Table 1.5 Comparison of Mobile Communication Systems—Mobile Station

Service	Coverage Range	Required Infra-structure	Complexity	Hardware Cost	Carrier Frequency	Functionality
TV Remote Control	Low	Low	Low	Low	Infrared	Transmitter
Garage Door Opener	Low	Low	Low	Low	< 100 MHz	Transmitter
Paging System	High	High	Low	Low	< 1 GHz	Receiver
Cordless Phone	Low	Low	Moderate	Low	1–3 GHz	Transceiver
Cellular Phone	High	High	High	Moderate	< 2 GHz	Transceiver

Table 1.6 Comparison of Mobile Communication Systems—Base Station

Service	Coverage Range	Required Infra-structure	Complexity	Hardware Cost	Carrier Frequency	Functionality
TV Remote Control	Low	Low	Low	Low	Infrared	Receiver
Garage Door Opener	Low	Low	Low	Low	< 100 MHz	Receiver
Paging System	High	High	High	High	< 1 GHz	Transmitter
Cordless Phone	Low	Low	Low	Moderate	1–3 GHz	Transceiver
Cellular Phone	High	High	High	High	< 2 GHz	Transceiver

required of the phone, thus limiting the battery life and rendering the service useless for hand-held users. Because of the extensive telecommunications infrastructure of copper wires, microwave line-of-sight links, and fiber optic cables—all of which are fixed—it is highly likely that future land-based mobile communication systems will continue to rely on fixed base stations which are connected to some type of fixed distribution system. However, emerging mobile satellite networks will require orbiting base stations.

1.5 Trends in Cellular Radio and Personal Communications

Since 1989, there has been enormous activity throughout the world to develop personal wireless systems that combine the network intelligence of today's PSTN with modern digital signal processing and RF technology. The concept, called Personal Communication Services (PCS), originated in the United Kingdom when three companies were given spectrum in the 1800 MHz range to develop Personal Communication Networks (PCN) throughout Great Britain [Rap91c]. PCN was seen by the U.K. as a means of improving its international competitiveness in the wireless field while developing new wireless systems and services for citizens. Presently, field trials are being conducted throughout the world to determine the suitability of various modulation, multiple-access, and networking techniques for future 3G PCN and PCS systems.

The terms PCN and PCS are often used interchangeably. PCN refers to a wireless networking concept where any user can make or receive calls, no matter where they are, using a light-weight, personalized communicator. PCS refers to new wireless systems that incorporate more network features and are more personalized than existing cellular radio systems, but which do not yet embody all of the concepts of an ideal PCN. Today, cellular and PCS are identical in functionality and differ only in frequency band.

Indoor wireless networking products are rapidly emerging and promise to become a major part of the telecommunications infrastructure within the next decade. As discussed in Chapter 2, an international standards body, IEEE 802.11, is developing standards for wireless access between computers inside buildings. The European Telecommunications Standard Institute (ETSI) is also developing the 20 Mbps HIPERLAN standard for indoor wireless networks. Breakthrough products such as Motorola's 18 GHz Altair WIN (wireless information network) modem, that was not commercialized, and Avaya's (formerly NCR and Lucent)/ORiNOCO waveLAN computer modem have been available as wireless ethernet connections since 1990 [Tuc93] and are beginning to penetrate the business world. As we enter the 21st century, products are emerging that allow users to link their phone with their computer within an office environment, as well as in a public setting, such as an airport or train station.

A worldwide standard, the Future Public Land Mobile Telephone System (FPLMTS)—renamed International Mobile Telecommunication 2000 (IMT-2000) in mid-1995—has been formulated by the International Telecommunications Union (ITU) which is the standards body for the United Nations, with headquarters in Geneva, Switzerland. The technical group TG 8/1 standards task group is within the ITU's Radiocommunications Sector (ITU-R). ITU-R was formerly known as the Consultative Committee for International Radiocommunications (CCIR).

TG 8/1 is considering how worldwide wireless networks should evolve and how worldwide frequency coordination might be implemented to allow subscriber units to work anywhere in the world. FPLMTS (now IMT-2000) is a third generation universal, multi-function, globally compatible digital mobile radio system that will integrate paging, cordless, and cellular systems, as well as low earth orbit (LEO) satellites, into one universal mobile system. A total of 230 MHz in frequency bands 1885 to 2025 MHz and 2110 to 2200 MHz was targeted by the ITU's 1992 World Administrative Radio Conference (WARC). In March 1999, ITU-R agreed to additional spectrum allocations that include the frequency bands 806 to 960 MHz, 1710 to 2200 MHz, and 2520 to 2670 MHz. This additional spectrum allocation was approved in May 2000 at the ITU World Radio Conference (WRC-2000). The types of modulation, speech coding, and multiple access schemes to be used in IMT-2000 were also locked down by the ITU Radio General Assembly in mid-2000. As discussed in Chapter 2, the selected radio interfaces for terrestrial wireless service include expansions of today's GSM and IS-95 CDMA, as well as a new time-code CDMA standard proposed by China.

Worldwide standards are also required for low earth orbit (LEO) satellite communication systems that were developed in the 1990s but which failed commercially at the turn of the century. Due to the very large areas on earth which are illuminated by satellite transmitters, satellite-based cellular systems will never approach the capacities provided by land-based microcellular systems. However, satellite mobile systems were touted as offering tremendous promise for paging, data collection, and emergency communications, as well as for global roaming. In early 1990, the aerospace industry demonstrated the first successful launch of a small satellite on a rocket from a jet aircraft. This launch technique was pioneered by Orbital Sciences Corp. and was more than an order of magnitude less expensive than conventional ground-based launches and allowed rapid deployment, suggesting that a network of LEOs could be rapidly launched for wireless communications around the globe. While several companies, such as Motorola's Iridium, proposed systems and service concepts for worldwide paging, cellular telephone, and emergency navigation and notification in the early 1990s [IEE91], the capital markets have not supported mobile satellite systems in general.

In emerging nations, where existing telephone service is almost nonexistent, fixed cellular telephone systems are being installed at a rapid rate. This is due to the fact that developing nations are finding it is quicker and more affordable to install cellular telephone systems for fixed home use, rather than install wires in neighborhoods which have not yet received telephone connections to the PSTN.

The world is undergoing a major telecommunications revolution that will provide ubiquitous communication access to citizens, wherever they are. The wireless telecommunications industry requires engineers who can design and develop new wireless systems, make meaningful comparisons of competing systems, and understand the engineering trade-offs that must be made in any system. Such understanding can only be achieved by mastering the fundamental technical concepts of wireless personal communications. These concepts are the subject of the remaining chapters of this text.