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GUEST EDITORIAL

Special Issue on Measurement Based Network Management

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1 Introduction

Network measurement and monitoring play a vital role in the healthy operation of networks of all sizes, and find their applications in essentially all aspects of network management, including network traffic engineering, network capacity planning, billing, network security, network protocol, and algorithm testing. Network measurement and monitoring provide the essential techniques, algorithms, and tools for any informed decision-making process in network management.

On the other hand, today's networks are becoming increasingly more heterogeneous in terms of both network technologies and traffic, impacted by various factors including the wide deployment of wireless and sensor networks and the increasing popularity of peer-to-peer applications, network games, and VoIP. In addition, network speed has been continuously increasing. Network attackers are also becoming more sophisticated in carrying out network attacks, recruiting zombie members, and hiding their true identities. All these developments pose profound challenges and present abounding opportunities in network measurement and monitoring research.

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2 Contributions in this Issue

One of the major challenges of packet level measurement for network management in high speed networks is the scalability. In the paper, "Deep Packet Inspection for High-Speed Traffic Analysis," Cascarano et al. have rigorously examined the feasibility of deep packet inspection (DPI) with the real traces for the problem of traffic classification. Though DPI is useful for unveiling hidden application traffic, it is difficult to maintain the new or old application signatures and the management parameters for optimal performance. The authors developed the Deterministic Finite Automata (DFA)-based algorithm to perform the matching of regular expression pattern, i.e., signature. The paper focuses on both the length of packet payload to be examined, and the number of classification attempts on a traffic flow. Based on three different packet traces, the authors argue that a packet-based DPI is feasible for traffic classification purposes with acceptable accuracy. That is, examining packet payload up to 256 bytes is enough with a few packets—2 for TCP and 10 packets for UDP. Typically, DPI is already used for so-called commercial QoS devices whose mechanisms are not known. The limited but feasible usage of DPI is interesting to the network management technologies that could use the correct traffic classification results for the baseline. Prior works have covered the availability and feasibility issues of DPI, but this paper makes up for the limited useful usages of DPI for the traffic classification.

The popularity of multimedia applications has introduced challenges for broadband access network management. Traditional admission control mechanisms underperform in the presence of multimedia services, as they often suffer difficulty in characterizing the needed resources effectively. On the other hand, the inherent structure of today's video services, allows for a more fine grained admission control decision. If not enough resources are available, an admission control mechanism may opt to still allow the requested session but at a reduced video quality, which requires less resources. In the paper, "PCN based Admission Control for Autonomic Video Quality Differentiation: Design and Evaluation", Latre et al. discuss the admission control for multimedia services. The proposed algorithm is an improvement on IETF Pre-Congestion Notification mechanism (PCN), specifically for video traffic. It uses a simple, yet effective estimation of bandwidth variability, and features a number of changes that make PCN easier to configure to handle bursty traffic and allow automatic adaption of the configuration. It also was enabled to differentiate the video quality levels in PCN to meet various levels of quality expectation per session.

Automatically optimizing and reconfiguring routing under dynamic traffic loads is a critical task and great challenge for large Internet service providers, in order to better utilize the network resources and to provide performance guarantees to meet the service level agreement. Recently, oblivious routing has attracted a lot of attention in the networking research community due to the potential to guarantee the worst-case performance under uncertain traffic loads. The paper "Reactive Robust Routing: Anomaly Localization and Routing Reconfiguration for Dynamic Networks", authored by Casas et al. follows the direction of and improves the performance of the oblivious routing algorithms, by combining both a proactive dynamic routing algorithm and a reactive dynamic routing algorithm. In particular,

for proactive routing, the authors developed a Multi-Hour Robust Routing algorithm to improve the performance of a previous oblivious routing algorithm, Stable Robust Routing, by partitioning a time period of network operation and shrinking the set of the uncertain traffic matrices used in each time slot. For reactive routing, the authors developed algorithms to detect and localize traffic volume anomalies, and to respond to and handle this type of traffic anomaly by expanding the uncertain set of traffic matrices.

Detecting icebergs such as heavy-hitters or frequent items has broad applications in network management including identifying flows involved in DDoS attacks. However, detecting icebergs is a challenging problem in high-speed networks, and it is even more challenging to detect icebergs in a distributed streaming setting, where a global iceberg is split and may not appear to be a local heavy-hitter at each monitoring point. Huang et al. developed an effective system to detect global icebergs by combining sketches and uniform sampling, in the paper, "Uncovering Global Iceberg in Distributed Streams: Results and Implications." By combing these two approaches, global icebergs can be potentially identified even if they do not appear to be local icebergs (based on sketches alone). In addition, this paper also presented a novel taxonomy of the existing sketches and performed detailed studies on the strengths and limitations of these schemes. Using both synthetic and real-world data traces, the authors showed that the proposed approach is robust against a number of global iceberg split patterns that may be used by adversaries to hide the true iceberg nature of their flows.

As the diversity of network applications increases on the Internet, there is a growing interest in accurately identifying the type of network traffic for various reasons such as billing, performance guarantee, or simply traffic filtering. Ideally, the identification should be done without the requirement to access the application data, i.e., packet payload, due to the increasing use of traffic encryption. In the paper, "A VoIP traffic identification scheme based on host and flow behavior analysis," Li et al. developed a simple and effective scheme to identify VoIP traffic by exploring both the host and flow characteristics. In particular, they utilized three host and flow features to identify VoIP traffic, including the difference between the number of port numbers of the source and destination machines, the packet size of a traffic flow, and the inter-arrival times of packets in the flow. By performing both controlled laboratory experiments and experiments based on real-world Skype voice traffic trace, they showed that the proposed scheme is an effective approach in identifying VoIP traffic in terms of both false positive and false negative rates.

3 Conclusion

Understanding characteristics of network usage and dynamics especially in high speed networks poses continual challenges to both researchers and practitioners. The new advances in measurement techniques would make network management tasks more meaningful and relevant. We hope these high quality articles in this special issue would prove to be insightful, and stimulate the research and practice in measurement-based network management.

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Author Biographies

Baek-Young Choi is an assistant professor of Computer Science & Electrical Engineering in School of Computing & Engineering at the University Missouri—Kansas City. She received her Ph.D. in Computer Science and Engineering at the University of Minnesota, Twin Cities in 2003. She held positions at Sprint Advanced Technology Labs and the University of Minnesota, Duluth, as a post-doctoral researcher and 3 M McKnight distinguished visiting assistant professor, respectively. Her research interests include network measurement and resource management of both wired and wireless networks. She has served as a TPC member, session chair, and reviewer in more than 30 international conferences including IEEE GLOBECOM 2010, IEEE/IFIP NOMS 2010, IWQoS 2009, IEEE ICCCN 2008, and journals such as IEEE Transactions on Multimedia, Networking, and Parallel and Distributed Systems.

Zhenhai Duan received the B.S. degree from Shandong University, China, in 1994, his M.S. degree from Beijing University, China, in 1997, and his Ph.D. degree from the University of Minnesota, in 2003, all in Computer Science. He joined the faculty of the Department of Computer Science at the Florida State University in 2003, where he is currently an associate professor. His research interests include computer networks and network security. Dr. Duan is a co-recipient of the 2002 IEEE International Conference on Network Protocols (ICNP) Best Paper Award, the 2006 IEEE International Conference on Computer Communications and Networks (ICCCN) Best Paper Award, and the IEEE GLOBECOM 2008 Best Paper Award. Dr. Duan has served as TPC co-chairs for the Next-Generation Networking Symposium, IEEE GLOBECOM 2010, and track co-chairs for Network Algorithms and Performance Evaluation, IEEE ICCCN 2007, 2008. He is a member of ACM and senior member of IEEE.

Sue Moon received her B.S. and M.S. from Seoul National University, Seoul, Korea, in 1988 and 1990, respectively, all in computer engineering. She received a Ph.D. degree in computer science from the University of Massachusetts at Amherst in 2000. From 1999 to 2003, she worked in the IPMON project at Sprint ATL in Burlingame, California. In August of 2003, she joined KAIST and now teaches in Daejeon, Korea. She has served as TPC co-chair for ACM Multimedia and the ACM SIGCOMM MobiArch Workshop, general chair for PAM, and TPC for many conferences, including SIGCOMM 2010, NSDI 2008 and 2010, WWW 2007–2008, INFOCOM 2004–2006, and IMC 2009. She won the best paper award in ACM SIGCOMM Internet Measurement Conference 2007, and was awarded the Amore Pacific Woman Scientist Award in 2009. Her research interests are network performance measurement and analysis, online social networks, and networked systems.