Using wireless in the home

We frequently get contacted with questions relating to how to improve wireless reception in the home or generally in a building.

You've seen the adverts on the telly of a Centrino notebook working on the top of Mount Everest? So now you think that WiFi works brilliantly and you can just switch your notebook on anywhere you like and pick up a fantastically clean and powerful signal. WRONG! In fact I'm amazed that trading standards haven't been on to Intel for such misleading adverts.

The Background

So let's set some background ground facts down for a start:

Now this might come as a shock but 2.4GHz WiFi does NOT go through brick walls or concrete. It MIGHT go through plasterboard; but not if the plasterboard is foil backed: Very often builders use foil backed plaster board on both walls and ceiling to help meet modern building regs concerning heat insulation and fire regs. The signal WILL go through wood (e.g. floorboards) but it is weakened in doing so (signal about halved through a solid softwood door). 2.4GHz will also go though a window but if it's 'K' glass double glazing (as installed according to building regs. for the last 10 years) then the metal vapour of the 'K' coating will knock the signal strength down by 30-50%. WiFi's good ain't it! ☺ The newer 5GHz WiFi technology is better because it will scatter and reflect better around the building however it still won't go through solid brick walls.

Therefore, if you want to get a wireless signal from the lounge to the upstairs bedroom then the normal method is for the signal to bounce around the lounge to get through the door. Then it ricochet down the hallway, up the stairs and into the bedroom. The problem then is you don't know if or how the signal will bounce or reflect so you don't know if the signal will ever reach the bedroom. At each reflection the signal strength is reduced and also there might be more than one route to the room upstairs (because the signal might reflect a different way to get to the room upstairs). Because the signal might go by multiple routes then the signals from each route arrive at slightly different times. This is called multi-path effects and causes many problems when the radio device tries to extract the data from the signal: It's like trying to hear someone talking to you in a night club with the music blaring in your face ☺ i.e. the signal is strong but garbled.

The nett effect is that the signal has a very good chance of not reaching the destination or being of a very poor quality when it does so the link ends up running at a slow speed.

The next confusion that needs clarifying is antenna. An antenna doesn't magically create extra signal out of thin air ☺ All it does is take your existing signal and concentrate it into a specific direction. A standard low gain (2db) antenna fitted to an access point or wireless LAN card sends out a signal in a roughly spherical pattern with a small dimple at the top and bottom. A so-called high gain omni antenna takes your existing spherical signal and flatterns it into more of a doughnut shape so it sends more signal out horizontally. Now, if the signal was getting from downstairs to upstairs by going through the floors (although not very well) then going to an antenna which sends a larger proportion of the signal out horizontally might make things worse!

Now the new white knight for WiFi is supposed to be 11n. Using multiple trasmitters/receivers and some high powered processing, 11n uses the multi-path 'problem' to its advantage to give, theoretically, better indoor range, coverage and speed. However 11n has got everything it's own way. The problem, at the moment, with 11n products is the quality of the RF stages on the wireless interface – they aren't as good as the best of the current 11g offerings. This manifests as lower power, poorer signal sensitivity and worse EVM (a measure of signal quality). So you can't always say that an 11n product will be better than 11g; in fact, at the moment, we're finding that the very best 11g products can often give better coverage than equivalent 11n units. Things are getting better though and 11n products will almost certainly improve.

What about 5GHz wifi? There are now several 5GHz wifi devices at the affordable end of the market. You will also have seen the term 802.11a which is used as the gerneral IEEE descriptor for lisence free devices operating in these bands. The technology for 11a equipment is pretty much identical to the older 11g system except operating at a much higher frequency range. There are several advantages to the higher frequency namely: 1. Better scatter (i.e. it will bounce around your walls better) 2. Much less effected by water or damp (2.4GHz hates water and is readily adsorbed by the slightest amount of water e.g. even your hand put over the antenna will half the signal strength) 3. Wider available operating spectrum (so less interfearence with other WiFi devices in the neighbourhood). These are all factors which mean 5GHz is more suitable for in buildings use.

I've written a separate article just on 5GHz technology which is worth reading…

5GHz Frequency Bands

A typical user question

So now we've got the ground work out of the way let's look at a typical user question:

e.g. A typical question might go "I am using a L*****s XYZ54 access point on the ground floor but the signal to my PC's on the first floor is not 100% reliable and I was wondering which antenna would be best for improving this signal? Also, my XYZ54 access point has two antenna sockets; should I connect an antenna to both sockets or only one?".

Looking at the first part of the question "…which antenna would be best for improving this signal…". From above you can see this is a hard one. If the signal is getting upstairs by going through the floorboards then a high gain omni antenna might make things worse by sending less signal upwards. However, if the signal is getting to your PC's by bouncing along the hallways and stairs then sending a stronger signal horizontally might make things better. You really don't know ☹

The first thing is think about the location of the AP (Access Point). Can you arrange to place it better in the building so it's closer to the PC's? Of course you don't know how the signal is getting from the AP to the PC's so you might have to try several different spots around the building to see if you get an improvement.

Now look at the antenna on PC; don't just consider the AP antenna. Normally the PC antenna is the weak link.

a) If it's a notebook with a built in antenna then the antenna is probably just a track on a circuit board or a spindly wire around the case – not the best antenna on the block! So try orientating the notebook in a different way. You might even have to try disabling the built in wireless and using a different radio device e.g. USB.
b) If the PC is a desktop with a basic USB dongle plugged in at the back of the computer then that's not the best position – hidden behind the metal case. So consider moving the dongle to the front of the case. It's also better to go for a palm USB adapter with a proper antenna – these can be placed on the top of the PC or on the desk to give better reception.

Next you could try simply upping your existing antenna a little bit in gain. If you go too high on the gain then you might make things worse. Remember a high gain antenna takes your existing signal and concentrates it to point in a specific direction. So going for too high a gain means you might have problems on where to point the antenna to make it work. Also, if you are trying to pickup the signal in several points in the building then you might end up improving things for one position but making it worse for the rest. ☹ So, if your device as the industry standard 2db little 'rubber-duck' antenna try changing them for 5db 'rubber-duck' antenna. See if that works.

If this doesn't work then you *might* consider going for an 8db omni **but** now you are starting to get pretty directional on your antenna now so you run a high risk of making things much worse rather than much better. If you are just trying to improve things on the same floor as the AP then normally higher gain omni antenna are a fairly safe bet (because you aren't trying to throw any signal up or down). I wouldn't normally advise using directional antenna to sort this problem, especially if you have PC's scattered all around the place.

If the area is just a large open plan office or warehouse then high gain omni antenna are a good bet. Even better consider a ceiling antenna which will give a nice wide beam covering a large area. If you want to go for the best solution for an office then think about a ceiling AP which has an excellent wifi AP built into a housing with a wide angle diversity antenna setup.

Now the second part of the question: "…my XYZ54 access point has two antenna sockets; should I connect an antenna to both sockets or only one?". The simple answer is connect to both sockets but I'll explain why. If a radio device has two antenna then this is because it is either 11n or it is 11g in diversity mode. With diversity mode, for reception, the radio device uses the particular antenna which gives the best signal. Because the wavelength of 2.4GHz WiFi is very short (about 12.5cm) then the signal strength can vary quite a lot over a space of just a few inches. This is the theory with diversity antenna setup and also the same effect is used to advantage by 11n devices. But what about transmission with diversity? Well with **most** diversity setups the radio device will transmite on only one of the two antenna. It doesn't matter which

antenna was used to receive the signal it only transmites back on the one specific antenna. In this case you *could* use just one high gain antenna but you must pick the antenna connection which does the transmitting as well as receiving. If you pick the wrong antenna socket then you end up still sending out a week signal. Using two antenna means you stand a better chance of picking the correct antenna connection.

Now some high-end WiFi devices use a different form of diversity. With these devices the transmittion happens on the same antenna that was used to receive the signal. The theory goes if antenna socket A was best to receive the signal from the other party then probably the same antenna is best for sending the stuff back. With this setup then you could still use one antenna because the radio device will automatically decide which antenna is best for receiving and transmittion. In effect the device ends up only using one of the antenna and your diversity advantages aren't used. Using two antenna though gives back full diversity operation.

11n devices choose from a range of transmission options so they are more flexible concerning which antenna to use for receiving and/or transmitting even including using all of the antenna! As such you can experiment to see which antenna solution is best i.e. left one or right one or both.

That covers the important aspects of distributing WiFi around your home/building now let's think about some of the less common systems.

Repeaters and WDS

What about repeaters? A WiFi repeater is supposed to take in the WiFi signal from a remote radio device and then blast it out again locally. So it would be nice to think you could put a WiFi repeater up on the first floor. It will then pickup the signal from downstairs and then broadcast it as a strong signal on the first floor. Sounds good but there are some problems (aren't there always ☺). The main one is the repeater must be able to get a good, reliable, stable signal from the radio it's repeating from. If it can't then it ends up repeating rubbish or even worse just slows the whole lot down with repeated resend messages. The other problem is each time the signal is repeated it slows the network down: Just one repeater half's the performance.

If you want to use repeaters then the best solution is to go for WDS (Wireless Distribution System). With a WDS system you configure each AP with details about which AP or APs to repeat from. This setting is based upon the MAC address of the APs. With WDS you could set all APs with the same SSID and WiFi settings which can make it easier for clients. With careful setup you can even arrange the repeater routing to give multiple routes for the traffic though this sort of setup requires a lot more thought and you need to ensure your AP devices have 'tree-spanning' capability to block loops in the traffic. Because it's harder to configure then WDS is probably not worth thinking about in a home setup but in a business with a multi-story building and offices scattered all around WDS is the best system for distributing using WiFi.

Meshing

Well meshing is like WDS except it's a lot easier to setup and more resilient. Setup is very easy because you just tell the devices their mesh ID and then the devices automatically create their own routes for the data traffic. The other good thing is the repeating routes aren't fixed: If something changes in the setup then the mesh nodes automatically redo their routing. So, if you have to do repeating then meshing is the preferred way. The downside though is meshing APs are more expensive and also they tend to only mesh with the same makes of products. So if you have an existing network you are trying to extend then adding some meshing units won't work. Again, a possible good solution for an office or business setup but probably beyond the average home setup.

What's the answer then?

Well the best answer is to dump wireless and run proper CAT5 LAN cables around the building. Obviously though this won't be either feasible of desirable in many cases: Though, if you just want to get a LAN connection to a single back office then running a LAN CAT5 cable around the **outside** (not inside) of the house will normally turn out to be the cheapest and most reliable method.

Another option is to consider going half and half i.e. use CAT5 cables where you can (i.e. where they are easy to run and don't upset your significant other ☺) and using wireless where you have to. For example you could have an AP in the lounge downstairs to cover that area and possibly the room next door. Then run a CAT5 cable around the outside of the house up to the first floor to a second AP running on a different radio channel. Hopefully you can position the second AP to give adequate coverage for your devices upstairs.

If you've exhausted the simple things like repositioning the devices etc… then consider 5GHz devices. The only problem is there aren't so many 5GHz products around and most clients (computers/phones/etc…) don't support 5GHz. 11n is certainly worth a try; some people do report good results and 11n devices are getting a lot cheaper now. However, unless your PC/client also supports 11n then you won't wee much of an improvement.

However, in my opinion, the best option though is to distribute your LAN via the wiring that is already present in your house i.e. the mains electrical sockets. PowerLine is a system designed to use your mains wiring to send LAN signals around your building. You use devices to connect your LAN cards in your PC's, or your routers, or switches (or anything which has a LAN socket) to the mains and then, hey presto!, you have LAN everywhere in the house.

See

http://www.solwise.co.uk/net-powerline.htm

Powerline is available in devices operating at 85meg (faster than 11g WiFi), 200meg (in practice twice as fast as 54g), and now also 500meg and even 1gig! Because PowerLine is unaffected by walls or obstructions it's considerably better at reaching those hard to reach spots in your house. It's also very simple to install (no nasty drivers to install) and will work with any devices that have a LAN port (e.g. gamesbox etc…). Also, because the network is restricted to your house wiring, then it's offers much better security then WiFi networking (where, ironically, some git with a big antenna can pick your network up from 100yards down the street even though you can't pick it up in the room next door!).