Special Issue on Multimedia Streaming

Guest Editorial

The penetration of broadband residential access and high-speed wireless access has dramatically increased the demand for multimedia content. As the broadband access rate increases, multimedia streaming applications are embedded in more and more hardware devices, e.g., TVs, cars, and cell phones. In the past decade, multimedia streaming has evolved from simple client-server applications to large-scale Peer-to-Peer (P2P) applications. Hundreds of sites, including CNN, MSN, and Yahoo, have joined the parade of multimedia streaming. Furthermore, sites like YouTube also provide the Video-on-Demand services that allow users to view the video clips from any playback point. In addition to video and audio streaming, the advances in multimedia streaming also stimulate the emerging Internet telephone and television services.

Multimedia applications are significantly different from other conventional networking applications. In particular, multimedia applications are very sensitive to end-to-end delay and bandwidth fluctuation, but are tolerable to occasional data loss. The quality of the video highly depends on the available bandwidth across the network. Endeavors have been made by researchers and application developers to improve the QoS (Quality of Services) in multimedia streaming from all aspects. On the application end, various codec and compression techniques have been proposed, e.g., MPEG and H.261, to reduce the bandwidth demand while maintaining the quality of the multimedia content. In communication networks, protocols and algorithms have been proposed and analyzed, including RTSP, RTP, RTCP, and SIP. From the network architecture point of view, we have the client-server setup and the Peer-to-Peer infrastructure. YouTube is by far the most successful client-server approach to video streaming with the cost of high bandwidth demand at the content source. In contrast, the Peer-to-Peer (P2P) approach invited peers (end hosts) to contribute their upload bandwidth and computational resources, resulting in better scalability, flexibility, and less demand on the servers. The success of P2P multimedia streaming has been demonstrated by systems like Octoshape and UUSee. Despite the advantages and the disadvantages of the existing solutions and technologies, there is no doubt that multimedia streaming is growing at a phenomenal rate.

In this special issue, we present six high-quality publications after a thorough peer-review process. The papers touch upon various aspects of multimedia streaming, from protocol/algorithm design to system analysis/characterization. Interestingly, the papers well reflect the current trends in multimedia streaming, namely, supporting Video-on-Demand functionalities and making the streaming systems more network friendly. The papers can broadly be divided into three categories. The first category proposes systems around different coding techniques. This is very essential as coding techniques can fundamentally changes the way multimedia content being disseminated across the network. The second category proposes systems to enhance viewing experience. As Video-on-Demand becoming an indispensable feature of multimedia streaming, it has received a great amount of attention in real-world applications research and development. It is very important as well as challenging to provide real-time user interaction while maintaining the playback quality in a streaming session. The third category focuses on network friendliness of multimedia streaming systems. The rapid growth in streaming traffics draws concerns for ISPs. To this end, papers in this category propose and analyze various approaches for making multimedia streaming systems more efficient in utilizing network resources.

The first two papers are oriented around two coding techniques, namely, scalable video coding (H.264) and network coding. The first paper, "Distributed Congestion Control of Scalable Video Streams" by J. Wagner and P. Frossard, extends a utility-based congestion control framework to efficiently handle heterogeneous delays in the network and video streaming. The authors proposed an implementation of the media-friendly distributed congestion control scheme for H.264/SVC streams. The simulation results show that bandwidth allocated in the propose systems respects network constraints and converges rapidly to a stable state. The second paper "A Framework for Video Network Coding with Multi-generation Mixing" by M. D. Halloush and H. Radha, proposes a framework for addressing the inefficiency in applying network coding in multimedia streaming. When network coding is applied within a generation of video packets, portions of the video can become undecodable even if only one packet is missing in a generation. The authors proposed to incorporate scalable video coding to enhance the reliability of the streaming service. In other words, lower video layers are encoded with higher layers using network coding to improve the decidability of the original video. The work is very interesting and timely.

The next paper by J. Noh and B. Girod, "Time-Shifted Streaming in a Tree-Based Peer-to-Peer System," presents a new design for live video multicast and Video-on-Demand (VoD) during a live session. The authors extend the Stanford Peer-to-Peer Multicast (SPPM) protocol to support playback control in VoD. The time-shifted streaming refers to the ability to store received video packets at participating peers and to share them with other peers upon request. The system is further detailed with a fast prefetching technique and peer selection scheme to improve the interactive response time of the VoD feature in a live session. The experimental results show that the proposed system significantly reduces the bandwidth demand on the server while providing better video availability.

The remaining three papers focus on reducing traffic imposed by streaming systems. The first paper, "Network Friendly Transmission Control for Progressive Download over TCP" by H. Hisamatsu, G. Hasegawa, and M. Murata, is

doi:10.4304/jcm.7.3.177-179

motivated by the tcpdump analysis on traffic from YouTube and nicovideo to a university network. The measurements show that the video streaming using TCP consumes excessive bandwidth and sends data at a much higher rate than the needed rate. The authors propose a transfer mechanism for video streaming over TCP that are able to maintain the buffers at a reasonable level on the receivers, in order to conserve network bandwidth. The second paper, "Characterizing Locality-Aware P2P Streaming" by J. Zhao and C. Wu, presents an analytical study on the relation between streaming performance and traffic locality in P2P live streaming systems. The paper provides several useful suggestions for reducing cross-ISP traffic volume, including server capacities into ISPs, which concurs with the next paper. The last paper, also our invited paper, "An Analysis and Comparison of CDN-P2P-hybrid Content Delivery System and Model" by Z. Lu, Y. Wang and Y. R. Yang, provides a survey on the recently emerging ideas on combining stable edges in content delivery networks (CDN) and scalable last-mile transmission from P2P networks, to control the traffic volume and to make streaming systems more ISP friendly. The paper points out that it is important to address the reliability, security, and ISP-friendliness in multimedia streaming systems. Furthermore, we still need better ways to integrate CDN and P2P without introducing additional overheads.

We feel that this special issue succeeds in its attempt to give readers an insight into on-going activities on fundamental as well as applied research in multimedia streaming systems. We would like to thank all the authors who submitted their work for this issue, and the reviewers for their timely and constructive feedback. With these papers, we hope to provide readers a comprehensive view of our current achievements and shed lights on future research direction in multimedia streaming. We also thank the staff at the JCM Academy Publisher for their help in handling the manuscripts. Lastly, we would like to extend our sincere appreciation to Dr. Haohong Wang, Editor-in-Chief of the Journal of Communications, for his great support and providing us the opportunity to organize this special issue.

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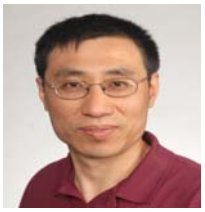
Mohammed Ghanbari is an Emeritus Professor at the School of Computer Science and Electronic Engineering, University of Essex, UK with the main research interest in the areas of Video Networking . He had the Chair of Video networking from 1996-2011 at the same school. He is best known for his pioneering work on layered video coding (which earned him IEEE Fellowship in 2001), now is known as SNR scalability in the standard video codecs. He has registered for eleven international patents and has published more than 550 technical articles on various aspects of video networking. He has authored/co-authored 6 books and edited a book, where his book *Video coding: an introduction to standard codecs,* published by IET press in 1999, received the year 2000 best book award by IET. He is a Fellow of IEEE, Fellow of IET and Chartered Engineer (CEng).

Hideki Tode received the B.E., M.E., and Ph.D degrees in communications engineering from Osaka University, Japan, in 1988, 1990, and 1997, respectively. He was adopted as assistant professor at the Department of Communications Engineering, Osaka University on Dec. 1991. In 1998 and 1999, he promoted to a lecturer and associate professor in the Department of Information Systems Engineering, and, in 2002, shifted in the Department of Information Networking, Graduate School of Information Science and Technology, Osaka University. From 2008, He is a professor in the Department of Computer Science and Intelligent Systems, Graduate School of Engineering, Osaka Prefecture University. His current research interests include high speed router architecture, QoS-aware network controls, optical network architecture and application-level contents distribution technologies. Dr.Tode is a member of IEEE, and a senior member of IEICE Japan.

Mea Wang received her Bachelor of Computer Science (Honours) degree from the Department of Computer Science, University of Manitoba, Canada, in 2002. She received her Master of Applied Science and Ph.D. degrees from the Department of Electrical and Computer Engineering at the University of Toronto, Canada, in 2004 and 2008, respectively. She is currently an Assistant Professor in the Department of Computer Science at the University of Calgary.

Her research interests include peer-to-peer networking, multimedia networking, cloud computing and networking system design and development. Her work on practical network coding for P2P multimedia streaming system, "R2: Random Push with Random Network Coding in Live Peer-to-Peer Streaming," has been highly recognized and won the 2009 Multimedia Communications Best Paper Award. She has been serving as an Associate Editor for the Journal of Communications since 2010, the Guest Editor of the Special Issue on "Multimedia Streaming (P2P)" and the Special Issue on "Multimedia Streaming (Scalability)" for IEEE Multimedia Communications Technical Committee E-Letter in October and December 2009, respectively.



Bin Wei is a research staff member at AT&T Labs - Research. He has been working on multimedia, communications and middleware support for various user devices, ranging from a display wall to handheld mobile devices. He has published many papers in major conferences. Currently, he is serving as the Vice Chair for IEEE Multimedia Communications Technical Committee and a Steering Committee member for International Conference on Multimedia and Expo (ICME). He received a Ph.D. on Computer Science at Princeton University. He is a Senior Member of ACM.