1. INTRODUCTION

More and more electrical engineers throughout the world are dealing with telecommunication technology. In this introductory chapter we discuss the basic terms of telecommunication and its significance for the human society. Main events of the telecommunication history will also be reviewed. The following part deals with the role of telecommunication and its location within the studies of electrical engineering. Finally, the structure of the book is presented.

1.1. Basic Terms

The term telecommunication denotes the entirety of technical solutions developed for the transmission of the information between arbitrary two points, to any distance. Distortions and errors caused by the transmission have to be kept low at levels within reasonable expenses. To understand this general definition better, let us complete it by some remarks:

- Communication is a transactional process of sharing meaning. People had communicated with each other even before telecommunication existed. Telecommunication however significantly contributes to cover their needs.
- There are several kinds of information to be transmitted, such as speech, music, text, picture, data etc.
- Essentially, telecommunication utilizes electromagnetic phenomena. One of the fundamental problems of telecommunication is to maintain the information fidelity despite of the unavoidable interfering effects.
- Telecommunication is a service. The user expects a constant service at any circumstances. The reliability of telecommunication is of great importance.
- Interconnection of two users for the time of transmission is the task of switching technique. Transmission of information between two users is the task of the transmission technique. Public exchange network is a typical example for the first task while the second task is solved by the wirebound telecommunication.
- The telecommunication engineer has to consider economical aspects, as well. Taking into consideration the restrictive conditions, he has to find the balance between cost and quality.

Telecommunication services can be classified by several points of view, such as:

- kind of the information to be transmitted,
- number of users, taking part in the communication,
- role (possibilities) of the users, i.e. whether the communication is unidirectional, bidirectional (dialogue) or multidirectional (conference).

If there are more than two participants using the same telecommunication service then the units interconnecting them form a network. In the case of broadcasting, the information is unidirectional transmitted from one source to several sinks. In the case of data collection, the information is sent from several sources to one common sink.

Communication link between the users is said to be switched if it is set up just for the time interval required by the users. In such a case the network contains switching units (telephone exchange) as well. To make the telecommunication network more efficient, the transmission paths and the switching networks are allocated for multiple use. The channel allocation techniques challenge further fundamental problems in telecommunication technology. To give an economically reasonable solution for satisfying the users' demands, problems of collision and queuing have to be examined.

The above classification of telecommunication services is listed in detail in Table 1.1. There is one more important factor: whether the communication is taking place between fixed or between mobile points. Recently, the mobile telecommunication is coming into the limelight.

Table 1.1. Example of some Telecommunication services

Kind of Information	Direction of Communication[1]				Type of Network[2]				Service
	UD	BD	MD	BC	DA	PP	SW	DS	
Speech		+					+	+	Telephone
			+				+	+	Remote conference
	+						+	+	Exact time
	+			+					Radio
Music	+			+					Radio
	+			+					Cable radio
Text	+					+	(+)	(+)	Telegram
		+	(+)				+	+	Telex, E-mail
Stationary picture		+					+	+	Fax
Moving picture	+			+					TV
Data	+				+				Remote measurement
	+				+				Remote supervision
	+					+			Remote control
			+				+	+	Computer Network

Note 1: UD: unidirectional link, BD: bidirectional link, MD: multidirectional link.
Note 2: BC: broadcasting, DA: data acquisition; PP: point to point communication, SW: switched link, DS: distributed network.

1.2. Social Significance of Telecommunication

The participants of the telecommunication services can be classified as follows:

- users (participants, subscribers, consumers), employing the services but knowing nothing about the technical details,
- servicing staff, satisfying the user demands by planning, building and operating the network,

- manufacturers, developing, manufacturing and selling the equipment needed for the service,
- authority, regulating the technical and economical conditions of the telecommunication service.

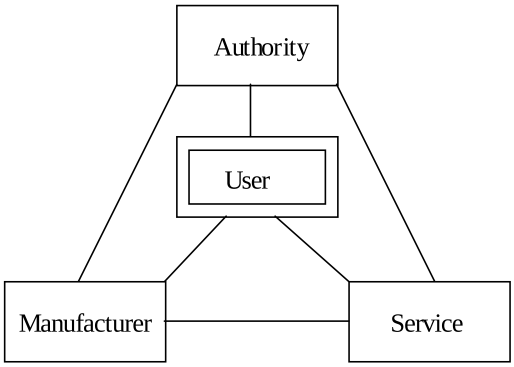

Figure 1.1. Participants of the Telecommunications

As it is shown in Fig. 1.1., it is the user who is in the focus of the telecommunication services. In Table 1.2., domestic telephone and television service is characterized by the number of telephone trunk lines and TV subscriptions, per 100 inhabitants. Although these parameters do not completely show the quality of the service but they are important data which characterize the state of the art and the trend of these services. The number of TV subscribers out of 100 inhabitants can be qualified as good, however the number of trunk lines per 100 inhabitants is enormously low.

Table 1.2. Telephone and TV Services in Hungary

	1970	1980	1990	1992
Number of telephone trunk lines (per 100 inhabitants)	3.86	5.76	8.76	11.3
Number of TV subscribers (per 100 inhabitants)	17.1	25.8	27.9	

The consequence of this deficiency is illustrated in Fig. 1.2. where the relation between the GDP and the number of trunk lines is shown. It turns out from the figure that there is a strong correlation between the GDP and the number of trunk lines normalized to the unity of population.

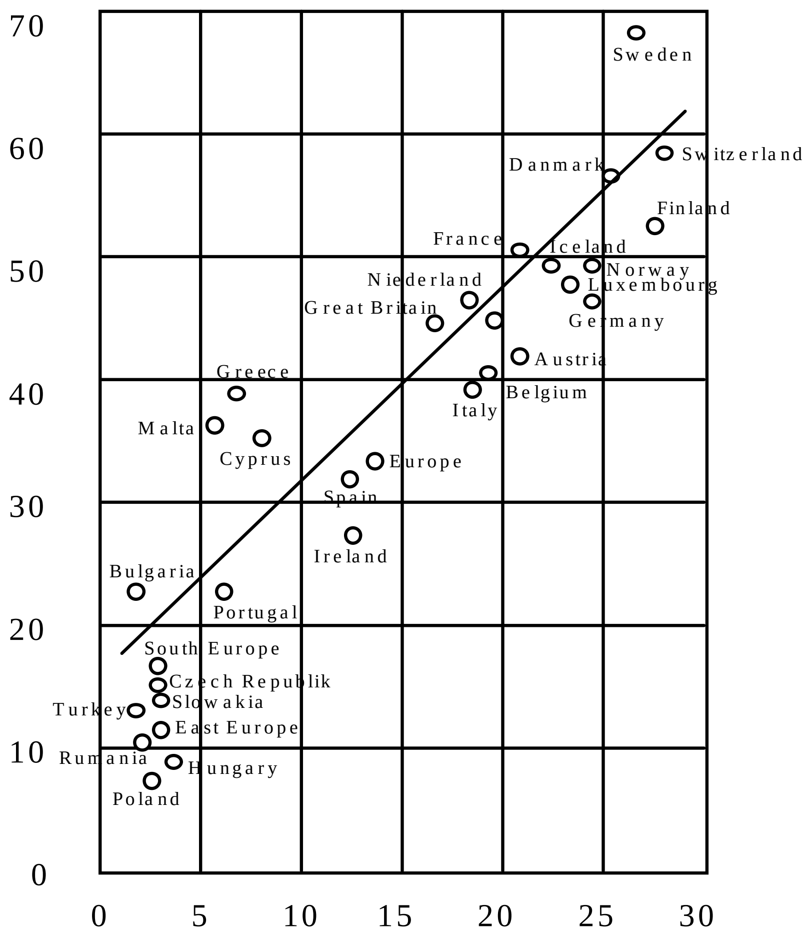

Figure 1.2. Relation Between the GDP and the Number of Telephone Lines

Since there are several other characteristics related to the GDP, it reflects the general state of development in the country. As it also turns out of the figure, the data of the East European countries are significantly under the regressive line.

It is interesting to estimate how much investment would be needed to increase the domestic trunk line density to 40 percent. In 1992, there were 1.2 million trunk lines in Hungary. Since there are 10.6 million inhabitants in Hungary, 4.24 million trunk lines would be needed on the whole for achieving the 40 percent density, i.e. 3.04 million new trunk lines should be installed. Taking $1.000 as the unity price of one trunk line, the investment would require about 3 billion dollars.

Further mapping of the social significance of telecommunication is left to the Reader. As a directive, let us point to the military demands, the applications in traffic, in catastrophe prevention, in technological telecommunication (e.g. electrical energy system), etc.

1.3. History of Telecommunication

The start of information transmission by means of an electrical device can be dated back to 1837, when the telegraph was invented by Morse. Morse encoded the letters of the alphabet in simple codes and can thus be considered the forerunner of the information and coding theory. Bell's invention of speech transmission (1876) initiated the development of the telephone. The start and progress in radio transmission can be connected with Marconi's activity (about 1900).

The progress was crucially influenced by the invention of electrical signal amplification, first by vacuum tube (1907) and later by semiconductors (1948). Semiconductor technology was significantly extended by the development of microelectronics and photonics. Since the first computer appeared, the computer and the telecommunication techniques support each other's development. As an important consequence of this support communication software has appeared, and its influence is still growing. Recently speech, picture and data transmissions are undergoing a revolutionary change into one integrated service.

The following three tables are characteristic for the development of telecommunication. Table 1.3., published by the Newsweek in October 1987, shows five milestones of the progress. Table 1.4. resumes the development of the theoretical background. The dates given here indicates the first release of fundamental papers or patents. Results presented there were further developed by several authors thus creating series of significant disciplines. Famous Hungarians, having contributed to this progress are listed in Table 1.5.

Table 1.3. Ten Milestones of the Progress in Telecommunication

Telephone (1876)	A. G. Bell
Radio Waves (1887-1907)	H. Hertz, A. Popov, G. Marconi
Television (1936)	British Broadcasting Corp.
Radio Telephone (1946)	Cellular System (1981)
Computer (1946)	Electronic Numeric Integrator and Computer (ENIAC), University of Pennsylvania
Satellite Transceiver (1962)	Telstar, Bell Laboratories
Microprocessor (1971)	INTEL Corporation
Digital Exchange (1976)	No. 4. ESS, Bell Laboratories
Optical Cable (1977)	Corning Glass Works
Local Area Network (1979)	Ethernet, Xerox-Intel-DEC

Table 1.4. Main Theoretical Fundamentals of the Progress

Network Theory	Ohm 1827, Kirchoff 1847 Heaviside 1900, Bode 1945
Electromagnetic Field Theory	Maxwell 1873
Traffic Theory	Erlang 1917
Signal Transmission and Modulation	Nyquist, Hartley 1920-28 Armstrong (FM) 1936 Reeves (PCM) 1937
Network Synthesis	Foster 1924, Cauer 1926-44 Brune 1931, Darlington 1939
Statistical Communication Theory	Rice, Wiener, Kotelnikov 1944-47
Information Theory and Coding	Shannon, Hamming 1948-50
Signal Processing	Cooley, Tukey 1965

Table 1.5. Outstanding Hungarian Contributions

Puskás Tivadar (1844-1893)	Telephone exchange, telephone courier, 1893
Pollák Antal (1865-1943)	High-speed telegraph, 1898
Virág József (1870-1901)	High-speed telegraph, 1898
Békésy György (1899-1972)	Research of the hearing mechanism, Nobel Price, 1961

Neumann János (1903-1957)	Principles of electronic computers
Bay Zoltán (1900-1992)	Reflection of radar signals from the Moon (1946)
Gábor Dénes (1900-1979)	Invention of holography, Nobel price. 1971
Kozma László (1902-1983)	Design of telephone exchange, Construction of computer, Kossuth price in 1948
Rényi Alfréd (1921-1970)	Information theory, Kossuth price, 1949 and 1954

1.4. Structure of the Book

This book takes aim of college students taking part in courses of electrical engineering education. The structure and content of the book presume preliminary training and preliminary studies with respect to the parallel subjects of the similar aim and prepare the students for the module choice where they will continue their studies in branches focused on special topics. The subject Telecommunication Systems is delivered four hours weekly during a period of 14 weeks. This condition as well as the price of the book limit the structure of the book.

Students of the subject have already a fair knowledge of computer science (digital circuits, programming and information theory) so that the current subject does not include these topics in spite of their importance (convergence of computer and telecommunication technologies, decisive role of communication software, computer networks). The same applies to electronics and microelectronics.

Albeit telecommunication systems are based on microelectronics, circuit implementations are discussed in other subjects. The book builds upon the knowledge of probability theory and there are several joining points to the preceding subject - Networks and Systems.

The book is divided into 20 chapters discussing the fundamental methods and services of telecommunication systems.

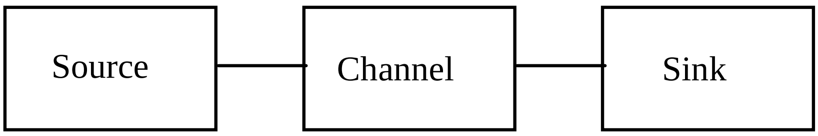

Figure 1.3 The Simplest Model of the Information Transmission

The fundamental task of telecommunication is the transmission of information from the source to the sink so that its model consists of the source, the sink and the transmission channel as it is shown in Fig. 1.3. The channel properties are determined by the transmission medium and by the characteristics of the circuits interfacing the source and the sink to the transmission channel (see Fig. 1.4.).

Figure 1.4. Model of the Information Transmission

Properties and mathematical description of the information sources and sinks are given in chapters 2., 3. and 4. Chapters 2. presents the general mathematical apparatus for signal description, Chapter 3. gives insight to the properties of sound and Chapter 4. to that of the image. Chapter 5. discusses the signal conversion from analog to digital and vice versa. General properties of the analog and digital channels and a short introduction to the information theory are described in chapter 6. Chapter 7. is devoted to the coding theory. Chapters 8. and 9. present the wire-bound and wireless transmission media, Chapter 10. deals with the noise. Source to channel interfacing techniques discussed in Chapters 11. and 12. consider analog and digital modulation procedures as well as the signal encoding and decoding techniques.

Chapter 13. opens the second part of the book which deals with telecommunication networks and services. As one of the basic procedures, channel multiplexing is treated in Chapter 13. One of the most widely-spread services is the public telephone network described in Chapter 14. This topic leads to the mass servicing theory and to the traffic theory which is described in Chapter 15. As an important implementation of these theories, mobile telecommunication is described in Chapter 17.

Chapter 16 discusses the terrestrial and satellite microwave transmission systems. Integrated service telecommunication networks are presented in Chapter 18. Chapters 19. and 20. deal with the questions of audio and video broadcasting.

The chapter sequence is ruled by the logical order given above. The chapters, however, are self-explanatory sections which can also be studied independently.

References

[1] P.G. Fontolliet: Telecommunication Systems. Artech House, Dedham. MA, 1986.
[2] A.B. Carlson: Communication Systems. McGraw-Hill, New York, 1986.
[3] A Nobel-díjasok kislexikona. Gondolat Kiadó, Budapest, 1974.
[4] Magyar Életrajzi Lexikon. Akadémiai Kiadó, Budapest, 1982.
[5] Magyar Statisztikai Zsebkönyv, 1989. Statisztikai Kiadó, Budapest, 1990.
[6] Magyarok a természettudomány és technika történetében. OMIKK, Budapest, 1992.