



Factors Affecting Wireless LAN Performance

“Why current Wireless LANs will remain a complimentary network solution; its all about performance...”

...and why that may be about to change.

Current widely-deployed Wireless LAN technologies – primarily 802.11B & G – provide great performance in the home environment, with few users, low traffic levels and the usually more limiting factor of the performance of a broadband Internet link itself in play.

These technologies have now also been used in the Corporate environment for some time and life has not proved so simple there, where demands are far more onerous. I believe the underlying limits of current generation WLAN technologies, when set against the widespread deployment of Enterprise wired networks with much higher and, as importantly, more consistent performance, will mean they are used to enhance them, not replace them.

The advent of the, as-yet-unratified, 802.11n enhanced WLAN standard may yet knock holes in this viewpoint; after all it promises a combination of much-improved throughput and range. If it is to do so, however, it must crack the problems inherent in scaling up WLAN for the enterprise and these have proved difficulty for 802.11A/B/G.

It's worthwhile remembering that a large number of factors affect Wireless LAN performance and many will apply equally to 802.11n as they do to A, B & G. Some of them are blindingly obvious, but as many are relatively obscure.

Wireless Network Managers should be aware of them all...

The Obvious Ones

- **Distance from the Access Point.**

The further away you get from an AP, the more the signal strength drops, (in a roughly inverse cube relationship with the distance).

- **Physical obstacles**

Unfortunately 2.4 GHz is not great for penetrating solids. This has both bad and good effects. In a building sub-divided into rooms you can cover only a fairly small number of rooms with a single AP – meaning you need more APs to cover, for instance, an entire school. On the plus side, the walls help form boundaries to allow APs on the same channel to co-exist in relative proximity to each other without interference.

- **Interference from other Wireless LANs.**

This is becomingly increasingly common in built-up city areas. In major cities it's not uncommon to be able to see in excess of twenty Wireless LANs from a single spot. It pays in designing and running your network to understand other businesses around you and work with them to avoid interference, to mutual benefit.

- **Non-WLAN interference / noise.**

Interference at 2.4 GHz is common, either from transient background sources or by other technologies which share unlicensed band – Bluetooth, some cordless phones etc. Even to such things as faulty microwave ovens.

- **Shared Medium.**

Wireless LAN is, for a single channel (configured on each AP) a shared medium – only one device can “talk” at a time; either the AP to a client or *one* of the clients to the AP. Wired Ethernet connections are dedicated – all clients on an Ethernet switch can talk simultaneously. Wired connections are also “full duplex” – can both send and receive simultaneously.

The Equally Obvious Ones – once you think about them a bit!

- **Half Duplex**

Really this is just a manifestation of the Shared Medium described previously; a LAN device can't send and receive traffic on the same channel at the same time.

- **Coverage is always dictated by environment**

In particular the materials and thickness of walls – especially if there is metal involved. Wire mesh is, for instance, a significant barrier to WLAN. For this reason a full Site Survey is still the most accurate way of assessing coverage needs. This involves actually trying it and seeing real results.

- **Network Load**

Again this is a manifestation of something mentioned previously; the shared medium. As you have more clients and clients themselves transmit and receive more traffic on an AP, the performance available to each of those clients is reduced.

- **Incorrectly oriented antennas**

All commonly deployed antennas have a degree of directionality; in the case of an omni, for instance, the doughnut radiates at right angles to the stick of the antenna. It's critical to know this orientation, particularly when using APs with built-in antennas where it may not be obvious. It's a particular waste to physically mount an AP so virtually all of it's power is lost into the floor or ceiling!

- **Limited spectrum**

Current areas of the radio spectrum available for WLAN have relatively limited “space”. In particular, in the popular 2.4 GHz band used by 802.11B and G the 13 channels (11 in the US) a maximum of three Access Points can be deployed in the same coverage area. It's often not understood that, on a given channel, an 11b/g device spreads it's transmission, to a significant degree, on the two channels directly above and the two channels directly below the central frequency. Therefore there should always be 5 channels between APs sharing airspace. In a single space, therefore, you'd usually find three APs configured for channels 1, 6 and 11. Note; channels 12 & 13 can't be used in the US; for this reason some WLAN clients don't support them at all. The situation will be somewhat different with the new technology, 802.11n. It seems likely that, although an individual AP spreads it's signal over an even wider part of the spectrum, other technological improvements will result in both increased throughput and range, even compared to an 802.11g solution with

three APs in a given area. This is still largely conjecture; 802.11n has not been widely deployed in Enterprise environments and is still only in Draft standard format.

- **Difficulties in limiting signal propagation.**

Particularly in open plan office areas it's difficult to control exactly how far a WLAN signal travels. This can limit the benefit from deploying multiple access into such an area. This can be managed to some degree with semi-directional antennas and manipulating radio power settings, but these have knock-on effects themselves.

- **Multi-path fade**

In complex environments multi-path fade (basically interference caused by signal reflections) causes significant loss in signal quality (note this is not a loss of strength). This can be overcome by using diversity antennas – two antennas placed the right distance apart on an AP. This distance largely ensures that, if signal quality is poor when communicating with a client via one of the antennas, the path via the alternate antenna will be free from multi-path fade. NB. Customers sometimes believe that two antenna sockets on an AP allows it to cover of two separate areas. This is not the case; for diversity to work effectively the antennas must cover the same area.

- **Inflexible use of Antennas**

The standard antennas employed by most clients and Access Points, as they aim to provide a uniform transmission (a "doughnut" shape) in the horizontal plane and a relatively broad signal also in the vertical dimension, usually have a relatively low gain (transmission strength) – 2 dBi is common. High gain antennas are available which "focus" an AP's radio power into a particular coverage pattern. This increases coverage in those areas at the expense of others. Such antennas can also enhance security, for instance by reducing or eliminating coverage outside a building.

The Slightly More Obscure Ones.

- **Regulatory power limitations; 50 mW radio power.**

B/G devices in the UK can transmit legally with a maximum radio setting of 50 mW. In the US this is 100 mW. With the more advanced modulation types used in 802.11G this drops still further (max. 30 mW). The effective range for WLAN here can therefore sometimes be significantly less than that quoted in documentation which has a US origin.

- **Regulatory power limitations; 20 dB EIRP.**

Users should bear in mind that there is a further regulatory limit (known as EIRP) which relates to the relative signal strength produced by the radio / antenna combination used. This means that, for increased-gain directional antennas, the resulting signal strength must be reduced, either by turning down the radio power or by introducing other losses (such as lengthening the cable linking AP with antenna) or a bit of both.

- **Wireless LAN overheads.**

The percentage of the headline connection rate available for real data (as opposed to protocol overheads) is significantly lower on a WLAN connection than on a wired Ethernet connection. WLAN protocol overhead means a real throughput somewhere around 50% of the connection rate. I.e. a WLAN client

connected at 54 Mbps will *experience* c. 27 Mbps – even if they're the only client associated to their AP.

- **Detrimental Effect of combined B and G networks.**

802.11G is backwardly compatible with B – i.e. an AP supporting G will allow both B and G clients to connect. Unfortunately operating both B & G simultaneously slows the WLAN down dramatically, due to compromises in the G-standard required for B compatibility. Fortunately it is possible on most APs to disable the B data rates, where B-only clients are not required, but this is only an option if you're guaranteed to have no B-only clients.

- **Antenna polarisation.**

WLAN is transmitted with the signal oriented in a specific plane (check your AP manufacturer documentation) – your clients should be as closely aligned with this as possible to maintain maximum performance. This factor particularly affects point-to-point Wireless Bridge links.

- **The effect of Performance on Performance (!)**

The WLAN standards allow clients to drop to lower connection rates as signal quality drops, for instance as they move further from the AP or if there is increased interference. Unfortunately, as the transmission rate drops or signal quality reduces and results in re-transmissions, the length of time taken to transfer data increases, thereby tying up the airwaves for longer and affecting all the other clients associated to the same AP.

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