Lecture Notes in Computer Science 13210

Founding Editors

Gerhard Goos
Karlsruhe Institute of Technology, Karlsruhe, Germany
Juris Hartmanis
Cornell University, Ithaca, NY, USA

Editorial Board Members

Elisa Bertino
Purdue University, West Lafayette, IN, USA
Wen Gao
Peking University, Beijing, China
Bernhard Steffen
TU Dortmund University, Dortmund, Germany
Gerhard Woeginger
RWTH Aachen, Aachen, Germany
Moti Yung
Columbia University, New York, NY, USA

More information about this series at https://link.springer.com/bookseries/558

Oliver Hohlfeld · Giovane Moura ·
Cristel Pelsser (Eds.)

Passive and Active Measurement

23rd International Conference, PAM 2022
Virtual Event, March 28–30, 2022
Proceedings

Springer

Editors
Oliver Hohlfeld
Brandenburg University of Technology
Cottbus, Germany

Giovane Moura
SIDN Labs - TU Delft
Arnhem, The Netherlands

Cristel Pelsser
ICube - University of Strasbourg
Illkirch, France

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-030-98784-8 ISBN 978-3-030-98785-5 (eBook)
https://doi.org/10.1007/978-3-030-98785-5

© The Editor(s) (if applicable) and The Author(s), under exclusive license
to Springer Nature Switzerland AG 2022
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

We are excited to present the proceedings of the 23rd annual Passive and Active Measurement (PAM) conference. After more than two decades, PAM continues to provide an essential venue for emerging and early-stage research in network measurements – work that seeks to better understand complex, real-world networked systems and offer critical empirical foundations and support to network research. In light of a still ongoing global COVID-19 pandemic, this 23rd edition of PAM was held as a virtual (online) conference during March 28–30, 2022. This year's edition benefited from experiences gathered by measuring the partcipants' feedback from PAM 2020 and PAM 2021, both held online.

This year's proceedings demonstrate the importance and extent to which measurements permeate systems – from protocols to performance to security. In total, we received 62 double-blind submissions from authors representing 47 unique institutions, of which the Technical Program Committee (TPC) selected 30 for publication – on a par with last year's published papers. A novelty this year was the possibility of submitting long papers. We received 30 long submissions, out of which half were accepted. We thus reached the same acceptance rate for long and short submissions. We paid particular attention to the TPC composition, intending to have it as broadly representative as possible, including both junior and senior researchers. We are indebted to the hard-working TPC members, who ensured that each paper received four reviews and carried out a lively (and in several cases spirited) online discussion to arrive at the final program. TPC members were asked to provide constructive feedback, bearing in mind PAM's focus and goals that recognize promising early work and reproducibility effort. For PAM 2022 we once again implemented a Review Task Force (RTF), following the model used by USENIX Security and ACM IMC. The RTF included senior, experienced researchers from the community, who are also great mentors. The engagement of such a group ensured that all the TPC's feedback met high standards of technical correctness, specific critiques, and a positive, constructive tone. To ensure the quality of the program and equanimity of the presented results, 18 papers were assigned a shepherd from the TPC members who reviewed the paper. We are delighted with the final set of 30 papers and hope the readers find them as valuable and provocative as we do.

We would be remiss not to thank the Steering Committee for helping organize the conference. We thank SIDN for being the hosting institution. We thank Marco Davids as Web chair, Moritz Müller as Registration chair, and Caspar Schutijser as Video chair, along with all the volunteers who helped run the online sessions. We also thank the legal team at SIDN (Maarten Simon, Karin Vink, and April Löwe) who helped us navigate the Dutch and European privacy laws. Last but not least, we thank all the

researchers who have made PAM such an exciting and essential conference for all these years.

March 2022

Oliver Hohlfeld
Giovane Moura
Cristel Pelsser

Organization

General Chair

Giovane C. M. Moura	SIDN Labs/TU Delft, The Netherlands

Program Committee Chairs

Oliver Hohlfeld	Brandenburg University of Technology, Germany
Cristel Pelsser	University of Strasbourg, France

Web Chair

Marco Davids	SIDN Labs, The Netherlands

Registration Chair

Moritz Müller	SIDN Labs/University of Twente, The Netherlands

Steering Committee

Marinho P. Barcellos	University of Waikato, New Zealand
Fabian E. Bustamante	Northwestern University, USA
Anja Feldmann	Max Planck Institute for Informatics, Germany
Jelena Mirkovic	University of Southern California, USA
Michalis Faloutsos	University of California, USA
Steve Uhlig	Queen Mary University of London, UK

Program Committee

Abhishta Abhishta	University of Twente, The Netherlands
Alan (Zaoxing) Liu	Boston University, USA
Alessandro Finamore	Huawei Technologies, France
Alessio Botta	University of Napoli Federico II, Italy
Alexander Gamero-Garrido	Northeastern University, USA
Amreesh Phokeer	ISOC, Mauritius
Anja Feldmann	MPI, Germany
Anna Brunström	KAU, Sweden
Anna Sperotto	University of Twente, The Netherlands
Anubhavnidhi Abhashkumar	ByteDance, USA
Aqsa Kashaf	Carnegie Mellon University, USA

Arani Bhattacharya	Indraprastha Institute of Information Technology (IIIT) Delhi, India
Benoit Donnet	University of Liège, Belgium
Carlos Ganan	ICANN, The Netherlands
Chadi Barakat	Université Côte d'Azur/Inria, France
Diana Andreea Popescu	Amazon Web Services, UK
Esteban Carisimo	Northwestern University, USA
Fabian Bustamante	Northwestern University, USA
Gareth Tyson	Queen Mary University of London, UK
Georgios Smaragdakis	TU Delft, The Netherlands
Ioana Livadariu	SimulaMet, Norway
Johan Mazel	ANSSI, France
Juan Tapiador	Universidad Carlos III de Madrid, Spain
Kensuke Fukuda	NII, Japan
Kevin Vermeulen	Columbia University, USA
Kittipat Apicharttrisorn	Carnegie Mellon University, USA
Kyle Schomp	Akamai, USA
Lianjie Cao	Hewlett Packard Labs, USA
Liz Izhikevich	Stanford University, USA
Luca Vassio	Politecnico di Torino, Italy
Maciej Korczyński	Grenoble Alps University, France
Marcel Flores	Edgecast, USA
Mark Allman	ICSI, USA
Marwan Fayed	Cloudflare, UK
Matteo Varvello	Nokia Bell Labs, USA
Matthew Luckie	University of Waikato, New Zealand
Matthias Wählisch	Freie Universität Berlin, Germany
Mattijs Jonker	University of Twente, The Netherlands
Maurizio Naldi	LUMSA University, Italy
Moritz Müller	SIDN/University of Twente, The Netherlands
Niklas Carlsson	Linköping University, Sweden
Olaf Maennel	Tallinn University of Technology, Estonia
Oliver Gasser	Max Planck Institute for Informatics, Germany
Owezarski Philippe	LAAS-CNRS, France
Ram Durairajan	University of Oregon, USA
Ramakrishna Padmanabhan	CAIDA/UC San Diego, USA
Randy Bush	IIJ, Japan/Arrcus, USA
Ricky K. P. Mok	CAIDA/UC San Diego, USA
Robert Beverly	NPS, USA
Roland van Rijswijk-Deij	University of Twente, The Netherlands
Romain Fontugne	IIJ, Japan
Ryo Nakamura	University of Tokyo, Japan
Sandrine Vaton	IMT Atlantique, France
Shuai Hao	Old Dominion University, USA
Soheil Abbasloo	University of Toronto, Canada
Solange Rito Lima	University of Minho, Portugal

Srdjan Matic	IMDEA Networks Institute, Spain
Stephen McQuistin	University of Glasgow, UK
Stephen Strowes	Fastly, UK
Suranga Seneviratne	University of Sydney, Australia
Tatsuya Mori	Waseda University, Japan
Thomas Krenc	NPS, USA
Tijay Chung	Virginia Tech, USA
Tobias Fiebig	TU Delft, The Netherlands
Vaibhav Bajpai	TU Munich, Germany
Vasileios Giotsas	Lancaster University, UK
Yang Chen	Fudan University, China
Youngjoon Won	Hanyang University, Korea
Zachary Bischof	CAIDA/UC San Diego, USA
Zili Meng	Tsinghua University, China

External Reviewers

Stefanie Roos	TU Delft, The Netherlands
Oğuzhan Ersoy	TU Delft, The Netherlands

Contents

Security

LogoMotive: Detecting Logos on Websites to Identify Online Scams - A TLD Case Study 3
Thijs van den Hout, Thymen Wabeke, Giovane C. M. Moura, and Cristian Hesselman

Early Detection of Spam Domains with Passive DNS and SPF 30
Simon Fernandez, Maciej Korczyński, and Andrzej Duda

Changing of the Guards: Certificate and Public Key Management on the Internet 50
Carl Magnus Bruhner, Oscar Linnarsson, Matus Nemec, Martin Arlitt, and Niklas Carlsson

Web

Design and Implementation of Web-Based Speed Test Analysis Tool Kit. . . . 83
Rui Yang, Ricky K. P. Mok, Shuohan Wu, Xiapu Luo, Hongyu Zou, and Weichao Li

BatteryLab: A Collaborative Platform for Power Monitoring: https://batterylab.dev 97
Matteo Varvello, Kleomenis Katevas, Mihai Plesa, Hamed Haddadi, Fabian Bustamante, and Ben Livshits

GPS-Based Geolocation of Consumer IP Addresses. 122
James Saxon and Nick Feamster

Performance

Jitterbug: A New Framework for Jitter-Based Congestion Inference. 155
Esteban Carisimo, Ricky K. P. Mok, David D. Clark, and K. C. Claffy

Can 5G mmWave Support Multi-user AR?. 180
Moinak Ghoshal, Pranab Dash, Zhaoning Kong, Qiang Xu, Y. Charlie Hu, Dimitrios Koutsonikolas, and Yuanjie Li

Routing

A First Measurement with BGP Egress Peer Engineering 199
Ryo Nakamura, Kazuki Shimizu, Teppei Kamata, and Cristel Pelsser

RouteInfer: Inferring Interdomain Paths by Capturing ISP Routing Behavior Diversity and Generality 216
Tianhao Wu, Jessie Hui Wang, Jilong Wang, and Shuying Zhuang

DNS and Routing

Measuring the Practical Effect of DNS Root Server Instances: A China-Wide Case Study 247
Fenglu Zhang, Chaoyi Lu, Baojun Liu, Haixin Duan, and Ying Liu

Old but Gold: Prospecting TCP to Engineer and Live Monitor DNS Anycast 264
Giovane C. M. Moura, John Heidemann, Wes Hardaker, Pithayuth Charnsethikul, Jeroen Bulten, João M. Ceron, and Cristian Hesselman

A Matter of Degree: Characterizing the Amplification Power of Open DNS Resolvers 293
Ramin Yazdani, Roland van Rijswijk-Deij, Mattijs Jonker, and Anna Sperotto

Routing II

IRR Hygiene in the RPKI Era 321
Ben Du, Gautam Akiwate, Thomas Krenc, Cecilia Testart, Alexander Marder, Bradley Huffaker, Alex C. Snoeren, and KC Claffy

Peering Only? Analyzing the Reachability Benefits of Joining Large IXPs Today 338
Lars Prehn, Franziska Lichtblau, Christoph Dietzel, and Anja Feldmann

On the Latency Impact of Remote Peering 367
Fabricio Mazzola, Pedro Marcos, Ignacio Castro, Matthew Luckie, and Marinho Barcellos

Internet Applications

Know Thy Lag: In-Network Game Detection and Latency Measurement 395
Sharat Chandra Madanapalli, Hassan Habibi Gharakheili, and Vijay Sivaraman

Differences in Social Media Usage Exist Between Western and Middle-East Countries 411
Jens Helge Reelfs, Oliver Hohlfeld, and Niklas Henckell

Measuring the (Over)use of Service Workers for In-Page Push Advertising Purposes 426
George Pantelakis, Panagiotis Papadopoulos, Nicolas Kourtellis, and Evangelos P. Markatos

Network Properties

ISP Probing Reduction with Anaximander 441
Emeline Marechal, Pascal Mérindol, and Benoit Donnet

Lights on Power Plant Control Networks 470
Stefan Mehner, Franka Schuster, and Oliver Hohlfeld

DNS

Assessing Support for DNS-over-TCP in the Wild 487
Jiarun Mao, Michael Rabinovich, and Kyle Schomp

Measuring the Accessibility of Domain Name Encryption and Its Impact on Internet Filtering 518
Nguyen Phong Hoang, Michalis Polychronakis, and Phillipa Gill

One to Rule Them All? A First Look at DNS over QUIC 537
Mike Kosek, Trinh Viet Doan, Malte Granderath, and Vaibhav Bajpai

Application Performance

Zoom Session Quality: A Network-Level View 555
Albert Choi, Mehdi Karamollahi, Carey Williamson, and Martin Arlitt

Zoomiversity: A Case Study of Pandemic Effects on Post-secondary Teaching and Learning 573
Mehdi Karamollahi, Carey Williamson, and Martin Arlitt

SSQoE: Measuring Video QoE from the Server-Side at a Global Multi-tenant CDN 600
Anant Shah, Juan Bran, Kyriakos Zarifis, and Harkeerat Bedi

Security II

Routing Loops as Mega Amplifiers for DNS-Based DDoS Attacks 629
Yevheniya Nosyk, Maciej Korczyński, and Andrzej Duda

Quantifying Nations' Exposure to Traffic Observation and Selective Tampering 645
Alexander Gamero-Garrido, Esteban Carisimo, Shuai Hao, Bradley Huffaker, Alex C. Snoeren, and Alberto Dainotti

Longitudinal Study of Internet-Facing OpenSSH Update Patterns 675
Jonathan Codi West and Tyler Moore

Author Index 691