# The Past, Present and Future of Wireless Networking

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Introduction:

The ability to communicate to an advanced level has always been one of the paramount achievements of the human race that sets the species apart from other living creatures on this planet. Of the many inventions in society, wireless networking has become a fundamental extension of man's desire for mobile communication. Early forms of communication have allowed society to connect entire communities and even entire continents. Part of the human condition however, is the desire to explore the unknown. It is with this faculty and desire that required society to consider more mobile and less restrictive forms of wireless communication. In the early 1800s, many scientists and inventors had developed similar methods of wired communication. This early technology was collectively known as the telegraph. Although primitive when compared to current communication standards, their utilization of the old binary system was a development that is still used today. This binary system is a numeric representation of the "on" and "off" status of a circuit which made possible the use of Morse code across a purpose built, wired communications channel. This same use of the binary system is currently used in wireless communications, although represented instead through a signal's wave peaks. One of the first discoveries of the radio wave was from Heinrich Hertz, a German scientist. Hertz created an assortment of inventions that transmitted a series of frequencies that were then received through other devices. With these experiments, Hertz was able to determine that electromagnetic waves not only existed, but that they could also be transmitted through some distance. Although unaware of the significance at the time, this find created the foundation for the wireless network communications used today, and likely of that for future technology (Hertz, 2010).

Information Sharing and Networks:

Some of the earliest forms of wireless communication took place through the radio wave spectrum. These transmissions allowed communication of news and other information through a wide range of radio frequencies (wireless, 2006). Many forms of communication technology developed over time utilizing one or more of these frequency ranges. These technologies include the television, radio, CB, shortwave, as well as others. This type of communication allowed society not only to share mass information, but the ability to become mobile without expensive wired infrastructure. Throughout history and perhaps well into the future, this directive continued to mandate and guide the growth of technology and wireless communications. With the advent of the home computer, and computing power becoming a necessity in the workplace, the computer network was developed. Although a typical company could have a variety of different positions and departments, it was often necessary for employees to share resources. This was made possible with the creation of Ethernet and compatible protocols. Networking allowed people to share files, printers, and other hardware devices throughout a building, office or school campus. For the majority of the commercial and consumer world, this type of infrastructure met all the necessary demands. The only perceived shortfall to this technology however, was the distance limitation to these networks. It was often either extremely expensive, or impossible with local infrastructure to connect distant offices. It was not until an invention by the Department of Defense that communications as society knew it would change forever.

Growth of the Internet:

During the height of the Cold War, the threat of a nuclear holocaust with Russia was very real. Both governments were spending considerable amounts of money to surpass each other in weapons, intelligence, and communication technology. Hundreds of billions of dollars were spent by each country creating numerous subterranean nuclear missile silos. Unfortunately, most of these immediately became obsolete within a few years of completion. As is often the case during times of an arms race, humankind reaches a technological zenith. Part of this technological revolution sought the need for continued defense communication through a nuclear disaster. The Department of Defense, in conjunction with a new agency known as the Advanced Research Projects Agency (ARPA), created ARPANET. This technologically sophisticated network was created to assist the US Air Force in remotely controlling its missiles, sites, and bombers through a nuclear devastation.

Although thankfully never used for its intended purpose, the "Internet" as it came to be called, slowly grew in popularity through the next twenty years. It was not until the mid 90s that true global awareness of the internet was created. Internet service providers (known as ISPs) were popping up in record numbers to provide service to a rapidly growing market. Companies like America On-Line, Prodigy, and CompuServe were among several of the ISPs in an industry that saw a growth of 150,000 users a month. The Internet became a collection of thousands of interlinked computer networks that communicate with each other using common computer languages and protocols. The Internet became a "virtual community" where some of the smartest minds communicated about everything conceivable (Resnick, 1994).

Early Wireless Networks:

As society began to depend upon the internet for nearly everything, they were faced with the same dilemma that they dealt with in the early days of the telegraph; they needed mobility.

What good was the internet if it could not be accessed everywhere a portable radio could? Society had become accustomed to mobility and often took for granted devices such as portable televisions, cellular phones, and even their in-car radio. With the significantly growing cost of materials, wireless communications became important once again from several aspects. One of these aspects was the need to connect other continents and countries with this infrastructure. Initially, existing telephony infrastructure was used; however, the cost of continuing to lay more and more cabling across the seas as demand increased became cost prohibitive. This was resolved through the use of wireless satellite communications. The other aspect of mobility focused on a more direct human behavioral level. For many, the need to access the internet away from the home or office was becoming paramount. To solve this technological hurdle, wireless networking was needed. With a digital wireless signal, the need for data accuracy became increasingly important for consumers. An error in a computer's transmission typically meant data was lost forever or at best, incomplete. In the instance of transmitting files such as documents and other static forms of media, this was considered unacceptable. Many existing network protocols such as TCP/IP were adapted to transmit data and handle the cyclical redundancy checks. This ensured that data packets were transmitted in their entirety, even through times of extreme signal latency or interference.

Current Wireless Technology:

Early forms of wireless LAN technology made use of many unlicensed frequency channels. Although the technology was sound, when put into practice it was realized that these frequencies interfered with a number of household appliances and commercial machinery. It was quickly determined that an industry-wide standard was necessary for conformity and successful market competition. In 1990, the Institute for Electronic and Electrical Engineers began work on an 802 standard for wireless networking. This standard would complement many of the IEEE's previously existing 802 networking standards and focused in the 2.4 and 5 GHz frequency range. In 1997, the group approved the initial 802.11 standard for wireless LAN. Early versions of this technology permitted transmission rates of 1 to 2 megabytes per second (Runnels, 2005). With packet checking and variable signal strength, typical data throughput was often closer to half of its official maximum rating. Initially, this throughput was sufficient to support the type of technology that was available on the internet at the time. However, this demand increased as websites grew not only in number, but in programming complexity. The web became more than what had ever been thought possible. Technologies like streaming digital video, sound and music files, high resolution graphics, voice over IP and other media quickly pushed the limits of the existing available wireless infrastructure. IEEE and other industries had to develop newer and more updated standards based off the original 802.11 wireless standard. The first subset standard to become popular was the 802.11b in 1999. This standard, while newer than the 802.11a, was actually approved sooner because of the lower cost of implementation and the use of the existing 2.4 GHz radio frequency. This new standard supported upwards of 11 megabytes of data transfer per second,

although was still subject to many of the same signal issues as the original. For its time however, this throughput was similar to that of more common wired local area networks. The 802.11a standard was approved shortly after but was not as popular among consumers. The high cost of implementation and support, along with the frequency change of 5 GHz meant that existing hardware in the 802.11 standard would be completely incompatible. Although finally approved, it was never utilized heavily in the marketplace. As wireless networks became more popular in the home, a more efficient 802.11g standard was introduced. This new standard utilized the same 2.4 GHz frequency as the 802.11b standard, but supported increased throughput of 54 Mbps as the older 802.11a standard had. The new 802.11g standard became immediately popular not only in the commercial industry, but in residential use as well. Simple and inexpensive wireless networking solutions were now available to the average home consumer. The possibilities this presented were astounding. With this technology now widely available, manufacturers could develop devices such as video game consoles, wifi internet-ready phones, and television receivers which made use of the wireless internet signal. This also had a positive effect on the sales of laptops since it provided the freedom of mobility for consumers to utilize the internet anywhere in their homes (Perlin, 2003). A new trend, which was made available by this inexpensive technology, was the creation of hot spots and internet cafes. Consumers could now get wireless internet with their laptops, phones, and PDAs at a number of coffee shops, libraries, and small restaurants.

The more advanced the wireless technology becomes, the less important wired infrastructure is. This however, has not come without additional risks. On existing wired technology, internal LANs and WANs can often be totally separated from outside

networks such as the internet. With wireless technology, there exists a level of exposure and security risk from the outside world within the range of the wireless networking signal. With this reality, the need for wireless security has grown in parallel with the advancement of the wireless hardware technology. Of these advancements, many new security features simply replace older security standards with higher bit encryption. For example, going from 64 bit to 128 bit security encryption would take nearly ten times the amount of time necessary to crack. Other standards completely change the way a password is configured. Using a hash sequence is another way to also decrease the risk of a security breach. Network security has truly become a separate industry with its own standards and supporting organizations. The consumer market for wireless network security has expanded far beyond what was thought possible.

Future Wireless Technology:

Although current wireless technology is impressive, society has only begun to scratch the surface. Recently, the 802.11n standard was announced by the IEEE. This latest standard provides a throughput in excess of 100 Mbps with a theoretical limit of 200 Mbps. Known as channel bonding, this throughput is made possible by utilizing multiple antennas to transmit multiple signals across a range of signal frequencies. This new standard was designed to replace all previously existing IEEE wireless standards. Although the formal standard has not yet officially been approved, many manufacturers have released "pre-N" compatible hardware based on the most recent information available from the IEEE. However, as this new standard is entirely compatible with existing wireless hardware, many corporations have chosen to upgrade early and take advantage of its benefits. Another standard the IEEE is also working on is the 802.16. This standard, known as WiMax, provides wireless internet and networking across a substantial geographic area. Most residential and commercial areas currently have to rely on wired infrastructure for their internet and cable television. With WiMax, a few microwave towers can provide immediate high speed internet to millions where wired high-speed internet was previously unavailable or customers were forced to rely on dial-up (Tapia, 2009). While there have been multiple 802.16 sub-standards in development for a few years, the most current provides a seamless connection for mobility. This means that while travelling through one WiMax service area to the next, there should never be an instance of a signal drop (Dean, 2010). There are currently more than 500 markets already utilizing this technology and many estimate a future throughput of up to a gigabyte per second (Tabesh, 2009), (WiMAX, 2010).

Conclusion:

Only a decade ago, it was though unlikely that wireless technology would replace wired internet and communications infrastructure. With the advent of recent wireless technological breakthroughs, it now seems holistically possible that wireless technology could in fact replace nearly all wired infrastructure now and into the future. Satellite communications and WiMAX are becoming more and more common across the globe, providing a means of global communications thought never before possible. The future of wireless technology is bright. With rapidly growing standards and capability, the possibilities are limitless.

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