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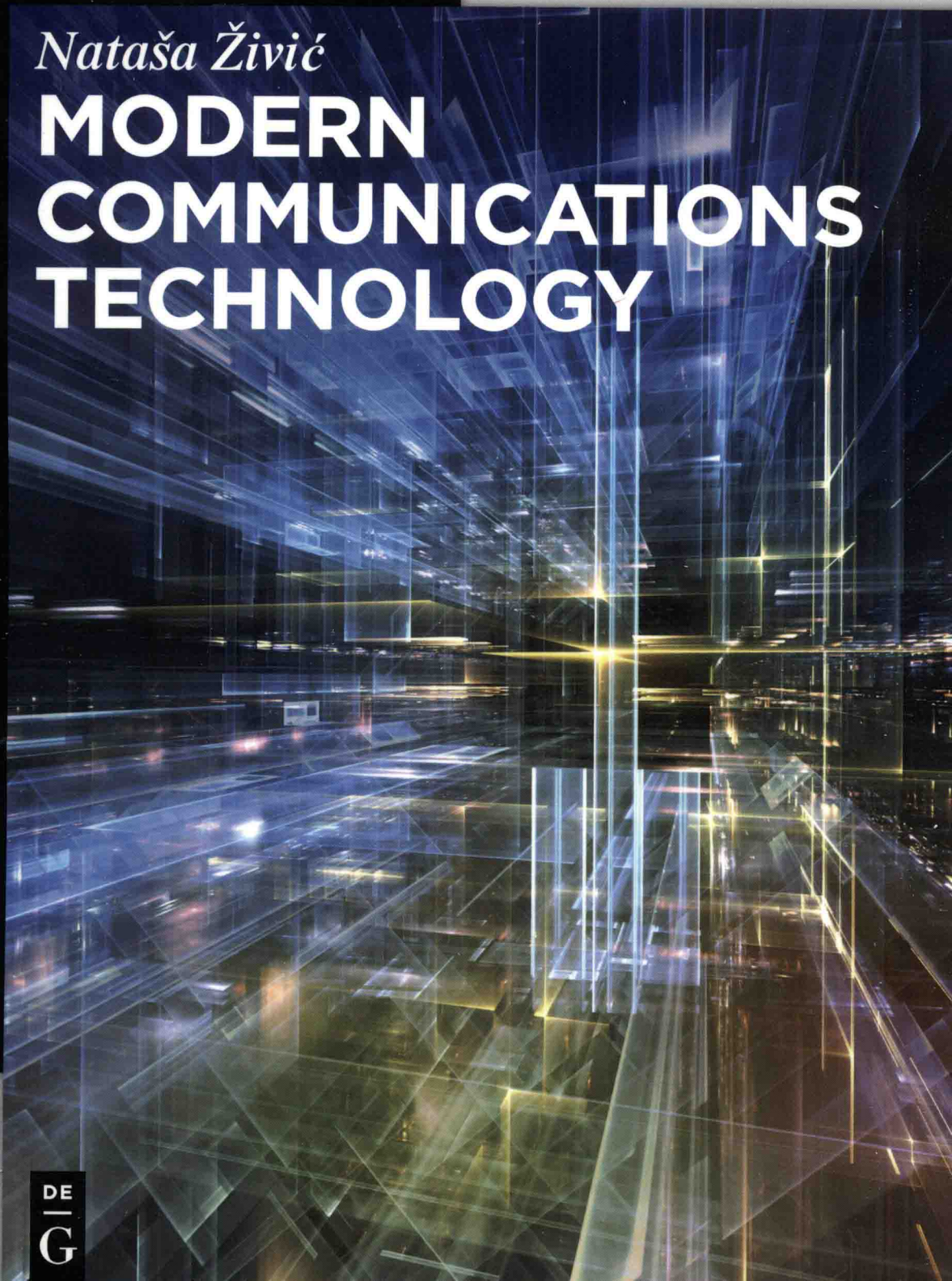

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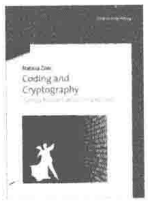

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The author
Siegen, June 2016

Foreword

This book is written using a decade-long experience in teaching "Fundamentals of Communications" and "Digital Communications Technology" at the University of Siegen, Germany. Thus, one part of the material is based on the scripts used for these lectures, as well as on the scripts for "Cryptographic methods and applications". Another part of the presented material is based on the author's working experience, which introduces a contribution to the book needed for engineering practice. Finally, several parts of the presented material are a result of work in the research field.

There are numerous books about communications technologies providing a basic knowledge for students and engineers. These books cover more or less the topics which cannot be substituted in learning communications technologies. Having that in mind, this book is written in a way that these essential topics are also present, but not with too many details which can be found in already existing literature. For example, topics on modulation, line coding and transmission channel are placed in one chapter, instead of three separate chapters, which is a common practice in most of literature. Similarly, information theory and source and channel coding are also merged into one chapter.

Instead, several topics which are not emphasized in most of the general books about communications technologies find more place and a greater emphasis in this book, as they are important for the state-of-the-art and possibly future development of communications. Therefore, one chapter is devoted only to the transmission over the wireless channel as wireless communications are dominating nowadays; another chapter is dedicated to wired transmission with accent to modern digital technologies and optical transmission, and a separate chapter addresses cryptography, which is inescapable in today's communication systems.

It is never easy to find the optimal amount of content and to introduce the needed background of mathematics and physics necessary for understandable and sufficient explanation of different topics, terms and concepts. This task is even more difficult when the technology from the past has to be jointly explained with the modern one, especially considering the fast progress and merging of communications technologies. It is up to the reader to estimate how far the book succeeded in the trial to put the basic knowledge together with the modern trends.

The author
Siegen, June 2016

Contents

1 Signals and Systems

1.1 Communication System

Signals are electrical equivalents of data to be transmitted through a communication system. A complete communication system consists of two stations, each equipped with a transmitter and a receiver, or combined into a single device called transceiver (Fig. 1.1). The medium of signal transmission can be wired (see Chapter 7) or wireless (see Chapter 8).

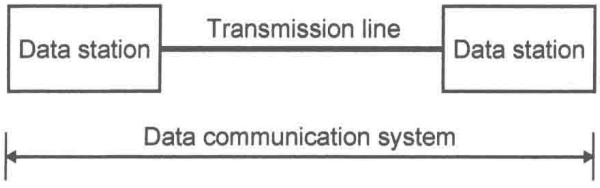

Fig. 1.1: Elements of communication system.

A data station consists of a Data Terminal Equipment (DTE) and a Data Circuit Terminating Equipment (DCE). DTE converts user data into signals or reconverts received signals into user data. DCE is intermediate equipment between DTE and a data transmission circuit (Fig. 1.2).

The boundary between DTE and DCE is called interface and is defined according to the properties of transmission lines and exchanged signals between DTE and DCE. Intermediate devices (e.g. error control device, synchronization devices etc.) can be added into interfaces. Generally, an interface is also a boundary for performance and achievement of a network provider, his ownership and responsibility. Interfaces are internationally standardized, e.g. by ITU-T:

- V: Data Communication over the telephone network (e.g. V.24/V.28, V.10, V.11)
- X: Data networks, open system communications and security (e.g. X.20, X.21, X.25, X.26, X.27)
- I: Integrated Services Digital Network (ISDN)
- G: Transmission systems in media, digital systems and networks
- H: Audiovisual and multimedia systems
- T: Terminals for telematic services
- Z: Languages and general software aspects for telecommunication systems
- etc.

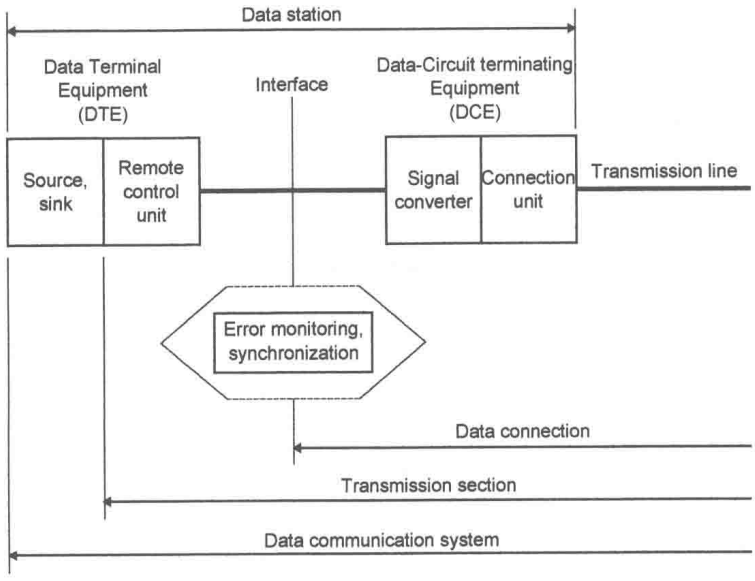

Fig. 1.2: Elements of data station.

A DTE is a functional unit serving as a data source or a data sink and providing control function for data communication accordingly to the link protocol. A DTE can be a user himself or a device interacting with user, e.g. through a human-machine interface. DTE consists of:

- Data source or data sink in a form of data producers (input devices), data processing devices and data consumers (output devices).
- Controller with data preparation device, parallel-serial converter and serial-parallel converter, error control device, address recognizer end device, synchronizer device, sending or receiving part, management and data transmission control.

Examples of DTEs are terminals, memories, keyboards, printers, data concentrators and computers.

A DCE (also called Data Communication Equipment and Data Carrier Equipment) performs functions such as: line clocking, conversion of signals from DTE in corresponding form for transmission (line coding and modulation, see Chapter 5) and, the opposite, conversion of transmitted signals into a form understandable for DTE (line decoding and demodulation, see Chapter 5). A DCE can be realized as:

- Modem (modulator/demodulator) for broadband transmission
- Data connection device for leased lines
- Data remote control device for data lines
- Network Terminator (NT) for ISDN and xDSL (see Chapter 7)