Preface

Technological developments are results of collaborations between scientists, but the collaboration itself is based on nothing but communication; experts are sharing their ideas about new ways of theorizing, defining, developing, and finally realizing products – either hardware or software – that may have a huge impact on our everyday life. It is interesting to note that communication tools like voice transmission, e-mail, and certain Web services themselves can also be products assisting in developing a complete bunch of new communication solutions. This is exactly what happened in the Conseil Européenne pour la Recherche Nucléaire (CERN) institute back in 1992, where scientists working hard on processing data coming from various measurement systems aimed to create a sort of network, in which the data could be forwarded and evaluated faster. They also needed a standardized frame, in which information could be stored in a somewhat uniformly determined way, to synchronize various types and versions of the collected data. The name, which was given to the final product of this development, is the World Wide Web – a merger of networks and databases heavily used today.

There are different approaches to describe what communication is and the way it is built up. However, it is evident that either human or computer communication must follow certain rules, which must adequately define the ways information is sent, processed, and received. For example, if we are unaware of saying a sentence in the right way, principally to keep the proper grammatical order of the words spoken, we will find that understanding us (the sender) will be quite problematic for the receiver. What is more, if we do not speak the language of the receiver at all, the communication will most likely be impossible. The very same thing happens if computers in a network cannot "speak" a common "language".

Our book, titled *Advanced Communication Protocol Technologies: Solutions, Methods and Applications* is about the rules of computer communication: the protocols. Simply speaking, the protocols ensure that information can be understood and processed by the computers in a network.

This book is composed of four sections. The first section deals with the fundamentals of protocol functions and protocol operations. The second section introduces the controlling protocols of ISDN and mobile networks. The third and largest section discusses the evolution of IP-based protocols, and shows advanced solutions for routing, mobility, and multimedia transmission. Finally, in the fourth section, special application fields are presented.

Section 1: Basics of Communication Protocols consists of four chapters. Chapter 1, "*Communication Protocols: An Introductory Overview*," by Katalin Tarnay, University of Pannonia (Hungary); and Gusztáv Adamis, Budapest University of Technology and Economics (Hungary), gives an overview of protocol history starting with the very first usage of an optical telegraph system installed during the Napoleonic wars in Europe. It continues with the creation of ARPANET and the most frequently used Internet protocols. Then it introduces the reader to the protocol theory with the help of the INRES protocol, which is used for demonstration purposes. The main quantitative and qualitative protocol features, as well as the steps of the protocol engineering are presented. At the end of the chapter, the authors give

some important guidelines for protocol classification. Chapter 2, "*Protocol Operation,*" by Gábor Árpád Németh, Budapest University of Technology and Economics (Hungary), gives a fundamental survey of communication protocol operations. The concept of layering is introduced along with the definitions of communication primitives, Protocol Data Units (PDU) and Service Data Units (SDU), data encapsulation, and service access points. Chapter 3, "*Protocol Functions,*" by Tibor Dulai, University of Pannonia (Hungary), presents the basic and advanced protocol functions to the reader. Therefore, the author highlights the Protocol Data Unit (PDU) creation, error handling, medium access, flow control, and congestion control. PDU deliveries based on addressing and routing are discussed. Chapter 4, "*Notations for Test Specification: TTCN3 and ASN.1,*" by Szilárd Jaskó and Dániel Muhi, University of Pannonia (Hungary), provides a simple, understandable approach to protocol testing. First, testing of protocols in the field of telecommunication is discussed. Then notations used in the test specification, namely the Test and Test Control Notation (TTCN3) and the Abstract Syntax Notation One (ASN.1) are introduced.

Section 2: Telecommunications Protocols consists of three chapters. This section gives an overview about the most frequently used protocols both of the ISDN and of the mobile networks. Chapter 5, "*Signaling Protocols of Integrated Services Digital Networks,*" by Gusztáv Adamis, Budapest University of Technology and Economics (Hungary) introduces the most important protocols used to control ISDN networks. First, the DSS1, the ISDN access protocol is discussed. This part of the chapter describes the message structure in detail as well as it shows how the messages are used for call establishment and release. The second part of Chapter 5 discusses the SS7, the core network protocol of the ISDN. Apart from the introduction to the architectural concept, a detailed description about the MTP and ISUP protocols can be found here. Chapter 6, "*Mobile Network Protocols of GSM and GPRS,*" by Gusztáv Adamis, Budapest University of Technology and Economics (Hungary) and Chapter 7, "*UMTS: 3rd Generation Cellular Mobile Radio System,*" by Péter Fazekas, Budapest University of Technology and Economics (Hungary) deal with the protocols used in the mobile networks. Chapter 6 provides an overview about the architecture of the GSM and GPRS networks, and discusses the protocols used in the core network in detail. The chapter focuses on SCCP, TCAP, MAP, BSSAP, and GTP protocols. To help to understand how these protocols are used, several typical scenarios, like call establishment, SMS transmission, and data transfer are presented as examples. Chapter 7 discusses the protocols used in the UMTS networks. After an overview about the UMTS architecture and the basics of the radio transmission, the chapter provides a detailed summary of the protocols used at various interfaces of the network: between the core network and the UTRAN, between the radio network controllers and the Node Bs, and at the radio interface.

Section 3: IP-Based Protocols consists of thirteen chapters. Chapter 8, "*IPv4 / IPv6 Coexistence and Transition: Concepts, Mechanisms and Trends,*" by László Bokor and Gábor Jeney, Budapest University of Technology and Economics (Hungary), presents the methods how IPv4 and IPv6 can exist and work together. After introducing IPv6, the chapter deals with the transition methods from IPv4 to IPv6 like Dual Stack, and the several methods of Tunneling or Encapsulation and Translation. Chapter 9, "*Network Mobility,*" by Arijit Ukil, Tata Consultancy Services (India), shows Network Mobility (NEMO), which is a Mobile IP extension for supporting movement of a complete network. The chapters describes the evolution from Mobile IP and Mobile IPv6 to NEMO and presents NEMO basic support protocol next to the architecture, QoS, route optimization, multihoming possibility, mobility management, security, and application of NEMO. Chapter 10, "*Protocols in Next Generation Networks,*" by Róbert Horváth, Gábor Kovács, Budapest University of Technology and Economics (Hungary) and Zoltán Pap, Ericsson (Hungary), defines Next Generation Networks (NGN) and presents its main protocols and services related to fixed access. The protocols covered in this chapter are NGN's core network protocols, regional network and aggregation network protocols, especially Ethernet, along with service access and provi-

sioning protocols. Chapter 11, "*Convergence of Fixed and Mobile Networks*," by Gábor Kovács, Gábor Árpád Németh, Budapest University of Technology and Economics (Hungary) and Zoltán Pap, Ericsson (Hungary), examines a trend in telecommunication: the fixed and mobile convergence (FMC). The chapter deals with the impact of FMC on the Next Generation Network architecture, the network and application layer mobility management solution, policy control, routing, AAA, and other security issues of FMC. Finally, it introduces long-term evolution of mobile telecommunications. Chapter 12, "*Host Identity Protocol: The Enabler of Advanced Mobility Management Schemes*," by László Bokor, Szabolcs Nováczki, and Sándor Imre, Budapest University of Technology and Economics (Hungary), introduces Host Identity Protocol (HIP), which is a promising protocol for separating the identification and location role of IP addresses. The chapter compares HIP with other protocols of the same purpose, and then shows several mobility management, privacy, and application solutions of HIP. Chapter 13, "*Overview of IP Multimedia Subsystem Protocols and Communication Services*," by Sándor Szabó, László Gyöngyösi, Károly Lendvai, and Sándor Imre, Budapest University of Technology and Economics (Hungary), shows an advanced subsystem which is relevant in Next Generation Networks and suits well to the convergence of fixed and mobile convergence: the IP Multimedia Subsystem (IMS). The chapter deals with the architecture, the main protocols (like SIP, SDP, RTO, RTCP, DIAMETER and MEGACO), and the most important services of IMS (like Presence Service, Instant Messaging and Circuit-Switched Combination Service). Chapter 14, "*The TFRC Protocol and Its Usage for Wireless Video Transmission*," by Christos Bouras, Vassilis Papapanagiotou, Giannis Zaoudis, Research Academic Computer Technology Institute, University of Patras (Greece); Kostas Stamos, Research Academic Computer Technology Institute, University of Patras and Technical Educational Institute of Patras (Greece), introduces TCP-Friendly Rate Control (TFRC) protocol. The chapter analyzes the effect of cross-layer management on wireless video transmission via TFRC. Results presented are related to the power consumption and transmission quality. Chapter 15, "*Cross-Layer Protocols for Multimedia Communications over Wireless Networks*," by Jaydip Sen, Tata Consultancy Services (India), goes into more details of cross-layer design for wireless multimedia transmission. Beside the transport layer, the data-link and the application layers are considered, and issues like channel estimation techniques, adaptive controls for energy efficiency, adaptive ARQ, transmission rate control, and priority based scheduling are investigated. Chapter 16, "*Session Management and Transport Protocols for Multimedia Services over IP Networks*," by László Lois and Ákos Sebestyén, Budapest University of Technology and Economics (Hungary), introduces application layer level protocols in the TCP/IP model, which care with session management and transport tasks of multimedia transmission. Especially the Real-time Transport Protocol (RTP), the RTP Control Protocol (RTCP), and the Real-time Streaming Protocol (RTSP) are highlighted. Their functions are introduced through a complex real-life application: IPTV. Chapter 17, "*A Solution for Evaluating QoS of Voice over IP: Measurements, Analysis and Modeling*," by Homero Toral-Cruz, Deni Torres-Román, and Leopoldo Estrada-Vargas, Center of Research and Advanced Studies (Mexico), presents a new model for VoIP QoS evaluation. After introducing the mathematical background of QoS concepts and IP traffic nature, jitter and packet loss behavior of VoIP is analyzed. Finally, the chapter proposes a model, which could be used well by other researchers of the topic. Chapter 18, "*SCTP: Solution for Transport Layer Mobility and Multihoming*," by Árpád Huszák and Sándor Imre, Budapest University of Technology and Economics (Hungary), introduces the Stream Control Transmission Protocol (SCTP) as a transport layer protocol, which is able to handle mobility management issues. In the chapter, SCTP's multihoming and multistreaming performances are analyzed using a native IPv6 UMTS-WLAN test environment. Regarding to SCTP's role, results can be used in future LTE-EPS architectures, as well. Chapter 19, "*IPv6 Routing in a Special Context: Serving Efficient Data Aggregation*," by Zoltán Kanizsai and Gábor Jeney, Budapest

University of Technology and Economics (Hungary), deals with IPv6 from routing aspects. Readers of this chapter can get familiar with the main unicast, multicast, and anycast IPv6 protocols. Finally, the authors introduce their ideas for aggregating measurement and multimedia feedbacks using the anycast routing protocols of IPv6. Chapter 20, "*Multiprotocol Label Switching Virtual Private Networks: Problems, Protocols, Possibilities*" by Jan Schankin and Eduardo Correira, Christchurch Polytechnic Institute of Technology (New Zealand), presents the basics of Multiprotocol Label Switching (MPLS) and its application in creating layer3 VPN over a shared physical channel (MPLS L3 VPN). After showing the protocols of this solution, the chapter summarizes its problems and possibilities. Finally, it describes the possible role of MPLS in the IP network of the future.

Section 4: Protocol Applications and Technologies consists of three chapters. Chapter 21, "*Time Synchronization in Wireless Sensor Networks*," by Gyula Simon and Gergely Vakulya, University of Pannonia (Hungary), familiarizes the reader with time synchronization services often required to support coordinated operation of the nodes in sensor networking applications, potentially containing hundreds or thousands of elements. The authors introduce various time synchronization models and emphasize the potential accuracy of the synchronization mechanisms that use these models. Chapter 22, "*Application-Driven Routing in Wireless Sensor Networks*," by Gyula Simon, University of Pannonia (Hungary), presents the sensor networks built from tiny, resource limited nodes, which are able to communicate with each other, providing distributed services. The chapter describes routing algorithms, important middleware services in sensor networks and the performance of the application, which is greatly affected by the quality of the utilized routing protocol. Chapter 23, "*Radio Frequency Identification*," by Róbert Schulcz and Gábor Varga, Budapest University of Technology and Economics (Hungary), discusses the history of Radio Frequency Identification (RFID) systems. In this chapter, the necessary components are listed, and systems are classified based on several parameters, in order to support planning and deployment of RFID systems.

We recommend *Advanced Communication Protocol Technologies: Solution, Methods and Applications* for experts, researchers, professors, and students working, teaching, and studying in the fields of telecommunications and Internet. We believe our book can be useful for those who have practical experiences to learn the theoretical background of communication, for those who are already familiar with the protocol theory to get an overview about various application areas, and this book can also serve as a textbook at universities.

Because we think the members of our target audience have different educational background and different practical experiences, we wanted to present some terms and certain protocols from different points of view, which is why the reader will find that some notions and applications are discussed in several chapters but in different context and approach.

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