Introduction to 2.4 GHz wireless networking

Wireless networking using the unlicensed 2.4-2.5GHz frequency band is the most popular form of radio based networking. The range of kit is massive with many hundreds of competitive kit available from simple PCMCIA cards for notebook computers up to powerful bridging units designed to link buildings.

There are two main ranges of wireless devices in the 2.4GHz band:

802.11b using DSSS (direct sequence spread spectrum) with speeds up to 11Mbps

802.11g using DSSS (at speeds less than 20Mbps) and OFDM (orthogonal frequency division multiplexing) for speeds above 20Mbps up to a maximum of 54Mbps.

The IEEE 802.11 standard defines various physical-layer rates for different types of WLANs, such as 1, 2, 5.5 and 11 Mbps for 802.11b and 802.11g. Rates for 802.11g include 6, 9, 12, 18, 24, 36, 48 and 54 Mbps. The user throughput is less than these link rates for several reasons:

• . Each packet includes additional data, such as preambles, headers (MAC, IP, TCP, etc.) and checksums.

• . When every directed (unicast) packet is received, the receiver transmits a short acknowledge packet back to the sender. You might also come across some devices quoting speeds of 108Mbps called 11g Turbo or similar. The Turbo system is not *really* 108Mbps. What actually happens is two wireless channels are simultaneously used: One for transmit and one for receive. In this way the devices can simultaneously send and receive data at the same time. Although this won't actually materialize as 108Mbps transfer speed, because the devices don't have to wait for a reply on the same channel there is a significant speed improvement.

• . Transmitters wait for short random times between packets to allow other users to contend for and share the channel.

Given these reasons, the theoretical maximum user-level performance for the various 802.11 systems is:

Standard	Wireless Speed	Actual TCP Speed	Actual UDP Speed
802.11b	11 Mbps	5.9 Mbps	7.1 Mbps
802.11g (with 11b compatibility enabled)	54 Mbps	14.4 Mbps	19.5 Mbps
802.11g (11g-only mode)	54 Mbps	24.4 Mbps	30.5 Mbps
802.11gTURBO	108 Mbps	42.9 Mbps	54.8 Mbps

These figures assume 1500-byte packets, encryption enabled, default 802.11 MAC configurations, zero packet errors, and maximum available channel bandwidth (that is, operating at close range). Note that some 802.11 implementations use tricks such as reducing back off times between packets to improve throughput performance. Such tricks can result in interoperability problems with other

vendors' systems though.

These figures also show two rates for 802.11g to account for the lower rates in 802.11b compatibility mode. The throughput of an 802.11g WLAN decreases significantly in 802.11b compatibility mode because every 802.11g (OFDM) packet needs to be preceded by a CTS packet exchange recognizable by legacy 802.11b devices. With no 802.11b devices connected, an 802.11g network can operate in 11g-only mode and should achieve the standard throughput of 802.11a. The current 802.11g draft standard also provides for a slower RTS/CTS header (instead of CTS-only) when in 802.11b compatibility mode, which will further reduce the 14.4 Mbps TCP/IP rate to 11.8 Mbps.

You therefore have two choices with 802.11g networks: You can achieve high rates or you can get 802.11b compatibility. You cannot have both at the same time. ☹

Due to the fact that 2.4GHz wireless networking was the first mass-market radio networking and has been around the longest equipment tends to be very wide ranging and relatively low cost. It is therefore often the preferred system for the home and small to medium size enterprise. This is why 2.4GHz networking is the preferred system for both private (home networks) and also for long range bridging. For small network use you have the choice of client devices like PCI or PCMCIA cards and also USB 'dongles' and low cost Access Points and small gain indoor antenna to try to improve the signal. See our article Wireless Around the Home for more information on wireless technology within buildings.

For long range and building-to-building operations you have more expensive bridging AP's and high gain, directional antenna giving ranges up to 30Km! (see our article Wireless Technical Discussion for more information on linking building using wireless).

However, there are new, cost effective, 5GHz products starting to appear which may start the threaten the 2.4GHz dominance.

See 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**