

802.11 Alphabet Soup

IEEE (Institute of Electrical and Electronics Engineers) Standard 802.11 defines wireless LANs. Although wireless data transmission has been available for years, 802.11 opened the door for enterprises to start deploying and using wireless LANs in buildings and over short ranges between buildings. This white paper is designed as a guide to help you through the alphabet soup of 802.11. More information on IEEE 802.11 and the working groups which set the wireless LAN standards is available at the IEEE 802.11 web page <http://grouper.ieee.org/groups/802/11/>.

Since 1997, when 802.11 was first released, the IEEE has been busily extending 802.11. Over 50 vendors supply hundreds of different products which are compatible with the 802.11 specifications. The IEEE is not the only standards organization involved in wireless communications. In both Europe and Japan, specific industry segments have created their own standards for special-purpose wireless communications. And wireless communications are not only defined with IEEE 802.11. For example, IEEE 802.16 defines standards for metropolitan area wireless networks. However, the clear leader in enterprise LANs is 802.11.

It is easy to be confused by all of the addenda to the original 802.11 Standard. Names such as 802.11a, 802.11b, and more are all being thrown around by vendors and users. Unfortunately, the order of the letters does not map to the order in which products were introduced. For example, 802.11b products were available in 2000 and 2001, while 802.11a products just started shipping in volume at the beginning of 2002.

Note: l and o are not used because it would be confusing. 802.11x will probably also not be used.

802.11

What is it: The 1997 version of the standard specifies the operation of wireless LANs, including the media access control (MAC) and wired equivalent privacy (WEP). It also includes three physical layers which have been superceded by revisions to the specification: the infrared (IR) PHY, which was never widely implemented; the frequency hopping spread spectrum (FHSS), which is no longer used; and the direct sequence spread spectrum (DSSS) PHY, which has been superceded by 802.11b and 802.11g. **Status:** Standard completed 1997. Contains the base for all 802.11 specifications.

802.11a

What is it: Physical layer that operates within the 5 GHz radio band. Offers up to 12 non-overlapping channels (as opposed to three with 802.11b). Uses Orthogonal Frequency Division Multiplexing (OFDM) to offer maximum standardized data rate of 54 Mbps. **Status:** Standard completed 1999. Products are shipping today in volume at low cost.

802.11b

What is it: Physical layer operating within the 2.4 GHz radio band. Offers only three non-overlapping channels. Uses complementary code keying (CCK) to achieve maximum standardized rate of 11 Mbps per channel. **Status:** Now-obsolete standard completed 1999. Products are no longer shipping, but 802.11b chipsets are widely used in low-cost and low-power devices.

802.11d

What is it: 802.11 was written to comply with the regulatory limits in the U.S., Canada, and Europe. New regulators may specify different constraints for transmit power and allowed frequencies. 802.11d allows an access point to "describe" allowed configurations to clients to make deployment easier. **Status:** Standard completed 2001; minor importance unless your country was not in 802.11.

802.11e

What is it: Quality of Service (QoS) enhancements for 802.11 networks. QoS may be critical for new applications, such as voice over 802.11. The Wi-Fi Alliance has released an interim snapshot called Wi-Fi Multimedia (WMM). **Status:** Standard not yet completed.

802.11F

What is it: This standard defined an inter-access point protocol. It has not been widely implemented. **Status:** Standard completed in 2003.

802.11g

What is it: An update that uses the OFDM encoding of 802.11a in the 2.4 GHz band. Because of being on the same frequency as 802.11b, if an 802.11b device enters an 802.11g environment, all 802.11g devices will use a "protection" mode for coexistence. **Status:** Completed in 2003.

802.11h

What is it: European radio regulations for the 5GHz band require products to have transmission power control (TPC) to limit RF energy and dynamic frequency selection (DFS) to minimize interference with other systems. 802.11h defined these functions to allow use of the 5 GHz band. **Status:** Standard completed in 2003.

802.11i

What is it: 802.11i offers dramatically improved security. Includes two new encryption algorithms: TKIP (Temporal Key Integrity Protocol), which synchronizes key changes between clients and APs; and CCMP (Counter Mode with CBC-MAC Protocol), an AES-based system. The Wi-Fi Alliance's WPA specification takes components available in September 2002 and calls them an "interim standard." **Status:** Standard completed in 2004.

802.11j

What is it: Japan has authorized a slightly different frequency band (4.9 GHz - 5 GHz) for 802.11a-like functionality. 802.11j brings OFDM PHY speeds to the authorized Japanese band. **Status:** Ratified in late 2004; major importance for Japan, but irrelevant for other areas.

802.11k

What is it: 802.11 equipment does not report much about the health and status of the radio link, and network managers have little insight into its performance. This project will make low-level data available to management systems so that equipment can dynamically change radio channels, power levels, and load balance clients across APs. **Status:** Standard ongoing. Last letter ballot in March 2005 narrowly failed.

802.11m

What is it: "Maintenance" update to 802.11 that will "roll up" changes made to 802.11-1999 by 802.11a, 802.11b, and 802.11d into a new revision of the 802.11 standard. **Status:** Schedule unknown.

802.11n

What is it: Pending project that will focus on increasing the speed of 802.11 beyond 100 Mbps using multiple-input/multiple output (MIMO) technology. Two proposals from consortia offer speeds above 600 Mbps. **Status:** Task group formed, but has not picked a starting proposal.

802.11p

What is it: Wireless Access in Vehicular Environments (WAVE). Initial focus is on adapting 802.11 technology for use in automotive transponders, such as electronic toll collection. **Status:** Task group reviewing draft proposal.

802.11r

What is it: Enhancements to roaming performance to enable faster handoff between APs. **Status:** Task group selecting a starting proposal from seven contenders.

802.11s

What is it: Task group to develop 802.11 mesh networks. **Status:** Task group is selecting a starting proposal.

802.11T

What is it: Group to develop test definitions and methodologies for 802.11 networks. **Status:** Task group has not yet started working on a draft.

802.11u

What is it: Group to develop "interworking" functions with other networks, such as cellular networks. This is related to work in 802.21, but handles changes required by 802.11 to support the 802.21 effort. **Status:** Draft in development based on requirements from other standards bodies.

802.11v

What is it: Group to develop wireless management functions. 802.11k will enable monitoring of stations, but not configuration. 802.11v will add the ability to configure stations. **Status:** Requirements are being developed.

802.11w

What is it: 802.11 management frames are currently authentication, and can easily be used for nefarious purposes. This group is studying the effort to add the protection of management frames into the standard, which would prevent attacks that depend on unencrypted and unauthenticated management. **Status:** Study group.