

The Cable and Telecommunications Professionals' Reference

3RD EDITION

VOLUME 1

**PSTN, IP and Cellular Networks,
and Mathematical
Techniques**

EDITED BY

Goff Hill



The Cable and Telecommunications Professionals' Reference

PSTN, IP and Cellular Networks, and Mathematical Techniques

Edited by Goff Hill



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To Mary, Joanna, Stephen, Suzanne, and Eleanor

Preface

The past decade has seen massive change in the telecom industry. The industry structure, regulation, technology, and services have all developed progressively. New technologies and services have appeared, displacing long-established ones, and the convergence of different networks, technologies, and services compounds the change.

The predecessor to this reference was called the *Telecommunications Engineer's Reference Book*. The recent trends toward convergence of voice, data and video technologies, and services has suggested that the title, scope, and content of the book should reflect these changes; for this reason, this new reference is titled *The Cable and Telecommunications Professionals' Reference*. Some of the content in the earlier edition has become dated and a substantial amount of new material is now included, so this text remains an authoritative reference book. Since some of the earlier content remains fundamentally relevant, it is retained in this volume.

Inevitably this means that some of the earlier material relating to the displaced technologies should, in some cases, be downsized and, in other cases, removed. Even so, the huge amount of new material entering the scene means that covering the full scope would lead to a significant increase in the length of the book. The current edition is therefore divided into three volumes and I have attempted to associate related material in each. Later volumes will address broadband network technologies and the ways in which they support new services, and core transport network technologies and the changes that are enabling them to deal with variable types of traffic.

Because of the many relationships among different topics, it is not possible to split them into three completely independent, separate volumes. The following are the topics covered in each:

- Volume 1: PSTN, IP and cellular networks, and mathematical techniques
- Volume 2: Core transport systems
- Volume 3: Broadband access

The topics in Volume 1 seem to form a logical grouping because of the historical influence of telephone networks on today's communications systems. Traditionally, telephone networks have been provided primarily, but not entirely, to carry voice traffic. Because of their ubiquity and versatility, they have also often been used to carry data services. Early analogue networks have been replaced by digital networks. Cellular radio and intelligent control processes have led to huge progress in mobile data services. More recently, the availability of the Internet and the Voice over Internet Protocol has provided an entirely new

paradigm for data and multimedia services. Mobile networks themselves are developing into ubiquitous networks, able to offer a wide range of data and video, as well as voice services. The Internet, which began as a data network, is now able to support voice and other real-time services.

These three networking approaches (circuit-switched, Internet, and cellular mobile) therefore provide the basis for this first volume, which is divided into six parts. Part One provides an overview of the industry structure and discusses standards and regulation. The underlying rationale for the OSI 7-layer reference model is also introduced in this part, as it underpins modern network architectural design.

Part Two deals with traditional circuit-switched, landline telephone networks (often referred to as Public Switched Telephone Networks or PSTN), and switching systems. While this existing infrastructure is increasingly regarded as being in decline, it is likely to be with us for some time yet and this volume would be incomplete without its inclusion.

Part Three describes basic principles of the Internet and Internet telephony. This includes the TCP/IP protocols, the carriage of real-time voice signals over the Internet, and developments leading to Next Generation Networks (NGN). The principles of Local Area Networks (LANs) are also covered here.

Part Four explains the principles of cellular mobile networks and the wide range of developments that have led to 2G, 2.5G, and 3G networks. Other wireless topics will be covered in later volumes.

Network design and optimization depend very heavily on mathematical techniques. The mathematical methods used in the design of cable and telecommunications networks have progressed with the technology. The basic methods, as well as more recent developments, are therefore discussed in Part Five, together with coverage of statistical methods, traffic simulation, queuing theory, and teletraffic.

In addition to the specialist mathematical methods used in network design, the more basic mathematical techniques associated with cable and telecommunications networks are covered in Part Six. These are reproduced from the earlier *Telecommunication Engineer's Reference Book* on the grounds that the basic techniques are "time invariant."

I am greatly indebted to the authors who have contributed to this volume of *The Cable and Telecommunications Professionals' Reference*. They are all experts in their fields and work at the forefront of technology. I should like to express my thanks to them and to their respective organizations for all the support they have given.

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Part One

Standards and Regulation

The economic well-being of a country has long been dependent on a good, reliable telecommunications service. The telecommunications sector underpins all forms of commercial, industrial, and domestic life, and its smooth running is vital. As the information society develops, and new technologies bring more advanced means of communications, this dependence continues to grow. Governments at both national and continental levels therefore take a keen interest in establishing and maintaining the health of their telecommunications industry sectors, and they set up regulatory bodies to oversee the market and ensure its proper functioning. Regulatory infrastructures at national and regional levels are therefore created to ensure that the interests of consumers are properly served, that the market operates smoothly, and that competition is open and fair.

In itself, good regulation does not guarantee a healthy industry sector. That calls also for strong industrial players with dynamic interactions. Standards bodies and related organizations play a vital role in promoting constructive cooperation as the industry develops and deploys the latest technologies within the market. The standards bodies, fora, and related trade associations strive to ensure full advantage is taken of rapidly developing technological capabilities, and they provide vital links in the value chain to deliver solutions to end users.

The shape of the regulatory environment is also important to the standards groups, as a healthy sector is essential for the successful deployment of standardized products. Regulatory bodies monitor and analyze the market and its operation and invite opinions from industry on a wide range of regulatory matters. Individual entities are invited to make submissions to regulatory bodies, but in addition to this, lobbying groups such as the European Telecommunications Network Operators Association (ETNO) and European Competitive Telecommu-