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Computer Communications

Voice and Data Communications Handbook

语音与数据通信手册

Regis J. "Bud" Bates • Donald Gregory

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Signature Edition

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Regis J. (Bud) Bates
Donald W. Gregory

McGraw-Hill

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世界图书出版公司
McGraw-Hill Book Co

书 名: Voice and Data Communications Handbook

作 者: R. Bates, D. Gregory

中 译 名: 语音与数据通信手册

出 版 者: 世界图书出版公司北京公司

印 刷 者: 北京中西印刷厂

发 行: 世界图书出版公司北京公司 (北京朝内大街 137 号 100010)

开 本: 1/32 850×1168 印 张: 29

出版年代: 2000 年 4 月

书 号: ISBN 7-5062-4559-0/TP·52

版权登记: 图字 01-1999-2721

定 价: 120.00 元

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INTRODUCTION

Welcome to the world of telephony and telecommunications! We are about to embark on a descriptive and narrative overview of the telecommunications industry. This book is designed to help clear the air for you. One of the major problems with this technology and industry is the use of jargon, or "telephonese," which causes confusion and misunderstanding in the industry for users, purchasers, and vendors alike. Even professionals who have been in the industry for years can have difficulty communicating. The reason is simple: too many acronyms are used, many with multiple meanings. An acronym will mean one thing to a voice telephony person and something completely different to an engineer who has 20 years of experience.

Your rule of thumb, therefore, should be to disallow the use of telecommunications acronyms in any discussions you have with any vendor, carrier, or end user. If the propensity exists for these people to use terms and acronyms, call a time-out. Have them explain all the alphabet soup they are using. You may be surprised to find out that they can't explain the acronyms. This will obviously cause you some concern, but fear not; these folks will ultimately get to the point. Furthermore, since they won't be using all those buzzwords, communications should flow more smoothly.

Now that the stage is set, let's get into a basic discussion of telephony and telecommunications principles. No magic exists here, merely an understanding of what telecommunications is all about: the principles of a telephone, the line connections employed, the forms of communications used, and an understanding of the telephone company networks. We intend to make things as simple as possible as we cover the various techniques and terminology used throughout this book. Be aware, however, that no matter how simple we attempt to make this information and no matter how smoothly we attempt to steer you through the guides outlined, this is a technical subject. Therefore, from time to time we may start sounding a little "techie." This is not done to impress or confuse you—we just cannot think of a way to make our explanation any more basic without destroying the flow. At any rate, this book is designed to give you a fundamental understanding of the overall concepts used in the telecommunications arena, both voice and data.

THE FORMAT

The format of this book is arranged to walk you right through the evolution of the industry as it progressed. Therefore in Chap. 1 we attempt to discuss the evolution of the network as it pertains to the user. The invention of the basic telephone set was a monumental milestone because it marked the birth of the telephony world. From this invention, a network of networks was designed. We approach the invention and the initial deployment of a network throughout the country on the basis of the original Bell System, and we look at the regulatory scene and the various legal issues that arose. As we all know, the monopoly was created to curtail competition associated with the universal access to a telephony network, but also to be a wedge to recover the costs associated with the deployment of the capacities and services. Later in Chap. 1 we discuss the impact of the new Telecommunications Act of 1996 and what it means to you, the end user. This one act has opened the door to competition in the areas of telephony, long distance, cable services, and many other technologies. The next three years will be exciting and confusing as the feeding frenzy begins. Users will be inundated with new opportunities to obtain service from a myriad of suppliers. We even hear that a used-car salesman in the Southwest acquired a license as a competitive telephone carrier. Now you can order your telephone service, cable services, Internet access, and long distance through this one company. By the way, you can buy a used car, too! Sound confusing? You bet it is. But read on and see what all this means to you in the future.

In Chaps. 2–5 we touch on the fundamentals of the voice evolution from the telephone company and end user perspective. In Chap. 2 we look at the basic characteristics of the human voice and how these characteristics formulated the way in which the network was developed. This also implies that certain constraints were put in place to carry an ordinary telephone call. Chapter 3 details how a series of connections was laid out across the country and ultimately across the world. This discussion of network evolution encompasses the distinct dialing plans and how things have changed to accommodate phenomenal growth. Chapter 4 describes the way a voice call is handled through the basic telephone set. We also look at the way this set has changed over the years from a basic nondial telephone to the latest and greatest all-digital display phone with a built-in speakerphone. The discussion also shows how the telephone set converts a sound wave into an electrical wave and prepares the electricity for transmission across the network.

In Chap. 5 we consider the changes that occurred in the network over the past 25 years following the introduction of digital standards. The basic network was designed around an analog transport system, which served us well. However, as frequently happens, we outgrew the services of this analog system. So it was only natural that appreciation of the capabilities and benefits of digital systems would emerge. We hope that you will understand the differences between digital and analog after reading this chapter.

In Chaps. 6–8 we look at the players in the industry and the needs they will experience in attempting to serve a user. Chapter 6 deals with the different service providers, their offerings, and some of the financial considerations that make us want to use their services. This new edition also includes a discussion about the new players in the industry, called competitive local exchange carriers (CLECs). But we go beyond the CLECs and discuss the cable companies that are vying for your voice business. By comparing lines and trunks and explaining the real differences between them, Chap. 7 will clear the air as to why things happen the way they do when we order a pair of wires. We further try to share some insight into why the old days of competition were so difficult and why the newer competitive situation eliminates these roadblocks forever. Chapter 8 is a mathematical discussion of how we and the carriers need to monitor the performance of our networks constantly. Regardless of whose service is being considered, end users and carriers all must try to predict the volumes of traffic that will appear on the network at any single point in time. The ill-conceived past method of trying to get too many calls on too few lines has disappeared. We now expect that at any time we should be able to access this network and get to any other end point in a moment on demand. What happens when all does not go according to plan? What are the risks that we have too few or too many circuits? How do we compensate for traffic loads that are variable, and where can we get the data to conduct our analyses? All of these points should become crystal clear after this discussion.

In Chaps. 9–11 we compare the capabilities and features of the equipment that we can plug into our telephone network through some form of connecting arrangement. Chapter 9 looks at the larger-market equipment called the PBX, which is used by organizations around the world. This section will explain what the PBX really is and how it is geared to function. From there we also look at an alternative to ownership of the big guns by exposing you to Centrex, a service offering from the players in the telephone companies that gives you PBX features and capabilities with the cost savings of building your own system. In Chap. 10 we step down

to the lower-end equipment and how it works for the smaller organization, the branch office of the larger organizations, or anyone else who has a need for multiple sets but wants to compare costs and conveniences. Next in Chap. 11 we look at the devices we can add on to our telephone networking equipment. Voice processing methods such as voice mail, automatic call distribution, and automatic attendants all constitute ways of serving our customers without labor-intensive human resources. However, we caution you about the risks associated with these techniques, since many organizations have already made a mess of implementing these aspects of communications. These organizations have turned their telecommunications systems into the worst public relations representatives to their customers.

We have added a new chapter (Chap. 12) to discuss the changes taking place with computer-to-telephony integration and what that means to the consumer and businessperson alike. Using a combination of communications devices and computers, the industry has changed the way phone calls are handled. Linking the computer database to the telephone system means that information becomes a strategic weapon in building customer loyalty and confidence. See what we have to say about this.

In Chap. 13 we discuss a subject that normally causes even the strong of heart to shudder: the use of an analog telephone line to transmit critical data. How can we make digital data look like a voice call? What are the tools that will enable us to get the information in a usable and understandable form? This section gets quite lengthy and, from time to time, a bit technical; however, you need to understand this concept. The world of today and tomorrow will demand the use of data transmission techniques. We must understand how to keep pace with the demands of the data world across a dial-up telephone voice network. If not, things will grind to a halt. So, take this section slowly and a little at a time; it will all come together at the end.

In Chap. 14 we explore the use of a digital network instead of an analog network. The use of T1 and T3 services is escalating rapidly, bringing users rewards that they could not believe possible. This technique gets us back into the all-digital transport system and makes the data more reliable. In an all-digital world, voice is data just as information is data. We have no choice, so we must learn how the digital network functions and embrace this technology before we get left behind. We attempt to make this discussion simple, but again there are some parts that get a bit complicated. Read this one in earnest; it is your future.

Chapter 15 is a lot of fun. We enjoyed coming up with the best way to present this to you. This section gets a little comical in the discussion of

the standards that we use in just about all aspects of the industry. In the data world there is a series of services and protocols. These are all based on standards or de facto standards. We compare the standards as they stack up against the granddaddy of them all, the OSI model. We think you'll really enjoy the way we present this very complex model, and how we can try to make all things simple if we take them one step at a time. Other operating standards exist in the data world: most prominent are the SNA world from IBM, the DNA world from DEC, and the TCP/IP world from the makers of the Internet. So draw your own conclusions and see whether this doesn't make more sense after you get through this chapter.

We next added two new chapters discussing two new and exciting parts of the industry. Chapter 16 deals with the explosion of the Internet around the world and how it works. This particular chapter will be rewarding to read and will help you understand why things happen so slowly when you dial into the World Wide Wait!

Chapter 17 takes you beyond the external networks and brings the discussion "in-house" to the Intranet. Many companies are now building internal networks mimicking the Internet. See what this technology can do for you and how the use of browsers can enhance the overall acceptance of technology by novice and experienced users alike.

Chapter 18 deals with the evolution of a packet network using an international standard known as X.25. We are not talking about some sci-fi robot or formula; this is a very well-documented standard for breaking large problems (our data) into smaller problems for reliable delivery across the network. It served us well and will be around for a while, so you will benefit from learning how this can also be taken into account. Our comparison and dialogue in this section is sure to amuse you and also provide a very simple analogy on how X.25 works for you!

Chapters 19–21 all deal with another way of moving data across a communications system, but on a localized basis. In the early 1980s a technique called a local area network emerged from the backdrop of our data communications systems. It was designed to make the data communications between and among computers, spread around our buildings, user friendly and easily accessible. So we consider what a LAN is and is not. Then we compare the way an Ethernet and a token ring system work. You will find this discussion most informative, but possibly a bit tricky. We cover the limitations, strengths, distances, and speeds of each of the topologies used. Also, the way to get the best from your data dollars is included in these sections.

Chapter 22 takes a comparative look at the terms used on our data networks. The baseband versus broadband discussion should really clear this

up for you. Too often we hear these words tossed around, but no one understands just what they mean. We will attempt to show you how and why each of the types of cable, and the capacities of the coaxial and the multiplexing schemes, will deliver high-speed communications to the desktop on a single platform.

In Chap. 23 especially, we now have discussion of LANs on steroids—called the Fast Ethernet and switched Ethernet—in an attempt to understand the differences between traditional LANs and the newer versions. Also included is a discussion of the emerging gigabit Ethernet! (That's a billion bits of information per second. *Wow!*) You won't be able to put this book down as you read through this evolutionary progress of raw power to the desktop.

Chapters 24–27 look at taking the LAN out of the building and making it more of a public rather than a localized service. In Chap. 24 we look at the ways of creating a campus area network (CAN), a metropolitan area network (MAN), or a wide area network (WAN) connectivity solution. Each of these will provide wider area coverage and higher-speed connections. In the SMDS discussion we look at the MAN solution to get the data across the network quickly and efficiently. In discussion of the fiber-optical connection using a higher-speed token-passing ring, we see the CAN emerging. These are all addressed in some detail, so some added time will be required to understand the concept and the reasons for using these technologies. Allow some extra time when reading these sections.

In Chap. 25 we describe how X.25 has evolved into a faster WAN connection solution. We take some time to describe the industry's fascination with trying to put voice over frame relay so you can understand what this is all about. Let's face it: sooner or later you will hear about it, so why not here? Why anyone would want to run voice over a data network is a mystery to us, but we try to remain objective in our discussions.

Chapters 26 and 27 deal with some of the latest and greatest "hot buttons" in the industry today. The first is the beginning of the emergence of ISDN, which does not mean "innovations subscribers don't need" but means that we are about to roll out several techniques to dial up a lot of voice and data on an all-digital network. The switched services of a digital network will make your current analog modems look like the turtle, and ISDN will represent the hare. This time, however, the hare wins. Yes, it was slow catching up, but it is finally ready for prime time. Services are appearing every day. Still, we do explain what to watch for and what doesn't quite fit yet. ATM is an emerging fast packet system that makes X.25 and frame relay look weak: ATM is packet-switching on steroids. ATM does not refer to the automated teller machines so prolific in the

banking industry. But if you read this section and don't scream "I want it now," you missed something. You'll see!

After all this discussion of the wired network solutions, we then take a different approach with Chaps. 28–30. This is a discussion of connectivity without wires. We look at cellular communications and personal communications for today and the future. The telephony and the data capacities of wireless are not equal to those of the fiber world, but there is some movement here. Enjoy learning how the wired and wireless future will share the same trail toward the turn of the century. We also look at wireless radio in the form of microwave (not the ovens) and satellite communications. These approaches are merely for purposes of comparing the connectivity solutions against the old reliable twisted pairs of wire. Then, of course, we added a section on the use of light beams without the fiber, called *infrared transmission*. That section details how a short-range communications need may be met without the use of wires, and also shows the strengths and weaknesses of this transport system.

The last four chapters are all add-ons about items we felt the average user might have some interest in, but would not be chomping at the bit to get specific details on. Chapter 31 describes how video conferencing has come a long way in terms of standards, availability, and cost advantages. Then, with an eye to the costs of any communications method, we included Chap. 32, which discusses rudimentary cost justification techniques that will help describe how to sell a system or network concept to management. This covers the basics of financial justifications. Chapter 33 describes the evolution of facsimile, or fax, machines and the trends of today. This is a form of E-mail that most people have gotten very accustomed to. We compare how the systems transmit and receive information, as well as the evolution of the fax cards used in our PCs and notebook computers today. As Chap. 34 unfolds, we discuss the capabilities of our cabling systems, from copper twisted wires to coaxial wires to fiber optics. The capacities and compositions of these wiring systems are outlined to give the reader an understanding of what to look for and what to steer clear of.

We hope that you are intrigued and will read on. This is not a novel; it cannot be read from cover to cover. So allot some time each day and take a chapter or a group of chapters together to gain an appreciation for the overall world of telecommunications. There is no reason this book cannot give you the tools necessary to deal with the novice or pro alike. The glossary of acronyms included in the Appendix should help you as a quick reference to deal with the issues at hand. Take some time to familiarize yourself with the ideas of the book; use the examples and analogies. Enjoy the stories and heed their message. Let's have some fun!

**VOICE AND DATA
COMMUNICATIONS HANDBOOK**

THE MCGRAW-HILL SERIES ON COMPUTER COMMUNICATIONS (SELECTED TITLES)

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Library of Congress Cataloging-in-Publication Data

Bates, Regis J.

Voice and data communications handbook / Regis J. (Bud)

Bates, Donald W. Gregory.—Signature ed.

p. cm.—(McGraw-Hill series on computer communications)

Rev. ed. of: Voice and data communications handbook / Bud Bates.

Donald Gregory.

Includes index.

ISBN 0-07-006396-6

1. Telecommunication—Handbooks, manuals, etc. I. Gregory,

Donald (Donald W.) II. Bates, Regis J. Voice and data communications handbook. III. Title. IV. Series.

TK5105.B317 1997

384—dc21

97-41786

CIP

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ISBN 0-07-006396-6

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IE ISBN 0-07-116044-2

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