1

Wireless and Mobile Networks

1.1. Introduction

This chapter discusses wireless networks, their functions, categories, types, etc. It also deals with mobile networks including their structures and the evolution from the first generation (1G) to the fourth generation (4G). The chapter also discusses the IEEE 802.22 standard, which is a cognitive radio (CR) standard.

"Mobile" and "wireless" are terms that are often used to describe existing networks, such as the global system for mobile (GSM) communication, IEEE 802.11 and Bluetooth. However, it is important to differentiate between the two types of networks, which cover the concepts of mobile and wireless, to avoid any confusion.

Mobile and wireless networks have experienced an unprecedented growth in recent years. This is partly because of local wireless networks that have become part of our daily life through the main standards such as Wi-Fi and Bluetooth, and partly due to the development of several successive generations of telecommunication networks, essentially dedicated to telephony (second generation (2G), GSM) and then more oriented toward multimedia (third generation (3G), universal mobile telecommunications system (UMTS)).

Today, the majority of computers and almost all "mobile" devices (such as mobile phones and electronic diaries) have the means to connect to one or more types of wireless networks, such as Wi-Fi, Bluetooth and infrared. Therefore, it is very simple to create a "wireless" network in just a few minutes, letting all these apparatus communicate with each other. The difficulty with implementing it is due to the zone of reception; this depends on the power of the transmitter, the detection of the receptor and the security of the transmitted data.

The main advantage of these communication systems is mobility. This feature has impressed a large number of people. Mobility enables users to communicate within an area of a certain size and to be able to continue communicating as they move. However, there are limits in speed and distance. The system offering this service on the largest scale is the cellular system. Such systems include GSM, whose coverage extends across countries and even continents.

Developments are taking place everywhere, as much as in the world of specialized networks (sensors, smart labels, etc.) as in telecommunication networks. From now on, these will see competing solutions coming from diverse domains: the world of traditional telecommunications, the world of wireless networks with worldwide interoperability for microwave access (WiMAX) or even the world of terrestrial and satellite television diffusion.

Finally, networks of an even bigger size are being developed using the IEEE 802.22 standard or wireless regional access networks (WRANs). This involves the definition of an interface point-to-multipoint access functioning in the very high frequency (VHF)/ultra-high frequency television (UHF-TV) band of diffusion. This standard must allow these bands to be used without interfering with active television channels. This solution should offer coverage in rural areas, by having larger band access.

1.2. Wireless networks

1.2.1. *Definition*

A wireless network is, as its name indicates, a network in which at least two terminals can connect without a cable connection.

Because of wireless networks, a user has the possibility of staying connected as he/she moves within the perimeter of a geographical area of a certain size; this is why people sometimes speak of "mobility".

A local wireless network transfers information by infrared or radio waves (generally using the 2.4 GHz frequency band). Transmission via radio waves is the most common method because of its wide geographical coverage and its higher bandwidth.

Wireless networks allow easy linkage of apparatus that may be tens of meters to several kilometers apart. Moreover, the installation of such networks does not require the heavy equipment of the existing infrastructures, as is the case with wired networks, which has brought a rapid development of this type of technology.

However, there is the problem of regulation of radio transmissions. Radio transmissions are used for a large number of applications, but are sensitive to interference, which is the reason why regulation is necessary, in every country, to define frequency ranges and the potential power for each category of usage.

There are a few simple rules that can be useful when conceiving a wireless network:

– The longer the wavelength, the further it will go.

– The longer the wavelength, the better it will travel through and around objects.

– More data can be transferred using shorter wavelengths.

1.2.2. *Function of a wireless network*

Wireless telephones enable us to communicate with a correspondent through a platform that acts as an access point (AP) for the telephone network.

Likewise, each computer belonging to the wireless network and equipped with a suitable network card can transmit and receive data to (and from) a network's AP. The latter can be physically connected to the wired network and then act as an AP toward the wired network.

Of course, the further you go from the AP, the more the bandwidth decreases: for a bandwidth of 1 Mbps, the range is 460 m in an environment without obstacles and 90 m in a typical office environment.

Considering the method of communication between mobiles, we can say that the wireless network offers two distinct operating modes: a mode with infrastructure and a mode without infrastructure.

1.2.2.1. *Network with infrastructure*

In the mode with infrastructure, which is also referred to as basic service set (BSS) mode, certain fixed sites called mobile support stations or base stations (BSs) are fitted with a wireless communication interface to allow direct communication with a site or mobile units (MUs), localized in a specific geographical area, called a cell.

Each BS corresponds with a cell from which MUs can send and receive messages. The fixed sites are interconnected through a wired communication network that is generally reliable and of a higher bandwidth. Wireless connections have a limited bandwidth, which greatly reduces the volume of information exchanged. In this model, an MU can be connected to only one BS at a given time.

Figure 1.1. *A basic service set*

1.2.2.2. *Network without infrastructure*

The network without infrastructure, which is referred to as *ad hoc* network or independent basic service set (IBSS), does not encompass the "fixed site" entity; all the sites belonging to the network are mobile and communicate directly by using their wireless interfaces to communicate. The absence of infrastructure or a wired network composed of BSs means that MUs must act as routers that participate in the discovery and maintenance of paths for other network hosts.

This mode does not benefit from any infrastructure. A working group belonging to the Internet Engineering Task Force (IETF) has studied this type of network and they define it as follows:

An *ad hoc* network consists of mobile platforms (e.g. routers interconnecting different hosts and wireless equipment) called nodes that are free to move without constraint. An *ad hoc* network, then, is an autonomous system of mobile nodes. This system can function in isolation or interface through fixed networks through a gateway. In the latter case, an *ad hoc* network is an extremity.

In this mode it is possible to deploy a wireless network quickly and in any place. The fact of not requiring an infrastructure, other than the stations and their interfaces, allows *ad hoc* network to have mobile nodes.

The difference between the *ad hoc* mode and the infrastructure mode is that in the latter, all communication must pass through the AP, whereas in the former, the

communication between two devices is done directly if they are within the scope of each other.

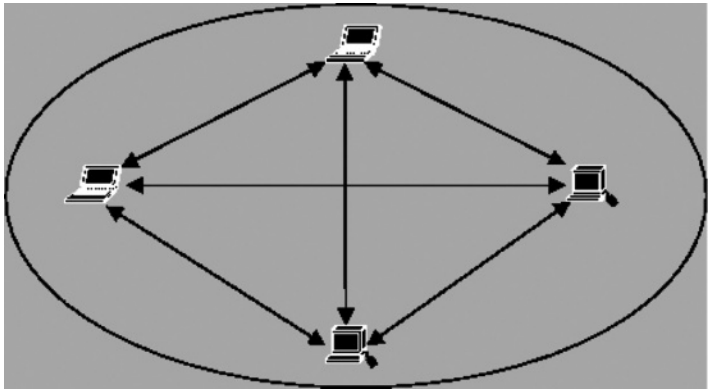

Figure 1.2. *Ad hoc topology*

1.2.3. *Types of wireless networks*

We usually distinguish between several categories of wireless networks according to their geographical perimeter that allows connectivity (called coverage area).

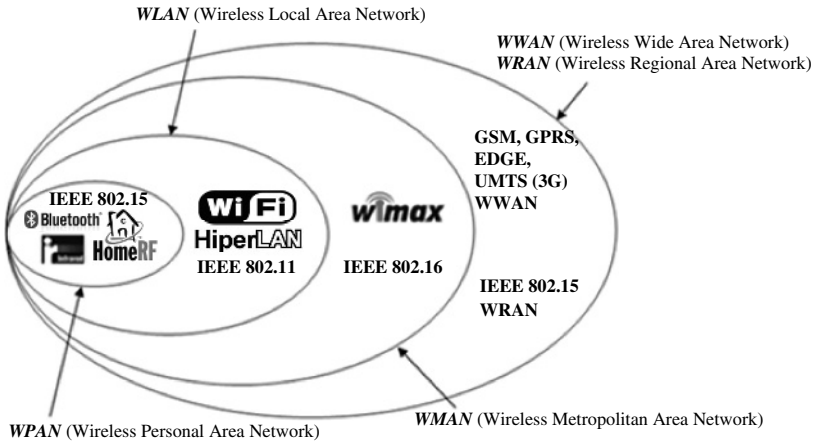

Figure 1.3. *Types of wireless network*

1.2.3.1. *Wireless personal area network*

The wireless personal area network (WPAN) is composed of connections between devices that are a short distance apart, such as in an office or a house.

– Bluetooth.

– HomeRF.

1.2.3.2. *Wireless local area network*

The wireless local area network (WLAN) corresponds to a perimeter of a local network, installed in a business, a household or even in a public space. All terminals within the WLAN's coverage area can connect to it. Several WLANs can be synchronized and configured in a way that the user is not even aware that they are moving across several coverage areas:

– IEEE 802.11a, 802.11b, 802.11g;

– HiperLAN.

1.2.3.3. *Wireless metropolitan area network*

The wireless metropolitan area network (WMAN) uses the IEEE 802.16 standard and is also known as WiMAX. It provides wireless network access to buildings connected by radio through an external antenna to central stations linked to the wired network.

1.2.3.4. *Wireless wide area network*

The wireless wide area network (WWAN) encompasses cellular networks such as GSM, general packet radio service (GPRS), UMTS and satellite networks. The distance between devices can be up to 3 km, and the cost of installing such a network is higher than that of the networks cited above.

1.2.3.5. *Wireless regional area network*

IEEE 802.22 standard is for a wireless regional area network (WRAN) that operates in unused television channels and provides access to wireless services. The final standard will support channels of 6.7 and 8 MHz for a global operation. WRAN is based on orthogonal frequency division multiple access (OFDMA). This standard is in the process of being developed and is currently at the preliminary stage.

1.2.4. *Different types of existing wireless networks*

There are two main types of wireless networks:

– networks using infrared waves;

– networks using radio waves.

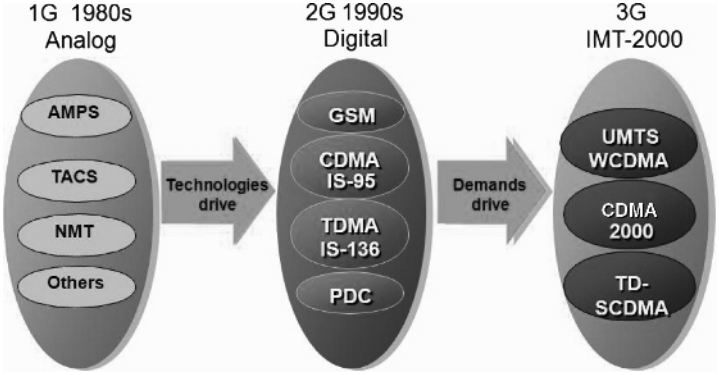

Figure 1.4. *WWAN*

1.2.4.1. *Networks using infrared waves*

Infrared waves are commonly used in everyday (in television remote controls, for example). Because of them, we are able to create small networks, notably between mobile phones and computers.

The main disadvantage of networks created using infrared waves is that to be effective, devices must be facing each other, separated by a maximum of a few tens of meters without any obstruction between the sender and the receiver, because the link between the two devices is directional. Of course, the only networks that can use this technology are WPAN.

1.2.4.2. *Networks using radio waves*

1.2.4.2.1. Bluetooth

Bluetooth is an industrial specification for a wireless personal area network (WPAN). It was created by Ericsson in 1994. This type of wireless connection enables two devices to connect via a microwave link. These devices can include digital cameras, PDAs or printers.

It offers a low bit rate (1 Mbps in theory) in a limited range (10–30 m in practice). The official standard for Bluetooth is IEEE 802.15 (version 1.x).

If secured, this connection is visible only if the two devices recognize each other.

Within a Bluetooth network, a device acts as the master of up to seven slave devices sharing the bandwidth. In theory, it is possible to have up to 10 groups of devices (i.e. 80 devices) communicating.

1.2.4.2.2. Home radio frequency

Initially supported by market players such as Compaq, HP, IBM, Intel® and Microsoft, home radio frequency (HomeRF) was designed for domestic use above all else. It uses the same frequencies as Bluetooth.

Furthermore, a HomeRF network connects portable and desktop computers and also supports digital enhanced cordless telecommunications (DECT) connections, voice transmission technology in digital mode through wireless networks.

HomeRF can permit 127 nodes in a network, and six simultaneous voice connections.

1.2.4.2.3. High performance LAN

Developed under the leadership of the European Telecommunications Standards Institute, high performance LAN (HiperLAN) is an exclusively European standard. Its aim is to create flexible, wireless environments, with high bit rate, that allow an *ad hoc* functioning. It possesses an error correction code to obtain the quality of transmission that is comparable to the quality obtained with a local network.

1.2.4.2.4. IEEE 802.11

With the advances in communications in recent years, several technologies are aiming to meet the real needs of their users. Radio began to gain ground when satellites started being used for personal use. It used to be considered expensive, but is becoming increasingly cost-effective.

IEEE invested in improving the 802.11 standard, with the same architecture and technology, but with a large data rate, between 5 and 11 Mbps, rather than pushing technology and stimulating scientific and industrial communities in order to standardize, conceive and produce products for these networks. There are several versions of the IEEE 802.11 standard. In general, the more recent the version, the more high the bit rates.

There are several IEEE 802.11 standards defining the transmission of data via the "terrestrial" medium. Their main differences depend on the bandwidth and transmission distance, as well as the bit rate they offer. The principal extensions are the following:

– *802.11a standard*

This standard was developed in 1999 (sometimes called WiFi5), it functions in the 5 GHz frequency band and it is incompatible with 2.4 GHz. The modulation scheme used was orthogonal frequency division multiplexing (OFDM). This limits interference and makes speeds of transmission up to 54 Mbps possible.

The limitations of this standard are the range (15 m) and its incompatibility with 802.11b.

– *802.11b standard, Wi-Fi or IEEE 802.11hr*

The term "Wi-Fi" refers to the standard that was the first WLAN standard used by a large number of users. It was approved in 1999 by the IEEE. The Wi-Fi standard allows interoperability between different existing materials. It offers a bandwidth of 11 Mbps, with a range of 300 m in an obstacle-free environment. It works using the 2.4 GHz frequency band, split across several channels.

– *802.11b+ standard*

The 802.11b+ standard derives from the 802.11b standard. It uses the same frequency range but with a unique, specific encryption that is done using 64, 128 or even 256 bits.

It is completely compatible with 802.11b. An 802.11b+ device will therefore accept a connection with 802.11b devices. However, this standard is not normalized. It is therefore possible that apparatus 802.11b+ made differently will not be compatible.

– *802.11g standard*

This standard was developed in 2003. This expands the 802.11b standard, by increasing the theoretical transfer rate up to (30 Mbps in reality). It also functions at 2.4 GHz, using the same area of frequency, which should allow it to mix with AP 802.11b. The central point adapts its speed depending on the device connected, letting 802.11b clients connect.

Because of this standard, the equipment using 802.11b can be used with 802.11g APs and vice versa. This standard uses static wired equivalent privacy (WEP) authentication, and it also accepts other types of wireless protected access (WPA)

authentication, with dynamic encryption (temporal key integrity protocol – TKIP and advanced encryption standard – AES encryption methods).

– *802.11g+ standard*

The improvement on 802.11g was released in early 2004 and has doubled the connection speed of 802.11g to reach 108 Mbps by compressing data. This speed is therefore more theoretical than practical.

– *802.11i standard*

Ratified in June 2004, this standard is concerned with security mechanisms of transmissions. It proposes communication encryption for transmissions using 802.11a, 802.11b and 802.11g standards. The 802.11i standard works by interacting with 802.11b and 802.11g standards. The theoretical transfer rate is therefore the same, with 11 Mbps for 802.11b and 45 Mbps for 802.11g.

– *802.11e standard*

Available since 2005, this standard aims at offering possibilities in terms of Quality of Service (QoS) at the data link layer level, functionalities of security and authentication. Therefore, this standard's aim is to establish the needs of different packages in terms of bandwidth and delay in transmission, so that there will notably be a better transmission of voice and video.

– *802.11n standard*

This standard was created in 2009. In theory, the maximum speed is between 150 and 300 Mbps. This is the transfer speed and does not account for control codes or encryption included in the message. In practice, the bit rate should be between 100 and 200 Mbps.

802.11n uses multiple input multiple output (MIMO), which can send and receive signals by using several antennae simultaneously. By altering the position of the APs' antennae like the network card, we increase the maximum distance (but still less than 100 m). This solution no longer makes it possible to "go through walls", but in certain cases, it allows us to get around then.

802.11n uses frequency bands of 2.4 GHz and 5 GHz (used by 802.11a).

– *WiMAX*

WiMAX is a wireless connection with a high bit rate covering long distances. In theory, it has a bit rate of 70 Mbps over a maximum of 50 km, but in practice it offers 10 Mbps over 2 Km.

Based on the IEEE 802.16 standard, the WiMAX network represents, in informal language, a set of standards and techniques in the world of metropolitan wireless networks (WMAN). WiMAX is principally based on a star topology, although mesh topology is also possible.

There are different versions of WiMAX that are in use:

– Version 802.16a allows a maximum distance of 20 km, with a maximum bit rate of 12 Mbps. It uses a frequency band situated between 2 and 11 GHz. It is now obsolete.

– The 802.16d standard, where fixed WiMAX reaches distances of 50 km. This is the standard currently marketed for Internet connections. This has a poor reputation for mobility and does not support "roaming".

– Version 802.16e transposes WiMAX for mobile telephones with a transfer rate of 30 Mbps up to a maximum distance of 3 km. This solution competes with current 3G connections (bit rate: 400–700 Kbps). The frequency band is between 2 and 6 GHz.

WiMAX is a technology that is different from other technologies for two reasons: on the one hand, it is characterized by its open, complete and extremely rapid normalization process and on the other hand, it was the first to adopt what appears to be the right choice of technology, notably in terms of modulation, security and, above all, QoS. WiMAX uses the OFDM. Figure 1.5 shows WiMAX and its closest competitors in terms of geographical coverage and offered bit rates.

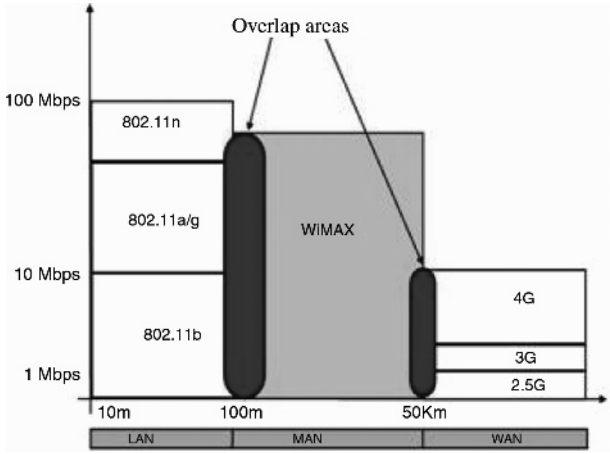

Figure 1.5. *WiMAX and its competitors*

1.2.5. *IEEE 802.22 standard*

IEEE 802.22 is a new working group from the IEEE 802 LAN/MAN normalization committee that aims to use wireless use of the regional network (WRAN) white spaces (channels that are not already being used) in the assigned spectrum of television frequency.

The 802.22 standard indicates that the network should function as point-to-multipoint base (P2MP). The system is composed of a BS and the customers home-band equipment (CPE, mentioned as APs).

The IEEE 802.22 standard is a CR norm, aiming to supply rural, less populated regions with a large band access by using free television channels. Provided that levels of industrial noise and ionospheric reflections remain relatively low, the antennae have reasonable dimensions; propagation characteristics without direct visibility are very good bands for television broadcasting in the high VHF range and low UHFs are ideal for the coverage of large rural regions with low population density.

The extensive use of CR technology, such as the detection of radio frequency (RF), geolocation, access to databases of the licensees of the broadcasting radio station and dynamic selection of frequency, aims to ensure coexistence with the licensees of the broadcasting station on a non-interfering basis, as well as the internal coexistence with other WRAN systems, which conforms to the 802.22 standard to maximize the spectrum's use.

1.3. Mobile networks

1.3.1. *Wireless and mobility*

The terms "mobile" and "wireless" are often used to describe existing wireless communication systems. It is important to distinguish between the two categories.

In wireless networks, the communication medium uses a radio interface: cordless, GSM, GPRS, UMTS, etc.

A mobile user is theoretically defined as a user who is capable of communicating outside his/her subscribed network while retaining his/her address.

– The cordless system is wireless but not mobile.

– Certain systems such as GSM offer mobility and wireless simultaneously.

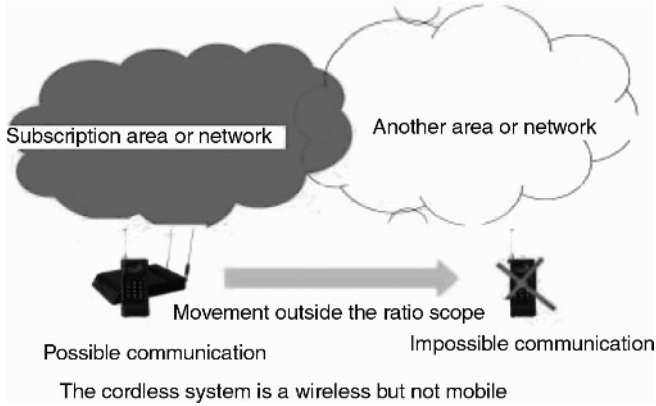

Figure 1.6. *Cordless system*

1.3.2. *Mobility*

In communication networks, mobility is defined as the ability to access all available services that are usually found in a wired and fixed environment from anywhere.

Mobile computing is defined as the possibility for users equipped with portable devices to be able to access services and developed applications through a shared network's infrastructure, independent of physical location or movement by users.

1.3.3. *Cellular architecture*

In a cellular network, the land covered or the coverage area is generally divided into small geographically limited areas that are commonly called cells.

– Pico-cell: it represents an operating space of a few meters in diameter.

– Micro-cell: it refers to a geographical area of some tens of meters in diameter.

– Cell: it corresponds to an area in which the diameter varies from several hundreds of meters to kilometers.

– Macro-cell: it corresponds to a geographical range varying in tens of kilometers in diameter.

– Umbrella cell: it covers a region with a diameter of hundreds of kilometers.

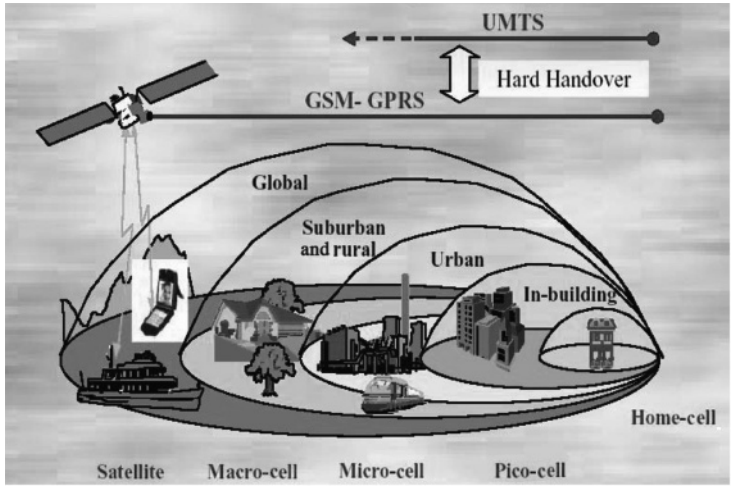

Figure 1.7. *Cellular architecture*

1.3.4. *Architecture of a cellular network*

The radio subsystem acts as the radio interface between each MU and the network itself.

– BS: it integrates radio equipment/antenna ensuring radio transmission and signaling inside that cell.

– Station controller: it manages the radio resources and bandwidths of the associated BSs.

As shown in Figure 1.8, cellular communication networks are formed with a three-tier hierarchy. On the first level is the subnetwork, which is responsible for registering a subscriber's profile. The second level is the location area, which regroups all the cells, and the final level is the BS, which serves the cell.

If the first two levels are provided with intelligence, in accordance with network terminology, the BS has very little work to do, assuming the simple role of a relay antenna. The switch, which controls a group of BSs, performs a maximum amount of procedures, to guarantee a connection: establishing a call, managing the intercellular transition, authentication and encryption, etc.

– GGSN: Gateway GPRS support node;

– SGSN: Serving GPRS support node;

– VLR: Visited location register;

– MS: Mobile station;

– HLR: Home location register;

– MSC: Mobile switching center;

– GMSC: Gateway mobile switching centre;

– BTS: Base transceiver station;

– BSC: Base station controller.

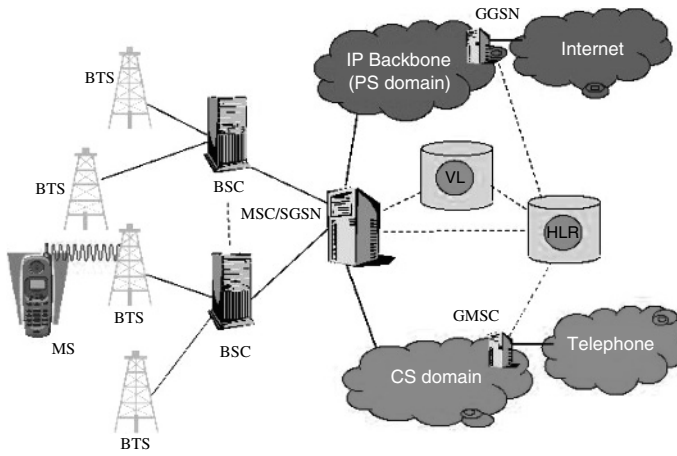

Figure 1.8. *Architecture of a cellular network*

1.3.5. *Telephony*

Telephony is a telecommunication system whose objective is to transfer sound and in particular the transfer of words. Telephony offers more advanced services such as voicemail, telephone conferences or voice services.

A telephone network is composed of three types of main equipment:

– Terminals (telephone, answering machine, modem, fax, servers).

– Central systems (telephone switchboard or telephone switch system).

– Connections between different apparatus, such as telephone cables (wire or fiber optic) or the antennae of mobile phones.

1.3.6. *Development of cellular systems*

1.3.6.1. *First generation*

The first generation of mobile telephones had an analogical function and were composed of relatively large equipment.

Problems:

– Limited capacity, as the system was based on frequency division multiple access (FDMA).

– Limited mobility, especially between the networks of different providers.

– Fraud, lack of security system.

– Analog (control and voice channel).

1.3.6.2. *Second generation*

– GSM (global system for mobile communication)

In Europe, this standard uses 900 and 1,800 MHz frequency bands. Conversely, in the United States, the frequency band used is 1,900 MHz. Together this is called tri-band–mobile phones work in Europe and the United States. It will transfer voices as well as low volumes of digital data, for example text messages called short message service (SMS) or multimedia messages called multimedia message service (MMS).

The operator must install fixed antennae; all antennas define a coverage area unique to the operator.

The GSM network's main role is to allow communication between mobile subscribers and subscribers of the public switched telephone network (PSTN). The GSM network interfaces with the PSTN network and consists of switches. Installing a GSM network will allow operators to suggest "voice" services to their customers by providing mobility access while maintaining an interface with the existing fixed PSTN network.

– Architecture of the GSM network

In a GSM network, the user's handset is called a mobile station. A mobile station has a subscriber identity module (SIM) card, allowing the user to be uniquely identified from a mobile terminal, that is the user's apparatus (the majority of the time a mobile phone).

Terminals (handsets) are identified by a unique 15-digit identification number, an international mobile equipment identity (IMEI). Each SIM card also possesses a

unique (and secret) identification number called international mobile subscriber identity (IMSI). This code can be protected by a password composed of four numbers called a personal identification number (PIN) code.

The SIM card lets each user be identified, independently of the terminal used, during communication with a BS. The communication between a mobile station and a BS is done using a radio link as an intermediary, generally referred to as an air interface (or more rarely the Um interface).

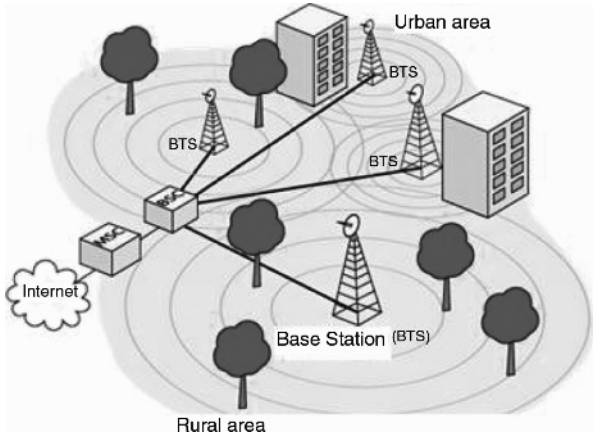

Figure 1.9. *Architecture of the GSM network*

All BSs belonging to a cellular network are connected to a station controller, in charge of managing the distribution of resources.

The group constituted by the station controller and the connected BSs constitute the radio subsystem (BSS–base station subsystem).

Finally, the station controllers are physically linked to the mobile service's communication, mobile switching center (MSC), managed by the telephone operator, which links them to the public telephone network and the Internet. The MSC belongs to a group called the network station subsystem (NSS), in charge of managing user identities, their localization and establishing communication with other subscribers.

For the transmission of data, a wireless application protocol (WAP) has been installed to allow convergence between mobiles and the Internet, but GSM offers only a low bit rate (9.6 Kbps). It is sufficient for voice but insufficient for data transfer.

– GPRS (2.5G)

GPRS can be considered as a development of GSM networks, before they passed to the third generation system.

However, the transition from GSM to GPRS requires more than a simple software modification. GPRS is inspired by the common uses of the Internet: when visiting webpages, a session can last for tens of minutes whereas data require only a few seconds to be transmitted, when downloading pages.

Currently, voices transmit through the GSM network, whereas data circulate through GPRS, whose bit rate is five times as fast as that of GSM. It integrates QoS.

– EDGE (2.75G)

Enhanced data rates for GSM evolution (EDGE) is a transition network between GPRS and UMTS. It allows an even higher bit rate.

EDGE results from the observation that, in a cellular system, not all mobiles deploy the same quality of transmission. The power control tries to compensate for these inequalities by giving favored mobiles a less powerful transmission. This saves the battery life of terminals rather than increase the speed of transmission. EDGE allows these favored users to benefit from more effective transmissions, consequently increasing the average traffic in this cell.

EDGE is even more interesting when associated with GPRS, especially because of the principle of adapting the connection. Adapting the connection involves choosing the modulation scheme and the best coding of radio conditions for mobiles using it.

1.3.6.3. *Third generation*

3G networks are very flexible when it comes to introducing new services. Bit rates are higher and they can reach 2 Mbps.

– Universal mobile telecommunication system (UMTS)

UMTS offers wireless communication services, multimedia as well as voice and data services (possibility of a video conference, or of watching television). The cost is very high.

1.3.6.4. *Fourth generation*

The increase in the number of mobile users due to the development of the Internet and its multimedia applications, the rapid emergence of wireless networks and the development of transferability of terminals has facilitated user mobility.

Mobile users have increasing needs to be able to access a rich ensemble of multimedia services, by using any available terminal, with a good QoS using any available network. Increasingly high data rates are used. 4G networks use OFDM and OFDMA. These networks are considered to be reliable, especially WLAN and WiMAX.

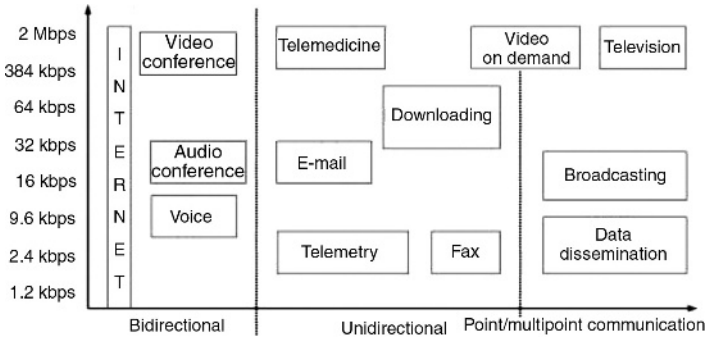

Figure 1.10. *Services offered by the 3G system*

1.4. WiMAX mobile and 4G

The 4G mobile user has several wireless technologies at his/her disposal. The user wants to be connected to the best network, regardless of where, when and which network. Because of this, different wireless technologies must co-exist so that the best technology can be retained depending on the user's profile and the type of application or service he/she wants. In this context, the mobile terminal should always search for the best accessible network to meet the needs of the user.

For the fourth generation of mobile networks, several possible scenarios have been identified. Their points in common are shown below:

– new input/output equipment will be available for the rapid exchange of data,

– new semiconductor industry (4G terminals will be available to all),

– access to 4G mobile networks will be less expensive,

– the number of users will reach a new high,

– there will be a lot of competition between applications and service providers to satisfy users,

– the quality of wired or wireless Internet access will be more or less the same,

– multimedia applications will be used on a wide scale,

– mobile networks will be stable, reliable and available all the time,

– interconnection between different systems (GPS, Internet, other communication networks) must be easy.

To meet the different needs of users, the fourth generation of mobiles must meet the following technical conditions:

– the majority of people can access voice or databases of services that are provided by mobile providers (it demands effective management of resources, for example using an *ad hoc* extension in wireless systems);

– the mobile network may be completely secured to the Internet because of its underlying concept (in this way, the IP technology will be used by the mobile network, voice over Internet protocol (VoIP));

– the limits of availability of communication in the network must converge toward 100%;

– a universal interface for hardware and software could be normalized, which should facilitate the development of new services without any problems.

It is because of the use of a new method of modulation, which is OFDMA, with a new system of multiple antennae, MIMO, that WiMAX mobile is expected to meet the needs of mobile users.

WiMAX mobile can hope to compete with UMTS and be the technology of the future fourth generation, which still has not been completely defined. WiMAX mobile networks should, in 2012, represent 25% of mobile communication equipment in terrestrial environments.

1.5. Conclusion

We have presented the principle of the mobility of networks, their applications, the difference between wireless networks and mobile networks, and the evolution of each type of network since their emergence.

The support for mobility of networks paves the way for developing the idea of an omnipresent Internet, at any moment, in any place, for everyone. Multimedia applications will be the first to benefit from this type of environment.

Wireless networks are generally interesting networks highly used in diverse fields such as industry, health and in the military domain. This diversity in usage highlights the different advantages of these technologies, such as mobility, ease of installation (no cables) and availability (commercial as well as in experiments).

However, the issue of security in this field is still a delicate subject; since this type of network began to be used, several flaws have been detected.

Wireless networks have experienced significant development in the last 10 years, giving users the impression that their qualities could be equivalent to wired networks. People have become accustomed to mobility. However, it is equally clear that one technological solution, whatever it may be, will not be able to handle all utilization of its contents.

New generations of networks must quickly produce exploitable solutions, offering compatibility between different networks, so that users can transparently switch from one system to another.