Mobile Multimedia Communications

Mobile Multimedia Communications

Edited by

David J. Goodman
Rutgers University WINLAB
Piscataway, New Jersey

and

Dipankar Raychaudhuri
NEC USA, C&C Research Laboratories
Princeton, New Jersey

Springer Science+Business Media, LLC

Library of Congress Cataloging in Publication Data

International Workshop on Mobile Multimedia Communications (3rd: 1996: Princeton, N.J.)
Mobile multimedia communications / edited by David J. Goodman and Dipankar Raychaudhuri.
p. cm.
"Proceedings of the Third International Workshop on Mobile Multimedia Communications, held September 25–27, 1996, in Princeton, New Jersey."
Includes bibliographical references and index.
ISBN 978-1-4899-0153-8 ISBN 978-1-4899-0151-4 (eBook)
DOI 10.1007/978-1-4899-0151-4
1. Wireless communication systems—Congresses. 2. Mobile communication systems—Congresses. 3. Multimedia systems—Congresses. 4. Mobile computing—Congresses. I. Goodman, David J., 1939– . II. Raychaudhuri, Dipankar. III. Title.
IN PROCESS
006.7'2—dc21 97-40565
CIP

Proceedings of the Third International Workshop on Mobile Multimedia Communications, held September 25 – 27, 1996, in Princeton, New Jersey

ISBN 978-1-4899-0153-8

Originally published by Plenum Press, New York in 1997
Softcover reprint of the hardcover 1st edition 1997

http://www.plenum.com

10 9 8 7 6 5 4 3 2 1

PREFACE

In 1997, the two hottest topics in information technology are the Internet and mobile communications. Each one has the enthusiastic attention of the consuming public, investors, and the technical community. In a time of rapid expansion, they both face technical obstacles to meeting the public's high expectations. This situation stimulates a high volume of research in both areas.

To bring the Internet into the twenty-first century, the research community focuses on multimedia communications in which integrated systems store, transport, and process many types of information simultaneously. A major challenge is to meet the separate performance requirements of each information service. This problem is especially challenging when a system has to deliver broadband, real-time services such as full-motion video.

Meanwhile, the mobile communications research community continues its long-term struggle against the triple challenge of mobility, ether, and energy. "Mobility" refers to the changing locations of terminals. When terminals are mobile, networks have to determine their locations and dynamically establish routes for information. The networks also have to rearrange themselves in order to maintain links to terminals with active communications sessions. "Ether" refers to the problems of wireless communications including limited bandwidth, rapidly changing radio propagation conditions, mutual interference of radio signals, and vulnerability of systems to eavesdropping and unauthorized access. "Energy" refers to the fact that portable information devices carry their own power sources. The rate at which the batteries of cellular telephones and portable computers drain their energy has a strong effect on their utility.

Although multimedia information systems and mobile wireless communications present separate technical challenges, a small but growing community of researchers examines both areas simultaneously. Their aim is to bring the benefits of advanced information technology to a mobile population. However, they find that the separate problems of multimedia and mobility are greatly magnified when it is necessary to confront them together. This community has met three times in a workshop atmosphere to identify research topics, exchange news of progress to date, and to chart the future. The Workshops have the title MoMuC - Mobile Multimedia Communications. The first MoMuC Workshop was held in Tokyo, Japan in December 1993 and the second one took place in Bristol, England in 1995. This book contains papers based on presentations at

the Third International Workshop on Mobile Multimedia Communications in Princeton, New Jersey, September 25-27, 1996. The Workshop was sponsored by WINLAB, the Wireless Information Network Laboratory at Rutgers, the State University of New Jersey, in cooperation with the IEEE Communications Society. NEC USA and Lucent Technologies were corporate patrons.

Although the people attending MoMuC-3 are addressing a wide range of issues, a few general themes emerged. The subject that had the broadest consensus was the relevance of ATM (Asynchronous Transfer Mode) communications to mobile, multimedia information services. Another subject of general concern was adaptation of existing protocols, such as the Internet Protocol (IP), to the needs of mobile communications. There was also considerable attention devoted to complications that arise in mobile communications when a network carries multimedia information.

These themes and others appear in the thirty-six chapters of this book, each based on a presentation at MoMuC-3. We have divided the book into four parts with the titles: Networks, Protocols, Media Access, and Signal Processing. Our classification is necessarily arbitrary. Many of the papers are broad in scope with details that fall into two or more of the categories.

The twelve papers in Part 1 focus primarily on networks. Chapters 1-4 describe network architectures that harness existing technologies to the needs of mobile multimedia communications. The first three chapters describe the use of ATM (Asynchronous Transfer Mode), a technology devised for multimedia communication in fixed networks. Conversely, Chapter 4 considers introducing a multimedia application, forest fire monitoring, to GSM, a network designed for mobile telephone communications. The theme of the final eight chapters of Part 1 is network control. Chapters 5-8 address the use of two control techniques in order to achieve Quality of Service (QoS) objectives. Chapters 5-7 consider call admission control and Chapter 8 addresses channel allocation. The subject of Chapters 9-11 is handoff control in multimedia networks with an ATM infrastructure like the networks described in Chapters 1-3. Chapter 12 presents three ad hoc algorithms for flow control in multicast applications.

Part 2 contains eight papers describing protocols designed to meet a variety of requirements of mobile multimedia communications. Like many of the earlier papers, Chapter 13 examines networks with an ATM infrastructure. It proposes an end-to-end protocol for negotiating Quality of Service. By contrast, Chapter 14 describes a protocol for maintaining Quality of Service on a link-by-link basis as information moves through a network. Chapters 15 and 16 analyze the roles of the two Internet protocols, TCP and IP in serving the needs of mobile communications. The four final chapters of Part 2 all address different issues. Chapter 17 identifies limitations of the real-time protocol RTP in mobile networks and proposes remedies. Chapter 18 describes a protocol that provides security to connectionless communications between a mobile computer and a server. Chapter 19 describes mobile middleware that takes into account the characteristics of the different terminals that will make use of a mobile multimedia communications system. Chapter 20 concludes Part 2 with a description of protocols for mobile multimedia mail applications.

Among the seven papers on media access control in Part 3, five describe time division techniques and the other two consider code division multiple access (CDMA). The techniques in Chapters 21-23 all establish reservations for multimedia communications. Chapter 21 proposes an adaptive form of packet reservation multiple access (PRMA) that meets the needs of variable-bit-rate information. The subject of Chapter 22 is a reservation time division multiple access (R-TDMA) system that efficiently multiplexes real-time and non-real-time information. Chapter 23 adds collision resolution to reserved idle signal multiple access (R-ISMA) in order to insure stability.

The objective of the priority-based multiple access scheme (PBMA) described in Chapter 24 is to establish contiguous time slot assignments in order to promote quality of service objectives in networks with an ATM infrastructure. An important objective of the TDMA scheme presented in Chapter 25 is to meet the requirements of variable-bit-rate compressed video transmissions in a wireless ATM network.

Chapters 26 and 27 both describe asynchronous CDMA transmission schemes. In Chapter 26, the purpose of asynchronous operation is to simplify system operation. Chapter 27 describes a voice, data, and video CDMA system in which many variable-bit-rate sources use the same spreading code. In this system, asynchronous operation is necessary because synchronism of sources would produce intolerable interference.

Part 4, with the general theme of signal processing, begins with Chapter 28, in which ten authors describe an impressive testbed that unites a large collection of technologies, including video compression, spread spectrum radio transmission, and a network operating system. Chapter 29 describes the role of channel coding in meeting diverse quality of service objectives in a wireless ATM network. Rate compatible convolutional codes provide unequal error protection to meet the requirements of different information sources. The subject of Chapter 30 is a modulation technique, orthogonal frequency division multiplexing (OFDM) that avoids intersymbol interference due to multipath propagation in a 1 Mb/s radio link. Alternative modulation techniques would require receivers with complex equalizers. Chapter 31 considers antennas in broadband communications systems operating at millimeter wave frequencies.

The final five chapters are all concerned with video coding. Chapter 32 addresses the power consumption in a wireless video camera. The paper describes a system that balances the power consumption due to data compression with the power consumption required for transmission. Chapters 33-36 explore various coding techniques based on signal segmentation for achieving robustness to the impairments of wireless channels. In Chapter 33 the segmentation is based on picture content, while the technique in Chapter 34 uses multiple description coding to achieve diversity. Chapters 35 and 36 describe robust transmission of video signals based on standard coding techniques. Chapter 35 describes work in progress in standards organizations to add robustness to two video coding methods, MPEG-4 and ITU-T H.263, while Chapter 36 describes a particular technique, adaptive block update, for achieving robustness in ITU-T H.263 video signals.

Together, the thirty-six papers in this book present a snapshot of work in progress in 1996 on the challenging, important subject of mobile multimedia communications. The rapid expansion of both Internet services and mobile communications services is certain to continue for many years. As a significant fraction of the population becomes accustomed to the benefits of both types of services, there will be a strong demand to merge them. The research described in this book will be a major factor in creating the technology that will meet this demand in the face of formidable technical challenges.

As conference organizers and editors of this book, we express our gratitude to the authors for the high quality of their presentations. We also thank Noreen DeCarlo for the skill and hard work she devoted to the production of the book.

David J. Goodman
WINLAB
Rutgers, The State University
of New Jersey
Piscataway, NJ

D. Raychaudhuri
NEC USA
Princeton, NJ

CONTENTS

PART 1 – NETWORKS

PART 2 – PROTOCOLS

PART 3 – MEDIA ACCESS

PART 4 – SIGNAL PROCESSING