What is a Wireless LAN?

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A wireless LAN (WLAN) is a local-area network in which digital devices communicate through a wireless medium such as radio or infrared instead of copper or fiber-optic cable.

Most WLAN equipment today is based on the Institute of Electrical and Electronics Engineers (IEEE) 802.11 series of standards, popularly known as Wi-Fi technology. All information given below refers to devices conforming to one or more of these standards.

IEEE 802.11b specifies operation in the 2.4-GHz band (2001-2497 MHz) at speeds up to 11 megabits per second (Mbps).

IEEE 802.11a specifies operation in the 5-GHz band (5150-5825 MHz) at speeds up to 54 Mbps. The higher frequencies used by 802.11a limit its typical transmission range to about 60% that of IEEE 802.11b.

IEEE 802.11g specifies operation in the 2.4-GHz band at 802.11a speeds and 802.11b ranges.

WLAN Range

A WLAN's transmission range is affected by the characteristics of the frequency band it uses; by government regulations limiting transmission power in that band; by electromagnetic conditions at the site (levels of radio-wave obstruction, absorption, reflection, and interference); and by the kinds of antennas used. There is tremendous variation, both in vendors' claims regarding transmission range and in the effective range achieved in different installations.

Most WLAN devices can automatically switch to a lower speed when signals deteriorate and return to higher speeds when signals improve. On an indoor 802.11b WLAN, it is usually possible to maintain a speed of 11 Mbps at distances up to 100 feet (33 meters). In some cases this speed can be maintained at up to 130 feet (40 meters).

WLAN Speed

The figures usually given for WLAN speed reflect the maximum _signaling rate_, that is, the highest rate at which ones and zeros can be sent out during a transmission. This is also called the bit rate, data rate, link rate, link speed, or transmission rate.

Because of the difficulty of maintaining multiple two-way radio links, however, much of the data sent is not user data but "overhead" -- preambles, headers, checksums, requests, responses, acknowledgements, etc., that pass between devices but are never seen by users. The standards require that many of these be sent out at 1 or 2 Mbps for more reliable reception. There are also the inevitable garbled messages and retransmissions, as well as required short intervals between transmissions. The result is that under average loads, roughly half of the "megabits per second" carry user data -- Web pages, e-mail, files, etc. The speed at which user data is successfully transferred is known as _throughput_. Under the best of conditions, throughput on a WLAN is roughly half the signaling rate.

Wireless LAN Standard

802.11b

Most WLANs today conform to IEEE standard 802.11b, which uses the 2.4-GHz band and provides a maximum signaling rate of 11 Mbps, with average throughput in the range of 4 to 6 Mbps. In a typical office environment, 802.11b's maximum range is about 250 feet (76 meters) at the lowest speed, and about 100 feet (33 meters) at the highest speed.

Bluetooth devices, 2.4-GHz cordless phones, and microwave ovens are sources of interference (and therefore degraded performance) for 802.11b networks. 802.11b networks can also cause interference to each other: the fourteen channels of the 802.11b specification are apportioned in such a way that no more than three can be used in the same area without frequency overlap.

802.11b equipment has been shipping in quantity for several years, so you will find that products are plentiful and affordable.

802.11b+

Texas Instruments (TI) has developed a modulation technique called Packet Binary Convolutional Code (PBCC) that can provide signaling rates of 22 and 33 Mbps. TI produces 802.11b-based chipsets that also support 22-Mbps PBCC. Products that incorporate these chipsets are referred to as 802.11b+ devices. They are fully 802.11b compliant, and when communicating with each other can automatically use the vendor-specific 22-Mbps signaling rate. Another TI enhancement that can be used between 802.11b+ devices is 4X mode, which uses a larger maximum packet size -- 4000 bytes -- to reduce overhead and increase throughput by as much as a third.

802.11a

Operating in the 5-GHz band, IEEE 802.11a provides signaling rates up to 54 Mbps, with effective throughput in the range of 20 to 25 Mbps under average loads. In a typical office environment, 802.11a's maximum range is about 150 feet (46 meters) at the lowest speed, and about 75 feet (23 meters) at the highest speed. Unlike the 2.4-GHz band, the 5-GHz band is relatively free of interference. IEEE 802.11a takes advantage of the size of this band to define only non-overlapping channels. Some countries make four channels available, some eight, and some even more.

802.11g

IEEE 802.11g offers the speed of 802.11a, the range of 802.11b, and backward compatibility with 802.11b. It uses the 2.4-GHz band but provides signaling rates of 6 to 54 Mbps. Like 802.11b, it has fourteen channels, of which no more than three can be used in the same area without frequency overlap.

802.11g achieves its speed by using orthogonal frequency-division multiplexing (OFDM), the same modulation scheme as 802.11a. 802.11g-compliant products are required, however, to be able to recognize and work with 802.11b devices, which use complimentary code keying (CCK) modulation. Communication at 22 and 33 Mbps using Texas Instruments' Packet Binary Convolutional Code (PBCC) modulation is recognized as a standard-compliant option in 802.11g.

802.11g+

802.11g+ is to 802.11g what 802.11b+ is to 802.11b: a Texas Instruments implementation of the IEEE standard, with the addition of several vendor-specific capabilities. As the standard requires, 802.11g+ products interoperate fully with 802.11b and 802.11g devices, in both homogeneous and mixed 802.11b/802.11g networks. On links to 802.11b+ devices, they can take advantage of TI's 802.11b+ enhancements. Communicating with each other in 802.11g+ mode, they are said to be able to achieve throughput equivalent to that of a 100-Mbps signaling rate.

802.11n

IEEE 802.11 Task Group N was formed in July 2003 to "define standardized modifications to both the 802.11 physical layers (PHY) and the 802.11 Medium Access Control Layer (MAC) so that modes of operation can be enabled that are capable of much higher throughputs, with a maximum throughput of at least 100 Mbps, as measured at the MAC data service access point (SAP)." This is the first 802.11 project focused on throughput rather than signaling rate. Other goals are to achieve the hoped-for throughput without sacrificing range, and to maintain interoperability with 802.11a and/or 802.11g devices. The initial schedule calls for a standard to be finalized by the end of 2005.

WiMax

The Worldwide Interoperability for Microwave Access (WiMAX) Forum is a coalition of wireless broadband access (WBA) equipment vendors and service providers organized in April 2001 to spur the development, refinement, and market acceptance of IEEE 802.16, a series of standards for fixed wireless broadband (FWB) metropolitan area networks (MANs) operating at frequencies from 10 to 66 GHz. In many people's minds, the term WiMAX has become synonymous with IEEE 802.16, just as Wi-Fi has become synonymous with IEEE 802.11.

802.11i

Expected to be completed and ratified by mid-2004, the IEEE 802.11i draft standard describes two new security schemes for 802.11a/b/g WLANs. The first is basically Wi-Fi Protected Access (WPA) with some added options; this will allow most WEP-capable devices to be made 802.11i-compliant via firmware upgrades. The second, called Robust Security Network (RSN) will require extra processing power (and therefore new hardware) to cope with the Advanced Encryption Standard (AES), a scheme developed under the sponsorship of the U.S. National Institute of Standards and Technology (NIST) and approved as Federal Information Processing Standard (FIPS) 197.