The Wireless Challenge

Building a wireless network is considerably more difficult than implementing a wired network. The reason is because every deployment location is a unique radio frequency (RF) environment. Even if you have offices or floors with the same physical layout, changes in construction material, the location of filing cabinets, the presence of microwave ovens, or differences in the way people congregate changes the way signals travel over-the-air. Therefore you cannot simple take a generic deployment blueprint and roll out your network. Every wireless network deployment requires a site inspection and the development of a site specific implementation plan.

This paper takes you through the key phases that you should follow when planning your wireless network and how to avoid the top ten common mistakes.

The Site Inspection

Site visits can be the most fun part of deploying your wireless network. A site visit is a visual inspection of the physical site. An opportunity for you to assess what will happen to your signals when you place Access Points in certain locations.

The first thing you should do is get a copy of the buildings blueprints. This should provide you with the layout of the building, the construction material and location of power outlets. This will form the basic framework for your deployment plan.

Knowing your buildings' construction is a crucial part of RF planning. Signals are absorbed as they propagate through walls and other obstructions. How much the signal is absorbed is dependent on the signal frequency and the material the signal is passing through. Signals attenuate more if they are passing through concrete walls versus plaster board walls.

Common mistake #1: Assuming the building blueprints are accurate.

Years ago I was doing a deployment in a converted slaughter house. After significant investigation I determined that the cause of the unexpected dropped coverage was caused by a lead lining that was added to the wall and plastered over. Although this was an extreme case, it is not uncommon to find that buildings have been altered and the blueprints have not been updated.

You should use the site inspection as an opportunity to verify the accuracy of the building blueprints. You should also take this opportunity to record the location of power outlets and any infrastructure equipment such as switches and routers. You will need this information later when connecting your Access Points.

Next you should identify items that will either block or cause interference to your planned WLAN. Obstacles that can block signals include fish tanks, metal filing cabinets, and mirrors. Sources of interference could be microwave ovens, neighboring Wi-Fi networks, cordless phones and cameras.

Common mistake #2: Failing to identify all sources of interference.

I was recently called in to investigate problems with a new Wi-Fi system deployed in a business center. It turned out there was a security system operating in the same 2.4 GHz frequency band. As the security system is operational all the time, this caused significant interference to the Wi-Fi system. As the security system could not be replaced, we replaced all the Access Points with those that could operate at the 5 GHz band.

The best way to find sources of interference is to use a spectrum analyzer.

Antennas should be placed where there are no obstacles in the “near-field”. The near-field is the area immediately around the antennas that suffer inductive effects due to current passing through the antennas. You should make sure that there is a space of at least one wavelength around the antennas. In other words, you should leave a space of at least 12.5 cm in the 2.4 GHz band and 6 cm in the 5 GHz band.

Common mistake #3: Failing to look at the ceiling.

When inspecting the site it is important to look up at the ceiling. The questions to ask are: Can the Access Points be hung just below the ceiling or must they be hidden in the ceiling? Are their sprinkler systems, metal duct work and other things that could be in the near-field?

Site Measurements

Now you are ready to put up an Access Point and take some signal strength measurements. You can use Velcro and duct tape to put the Access Point on the ceiling, and you can capture the measurements using a spectrum analyzer or you can just look at the signal strength and data rate on your laptop.

Common mistake #4: Taking measurements with Access Points that are not being deployed.

Do the site measurements using the same Access Points that you plan to deploy. Different radios and antennas perform differently, so it is likely that you will get different results from different equipment. In particular you should make sure that you do not do your measurements using an 802.11a or g Access Point if you

planning to deploy 802.11n, as the coverage and capacity are very different with 802.11n radios due to the usage of MIMO antennas.

If you have a dual mode Access Point which can operate in both the 2.4 and 5 GHz bands remember to do measurements in both bands.

You should walk around the Access Point and note down on the blueprint copy the location of the Access Point and the data rates at various locations. What you are looking to do is to determine the typical range from the Access Point for different data rates and areas where the coverage is problematic.

Common mistake #5: Thinking that the maximum data rate is achievable everywhere.

Users that are in a better radio frequency (RF) environment, such as close to the Access Point and away from interfering sources, can transmit at higher data rates than users on the edge of coverage and closer to interfering sources. As the user moves into more difficult RF conditions, such as moving towards the edge of cell coverage, their data rate will drop. This means that the maximum data rates are only available in a small area of the cell, not across the entire cell.

Deployment Plan

In large deployments you would use an RF planning tool to calculate where to place the Access Points. In smaller deployments is it just as easy to manually plan the network, especially if you have a fairly uniform office environment. The way you do this is by using those concentric coverage circles you formed from you initial signal measurements.

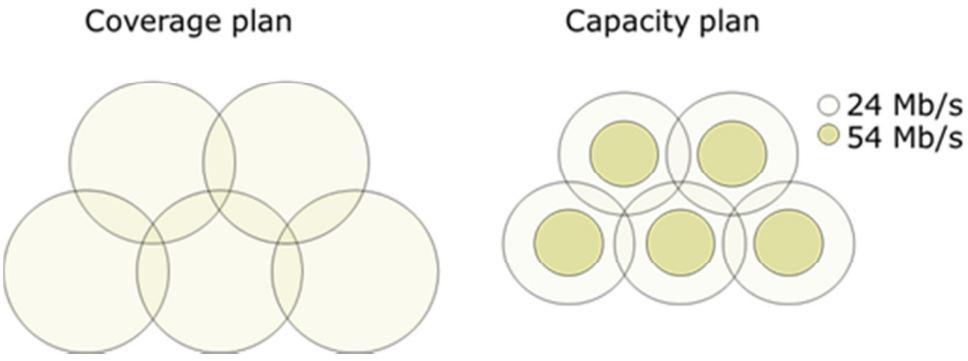

Figure 1: Coverage and capacity plans

There are two primary types of RF plans: coverage and capacity. As the name suggests, a coverage plan calculates the number of Access point required to give

you wireless coverage where you need it. A capacity plan calculates how many Access Points will be required to achieve the desired minimum data rates. Simply draw these circles on the copy of your blueprint as shown in Figure 1.

Common mistake #6: Planning for coverage only.

Many people create a coverage plan for their wireless network. Then after they roll out the network they discover that network performance is not meeting their expectations.

There are several deployment scenarios where coverage plans are ideal. For example free public hot spots or free guest access WLANs. However, in most business situations you need to ensure that the users have sufficient bandwidth. In these situations you should create a capacity plan. To develop a capacity plan you typically would define the minimum acceptable data rate.

To determine your capacity needs it is always a good idea to look at today's wired traffic using a packet analyzer. Two areas to pay particular attention to are streaming video and VoIP as these have additional Quality of Service requirements.

The higher the minimum data rate you set for a cell, the smaller the size of the cell. In other words a cell with a minimum data rate of 24 Mbps will be smaller than a cell with a minimum data rate of 6 Mbps. This means that you will need to deploy more Access Points.

Wi-Fi Access Points are deployed with overlapping coverage to provide protection against changes in the received signal strength. If the signal becomes weak the user's device searches for and connects to another Access Point. The greater the overlap the better the user is protected against loss of connectivity but the higher the cost of deployment as more Access Points are required.

Common mistake #7: Deploying with insufficient cell overlap.

For data traffic a 10 to 15% overlap on cell coverage is normally adequate. However, the deployment of wireless networks often triggers a change in usage patterns, particular in the area of mobility and the ability to handover VoIP calls between Access Points.

To roam between Access Points the device must first authenticate and associate with the new Access Point. This process may take several hundred milliseconds. For time sensitive applications such as voice calls, the authentication and association to the new Access Point needs to be done prior to handing over the call. To minimize the risk that the users goes out of coverage before the authentication and

association process is completed, Access Points need to be deployed with 25 to 30% overlapping cell coverage.

Access Point Configuration

If you plan to deploy in the 2.4 GHz band you will deploy your Access Points on channels 1, 6 and 11 in North America. Care has to be taken to make sure adjoining cells do not have the same channel assigned. Adjacent cells on the same channel will interfere with each other and will reduce throughput.

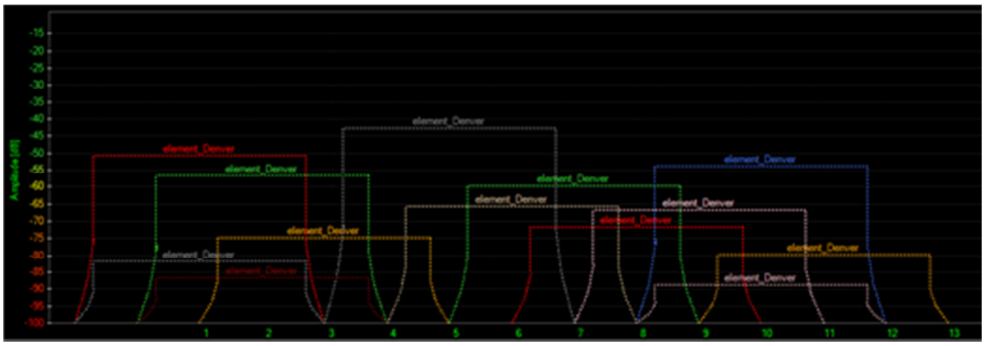

Figure 2: Example of poor channel planning.

If you plan to deploy in the 5 GHz band you have several channels to select from. Most offices use the UNII-1 band channels 36, 40, 44, and 48. Figure 2 above illustrates a live deployment where they did not assign non overlapping channels.

Common mistake #8: Deploying adjacent Access Points on the same channel.

If you deploy adjacent Access Points on the same channel they will still work but performance will be significantly degraded. Interference between two cells on the same frequency is called intercell interference.

The transmit power level of the Access Point should be set to be comparable with the user's devices. If the Access Point transmit power is too higher, users will be able to receive signals but will not be able to send signals to the Access Point. This is particularly import if you have smart phones connecting as these devices typically have low power transmissions to conserve battery power.

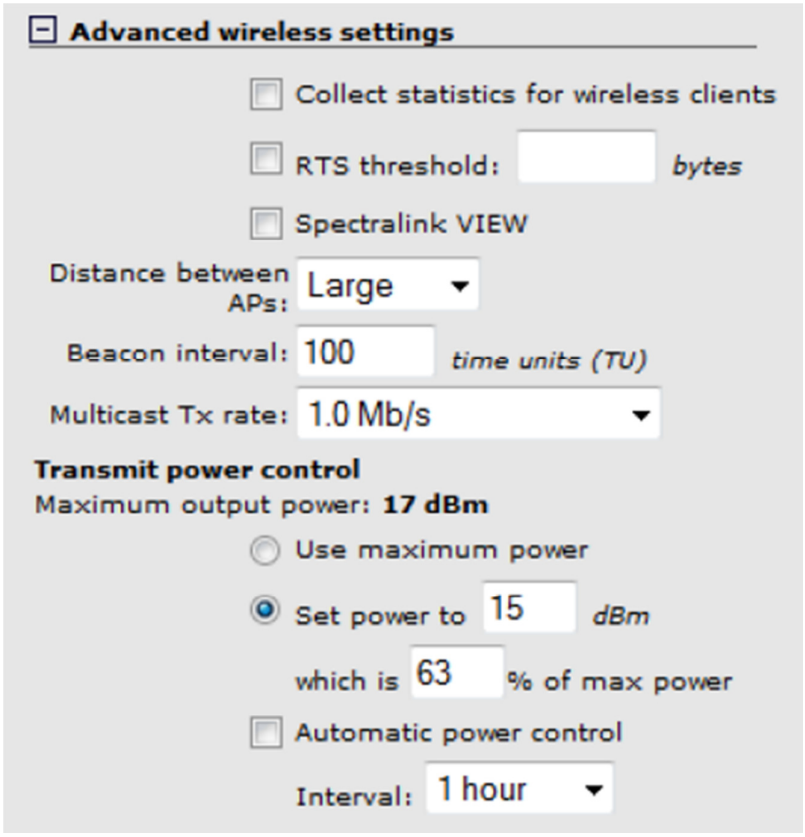

Figure 3: Adjusting an Access Point's transmit power.

After deployment, you can adjust the transmit power on the Access Point to adjust the cell coverage. If you need more coverage you can increase the power, or if you need less you can decrease the power. Figure 2 shows that you can adjust your Access Point power level normally in the advanced setting tab.

Common mistake #9: Assuming maximum transmit power.

You should plan to deploy your Access point at 70 to 90% of the desired power. This gives you the ability to raise the power on a specific Access Point if you find after deployment that you are having coverage problems in a particular area. Or decrease the power if an Access Point is causing strong intercell interference to a nearby Access Point on the same channel.

If you are deploying on multiple floors in a building, make sure the Access Point immediately above the one below is deployed on a different channel. This will minimizes the risk of interference between floors.

Common mistake #10: Forgetting to minimize interference between floors.

After deployment it is valuable to walk around and check for intercell interference. Channel selection is a critical consideration to ensure good performance.

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