Introduction to Wireless Networking

See our 'Wireless Around the Home' article and our Wireless Networking Prima for a broad overview. A useful article to read if you are looking to link buildings is Linking Buildings using Wireless

Wireless networking is, potentially, a quick and easy and economical alternative to running wires around your home or office. It also opens up possibilities for connecting buildings which are up to several kilometres apart. There are currently three standards upon which wireless networking devices are built. The table summarises some of the features for each

Standard	Data Rate	Frequency	Comment
802.11a	54 Mbps	5.1-5.7GHz	Product now starting to appear which promise better obstacle penetration and scatter making them superior for non-line-of-site (NLOS) operation than the 2.4GHz products. Larger number of non-overlapping channels also makes this standard suitable for high cell densities.
802.11b	11/22 Mbps	2.4GHz	The first system to appear at mass-market pricing. Suitable for both internal and inter-building applications though poor penetration and scatter can reduce effectiveness for both indoor and remote bridging applications.
802.11g	54 Mbps	2.4GHz	Newish 2.4GHz standard gives much the same functionality as 802.11b but at higher data rates. OFDM standard is supposed to give improvements over the older 11b products for indoor use. In practice though the lower signal sensitivity at higher speeds reduces effectiveness.

Range

You will see specifications for different brands of wireless networking devices quoting wildly different ranges. Take these claims with a pinch of salt. Unless the manufacturers have got something very wrong, or are operating at illegal power output levels, then products from different sources will all behave similarly since they are built to the same power standard.

There are two types of application in which wireless networking is used: internal and inter-building.

Indoors

Radio waves travel in straight lines and at 2.4GHz do not penetrate obstacles very well. Some surfaces reflect the signals quite well whilst others tend to absorb them. Water, which comprises most of *you* , is particularly good at absorbing the energy, so you will find that putting your hand over an antenna can reduce the signal substantially. (Your hand won't warm up because output power is limited to 100mW in Europe - well below the power output of your mobile phone!). 5GHz wireless suffers from similar problems BUT, with better penetration and scatter, it offers considerably improved non-line-of-site (NLOS) capabilities over 2.4GHz devices.

As a general rule 802.11b/g devices will usually cover a house quite well but there are no guarantees. You might also find, particularly for 11g, that the connection speeds will drop in order to get a reliable link. In fact, often an 11g product with up to 54meg potential will give similar performance to an 11b device even though 11b is only up to 11meg speed. The signal passes better through wooden floors and ceilings than through brick walls, and has no chance at all through concrete or stone. The use of an access point in the loft connected to a directional antenna pointing down from the rafters has proved an effective way to get full coverage in a typical house. For a more restrictive range the built-in antennas often work very well.

Your choice of wireless network adapter may be significant. If your mini tower PC stands on the floor with it's back to a radiator, you can't a expect built-in adapter with integral aerial to work very well. Or if you tend to sit with your notebooks aerial sticking out of the left hand side and your access point is down the corridor to your right, then the computer itself will screen the signal. Try an adapter with an external aerial that can see over your keyboard.

See our 'Wireless Around the Home' article for a more in depth discussion on using 2.4GHz wireless in buildings

802.11a/5GHz radio, although costing a little more than 2.4GHz products, has much better penetration and scatter making it considerably better for indoors operation where it needs to reach remote rooms. In our opinion, 5Ghz is the future for wireless networking in buildings

You can read more information on 5GHz wireless in our '5GHz Frequency Bands' Article.

Outdoors

The following table is a guide to the distances you might expect to achieve using 'off-the-shelf' wireless devices a standard 100mW access point with a given antenna gain at both ends . A receiver sensitivity of about -83dB is assumed.

Effective Gain	Line of sight range for 2.4GHz (20db UK power limit)	Line of sight range for 5.4GHz (30db UK power limit)
0dB	200m	280m
4dB	440m	620m
7dB	620m	868m
10dB	1.25Km	1.75Km
13dB	2.8Km	5Km
16dB	5Km	7Km
20dB	12.5Km	17.5Km
24dB	31Km	43Km

- Effective gain takes into account the antenna gain and also any losses in cabling. For instance if you have a 12dB antenna but lose 5dB in the cable to it, then you have an effective gain of 7dB.
- The table should only be used as a rough guide, we are not promising that you will achieve these numbers, nor that the figures represent maximum or minimum limits.
- Please also see our article about line-of-sight signal propagation.
- You should ensure that you do not exceed any legal power density limits which apply in your region.
- Metal, external antennas can make good lightning conductors! Consider what equipment you are putting at risk if you choose not to invest in a lightning arrester.
- The distance figures for 5GHz operation may look bad when compared to 2.4GHz but it's worth remembering that the permitted power output levels for 5Ghz are 4 times those for 2.4GHz wireless! That means, if you stick to the legal power limits, then the range for 5GHz devices is about 10 times further than the equivalent 2.4GHz equipment.

Antenna Gain

Q. How does an antenna produce gain?

A. By focusing the available radio energy in one direction.

Q. OK, so how can an 'omni-directional' antenna have gain?

A. Because it radiates around itself in a disc pattern, stealing power from above and below.

The above Q&As should help you get a feel for the radiation pattern for different types of antennas. A 0dB antenna radiates equally over a complete sphere. Bearing in mind that 3dB represents a doubling of radiated power, you could imagine a 3dB *directional* antenna radiating its signal into one half of that sphere. A 3dB *omni-directional* antenna would have a radiation pattern in the shape of a sphere with a cone removed from the top and bottom.

Diversity Receivers

Wireless signals (both 2.4GHz and, to a much greater extent, 5Ghz) reflect readily off many surfaces, there will often be a pattern of patches around the room where reflected signals cancel out the direct signals leading to 'dead zones'. If your antenna is in such a dead zone you get no signal. However, for every dead zone there will be a 'double-power' zone. Due to the shortness of the radio waves at these high frequencies then the distance between a good patch and a bad patch can be only a few centimetres Wouldn't it be nice if you could have a second antenna, just a few centimetres away? Then, there would be a good chance of this second antenna sitting in a better reception zone.

A system with two aerials in this arrangement is called a diversity receiver. Many wireless devices use diversity receivers to try and improve NLOS operation.

More Articles

More in depth discussions on using wireless devices can be found on the following articles:

Line of Site and building linking

Wireless around the home

Solwise Range R&TTE Certificates

'ADSL Around the Home'