

TYPES OF WIRELESS LANs

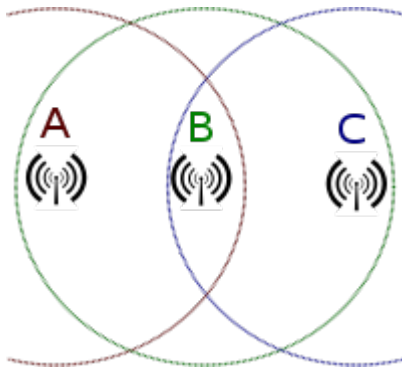
1. Peer-to-peer

Peer-to-Peer / Ad-Hoc



Peer-to-Peer or ad-hoc wireless LAN

An ad-hoc network is a network where stations communicate only peer to peer (P2P). There is no base and no one gives permission to talk. This is accomplished using the Independent Basic Service Set (IBSS). A peer-to-peer (P2P) network allows wireless devices to directly communicate with each other. Wireless devices within range of each other can discover and communicate directly without involving central access points. This method is typically used by two computers so that they can connect to each other to form a network. If a signal strength meter is used in this situation, it may not read the strength accurately and can be misleading, because it registers the strength of the strongest signal, which may be the closest computer.



Hidden node problem: Devices A and C are both communicating with B, but are unaware of each other IEEE 802.11 defines the physical layer (PHY) and MAC (Media Access Control) layers based on CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance). The 802.11 specification includes provisions designed to minimize collisions, because two mobile units may both be in range of a common access point, but out of range of each other.

The 802.11 has two basic modes of operation: Ad hoc mode enables peer-to-peer transmission between mobile units. Infrastructure mode in which mobile units communicate through an access point that serves as a bridge to a wired network infrastructure is the more common wireless LAN application the one being covered. Since wireless communication uses a more open medium for communication in comparison to wired LANs, the 802.11 designers also included shared-key encryption mechanisms: Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA, WPA2), to secure wireless computer networks.

Bridge

A bridge can be used to connect networks, typically of different types. A wireless Ethernet bridge allows the connection of devices on a wired Ethernet network to a wireless network. The bridge acts as the connection point to the Wireless LAN.

Wireless distribution system

A Wireless Distribution System enables the wireless interconnection of access points in an IEEE 802.11 network. It allows a wireless network to be expanded using multiple access points without the need for a wired backbone to link them, as is traditionally required. The notable advantage of WDS over other solutions is that it preserves the MAC addresses of client packets across links between access points.

An access point can be either a main, relay or remote base station. A main base station is typically connected to the wired Ethernet. A relay base station relays data between remote base stations, wireless clients or other relay stations to either a main or another relay base station. A remote base station accepts connections from wireless clients and passes them to relay or main stations. Connections between "clients" are made using MAC addresses rather than by specifying IP assignments.

All base stations in a Wireless Distribution System must be configured to use the same radio channel, and share WEP keys or WPA keys if they are used. They can be configured to different service set identifiers. WDS also requires that every base station be configured to forward to others in the system. WDS may also be referred to as repeater mode because it appears to bridge and accept wireless clients at the same time (unlike traditional bridging). It should be noted; however, that throughput in this method is halved for all clients connected wirelessly. When it is difficult to connect all of the access points in a network by wires, it is also possible to put up access points as repeaters.

Roaming

Roaming among Wireless Local Area Networks

There are two definitions for wireless LAN roaming:

- **Internal Roaming (1):** The Mobile Station (MS) moves from one access point (AP) to another AP within a home network because the signal strength is too weak. An authentication server (RADIUS) presumes the re-authentication of MS via 802.1x (e.g. with PEAP). The billing of QoS is in the home network. A Mobile Station roaming from one access point to another often interrupts the flow of data among the Mobile Station and an application connected to the network. The Mobile Station, for instance, periodically monitors the presence of alternative access points (ones that will provide a better connection). At some point, based on proprietary mechanisms, the Mobile Station decides to re-associate with an access point having a stronger wireless signal. The Mobile Station, however, may lose a connection with an access point before associating with another access point. In order to provide reliable connections with applications, the Mobile Station must generally include software that provides session persistence.^[7]
- **External Roaming (2):** The MS (client) moves into a WLAN of another Wireless Internet Service Provider (WISP) and takes their services (Hotspot). The user can independently of his home network use another foreign network, if this is open for visitors. There must be special authentication and billing systems for mobile services in a foreign network.

IEEE 802.11 is a set of standards for implementing wireless local area network (WLAN) computer communication in the 2.4, 3.6 and 5 GHz frequency bands. They are created and maintained by the IEEE LAN/MAN Standards Committee (IEEE 802). The base version of the standard **IEEE 802.11-2007** has had subsequent amendments. These standards provide the basis for wireless network products using the Wi-Fi brand name.



General description

The 802.11 family consists of a series of over-the-air modulation techniques that use the same basic protocol. The most popular are those defined by the 802.11b and 802.11g protocols, which

are amendments to the original standard. 802.11-1997 was the first wireless networking standard, but 802.11b was the first widely accepted one, followed by 802.11g and 802.11n. 802.11n is a new multi-streaming modulation technique. Other standards in the family (c–f, h, j) are service amendments and extensions or corrections to the previous specifications.

802.11b and 802.11g use the 2.4 GHz ISM band, operating in the United States under Part 15 of the US Federal Communications Commission Rules and Regulations. Because of this choice of frequency band, 802.11b and g equipment may occasionally suffer interference from microwave ovens, cordless telephones and Bluetooth devices. 802.11b and 802.11g control their interference and susceptibility to interference by using direct-sequence spread spectrum (DSSS) and orthogonal frequency-division multiplexing (OFDM) signaling methods, respectively. 802.11a uses the 5 GHz U-NII band, which, for much of the world, offers at least 23 non-overlapping channels rather than the 2.4 GHz ISM frequency band, where adjacent channels overlap.^[1] Better or worse performance with higher or lower frequencies (channels) may be realized, depending on the environment.

The segment of the radio frequency spectrum used by 802.11 varies between countries. In the US, 802.11a and 802.11g devices may be operated without a license, as allowed in Part 15 of the FCC Rules and Regulations. Frequencies used by channels one through six of 802.11b and 802.11g fall within the 2.4 GHz amateur radio band. Licensed amateur radio operators may operate 802.11b/g devices under Part 97 of the FCC Rules and Regulations, allowing increased power output but not commercial content or encryption.^[2]

Protocols

- ^{A1 A2} IEEE 802.11y-2008 extended operation of 802.11a to the licensed 3.7 GHz band. Increased power limits allow a range up to 5,000 m. As of 2009, it is only being licensed in the United States by the FCC.
- ^{B1 B2} Assumes short guard interval (SGI) enabled, otherwise reduce each data rate by 10%.

802.11 network standards

802.11 protocol	Release	Freq. (GHz)	Bandwidth (MHz)	Data rate per stream (Mbit/s)	Allowable <u>MIMO</u> streams	Modulation	Approximate indoor range (m)	Approximate outdoor range (m)
	Jun 1997	2.4	20	1, 2	1	<u>DSSS</u> , <u>FHSS</u>	20	100
a	Sep 1999	5	20	6, 9, 12, 18,	1	<u>OFDM</u> <u>QAM</u>	35	120
		3.7		54			—	5,000
b	Sep 1999	2.4	20	5.5, 11	1	<u>DSSS</u>	38	140
g	Jun 2003	2.4	20	6, 9, 12, 18, 24, 36, 48, 54	1	<u>OFDM</u> <u>QAM</u> , <u>DSSS</u>	38	140

n	Oct 2009	2.4/5	20	7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65, 72.2 ^[B]	4	<u>OFDM</u> <u>QAM</u>	70	250
			40	15, 30, 45, 60, 90, 120, 135, 150 ^[B]			70	250
			80	433, 867				
ac (DRAFT)	Nov. 2011	5	160	867, 1.73 Gbit/s, 3.47 Gbit/s, 6.93 Gbit/s	8	<u>OFDM</u> <u>QAM</u>		

802.11-1997 (802.11 legacy)

The original version of the standard IEEE 802.11 was released in 1997 and clarified in 1999, but is today obsolete. It specified two net bit rates of 1 or 2 megabits per second (Mbit/s), plus forward error correction code. It specified three alternative physical layer technologies: diffuse infrared operating at 1 Mbit/s; frequency-hopping spread spectrum operating at 1 Mbit/s or 2 Mbit/s; and direct-sequence spread spectrum operating at 1 Mbit/s or 2 Mbit/s. The latter two radio technologies used microwave transmission over the Industrial Scientific Medical frequency band at 2.4 GHz. Some earlier WLAN technologies used lower frequencies, such as the U.S. 900 MHz ISM band. Legacy 802.11 with direct-sequence spread spectrum was rapidly supplanted and popularized by 802.11b.

802.11a

The 802.11a standard uses the same data link layer protocol and frame format as the original standard, but an OFDM based air interface (physical layer). It operates in the 5 GHz band with a maximum net data rate of 54 Mbit/s, plus error correction code, which yields realistic net achievable throughput in the mid-20 Mbit/s

Since the 2.4 GHz band is heavily used to the point of being crowded, using the relatively unused 5 GHz band gives 802.11a a significant advantage. However, this high carrier frequency also brings a disadvantage: the effective overall range of 802.11a is less than that of 802.11b/g. In theory, 802.11a signals are absorbed more readily by walls and other solid objects in their path due to their smaller wavelength and, as a result, cannot penetrate as far as those of 802.11b. In practice, 802.11b typically has a higher range at low speeds (802.11b will reduce speed to 5 Mbit/s or even 1 Mbit/s at low signal strengths). 802.11a too suffers from interference, but locally there may be fewer signals to interfere with, resulting in less interference and better throughput.

802.11b

802.11b has a maximum raw data rate of 11 Mbit/s and uses the same media access method defined in the original standard. 802.11b products appeared on the market in early 2000, since 802.11b is a direct extension of the modulation technique defined in the original standard. The

dramatic increase in throughput of 802.11b (compared to the original standard) along with simultaneous substantial price reductions led to the rapid acceptance of 802.11b as the definitive wireless LAN technology. 802.11b devices suffer interference from other products operating in the 2.4 GHz band. Devices operating in the 2.4 GHz range include: microwave ovens, Bluetooth devices, baby monitors, and cordless telephones.

802.11g

In June 2003, a third modulation standard was ratified: 802.11g. This works in the 2.4 GHz band (like 802.11b), but uses the same OFDM based transmission scheme as 802.11a. It operates at a maximum physical layer bit rate of 54 Mbit/s exclusive of forward error correction codes, or about 22 Mbit/s average throughputs. 802.11g hardware is fully backwards compatible with 802.11b hardware and therefore is encumbered with legacy issues that reduce throughput when compared to 802.11a by ~21%.

The then-proposed 802.11g standard was rapidly adopted by consumers starting in January 2003, well before ratification, due to the desire for higher data rates as well as to reductions in manufacturing costs. By summer 2003, most dual-band 802.11a/b products became dual-band/tri-mode, supporting a and b/g in a single mobile adapter card or access point. Details of making b and g work well together occupied much of the lingering technical process; in an 802.11g network, however, activity of an 802.11b participant will reduce the data rate of the overall 802.11g network. Like 802.11b, 802.11g devices suffer interference from other products operating in the 2.4 GHz band, for example wireless keyboards.

802.11-2007

In 2003, task group TGma was authorized to "roll up" many of the amendments to the 1999 version of the 802.11 standard. REVma or 802.11ma, as it was called, created a single document that merged 8 amendments (802.11a, b, d, e, g, h, i, j) with the base standard. Upon approval on March 8, 2007, 802.11REVma was renamed to the then-current base standard **IEEE 802.11-2007**.

802.11n

802.11n is an amendment which improves upon the previous 802.11 standards by adding multiple-input multiple-output antennas (MIMO). 802.11n operates on both the 2.4 GHz and the lesser used 5 GHz bands. The IEEE has approved the amendment and it was published in October 2009. Prior to the final ratification, enterprises were already migrating to 802.11n networks based on the Wi-Fi Alliance's certification of products conforming to a 2007 draft of the 802.11n proposal.

802.11ac

IEEE 802.11ac is a standard under development which will provide high throughput in the 5 GHz band. This specification will enable multi-station WLAN throughput of at least 1 Gigabit per second and a maximum single link throughput of at least 500 megabit per second, by using wider RF bandwidth, more streams (up to 8), and high-density modulation (up to 256 QAM).