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Guest Editorial: Introduction to the Special Section on Sensor Data Computing as a Service in Internet of Things

CHARITH PERERA, (Member, IEEE), ATHMAN BOUGUETTAYA, (Fellow, IEEE), SALIL KANHERE, AND CHI HAROLD LIU, (Senior Member, IEEE)

The Internet-of-Things (IoT) has gained significant attention over the past decade. It "allows people and things to be Anytime, Anyplace, with Anything and Anyone, ideally using Any path/ network and Any service". The IoT promises to create a world where everyday objects (also called *things*) around us are connected to the Internet and communicate with each other with minimum human intervention. The number of things connected to the Internet exceeded the number of people on Earth in 2008. The sensory data these objects produce have significant value to many different parties from supply chain management to healthcare services to many more.

Today, the Internet of Things (IoT) is advanced enough that combining different IoT solutions can capture large amounts of data, covering numerous aspects of our lives, including behaviors, habits, preferences, life patterns, resource consumption, and so on. Over the last decade, we have seen a large number of these IoT solutions appear on the market. Typically, each of these IoT solutions are designed to perform a single or minimal number of tasks. For example, a smart sprinkler may only be activated if the soil moisture level goes below a certain level in the garden. Smart plugs allow users to control electronic appliances (including legacy appliances) remotely or create automated schedules. Undoubtedly, such automation not only brings convenience to their owners but also reduces resource wastage.

Sensing as a Service[1] model envisions to offer sensor data to interested consumers on demand. It will provide sensing capabilities as a service similar to other utility-based models such as infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), and software-as-a- service (SaaS). Sensing-as-a-service model is also expected to be built on top of an IoT infrastructure and creates novel business and financial opportunities to increase the sustainability of IoT.

Sensing as a Service is business model which support data exchange between data owners and data consumers. When there are many data owners and potential data consumers, it creates and open data market. In this market, data may not be freely available for everyone to access, but only the meta data would be available. The interested data consumers will need to evaluate the available meta data schemes and negotiate with the relevant data consumers in order to get access to their data. Sensing as a service model utilize the data primarily generated by IoT products. Data collected by different IoT products has a significant value when they are aggregated and processed in large scale (e.g., Data collected from 10,000 households where each house has ten different IoT products). Sensing as a Service model allows interested parties to buy data from an open market. Sensing as a Service model needs to be supported by wide range of sensing, storage, data analysis, and communication technologies. Majority of these sensor data will come from the internet connected smart objects.

This special section address some of the above fundamental issues and applications of sensor data computing as a service in Internet of Things domain. This special section contains three papers chosen after an extensive review process from 12 submitted manuscripts.

The first paper, *"A Two-layer Dimension Reduction and Two-tier Classification Model for Anomaly-Based Intrusion Detection in IoT Backbone Networks"* by Hamed Haddad Pajouh, Reza Javidan, Raouf Khaymi, Ali Dehghantanha, and Kim-Kwang Raymond Choo have presented a novel model for intrusion detection based on two-layer dimension reduction and two-tier classification module, designed to detect malicious activities such as User to Root (U2R) and Remote to Local (R2L) attacks. Industrial Internet of Things (IIoT) has different security requirements, and one of which is studied by the authors of "Certificateless Searchable Public Key Encryption Scheme for Industrial Internet of Things". Specifically, they studied the problem of searchable encryption and explained the need for an efficient scheme for IIoT applications, before presenting their SCF-MCLPEKS (secure channel free certificateless searchable public key encryption with multiple keywords scheme). A security scheme needs to be proved mathematically or using some formal methods, and similarly the authors proved the security of SCF-MCLPEKS in a widely accepted security model. The authors also evaluated the performance of their proposed scheme.

[1]https://leanpub.com/sensingasaservice

The next work *"Sender-Receiver Role-based Energy-aware Scheduling for Internet of Underwater Things"* by Ming Xu and Ling Liu, has focused on the problem of providing a scheduling service to support the transmission of sensory data of these smart underwater objects with high computation-utilization and high energy-efficiency. They have designed and implemented a sender-receiver role-based scheduling protocol for Energy-Aware scheduling with Spatial-Temporal reuse, called EAST. Their work shows that EAST outperforms existing representative MAC protocols in terms of network throughput, successful delivery ratio and energy consumption.

The final paper *"Utility Based Data Computing Scheme to Provide Sensing Service in Internet of Things"* by Yilong Hui, Zhou Su, and Song Guo by Yilong Hui *et al.* studied the scheme to provide sensing service in IoTs with a utility-based data computing which can help vehicles collect mobile data in the urban area. In particular, by introducing roadside buffers to obtain sensor data, a bargaining game model is developed with incentives where the optimal price can be determined to provide sensing service for IoTs.

Finally, we would like to express our thanks to the authors of all submitted papers and the referees for their outstanding review in a timely manner. This special section would not have been possible without the support of Prof. Fabrizio Lombardi, the former *IEEE TETC* Editor-in-Chief who stood behind our effort on this special section on Sensor Data Computing as a Service in Internet of Things. We would also like to thank Ms. Alexandra Titta of *IEEE TETC* for her help throughout this project.

CHARITH PERERA,
Cardiff University, United Kingdom
ATHMAN BOUGUETTAYA,
University of Sydney, NSW, Australia
SALIL KANHERE,
University of NEW South Wales, Australia
CHI HAROLD LIU,
Beijing Institute of Technology, China

CHARITH PERERA received the BSc (hons) degree in computer science from Staffordshire University, Stoke-on-Trent, United Kingdom, in 2009, the master of business administration (MBA) degree from the University of Wales, Cardiff, United Kingdom, in 2012, and the PhD degree in computer science from the Australian National University, Canberra, Australia. He is a lecturer (assistant professor) in computing science with Cardiff University, United Kingdom. He completed his post-doctoral with Newcastle University, United Kingdom and Open University, United Kingdom. Previously, he was with the Information Engineering Laboratory, ICT Centre, CSIRO, Australia, where he is involved in the EU Open source blueprint for large scale self-organizing cloud environments for IoT applications (FP7 OpenIoT) Project. His research interests include Internet of Things, sensing as a service, infrastructure and architectures, privacy, and security. He is a member of the ACM and IEEE.

ATHMAN BOUGUETTAYA a received the PhD degree in computer science from the University of Colorado at Boulder, in 1992. He is a professor and the head of the School of Computer Science, University of Sydney, NSW, Australia. He was previously a science leader in service computing with CSIRO ICT Centre, Canberra. Australia. Before that, he was a tenured faculty member and program director with the Computer Science Department, Virginia Polytechnic Institute and State University (commonly known as Virginia Tech). He is a founding member and past the president of the Service Science Society, a non-profit organization that aims at forming a community of service scientists for the advancement of service science. He is or has been on the editorial boards of several journals including, the *IEEE Transactions on Services Computing*, the *ACM Transactions on Internet Technology*, the *International Journal on Next Generation Computing*, the *VLDB Journal*, the *Distributed and Parallel Databases Journal*, and the *International Journal of Cooperative Information Systems*. He is also on the editorial board of the Springer-Verlag book series on Services Science. He was a guest editor of a number of special issues including the special issue of the *ACM Transactions on Internet Technology* on Semantic Web services, a special issue of the *IEEE Transactions on Services Computing* on Service Query Models, and a special issue of the *IEEE Internet Computing* on Database Technology on the web. He has published more than 180 books, book chapters, and articles in journals and conferences in the area of databases and service computing (e.g., the *IEEE Transactions on Knowledge and Data Engineering*, the *ACM Transactions on the Web*, the *World Wide Web Journal*, the *VLDB Journal*, SIGMOD, ICDE, VLDB, and EDBT). He received several federally competitive grants in Australia (e.g., ARC) and the US (e.g., NSF, NIH). He is a fellow of the IEEE and a distinguished scientist of the ACM.

SALIL KANHERE received the MS and PhD degrees in electrical engineering from Drexel University, Philadelphia, Pennsylvania, in 2001 and 2003, respectively. He is currently an associate professor with the School of Computer Science and Engineering, University of New South Wales, Sydney, NSW, Australia. He is also a contributing research staff member with National ICT Australia, Sydney, NSW, Australia, and a faculty associate with the Institute for Infocomm Research, Singapore. He has authored or coauthored more than 140 peer-reviewed articles and delivered more than 15 tutorials and keynote talks. His current research interests include pervasive computing, crowdsourcing, embedded sensor networks, mobile networking, privacy, and security. He is a senior member of the ACM. He currently serves as the area editor of the *Pervasive and Mobile Computing*, the *Computer Communications*, the *International Journal of Ad Hoc and Ubiquitous Computing*, and the *Mobile Information Systems*. He regularly serves on the organizing committee of a number of IEEE and ACM international conferences (e.g., IEEE PerCom, ACM MobiSys, ACM SenSys, ACM CoNext, IEEE WoWMoM, IEEE LCN, ACM MSWiM, IEEE DCOSS, IEEE SenseApp, ICDCN, and ISSNIP). He was a recipient of the Humboldt Research Fellowship in 2014.

CHI HAROLD LIU (M'10-SM'15) received the BEng degree in electronic and information engineering from Tsinghua University, China, in 2006, and the PhD degree in electronic engineering from Imperial College, United Kingdom, in 2010. He is currently a full professor and vice dean with the School of Computer Science and Technology, Beijing Institute of Technology, China. He also serves as the director of IBM Mainframe Excellence Center (Beijing) and IBM Big Data and Analysis Technology Center. Before moving to academia, he worked for IBM Research - China as a staff researcher and project manager from 2010 to 2013, worked as a postdoctoral researcher with Deutsche Telekom Laboratories, Germany, in 2010, and as a research staff member with IBM T. J. Watson Research Center, in 2009. His current research interests include the big data analytics, mobile computing, and machine learning. He received the IBM First Plateau Invention Achievement Award in 2012, and IEEE DataCom'16 Best Paper Award. He has published more than 90 prestigious conference and journal papers and owned 14 EU/UK/U.S./China patents. He serves as the area editor of the *KSII Transactions on Internet and Information Systems* and (lead) guest editor of the *IEEE Transactions on Emerging Topics in Computing* and the *IEEE Sensors Journal*. He was the book editor for 11 books published by Taylor & Francis Group and China Machine Press, China. He serves as the TPC for IEEE INFOCOM'19, IWQoS'19, and symposium chair for ICC'20 on Next Generation Networking; and has served as the general chair of IEEE SECON'13 workshop on IoT Networking and Control, IEEE WCNC'12 workshop on IoT Enabling Technologies, and ACM UbiComp'11 Workshop on Networking and Object Memories for IoT. He served as the consultant to Asian Development Bank, Bain & Company, and KPMG, and the peer reviewer for Qatar National Research Foundation, and National Science Foundation, China. He is a fellow of the IET, and a senior member of the IEEE. For more information, please visit: http://haroldliu.weebly.com