

May 2001 Vol. 39 No. 5

IEEE

Communications

www.comsoc.org

MAGAZINE

S
INS
EL24
CO35

*IP-Oriented
Operations and Management
Topics in Wireless Communications*

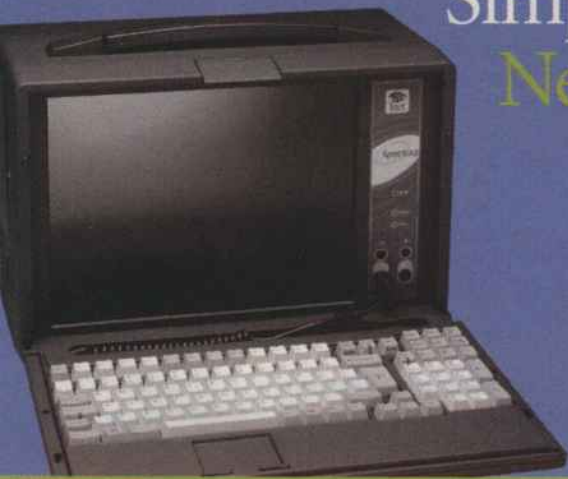
PUBLICATION PARTNER
PERCOMM 2001
The World of Communications

**DOCKET
ALARM**

Find authenticated court documents without watermarks at docketalarm.com.

Can you ensure today's **quality** in tomorrow's network?

Inet Technology Simplifies Networks



Tomorrow's VoIP technologies bring significant new challenges to network development and operations. The architects of next-generation networks require the ability to develop, validate and ratify this new technology – Inet's Spectra2 MG™ is the diagnostic solution.

Spectra2 MG offers powerful applications to test media and associated signaling in the emerging packet-switch environments of next-generation networks. It allows carriers and equipment manufacturers to verify network operation under true conditions and ensure network interoperability. Spectra2 MG offers Media Gateway (MG) and Media Gateway Controller (MGC) test tools, allowing developers to test these critical elements of the next-generation network.

www.INET.com

KURT F. WENDT LIBRARY
COLLEGE OF ENGINEERING

MAY 10 2001

UW-MADISON, WI 5370

SOFTSWITCHING | INTERCONNECT MANAGEMENT | QUALITY OF SERVICE | CUSTOMER CARE | SPECIAL STUDIES | NETWORK SECURITY | DIAGNOSTICS | WE SIMPLIFY NETWORKS



**DOCKET
ALARM**

Find authenticated court documents without watermarks at docketalarm.com.

Director of Magazines
Mark J. Karol, Avaya Inc. (USA)

Editor-in-Chief
G. S. Kuo, National Chengchi University (Taiwan)

Senior Technical Operations Editor
Roch H. Glitho, Ericsson Research (Canada)

Senior Technical Editors
Koichi Asatani, Kogakuin U. (Japan)
Thomas M. Chen, Southern Methodist U. (USA)
Harry Rudin, IBM Zurich (Switzerland)
Kazem Sohraby, Lucent Tech.-Bell Labs (USA)

Technical Editors
Nirwan Ansari, NJIT (USA)
Christos Douligeris, U. of Miami (USA)
Joan Garcia-Haro, Polytechnic U. of Cartagena (Spain)
Silvia Giordano, EPFL (Switzerland)
Sol Greenspan, GTE Labs (USA)
Khaled Ben Letaief, Hong Kong U. of S. & T. (China)
Pascal Lorenz, U. of Haute Alsace (France)
Torleiv Maseng, Lund U. (Sweden)
Stan Moyer, Telcordia (USA)
John O'Reilly, U. College London (UK)
Andrzej R.Pach, U. of Mining & Metallurgy (Poland)
Algirdas Pakstas, U. of Sunderland/Lithuanian Acad. Sci. (UK and Lithuania)
Michal P. Pioro, Warsaw U. of Techn./ Lund U. (Poland and Sweden)
Ramjee Prasad, Aalborg U. (Denmark)
Sirin Tekinay, New Jersey Institute of Technology (USA)
Mehmet Ulema, Daewoo Telecom. Ltd. (USA)
Naoaki Yamanaka, NTT (Japan)

Feature Editors
Book Reviews, Andrzej Jajszczyk, AGH University of Technology (Poland)
CommuniCrostic Puzzle, Paul Green (USA)
Conference Calendar, Anant Kumar Jain, Lucent (USA)
Light Traffic, S. Pasupathy, U. of Toronto (Canada)
News and Events, Joe El-Batal, Ericsson (Canada)

On Track, Celia Desmond, World Class - Telecommunications (Canada)
Scanning the Literature, Nirwan Ansari, NJIT (USA)
Your Internet Connection, Amane Nakajima, IBM Corp. (Japan)
Eddie Rabinovitch, Cervalis (USA)
Broadband Access Series, Steve Gorshe, NEC eLuminant Techn. (USA)
Zdzislaw Papir, University of Mining and Metallurgy (Poland)
Internet Technology Series, Khaled Elsayed, Cairo U. (Egypt)
Michah Lerner, AT&T Labs (USA)
Lightwave Series, Philip J. Lin, Tellabs Research Center (USA)
Sudhir Dixit, Nokia (USA)
Software & DSP in Radio, Joe Mitola, The MITRE Corporation (USA)
Zoran Zvonar, Analog Devices (USA)
Standards, Yoichi Maeda, NTT (Japan)
Mostafa Hashem Sherif, AT&T (USA)
Wireless Communications, Willie W. Lu, Siemens (USA)
Moshe Zukerman, U. of Melbourne (Australia)

IEEE Production Staff
Joseph Milizzo, Assistant Publisher
Eric Levine, Advertising Sales Manager
Susan Lange, Digital Production Manager
Catherine Kemelmacher, Associate Editor
Jennifer Porcello, Digital Production Associate
Janet Swaim, Production Editor
Joanne O'Rourke, Staff Assistant



IEEE Communications MAGAZINE

May 2001 Vol. 39 No. 5

www.comsoc.org/~ci

IP-ORIENTED OPERATIONS AND MANAGEMENT

GUEST EDITORS: ANDRZEJ JAJSZCZYK AND GEORGE PAVLOU

77 GUEST EDITORIAL: IP-ORIENTED OPERATIONS AND MANAGEMENT

80 **A MANAGEMENT AND CONTROL ARCHITECTURE FOR PROVIDING IP DIFFERENTIATED SERVICES IN MPLS-BASED NETWORKS**

As the Internet evolves toward the global multiservice network of the future, a key consideration is support for services with guaranteed quality of service. The proposed differentiated services framework is seen as the key technology to achieve this.

PANOS TRIMINTZIOS, ILIAS ANDRIKOPOULOS, GEORGE PAVLOU, PARIS FLEGGAS, DAVID GRIFFIN, PANOS GEORGATOS, DANNY GODERIS, YVES T'JOENS, LEONIDAS GEORGIADIS, CHRISTIAN JACQUENET, AND RICHARD EGAN

90 **MANAGEMENT OF QUALITY OF SERVICE ENABLED VPNS**

New emerging IP services based on differentiated services and the IP security architecture offer the level of communication support that corporate Internet applications need nowadays. However, these services add an additional degree of complexity to IP networks which will require sophisticated management support.

TORSTEN BRAUN, MANUEL GUENTER, AND IBRAHIM KHALIL

100 **MANAGEMENT OF SERVICE LEVEL AGREEMENTS FOR MULTIMEDIA INTERNET SERVICE USING A UTILITY MODEL**

The efficient management of a quality level of Internet service is becoming increasingly important to both customers and service providers. The authors describe how service level agreements for multimedia Internet service can be managed and controlled.

JONG-TAE PARK, JONG-WOOK BAEK, AND JAMES WON-KI HONG

108 **INTERNET ACCOUNTING**

The authors provide an introduction to Internet accounting and discuss the status of related work within the IETF and IRTF, as well as certain research projects. To understand Internet accounting, it is important to answer questions like "what is being paid for" and "who is being paid."

AIKO PRAS, BERT-JAN VAN BEIJNUM, RON SPRENGELS, AND ROBERT PARHONYI

114 **THE IETF ACTIVITIES IN THE OPERATIONS AND MANAGEMENT AREA**

The Internet Engineering Task Force works on standardization of Internet related protocols. The work is divided into various areas. One of the areas is operations and management. The author provides first a summary of the areas that exist within the IETF and then describes in some detail the tasks for each of the Working Groups (WGs) in the operations and management area.

BERT WUNEN

TOPICS IN WIRELESS COMMUNICATIONS

118 **THE WIRELESS ART AND THE WIRED FORCE OF SUBSCRIBER ACCESS**

The authors compare different technologies for subscriber access. Starting with the various transmission media characteristics of all systems, the well-known twisted pair lines with their corresponding digital subscriber line services are evaluated against wireless local loops, communications over ubiquitous power lines, high-bandwidth cable modems, and mobile radio.

CHRISTIAN DREWES, WOLFGANG AICHER, AND JOSEF HAUSNER

2001 Communications Society Officers

J. Roberto B. de Marca, *President*
Celia Desmond, *President-Elect*
Curtis A. Siller, Jr., *VP-Technical Activities*
Horst Bessai, *VP-Membership Services*
Douglas N. Zuckerman, *VP-Membership Development*
Alex Gelman, *VP-Society Relations*
Harvey Freeman, *Treasurer*
John M. Howell, *Secretary*

Board of Governors

The officers above plus Members-at-Large:

Class of 2001

Laura Cerchio, Leonard Cimini
Roberta Cohen, William Tranter

Class of 2002

Tomonori Aoyama, Roberto Saracco
Roch Guerin, Byeong Lee

Class of 2003

Elizabeth Adams, Ross Anderson
Lawrence Bernstein, Harvey Freeman

2001 IEEE Officers

Joel B. Snyder, *President*
Raymond D. Finlay, *President-Elect*
Hugo M. Fernandez Versteegen, *Secretary*
Dale Caston, *Treasurer*
Bruce A. Eisenstein, *Past President*
Daniel J. Senese, *Executive Director*
Tom Rowbotham, *Director, Division III*

IEEE COMMUNICATIONS MAGAZINE (ISSN 0163-6804) is published monthly by The Institute of Electrical and Electronics Engineers, Inc. Headquarters address: IEEE, 3 Park Avenue, 17th Floor, New York, NY 10016-5997, USA; tel: +1-212-705-8900; http://www.comsoc.org/~ci. Responsibility for the contents rests upon authors of signed articles and not the IEEE or its members. Unless otherwise specified, the IEEE neither endorses nor sanctions any positions or actions espoused in *IEEE Communications Magazine*.

ANNUAL SUBSCRIPTION: \$23 per member per year included in Society fee. Non-member subscription: \$160. Single copy \$10 for members and \$20 for nonmembers.

EDITORIAL CORRESPONDENCE: Address to: Editor-in-Chief, G.S. Kuo, National Chengchi University, Taipei, Taiwan 11623; tel: +886 2 86617453, fax: +886 2 86617432, e-mail: gskuo@ieee.org.

COPYRIGHT AND REPRINT PERMISSIONS: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limits of U.S. Copyright law for private use of patrons: those post-1977 articles that carry a code on the bottom of the first page provided the per copy fee indicated in the code is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For other copying, reprint, or republication permission, write to Director, Publishing Services, at IEEE Headquarters. All rights reserved. Copyright © 2001 by The Institute of Electrical and Electronics Engineers, Inc.

POSTMASTER: Send address changes to *IEEE Communications Magazine*, IEEE, 445 Hoes Lane, Piscataway, NJ 08855-1331. GST Registration No. 125634188. Printed in USA. Periodicals postage paid at New York, NY and at additional mailing offices. Canadian Post International Publications Mail (Canadian Distribution) Sales Agreement No. 264075.

SUBSCRIPTIONS, orders, address changes—IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA; tel: +1-732-981-0060; e-mail: address.change@ieee.org.

ADVERTISING: Advertising is accepted at the discretion of the publisher. Address correspondence to: Advertising Manager, *IEEE Communications Magazine*, 305 East 47th Street, New York, NY 10017-2394, USA.

SUBMISSIONS: The magazine welcomes tutorial or survey articles that span the breadth of communications. Submissions will normally be approximately 4500 words, with no mathematical formulas, accompanied by up to six figures and/or tables, with up to 10 carefully selected references. Electronic submissions are preferred, and should be sent to the Senior Technical Operations Editor at lmcrogl@lmc.ericsson.se, or four copies by mail to: Roch H. Glitho, Senior Technical Operations Editor, Ericsson Research Canada, 8400 Decarie Blvd., Town of Mount Royal, Quebec, H4P 2N2 Canada. All submissions are subject to review.



126 WIRELESS INTERNET OVER LMDS: ARCHITECTURE AND EXPERIMENTAL IMPLEMENTATION

The authors argue that the former emphasis only on multimedia and ATM-based communication over LMDS was a mistake. The most exciting prospect for LMDS should be in the role of enabling Internet and data services together with multimedia. We introduce a basic architecture for two-layer IP-LMDS based on a trial network built between 1996 and 2000.

PETRI MÄHÖNEN, TOMMI SAARINEN, ZACH SHELBY, AND LUIS MUÑOZ

ALSO IN THIS ISSUE

134 QoS AND SERVICE INTERWORKING USING CONSTRAINT-ROUTE LABEL DISTRIBUTION PROTOCOL (CR-LDP)

Introducing quality of service features to the IP/TCP protocol suite has become a hot topic of research in both industry and academia. Several architectures have been proposed for QoS support at the network layer (layer 3 in the OSI model).

OSAMA ABOUL-MAGD AND BILEL JAMOSSI

140 THE ITU-T BICC PROTOCOL: THE VITAL STEP TOWARD AN INTEGRATED VOICE-DATA MULTISERVICE PLATFORM

At the end of 1999, the ITU-T completed the first edition of the Bearer-Independent Call Control (BICC) protocol, just nine months after the start of this activity. The development of BICC can be considered historic. For the first time a full-fledged operator-grade PSTN/ISDN service can be offered over a variety of packet networks, using only standardized protocols.

M. OSKAR VAN DEVENTER, IKO KEESMAAT, AND PIETER VEENSTRA

146 EXPERIMENTS AND ENHANCEMENTS FOR IP AND ATM INTEGRATION: THE ITHACI PROJECT

IthACI has been a European project of the ACTS framework concentrating on fast layer 2 forwarding methods for IP traffic based on labeled flow mechanisms. The approach is also known as IP switching and is considered promising for enhancing IP performance.

ILIAS ANDRIKOPOULOS, GEORGE PAVLOU, PANOS GEORGATSOS, NIKOS KARATZAS, KOSTAS KAVIDOPOULOS, JÜRGEN RÖTHIG, SIBYLLE SCHALLER, DIRK OOMS, AND PIM VAN HEUVEN

156 A COMPARATIVE EVALUATION OF DECT, PACS, AND PHS STANDARDS FOR WIRELESS LOCAL LOOP APPLICATIONS

In a comparative analysis performance and capacity of DECT, PACS, and PHS for wireless local loop (WLL) applications have been investigated. This article reports the results of both qualitative and quantitative analysis.

OMID MONTAHAN AND HOMAYOUN HASHEMI

164 FUNDAMENTAL LIMITS AND POSSIBILITIES FOR FUTURE TELECOMMUNICATIONS

Using fundamental physical and information theoretical relations, the author considered fundamental capacity limits and possibilities of fiber optical, cellular radio, and satellite communication systems. In a fiber to the home scenario more than 1 Gb/s equivalent circuit-switched capacity may well be feasible in the future. In a microwave cellular or satellite radio network for mobile subscribers it may well be feasible, although requiring low-cost very advanced electronics, to reach several tens of megabits per second.

OLLE NILSSON

168 INTERNATIONAL DIRECT DIALING QUALITY IN A COMPETITIVE TRANSITIONAL TELECOMMUNICATIONS MARKET

The introduction of resale-based competition in international direct dialing services in January 1999 triggered a round of extremely fierce competition in Hong Kong's IDD market. In response, both the incumbent operator and new entrants had to adopt aggressive strategies to defend or gain market share.

XU YAN AND JAMES Y. L. THONG

Message from the President	9	Your Internet Connection	56
Society News	12	Product Spotlights	60
Conference Calendar	26	Global Communications Newsletter	69
Solution to CommuniCrostic #218	38	CommuniCrostic #219	74
Conference Preview	40	OFC Product Roundup	175
On Track	52	Advertisers' Index	184

Experiments and Enhancements for IP and ATM Integration: The IthACI Project

Ilias Andrikopoulos and George Pavlou, CCSR, University of Surrey

Panos Georgatsos, Nicholas Karatzas, and Kostas Kavidopoulos, Algonet S.A., Greece

Jürgen Röthig and Sibylle Schaller, CCRL, NEC Europe Ltd., Germany

Dirk Ooms, Alcatel Bell, Belgium

Pim Van Heuven, IMEC, University of Gent, Belgium

ABSTRACT

IthACI has been a European project in the ACTS framework concentrating on fast layer 2 forwarding methods for IP traffic based on labeled flow mechanisms. The approach is also known as IP switching and is considered promising for enhancing IP performance. Several flavors of IP switching have been proposed by various vendors (e.g., IP Switching by Ipsilon, Tag Switching by Cisco, ARIS by IBM, IPSOFACTO by NEC), all of them different and not interoperable. IP Switching has been adopted by the IETF under the umbrella of Multi-Protocol Label Switching (MPLS).¹ Although MPLS has made remarkable progress recently, a number of issues remain largely open for further investigation. The scope of the IthACI project was to address such issues and propose solutions. The issues addressed were multicast, QoS, resource management, and mobility support in a multicast environment. IthACI conducted both theoretical and experimental work. Three network islands, each based on a different flavor of IP switching, were set-up and the interoperability of these different IP switching/MPLS flavors were investigated and demonstrated.

INTRODUCTION

Since its inception around 1990, asynchronous transfer mode (ATM) network technology has been regarded as an antipode to existing Internet Protocol (IP) technology. ATM has started being deployed by traditional voice carriers (telephone companies), while IP is deployed by carriers of data traffic. ATM is considered to be fast, but complex, expensive, and ineffective for short-lived applications, mainly due to its connection-oriented nature. IP is regarded as sim-

years, but missing QoS functionality and resulting in slow speeds due to the implementation routing functionality in software. Efficient methods for combining IP and ATM technology and transporting IP traffic over ATM backbone infrastructure have been considered. The result is known as "IP Switching" — a kind of IP router with IP protocol functionality that employs ATM hardware for efficient data forwarding.

Originally, various flavors of IP Switching were proposed: Ipsilon IP Switching, Cisco Tag Switching, IBM ARIS, Toshiba CSR, NEC IPSOFACTO, just to name a few. This prompted the Internet Engineering Task Force (IETF) to address a standardized approach through a working group on multiprotocol label switching (MPLS).

IthACI [1] (*Internet and the ATM: Convergence and Integration*) was a European Advanced Communications Technologies and Services (ACTS) project, which ran from March 1998 to Dec 1999 with the overall scope to evaluate and contribute to the different technologies that permit the efficient transport of IP traffic over, private or public, ATM backbone infrastructure. In this context, the project addressed the requirements for efficient IP multicasting, accommodation of QoS demands, mobility in a multicast environment, and resource management. It subsequently undertook enhancements of existing IP switching solutions with respect to the previous features, and generated recommendations based on experience gained from implementation and experimentation.

Besides the functional enhancements, the project's main goal was to influence the actual standardization process in the area of IP switching, and thus to work within and bring the pro-

¹ The terms MPLS and IP switching are used interchangeably throughout

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.