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Internet of Things: Opportunities and Challenges to Business, Society, and IS Research

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Internet of Things: Opportunities and Challenges to Business, Society, and IS Research

Panel

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Abstract

Recent research reports illustrate that Internet of things (IoT) is projected to be a multi-trillion dollar opportunity by 2020, with 50 billion devices connected by then. The IoT is a leading-edge topic in Information Systems (IS). In a hyper-connected economy, IoT can transform a business radically. Numerous devices are being produced with software and connectivity added to them, making them what is commonly referred to as "smart" devices. The IoT is in position to make a huge impact on the world where it is considered to be the next industrial revolution. It will influence the way consumers, businesses, and governments interact with the world. The panel covers IoT issues, such as devices/connection efficiency, security, privacy, analytics, monetization and end-user services, IoT and Blockchain convergence, platform and standards, and compliances. Three themes, i.e., how IoT transforms business and society, the bright and dark sides of IoT, and IoT research questions in the IS field will be explored.

Keywords: Internet of Things, Low Power Wide Area Network, Device and Connection Efficiency, Data Analytics, Monetization, Security, IoT Platform and Standards, Blockchain, Privacy, Compliance
Introduction

The Internet of Things (IoT) is a leading edge topic in Information Systems field. According to Gartner, Deloitte, McKinsey, and Info-Tech Research Group reports (Raynor and Cotteler. 2015; Info-Tech Research Group. 2015; Zhang. 2016), the IoT is projected to be a multi-trillion dollar opportunity by 2020, with 50 billion devices connected by then. In a hyper-connected economy and environment, IoT can transform a business radically. Numerous physical devices are being produced with software and connectivity, making them what is commonly referred to as "smart" devices. The connectivity can be described as "instrumented", "interconnected", and "intelligent". IoT is in position to make a huge impact on the world as we know it. IoT may be the next industrial revolution. It will influence the way consumers, businesses, and governments interact with the world. To be or not to be connected will not be the question as IoT becomes a way of life.

IoT can be applied to and adopted in various industries, such as utilities, transportation and logistics, consumer electronics, public sectors.smart cities, smart buildings, and industry automation. As shown in Figure 1, there are a number of use cases (Shim et al. 2017; Kamilaris & Pitsillides. 2016). There are two basic IoT divisions: one is Industrial IoT; the other is Consumer IoT. Industrial IoT would be used, for example, by power companies to control the electrical grid, and transportation agencies to control traffic signs. Consumer IoT encompasses common devices for every day use, such as: smart phones, tablets, refrigerators, TVs and household appliances. These represent only a very small handful of devices, as it also covers remote monitoring devices used in places like daycares, hospitals, and homes for home security.

There are two types of spectrum in the low power wide area network: unlicensed spectrum and licensed spectrum. The difference between these technology types include: the radio spectrum that the technologies use [unlicensed versus licensed] as well as the commercial strategies deployed by companies. Several major technology standards are key players and competitors in the unlicensed spectrum [i.e., Sigfox, LoRa]; the other technology standards are key players in licensed spectrum [i.e., LTE CAT-M1, ECGSM, LTE CAT-M2] (Shim et al. 2017; Georgiou and Raza. 2017).

Businesses in all industries can use IoT to improve productivity, reduce operating expenses, and assist with new product development. We can see the implications of IoT everywhere. As a real-world example, Coca-Cola employs IoT to improve their business by gathering real-time data on products that need to be restocked in their vending machines. Coca-Cola is also able to pull data on which products are selling well in order to improve their product line (Coates. 2016).

source: "IoT and the Opportunities for Mobile Operators" at IoT Panel Discussion by J. P. Shim (GSU), Rob v.d.Dam (IBM), C. Coursey (AT&T), and D. Barney (Synapse Wireless, Inc.), 2017 WTS/IEEE.

Figure 1. IoT in Various Industries and Use Cases

source: "IoT and the Opportunities for Mobile Operators" at IoT Panel Discussion by J. P. Shim (GSU), Rob v.d.Dam (IBM), C. Coursey (AT&T), and D. Barney (Synapse Wireless, Inc.), 2017 WTS/IEEE.
There are various issues highlighting IoT, such as connection efficiency, platform and standards, security, data analytics, monetization and end-user services, IoT and Blockchain convergence, privacy, and compliance. For instance, what are the connectivity issues for IoT (i.e., devices with sensors, network connection)? What about the connection efficiency in terms of latency or battery life? What is the current status of IoT platforms and standards? Why is IoT security so important? (Lindqvist and Neumann, 2017) What role does cyber security play in IoT? What characteristics, challenges, and trends of IoT data analytics are being displayed? What about sensor-based service management, IoT data monetization, and new customer services based on radical thinking of IoT possibilities? Does the convergence of IoT and Blockchain technology play a role? What can we expect from benefits and privacy concerns, and compliance of IoT? Numerous related opportunities and challenges in IoT from multi-faceted perspectives should be explored and discussed for a holistic view.

Positions and Exploration

Following an introduction, the panel will discuss various issues of IoT. Building on research experiences on IoT, J. P. Shim will highlight IoT devices and connection efficiency; Alan Dennis will highlight the security in IoT; Olivia Sheng will highlight data analytics in IoT; Matti Rossi will highlight the monetization and end-user services in IoT; Michel Avital will highlight the IoT and blockchain convergence; Carsten Sorensen will highlight platform and standards in IoT; and Aaron French will highlight privacy and compliance issues in IoT. On each issue, panelist(s) will make comments and share his/her own views on the various IoT issues, such as devices and connection efficiency, security, data analytics, data monetization and end-user services, the IoT and blockchain convergence, platform and standards, and privacy and compliances.

Multi-Faceted Perspectives about Internet of Things (IoT):

IoT Devices and Connection Efficiency

Among the requirements in IoT, IoT gateways and devices (i.e., sensors) and IoT communication services (i.e., M2M and networking protocols) are key enablers. Making the most efficient use of radio resources is important for IoT devices. A number of network requirements vary, depending upon latency, penetration, mobility, voice, battery life, size, and throughput. The network operator does not want to use valuable spectrums in an inefficient manner. A poorly designed device may attempt to ping an unavailable server every 5 seconds. There are other important but less tangible reasons for ensuring that IoT devices are efficient on wireless networks, including improved battery life on the device and less signal congestion on the network. With the proliferation of IoT devices, the need for efficiency will only continue to grow. As the use cases for IoT grow, the number of IoT platforms available in the market also increases.

IoT Security

When was the last time you updated the software in your TV? Your thermostat, security camera or baby monitor? If you don’t know, that’s a good illustration of why IoT security is important. Security experts like to say that IoT really stands for Internet of Targets. The October 2016 DDoS attack that targeted the DNS servers operated by DYN and brought down large parts of the Internet for several hours was made possible by thousands of homeowners with poorly secured IOT devices. There are many other cases in which hackers have taken control of IoT devices and used them to spy on their owners, or engage in other malicious activities. These are the harbingers of a new era in security threats, both to ordinary citizens and to the companies that make IoT devices. If hackers took control of your car, would you sue the manufacturer – assuming you escaped safely?

IoT Data Analytics

This section will discuss characteristics, challenges, related fields and trends of the IoT data analytics research. Data input from IoT predominantly consists of data streams which are continuous, distributed, unbounded, non-persistent, and dynamic in nature. Hence, IoT data analytics are related to data stream mining, temporal-spatial analytics, network or social network analytics, real-time analytics as well as
determined data management and processing. IoT’s ubiquitous identification, sensing, and communication features are transforming applications in many domains. IoT data analytics in different domains face several common challenges including data aggregation and segmentation, incomplete data as well as security, privacy, integrity, mobility support, heterogeneity of objects and scalability. In an IoT application, machine objects become another major type of analytics consumers. Hence, context aware intelligence that supports machine objects’ operations also relies on IoT data analytics.

**IoT Monetization and End-User Services**

IoT is seen by many as a way of making supply chain management more efficient and as a means of providing sensor-based service management in b-to-b and/or b-to-c contexts. Although these are viewed as important, this will not recover the costs sunk to development of the complex systems needed. New customer services based on radical rethinking of IoT possibilities offer far more interesting opportunities for providing customer value and monetizing the services. For example, we can follow the processing of food in the supply chain, and it will help in fighting food-borne disease outbreaks, which is a good preventive measure. However, we can also provide the customers detailed information about the food sources and treatment of the plants and animals and thus provide a story and experience through the use of IoT.

**IoT and Blockchain Convergence**

Ever-growing streams of data that are produced by smart objects, smart machines, and smart building have become part and parcel of the human enterprise. By its ability to create a distributed and immutable digital record system, blockchain can turn IoT data traces from a security hazard into a reliable source of valuable data. Leveraging on blockchain technology, IoT devices can send data to a private blockchain-based tamper-resistant database, thereby allowing only authorized stakeholder who are involved with the transaction to access and contribute IoT data without the need for central control and management. Consequently, by providing the transparency across different stakeholders and across borders, IoT on blockchain helps to reduce misrepresentation and fraud in the entire supply chain. IoT on blockchain can provide more than just visibility. The convergence of IoT and blockchain can benefit not only logistics and supply chain management, but also payment and value exchange management, organization and public administration, and advanced collaborative economy on a global scale.

**IoT Platform and Standards**

The Internet of smartphones has taken the world by a storm through scaling of the iOS and Android operating systems and associated smartphones. However, the further increase in scope to the IoT will likely see different innovation dynamics. The expansion into a much more complex device ecology serving a far greater variety of use cases will challenge both non-digital incumbent industries, and current smartphone platform owners. The present duopoly of Apple and Google is seeking to expand their platform scope to driverless cars, watches, home automation, and home entertainment. While these efforts may succeed, IoT will present significant opportunities for firms with already established device ecologies and associated standards. One of the main challenges for the establishment of the IoT is precisely the battle over the standards to enable the emergence of collaborative operating systems and platforms. If platformization ends up as a battle for full control, with resulting fragmentation, we could end up with an Internet of Nothings.

**IoT Privacy and Compliance**

While IoT provides many benefits, there are privacy concerns that must be addressed due to the type of information that can be captured by these devices. The use of location-based services providing abilities to track users and capturing of health information are two major concerns that must be addressed. While much of the information gathered by IoT devices is not sensitive in regards to security, users of these devices regard their personal privacy very highly. In the case of the “My Friend Cayla” doll, the IoT-enabled doll provided opportunities for hackers to listen in or spy on others through Bluetooth capabilities. In addition, compliance issues must also be addressed. While there are currently no IoTspecific compliance standards in place, compliance standards related to healthcare, credit card processing, finance, and ADA are major areas that will require attention to protect IoT users and provide accessibility to everybody.
Discussion Format

The panel will use a roundtable discussion format to seek new insights about IoT in the information systems field. J.P. Shim will serve as the moderator of the panel discussion, taking 5 to 7 minutes to deliver an overview, current status of IoT, IoT devices and connection efficiency. The primary purposes of this panel are: 1) to disseminate new points of view and multi-faceted perspective on IoT; and 2) to stimulate an engaging discussion and/or a healthy debate on potentially controversial topics. The panel will provide a fruitful and informative dialogue to the audience.

Following an introduction by the moderator, the panelists will be given about 35-40 minutes to share their views and to provide an opposing or supporting view on the issues. The panel will be asked to draw on their expertise in the above scribed seven multi-faceted perspectives of IoT to address the two initial questions, as follows:

- How IoT may transform business and society in the future?
- What are the bright and dark sides of IoT?

After the discussion induced by these framing questions, the audience will be invited to voice their opinion in response to the panelists' remarks or question them about the topic for about 20 minutes.

After the first round of two questions and audiences' comments, the panelists will draw on their expertise and knowledge on IoT to address the second round of question for about 15-20 minutes, followed Q&A from the audiences for another 10 minutes. Question for this portion of the panel discussion will be as follows:

- What IS research questions arise for IoT?

Finally, the moderator and the panelists will make brief closing statements (up to one minute each) for the remaining of the time.

Dr. J. P. Shim is CIS faculty and KABC Director at Georgia State. He is Professor Emeritus and was Professor/Notable Scholar/John Grisham Professor at Mississippi State (MSU). He received grants on telecom/RFID/e-business from NSF, Microsoft, Small Business Administration, and Mississippi IHL. He has published books and 100+ articles. He taught at U of Wisconsin, New York University, Chinese U of HK, and MSU. He was WTS/IEEE Program/chair, IoT Track/Panel/chair, and AMCIS Program Co-chair.

Dr. Michel Avital is Microsoft Chair and Professor of IT Management in Copenhagen Business School. Digital innovation is the leitmotif of Michel’s work that examines the crossroads of information, technology, and people. He has published over 100 articles and his recent work is focused on blockchain and distributed ledger technology. Michel serves as an editorial board member of seven leading IS journals and he is an advocate of openness, cross-boundaries exchange and collaboration.

Dr. Alan Dennis is Professor of Information Systems and holds the John T. Chambers Chair of Internet Systems in the Kelley School of Business at Indiana University. He was named a Fellow of the AIS in 2012. His research focuses on three main themes: team collaboration; IT for the subconscious; and digital innovation. He is Editor-in-Chief of AIS Transactions on Replication Research, and AIS Vice President for Conferences.

Dr. Olivia Sheng is Presidential Professor and Emma Eccles Jones Presidential Chair of Information Systems at the University of Utah. Her research focuses on web, text and data mining techniques including clickstream and data stream analysis, and social network analysis. The application domains of her research include healthcare predictive analytics, ambient intelligence, Internet retailing, stock price movement prediction, as well as company valuation and relationship analysis.

Dr. Matti Rossi is a professor of information systems at Aalto University School of Business. He was the winner of the 2013 Millennium Distinction Award of Technology Academy of Finland for open source and data research. His research papers have appeared in journals such as MIS Quarterly, Journal of AIS, Information and Management and Information Systems. He is a past Editor-in-Chief of Communications of the AIS and the President of AIS.
**Dr. Carsten Sorensen** is Reader (Associate Professor) in Digital Innovation within Department of Management at The London School of Economics and Political Science. Carsten has since the 1980s researched digital innovation, for example enterprise mobility, and infrastructures and platform dynamics. He has published widely within, for example, MISQ, ISR, JIT, and ISJ and has 25 years industry consulting experience for IMF, Microsoft, Google, PA Consulting, Orange, Vodafone, Intel, to name just a few.

**Dr. Aaron M. French** is Assistant Professor of MIS at University of New Mexico. He received his PhD from Mississippi State University. His research has been published in the Journal of Information Technology, Information & Management, Behaviour & Information Technology, Journal of Computer Information Systems, and Communications of the AIS. His research interests include Internet of Things, Bring Your Own Device, social networking, big data & analytics, and cross-cultural studies.

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