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Wireless Media: A New Paradigm

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Abstract

In this review we have tried to represent knowledge about wireless media, which is fast emerging as a new area in the field of computer science. Wireless networks are emerging fast as latest technology, to allow users to access information and services via electronic media, without taking geographic position in account. Mobile hosts and wireless networking hardware are becoming widely available, and extensive work has been done recently in integrating these elements into traditional networks such as the Internet. We have tried to present the basic knowledge required for a layman to know about Wireless media starting from History to most current trends and trends still to come. This effort is a part of research work by authors in mobile computing. The review is divided into four parts as history, evolution of cellular networks, wireless devices and types of wireless media. A tabular representation based on comparative study is shown for wireless media attributes such as frequency range, cost, installation, bandwidth and node capacity, etc.

1. HISTORY

Starting from Graham Bell to modern day telephone a very long distance have been traversed. We just take a peep into the past to see how the development process in wireless media has taken place.

Most closely connected with success of Wireless communication is Gulielmo Marconi in 1895 using long wave transmission with very high transmission power (> 200 KW). First transatlantic transmission followed in 1901. In 1907 first commercial transatlantic connections were set up[6]. First radio broadcast took place in 1906 when Reginald A Fessendan transmitted voice and music for Christmas. In 1915 first wireless voice transmission was set up between New York and San Francisco. First commercial radio station started in 1920. In 1920, discovery of short waves was done by Marconi. This reduced size of antennas and high transmission towers. In 1926 first telephone in train was available (wires parallel to the railroad track worked as antenna). First radio for cars was commercially available in 1927. 1928 was year for many trials for Television broadcasting. First telecasting started in 1932 from CBS station. Up to this all wireless communication used amplitude modulation which offered relatively poor quality due to interference. In 1933 Edvin H Armstrong discovered frequency modulation. In 1958 Germany has first network as analog A. Netz using a carrier frequency of 160 MHz. In 1979, Denmark, Finland, Norway and Sweden agreed upon NMT (Nordic mobile telephone) system. It used 45 GHz carrier. In 1983 US started AMPS (advanced mobile phone system) at 850 MHz. In 1984 Cordless telephone came. Early 1990 marked use of fully digital systems. In 1991 came DECT (digital European cordless telephone) at 1800 MHz. In 1991 GSM[2] (global system for mobile communication) was standardized as a document of more than 5000 pages. GSM works at 900 MHz and uses 124 full duplex channels. It offers full international roaming,

automatic location services, authentication, encryption, high audio quality, etc., and also SMS (short message service). Again more efficient in bandwidth systems were developed[3] as TDMA[5] (time division multiple access) in 1996 and CDMA (code division multiple access) in 1997[4] working at 1800 MHz. GSM has been switched to 1800 MHz, now called DCS (digital cellular system). In 1997 IEEE 802.11 for LAN at 1.4 GHz was standardized. 1998 marked the beginning of mobile communication using satellites, also in same year European agreed on UMTS (universal mobile telecom system). UMTS combined GSM with more efficient bandwidth efficient CDMA solution.

2. EVOLUTION OF MOBILE CELLULAR NETWORKS

(a) **First Generation Mobile System:** It included AMPS[8] (advanced mobile telephone system) made available in 1983. It was first deployed in 1974 in Chicago, with a service area of 2100 square miles. Data rate of 10 kbps (Kilo bytes per second) with 832 channels was offered. Also in Europe TACS (total access communications system) was introduced with 1000 channels and data rate of 8 kbps. First generation supports voice traffic, paging data and fax services.

(b) **Second Generation Mobile System:** Second generation uses digital multiple access technology, such as TDMA and CDMA. GSM[9] was introduced in this category. Examples of second generation systems are GSM, cordless telephone second generation (CT2), Personal Access Communication systems (PACS) and DECT,[10] PHS (personal handy phone system). Second generation systems are in current use around the world. Second generation systems support voice, limited data communications, fax, SMS.

(c) **2.5 G Mobile Systems:** The move into 2.5 G world will begin with GPRS (general packet radio service). GPRS is a radio technology for GSM. Network based on this technique is known as EDGE (enhanced data rate for GSM evolution). GPRS will support flexible data transmission rates as well as continuous connection to network.

(d) **Third Generation Mobile systems**[11]: It is faced with several challenging technical issues, such as provision of seamless services across both wired and wireless networks and universal mobility. Advanced multiple access techniques are investigated in this connection, one based on wideband CDMA and another that uses a hybrid TDMA/CDMA/FDMA approach. Here new network technologies like ATM (asynchronous transfer mode) backbone, network management, and service creation are integrated into existing second generation core networks. Air interfaces like Wideband CDMA (W-CDMA) and CDMA2000 are major third generation radio standards.

(e) **UMTS (universal mobile telecommunication system):** UMTS is commonly referred to as a Third generation system and is targeted to be deployed in 2003. UMTS uses an ATM based switching network architecture and aims to provide service for both mobile and fixed subscribers by common call processing procedures. UMTS will provide at least 144 kbps for full mobility, 384 kbps for limited mobility applications and 2048 Mbps for low mobility applications. UMTS terminals will be multiband and multimode so that they can work with different standards.

Cellular, cordless and PCS (personal communication services) systems follow different design guidelines.[12]

Under cellular telephony comes AMPS (advanced mobile telephone system), GSM, DCS (digital cellular system) as major designs.

Under Cordless category are CT2, DECT, etc.

Under Low tier category are PHS, PACS, etc.

Characteristics of Cellular, cordless and low tier PCS are shown in table 1.[13]

Table 1. Charateristics of cellular, low tier purchase, and Cordless systems

System	Cellular	Low Tier PCS	Cordless
Cell Size	Large (few Km)	Medium (30-600 ft)	Small (30-60 ft)
User Speed	High	Medium	Low
Area Covered	Large	Medium	Small zones
Handset Complexity	High	Low	Low
Power Consumption	High (100-800 mW)	Low (5-10 mW)	Low (5-10 mW)
Delay	High<=600ms	Low<=10ms	Low<=20ms
Speech Coding Rate	Low (8-12 kbps)	High (32 kbps)	High (32 kbps)

3. WIRELESS AND MOBILE DEVICES

Sensor: A very simple wireless device is represented by a sensor transmitting state information. e.g. Switch sensing the office door

Embedded Controllers: Applications containing simple or complex controllers of some type as Keyboard, Mouse, Washing Machine, etc.

Pager: Simple receiver, a tiny display shows text messages

Mobile Phones: Simple phones, small size, light weight. They are able to handle text, graphics, color, audio and video

PDA (Personal Digital Assistance): Accompany a user and offer simple versions of office software (calendar, mail, notepad, etc.)

Palmtop/Pocket Computer: Tiny keyboard, color displays, simple programs like text processing, spread sheets, etc.

Laptop/Notebook: More or less same as desktop computer. Uses same software, only technical difference being size, weight and ability to run on a battery.

Wireless media does not use an electrical or optical conductor. For the data, the earth's atmosphere is the physical path for most cases. When distances, obstructions make bounded media difficult, then the wireless media is very useful.

4. WIRELESS MEDIA TYPES

The main types of wireless media are: radio wave, microwave and infrared. Figure 1 shows the frequency pattern[7]:

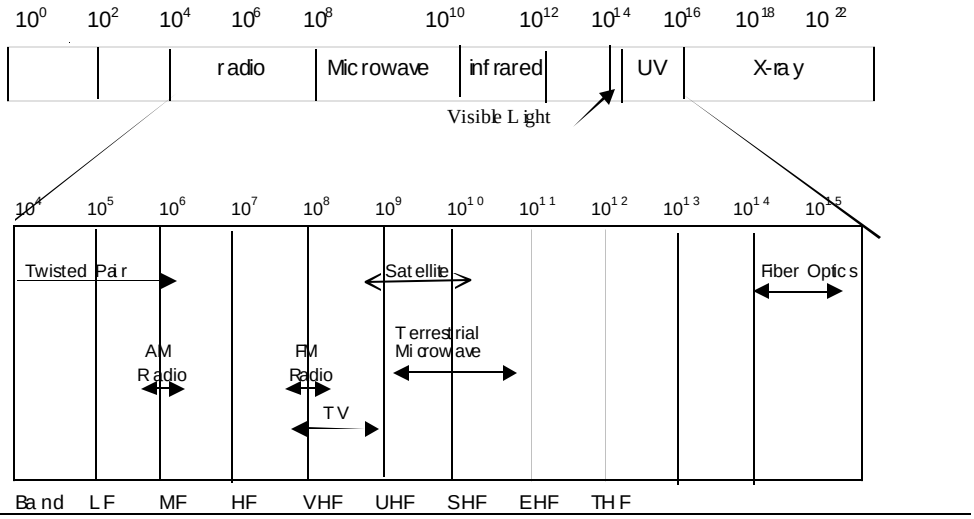

Figure 1. Frequency Pattern

4.1 Radio Wave Transmission Systems

Radio waves frequency range is 10 KHz and 1 GHz. In electromagnetic spectrum range between 10 KHz and 1 GHz is also called therefore (radio frequency). Radio waves are of following types:

- Short wave
- Very high frequency (VHF) and FM radio
- Ultra high frequency (UHF) radio and Television

Most radio frequency are regulated. Regulated frequencies ensure clear radio transmission. Radio waves can be broadcast omni directionally or directionally. Various types of antennas can be used for broadcasting.

Some of most commonly used antennas are (figure 2):

1. Omni directional towers
2. Half wave dipole
3. Random length wire
4. Beam

For computer network applications, radio waves fall into three categories:

- Low power, single frequency
- High power, single frequency
- Spread – spectrum

Table 2 represents basic features of three types.[14]

For all tables in this paper, the term Freq. Range refers to frequency range. Cost refers to cost of equipments and is evaluated against performance it provides. Installation refers to install guidelines, Installation may depend on individual situation, general comparison between media are taken. Bandwidth capacity is data rates, the range of frequencies that a medium can accommodate. Bandwidth is measured in terms of the number of bits that can be transmitted across a given medium per second. Node capacity refers to how many computers you can easily attach to the network. EMI refers to immunity from electromagnetic interference. It is caused by outside electromagnetic waves affecting the

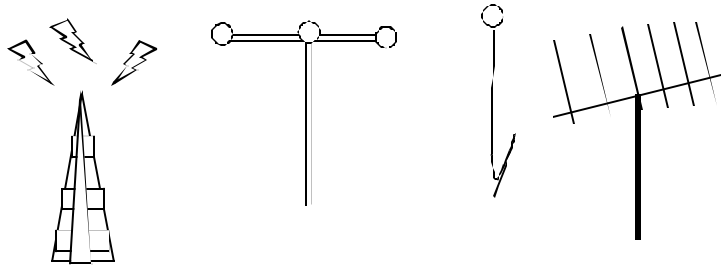

Figure 2. Commonly Used Antennas

Table 2. Basic features of three categories of radio waves

	Freq. Range	Cost	Installation	Bandwidth	Attenuation	EMI
Low power single freq.	All radio (low GHz)	Moderate	Simple	1 – 10 Mbps	25 meters	Poor
High power single freq.	All radio Low (GHz)	Higher	High	1-10 Mbps	Low	Poor
Spread-spectrum	All radio (MHz)	Moderate	Moderate	2-6 Mbps	High	Fair

desired signal, making it difficult for receiving computer to decode it.

4.2 Microwave Transmission System

Microwave system uses lower gigahertz frequencies of the electromagnetic spectrum. These frequencies are higher than radio frequencies. They produce better performance and throughput.

Microwave data communication systems are of following types:

- Terrestrial
- Satellite

Terrestrial use directional parabolic antennas to send and receive signals. Microwave links connect separate buildings where cabling is difficult or expensive.

Satellite systems transmit signals between directional parabolic antennas. Main difference between satellite system and terrestrial system is that in a satellite system one antenna is on a satellite in geosynchronous orbit about 50,000 kilometers above the earth. Because of this, satellite microwave systems can reach the most remote places on earth and communicate with mobile devices. LAN sends a signal through cable media to antenna, which beams the signal to the satellite in orbit above the earth. The orbiting antenna then transmits the signal to another location on the earth or, if the destination is on the opposite side of the earth, to another satellite, which then transmits to a location on earth. There are some propagation delays which may range from .5 to 5 seconds. Table 3 shows some features of the two microwave data communication systems.

4.3 Infrared Systems

Infrared media uses infrared light to transmit signals. Light emitting diodes (LED) transmit the signals, and photodiodes receive the signals. From electromagnetic spectrum, infrared uses terahertz range (high frequency range). The remote controls of different electronic devices uses this technology. Though infrared signals have a good throughput, but problem is that they cannot pass solid materials, also they are diluted by strong light sources. Infrared allows both point to point and broadcast transmission. Point to point allows better transmission rate, but devices must be within its location, and on other side, broadcasting gives more flexibility but rate of data transfer is slow. Table 4 represents basic features of two types of infrared transmission.

Point to Point: Infrared beams can be tightly focused and directed at a specific target. Careful alignment of transmitter and receiver is required.

Broadcast: Broadcast infrared systems spread the signal to cover a wider area and allow reception of the signal by several

Table 3. Basic Features of the Two Microwave Data Communication Systems

	Freq. Range	Cost	Installation	Bandwidth capacity	Node capacity	EMI
Terrestrial Microwave	Low GHz 21-23 GHz	Moderate	Difficult	1-10 Mbps	2	Poor
Satellite Microwave	Low GHz 11-14 GHz	High	Difficult	1-10 Mbps	2	Poor

Table 4. Basic Features of Two Types of Infrared Transmission.

	Freq. Range	Cost	Installation	Bandwidth capacity	Node capacity	EMI
Point to Point	100 GHz to 1000 THz	Moderate to expensive	Precise alignment	100 Kbps to 16 Mbps	Depends on application	Good
Broadcast	100 GHz to 1000 THz	Expensive	Very simple	I Mbps	Depends on application	Poor

receivers. One of the major advantage is mobility.

5. MOBILE APPLICATIONS

Future Wireless communication is going to help the user in a lot of ways. A few future applications are projected here.

- With help of mobile devices you will be able to download e-mails, update schedules, change meeting times, transfer files thus helping in office environment.
- Most flight reservations can be done online. Next step will be, when you enter airport, the airline reservation system would be able to respond to your mobile device. When you enter the terminal, your device will communicate to airline system and all your formalities regarding, boarding pass, etc. will be taken care of.
- Home devices could also be wirelessly enabled. A user's device could communicate with home devices to unlock doors, activate lights and home audio and video entertainment units, adjust heating/cooling settings to preset preferences and also deactivate security alarms.
- User driving a car in a foreign state can receive e-mail messages via wide area wireless system installed in the car.
- Wireless RF (radio frequency) tags can be used in shopping malls and can be used to provide pricing, sale and stock information. This will enhance shopping lifestyle and increase inventory productivity.
- Also in modern battlefield wireless communication has become very important.

CONCLUSION

This technical review gives a brief reference about, what is a wireless environment and how have we reached to the current small, presentable cellular devices. A lot of technological revolution has taken place in the span of time to reach at modern wireless media. This media can now transmit audio, video and text and that too with much faster speed and accuracy. We studied different range patterns for wireless medium and assigned metric parameters such as cost, installation, frequency range, bandwidth capacity, node capacity and EMI (immunity from electromagnetic spectrum).

It was inferred that:

- Computer networks applications uses Radio frequency range (from 10 KHz to 1 GHz), which falls into three categories as Low power-single frequency, High power-Single frequency and Spread-spectrum.
- Microwave data communication system uses lower GHz frequency range for transmission, uses terrestrial medium and satellite medium.
- Infrared uses terahertz frequency range (high range) for trans mis sion, uses point to point and broad cast sys tem.

Taking maximum metrics into account, is was seen that Satellite medium is better option than Terrestrial and Point to point transmission is better than Broadcast transmission. Future use of mobile devices in daily life has also been discussed and it is further emphasized that all this still need a lot of security features to implement and also a better QOS (quality of service). Our future study is based on these parameters.

REFERENCES

1. Bah, S. Wireless system installed in the car. Supporting Digital Video in Wireless Networks. *IEEE*, 1999, **36** (6).
2. GSM Data. Intel Corp. 1998. gsmdata.com
3. Halsall, F. Data communication, computer networks and open system. Addison Wesley, 1996.
4. Keshov, S. An engineering approach to computer networks. Addison Wesley, 1997.
5. TIA. TDMA cellular radio mobile station base structure compatibility. 136 A,1996
6. Schiller, J. Mobile communication. Addison Wesley, 2001.

7. TanenBaum, Andrew. Computer networks. Prentice Hall of India, 2002.
8. Young, W. R. Advanced mobile phone service. *Bell sys technical journal*, 1979, **58**.
9. Garg,Vijay & Wilkes J. Principals and applications of GSM. Prentice hall, 1999.
10. DECT Forum. DECT forum web page, 2000.
11. Toh, C. K. Ad hoc mobile wireless Networks. Prentice Hall, 2002
12. Lin.Y, Chlamtac, I. Wireless and mobile architectures. Wiley Computer Publ., 2001.
13. Cox, D.C. Wireless personal communications what is it. *IEEE*, April 1995.
14. Chellis. J., Perkins, C. Networking essentials study guide. BPB Publ., 1997.

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