

Commenced Publication in 1973

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, UK

Takeo Kanade

Carnegie Mellon University, Pittsburgh, PA, USA

Josef Kittler

University of Surrey, Guildford, UK

Jon M. Kleinberg

Cornell University, Ithaca, NY, USA

Friedemann Mattern

ETH Zurich, Switzerland

John C. Mitchell

Stanford University, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

Oscar Nierstrasz

University of Bern, Switzerland

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

University of Dortmund, Germany

Madhu Sudan

Massachusetts Institute of Technology, MA, USA

Demetri Terzopoulos

New York University, NY, USA

Doug Tygar

University of California, Berkeley, CA, USA

Moshe Y. Vardi

Rice University, Houston, TX, USA

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Constantinos Dovrolis (Ed.)

Passive and Active Network Measurement

6th International Workshop, PAM 2005
Boston, MA, USA, March 31 – April 1, 2005
Proceedings

Volume Editor

Constantinos Dovrolis

Georgia Institute of Technology, College of Computing

801 Atlantic Drive, Atlanta, GA 30332, USA

E-mail: dovrolis@cc.gatech.edu

Library of Congress Control Number: 2005922930

CR Subject Classification (1998): C.2, C.4

ISSN 0302-9743

ISBN-10 3-540-25520-6 Springer Berlin Heidelberg New York

ISBN-13 978-3-540-25520-8 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springeronline.com

© Springer-Verlag Berlin Heidelberg 2005

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper SPIN: 11414100 06/3142 5 4 3 2 1 0

Preface

Welcome to the 6th International Workshop on Passive and Active Measurement, held in Boston, Massachusetts. PAM 2005 was organized by Boston University, with financial support from Endace Measurement Systems and Intel.

PAM continues to grow and mature as a venue for research in all aspects of Internet measurement. This trend is being driven by increasing interest and activity in the field of Internet measurement. To accommodate the increasing interest in PAM, this year the workshop added a Steering Committee, whose members will rotate, to provide continuity and oversight of the PAM workshop series.

PAM plays a special role in the measurement community. It emphasizes pragmatic, relevant research in the area of network and Internet measurement. Its focus reflects the increasing understanding that measurement is critical to effective engineering of the Internet's components. This is clearly a valuable role, as evidenced by the yearly increases in the number of submissions, interest in, and attendance at PAM.

PAM received 84 submissions this year. Each paper was reviewed by three or four Program Committee (PC) members during the first round. Papers that received conflicting scores were further reviewed by additional PC members or external reviewers (typically two). After all reviews were received, each paper with conflicting scores was discussed extensively by its reviewers, until a consensus was reached. The PC placed particular emphasis on selecting papers that were fresh and exciting research contributions. Also, strong preference was given to papers that included validation results based on real measurements. Eventually, out of the 84 submissions, 24 were accepted as full papers and 12 were accepted as poster presentations. The accepted papers cover a wide range of measurement areas, from topology and routing to wireless network and application measurements. Also, the PAM 2005 program shows the truly diverse and international identity of the network measurement community; the 36 accepted contributions are from 13 different countries in North and South America, Asia, Europe, and Oceania.

This year's conference was held in Boston's Back Bay, a lively neighborhood in the heart of the city. Our location is close to many of the best attractions Boston has to offer, and we hope that attendees found an opportunity to enjoy some of them.

The workshop depended on the support of many people, whom we wish to thank. The PC members worked long and hard to evaluate papers, write reviews, and come to consensus on paper acceptance; this work took place under tight deadlines.

We would like to thank Boston University for their support. Special thanks go to Manish Jain at Georgia Tech, who prepared the conference webpage, ran the online review system (CyberChair), and helped significantly in preparing the

final proceedings. Many thanks also to George Smaragdakis at Boston University for helping with the conference website and with the local arrangements. And we are grateful to Ellen Grady at Boston University for her work in local arrangements, financial management, and registration. The PC Chair wishes to acknowledge the authors of CyberChair, the software used to manage the review process, for making their system publicly available.

We are very grateful to Endace Measurement Systems and to Intel for financial support that allowed us to keep registration costs low.

Finally, our thanks to all authors of submitted papers, to the speakers, and to all the participants for making PAM 2005 a success!

We hope attendees enjoyed the PAM 2005 workshop, and had a pleasant stay in Boston.

Mark Crovella (General Chair)
Constantinos Dovrolis (PC Chair)

Chadi Barakat, Nevil Brownlee, Mark Crovella,
Constantinos Dovrolis, Ian Graham, and Ian Pratt
(Steering Committee)

Organization

PAM 2005 was organized by Boston University.

Program Committee

Suman Banerjee (University of Wisconsin-Madison)
Chadi Barakat (INRIA)
Supratik Bhattacharyya (Sprint ATL)
Andre Broido (CAIDA)
Nevil Brownlee (University of Auckland)
Neal Cardwell (Google)
kc Claffy (CAIDA)
Les Cottrell (SLAC)
Mark Crovella (Boston University)
Christophe Diot (Intel Research)
Constantine Dovrolis (Georgia Tech)
Avi Freedman (Akamai)
Ian Graham (Endace)
Khaled Harfoush (North Carolina State University)
Loki Jorgenson (Apparent Networks)
Simon Leinen (Switch)
David Meyer (Cisco Systems)
Dina Papagiannaki (Intel Research)
Ian Pratt (University of Cambridge)
Matt Roughan (University of Adelaide)
Kave Salamatian (CNRS/LIP6)
Anees Shaikh (IBM T.J. Watson)
Patrick Thiran (EPFL)
Alex Tudor (Agilent Labs)
Steve Uhlig (Université catholique de Louvain)
Darryl Veitch (University of Melbourne)

Additional Reviewers

Olivier Bonaventure	Marina Fomenkov	Bradley Huffaker
Manish Jain	Dima Krioukov	Matthew Luckie
Priya Mahadevan	Jiri Navratil	Cristel Pelsser
Bruno Quoitin	John Reumann	Ulrich Schmid
Kay Sripanidkulchai	Paul Vixie	Brett Watson

Sponsoring Institutions

Endace Measurement Systems (www.endace.com)

Intel Corporation (www.intel.com)

Table of Contents

Section 1: TCP Measurements

On the Impact of Bursting on TCP Performance <i>Ethan Blanton, Mark Allman</i>	1
A Study of Burstiness in TCP Flows <i>Srinivas Shakkottai, Nevil Brownlee, kc claffy</i>	13
On the Stationarity of TCP Bulk Data Transfers <i>Guillaume Urvoy-Keller</i>	27

Section 2: Application Measurements

Toward the Accurate Identification of Network Applications <i>Andrew W. Moore, Konstantina Papagiannaki</i>	41
A Traffic Identification Method and Evaluations for a Pure P2P Application <i>Satoshi Ohzahata, Yoichi Hagiwara, Matsuaki Terada, Konosuke Kawashima</i>	55
Analysis of Peer-to-Peer Traffic on ADSL <i>Louis Plissonneau, Jean-Laurent Costeux, Patrick Brown</i>	69
Analysis of Communities of Interest in Data Networks <i>William Aiello, Charles Kalmanek, Patrick McDaniel, Subhabrata Sen, Oliver Spatscheck, Jacobus Van der Merwe</i>	83

Section 3: Network Inference and Problem Diagnosis

Binary Versus Analogue Path Monitoring in IP Networks <i>Hung X. Nguyen, Patrick Thiran</i>	97
Exploiting the IPID Field to Infer Network Path and End-System Characteristics <i>Weifeng Chen, Yong Huang, Bruno F. Ribeiro, Kyoungwon Suh, Honggang Zhang, Edmundo de Souza e Silva, Jim Kurose, Don Towsley</i>	108
New Methods for Passive Estimation of TCP Round-Trip Times <i>Bryan Veal, Kang Li, David Lowenthal</i>	121

Detecting Duplex Mismatch on Ethernet <i>Stanislav Shalunov, Richard Carlson</i>	135
---	-----

Section 4: Topology Measurements

Improved Algorithms for Network Topology Discovery <i>Benoit Donnet, Timur Friedman, Mark Crovella</i>	149
Using Simple Per-Hop Capacity Metrics to Discover Link Layer Network Topology <i>Shane Alcock, Anthony McGregor, Richard Nelson</i>	163
Revisiting Internet AS-Level Topology Discovery <i>Xenofontas A. Dimitropoulos, Dmitri V. Krioukov, George F. Riley</i>	177

Section 5: Wireless Network Measurements

Application, Network and Link Layer Measurements of Streaming Video over a Wireless Campus Network <i>Feng Li, Jae Chung, Mingzhe Li, Huahui Wu, Mark Claypool, Robert Kinicki</i>	189
Measurement Based Analysis of the Handover in a WLAN MIPv6 Scenario <i>Albert Cabellos-Aparicio, René Serral-Gracià, Loránd Jakab, Jordi Domingo-Pascual</i>	203

Section 6: Monitoring Facilities

A Distributed Passive Measurement Infrastructure <i>Patrik Arlos, Markus Fiedler, Arne A. Nilsson</i>	215
lambdaMON – A Passive Monitoring Facility for DWDM Optical Networks <i>Jörg B. Michael</i>	228

Section 7: Routing and Traffic Engineering Measurements

Internet Routing Policies and Round-Trip-Times <i>Han Zheng, Eng Keong Lua, Marcelo Pias, Timothy G. Griffin</i>	236
---	-----

Traffic Matrix Reloaded: Impact of Routing Changes <i>Renata Teixeira, Nick Duffield, Jennifer Rexford, Matthew Roughan</i>	251
--	-----

Some Observations of Internet Stream Lifetimes <i>Nevil Brownlee</i>	265
---	-----

Section 8: Spectroscopy and Bandwidth Estimation

Spectroscopy of Traceroute Delays <i>Andre Broido, Young Hyun, kc claffy</i>	278
---	-----

Measuring Bandwidth Between PlanetLab Nodes <i>Sung-Ju Lee, Puneet Sharma, Sujata Banerjee, Sujoy Basu, Rodrigo Fonseca</i>	292
--	-----

Comparison of Public End-to-End Bandwidth Estimation Tools on High-Speed Links <i>Alok Shriram, Margaret Murray, Young Hyun, Nevil Brownlee, Andre Broido, Marina Fomenkov, kc claffy</i>	306
---	-----

Section 9: Poster Session

Traffic Classification Using a Statistical Approach <i>Denis Zuev, Andrew W. Moore</i>	321
---	-----

Self-Learning IP Traffic Classification Based on Statistical Flow Characteristics <i>Sebastian Zander, Thuy Nguyen, Grenville Armitage</i>	325
--	-----

Measured Comparative Performance of TCP Stacks <i>Sam Jansen, Anthony McGregor</i>	329
---	-----

Applying Principles of Active Available Bandwidth Algorithms to Passive TCP Traces <i>Marcia Zangrilli, Bruce B. Lowekamp</i>	333
---	-----

A Network Processor Based Passive Measurement Node <i>Ramaswamy Ramaswamy, Ning Weng, Tilman Wolf</i>	337
--	-----

A Merged Inline Measurement Method for Capacity and Available Bandwidth <i>Cao Le Thanh Man, Go Hasegawa, Masayuki Murata</i>	341
---	-----

Hopcount and E2E Delay: IPv6 Versus IPv4 <i>Xiaoming Zhou, Piet Van Mieghem</i>	345
Scalable Coordination Techniques for Distributed Network Monitoring <i>Manish R. Sharma, John W. Byers</i>	349
Evaluating the Accuracy of Captured Snapshots by Peer-to-Peer Crawlers <i>Daniel Stutzbach, Reza Rejaie</i>	353
HOTS: An OWAMP-Compliant Hardware Packet Timestamping <i>Zhang Shu, Katsushi Kobayashi</i>	358
Practical Passive Lossy Link Inference <i>Alexandros Batsakis, Tanu Malik, Andreas Terzis</i>	362
Merging Network Measurement with Data Transport <i>Pavlos Papageorgiou, Michael Hicks</i>	368
Author Index	373