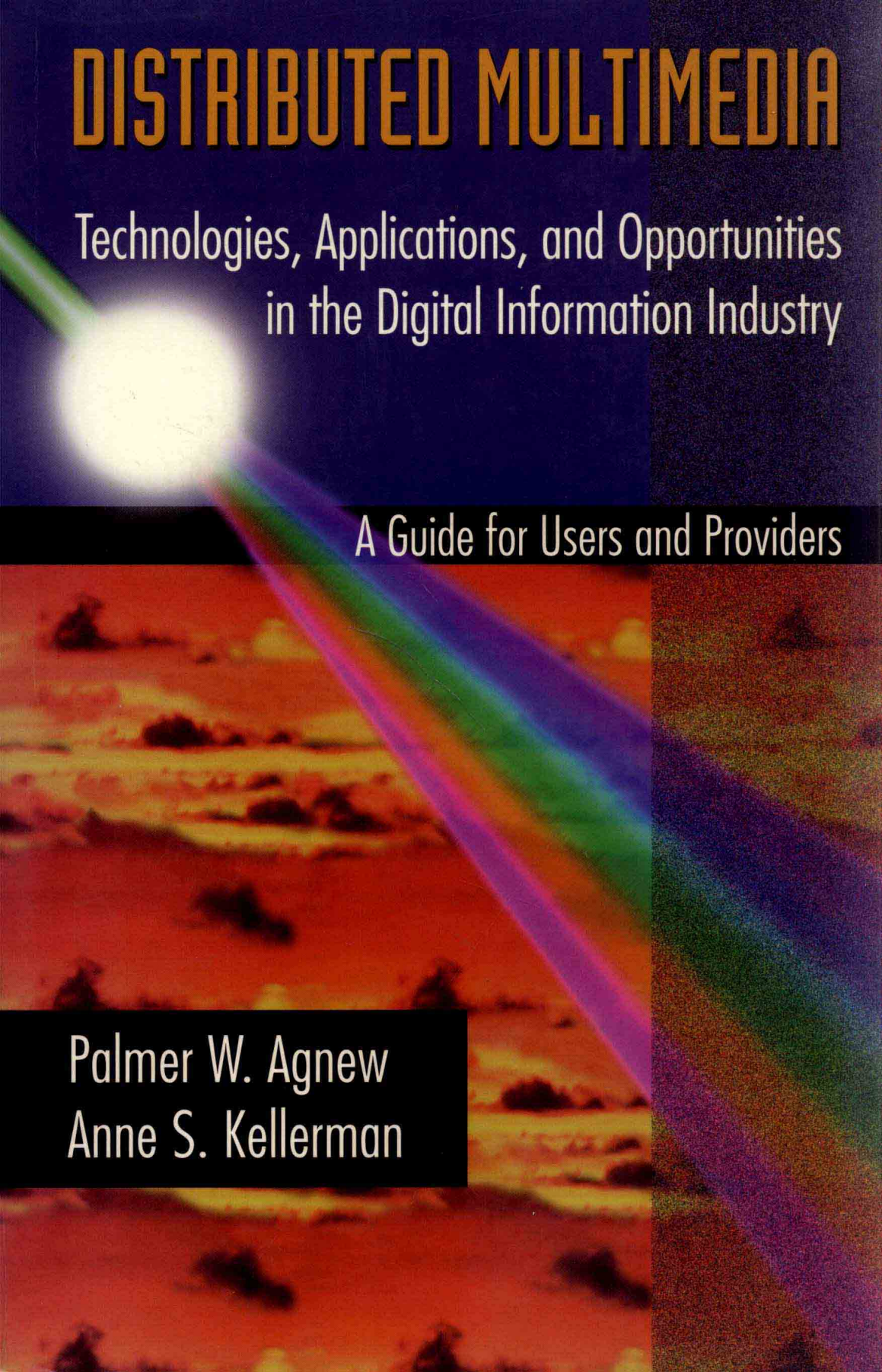
DISTRIBUTED MULTIMEDIA

Technologies, Applications, and Opportunities in the Digital Information Industry

A Guide for Users and Providers



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We dedicate this book to our parents and inspirations:

Anne Wright Agnew and Ralph Palmer Agnew and Esther Weber Minkin and Joseph Louis Minkin,

and to the next generations,

David, Tom, Deborah, Bernardo, Corey, Aviva, and Daniel who will vigorously create and greatly enjoy the future of distributed multimedia.

About the Authors

Palmer W. Agnew has provided extensive technical guidance on multimedia, consumer electronics, advanced networking, and other topics, in both industry and academia. Recently a senior technical staff member advising IBM's Multimedia Business Unit, previously he developed design automation software for IBM, designed microcode for terminal controllers, developed microprocessor-based implementations of mainframe architecture, worked with both mainframe and personal computer applications, and is the holder of six patents. Agnew is a graduate of Cornell University with a B.S. in Physics and an M.S. in Applied Mathematics. He is a member of the ACM and the IEEE.

Anne S. Kellerman, a senior manager advising IBM's Multimedia Business Unit, now on leave of absence, has handled special projects focused on multimedia strategies and has managed a large information systems installation. She has also managed several complex technical projects, including the development of architecture for computer and consumer electronics and IBM joint grants to universities, such as UCLA, University of Michigan, Cornell University, and MIT. She has represented IBM in a national K-12 education initiative and has been involved in setting IBM strategies for consumer products and multimedia. She holds five patents. A member of the ACM and the IEEE, Kellerman holds B.S. and M.S. degrees from Georgia Institute of Technology.

As consultants, both authors have worked with college instructors on incorporating multimedia in courses and are coauthors of *Multimedia in the Classroom*, a guide for educators and technologists. Agnew and Kellerman are also adjunct instructors in the graduate school at Binghamton University, part of the State University of New York, and they conduct a distance-learning course given by the New School in New York City. They have traveled widely, learning and teaching about multimedia developments, challenges, social effects, and requirements in business and education.

Preface

Distributed multimedia has the potential to improve your life by helping you to interact with all media by way of networks and convenient end-user devices that will combine the most useful functions of television sets, telephones, computers, and even game machines. Advances in digital computer technologies are gradually making it practical for you to interact not only with text, graphics, and images, which are traditional computer media, but also with audio and video, which place more severe demands on computers and networks. Advances in digital network technologies, including the Internet and the World Wide Web, allow you to take advantage of all five of these media when communicating with remote users and when interacting with remote data.

In this book we describe the technologies that are making distributed multimedia not only possible but affordable. We describe interactive audio and video applications that will make multimedia attractive and helpful to users. Finally, we outline opportunities, challenges, and risks facing providers of multimedia products and services as today's entertainment, computer, consumer electronics, and telecommunications industries converge into a single digital information industry. We discuss promises that providers are making and clarify how realizing some of these promises can create the reality of a major new industry.

Purpose Why should you read this book? If you are a user who tends to adopt new technologies early, you will see where the industry is going and be able to avoid products that will soon become obsolete. If you are a user who wants to benefit from knowing how things work, you will find out what is inside your boxes and beyond your wall plugs. If you have a technical position in a company that provides particular distributed multimedia products or services, you will see how you and your company fit into the industry, both technically and commercially. If you manage or invest in parts of the information industry, you will gain insights that will help you distinguish reasonable technical proposals from those that amount to perpetual-motion machines and faster-than-light travel. The background knowledge

you acquire will help you to recognize proposals for products and services that consumers or businesses will actually want to buy.

Technologies The most important distributed multimedia technologies are inexpensive digital integrated-circuit processor and memory chips fast enough to handle all the media in digital form, inexpensive hard drives with sufficient capacity to store meaningful quantities of all the media, high-capacity fiber-optic cables, and sophisticated circuits that can send media in digital form up and down not only fiber-optic cables but also ordinary television cables, telephones wires, and even power lines.

Applications Users can take advantage of distributed multimedia applications that rely on advanced technologies to ask questions and receive answers more efficiently and effectively than would be possible using merely text, graphics, and images. A user is also likely to find that interactive entertainment is more entertaining than merely receiving audio and video. Distributed multimedia applications allow vigorous competition among providers of telephone service, cable television service, computer networking, and even electric power. They also allow competition among providers of telephones, television sets, computers, and all forms of consumer electronics and entertainment. Individual firms have opportunities to expand into new products and services that are part of the same converged industry, but they risk losing control of existing markets. Governments, as providers of regulations, face conflicting pressures from industries and users to protect existing positions without stifling innovation.

Delivery Networks If differences of opinion make horse races interesting, competing technologies make delivering multimedia fascinating. Local telephone companies have over $300 billion invested in switches and copper twisted-pair local loops designed to carry unique information to and from individual users. However, such telephone lines can carry video only by adding particularly sophisticated circuitry. CATV cable companies have large investments in coaxial cables designed to carry video. Most cable plants, however, have one-way amplifiers that will carry information downstream from a central site to users but will not carry information back upstream. Computer networks are designed for two-way interactivity, but computers and computer networks will require major improvements to send and receive large volumes of isochronous (smooth) audio and video. Both terrestrial broadcasting and satellite broadcasting are in the running as delivery channels for distributed multimedia. Electric power utilities are a dark horse with connections not only to almost every home and business but to almost every room.

Themes In Chapter 1, we introduce the following unifying themes.

Interacting vigorously with all media is far more effective than passively listening to audio or watching video and the other media.

All media are in the process of converging into a single digital form for storage and transmission, rather than continuing to use different forms, storage, and networks for different media. With distributed multimedia, we will no longer use only audio cassettes, telephone lines, and telephones for audio and only video cassettes, television cables, and television sets for video. Having all media in digital form provides enormous flexibility to combine and distribute the media in creative and effective ways.

Several major industries that deal with separate media are converging into a single industry that deals with all media in digital form. Although this convergence is likely to increase users' choices and decrease users' prices, existing companies within today's industries may not converge or even survive. Another negative aspect of this theme is that distributed multimedia draws inconsistent terminology from many existing industries. In this book, we keep the resulting confusion at bay by continually pointing out ambiguous and conflicting terminology and offering clear definitions.

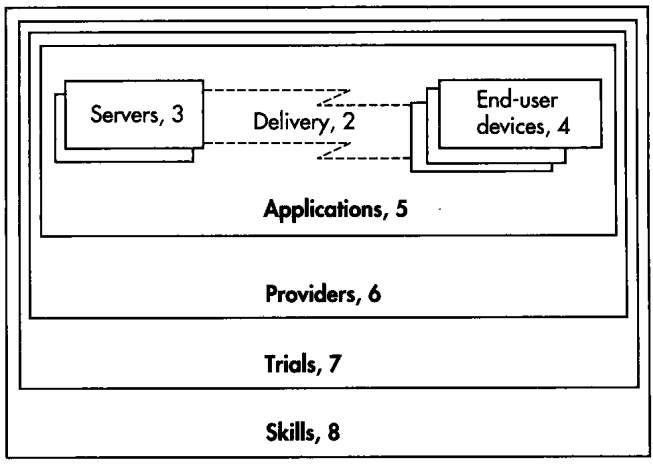
Results of research into human physiology set numerical limits on acceptable multimedia content. Physiology is as important to distributed multimedia as are computer science and network theory.

The digital forms of text, graphics, image, audio, and video require successively larger storage capacities and speeds in order to be acceptable. For example, you typically read text at 300 bits per second, speak and listen to audio at 64 thousand bits per second, and watch video at more than 1.2 million bits per second. In this book, we provide many sample calculations to tell stories in which the punch lines are such numbers.

Distributed multimedia has genuine potential for improving the quality of lives and the efficiency of businesses because using networks gives more timely access to more interesting and useful information, interacting with information adds significant value, and expressing information in multiple media aids comprehension and enjoyment.

Chapters After Chapter 1, each chapter discusses one part of distributed multimedia, as the framework figure on the following page shows.

Chapters 2 through 4 discuss technologies that apply to delivery networks, multimedia servers, and end-user devices such as telephones, computers, and television set-top boxes. The figure shows that applications use all three types of technologies and that providers provide applications as well as technologies. Chapter 7 covers trials in which compatible groups of companies provide distributed multimedia technologies and applications to manageable groups of users. The companies use such trials to determine



which technologies they can support reliably and which applications they can sell profitably. Chapter 8 discusses skills that you may need in order to participate in distributed multimedia. Like the rest of the book, Chapter 8 provides information that can guide you, whether your primary role is as a user or as a provider of multimedia and whether you are primarily interested in technical or business issues.

Sections We have organized each chapter around the same set of eight section headings to emphasize the evolutionary nature of distributed multimedia. Better and better functions will become practical for more and more people as prices decrease, as products become easier to use, and as improved infrastructures reach new geographic areas. A chapter's *Background* section gives information that you need in order to understand the chapter's part of distributed multimedia. *Vision for the Next Decade* tells where we expect the chapter's part to be by 2005. *State of the Art* provides a snapshot of where that part happens to be today. *History* illustrates how this state came about and provides cogent examples of past events that you can use to project and comprehend future events. It tells you how fast you can expect the industry to bridge the gap between today's state and the state that we envision existing in 2005. The section called *Differences* provides more details about that gap, and *Trends* looks at what various providers are doing and planning to do in order to bridge the gap. In *Critical Success Factors* and *Summary,* we attempt to distill the major challenges that providers must overcome and the major changes that we expect to take place by 2005. We have used features called *Focus* to set off some details that you may want to skip or scan initially and read in detail later. Focus *interviews* show how real people who work with distributed multimedia feel about what they are doing.

Authors After designing hardware and software for three decades, we had the opportunity to assemble a large corporation's distributed multimedia strategy. We traveled around the world visiting a wide variety of corporate, governmental, and academic sites in which innovators were inventing, developing, and using distributed multimedia. By employing systematic analyses such as total quality management (TQM), we formed reasonable projections of what such people were likely to develop and use in the next 10 years, attempting to avoid the twin pitfalls of overstating short-term evolutions and understating long-term revolutions. We share the resulting expectations with you in this book. We have accumulated several roomfuls of state-of-the-art multimedia hardware and software and employed them for such practical applications as developing educational materials. We also share the results of this experience, together with decades of experience as early adopters of computers, computer time-sharing terminals, and computer networking. Having taught this book's material in several theoretical and practical courses, we have learned what students and professionals need to know about the subject, and we present it here.

Intended Audience The following three groups of people will benefit from reading this book.

1. *Knowledgeable people who plan to use or provide distributed multimedia* need more than an introduction to the subject. They need a framework for acquiring future knowledge as the industry progresses. For example, Joe is a retired civil engineer and school teacher who lives in an area slated for a large trial of switched digital video. Joe has been intellectually curious all of his life and wants to know what is behind his local newspaper's headlines about this new technology. As an active financial investor he wonders whether he should invest in multimedia-related stocks. Jeanine is a professor of computer science who knows that most of her students' jobs will depend on developments in the area of distributed multimedia; she wants to give them the best information possible about this field.

2. *People who are actually working in the field of distributed multimedia* need the big picture. Specialists in one area such as content production, Web page creation, or fiber-optic connectors, but who want to gain a general knowledge of the rest of the field, can do so with this book. Among such readers would be the following. Tom sells fiber optic cables and connectors to companies participating in early trials of interactive television. He wants to become knowledgeable about distributed multimedia so he can better serve his customers. Jim is a programmer working as a consultant on a project that involves recommending approaches to multimedia. Bernardo is a doctoral candidate

who uses the Internet for his research and who would like to publish electronically his thesis results, which include video. David designs object-oriented systems for telephone companies and others. He needs to know what demands multiple media and interactivity will place on his customers' networks.

3. *College students, primarily in the fields of business and computer science,* can gain valuable exposure to the digital frontier. One example is our former student Mike who writes, "It is really pretty wild to be right in the middle of this multimedia revolution that is happening in downtown New York City." He is applying what he learned in our course to make companies' World Wide Web home pages more dynamic. We encourage students to learn more about distributed multimedia.

Acknowledgments We want to thank our families, friends, students, and many colleagues around the world who have helped us refine, develop, and test our ideas. We especially want to thank Mike Braun, chairman of the IMA; Lucie Fjeldstad, president of Tektronix Video; and Dr. Frank Moore, Vice President Information Technology at the New School. They were instrumental in making it possible for us to work with and learn about distributed multimedia over many years. We also want to thank our reviewers, particularly Joe Minkin, who both collected massive amounts of information about his local multimedia trial and reviewed many of our drafts, the highly constructive editors, and their reviewers, the more caustic the better. We are also indebted to many colleagues and friends, particularly Tom Kellerman of IBM's Microelectronics Division and Dr. William H. Tetzlaff of IBM Research for their technical expertise and advice.

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