Chapter 1: Overview of Wireless Standards, Organizations, and Fundamentals

Wireless communication has been studied and attempted since the 19th century, with key innovators like Thomas Edison, Nikola Tesla, and Michael Faraday spearheading the development of the technology by discovering the existence of radio frequency bands in the electromagnetic field. Its first practical use was during World War II, when communications were transmitted across enemy lines containing encrypted battle plans. Technology used during this period was later patented and implemented almost 20 years later. 1970 marked the dawn of the first wireless network, ALOHAnet, which was developed by the University of Hawaii. This implementation used the second layer of the OSI model broadcasting with a frequency range of 400 MHz. ALOHAnet's technology allowed for the invention of Medium Access Control (MAC), which is used in every communication device in modern technology. Commercially, wireless communication technology started appearing in the 90s, when IEEE made a pass at standardizing the wireless technology standard. This 802.11 network is commonly referred to as Wi-Fi. Wi-Fi does not stand for anything, contrary to popular belief. It's actually just a brand name marketing strategy to promote the 802.11 network that a majority of devices worldwide use today. The FCC regulates all communications incoming and outgoing to the US, and works in conjunction with providers around the world to regulate frequency, bandwidth, max power of the intentional radiator, maximum equivalent isotropically radiated power, use, and spectrum sharing rules. The organization defines two separate types of regulation: licensed and unlicensed network configurations. Licensed bands are typically expensive, but less cluttered compared to its free unlicensed counterpart.

Chapter 2: IEEE 802.11 Standard and Amendments

IEEE defined the standard for LAN over radio frequencies as 802.11 in 1997, known as 802.11 prime. This standard was later redefined 10 years later as IEEE Std 802.11-2007, which remained in effect until 2012, when IEEE Std 802.11-2012 was developed. The most recent iteration of the standard was released in 2016. The model handles the specification at the physical layer and MAC sublayer of the data-link layer in the OSI model. The standard does not regulate the upper layers of the OSI model, but may interact with them. IEEE tasked multiple committees with defining various aspects of the specification. The PHY and MAC committees worked together to define three main physical layer specs: Infrared, Frequency Hopping Spread Spectrum, and the Direct Sequence Spread Spectrum. In the first case, Infrared used light to transmit data across the physical space and is commonly used in TV remotes, Face ID, and motion tracking. FHSS is among the oldest technology in this field, and is defined as having the ability to broadcast a wider frequency range than what is required by the data. This is no longer a part of the IEEE 802.11 standard as of the 2016 release. DSSS is similar to FHSS, but it uses fixed channels opposed to the adaptive properties of FHSS. Initially, 802.11 Prime specified the 2.4 GHz band as to be used for unlicensed connections. Later, the 5 GHz band was opened as technology evolved and the 2.4 GHz band was cluttering up. In 2005, VoiP and QoS were added to the specifications as they were left out from 802.11 Prime due to the technology not being readily available upon its conception. As of now, there are 3 amendments to the 802.11 Prime specification. 802.11b operates on the 2.4GHz spectrum and increased the bandwidth available. 802.11g also operates on this band, and increased the speed even further. 802.11a operates on the 5 GHz band, and specified that 6, 12, and 24 Mbps were mandatory.

Chapter 3: Radio Frequency Fundamentals

Radio Frequencies originate as alternating current which is transmitted through a coaxial cable to an antenna. This antenna converts that current into a wave to be used as a wireless signal. In those signals, 4 characteristics are present in each: wavelength, frequency, amplitude, and phase. Wavelength is defines as the distance between the apex of each oscillation. It determines what kind of wave is being transmitted for various purposes. A shorter wavelength is used in Gamma Rays and are highly radioactive. Low frequency/long wavelengths are used for Radio frequencies, and there are varying degrees in between the two ends of the spectrum. The wavelength on the 2.4 GHz network operates at 4.82 inches, compared to the 5 GHz band operating at 2.04 inches. Frequency in a wave is how fast that wave moves in a certain period of time. Each cycle per second is called a Hertz. 1,000 cycles is a kilohertz, and 1 million cycles is called a megahertz. Wavelength and frequency have an inverse relationship, meaning the higher the frequency, the shorter the wavelength is. Amplitude defines how strong the signal is, which results in higher or lower power usage depending on how high the amplitude is. Transmit amplitude is used to describe the strength of a wave that leaves a transmitter. Lastly, phase is the relationship between multiple waves. Two frequencies are in phase if the peak of the waves match heights and are out of phase if these are not matching. Waves are also affected by the materials in the environment of the wave. For instance, Wi-Fi frequencies can be interfered with by walls, appliances, and ducting. Wave propagation is the way that frequency moves throughout its atmosphere. Absorption is when the wave is not bounced or interfered with the surrounding materials, but passed through them.