NEXT GENERATION TELECOMMUNICATIONS NETWORKS, SERVICES, AND MANAGEMENT

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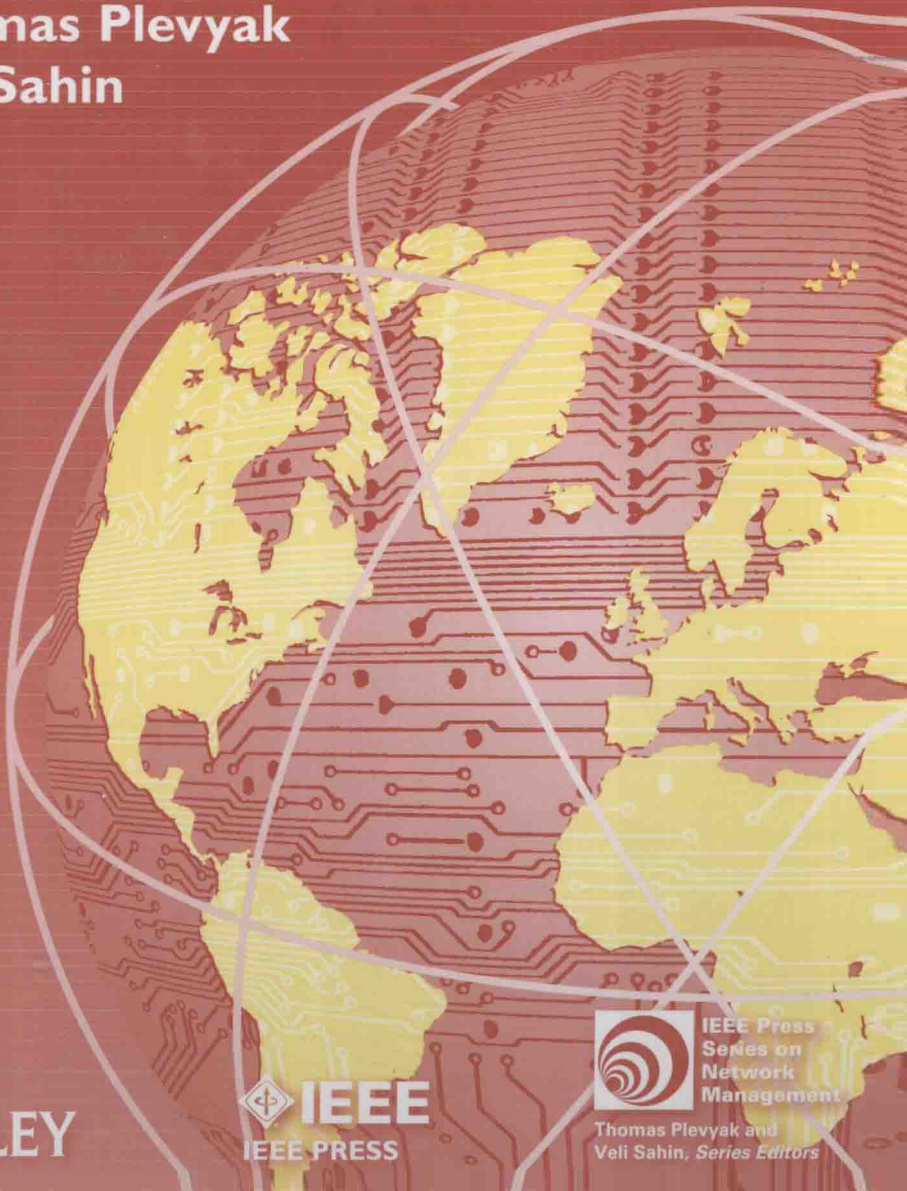

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The Cornerstone of Successful Societies

GUEST INTRODUCTION

Rapid progress in information and communications technology (ICT) induces improved and new telecommunications services and contributes greatly to society in general and to vendors and network and service providers. In addition to existing services such as telephony or leased line services, spread of the Internet, the Internet Protocol (IP) phone, and new communications services like IPTV are making great progress with the development of digital subscriber lines (DSL) and high-speed communications technologies like fiber to the home (FTTH). Furthermore, with the deployment of Next Generation Networks (NGNs), development of still newer services is anticipated. Construction of NGNs, in accordance with standards specified by international standardization organizations and feasibility studies and investigations, have begun in Japan and many countries around the world. The amount of information that a user can exchange has been expanding exponentially. Services can be used simultaneously (anywhere, anytime, and any device) and seamlessly with the development of broadband wireless access technology in NGN. Moreover, since service and application functions are separated and transport functions are independent from access technologies such as xDSL, FTTH, WiFi, WiMAX, Third Generation (3G), and Long Term Evolution (LTE), services of fixed and mobile communications are also unified. Furthermore, since the service and application functions consist of several common components, cooperation with third party applications becomes easier, resulting in practical use of various kinds of existing communications services (e.g., IT-based services and broadcasting services). Simultaneously, network reliability and security are also improving with the development of related technologies. In summary, NGN creates a new market by offering new services and rejuvenates markets such as career, enterprise, IT, and broadcasting businesses with new business models.

Maintaining the outstanding aspects of the existing network, NGN aims at larger scale, higher quality, and greater reliability. NGN is considered the biggest turning point in the history of communications. Although the present Internet provides services very conveniently for a user, the design of the Internet as a social infrastructure is inadequate. NGN can apply the technology of the Internet, can realize service level agreements (SLAs) and can provide mission-critical services. Users can choose high-price services for mission critical systems, medium-price services with high security, and low-price services as seen with the existing Internet. Wide-area client/server systems, which have high investment cost, were difficult to realize but will become realizable in NGN with the availability of super-mass storage systems. These allow integrated servers using the high-quality network services offered by NGN. As services spread for individual subscribers using NGN, IPTV, and voice over data, with development of NGN, a higher-definition video can be provided inexpensively.

Software as a Service (SaaS), using NGN will develop for business users. A reliable SaaS solution can be offered with security and SLA features that guarantee quality-of-service to each user of NGN. NGN will be ubiquitous. If information from rain sensors deployed all over a country is transmitted via NGN and processed and analyzed by a server, accurate weather forecasts will become reality. NGN will connect the medical systems of an area. If a doctor and residents can share medical information via the service of "virtual visits" by medical specialists in remote areas then we can offer medical consultation, medical checkup, etc. If a mobile IP network with an access speed of 100 Mbps is available, the distinction between mobile and fixed networks will diminish. NGN applications can be common to mobile networks and fixed networks. The wide area client/server system, which unifies mobile and fixed networks, will be completed by 2012. NEC Corporation has advanced communications and computers (C&C) as a concept, marrying communications and computers. NEC has been working on research and development of the future architectures realizing long-term C&C goals and views NGN as the field that realizes the philosophy of C&C.

This book aims at deepening the understanding of NGNs, services, service management technologies, Operations Support Systems (OSS), cable services, IP Multimedia System (IMS) and convergence services, ad hoc networks, sensor networks, etc. The book provides detailed explanations of latest technology trends. I am pleased and honored to provide the introduction to this book, which will promote your understanding and construction of NGN. I believe that an important benefit of NGN is further fullness to society and personal lives. I also believe that NGN further expands economic activities and can contribute to ecosystems by, for example, measuring climate change and global warming via efficient network deployment and management.

Botaro Hirosaki
Senior Executive Vice President and Board Member, NEC

GUEST INTRODUCTION

To say that we live in the information age is, of course, a cliché, and a 20-year-old cliché, at that. But the fact that it is a cliché doesn't make it any less true. Communications networks developed over the last two decades have profoundly changed how we carry out our everyday lives—how we exchange information, engage in commerce, form relationships, entertain ourselves, protect ourselves, create art, learn, and work. The convergence of communications and computing, long anticipated, is now a fact.

The "modern" communications industry is actually more than 130 years old. For almost all of that history, the industry's goal has been the reliable delivery of a particular kind of analog signal—first speech, then music, then video—over links and networks established for *only that signal.* It is only since the two-pronged emergence of the Internet and mobile telephone networks that we have been able to glimpse the splendid opportunities made possible by multimedia networks operating over a diversity of channels—wireless, wireline, and cable—delivering a wide array of content to an assortment of devices, including PCs, notebooks, TVs, mobile phones, and PDAs.

But as communications networks have become more complex and the services offered over those networks have become more diverse and numerous, the problem of managing networks has become profound. Different types of data mean different requirements in terms of latency, quality-of-service, and security. Different types of communications media mean significantly different operating environments in terms of delay, reliability, and bandwidth efficiency. Fortunately, the Telecommunications Management Network (TMN) model offers system designers a framework for interconnectivity across heterogeneous networks. It is an architecture that enables network management and provides a "handle" to engineers and computer scientists seeking to design products and services that will become part of the information infrastructure.

This book goes beyond the Network Management Layer (NML) of TMN to the Service Management Layer (SML) and business frameworks. As new services and "apps" are rolled out every day—new ways to use your smartphone or your home network that you have not yet envisioned—the challenge of managing those new capabilities, efficiently and securely, and their solutions, are addressed in this book. Its chapters describe some of the latest multimedia services offered by the telecom and cable industries and provide insight into how they are best managed. It looks ahead to IP-based next-generation telecommunications networks, services, and management, as well as ad hoc and sensor networks. This book offers a vision of how pervasive, heterogeneous, and converged multimedia networks will be deployed and managed well into the 21st century.

What role will academia play in this evolutionary (and, sometimes, revolutionary) process? It will be a fundamentally important role. Universities will continue to educate the designers, managers, and implementers of these networks and carry out the long-term, basic research that will help enable the next generation of networks. As teachers, we have the obligation to make sure that graduating electrical and computer engineers and computer scientists understand the fundamental properties of heterogeneous information networks. As researchers, we have the opportunity to use our tools—modeling, analysis, simulation—and our imaginations, to fashion better networks and to manage them more efficiently, securely, and robustly.

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Jean Craveur presently heads the France Telecom Group Transverse Mission and is in charge of preparing the group networks transformation from PSTN to NGN/IMS. He has previously steered, in France Telecom, the IT and Network overall architecture and strategy department and headed the R&D center on core network. He held several responsibilities in international telecommunication organizations: as a member of the International Experts Group, which wrote the first CCITT N°7 signaling specifications; as chairman of the CEPT and ETSI Subtechnical Committee, which issued the roaming architecture and signaling for the GSM system; as chairman of the "Network Group" of the European Cooperation on ISDN; and, finally, as vice chairman of the ETSI Technical Commitee on Signalling Protocol and Switching. He was also one of the vice presidents for Europe in the TINA Consortium. Jean Craveur has published several papers related to signaling and telecommunication networks in telecommunication reviews and presented in the International Switching Symposium (ISS). He graduated from Ecole Nationale Supérieure de l'Aéronautique et de l'Espace (SUP'AERO) and holds a masters in economic science from Université des Sciences Sociales in Toulouse and a diploma in automatic and complex systems from Ecole Nationale Supérieure de l'Aéronautique et de l'Espace.

Michael Fargano has broad telecommunications industry leadership responsibility and is the current Industry Standards Program Manager at Qwest Communications International. His career spans more than 25 years and is grounded in leadership in many successful telecommunications R&D projects, advanced systems architecture and engineering projects, and standards projects such as AIN, TMN, 3G wireless, NGN, emergency services, and security management at several well-known and respected telecommunications companies/departments such as Bell Labs, Bellcore, US WEST Advanced Technologies, and Qwest. In addition, he has been an adjunct instructor at several institutions and universities including Bell Labs, Stevens Tech, University of Denver, and University of Colorado, covering a wide variety of engineering topics including telecommunications network management and standards. He was chairman of several standards committees and is a sought-after leader in standards development, for which he was honored with several industry awards including the ANSI Meritorious Service Award and ATIS Leadership in Standards Development Award. He also holds several patents. He graduated in 1980 from a special simultaneous bachelor/master program in general engineering and electrical engineering at the Stevens Institute of Technology. He also holds an advanced business/technology management graduate certification from the University of Denver–Daniels College of Business, with a specialty in Strategic Program Management.

David Jacobs is chief technical officer in the Amdocs Broadband, Cable & Satellite Division with responsibility for driving Amdocs products strategy for Cable MSOs and Satellite operators who provide next generation services to residential and commercial customers. He joined Amdocs following the acquisition of Jacobs Rimell by Amdocs in April 2008. As co-founder and CTO of Jacobs Rimell, he was responsible for the company's technology and product direction, enabling it to become one of the leading providers of customer-centric fulfillment solutions for the cable industry. Previously, he spent 11 years with Reuters in a number of senior roles, culminating in the deployment of a global frame relay infrastructure and one of the world's first global IP extranets for the delivery of Reuters' information services. He holds a BSc in electrical and electronics engineering from Middlesex Polytechnic, London and a Full Tech City and Guilds Certificate in Telecommunications. He holds two U.S. patents and contributed to a third.

Keizo Kawakami is a project manager in the Network Management Systems Division of the Network Software Operations Unit of NEC. He joined NEC in 1989 and he has been engaged in software development of mobile, satellite, and fixed networks management systems for 15 years. He is now in charge of strategic planning and development of service and management solutions for mobile and fixed operators. He is a principal contact of the TeleManagement Forum (TMF) in NEC.

Kaoru Kenyoshi is a chief manager in the first Carrier Solutions Operations Unit of NEC. He joined NEC in 1984. He has been engaged in software development for ISDN switching systems and B-ISDN for 10 years. From 1995 to 2000, he worked as a manager in the planning division for switching systems and was in charge of strategic planning for services and products of switching systems for the carrier market. From 2000 to 2006, he worked as a general and chief manager in the sales and solution department for fixed and mobile networks. He is now in charge of promotion of NGN and IPTV solutions for fixed and mobile operators. He is very involved in standardization activities and is leader of the IPTV Network Architecture Sub-working Group and member of the Strategy Committee of TTC in Japan and one of the vice chairman of ITU-T SG11.

Bhumip Khasnabish, PhD, is a Senior Member of IEEE and a Distinguished Lecturer of the IEEE Communications Society (ComSoc). He is a Director in the Standards Development and Industry Relations Division of ZTE USA Inc. with responsibility to set direction, goal, and strategy of the Company for Next Generation Voice over IP (VoIP) and peer-to-peer (P2P) multimedia services. Previously, Bhumip was a Distinguished MTS of Verizon Network & Technology in Waltham, MA, USA. He is the founding chair of the recently created ATIS Next Generation Carrier Interconnect (NG-CI) Task Force. Bhumip also founded MSF Services Working Group, and led the world's first IMS-based IPTV Interop during GMI08. At Verizon, he focused on NGN and Carrier Interconnection projects related to delivering enhanced multimedia services. He also represented Verizon in the Standards activities of MSF and ATIS NG-CI. An Electrical Engineering graduate of the University of Waterloo and the University of Windsor (both in Ontario, Canada),

Bhumip previously worked at Bell-Northern Research (BNR) Ltd. in Ottawa, Ontario, Canada. While at BNR he initially designed, implemented, and then led the implementation of trunking and traffic management software modules for BNR's flagship Passport® multi-service switching product. Dr. Khasnabish has authored/co-authored numerous patents, books, chapters, technical reports, Industry Standards contributions, and articles for various international archival journals, magazines, and referenced conference proceedings. His recent book entitled, "*Implementing Voice over IP*" [ISBN: 0-471-21666-6] is currently in its second printing. Previously, he edited/co-edited "*Multimedia Communications Networks: Technologies and Services*" [ISBN-10: 0890069360, ISBN-13: 978-0890069363], and many Special Issues of *IEEE Network*, *IEEE Wireless Communications*, *IEEE Communications Magazines*, and the *Journal of Network and Systems Management (JNSM)*. He is also a member of the Board of Editors of the JNSM, and an adjunct faculty member of Brandeis University, Bentley University, and Northeastern University.

Toshiyuki Misu is a chief manager of the Network Software Operations Unit, NEC Corporation. Since he joined NEC, he has been engaged in software development of digital switching systems, Intelligent Networks, VoIP, IMS/NGN, and Service Delivery Platform. He is now in charge of NGN Service Promotion and Service API Standardization. From 1991 to 1992, he was a visiting researcher of CTR (Center for Telecommunications Research), Columbia University.

Steve Orobec is British Telecom's (BT) lead OSS standards manager and enterprise architect. The focus of his work is in the TM Forum, where he is the leader of the architecture harmonization team. He also leads the BT OSS team in ETSI TISPAN Working Group 8, collaborating with 3GPP to specify IMS/NGN management systems and solutions for integrating them into OSS. He has also represented BT at ITU Study Group 4 meetings. He has worked in all parts of the software lifecycle from validation and test, software development, solution design, and architecture during his 17 years at BT. He reports at director level and co-ordinates his activities to ensure that BT's requirements are represented in the TM Forum and that TM Forum standards are utilized in BT's OSS. He is currently responsible for developing an automated, standards-based OSS management solution that will reduce BT's OSS costs and increase agility. He holds a degree in physics and astrophysics from Leicester University.

Thomas Plevyak is a past president of the IEEE Communications Society (ComSoc). He has served as ComSoc's editor-in-chief of *IEEE Communications Magazine*, director of publications, and Member-at-Large of the Board of Governors. Mr. Plevyak is an IEEE Fellow for contributions to the field of Network Management. He is a Distinguished Member of Technical Staff in Verizon's Network & Technology organization, currently responsible for domestic and international wireline and wireless operations and network management standards. He holds a BS in engineering from the University of Notre Dame, an MS in engineering from the University of Connecticut, a certificate from the Bell Laboratories Communications Development Training (CDT) program and an MS in advanced management from Pace University. He is co-editor of *Telecommunications Network*

Management into the 21st Century, as well as a series of six books in the field of network management. He is the author of many technical publications and holds two U.S. patents.

Veli Sahin, Ph.D., is senior director of Business Development at NEC Corporation of America in Irving, Texas. Previously, he held management and leadership positions at Bell Laboratories, Bellcore, Samsung, and Marconi. He has been working in the area of Telecommunications Networks for over 25 years. His current interest includes Next Generation Networks (NGN), IP Multimedia Subsystems (IMS), Triple/Quad Play Services, IPTV Services, development of TMN-based management systems and wireline/wireless national and global information infrastructures for the 21st century. Dr. Sahin has over 100 internal and external publications, is co-author of an IEEE Press book chapter and co-editor of the IEEE Press Book Series on Network Management. He received an MS and PhD (multi-hop packet radio networks) in computer science and an MS in electrical engineering at Polytechnic University, Brooklyn, New York. He also received a BS in electronics engineering at Istanbul Technical University, Istanbul, Turkey. He received IEEE/IFIP The Salah Aidarous Memorial Award in 2008 for his contributions to IT and Telecommunications Network Management. He was general chair of the 1998 and 2002 Network Operations and Management Symposium, co-founder and first chair of the IEEE ComSoc Technical Committee on Information Infrastructure (from 1995 to 1998), and chair of the IEEE ComSoc Technical Committee on Network Operations and Management (from 1998 to 2000). Dr. Sahin was also a member of the editorial board and/or advisory board of several respected journals. He is currently MSF Board Member and also project leader for the NEC MSF and Verizon VIF Interoperability Testing (IOT) activities.

Roberto Saracco holds a bachelor's degree in computer science, a master's degree in math, and a postdoctoral degree in physics. He joined Telecom Italia in 1971, contributing to the development of the first SPC system in Italy. Through the years he worked on data transmission, switching, and network management. In the last 10 years he has worked on the economic side of telecommunications, creating and directing a research group at the Future Centre in Venice. Author of many papers and nine books in the field of telecommunications, with the last five on the topic of living and communicating in the next decade, he has worked on the foresight Panel of the European Commission, charged to imagine the Internet beyond 2020. He is currently director of Telecom Italia Future Centre, in Venice, and co-chair of the Edge-Core group of the Communications Future Program of MIT. He is a senior member of IEEE ComSoc, serving in many roles, including TC secretary, NM chair, and vice president of Membership Relations. He is currently ComSoc's director for Sister- and Related-Societies.

He received the Salah Aidarous Award in 2005 for his contribution to network management and the 2007 Donald McLellan Meritorious Service Award for his contribution to strengthening the Communications Society presence worldwide.

Mehmet Ulema is a professor at the Computer Information Systems Department at Manhattan College, New York. Previously, he held management and technical

positions in Daewoo Telecom, Bellcore (now Telcordia), AT&T Bell Laboratories, and Hazeltine Corporations. He has numerous publications in various international conferences and journals. He holds two patents. He gave a number of talks and tutorials on Network management and wireless networks. He is on the editorial board of the IEEE Transactions on Network and Service Management, the ACM Wireless Network Journal, and the Springer Journal of Network and Services Management. He is an active Senior Member of IEEE. He served as the chair and co-founder of the IEEE Communications Society's Information Infrastructure Technical Committee. Previously he served as the chair of the Radio Communications Technical Committee. He is involved in a number of major IEEE conferences as technical program chair (Globecom 2009, ICC 2006, CCNC 2004, NOMS 2002, ISCC 200). He was a general chair of NOMS 2008. He received MS & Ph.D. in Computer Science at Polytechnic University, Brooklyn, New York. U.S.A. He also received BS & MS degrees at Istanbul Technical University, Turkey.

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