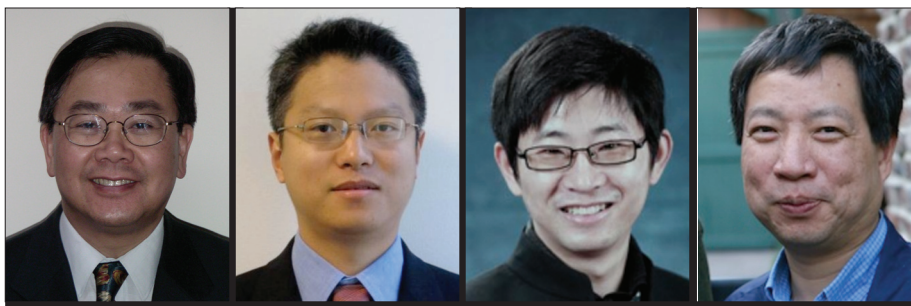


MOBILE CLOUD COMPUTING



VICTOR C. M. LEUNG

YONGGANG WEN

MIN CHEN

CHUNMING RONG

Latest advances in mobile communication networks and the increasing penetration of smart phones are transforming the mobile Internet and are empowering end users with rich mobile experience. However, the limited onboard computing and information/energy storage capabilities of mobile devices are hampering their ability to support the increasingly sophisticated applications demanded by users. The emerging cloud computing technology offers a natural solution to extend the limited capabilities of mobile devices. The resulting new paradigm of mobile cloud computing is being embraced by researchers and practitioners as an exciting new way to extend the capabilities of mobile devices and mobile platforms, which has the potential for profound impacts on the business environment and people's daily life.

Empowered by mobile cloud computing, previously infeasible mobile applications are finding their ways into mobile devices. These emerging applications range from mobile storage and synchronization, fast content delivery, audio/video streaming, to interactive rich media services. Nevertheless, the implementation and wide deployment of these applications faces various technical challenges across the different layers of wireless networks. The main challenges of mobile cloud computing include, but are not limited to:

- The development of next-generation mobile cloud computing services and applications
- The development of dynamic allocation algorithms for smart devices connected to mobile cloud services
- The design of access and communication schemes for cloud computing in mobile environment
- The required advances in mobile cloud computing so as to enable mobile rich media

In response to the call for contributions, we have received 30 paper submissions. After two rounds of careful reviews, seven outstanding papers have been collected for this special issue, addressing the various aspects of mobile cloud computing, such as mobile cloud computing services and applications,

virtual machine migration mechanisms, uninterrupted communication in wireless heterogeneous networks, as well as mobile cloud for rich media.

The volume opens with a comprehensive survey on diverse ways of combining cloud computing and mobile platforms towards a new computing/communications paradigm. In "Gearing Resource-Poor Mobile Devices with Powerful Clouds: Architecture, Challenges, and Applications," Liu *et al.* provide a complete taxonomy of mobile-cloud offloading architectures and a new genre of real-world commercial applications. The authors envision the seamless integration of heterogeneous cloud platforms and mobile devices into a human-centric computing ecosystem.

Contemporary mobile devices generate heavy loads of computationally intensive tasks, but are characterized by limited processing and energy capabilities. Cloud facilities appear as a promising option that enables mobile devices-clients to offload their tasks to remote cloud servers. Due to the user mobility though, minimizing task execution is a challenging task. In the second article, "Migrate or Not? Exploiting Dynamic Task Migration in Mobile Cloud Computing Systems," Gkatzikis and Koutsopoulos demonstrate how efficient virtual machine (VM) migration mechanisms can be used to deal with the inherent performance uncertainty of mobile cloud computing environments. The authors advocate the need for bringing the computing power of the cloud closer to the mobile user and identify user mobility, multinancy cost and data volume evolution as the driving forces behind migrations. The article also provides a detailed description of open research problems related to VM migrations.

As the wireless environment is highly volatile, reliable and uninterrupted connections over wireless heterogeneous networks are important for non-interruptive mobile cloud services. In the third article, "Challenges on Wireless Heterogeneous Networks for Mobile Cloud Computing," Lei *et al.* point that providing a cloud service with quality of service guarantee requires proper radio resource management that

considers not only the unique characteristics of the mobile cloud computing applications but also the wireless heterogeneous networks. A framework of heterogeneous network that can fulfill mobile cloud computing service requirements has been proposed, where each functional block needs to make a joint decision towards optimal performance.

The remaining articles focus on mobile cloud media. The fourth article, “A Survey of Mobile Cloud Computing for Rich Media Applications,” coauthored by Xu and Mao focuses on mobile media cloud. The article presents a comprehensive survey of the technical challenges and existing solutions towards exploiting mobile cloud computing for rich media applications, such as video streaming and online gaming. The authors review the state-of-the-art of prototyping efforts and discuss open problems in this important area. In the fifth article, “Exploring Blind Online Scheduling for Mobile Cloud Multimedia Services,” Zhou *et al.* propose a blind online scheduling scheme for practical mobile cloud multimedia services in which the service time and service request are totally unknown for the system operator.

While the demands of video streaming services over the mobile networks have been soaring over these years, the wireless link capacity cannot practically keep up with the growing traffic load. The gap between traffic demand and link capacity, along with time-varying link conditions, results in poor service quality of video streaming services over the mobile networks, such as intermittent disruptions and long buffering delays. In the sixth article, “Cloud-Assisted Real-Time Transrating for HTTP Live Streaming,” Lai *et al.* propose a real-time transcoding mechanism with dynamic bandwidth demand on cloud side, which contains HTTP live streaming protocol, a coding mode transition state machine, and three bandwidth evaluations of error patterns. In the last article entitled “Cloud-Assisted Adaptive Video Streaming and Social-Aware Video Prefetching for Mobile Users,” Wang *et al.* introduces a new framework to deploy cloud agents for each active user. Such agents can perform adaptive video streaming based on the scalable video coding technique, which results in acceptable performance in the cloud. Besides, agents enable social-aware video prefetching based on the analysis of user social activities and access delays, so that the videos shared among friends are effectively prefetched to mobile users in advance via the cloud service.

In closing, we would like to thank all the authors who submitted their research work to this special issue. We would also like to acknowledge the contribution of many experts in the field who have participated in the review process, and provided helpful suggestions to the authors on improving the content and presentation of the articles. We would in

particular like to thank Professor Hsiao-Hwa Chen, the Editor-in-Chief, for his support and very helpful suggestions and comments during the delicate stages of concluding the special issue.

BIOGRAPHIES

VICTOR C. M. LEUNG [F] (vleung@ece.ubc.ca) [F'03] is a Professor of Electrical and Computer Engineering and holder of the TELUS Mobility Research Chair at the University of British Columbia (UBC). He has contributed some 650 technical papers, 25 book chapters and 5 book titles in the areas of wireless networks and mobile systems. He was a Distinguished Lecturer of the IEEE Communications Society. He has been serving on the editorial boards of the IEEE Transactions on Computers, IEEE Wireless Communications Letters and several other journals, and has contributed to the organizing and technical program committees of numerous conferences. Dr. Leung was a winner of the 2012 UBC Killam Research Prize, and the IEEE Vancouver Section Centennial Award.

YONGGANG WEN is an Assistant Professor with School of Computer Engineering at Nanyang Technological University, Singapore. He received his PhD degree in Electrical Engineering and Computer Science (with minor in Western Literature) from Massachusetts Institute of Technology (MIT), Cambridge, MA, USA, in 2008; his MPhil degree (with honor) in Information Engineering from Chinese University of Hong Kong (CUHK), Hong Kong, China, in 2001; and his BEng degree (with honor) in Electronic Engineering and Information Science from University of Science and Technology of China (USTC), Hefei, Anhui, China, in 1999. Previously, he has worked in Cisco as a Senior Software Engineer and a System Architect for content networking products. He has also worked as a Research Intern at Bell Laboratories, Sycamore Networks and Mitsubishi Electric Research Laboratory (MERL). He has published more than 60 papers in top and prestigious conferences. His system research has resulted in two patents and has been featured by international media (e.g., Straits Times, Business Times, Lianhe Zaobao, Channel News Asia, ZDNet, CNet, ACM Tech News, United Press International, Times of India, Yahoo News, etc.). His research interests include cloud computing, mobile computing, multimedia network, cyber security and green ICT.

MIN CHEN (minchen@ieee.org) [S'09] is a professor in School of Computer Science and Technology at Huazhong University of Science and Technology. He was an assistant professor in School of Computer Science and Engineering at Seoul National University from Sep. 2009 to Feb. 2012. He received Best Paper Award from IEEE ICC 2012, and Best Paper Runner-up Award from QShine 2008. He is a Guest Editor for IEEE Network, IEEE Wireless Communications, etc. He is Symposium Co-Chair for IEEE ICC 2012 and IEEE ICC 2013. He is General Co-Chair for IEEE CIT 2012. He is an IEEE Senior Member since 2009.

CHUNMING RONG (chunming.rong@uis.no) [S'XX] is head of the Center for IP-based Service Innovation (CIPSI) at the University of Stavanger (UiS) in Norway, where his work focus on big data analytics, cloud computing, security and privacy. He is also an advisor for SINTEF ICT and has extensive contact network and projects in both the industry and academic. He was visiting chair professor at Tsinghua University (2011–2013) and served also as an adjunct professor at the University of Oslo (2005–2009). He is co-founder and chairman of the Cloud Computing Association (CloudCom.org) and its associated IEEE conference and workshop series. He is vice chair of IEEE Computer Society Special Technical Community (STC) for Cloud Computing, and is the co-Editors-in-Chief of the Journal of Cloud Computing (ISSN: 2192-113X) by Springer and associate editor of the IEEE Transactions on Cloud Computing (TCC). He received award as Editor's Choice in Discrete Mathematics for 1999, ConocoPhillips Communication Award for 2007, and Sparebank 1 SR-bank Innovation Award for 2011. He coauthored a book titled “Security in Wireless Ad Hoc and Sensor Networks” published by John Wiley & Sons in 2009. Prof. Rong has extensive experience in managing R&D projects funded by both industry and funding agencies, such as the Norwegian Research Council and the European Framework Programs.