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1.0 Wireless Applications

Objectives

The principal objectives of this textbook are to:

- Introduce the college student to the wireless world
- Examine various system architectures
- Examine trends in communications

An attempt will also be made to:

- Determine some of the forces influencing systems design today
- Examine the impact of telecommunications on society today
- Imagine new applications for modern technology

The information collected in this introduction comes from textbooks, magazine articles, people in the telecommunications industry, the Internet and the author's own experience. Additional references are supplied to assist the student to further their studies.

Any section with a bar to the right hand side of the page, contains information gleaned from news articles in various technical journals and as a result, is liable to change without notice.

The wide outside margins allow students to add their own notes. At the end of each section are a series of assignment questions. The answers to some of these can be found in the text but others require research.

The various sections in this text can be expanded and updated as more information becomes available.

Constructive comments would be gratefully received.

Why wireless?

One of the most exciting developments in modern computer based communications is the deployment of mobile wireless intelligent networks[1]. Current cellular radio systems are enjoying wide popularity all over the world. Systems such as CT-3 and GSM[2] use all digital technology[3] and naturally lend

1 Emerging Mobile and Personal Communications Systems, IEEE Communications, June 1995 Vol. 33, No. 6

2 Integration of Intelligent Network Services into Future GSM Networks, IEEE Communications, June 1995 Vol. 33, No. 6

3 Advanced Digital Receiver Principles and Technologies for PCS, IEEE Communications, January 1995 Vol. 33, No. 1

themselves to computer interfacing and data handling[4]. Even in regions where digital cellular radio is not supported, manufacturers have developed wireless modems to allow the conventional AMPS cellular systems connect to laptop computers and fax machines. The new emerging wireless systems known generically as PCN or PCS, will use both micro-cells[5] and satellites to provide world-wide communications.

All major communications carriers are spending enormous amounts of money deploying PCN[6]/PCS[7]. In the United States, the FCC has recently the auctioned off the A and B frequency blocks for 7.7 B$US and expects another 8 B$US for the C block[8]. In December 1995, the CRTC issued the first two 30 MHz PCS national licenses in Canada: Clearnet PCS Inc. of Pickering, and MicroCell Network Inc. of Montreal. Another two 10 MHz licenses were issued to Cantel and Mobility Panacom.

A very important group of wireless networks are the mobile radio data systems. These are used by nation-wide trucking fleets and delivery services. Some of the principle carriers include: ARDIS, Cellular Data, CoveragePLUS, DRN, and Mobitex. These wireless operators have thousands of network access sites and can be found in every major city in North America.

The development of wireless networks will have a profound impact on the entire nature of communications and on society since communications will be between people and not terminals.

There are also many serious issues such as legal and security concerns which need to be resolved.

Some industry comments on PCS:

> "Exploitation of the enormous potential of personal communication system (PCS) technology has become a major goal of the telecommunications industry today." — *T&M vendors get ready for the PCS challenge*, ep&t, March/April, 1996

> "... the 21st century will witness the widespread deployment of wireless networks that will revolutionize the concept of communication and information processing for business, professional, and private applications. The field of wireless communications is experiencing unprecedented market growth,

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4 Teletraffic Implications of Database Architectures in Mobile and Personal Communications, IEEE Communications, June 1995 Vol. 33, No. 6

5 Spread Spectrum Access Methods for Wireless Communications, IEEE Communications, January 1995 Vol. 33, No. 1

6 Overview or Wireless Personal Communications, IEEE Communications, January 1995 Vol. 33, No. 1

7 Distributed Call Processing for Personal Communications Services, IEEE Communications, June 1995 Vol. 33, No. 6

8 May the Best Standard Win, Discovery - Nokia Telecommunications Customer Magazine, vol. 40, first quarter 1996

> as evidenced by the rapid increase in the size of the cellular and cordless telephone, paging, mobile data, and wireless LAN industries. ... [This] has resulted in important initiatives in this industry, ... These developments are all part of a major paradigm shift in the world of telecommunications, ..." — *Wireless Information Networks*, K. Pahlavan & A. H. Levesque, Wiley, 1995.

A Little Bit of History

1865 - James Clerk Maxwell predicted the existence of electromagnetic radiation. He developed a series of equations, now known as Maxwell's equations, which linked electric and magnetic forces. They also showed that light and radio waves were different manifestations of the same phenomenon.

1887 - Heinrich Hertz used a spark generator to create the first radio waves in the VHF band. The receiver consisted of wire rectangle with a small gap. Sparks would appear in the gap whenever the transmitter was discharged. Hertz proved that the radiation was due to waves and not an induction field.

1895 - Guglielmo Marconi developed what is generally recognized as the first practical radio wave transmitter. By 1897 he demonstrated transmission over several miles.

The first transatlantic transmissions were attempted from a four tower circular array at Poldhu, England. The wooden towers were 61 meters in height. The transmission frequency was approximately 600 KHz. The spark transmitter input power was about 18 kilowatts.

On December 12, 1901, at Signal Hill, St. Johns, Newfoundland, Marconi received the first transatlantic broadcast consisting of three dots representing the letter S in Morse code. The transmitter was operated by John Ambrose Fleming, who later invented the diode vacuum tube.

On December 24, 1906, Reginald Fessenden made the first audio broadcast from Rock, Massachusetts. About a year later, Lee DeForest invented the "Audion" vacuum tube.

There is apparently little agreement among the various radio historians as to who was the first to put all of this together and form the first broadcast facility. However, on January 13, 1910 a radio broadcast featuring Caruso and others was made from the Metropolitan Opera in New York. The first broadcast license in the US was issued in 1911, to George Hill

Howard Armstrong conducted the first regular FM transmissions in 1935 at a 42.1 MHz. Regular programming started in 1940. The first commercial FM station started on January 1, 1941 in Nashville.

1924 - John Logie Baird broadcasts the first video image using an electro-mechanical system with a resolution of 30 lines. On November 18, 1929 V.K. Zworykin demonstrated the first CRT receiver.

March 1935 - The German government began the first non-experimental public television service. The first scheduled television broadcasts in the UK began November 11, 1926. The first regularly scheduled television broadcasts in the US were in 1939.

January 1997 - KOMO/Channel 4 in Seattle became the first commercial broadcast station on the West coast to transmit digital HDTV.

Significant Moments in Wireless Communications History

1885 Maxwell predicts the existence of radio waves

1887 Hertz verifies the existence of radio waves

1895 Marconi invent the first radio transmitter/receiver

1901 Marconi transmits the first radio signal across the Atlantic

1906 The first audio broadcast is made

1911 The first broadcast license is issued in the US

1912 Hundreds on the Titanic were saved due to wireless

1924 The first video signal is broadcast

1929 The CRT display tube is invented

1935 The first television service goes into operation

1935 FM is invented

1939 The *blitzkrieg* and WW II are made possible by wireless

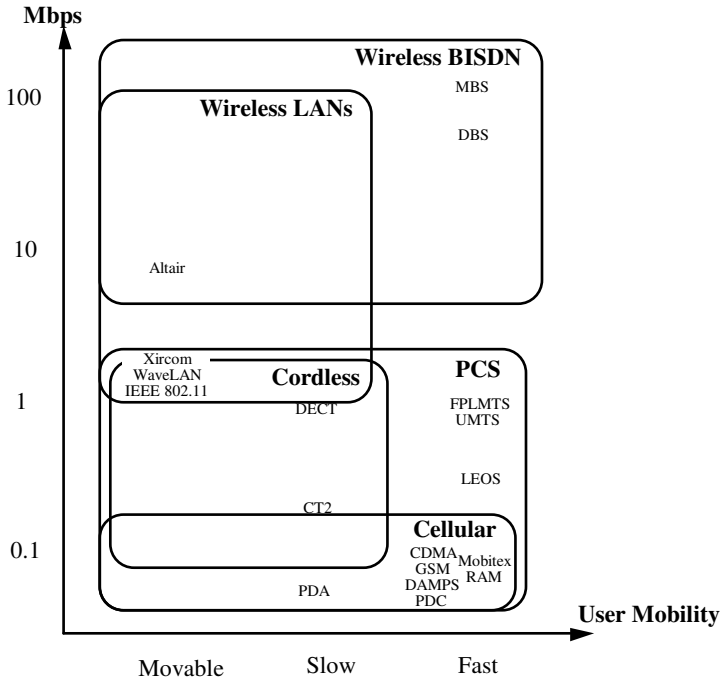
1946 The first mobile radio system goes into service in St. Louis

1957 The first artificial satellite, Sputnik goes into orbit

The wireless world has many layers, each with their own peculiar needs. These are some times referred to as tiers. Starting from the lowest level they are:

- Unlicensed PCS — to provide private access. The most common example of this is the cordless phone. Neither the end user or service provider requires a license. Power, range and service offering are quite limited
- Low powered licensed PCS — this is used for pedestrian, urban office, and residential traffic. Some of these services are just now being offered by service providers. The present cellular phone companies can offer only a limited set of PCS functions.
- Terrestrial cellular — this is used to support high user mobility and provide wide area coverage. This is again offered only sporadically by a number of different service providers. Most of these services are provided by these present cellular networks or secondary radio systems such as wide area paging and mobile data
- Satellite coverage — this is the highest tier and will provide worldwide coverage. Two of the most promising contenders are the Iridium and Globstar LEO systems.

Wireless Service	Comments
First Generation: Analog Cellular	AMPS, ETACS
Second Generation: Digital Cellular	GSM, IS-54, PDC, IS-95
Third Generation: Digital PCS	CT2, DECT, DCS1800, PHS
Mobile Data	ERMES, Mobitex, CDPD
Wireless LAN	IEEE 802.11, Altair, WaveLAN, Net3



1.1 Cellular Phone

The radiotelephone has evolved a great deal since its inception in 1946. In the beginning, a connection was made to the PSTN by means of a radio operator. All subscribers to the system had to access the same broadcast tower, which meant that both the range and number of simultaneous calls that could be handled was quite limited. The system was essentially the same as radio dispatch systems still used by taxis, police, and other such agencies.

With the advent of the automatic exchange, the operator position was eliminated. The number of customers the system could handle was increased by deploying more broadcast antennas but with much reduced range.

Several different cellular systems have been developed throughout the world. In most cases, the systems deployed in each country have been standardized and licensed by a government agency. Today however, there are even more systems being developed, but governments are presently reluctant to select one system over any other. Consequently, several countries are now deploying mutually incompatible systems within their own jurisdiction.

1.2 Cordless Telephones

Cordless phones have been used in the home for many years, and allow the user to move about freely in their home or yard without having to be tethered to the phone. Generally each telephone has its own base station which is connected to the PSTN.

These cordless phones allow employees to move about freely anywhere within a building or campus environment. This allows people to be easily contacted when they are not at their desks. This is certainly much more convenient than using a bulky walkie-talkie.

Light weight, feature rich cordless phone have immediate applications in hospitals, manufacturing plants, warehouses, hotels, the service industry, etc. Small microcell base stations are placed at strategic locations throughout a building complex, and as a person moves about, any calls in progress are automatically handed-off to the nearest cell.

1.3 PCS/PCN

Minimum Reading

Growth of PCS

AT&T PCS Tutorial

Personal communications services are the ultimate goal of telecom service providers. Some may argue that it already exists, others that it may never exist. The point is, all of the necessary pieces needed to put it together exist. Only time will tell what it will eventually turn out to be.

PCS is the logical development to make communications ubiquitous. This requires the use of microcell and cordless technology in the PSTN. Couple this along with satellite technology to provide coverage where there are no cells, and any person could conceivably contact anyone else in the world, regardless of where they are.

1.4 Satellite Systems

Satellites in geostationary orbit have been used for many years to provide both Television and telephone service. The satellite in this type of system is somewhat different from satellites deployed in PCS/PCN networks, in that they are approximately 36,000 Km. This means that communication is established primarily through ground station terminals.

A whole new generation of satellite technology is now emerging namely LEOs and MEOs. These systems use dozens of satellites to provide a sort of cellular system in the sky. These systems will have the ability to provide worldwide service independent of the underlying terrestrial infrastructure.

1.5 Wireless Packet Systems

There are several different national service carriers. The principle application is the transfer of information such as purchase requisitions and delivery orders to national trucking fleets, courier services,, inventory control and so on.

1.6 Digital Microwave Radio

Long distance signals are conveyed by four principle methods: fiber optics, satellites, microwaves, and coaxial cable. The long haul microwave systems are now all digital, and hence the term, digital microwave.

1.7 Wireless Optical Networks

Laser beams are sometimes used to transmit data over a line of sight path. Such links are very quick and easy to install. This is in contrast to the cost and time required installing cables. In some cases such as in existing buildings, it may not be possible to add more cabling. In other cases, it may not be warranted because the facility is only needed for a fixed period.

A second type of optical facility is the IR LAN. In this case, the various computer terminals may be connected to a hub via an infrared link. Again, this allows networks to be quickly installed without the need for extensive rewiring.

Assignment Questions

Composition Questions

1. Locate at least one internet web site for each of the applications areas mentioned above.
2. What are fundamental differences between cordless and cellular technology?
3. What are the four basic tiers and their applications in the wireless world?

For Further Research

Siemens Telecom Report International: www.jou.ufl.edu/siemens/telcom.htm

Wireless Week http://www.wirelessweek.com/

Wireless Design http://www.wirelessdesignmag.com/

Global Wireless http://www.rcrnews.com/

Yellow Pages http://www.rfyellow.com/

Broadcast Industry's Home Page http://broadcast.net/

Practical Radio Communications http://zeta.hpnc.com/~pracradcom/

Radio Shopper http://www.radioshopper.com/

Performance Specifications http://www.ofta.gov.hk/stndhm2.html

Applications Notes http://www.rfmd.com/DataBooks/db97/ta0020.pdf