

Wireless Internet

The Future is Here

Author:

Ioan Raicu

1.0 Introduction

Among the earliest forms of transporting encoded data via electromagnetic signaling devices using guided media was the telegraph, invented by the American Samuel Morse in 1837. Since then, there have been astronomical technological innovations and improvements. The ever-advancing technological era of the 20th century had so many surprises up its sleeves that it the most people just could not keep up. Unfortunately, or perhaps fortunatly, the 21st century is not slowing down; the communication industry will be transformed from its predecessor wire based approach to the new wireless systems.

As technology is becoming cheaper, ideas that were once impractical are now very feasible and attractive. For example, look at the classic case of how the computer evolved; twenty years ago, the PC cost thousands of dollars and had a utility very small to the average person; today, PC prices start as low as a few hundred dollars, and have a utility that is unprecedented. Most people who have a PC at home usually rely on the computer for all the basic daily activities.

Some of the myths about wireless communication include that wireless technology is hard to use, not scalable, small wireless coverage, bad data transfer reliability, short battery life, management of multiple devices difficult, and connectivity problems. However, most of these might have been true maybe 10 or even 5 years ago, but now that it has matured a bit, one would find that wireless communication is really easy to use, gives people the freedom to work wherever they desire, ease of access, instant-on features, wide coverage, and longer and longer battery life.

The growth of the wireless revolution will not stop. At the moment, there are about 500 million wireless handsets worldwide, and it is expected to reach over 1 billion by 2005. Today, there is already about 15% of the US workforce classified as “mobile workers”[4]. For example, more mobile phones were shipped in 1999 than the total number of cars and personal computers together. According to Hellstrom in [8], mobile phones will outsell wired phones by the end of 2001. By 2005, wireless handsets will outnumber televisions and PCs combined. By 2004, at least 40 percent of business-to-consumer e-commerce transactions outside North America will be initiated from wireless devices. Europe is about 2 ~ 3 years ahead while Japan is 3 ~ 4 years ahead, but since wireless is a global business driver, the technology is quickly evolving and maturing everywhere. In Japan, the number of subscribers to cellular and Personal Handyphone System (PHS) services has reached close to 57 million as of March 2000; this number is equivalent to a penetration rate of around 45% in the population. [3] Another interesting fact is that fixed analog telephone users have been steadily declining from its peak in 1997 of 61 million users, to only 55 million by the middle of 2000, while the mobile handheld devices have skyrocketed in numbers.

Two wireless technologies have evolved: Bluetooth and IEEE 802.11b. Each is a method that allows your portable devices to access the network as well as talk with one another wirelessly. IEEE 802.11b is an 11 Mbps wireless standard designed to provide full network services to a user with a notebook or desktop PC. Bluetooth is a 1 Mbps technology optimized for low cost and low power to provide wireless connectivity to a much wider variety of mobile devices. [9]

Al in all, wireless technology will forever change the way human kind communicates and interacts with its environment. It is the natural progression of technology, and only time will tell how well these innovative and promising solutions hold up to the real test, global wide deployment.

2.0 The different Generations – Past, Present, and Future

Just like any other technology, wireless communications have also skyrocketed in terms of price vs. performance. Its features are ever growing, and its use is ever spreading. As a brief overview of the history, present, and future of wireless communication, refer to Table 1.

Wireless communication in the form of handheld devices first appeared in the early eighties, and were known as the 1st Generation (1G). The architecture was analog using FDMA and supported only voice transmissions. These systems employed analog FM wireless access using narrowband FDMA with the channel spacing of around 25-30 kHz. [3]

Generation	1G	2G	3G	4G
Year	1981	1991	2001	*2011
Terminal	Phone	Phone with Message	Multi Media Terminal	*Virtual Reality Device (3D)
Bearer	Symmetric Circuit	Symmetric Packet (GPRS)	Symmetric Packet (GPRS)	*Asymmetric Packet
Network	Circuit-Based	Circuit-Based ISDN based	Circuit and Packet Based	*All IP
Performance	.3 ~ 2.4 Kbps	9.6 Kbps–144 Kbps	384 Kbps–20 Mbps	*20 Mbps – 100 Mbps
Access	Analog FDMA	Digital TDMA CDMA One	Digital WCDMA EDGE CDMA 2001Xev	*Multi Access WCDMA/EDGE Bluetooth WLAN / MBS

Table 1. Generations of Wireless Communications [2]

**These are Eriksson's predictions found in [2].*

The 2nd Generation (2G) is the explosion of cellular phones that started in the early nineties and are still in use today. This architecture is digital, supports text messaging and achieves moderate transfer rates of 9 ~ 144 kbps. In North American, 2G standards include IS54/136; in European they are Global System for Mobile (GSM); and in Japan, they are Personal Digital Cellular (PDC); these all adopted TDMA with the channel spacing ranging from 25 to 200 kHz. The current devices on the market are either 2G or 2.5G. 2.5G is the code name for 2G devices that are trying to incorporate 3G features into their devices. They might very well provide a nice preview of what is to come in the next decade.

A recent study shows that over 75% of mobile phone owners also use the internet on a regular basis; therefore, it only makes sense for the market to be receptive to this group and bring about mobile data solutions to meet the market's demands. Integrating cellular phones and the Internet was the next obvious step. Wireless Application Protocol (WAP) is the basis for the Mobile Internet. Thanks to WAP, people are able to access the Internet and keep in touch with the world anytime, anywhere, via the micro browser equipped wireless phone. At the time of its founding, there were four companies involved (Phone.com, Nokia, Ericsson, and Motorola); now, it has over 500 members. Sitting between a WAP phone and the Internet is a WAP proxy. The function of the WAP proxy is to provide a gateway between the wireless environment and the

Internet. The WAP proxy also tokenizes the data before transmitting it to the phone, thus achieving a measure of data compression. WAP defines a markup language WML (Wireless Markup Language) which is based on XML standards; developers of WAP viewable sites will use WML in much the same way as HTML is used for web sites. [5]

3rd Generation (3G), also known the International Mobile Telecommunication Systems (IMT-2000), is where most of Japan and Europe are, and where the US will be in the next few years. It is digital, built on a mix of circuit switched and packet switched network, supports voice and multimedia applications, and achieves comparable performance as DSL lines or cable modem. The 3G system standardization process is in the final stage in the ITU. Wideband DS-CDMA has been adopted as the wireless access technique. There are three operation modes: Frequency division duplex (FDD) single-carrier, FDD multi-carrier, and time division duplex (TDD). They will use the 2-GHz band. There are two fully globally established core networks presently used for the 2G systems: GSM-MAP for GSM systems and ANSI-41 for AMPS and IS-95 systems. Both core networks will evolve into 3G core networks and the above- mentioned air-interfaces will connect to both GSM-MAP and ANSI-41 core networks. [3]

4G is the dream that everyone in the telecommunication industry is hoping to finally come true. It has a ten year timeframe to deliver the architecture, and thus enough time for 3G networks to fully mature. The wireless part will become closer to a wireless LAN, but with wide area mobility management as in the 2G and 3G systems. Mobile communications systems require many call control functions and a distributed database, and quick and stable connections between these are necessary. These will be embedded in the TCP/IP based core networks based on a virtual leased line concept. Voice traffic can be transferred as TCP/IP packets, as in voice over IP (VoIP). Another incredible foreseeable benefit of 4G networks will be its performance

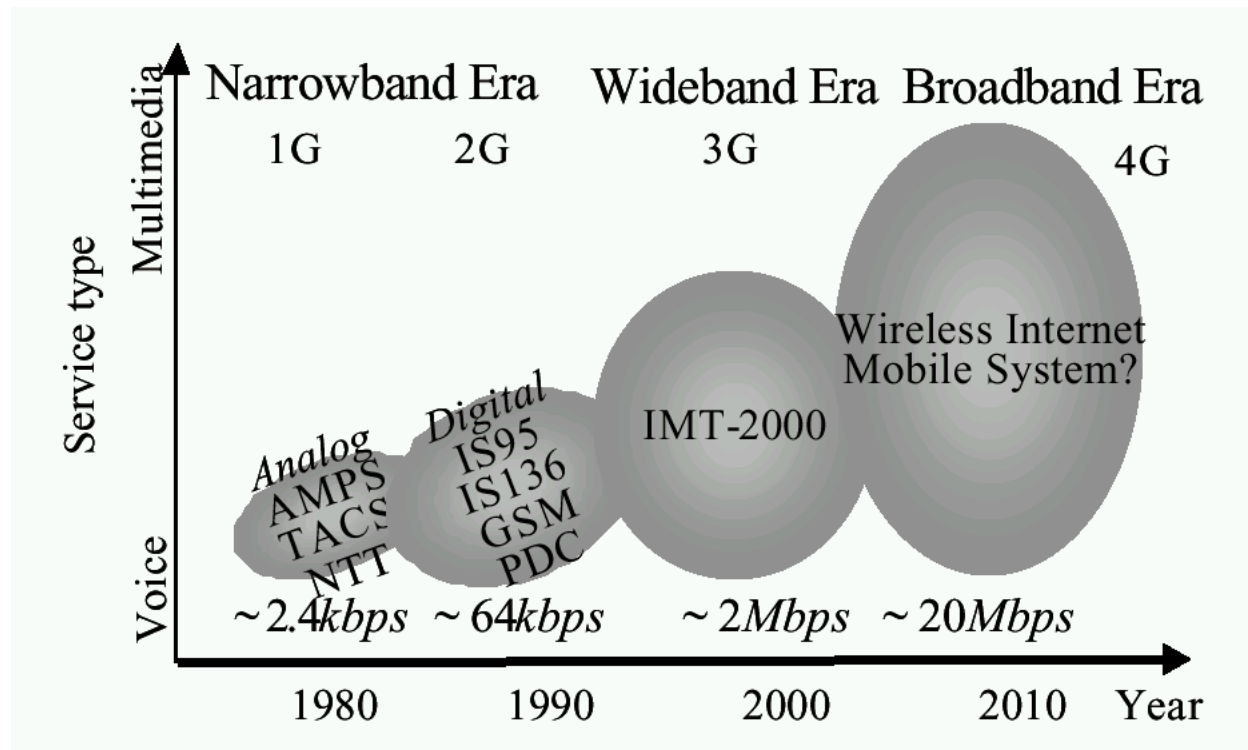


Figure 2. Evolution of Wireless Communication [3]

superiority over the first 3 generations as it will be able to achieve 20 ~ 100 Mbps transfer rates. Regardless, it is still a dream, that one day, we all hope will come true with its full potential.

The evolution of wireless communication has been very steady. Below you can observe a graphical representation of the evolution of wireless communication. [3] To enable as many mobile users as possible to communicate with the same base station, wireless multiple-access techniques must be adopted. There are a number of multiple access techniques (see Figure 3); the type that is used depends on the type of traffic. If there is continuous traffic requiring a very short transmission delay, like voice conversation, demand-assign based multiple access is applied, in which the channels are divided in a static fashion and each user is allocated one or more channels by a base station during its communication, irrespective of whether or not transmitted data is generated. The demand-assign based multiple access includes frequency division multiple access (FDMA), time division multiple access (TDMA), and code division multiple access (CDMA). Channels are configured using the available bandwidth either in frequency, time, or code space (see Figure 4). In CDMA, unlike in FDMA and TDMA, all the base stations use the same frequency bandwidth, and all users share the same frequency bandwidth and time, but use different spreading code sequences to separate each user.

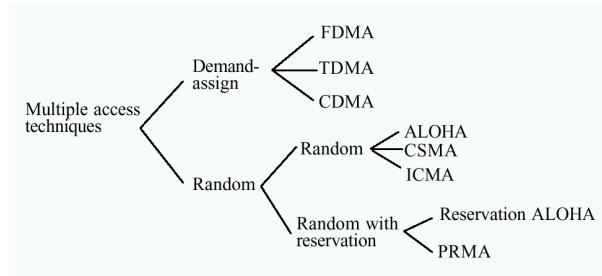


Figure 3. Multiple Access Techniques [3]

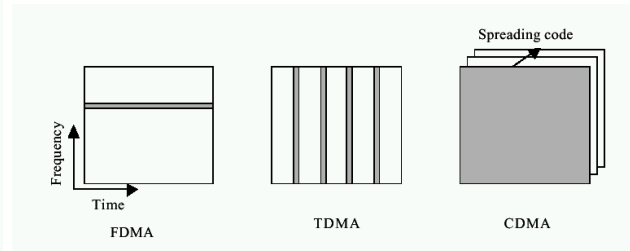


Figure 4. FDMA, TDMA, CDMA [3]

According to a study done by Renaissance Analysis in [4], below will be some numbers characterizing the different technology types and their actual transfer rates, not theoretical limits. Obviously, some of the data rates for the real promising architectures such as the coming 3G and 4G systems are unavailable since the systems are still in the research and implementation phases. The numbers below represent services that are currently available and testable.

Technology Type	Transfer Rates	Supported Services	Technology Foundation
2Way Radio	6.4 kbps	Voice and Data	FDMA
CDPD	6.4 kbps	Voice and Data	TDMA & CDMA
HSCSD	38.4 kbps	Voice and Data	-
CDMA One	4.8 kbps	Voice and Data	CDMA
CDMA 1XRTT	48 kbps	Voice and Data	CDMA
GPRS	43 kbps	Voice and Data	TDMA
HDR	33 kbps	Data	CDMA
EDGE	128 kbps	Voice and Data	TDMA
3G	128 kbps	Voice and Data	WCDMA
Metricom	176 kbps	Data	MCDN

Figure 5. Technology Types and Realistic Transfer Rates [4]

3.0 Products and Service

Some of the Mobile Internet services that could be offered fall under several different categories: m-commerce (Mobile Commerce), mobile infotainment, and mobile messaging. M-commerce includes services such as banking, trading (stocks), ticketing, shopping, etc... Mobile infotainment includes services such as: browsing for information such as news, sport, etc...; entertainment such as music, games, etc ...; and navigation services such as GPS. The last one, mobile messaging includes: e-mail, voice-mail, SMS, video/image-mail such as postcards, and instant messaging. For example, in Europe, the use of Vodaphone text messages increased from 14 million in April 1999 to 141 million in April 2000. The demand is definitely present, and it is only up to the industry if it will continue to serve the publics thirst for this new technology.

One of the products, which already is out on the market, and will undoubtedly forever change the way we look at cellular phones, is the multi purpose cellular phone, which is currently running on the 2.5G technology, and later it will be on the 3G architecture. New cellular phones have much more capability than plain voice transmissions. Many have wireless data capabilities that can use a built in internet browsers to browse specific web sites, check out stock quotes, send and receive email, etc... According to Ericsson in [2], handheld mobile phones that have internet support make up only 15% of the market; however, by 2005, they will overshadow conventional handheld mobile phones by 600%.

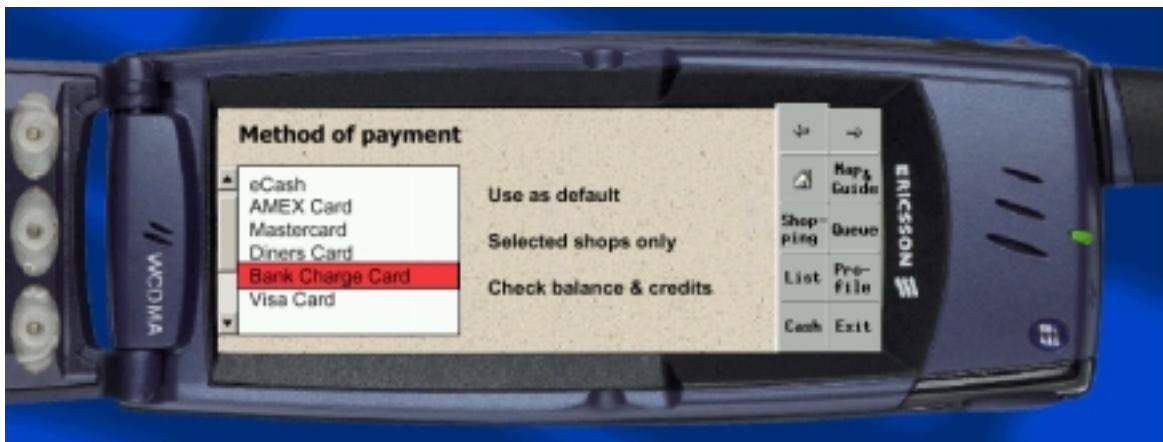


Figure 2. “The Credit Card with an Antenna” [2] – A glimpse at a cellular with a browser.



Figure 3. Streaming Live Data [2]



Figure 4. Navigation System [2]

With sufficient time given, devices such as the ones in Figure 2, 3 and 4 will be in everyone's pockets, and people will take it for granted all the possibilities of the coming era of wireless communication. As stated earlier, this revolutionary technology will allow us to access things like bank account, pay by credit card directly from the cellular phone, watch live streaming videos, up to the minute scores on sports, or stock quotes, find your way through an unknown neighborhood by looking at your GPS enabled cellular map, or even saving someone's life because the ambulance was able to find the scene of the accident because they followed your cellular's position. The possibilities are endless, and with enough forward drive, which is definitely very abundant now a days, wireless communication will revolutionize our way of life.



Figure 5. The implication of Wireless Technology in our near foreseeable future [2]

In the above diagram, Figure 5, there is another example in which a wireless LAN would be at the center of most productive things throughout a normal day. For example, let's take the refrigerator, it send a message to the phone stating what it is short on. Then, the phone send a message to the Mobile Shopping Terminal, who then gives the user instructions where to find the respective items. The Mobile Shopping Terminal is updated in real time as prices change and inventory depletes. When done, you pay with the cellular phone, and once home, the phone will update the fridge with the new items you bought. And all these should work seamlessly without any user intervention.

One good example is the success of the mobile Internet access services called "i- mode services" provided through the 2G cellular systems using the Japan standard PDC-Packet technology. A variety of services are available, including e-mail, Web access, and on- line services ranging from bank transactions to entertainment, in addition to conventional voice conversation (Fig. 6) [3].

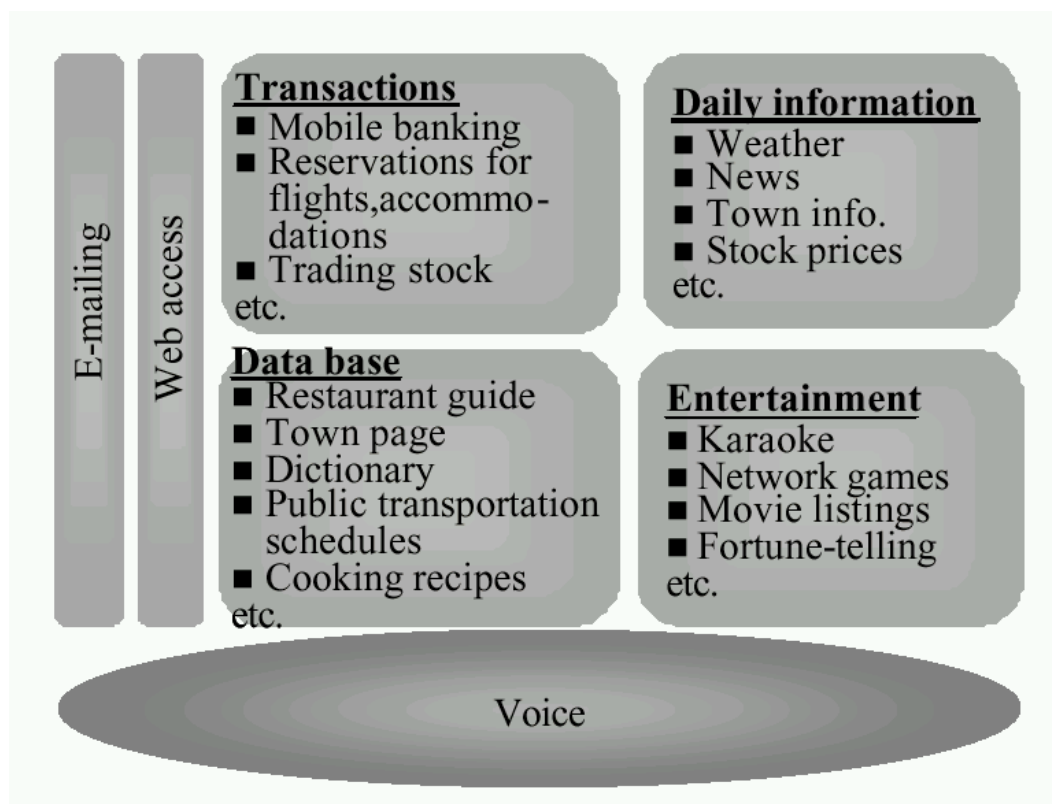


Figure 6. I-mode services available with 2G systems [3]

In 1999, the Palm OS® owns 78.4% of the global handheld computing market. They are targeted at simplicity, wearability, and mobility. WindowsCE and PocketPC by Microsoft is also growing very fast; Microsoft's share of the handheld device market has grown tremendously in the past year or two. According to some analysts, there are projections that Microsoft will hold 40% of the handheld device operating system market by 2004.

Metricom Ricochet is joining the market with their wireless internet solutions for laptops and PCs. They have set up a WAN of wireless devices throughout some of the nations largest metropolitan areas. With the use of a wireless modem (probably a network card), users can connect to the internet while out of the office on the go at rates from 128 ~ 176 kbps even while

moving at 70 mph in a vehicle. Metricom offers broadband wireless services for a flat fee of only \$80 a month, while many others charge per kB with much lower transfer rates.

Recently, American Airlines and Sabre Holdings have announced plans to roll out wireless check-in systems. [7] Boeing Aircraft also plan to add a high speed Internet access and live television to commercial jets via a WLAN; the jet would be linked directly with a satellite and would offer passengers a 20 Mbps connection on laptops during flights. The expected rollout date should be sometime this year. [8] The banking industry is also jumping on the wagon for wireless technologies. Bank of America already offers wireless service to their costumers in Dallas, Baltimore, and Washington. Many tech companies are also joining in as music fans will enjoy the wireless fray. Samsung Telecom and Sprint PCS launched Samsung Uproar, a wireless digital phone built with an MP3 player. Ericsson released its T20 phone in Europe, which connects to either Ericsson FM radio or MP3 player. Hantro Products in Finland is developing an MPEG-4 product that enable two way video transfer for wireless devices. It promises to deliver high quality video at 15 frames per second, good enough for mobile teleconferencing. [7]

At the famous Comdex Convention in Las Vegas this past Nov, 2000, wireless devices were the hype the of the show. Bill Gates demonstrated the company's prototype Tablet PC, a Windows-based wireless "electronic clipboard" that will be a full featured PC, but smaller than a laptop. This tablet, which is scheduled to be released sometime in 2002, can recognize handwriting and lets users write directly on the tablet screen and then format and transmit the text as an email or instant message. [8]

Another application of wireless communication is fixed wireless, since it will play an important role in broadband access. Sprint is already at the forefront of offering fixed wireless services in areas with low population density, in which it is not worth the investment of wires. There are some disadvantages to fixed wireless when compared to a wired solution. Some of these are limited channel capacity, distortion due to multi-path or environmental effects, line of sight, and directional antenna requirements at carrier frequencies beyond 10 GHz. [6]

5.0 Conclusion

Wireless technology will unquestionably change our lives, and most likely for the better. We will be able to be more productive on the go, which means that in theory we should have more time for ourselves, our families, and the things we love to do. It is true that with the coming of wireless technology in every little thing imaginable, it will become harder and harder to maintain privacy from unwanted eyes. The more computerized our world is becoming, the more control Uncle Sam has over our daily lives, however I believe it is worth the price in order to achieve the increased productivity as a society and the comfort of having the world at our fingertips no matter if we are in the Sahara desert, the Swiss Alps, or New York City.

6.0 Works Cited

- [1] Coulouris, George and Dollimore, Jean and Kindberg, Tim. Distributed Systems, Concepts and Design. Pages 448 ~ 450.
- [2] Eriksson, Hakan. 3G Services and the Roadmap Ahead. Dec 12, 2000.
- [3] Adachi, Fumiyuki. Wireless Past and Future - Evolving Mobile Communications Systems. IEICE Trans. Fundamentals, vol. E83-A, Dec. 2000.
- [4] DeVegt, Rolf & Steels, Elizabeth. "Beating the Mobile Data Access Bottleneck." Adventis Horizon, 2000.
- [5] "Mobile Internet for the 21st Century." <http://wapsight.com>.
- [6] C. Keramane, "The wireless World Web," IEEE Multimedia, Vol. 7, No. 2, Apr-June 2000 pp 10-14.
- [7] "Wireless App Roundup." IEEE Multimedia.
- [8] "Comdex Goes Wireless." IEEE Internet Computing, Feb 2001 pp 14-16.
- [9] 3COM Corporation. "Bluetooth and IEEE 802.11b, Wireless Technology Positioning Paper." Feb 2000.