for bandwidth for a company WLAN. When installed 500 Mbps is required, and this demand increases over time. A well-designed WLAN in this environment should be able to produce some level of capacity - here illustrated at 2.5 Gbps across all available channels with the customer’s mix of client devices, etc. However, the supplier has done a poor design which is only capable of delivering 1 Gbps.

Initially all appears well, basic tests using Speedtest.net show awesome client throughput (with 80 MHz channels) and the network is signed off. However, as time goes bandwidth demands increase and the network begins to struggle. Average speeds drop, voice quality decays and around a year later the first complaints start to hit the service desk.

In most cases the supplier who installed the network will be long gone by this point as the project to refresh the Wi-Fi is finished with the project was signed off as successful.

An alternative Approach: “Hybrid RF Design”

This section describes an alternative approach and how it solves the some of problems with the traditional approach to wireless network design.

Why “Hybrid”

The author has adopted the term “Hybrid RF Design” to describe this methodology, however did not coin the term. It really refers to the fact that the approach uses some on site “AP on a Stick” measuring but supplements this with other methods. Initially this tended to be the inclusion of a simulation built with Ekahau Site Survey however in practice this is only really required in more complex buildings with thicker walls (think: a hospital built in 1960). Now, with designs driven by capacity we rarely have to test to see “if an AP placed here will provide coverage to this bit over here”; it’s likely that “the bit over there” will require its own AP to meet capacity requirements anyway.

Why “RF DESIGN”

The term “Survey” leads to many unfortunate consequences. When you procure a “wireless survey” you only tend to pay for the time an engineer spends on-site, and “the survey” to be done as an isolated piece of work. By using the word *design* we’re encouraging a more holistic process – from correctly scoping at the pre-sales stage, consulting with the customer (the requirements capture) through to the active engineering process (“the survey”), installation and finally to operational support.

Comprehensive Capacity Plan

Whether done at the pre-sales stage or as a paid piece of consultancy (since it could be a couple of days work at least, for large projects), requirements must be gathered to allow proper scoping of the network. Arguably this is the most important part of the whole process process and should always be conducted in a form and scale suitable to the project at hand.

Ideally, the customer can be presented with a comprehensive report which describes what it is they say they want, what the implications are, and how many clients each AP may serve, both now and into the future.

This process ensures that the new network will deliver value; it shows APs are there for a reason and provides confidence that the supplier knows what they’re talking about. Customer expectations can be set, and a baseline AP configuration can be produced – critical information which needs to be given to the guys doing any on site surveying!

The level of detail can be altered to suit the size of the project – clearly a 10 AP project will not support a 2-day requirement capture process in all but the most extreme cases, but basic assumptions and calculations should be included to ensure that even in these scenarios the network is not over/under engineered.

A note on Applications

Part of the requirement capture process is finding out what applications are likely to be in use on the network. Unfortunately, the reality is that nobody ever really knows. It’s also very hard to know how much throughput people *actually* use on a network, so this information is like gold dust and should be sought out, accumulated and closely examined at every opportunity. Depth of experience with in some vertical pays dividends here.

On Site Data Gathering – Propagation assessment

When the requirements capture is complete (and ideally, signed off by the customer as accurate) the "Survey" can commence. For building projects this may involve guidelines as to where to put data sockets to support a future survey. It may also include a design in a tool like Ekahau Site Survey. The broad aim is to scope out the rough number of APs required according to the capacity plan, and approximate locations. It should then be followed up by on-site work when the project is suitably developed.

In all but the smallest projects, where financial pressures do not support on- site work (bad Salesperson!) an engineer should now visit site with a tripod mounted AP. The difference is, the data collected should inform the designer how RF propagates through the building, and does not have to be tied to the final location of an AP. (Indeed, you may not even know where the APs should go until you've conducted some assessments of propagation!)

It's hard to crystallise the experience down to a set of rules to follow, however the thought process used to understand RF propagation may include the following: -

- I'll place my AP here, so I can test penetration through these obstacles
- I can see that there are no RF obstructions in the open plan areas.
- And I can see that these partitions hardly block either 2.4 or 5 GHz radiation
- So, I need to be careful to minimise CCI… Lower power levels may be required
- But this one is pretty solid, I can use that to limit interference and cell sizes
- And I think I will need to recommend using 20 MHz channels…
- But I can see that there is literally no propagation through the floor, which will limit interference
- But there is lots of competing Wi-Fi across the street
- And I need to be careful to limit bleed between floors through that atrium

And so on.

This compares to: -

- I think I'll start by putting an AP in this room
- -67 goes out to here… so I'll need another AP somewhere over there…

As a rule of thumb, up to 1/5 of the survey locations required for a full AP on a Stick survey are required to complete a hybrid survey and as we do not need to paint complete heat-maps, the engineer must walk only routes which provide information – not complete thorough walks of an area. For example, if coverage reaches the end of a row of 5 offices, it's fair to assume that the rest of the offices in the middle will be covered if the AP is sited in the first office.

A note on flexibility

It should also be noted that the Hybrid process is much more flexible than the traditional approach. Because the engineer has much more freedom to choose where to site the tripod mounted AP, it is easier to survey building sites, confined spaces, operational buildings or any other area where either the presence of engineer (or tripod) is undesirable.

Spectrum analysis and Interference analysis.

Given that less time is spent performing the creation of low value heat maps, it is more likely that commercial limitations will still allow for Spectrum Analysis and Interference analysis to be conducted.

Spectrum Analysis, when conducted by a suitably qualified engineer will allow any non-wi-fi issues which may affect performance to be identified and the results recorded. Similarly, Interference Analysis allows an engineer to record any other Wi-Fi networks in an area and make a judgement as to whether they will have an impact on Wi-Fi performance.

Any interference identified may not be able to be mitigated, but expectations can be set, providing the Supplier with some degree of indemnity against future network issues which can be shown to be caused by other users (Wi-Fi or otherwise) of the unlicensed frequencies in which a customer's WLAN operates.

Advanced Features of the Hybrid Approach

The limits of what can be achieved and the amount of risk which can be designed out of a project are limited mainly by the knowledge level of the engineer (discussed later on). Advanced study could determine, for example, whether a particular competing network is actually busy or not, and from that gauge the impact it might have on performance. Other examples include: -

- Ensuring adequate secondary coverage to support client roaming
- Checking client support for DFS channels
- Propagation assessment from a typical client device,
- Optimising cell sizes
- Optimising a network to perfect hitless roaming.
- Testing end-to-end QoS (both Wired and Wireless)

Whether these tasks should be completed will depend on the use cases applicable to the network. A bulk data network may not require, for example, the testing of QoS markings.

Configuration updating

Another critical part of the hybrid process is ensuring that any relevant RF configuration parameters are fed into the configuration of the WLAN control software.

A number of these will need to be identified at the requirements capture phase, however some options such as AP channel and power settings or 5 GHz channel widths may need to be altered be based on recommendations made by the engineer who surveyed the site and included. These should be included in the RF survey report. Again, clearly a certain level of engineering skill is required to make these judgements, and this is required in order to squeeze the maximum performance out of the WLAN.

Because this rarely happens in practice, "Default config controllers" are in the majority and many networks are crippled by this despite any money paid for site-surveys and any heatmaps showing amazing levels of coverage. Again, just consider what happens when APs are left under the control WLAN control software's radio management routines. Without guidance from somewhere, these are likely to mean that the actual AP power levels and coverage areas are nothing like those suggested by heat maps compiled at site survey time.

Reporting

A good report helps both Supplier and Customer, providing both parties with a record the entire design/survey process. This should include what was observed on site as well as providing an opportunity for some narrative. An RF survey report should stand on its own and another party should be able to understand the contents and their implications without needing access to the individual who compiled it or completed the on-site works.

As a minimum it should include the following: -

- An overview of requirements and how these were acquired
- An RF specification with justification
- An overview of capacity planning (possibly as an appendix)
- A summary of results (the number of and types of AP required)
- A summary of observations and decisions made by the survey engineer
- An explanation of how coverage was achieved; showing propagation assessments taken
- Interference analysis from both Wi-Fi and non-Wi-Fi, alongside an impact assessment
- Recommendations for future and remedial actions
- Recommendations for suitable AP and WLAN controller configuration (with respect to AP radio management)

For larger projects it should include an executive summary to allow the critical points to be picked up and digested by both supplier and customer without having to wade through the entire document.

It should *not* include any heatmaps or other technical information that does not also include an adequate explanation of its meaning or relevance. Indeed, there is little value in simply reporting on findings without also presenting technically accurate conclusions and any relevant recommendations.

A suitably Qualified Engineer

Throughout this paper the term "suitably qualified engineer" issued. Beyond any specific technical shortcomings, perhaps the most important aspect affecting WLAN design is the level of expertise possessed by the engineer (or team) in charge of the design. This is true for networks of all sizes, for even the humble Primary (Elementary) School WLAN can be over/under-engineered by an unskilled engineer.

The Hybrid RF survey methodology does require a higher level of expertise to carry out but the output and designs created this way will improve in line with the skill level and experience of the engineer carrying out the work.

The big question is then, what skills and experience are required to produce an effective WLAN design?

We could argue about specific qualifications and never reach a consensus, but at **very least**, an engineer should understand all the concepts described within this document, however that is achieved! In reality this is going to take a number of years of work. Perhaps ideally all engineers would hold the CWNP's CWNA certification as this is currently the only widely available certification which covers the fundamentals of 802.11 Wi-Fi operations in any detail. Higher skill levels, such as engineers holding the converted CWNE cert' would progressively reduce risks, for example, that some facet of the process is done incorrectly, or some facet of the design overlooked. Engineers of this calibre and training are hard to come by and unfortunately not realistically obtainable for the majority of projects.

If working as “smart hands” as part of a wider team, an engineer may not need to be as highly qualified, but should be able to spot when the survey rig he or she is using is incorrectly configured or providing spurious data.

Vendor specific certifications (for example, Cisco’s CCNA-W or HPE Aruba’s ACMP) are also helpful and the engineer working on your project should have experience with the technology you are using, but it should be noted that the attainment of vendor specific qualifications does not in itself confer competence to complete an RF survey. Indeed, vendor courses only lightly touch on many of the aspects required for a good RF Design and this is arguably one of the main causes of the knowledge gap described in this document. They teach the “how to configure” not the “why you will want to configure this” of WLAN engineering. Vendor certifications such as these supplement those skills described above, but they are not in themselves sufficient.

An engineer possessing all these skills and of this calibre is going to cost more than another party who’s only received a basic understanding of RF survey software, but hopefully this document has made is clear why that knowledge is required. Whilst more expensive, such highly skilled individuals can be utilised across many business functions, adding value to Sales or Pre-sales or helping troubleshoot problems in support positions of for managed service customers. They are often self-reliant and require a lower management overhead to be effective.

Splitting the load

For larger projects, it is unlikely that the architect or lead engineer will be able carry out all the survey work; neither project timescales or commercials are likely to support such serial modes of operating. In these scenarios a team should be deployed where engineers acting as the “brawn” collect the data and this is reviewed by a more senior engineer who produces the final designs. In this scenario, the Brawn element only needs to be reliable and have the experience at performing some manner of on-site survey. This experience can be built upon such that collecting suitable data to support a Hybrid design can be trained relatively quickly.

This is especially useful in high density design scenarios where we know that APs numbers are going to provide blanket coverage very easily, but we need to test a few key areas and get a general appraisal of RF propagation.

Summary

This section has shown an alternative approach to RF Design in which a more highly qualified engineer a more ‘holistic’ approach to the design, starting with a detailed requirement capture, a more informative and efficient on-site survey process, followed by the generation of high quality bespoke reporting.

In the next section we will move on to consider the value proposition and any risks that a change of process might expose a supplier to.

Commercial Advantages of the Hybrid Survey

Given the huge technical limitations standard approach to WLAN design outline above and it's labour intensive nature the Hybrid methodology has clear advantages. However, we also should also consider whether Hybrid surveys are commercially attractive.

This section shows that given a level playing field the Hybrid approach could be significantly cheaper than the traditional approach. This is both in terms of immediate costs in survey effort and in terms of reduced risks and lower support overheads for the operator of wireless networks resulting from it.

This should provide a competitive advantage to a supplier looking to win bidding process against competitors who are only able to offer use the traditional surveys and design process.

In addition to commercial advantage in a bidding process, good pitch extoling the virtues of the Hybrid approach and the shortcomings of the traditional survey would certainly cause any potential customer to pause for thought when considering other possible suppliers: -

> *Hey, isn't this how those other guys said they'd do it… maybe we don't want that after all?*

First and foremost, let us look at how the Hybrid Survey enables a supplier to deliver a better value solution.

Better Value?

If, when the designing a WLAN the engineer is freed from restrictions placed upon her by having to laboriously create heaps of heatmap, suddenly resource (time) becomes available for gathering useful data. In the majority of cases, this resource release is significant and will bring down the cost of a project. This leaves the supplier free to decide whether to reduce the cost to the customer or improve the quality of the product (the wireless network design).

Assuming all other elements of the processes stay the same and no extra features of a Hybrid survey (such as interference analysis) were added then the cost in man days for delivering this a new network design can fall by around 50%, simply based on the number of APs which can be surveyed by an engineer performing a Hybrid survey each day.

Using the traditional approach, with uninterrupted access to site an engineer can, optimistically, map out 20 APs per day. Like for like (testing to ensure adequate signal strength will be achieved), a Hybrid approach would likely be able to complete as many as 60 locations in one day, and almost certainly, 40, depending upon factors such as the required WLAN capacity and the environment being surveyed.

If extra tasks such as interference and spectrum analysis are included, it likely that this number will be lower, but in most cases 40 AP locations can still be surveyed in a single day by an engineer working alone.

For illustrative purposes consider this example: -

> *Acme Offices have embarked on a WLAN refresh and wish to deploy a new enterprise WLAN in one of their office buildings. A capacity plan has suggested that 100 APs will be required, and the design should be capacity driven.*

Using the traditional approach, surveying 100 AP locations would take 5 days, with an engineer capable of surveying 20 locations in one day.

For a hybrid survey the engineer would likely be able to survey at least 40 locations in one day, meaning the engineer is likely to complete the task in 2.5 days. If the office environment consists of many open plan offices, this is more likely to be simply 2 days.

Time for extra services

The primary driver for this paper is not to save money on WLAN services. As such, I would expect a good RF Design process to include the extra services and tasks outlined above into the solution design process, rather than simply providing Hybrid RF Surveys that just deliver basic coverage. The examples above illustrate the difference in the cost of surveying every AP location but this extra time should be used to increase the technical quality level rather than simply reduce the cost of the survey

Risk

Some commercial risks may exist when considering any alternative to the industry standard (no matter how overpriced or poorly performing this standard is).

The industry reliance on signals strength heat-maps does raise a few issues and which the Hybrid survey method must be sure to address. Perception is king – if a potential customer of a Hybrid Survey sees risks in the process then the perceived risks should be addressed - whether real or not.

Technical Risks raised by the Hybrid Survey

Nobody got fired for buying IBM. it's a well-known phrase, meaning that you can safely follow the herd and do what everyone else is doing and if there are any problems you've got the excuse that "everyone buys it, it's a safe bet" as an excuse to defend your decisions.

A similar principle can be applied to the process of RF network design. Some might argue that you can safely follow the standard approach - it's a safe bet because that's what everyone else does.

In this section we'll see how this is not appropriate for the process of RF WLAN design.

Supplier Support

One reason a supplier may look to stick to the traditional approach to RF WLAN design is that they consider that any move to an alternative approach will raise the risk that suppliers of Wi-Fi equipment (HPE Aruba, Cisco, etc) may not back them if something goes wrong.

In reality it is unlikely that vendors of Wi-Fi network equipment will be unlikely to support any methodology at all and will insist that a supplier underwrite their own work. In the majority of cases the performance of the resulting RF network will show whether design is any good or not (eventually – see "But How Can This Happen", above). What data and how it's collected is not nearly as relevant as the results. Any network which exhibits problems for a customer may come under examination and in these circumstances the design may be examined with a fine-tooth comb to understand whether the supplier is culpable.

The standard AP on a Stick heat maps can be se to defend a supplier from criticism as they can show that the supplier has followed the standard process and produced a standard set of results showing "full coverage". However, the majority of reports for traditional surveys could well be picked apart by a suitably qualified engineer, and it is unlikely that having followed the pack (making the same mistakes) would offer any protection where shortcomings were identified.

Whatever design process is used must be clearly documented. In the case of a traditional survey, as the process is well understood the documentation could consist of a few lines describing the process alongside the heatmap outputs. In the case of the Hybrid survey, the survey report would need to stand on its own to describe the data it contained and how it supports the resulting design.

How do I know it works when there are no heat-maps of coverage?

With a Hybrid survey there *is* a risk that the customer will not understand the data presented from a non-standard report, especially where there is no overview heat-map showing that the entire area is covered with RF of a suitable colour as this is the one thing that a customer is going to intuitively look for to show the design is suitable.

This risk should be mitigated by managing expectations at the pre-sales stage. Sales and Pre-Sales teams can highlight how a report full of heat maps is actually very expensive to produce and bear little resemblance to reality.

If a customer is insistent on spending all their budget on Per-AP Heat-maps this should not be at the cost of other services. They would need to see and understand the extra caveats which would need to be attached to the design as a result, such as: -

- *No Capacity planning has been conducted and therefore the Supplier cannot guarantee that adequate bandwidth will be available to meet demand*
- *No interference analysis has been conducted and therefore the supplier cannot guarantee the planned network capacity will be available.*
- *No optimisations to support voice traffic have been included in this WLAN design and therefore the supplier cannot guarantee faultless voice performance or seamless client roaming*

Whatever method used to conduct the work, in each case the data collected must lead the customer to the conclusions presented in a comprehensive report. This should give confidence that the design is correct.

Instilling confidence when fewer heat-maps are produced

It is still useful to show *some* kind of heat-map within the reporting for the RF Survey. This should be informative and come alongside a brief description to highlight what it means. For example, showing that certain features block RF and in other areas there are few obstructions.

If there is any doubt regarding "coverage", then a simple post install RF survey can prove that coverage is adequate. As suggested above, with a high capacity design it's likely that even a truly random placement of APs would achieve good coverage, and so it is relatively trivial to provide an "all green" map should this be requested by the customer. (Note that a good post installation RF Survey should include more than just confirmation of RSSI, but a full discussion of this process is out of the scope of this document).

Therefore, the activities performed by the Hybrid survey team should not be introducing any new risks.

Good design practice for any process should include steps to remove risks from any known source. A Hybrid survey is no different. The following section highlights how it removes a number of risks (of a poor design resulting poorly performing Wi-Fi) which standard approach does not.

Risks Mitigated by the Hybrid Survey

The biggest risks to the hybrid survey methodology have already been discussed, now we should consider what risks are *mitigated* by this method.

As with any piece of technology, the more thought put into the design the more robust the solution will be. In that sense, the Standard Approach is analogous to a car crash test setup where only a head on collision with a car travelling at 200mph has been tested, but nothing else. The scenario only has borderline real-world validity and only a small sample of possible scenarios have been tested - we simply don't know whether the vehicle will survive a side impact or a rear shunt, despite the myriad of data we have on head on impacts. In this analogy, signal strength is our head-on impact data.

The likelihood of a complete hard failure of a customer network is relatively small given that Wi-Fi is designed to work despite interference and poor design, however the lack of expertise inherent in the standard approach does leave the supplier open to a number of risks.

The table on the following page highlights some of the risks which present in the traditional approach which are actually mitigated by a hybrid survey (if conducted by a suitably qualified professional.)

Table of Technical Risks

The table below suggests some of the risks inherent with the traditional approach and how they are mitigated by the Hybrid approach.

Risk	Traditional Survey	Hybrid Survey
The Signal Strength is insufficient	Rarely are power levels used in RF surveys actually configured onto controllers and therefore there is a risk that coverage will not be as planned. Insufficient training leads to poor quality data gathering RSSI from mobile devices may vary significantly from readings taken with a survey laptop Oft mitigated by over deploying APs.	Propagation assessment surveys are conducted to ensure that RF propagation is understood by the on-site engineer and that any areas where coverage may be hard to achieve are tested thoroughly. The hybrid survey is conducted by an engineer who understands this. The process ensures that configuration recommendations are made and implemented by customers. The survey can be conducted with typical client devices rather than non-representative NICS compatible with site survey software.
Poor Network Performance	The traditional approach leaves many stones unturned, each one possibly hiding a bug which will reduce performance. This can come from poor configuration, interference, and a myriad of other places due to the lack of technical expertise within the design. Following from the above, where issues are discovered, the Supplier is likely to be blamed for poor performance.	By conducting a multitude of activities and reporting on issues explicitly in reports, the Hybrid Survey engineer is able to identify possible issues which will cause performance early in the process. Where mitigation is not possible, customer expectations can be set. By highlighting possible issues in advance and offering strategies for mitigation, poor performance can be avoided, and the Supplier will not attract blame.
Poor quality voice over Wi-Fi	Ensuring high quality voice calls and adequate client roaming can be challenging. More bases must be covered to be *sure* voice quality will be high. Overprovisioning APs is not enough to cover more than incidental use. Issues may arise, for example, simply because a client is able to roam to a 2.4 GHz radio which is congested, causing voice quality to drop. Competing use cases (high data throughput vs optimised roaming, for example) lead to poor service performance.	A suitably qualified engineer will ensure that all required factors are considered during the process of designing a wireless network for voice. This might include, for example asking for specific details of the system during the requirements capture phase. The customer can be informed of likely performance and anything they must do to ensure it works. This includes discussions of end-to-end Quality of Service, configuration of fast roaming, etc. A suitably qualified engineer can manage expectations where required and provide the customer with options prior to the install.
Over / Under	Without sufficient capacity planning the wrong number of	A detailed capacity plan defines exactly how many active users should

engineering.	APs is likely to be installed. Both under of over provisioning can lead to poor network performance. Over-engineering also costs clients' money.	connect to each AP as well as how many APs will be required to handle the expected number of device associations. A qualified engineer armed with this knowledge can then define the correct number and place for APs following an RF propagation assessment.
Poor Quality Reporting	Including irrelevant, misleading or incorrect data, graphs and statements could lead the supplier to be called to account for results which differ from post-installation reality, or where descriptions and technical data is simply incorrect.	All report templates are created by a qualified engineer and they are tailored to ensure that only valid data are included. On-site engineers are trained to ensure that they understand the implications of the data they collect such that only relevant entries are put into reports.
Competent Technical Review	A technical review by a competent party could highlight any of the flaws above, leading to loss of reputation and significant costs in putting things right	Getting things right first time will reduce the risk any review being required.

Risk mitigation for Managed Services

Managed Wi-Fi services are worth a special mention. Where a supplier is responsible for the day to day operations of a wireless service, including maintaining a service level agreement, the WLAN supplier now owns any issues which have been designed into it. They will almost certainly start incurring costs remediating issues if clients start complaining of problems.

Whilst the likelihood of a complete network failure for a customer is relatively small, (especially soon after install) but client issues are likely to still occur and will increase in frequency as time goes on. Therefore, it is in the interest of any supplier of WLAN managed services to ensure that designs are top quality to ensure lower long term costs.

Maintaining a highly skilled RF Design team can pay dividends here as engineers who really know how Wi-Fi works can aid in rapid problem identification and resolution of issues beyond those reported on a WLAN controller console. Where a business does not have any skilled and knowledgeable engineers (beyond vendor training) then troubleshooting tends to involve escalation to the vendor and tweaks to configuration until the problem goes away. Any RF surveys conducted to help resolve the problem are likely to be of limited effectiveness because the engineer is likely only to be able to report in signal strength and may lack the understanding to look beyond this for the causes of problems. When the time to resolve issues is long, confidence in the supplier can rapidly dissipate, and once a negative cognitive bias sets in with a customer confidence can be very hard to restore.

Suitably Qualified Engineers

As described in this document far the biggest driver influencing the quality of designs is the experience and skill level of the *suitably qualified engineer* who does the design work.

What does Suitably Qualified Mean?

So what would make an Engineer Suitably Qualified to carry out acceptable quality WLAN design work? What exactly denotes such an engineer is debatable, however we can consider some general guidelines.

Whilst we might suggest recruiting and engineer holding the CWNP’s Certified Wireless Network Expert (CWNE) qualification, alongside a vendor certification such as Cisco’s, engineers with these qualifications are hard to come by, so we need to be more pragmatic and consider what the minimum we might accept is.

I suggest this means: -

- The engineering team *as a whole* should be able to carry out all the tasks in the design process, including at least one individual who understands;
- How to optimise vendor equipment RF parameters (etc),
- How to carry out an in depth requirements capture,
- The details of 802.11 WLAN operations – typically obtained through study the CWNP’s certifications rather than vendor certifications;
- How to use all WLAN design tools to a good level, (E.g, can use a spectrum analyser and analyse the output)
- And possesses the relevant vendor certifications in order to understand how to apply available features from the chosen vendor.

At present, by far the best single resource for this is the CWNP's CWNA certification. To obtain this certification you have to possess wide ranging knowledge of many of the fundamentals of WLAN operation, from the Physics of RF to VLANs and authentication methods.

As well as this Certification, significant "trigger time" in the role of WLAN Design Engineer is also required. You can't learn to identify RF interference purely from a book – you need to actually *use* a spectrum analyser in earnest in order to be able to interpret the output.

The Cost of Quality

The cost of engineering resource is a cost must be borne by any project. It goes without saying that engineers with more experience and qualifications will be more expensive.

For small to medium sized projects it is likely that the consulting engineer may complete most of the engineering work.

For larger projects where RF Design is required for large numbers of sites it is likely that an alternative approach would be required in order to allow the project to pursue different sites in parallel. In these instances, it is likely that the consulting engineer would take on oversight of the project and would evaluate data collected by more junior colleagues in order to complete designs. This would help to keep costs to a manageable level without introducing too much risk (through reduced quality of designs) into the project. This approach also has the advantage that as a lower skill level of engineer is deployed in the field, a greater variety of engineers could take part – as long as they have the training in using the tools and the data that is required. This means that in a well organised outfit it may be possible to involve engineers with data collection who were otherwise spending time sitting on the bench.

Pay Back

It should be noted that there are many benefits from keeping more expertise 'on the books' which also help to ensure that there is commercial advantage to employing Suitably Qualified Engineers. More senior engineers can add value across the any business, from pre-sales assistance to providing an escalation point for managed service support tickets; however most of this is invisible work and tends not to explicitly appear on the company books, even if it positively influences the bottom line.

Differentiation

Because the difference in design approach described here is so stark and the potential outcomes are so significant, it should be relatively easy to sell. If the technical difference were slight, or so grossly complicated that no mortal would be able to understand them, then we fall into the trap where everyone professes that their WI-Fi solution is going to be The Best, and any differences are simply one bit of sales patter vs another. Wi-Fi *is* very complicated; however high-quality sample outputs should clearly shine a light on the quality of the process – even if presented to non-technical customer stakeholders.

Summary of Conclusions

This paper has highlighted many flaws with the dominant method of designing WLANs and shown some ways in which the process should be improved. Instead of a stand-alone "RF Survey", a more holistic design process is required which includes a comprehensive requirements capture and is carried out by qualified staff. This process should lead to better outcomes for customers without incurring significant extra costs.

Failure to do this has many hidden risks which suppliers of WLAN designs ignore at their peril.

Beyond the suggestions made in this document there is a real requirement for an industry recognised process. Those procuring WLAN design services need to be able to call off a standard WLAN design and know that all bases are covered and it will be completed by a team who possess all the relevant skills. The processes described in this document are not that, but hopefully highlight shortcomings of the current industry standard approach to RF WLAN design and show that there are alternative methodologies that can be applied to the task of designing a Wireless Network.

References:

https://www.brighttalk.com/webcast/5522/205335

(Is APoaS Surveying Obsolete?)

http://divdyn.com/wifi-design-deployment-methodology/

(Design Methodology)

http://www.ieee802.org/11/

(The 802.11 standard, available from the IEEE. This is a 3000+ page document and is included with tongue firmly in-cheek: - Is the engineer who designed your network aware that this document exists?)

Glossary of Terms

RSSI - Note, the correct terminology is "RSSI – Received Signal Strength Indicator", but 'Signal Strength' will be used here for simplicity.

WLAN – Wireless network operating using the IEEE's 802.11 standard, commonly known as "Wi-Fi".

AP –Wireless Access Point.

APoaS -AP on a Stick. Industry slang for a Wi-Fi survey carried out with an access point mounted on a tripod.

About the Author

This white paper was written by Jon Foster, a Wireless LAN consultant for The BBC in the UK.

The views expressed here in no way represent those of the BBC.

E-mail: jon@weaponsgradewifi.com

Web: http://www.weaponsgradewifi.com/

Twitter: @ukeljay