

Wireless and Cellular Technologies

by Sophia



WHAT'S COVERED

In this lesson, you will be introduced to wireless networks and the technologies in use today.

Specifically, this lesson will cover the following:

1. Introduction to Wireless Technology

1a. Improving Wireless Coverage

1b. Wireless Network Governance

2. Cellular

2a. GSMC

2b. FDMA

2c. TDMA

2d. CDMA

3. Introduction to the 802.11 Standards



BEFORE YOU START

While you are sipping coffee at a café or in an airport waiting to board your flight, you have the option to connect to the local wireless network and catch up on your emails, blog, do a little gaming, or get some work done. Many of us would not even think of checking into a hotel that does not have wireless internet access. Understanding the basics of wireless networking is an important skill for many information technologists.

Most people rely on wireless networks today, so it is critical for them to evolve quickly to keep up with our rapidly evolving needs for speed and security. This lesson, and the following three tutorials, will cover the various components used; the IEEE 802.11 standards; wireless installation; and wireless security.

1. Introduction to Wireless Technology

Wireless LANs (WLANs) use radio frequencies (RFs) that are radiated into the air from an antenna that creates radio waves. These waves can be absorbed, refracted, or reflected by walls, water, and metal surfaces, resulting in low signal strength. So, because of this innate vulnerability to the surrounding environmental factors, it is likely that wireless will never offer us the same robustness as a wired network. However, the mobility that wireless networks enable is a feature that many end users demand.

1a. Improving Wireless Coverage

To improve wireless coverage by gaining a greater transmitting distance, we can increase the transmitting power, but doing so can create some distortion, so it has to be done carefully. By using higher frequencies, we can attain higher data rates; however, this is, unfortunately, at the cost of decreased transmitting distances. And if we use lower frequencies, we get to transmit greater distances but at lower data rates. There is no perfect wireless system, so understanding all the various types of WLANs you can implement is imperative to creating the LAN solution that best meets the specific requirements of the unique situation you're dealing with.

Also important to note is the fact that the **802.11** specifications were developed so that there would be no licensing required in most countries, which ensures that the user has the freedom to install and operate without any licensing or operating fees. This means that any manufacturer can create wireless networking products and bring them to market. It also means that all our computers should be able to communicate wirelessly without much configuration.



TERM TO KNOW

802.11

A set of local area network (LAN) technical standards; it specifies the set of media access control (MAC) and physical layer (PHY) protocols for implementing wireless local area network (WLAN) computer communication.

1b. Wireless Network Governance

Various agencies have been around for a very long time to help govern the use of wireless devices, frequencies, standards, and frequency spectrums. The table below shows the current agencies that help create, maintain, and even enforce wireless standards worldwide.

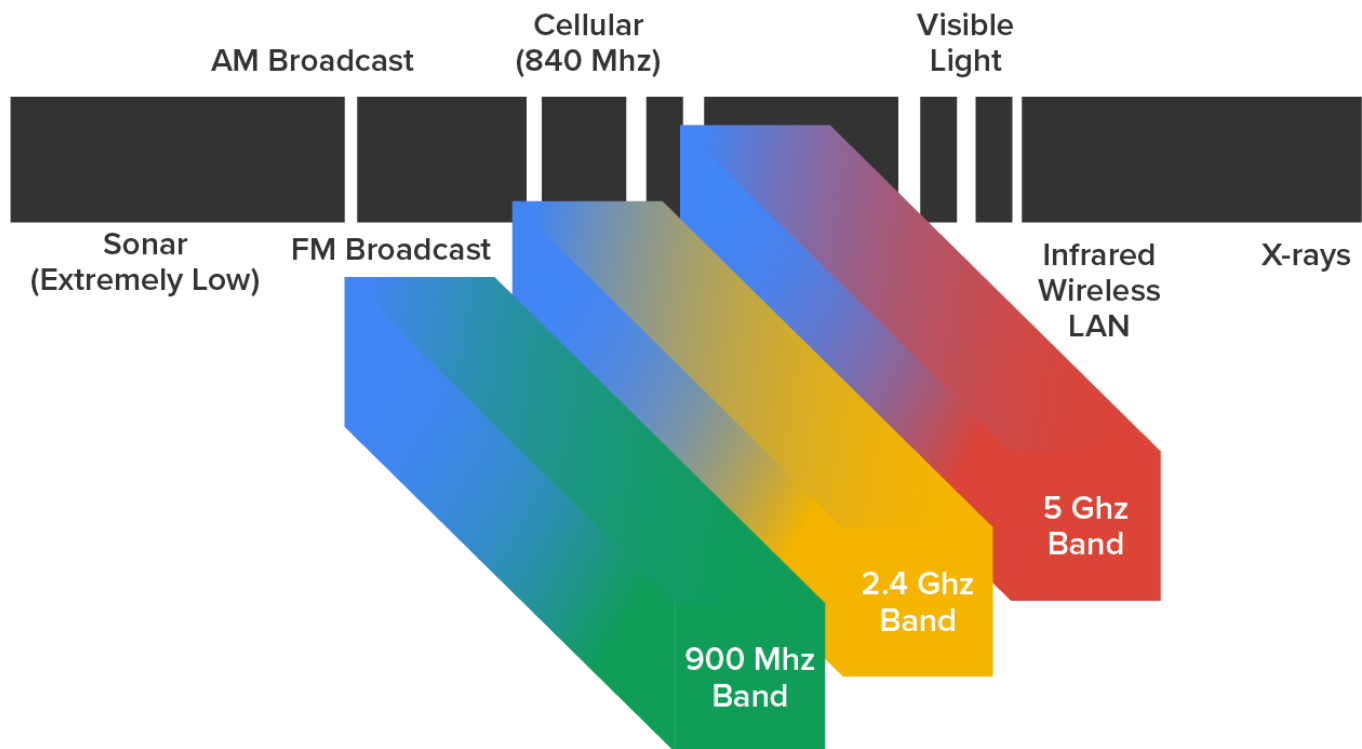
Agency	Purpose	Website
Institute of Electrical and Electronics Engineers (IEEE)	Creates and maintains operational standards	www.iee.org
Federal Communications Commission (FCC)	Regulates the use of wireless devices in the United States	www.fcc.gov
European Telecommunications Standards Institute (ETSi)	Chartered to produce common standards in Europe	www.etsi.org
Wi-Fi Alliance	Promotes and tests for WLAN interoperability	www.wi-fi.com
WLAN Association (WLANA)	Educates and raises consumer awareness regarding WLANs	www.wlana.org

Because WLANs transmit over RFs, they are regulated by the same types of laws used to govern things like AM/FM radios. In the United States, the Federal Communications Commission (FCC) regulates the use of WLAN devices and the Institute of Electrical and Electronics Engineers (IEEE) creates technical standards based on what frequencies the FCC releases for public use.



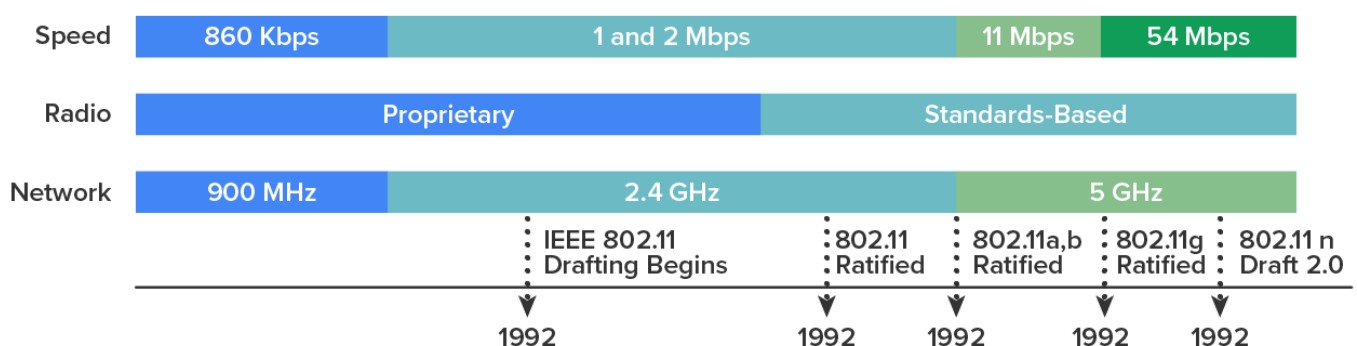
BIG IDEA

The FCC has released three unlicensed bands for public use: 900 MHz, 2.4 GHz, and 5 GHz. The 900 MHz and 2.4 GHz bands are referred to as the **industrial, scientific, and medical (ISM) bands**, and the 5 GHz band is known as the **Unlicensed National Information Infrastructure (U-NII) band**. The diagram below shows where the unlicensed bands sit within the RF spectrum. A newer addition to this (not shown in the figure) is the 60 GHz band that is used for the new 802.11ad standard, which is a very high-speed, short-range wireless technology.



If you opt to deploy wireless in a range outside the three public bands mentioned above, you need to get a specific license from the FCC to do so. Once the FCC opened the three frequency ranges for public use, many manufacturers were able to start offering a myriad of products that flooded the market, with 802.11b/g/n being the most widely used wireless network found today.

The diagram below shows the WLAN history that is important to us. Although wireless transmissions date back many, many years, the type we really care about is wireless as related to WLANs, starting in the 1990s. The ISM band started being used in early 1990, and it is deployed today in multiple environments, including outdoor links, mesh networks, office buildings, health care facilities, warehouses, and homes.



802.11ac was released in December 2013 and is widely in use today. 802.11ax was finalized in September 2020 and is expected to become the dominant standard in the next few years.

The Wi-Fi Alliance grants certification for interoperability among the 802.11 products offered by various vendors. This certification provides a sort of comfort zone for the users purchasing the many types of products, although it is easier if you buy all your access points from the same manufacturer.

In the current U.S. WLAN market, there are several accepted operational standards and drafts created and maintained by the IEEE. We will now take a look at these standards and then talk about how the most commonly used standards work.



TERMS TO KNOW

Industrial, Scientific, and Medical (ISM) Bands

Portions of the radio spectrum reserved internationally for industrial, scientific, and medical purposes, excluding applications in telecommunications.

Unlicensed National Information Infrastructure (U-NII)

A part of the radio frequency spectrum used by WLAN devices and by many wireless ISPs.

2. Cellular

Many people use their smartphones as their primary devices for wireless computing. Smartphones are generally configured to use Wi-Fi when it is available and cellular internet access when Wi-Fi is not available. As part of implementing the appropriate cellular and mobile wireless technologies and configurations, consider the following options.

2a. GSMC

The **Global System for Mobile Communication (GSMC)** is a type of cell phone that contains a **Subscriber Identity Module (SIM)** chip. These chips contain all the information about the subscriber and must be present in the phone for it to function.



REFLECT

Think about the last time you upgraded your cellular phone, or swapped out the SIM chip. One of the dangers with these phones is **cell phone cloning**, a process where copies of the SIM chip are made, allowing another user to make calls as the original user. Secret key cryptography is used (using a common secret key) when authentication is performed between the phone and the network.



TERMS TO KNOW

Global System for Mobile Communication (GSMC)

A standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile devices such as mobile phones and tablets.

Subscriber Identity Module (SIM)

An integrated circuit (IC) intended to securely store the international mobile subscriber identity (IMSI) number and its related key, which are used to identify and authenticate subscribers on mobile telephone devices.

Cell Phone Cloning

A process where copies of the SIM chip are made, allowing another user to make calls as the original user.

2b. FDMA

Frequency-division multiple access (FDMA) is one of the modulation techniques used in cellular wireless networks. It divides the frequency range into bands and assigns a band to each subscriber. This was used in first-generation (1G) cellular networks.



TERM TO KNOW

Frequency-Division Multiple Access (FDMA)

A channel access method used in some multiple-access protocols.

2c. TDMA

Time-division multiple access (TDMA) increases the speed over FDMA by dividing the channels into time slots and assigning slots to calls. This also helps to prevent eavesdropping on calls.



TERM TO KNOW

Time-Division Multiple Access (TDMA)

A channel access method for shared-medium networks that allows several users to share the same frequency channel by dividing the signal into different time slots.

2d. CDMA

Code-division multiple access (CDMA) assigns a unique code to each call or transmission and spreads the data across the spectrum, allowing a call to make use of all frequencies.



TERM TO KNOW

Code-Division Multiple Access (CDMA)

A channel access method used by various radio communication technologies where several transmitters can send information simultaneously over a single communication channel.

3. Introduction to the 802.11 Standards

Wireless networking has its own IEEE 802 standards committee and subcommittees called IEEE 802.11.

IEEE 802.11 was the first, original standardized WLAN at 1 Mbps and 2 Mbps. It operates on the 2.4 GHz RF. It was ratified in 1997, although we did not see many products pop up until around 1999, which is when 802.11b was introduced.

Committee	Purpose
IEEE 802.11a	54 Mbps, 5 Ghz standard
IEEE 802.11ad	A very high-speed, short-range wireless technology
IEEE 802.11b	Enhancements to 802.11 to support 5.5 Mbps and 11 Mbps
IEEE 802.11g	54 Mbps, 2.4 Ghz standard; backward compatible with 802.11b
IEEE 802.11n	Higher throughput improvements using multiple-input, multiple-output (MIMO) antennas
IEEE 802.11ac	1 Gbps, 5 GHz standard
IEEE 802.11ax	Operates simultaneously in the 2.4 GHz, 5 GHz, and 6 GHz ranges; enables speeds up to 9608 Mbps

In the next tutorial, we will discuss some important specifics of the most popular 802.11 WLAN standards.



SUMMARY

In this lesson, you were introduced to **wireless networks**, including how to **improve wireless coverage** and **wireless network governance**. Cellular telephone technologies, including **GSMC**, **FDMA**, **TDMA**, and **CDMA**, were discussed. Wi-Fi standards were introduced. Finally, you learned about the **802.11 standards**.

Source: This content and supplemental material has been adapted from CompTIA Network+ Study Guide: Exam N10-007, 4th Edition. Source [Lammle: CompTIA Network+ Study Guide: Exam N10-007, 4th Edition - Instructor Companion Site \(wiley.com\)](#)



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