Guide to surveying buildings for wireless networking

Scott Armitage, Loughborough University

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Introduction

Wireless networks can be affected both passively and actively by the environment in which they operate due to the fact that they use a radio frequency (RF) medium for data transfer.

Many problems can exist which interfere with wireless networking from the building fabric, such as signals reflecting differently off different materials (multipaths - http://www.intel.com/support/wireless/sb/CS-025346.htm [1]) and signals being blocked by materials used in the building fabric such as brick, glass, reinforced concrete etc. As well as passive signal interference, there are also natural sources of ambient active interference from electrical equipment generating RF noise. Therefore, before installing wireless networking into a building, it is important that the building is suitably surveyed to identify and mitigate potential issues which could affect the wireless service in that building.

A comprehensive survey of a building ensures the installed solution matches the pre-installation expectations. Surveying is a multistep process which involves gathering requirements and running tests within the installation environment to decide how to best meet the requirements. The ultimate goal of a wireless survey is to produce a document which describes how many wireless access points (APs) are required and where they are to be located. Additionally the document should provide information regarding expected signal strengths/quality, likely sources of interference and infrastructure requirements (i.e. power, network switches and network cabling).

Eliciting Requirements

Before a survey begins, it is important to decide what is expected of the wireless system being installed. This has two components: coverage and density.

Coverage

It is important to understand where exactly coverage is required. If you ask where users want coverage, the answer is usually ‘everywhere’, but is that really required? For example is it vital to have wireless coverage in a cleaner’s cupboard or storeroom? The best approach to take is to obtain floor plans of the building being surveyed and mark the rooms into one of three categories:

- Green – Wireless coverage is essential
- Yellow – Wireless coverage is desirable

- Red – Wireless coverage is not required

Density

Once it is known where coverage is needed, it is then important to understand what quality of coverage is required. Is it a requirement to support 200 client devices in a single room? Is there a need to support wireless voice calls? Areas where high volumes of clients are expected should be marked on the diagram. The approximate number of clients should be indicated. This is of particular importance if the coverage area would, under normal circumstances, require only a single access point. If support for VoIP over WLAN is a requirement, the areas requiring coverage for voice should also be marked on the plan.

First Guess Mark up

Once a floor plan has been marked up, a first attempt can be made to suggest locations for wireless access points. This is something of a ‘dark art’ and requires both common sense and experience of deploying wireless networks.

There are a number of software products available which can help with this process such as AirMagnet Planner (http://www.flukenetworks.com/enterprise-network/wireless-network/AirMagnet-Planner [2]). Whether planning manually or using software this information is required:

- type of environment – e.g. open plan office
- wiring considerations for access point data sockets
    - knowledge of data cable routes
- wall types and materials
    - Different materials affect signal propagation differently
- lift shafts and plant machinery
    - electrical equipment such as elevator motors often generate large amounts of RF noise

Visiting the Building

After marking up plans with the expected locations of APs, an initial survey needs to be made to ensure that the actual coverage matches the prediction. There are a number of approaches to this type of in situ survey.

The most basic survey is to take a single access point to the proposed locations. The AP is powered up in situ and then a survey is conducted using surveying software and a suitable client device. Once the survey for that location is completed, the AP is moved to the next proposed location in the building. This approach requires minimal equipment however it does have some drawbacks. There will be a certain amount of resurveying of the same space due to the

overlap of coverage areas of access points. Additionally this approach gives no indication of how access points will interact with each other operating in the same space.

The next type of survey is to use multiple access points e.g. three access points. The APs are placed in proposed locations which are close to each other. The survey of that area is then conducted. This approach is similar to the basic survey but by having multiple APs there is

less resurveying of overlap and the survey provides a better indication of the interaction between access points operating in the same space.

In all instances, the power level on the access points should be reduced from maximum power to around 80 – 90%. This ensures that buildings are slightly over provisioned. Therefore, if dead spots or signal strength issues do emerge in the deployed solution, the power of the access points can be increased to 100% to cover the dead spot.

Surveying buildings

To properly survey a building it is recommended that specialist surveying software is used. Using surveying software makes the process much simpler and produces clear diagrams of expected coverage. For the purpose of this document AirMagnet Survey software has been used, however the techniques are applicable to most other surveying software. The technique is derived from the 'Seven Rules for Accurate Site Surveys' document (http://wirelesslanprofessionals.com/wlw-022-seven-rules-for-accurate-site-surveys/ [3]).

Firstly obtain scale diagrams of buildings floor plans and import them into the survey software. These diagrams must be to scale and then the software should be appropriately configured to match the scale. Incorrectly scaled diagrams may produce inaccurate survey heat maps. It is recommended when calculating scale to either use the scale marker on the diagram, or if this isn't available to take measurements in the actual building. If you are taking measurements in the actual building, use a large wall and not a short distance such as a doorframe. Large distances will produce more accurate scale measurements.

Once the floor plans have been imported, select the channels the survey software is to scan for. Test access points should be configured to be on fixed channels, and then survey software should be configured to only scan for those channels. This prevents the survey software from wasting time scanning channels that are not in use by the survey access points.

The next part of setup concerns setting the signal propagation. The propagation is linked to how accurate a survey is required. Shorter propagation values will mean covering more space when doing the survey walk. Longer propagation values will mean less walk coverage but more extrapolation. Typical values for propagation should be in the 5–30 metre range. Linked to this value is the sample rate. Sampling should be taken at a rate that will ensure the propagation range isn't exceeded. For example if the propagation range was 10m then the sample rate should be set to take at least one reading every 10m. Setting this will depend on how quickly the person surveying walks and therefore will involve a little guesswork and trial and error.

Once the survey software is configured as desired the survey walk can begin. The surveyor should always conduct a passive survey, even if they intend to conduct an active survey as well. To begin the survey, the surveyor should click on the start walk button and then click on the map to indicate their location. The surveyor should then walk around the survey area and click on the map at regular intervals to update their position. Surveyors should try to gather as many information points as possible but make sure they are accurate about their location when clicking on the map. This includes capturing corridors as well as inside rooms and walking around the perimeter of a room and not just taking a single reading in the centre of the room. When surveying, it is often easier to break the surveying activity down into multiple separate surveys. This could be, for example, each room or corridor instead of one big survey

for the whole floor. The surveys can then be merged together at the end.

Once all individual surveys have been completed and merged together a heat map will be created. This shows the expected coverage signal strength, indicating areas of poor coverage in orange and red, and areas of strong coverage in blue and green. Using the heat map it can be decided if the proposed deployments plan will provide the desired coverage. If coverage is not as expected and access points need repositioning or additional access points adding, it is suggested that the revised area is resurveyed.

Spectrum Analyser

When conducting a survey of a building it is advisable to use a spectrum analyser to locate potential sources of interference which could cause problems with the wireless network. Spectrum analysers are available from a variety of sources and vary in price. Spectrum analysers will provide various graphical representations of Fast Fourier Transform (FFT - http://www.airmagnet.com/faq/index.php?page=index_v2&id=155&c=15 [4]) captures of the wireless spectrum. There are a number of common terms associated with spectrum analysis:

- **Receive Signal Stength Indicator (RSSI).** RSSI is a metric used by manufacturers to give users an indication of the signal strength their wireless device is receiving for a wireless network. This is calculated in different ways by different manufacturers.
- **Noise Floor.** The noise floor is the ambient or background RF noise for a wireless channel.

- **Signal Noise Ratio (SNR).** Usually represented in dB, the SNR is the difference between the noise floor and the RSSI of a device.
- **Duty Cycles.** One of the most commonly used outputs from spectrum analysis is the duty cycle reading. A duty cycle refers to the amount of time that an access point is transmitting on a channel. For example when a device is transmitting all the time, it is said to have a 100% duty cycle. In the simplest terms, the duty cycle indicates the availability of the spectrum. If a device is generating a duty cycle of 100%, it is in effect performing a Denial of Service (DOS) on that channel. Duty cycles measurements are always taken on RF activity above the noise floor.
- **Channel Utilization.** Following on from duty cycles the channel utilization will show the duty channel as a function of the channel. Therefore it will indicate the utilisation of the channel and which devices are contributing to that utilisation. This is useful in channel planning as channels which have existing high utilisation should be avoided. It is also useful for identifying problem devices which are interfering with normal wireless network operation.
- **Real-time FFT.** The real time FFT displays RF power in dBm as a function of frequency. Decibel milliwatts (dBm) are a measure of power referenced to one milliwatt. Typical values range from a poor signal -80 dBm (10 picowatts) to a strong signal of -20 dBm (10 microwatts).

Many spectrum analysers currently available have a range of features to assist the user in interpreting the output. One example is the automatic identification of interference sources (e.g. microwave, access points, Bluetooth headsets, etc.). Using directional antenna it is also possible for spectrum analysers to locate the source of interference.

Summary

Following the guidelines above should enable sites to produce accurate building surveys which will aid in the deployment of wireless networking. Whilst the above instructions provide the basics of wireless surveying, this document is intended only as a guide. Individual sites should adapt their surveying technique to match appropriately the environment being surveyed. When conducting wireless surveys a common sense approach should be taken to ensure that the resulting survey documents are useful and accurate. As sites complete more surveys the experience gained should allow them to improve their surveying technique.

Links
[1] http://www.intel.com/support/wireless/sb/CS-025346.htm
[2] http://www.flukenetworks.com/enterprise-network/wireless-network/AirMagnet-Planner
[3] http://wirelesslanprofessionals.com/wlw-022-seven-rules-for-accurate-site-surveys/
[4] http://www.airmagnet.com/faq/index.php?page=index_v2&id=155&c=15