Program

Time	Plenary: Melati	4201A+4201B (138)	4202 (130)	4203 (130)	4204 (130)	4205 (130)	4301A+4301B (138)	4302 (130)	4303 (130)	4304 (130)	4305 (130)	Exhibit Hall
Monday, February 5												
06:00-21:00												EXH: Internet of Things Showcase at the Exhibit Hall
10:30-12:30		EC: Session on Edge Computing and IoT	VEH: Session on Secure Trust Environment Model for Intelligent Vehicles	UCS: Session on User Centric Security and Privacy for Smart Cities	WAT: Session on Wireless Access Technologies and Architectures for IoT	T2: Tutorial 2 - From Research to Innovation in IoT: Why is Technology Transfer So Hard?	T5: Tutorial 5 - ComFlux: Dynamic Creation of Pervasive Applications from Plug-and-Play Modules		T7: Tutorial 7 - Standardization Landscape in IoT, WoT and Smart Home	T1: Tutorial 1 - Blockchain and Cryptocurrencies	T3: Tutorial 3 - Lightweight Virtualization on IoT Edge Nodes: Unleash the Value of Container Technologies on Low-Power Devices	
12:30-13:30	LN: Lunch (Peony Room)											
13:30-15:30		EC: Session on Edge Computing and IoT	VEH: Session on Secure Trust Environment Model for Intelligent Vehicles	UCS: Session on User Centric Security and Privacy for Smart Cities	WAT: Session on Wireless Access Technologies and Architectures for IoT	T2: Tutorial 2 - From Research to Innovation in IoT: Why is Technology Transfer So Hard?	EES: Session on Energy Efficient Solutions Based on IoT	MA: Session on Military Applications of IoT	BMI: Session on Business Model Innovation and IoT	T1: Tutorial 1 - Blockchain and Cryptocurrencies	T3: Tutorial 3 - Lightweight Virtualization on IoT Edge Nodes: Unleash the Value of Container Technologies on Low-Power Devices	
15:30-16:00	CB: Coffee Break (Peony Room)											
16:00-18:00		T4: Tutorial 4 - Mobile Power for the Internet of Things		T6: Tutorial 6 - Algorithms for Cooperative IoT: From Edge Computing to Smart Social Vehicles	T8: Tutorial 8 - Mobile Edge Cloud: Opportunities and Challenges		EES: Session on Energy Efficient Solutions Based on IoT	MA: Session on Military Applications of IoT	BMI: Session on Business Model Innovation and IoT			

Tuesday, February 6

08:45-09:00	OPEN: Opening Remarks and Overview											
09:00-18:00	KEY: Keynote Speakers: Dr. Yaacob Ibrahim & Bill Ruh											EXH: Internet of Things Showcase at the Exhibit Hall
10:00-10:30	CB: Coffee Break (Exhibit Hall)											
10:30-12:30		V1: Vertical 1 - Smart Cities and Nations	V3: Vertical 3 - Logistics	IFO6: Industry Forum Panel - IOT Security: Issues and Challenges for Mass Market Deployment	H1: Session on IoT and eHealth and AAL (I)	ET1: Session on IoT Enabling Technologies (I)	V2: Vertical 2 - Public Safety, Emergency Response, and Humanitarian Technologies	TOP1a: Topical 1 - Security and Privacy Regimes - Part 1	ENV: Session on IoT and Smart Environments	SP1: Session on Security and Privacy for Internet of Things (I)		
12:30-13:30	LN: Lunch (Peony Room)											
13:30-15:30		V1: Vertical 1 - Smart Cities and Nations	V3: Vertical 3 - Logistics	IFO3: Industry Forum Panel - IoT Industrial Deployment	H2: Session on IoT and eHealth and AAL (II)	ET2: Session on IoT Enabling Technologies (II)	V2: Vertical 2 - Public Safety, Emergency Response, and Humanitarian Technologies	TOP1a: Topical 1 - Security and Privacy Regimes - Part 1	DS: Doctoral Symposium	SP2: Session on Security and Privacy for Internet of Things (II)		
15:00-18:00											JM: IEEE Young Professional and IoTSG Joint Meeting on Internet of Things	
15:30-16:00	CB: Coffee Break (Exhibit Hall)											
16:00-18:00		V1: Vertical 1 - Smart Cities and Nations	V3: Vertical 3 - Logistics	IFO4: Industry Forum Panel - Application of Cyber Physical Systems and IoT in Manufacturing, Transportation, Energy and Healthcare		ET3: Session on IoT Enabling Technologies (III)	V2: Vertical 2 - Public Safety, Emergency Response, and Humanitarian Technologies	TOP1a: Topical 1 - Security and Privacy Regimes - Part 1	UAV: Session on IoT, Drones and UAV	LPWAN: Session on LPWAN Technologies and IoT		

Wednesday, February 7

08:30-10:00	KEY: Keynote Speakers: Jan Rabaey, Maciej Kranz & Tim Hahn											EXH: Internet of Things Showcase at the Exhibit Hall
09:00-18:00												
10:00-10:30	CB: Coffee Break (Exhibit Hall)											
10:30-12:30		TOP5: Topical 5 - Automation and Artificial Intelligence	TOP4: Topical 4 - BlockChains and Applications	IFO2: Industry Session on IoT IC Design	ET4: Session on IoT Enabling Technologies (IV)	ID: Session on IoT Identification	TOP3: Topical 3 - Best Practices, Standards and Open Source - Part 1	TOP1b: Topical 1 - Security and Privacy Regimes - Part 2	SC1: Session on Smart Cities (I)	INF: Session on IoT Infrastructure		
12:30-13:30	LN: Lunch (Peony Room)											
13:30-15:30		TOP5: Topical 5 - Automation and Artificial Intelligence	TOP4: Topical 4 - BlockChains and Applications	IFO1a: Industry Forum Panel - Investment and Entrepreneurship in IoT (I)	ET5: Session on IoT Enabling Technologies (V)	EXP1: Session on IoT Experimental Results and Deployment Scenarios (I)	TOP3: Topical 3 - Best Practices, Standards and Open Source - Part 1	TOP1b: Topical 1 - Security and Privacy Regimes - Part 2	SC2: Session on Smart Cities (II)	SP3: Session on Security and Privacy for Internet of Things (III)	V4: Vertical 4 - Industrial IoT (Part 1)	
15:30-16:00	CB: Coffee Break (Exhibit Hall)											
16:00-18:00		TOP5: Topical 5 - Automation and Artificial Intelligence	TOP4: Topical 4 - BlockChains and Applications	IFO1b: Industry Forum Panel - Investment and Entrepreneurship in IoT (II)	ET6: Session on IoT Enabling Technologies (VI)	EXP2: Session on IoT Experimental Results and Deployment Scenarios (II)	TOP3: Topical 3 - Best Practices, Standards and Open Source - Part 1	TOP1b: Topical 1 - Security and Privacy Regimes - Part 2	SC3: Session on Smart Cities (III)	SP4: Session on Security and Privacy for Internet of Things (IV)	V4: Vertical 4 - Industrial IoT (Part 1)	

Thursday, February 8

08:30-10:00	KEY: Distinguished Panel on Smart Cities and Regulations											
09:00-13:00												EXH: Internet of Things Showcase at the Exhibit Hall
10:00-10:30	CB: Coffee Break (Exhibit Hall)											
10:30-12:30		TOP2: Topical 2 - Smart Cities and Nations (Policy and Regulations)	V4: Vertical 4 - Industrial IoT (Part 2)		LOC: Session on Location and IoT		TOP3: Topical 3 - Best Practices, Standards and Open Source - Part 2	V5: Vertical 5 - IoT for Agriculture	AS1: Session on IoT Application and Services (I)	TM1: Session on Broadly Applicable IoT Techniques and Methods (I)		
12:30-13:30	LN: Lunch (Peony Room)											
13:30-15:30		TOP2: Topical 2 - Smart Cities and Nations (Policy and Regulations)	V4: Vertical 4 - Industrial IoT (Part 2)	IFO5: Industry Forum Panel - Exponential Changes of Industrial IoT Space, Now and Future	IL: Session on Indoor Location			V5: Vertical 5 - IoT for Agriculture	AS2: Session on IoT Application and Services (II)	TM2: Session on Broadly Applicable IoT Techniques and Methods (II)		
15:30-16:00	CB: Coffee Break (Garden Terrace)											
16:00-18:00		TOP2: Topical 2 - Smart Cities and Nations (Policy and Regulations)	V4: Vertical 4 - Industrial IoT (Part 2)		EFC: Session on Edge/Fog/ Cloud Computing and IoT		SCM: IEEE-SA IoT Steering Committee Meeting	V5: Vertical 5 - IoT for Agriculture	AS3: Session on IoT Application and Services (III)			

Monday, February 5, 06:00 - 21:00

EXH: Internet of Things Showcase at the Exhibit Hall

Welcome Reception
Chihhsiong Shih

Room: Exhibit Hall

The 4th IEEE World Forum on Internet of Things features a number of IoT showcases of interest to the attendees at the Exhibit Hall. The Exhibit Hall is located in the Orchard Rooms 4211-4312 at Level 4.

The Exhibit hours are:

Monday, 5 February 2018	06:00 - 21:00 (Welcome Reception)
Tuesday, 6 February 2018	09:00 - 18:00
Wednesday, 7 February 2018	09:00 - 18:00
Thursday, 8 February 2018	09:00 - 13:00

Showcase 1: A Smart Parking Guidance System *Chihhsiong Shih, Tunghai University*

We developed a smart parking guidance system for large scale parking lots. Finding an available empty slots in a busy sector of the city is always an issue for city people. Very often, it takes forever to circle around the parking lot drive way and not being able to find an empty spot. Our system includes sensors such as ultra wave and magnetic sensors mounted on the parking spot and on drive ways. The sensors work with mobile devices to guide the driver toward an empty spot controlled by the central cloud server. The cloud server is in charge of coordinating the complete guiding system. We keep track of the vehicle entering the parking lot. On each turn corner of the drive way, we give the driving direction through the mobile phone in the vocal signals. Once the vehicle parked into the slot, an LED light is turned on indicating the slot is occupied.

Showcase 2: A Smart Exercise Coach for Taichi *Chihhsiong Shih, Tunghai University*

We developed a smart coach IoT system that can guide the Taichi learning process. In a regular Taichi session, the learner generally has to follow the coach's motion in every stroke. However, it is difficult for the coach to correct the learner's stroke in every detail. Learners always miss the tempo or place their limbs in a wrong angle or places without knowing it. We place the 6-axis motion sensors on the arms and limbs of the learners. These sensors detect the inclination angle of the learners. By comparing the inclination angles to those of the coach, we are able to detect the correctness of the Taichi motion of the learner in real time. Once errors are detected, a vibration signal is given to specific parts of the learner. They then correct their motion accordingly.

Monday, February 5, 10:30 - 12:30

EC: Session on Edge Computing and IoT

Room: 4201A+4201B (138)
Chairs: Nikos Kouvelas (Delft University of Technology, The Netherlands), Stefano Savazzi (Consiglio Nazionale delle Ricerche CNR, Italy)

EC.1 10:30 ***Mobile Edge Computing with Network Resource Slicing for IoT***
Syed S Husain (DOCOMO Labs & NTT DOCOMO, USA); Andreas Kunz (Lenovo, Germany); Athul Prasad (Nokia Bell Labs, Finland); Konstantinos Samdanis (Huawei, Germany); JaeSeung Song (Sejong University, Korea)
Slicing Network functions, radio accesses, and Clouds for Internet-of-Things (IoT) is a recent trend towards providing information-centric end-to-end IoT service at the mobile edge cloud. The key idea is to virtualize all the resources from radio accesses to IoT service layers, IoT service providers can automate resource provisioning and management for users at the mobile edge cloud. This paper introduces a recent standards effort on network resource slicing for IoT in various standards bodies such as 3GPP and oneM2M. In particular, standards activities on ETSI Multi-Access Edge Computing (MEC), 3GPP Network Slicing & Virtualization and oneM2M IoT service layer resource slicing are introduced. Finally, this paper proposes a novel Mobile Edge Computing architecture moving required network resources for an IoT service at an edge cloud as close to users as possible so that we can minimize the amount of communications and provide optimal IoT services.
pp. 1-6

EC.2 11:00 ***Subject-oriented Fog Computing: Enabling Stakeholder Participation in Development***
Christian Stary (Johannes Kepler University Linz, Austria); Albert Fleischmann (Interaktiv Expert, Germany); Werner Schmidt (Technische Hochschule Ingolstadt, Germany)
With the increasing demand for advanced customized applications including devices on the edge of communication networks, the design and execution challenges to meet these demands from a development perspective have become prominent. Existing solutions, such as mobile cloud computing so far highly depend on additional infrastructure deployment. Given choreographic development approaches we can build on the capacity to coordinate a number of infrastructure or application components, and adapt them offering individualization opportunities without programming skills. Therefore, we conceive the idea of utilizing modular behavior abstraction, i.e. subjects, as elementary elements of smart infrastructures for application development. Subject-oriented Fog Computing (SFC) provides an architecture that utilizes an interacting multitude of stakeholder-specific behavior encapsulations including near-user edge devices to carry out communication and domain-specific logic execution.
pp. 7-12

EC.3 11:30 ***A Unified Architecture for Integrating Energy Harvesting IoT Devices with the Mobile Edge Cloud***
Venkatraman Balasubramanian and Nikos Kouvelas (Delft University of Technology, The Netherlands); Kishor Chandra (TU Delft, The Netherlands); Venkatesha Prasad (Delft University of Technology, The Netherlands); Artemios G. Voyiatzis (SBA Research, Austria); William Liu (Auckland University of Technology, New Zealand)
Recently, the edge resource provisioning schemes were defined considering the low-latency Mobile Edge Computing (MEC) paradigm. Most of these models only consider battery-powered devices like smart-phones, thus are agnostic to the energy harvesting techniques that achieves a green MEC system. Further, most of the studies on MEC assume unlimited edge resources which is not the case as it is with the conventional data-centers (public clouds). Hence, unrestricted use of edge resources is not ideal. This work mainly considers two problems: (1) the offloading of data traffic from the Internet of Things (IoT) devices that rely on energy harvesting to the MEC entities and (2) assignment of the resources at the MEC. The novelty of this paper lies in the energy scavenging based architecture that is developed over the Contiki OS. Secondly, saving the energy for computations to maximize the lifetime of the sensing nodes by performing the execution of the computationally intensive tasks at the edge which is a single hop away. The proposed architecture uses the ambient triggers to form the sensor network and establish links with computationally capable resources located at the edge. Further, a mathematical model to manage the resources at the edge is proposed. Finally, we evaluate a threshold-policy for optimizing the resources participating in an edge computation service for an IoT scenario and discuss the improvements achieved.
pp. 13-18

EC.4 12:00 ***Cloud Control DTN Utilizing General User' Smartphones for Narrowband Edge Computing***
Takeshi Ogawa (Tokyo Denki University, Japan)
By realizing "narrowband edge computing", which applies low power wireless access network (LPWAN) to communication between the edges and the cloud, it is expected that edge computing will be further economized. However, in some situations, it is necessary to upload a large amount of data that exceeds the capacity of the LPWAN if the data processing cannot be completed within the edge. In this paper, we propose cloud control DTN (CC-DTN) to upload large amounts of data from the edge to the cloud by multi-hop communication using Wi-Fi via the smartphones of general users who happen to be in the vicinity of the edge. With the proposed CC-DTN, the cloud centrally controls the connection between the edges and the smartphones via the LPWAN and LTE networks by using the movement history of the smartphones. Therefore, unlike the existing DTN, where the terminal performs data transmission based on local information exchanged between the terminals, large data can be efficiently transferred to the cloud while suppressing the power consumption of the edge. Furthermore, we report the effectiveness of the proposed method by simulations.
pp. 19-24

T1: Tutorial 1 - Blockchain and Cryptocurrencies

Yong Yuan

Room: 4304 (130)

Blockchain and Cryptocurrencies

Yong Yuan, Institute of Automation, Chinese Academy of Sciences, Beijing, China

Blockchain, as an emerging decentralized architecture and distributed computing paradigm underlying Bitcoin and other cryptocurrencies, has attracted intensive attention in both research and applications recently. Blockchain, especially powered by chain-coded smart contracts, has the full potential of revolutionizing increasingly centralized Cyber-Physical-Social Systems (CPSS) for constructions and applications, and reshaping traditional knowledge automation workflows. The key advantage of blockchain technology lies in the fact that it can enable the establishment of secured, trusted and decentralized autonomous ecosystems for various scenarios, especially for better usage of the legacy devices, infrastructure and resources. Blockchain and smart contracts can be expected to find a wide spectrum of application scenarios in CPSSs, especially the cyber-physical systems with large numbers of IoT (Internet of Things) devices. Actually, blockchain is an elegant solution to IoT, and the novel "blockchain of things (BoT)" can thus lay a solid foundation for connecting the cyber and physical worlds and establishing a decentralized autonomous BoT network. This tutorial will introduce fundamental theories, techniques and possible applications of blockchain and cryptocurrencies. Part 1 of this tutorial is an introduction to Bitcoin and other crypto-currencies. Part 2 presents a hierarchical reference model of the blockchain framework, and discusses its technical details. Part 3 examines the blockchain consensus algorithms. Part 4 discusses the integration of blockchain and IoT, and the framework of the emerging BoT technique. Part 5 lists several potential problems of blockchain. Part 6 presents an illustrative example of blockchain-based intelligent transportation systems. Part 7 concludes, and introduces the future trend of parallel blockchain.

T2: Tutorial 2 - From Research to Innovation in IoT: Why is Technology Transfer So Hard?

Raffaele Giaffreda

Room: 4205 (130)

From Research to Innovation in IoT: Why is Technology Transfer So Hard?

Raffaele Giaffreda, Chief IoT Scientist at FBK, CREATE-NET, Italy

This tutorial will present lessons learnt in more than 6 years of R&D activity in the domain of Internet of Things and it will be structured in three main parts (research, development and business). More in detail, the first part will focus on existing and emerging trends for IoT as it moves out of the Gartner Hype Cycle: Edge Computing for IoT, Analytics and Cognitive IoT, Blockchains for IoT will all be covered amongst other technology oriented research challenges. The second part will illustrate what it takes to transform research ideas and demo prototypes into the development of viable solutions that address real market needs in this highly fragmented and overly-standardised domain. Focus here will be given on IoT platforms for the rapid prototyping and deployment of IoT solutions in Industrial and eHealth contexts. In the third part of the tutorial the presenter will share part of his technology transfer journey focusing on the business aspects and the economic issues one must be ready to tackle in order to bring innovation to fruition in this exciting field.

T3: Tutorial 3 - Lightweight Virtualization on IoT Edge Nodes: Unleash the Value of Container Technologies on Low-Power Devices

Roberto Morabito

Room: 4305 (130)

Lightweight Virtualization on IoT Edge Devices: Unleash the Potential of Container Technologies on Low-Power Nodes

Roberto Morabito, Ericsson Research Finland and Aalto University, Finland

Container-based virtualization has widely spread across the industry and is really making an impact on the development of new generation applications. Although also the IoT world has started benefiting from these emerging technologies, the potential numerous advantages introduced by the use of these tools are still not widely known. The intent of the tutorial is to fill the gap in this respect and to transfer, to a wide IoT audience, the know-how for easily turning container technologies in a powerful IoT tool to be exploited not only in cloud environments. More specifically, the main scope is to provide an exhaustive overview about the aforementioned technologies and at the same time showing how deploying virtualized instances on IoT Edge low-power nodes can lead a disruptive impact, also in resolving two main issues linked to the fragmented IoT world: Heterogeneity and Service Management Complexity. Performance aspect will be also considered, together with concrete demonstrations of how these technologies can be efficiently used in a heterogeneous set of IoT use cases.

T5: Tutorial 5 - ComFlux: Dynamic Creation of Pervasive Applications from Plug-and-Play Modules

Raluca Diaconu, Jean Bacon, Jie Deng and Jatinder Singh

Room: 4301A+4301B (138)

ComFlux: ComFlux: Dynamic Creation of Pervasive Applications from Plug-and-Play Modules

Contributors: Raluca Diaconu, Microsoft Research Ltd, Cambridge, UK; Jean Bacon, Jie Deng and Jatinder Singh, University of Cambridge, UK

ComFlux is a middleware that enables an external management regime, whereby component interactions, communication methods and security constraints can be dynamically defined, extended and updated at runtime - without requiring redeployment or changes to the application logic of the components themselves, and without imposing constraints on system design. ComFlux offers means to 'instruct' components how, when and with whom they should interact, taking into account usability, modularity and access control. The goal is to enable policy enforcement in highly distributed systems, such as the Internet of Things (IoT). The scope of this tutorial is to show the need for mechanisms enabling the external command and control of IoT components, in order to enable their usage in ways and by means not envisaged by their creators. The key benefit of this tutorial is to provide a practical demonstration of the potential for dynamic, external command and control capabilities, focusing on the flexibility, reliability, and usability of IoT components. ComFlux offers a management API to the developer and also opens up its reconfiguration layer externally to make it accessible by others. We demonstrate how to build applications dynamically using an open implementation of ComFlux. This tutorial will be divided in two parts. The first part will argue the necessity of an infrastructure for external management and the model that enables it. The second part will demonstrate how to build applications dynamically using an open implementation of ComFlux to control IoT devices.

T7: Tutorial 7 - Standardization Landscape in IoT, WoT and Smart Home

Soumya Kanti Datta and Thinagaran Perumal

Room: 4303 (130)

Standardization Landscape in IoT, WoT and Smart Home

Soumya Kanti Datta, EURECOM, France
Thinagaran Perumal, Universiti Putra, Malaysia

The Internet of Things (IoT) has ushered another industrial revolution where every aspect of our lives become connected. Our homes, vehicles, healthcare, cities are set to benefit from the IoT. However, at its current state, the products and services in IoT do not interoperate with each other. This creates data, product and security silos and consumers do not get the true benefit of IoT. This tutorial will highlight the current IoT ecosystem, industrial services and consumer products. Then we will provide an in-depth analysis of lack of interoperability leading to market silos. Standard Development Organizations around the world are working to create sustainable IoT standards to address the market fragmentation. The evolution of IoT in the Web of Things (WoT) will be discussed in this context. IEEE P2413, oneM2M IoT architecture and W3C WoT specifications will be discussed. Among industrial alliances, OCF, OMA LwM2M and Zigbee 3.0 will be described. Smart Home is an important vertical in the IoT. Role of IEEE and relevant standards will be covered.

UCS: Session on User Centric Security and Privacy for Smart Cities

Room: 4203 (130)
Chair: Antonio Fernando Skarmeta Gomez (University of Murcia, Spain)

UCS.1 10:30 *A Digital Identity Stack to Improve Privacy in the IoT*
Stephen Wilson (University of New South Wales & Lockstep Technologies, Australia); Nour Moustafa and Elena Sitnikova (University of New South Wales at Canberra, Australia)
The Internet of Things increasingly involves collection, processing and transmission of a wide variety of data to services and other devices. Business and engineering considerations are both increasing the volumes and detail of IoT data flows. Reasonably obvious privacy risks result from IoT-connected devices when they emit identifiable information, for this can reveal the activities of device users. More subtle risks arise when bulk device data is available for analysis, and linkage to auxiliary data sets, because identification or re-identification of users can follow. At the same time, security engineers are now designing for the "Identity of Things", exploiting embedded cryptography and SIM-like modules to help with the authentication and authorization of devices acting as independent agents in the IoT. To help protect privacy while allowing precise authentication, this paper sets out a new model for digital identity management, comprising a stack of identities, attributes, and attribute metadata. As with the familiar OSI network stack, the digital identity stack helps to decouple different layers of authentication technology, so that IoT data is shared on an explicit need-to-know basis, and extraneous disclosures are minimized.
pp. 25-29

UCS.2 11:00 *Secure and Trusted Telemedicine in Internet of Things IoT*
Umar Albalawi (University of Tabuk, Saudi Arabia); Shital Joshi (Oakland University, USA)
Internet of Things (IoT) is a revolutionary technology for the modern society. IoT can connect every surrounding objects for various applications like security, medical fields, monitoring and other industrial applications. This paper considers the application of IoT in the field of medicine. IoT in E-medicine can take the advantage of emerging technologies to provide immediate treatment to the patient as well as monitors and keeps track of health record for healthy person. IoT then performs complex computations on these collected data and can provide health related advice. Though IoT can provide a cost effective medical services to any people of all age groups, there are several key issues that need to be addressed. System security, IoT interchangeability, dynamic storage facility and unified access mechanisms are some of the many fundamental issues associated with IoT. This paper proposes a system level design solution for security and flexibility aspect of IoT. In this paper, the functional components are bounded in security function group which ensures the management of privacy and secure operation of the system. The security function group comprises of components which offers secure communication using Ciphertext-Policy Attribute-Based Encryption (CP-ABE). Since CP-ABE are delegated to unconstrained devices with the assumption that these devices are trusted, the producer encrypts data using AES and the ABE scheme is protected through symmetric key solutions.
pp. 30-34

UCS.3 11:30 *Ontology-Based Automation of Security Guidelines for Smart Homes*
Yasir Khan and Maryleen Ndubuaku (Coventry University, United Kingdom (Great Britain))
The introduction of Internet of Things has attracted increasing number of security risks to the smart home due to the continual exposure of devices to remote network. Security guidelines are provided to the users of the smart home as the last line of defense to mitigate against these risks. With the increasing attack vectors, new security guidelines are bound to keep coming. However, these guidelines have no standard representation for common sharing and understanding among the smart home actors users, vendors and security community. Moreover, the smart home user is laden with the responsibility of executing the guidelines, thus diminishing the convenience objective of the smart home. In this work, an ontology is proposed to represent knowledge about the security guidelines for interoperability and understanding among the smart home actors. Further to this, a context-based ontology is developed, which adapts to changing contextual information like user context and physical context. We highlight different use cases of security guidelines and discuss how the context-based ontology can help the user perform these guidelines automatically.
pp. 35-40

UCS.4 12:00 *Towards Privacy Preserving Data Provenance for the Internet of Things*
Jose Luis Canovas, Jorge Bernal Bernabé and Antonio Fernando Skarmeta Gomez (University of Murcia, Spain)
As the Internet of Things evolves, security and privacy aspects are becoming the main barriers in the development of innovative and valuable services that will transform our society. One of the biggest challenges in IoT lies in the design of secure and privacy-preserving solutions guaranteeing privacy properties such as anonymity, unlinkability, minimal disclosure of personally identifiable information, as well as assuring security properties, such as content integrity and authenticity. In this regard, this paper provides a data provenance solution that meets those properties, enabling a privacy-preserving identity auditing of the IoT sensor's exchanged data, whereas allowing de-anonymization of the real owner identity of the associated IoT shared data in case of law enforcement inspection is needed, (e.g. identity theft or related cyber-crimes). This research is built on the foundations of the ARIES European identity ecosystem for highly secure and privacy-respecting physical and virtual identity management processes.
pp. 41-46

VEH: Session on Secure Trust Environment Model for Intelligent Vehicles

Room: 4202 (130)
Chair: Madhusudan Singh (Yonsei Institute of Convergence Technology & Yonsei University, Korea)

VEH.1 10:30 *An Empirical Study on Automotive Cyber Attacks*
Madhusudan Singh (Yonsei Institute of Convergence Technology & Yonsei University, Korea); Aman Singh (Indian Institute of Technology-Delhi, India)
There has been various technological advancements in the field of autonomous vehicles. Which increase the possibility of the introduction of these vehicles in the market in some years. Moreover, then we will surround all with numerous autonomous vehicles and other intelligent systems making our life easier. They will include various networked embedded systems connected to internet running on numerous algorithms. These systems may contain vulnerabilities and threats that can be exploited. Therefore, the s e systems must be developed in order to minimize all the possible threats and vulnerabilities. In this study, we will majorly focus on the cyber security vulnerabilities and threats that are possible in automotive electronics.
pp. 47-50

VEH.2 11:00 *Blockchain: A Game Changer for Securing IoT*
Madhusudan Singh (Yonsei Institute of Convergence Technology & Yonsei University, Korea); Abhiraj Singh (Indian Institute of Technology-Roorkee, India); Shiho Kim (Yonsei University, Korea)
Internet of Things (IoT) is now in its initial stage but very soon, it is going to influence almost every day-to-day items we use. The more it will be included in our lifestyle, more will be the threat of being misused. There is an urgent need to make IoT devices secure from being cracked. A very soon IoT is going to expand the area for the cyber-attacks on homes and businesses by transforming objects that were used to be offline to online systems. Existing security technologies are just not enough to with this problem. Blockchain has emerged as the possible solution for creating more secure IoT systems in the time to come. In this paper, We will first provide an overview of the blockchain technology and its implementation, then we will discuss the infrastructure of IoT which is based on Blockchain network and at last a model will be provided for the security of internet of things using blockchain
pp. 51-55

VEH.3 11:30 *Private Information Retrieval in Vehicular Location-Based Services*
Zheng Tan (Tongji University, P.R. China); Cheng Wang (Tongji University, Shanghai, P.R. China); Mengchu Zhou (New Jersey Institute of Technology, USA); Luomeng Zhang (Tongji University, P.R. China)
Acting as a new type of mobile terminals, vehicles are able to access Internet in real-time. Consequently, a specific kind of Location-Based Services (LBS), usually named Vehicular LBS (VLBS), has received significant attention because of its bright prospects. VLBS can answer drivers' location-dependent queries to Points of Interest and provide more dedicated services for drivers by utilizing transportation information. Accompanying with convenience, however, users may suffer from some serious privacy leak problems. Previous work has proposed a series of privacy protection methods for LBS. As a well-known method for its high effectiveness in protecting privacy, computational Private Information Retrieval (cPIR) can provide provable privacy protection. Yet, it is usually considered impractical because of its prohibitive computational cost. An important research question arises: can cPIR be improved and used in VLBS to preserve privacy?We answer it by proposing a privacy preserving framework for VLBS based on it. Under the restriction of road network, the proposed framework, which applies the available transportation information as prior knowledge for cPIR, can drastically reduce the computational cost. We perform several experiments on a real dataset to validate its effectiveness.
pp. 56-61

VEH.4 12:00 *Trust Bit: Reward-based Intelligent Vehicles Communication Using Blockchain*
Madhusudan Singh (Yonsei Institute of Convergence Technology & Yonsei University, Korea); Shiho Kim (Yonsei University, Korea)
The Intelligent vehicle is experiencing revolutionary growth in research and industry, but it still suffers from a lot of security vulnerabilities. Traditional security methods are incapable of providing secure IV, mainly in terms of communication. In IV communication, major issues are trust and data accuracy of received and broadcasted reliable data in the communication channel. Blockchain technology works for the cryptocurrency, Bitcoin which has been recently used to build trust and reliability in peer-to-peer networks with similar topologies to IV Communication world. IV to IV, communicate in a decentralized manner within communication networks. In this paper, we have proposed, Trust Bit (TB) for IV communication among IVs using Blockchain technology. Our proposed trust bit provides surety for each IVs broadcasted data, to be secure and reliable in every particular networks. Our Trust Bit is a symbol of trustworthiness of vehicles behavior, and vehicles legal and illegal action. Our proposal also includes a reward system, which can exchange some TB among IVs, during successful communication. For the data management of this trust bit, we have used blockchain technology in the vehicular cloud, which can store all Trust bit details and can be accessed by IV anywhere and anytime. Our proposal provides secure and reliable information. We evaluate our proposal with the help of IV communication on intersection use case which analyzes a variety of trustworthiness between IVs during communication
pp. 62-67

WAT: Session on Wireless Access Technologies and Architectures for IoT

Room: 4204 (130)
Chairs: Wibowo Hardjawana (The University of Sydney, Australia), Phee Lep Yeoh (University of Sydney, Australia)

Monday, February 5, 12:30 - 13:30

LN: Lunch (Peony Room)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Monday, February 5, 13:30 - 15:30

BMI: Session on Business Model Innovation and IoT

Room: 4303 (130)
Chair: Mirko Alexander Presser (Aarhus University, Denmark)

BMI.1 13:30 *Comparison of Seven Business Model Innovation Tools for IoT Ecosystems*
Hussam Mansour, Mirko Alexander Presser and Torben Bjerrum (Aarhus University, Denmark)
This paper presents seven different business model innovation tools and how they compare when applied to business model innovation using the internet of thing ecosystem. The work leading up to this publication encompasses research that reviewed existing literature on business innovation tools and establishing internet of things ecosystem characteristic that need to be exposed when working with business model innovation. The conclusion is that the more mature and easy-to-use tools fall short on taking into consideration important internet of things characteristics, while the less mature specialized tools are more inline by exposing these characteristics but falling short on maturity and usability. The paper clearly identifies this gap.
pp. 68-73

BMI.2 14:30 *Case Study of IoT as a Driver for Business Model Innovation in the Wind Industry*
Szabolcs Nagy, Hussam Mansour and Mirko Alexander Presser (Aarhus University, Denmark)
This paper presents a case study of Internet of Things (IoT) as a business model innovation driver using the Lean Startup Methodology. The paper follows the journey of two IoT concepts from customer requirements, to the development and testing of a Minimum Viable Product (MVP) and an analysis of business models using a proposed framework to build MVP IoT services based on the St. Gallen Business Model Navigator. The conclusion is that companies that are considering IoT as means of enhancing their product or service offerings, can in a short period test their assumptions by building an MVP and use this to unlock new revenue streams and value offering to the customer. The case study has focused on the wind turbine industry, but the findings can be applied across other industries as well.
pp. 74-79

EC: Session on Edge Computing and IoT

Room: 4201A+4201B (138)
Chair: Soumya Kanti Datta (EURECOM & Co-Founder, Future Tech Lab, France)

EC.1 13:30 *Securing the Mobile Edge Through Named Data Networking*
Marica Amadeo, Claudia Campolo and Antonella Molinaro (University Mediterranea of Reggio Calabria, Italy); Cristina E.M. Rottondi (Dalle Molle Institute for Artificial Intelligence (IDSIA), Switzerland); Giacomo Verticale (Politecnico di Milano, Italy)
The continuous growth in the number and capabilities of connected Internet of Things (IoT) and consumer devices, coupled with the increasing diversification of services running over the Internet, call for the adoption of cutting-edge technologies to exchange, store and process the big amount of generated data. Mobile Edge Computing (MEC) and Information-centric Networking (ICN) are candidate enabling technologies to cope with the raised issues in terms of scalability, low-latency, availability reliability, security. This paper proposes a protocol for secure and privacy-friendly service provisioning at the mobile edge, which also provides a fast way to build trust between consumers (mobile/IoT devices) and providers (middle tier servers and other mobile devices). The solution builds upon ICN pillars, in particular upon the Named Data Networking (NDN) paradigm. The security properties of the designed protocol are discussed and its behaviour practically shown in a reference use case.

pp. 80-85

EC.2 14:00 ***A Survey and Analysis of Ontology-Based Software Tools for Semantic Interoperability in IoT and WoT Landscapes***
Amelie Gyrard (Ecole des Mines de Saint Etienne, France); Soumya Kanti Datta (EURECOM); Christian Bonnet (Institut Eurecom, France)
The current Internet of Things (IoT) ecosystem consists of non-interoperable products and services. The Web of Things (WoT) advances the IoT by allowing consumers to interact with the IoT ecosystem through the open and standard web technologies. But the Web alone does not solve the interoperability issues. It is widely acknowledged that Semantic Web Technologies hold the potential of achieving data and platform interoperability in both the IoT and WoT landscapes. In this context, the paper attempts to review and analyze the current state of ontology-based software tools for semantic interoperability.
pp. 86-91

EC.3 14:30 ***IPv6 Communications over LoRa for Future IoV Services***
Ramon Sanchez-Iborra, Jesus Sanchez-Gomez, Jose Santa, Pedro Javier Fernández Ruiz and Antonio Fernando Skarmeta Gomez (University of Murcia, Spain)
The advantages of all-IP scenarios are clear for both high-level protocol and application developers. However, the usage of IPv6 together with new communication technologies especially designed for Internet of Things (IoT) deployments is not straightforward. This is the case of Low Power-Wide Area Networks (LP-WAN), where packets have a restricted length and the sole IPv6 header implies an excessive load. Fortunately, the arrival of the edge computing paradigm presents a perfect frame to locate adaptation mechanisms for embedding IPv6 datagrams within these networks at the frontier between the LP-WAN and the Internet. In this line, this work presents a solution in the area of vehicular IoT, which allows the IPv6 end-to-end connectivity between a moving device and an Internet node, by means of an adaptation mechanism performed in a Multi-Access Edge Computing (MEC) node attached to the LP-WAN gateway. IPv6 datagrams are compressed following recent IETF guidelines to traverse a LoRa network segment in a transparent way for higher level applications. The solution has been implemented and a real test-bench has been set-up to validate the proposal and extract experimental results that reveal its suitability for traffic-efficiency and warning services in the vehicular domain.
pp. 92-97

EC.4 15:00 ***NFV Enabled IoT Architecture for an Operating Room Environment***
Igor Miladinovic and Sigrid Schefer-Wenzl (University of Applied Sciences FH Campus Wien, Austria)
The Internet of Things (IoTs) refers to the interconnection of billions of smart devices. The steadily increasing number of IoT devices with heterogeneous characteristics requires that future networks evolve to provide a new architecture to cope with the expected increase in data generation. Network function virtualization (NFV) provides the scale and flexibility necessary for IoT services by enabling the automated control, management and orchestration of network resources. In this paper, we present a novel NFV enabled IoT architecture targeted for a state-of-the art operating room environment. We use web services based on the representational state transfer (REST) web architecture as the IoT application's southbound interface and illustrate its applicability via two different scenarios.
pp. 98-102

EES: Session on Energy Efficient Solutions Based on IoT

Room: 4301A+4301B (138)
Chair: Giancarlo Fortino (University of Calabria, Italy)

EES.1 13:30 ***Wireless Power Transfer Solution for Smart Charger with RF Energy Harvesting in Public Area***
Satrio Yudo Prawiro, Satrio Prawiro and Muhammad Ary Murti (Telkom University, Indonesia)
In this paper, the Smart Charge system is proposed as a solution to the problem of battery constraints on the user's device. The system uses a resonant coupling-based wireless power transfer according to ISO / IEC JTC 1 / SC 6 standards. To detect devices, the system uses device discovery methods in standardized device-to-device communications as proximity-based services (ProSe). The system is expected to meet the community's need for wireless charging solutions that do not interfere with device usage, do not limit the movement of device users, are accessible, and multiple devices can be used simultaneously. The system is expected to overcome the demand for wireless charging solutions that do not interfere with normal usage, does not affect user movement, are easily accessible, and can be accessed by the number of user devices. Energy harvesting features are also expected to help wireless smart charge technology be used with renewable energy sources. The use of RF sensors becomes a secondary source with sufficient efficiency.
pp. 103-106

EES.2 14:00 ***A Double Regulated Footer and Header Voltage Technique for Ultra-Low Power IoT SRAM***
Huan Minh Vo (Ho Chi Minh University of Technology and Education, Vietnam)
This work presents an ultra low power SRAM circuit which is suitable for tight power budget of IoT microcontrollers. The leakage power reduction technique using double regulated footer and header voltage in order to meet the requirements for retaining data SRAM in IoT applications. In normal SRAM operation, header and footer voltage are regulated full rail voltage by VDD and VSS, respectively. In idle mode, SRAM cell supply voltage should be lowered as much as possible to reduce more leakage current but still keep data without loss. Body effect is more efficient by lowering supply voltage on double header and footer than just only header or footer at same noise margin. By doing so, the author compares three techniques of the single regulated footer voltage (SRFV), single regulated header voltage (SRHV) and double regulated footer and header voltage (DRFHV) to make conclusion in term of power saving. In the fair comparison in active mode, author realizes that double regulated footer and header voltage technique is more efficiency power saving than three other techniques in retention mode.
pp. 107-111

EES.3 14:30 ***Energy Efficient Communication in Smart Building WSN Running Distributed Hidden Markov Chain Presence Detection Algorithm***
Charikleia Papatsimpa (Technische Universiteit Eindhoven, the Netherlands); Jean-Paul Linnartz (Technische Universiteit Eindhoven, The Netherlands)
Occupancy detection in smart buildings suffers from high sensor unreliability. The combination of data from multiple sensors can largely improve reliability. However, battery-powered sensor nodes have communication limitations. This paper addresses the problem of presence detection in a building as Distributed Sensing of a Hidden Markov Model (DS-HHM). Optimal solutions require excessive communication over a perfectly reliable channel. We propose and investigate an efficient transmission policy, jointly with a fusion algorithm, to merge data from various HMMs running separately on all sensor nodes. The algorithm showed improved performance and potential energy savings in a real world set-up, where user presence and sensor errors may not exactly follow idealized model assumptions.
pp. 112-117

EES.4 15:00 ***Bacteria to Power the Smart Sensor Applications: Biofuel Cell for Low-Power IoT Devices***
Andrey Somov (Skolkovo Institute of Science and Technology, Russia); Pavel Gotovtsev and Andrey Dyakov (Kurchatov Institute, Russia); Alisa Alenicheva (National Research Centre Kurchatov Institute, Russia); Yuliya Plehanova, Sergey Tarasov and Anatoly Reshetilov (Skryabin Institute of Biochemistry and Physiology of Microorganisms of the RAS, Russia)
The Internet of Things (IoT) paradigm has penetrated into a number of Smart-x applications. However, most 'things' are battery powered devices with limited energy resource. We present a microbial biofuel cell based on Gluconobactor oxydans bacteria which is able to continuously generate nearly 0.2 mW·cm-2 at 0.5 V in waste or sewage water. The proposed solution is capable of supplying a low-power IoT device with processing, wireless communication (2.4 GHz) and sensing functions (temperature, humidity and light) onboard. The IoT device is powered via a supercapacitor which acts as an energy buffer for the biofuel harvester. The system operates at low 1% duty cycle.
pp. 118-122

MA: Session on Military Applications of IoT

Room: 4302 (130)
Chair: Niranjan Suri (US Army Research Laboratory (ARL) & Florida Institute for Human & Machine Cognition (IHMC), USA)

MA.1 13:30 ***Leveraging Civilian IoT Infrastructures to Support Warfighting Activities in Urban Environments***
Giulio Riberto (University of Ferrara, Italy); Marco Govoni (University of Ferrara, unknown); Cesare Stefanelli (University of Ferrara, Italy); Niranjan Suri (US Army Research Laboratory (ARL) & Florida Institute for Human & Machine Cognition (IHMC), USA); Mauro Tortonesi (University of Ferrara, Italy)
In the last decade, governments and municipalities have been investing large amounts of money to improve the style and quality of life of Smart Cities' citizens. This led to a huge adoption of Internet of Things (IoT) installations producing a wide amount of data. To exploit at best the many advantages of the IoT, Smart Cities have also begun to make that data freely accessible through Open Data services. The combination of IoT and Open Data can bring benefits in different fields, including the military domain. More specifically, Humanitarian Assistance and Disaster Relief (HADR) missions would significantly benefit from the integration of military systems with the civilian IT infrastructure of Smart Cities. In this context, the deluge of data generated by the IoT calls for dedicated solutions to analyze it and disseminate the results. This paper presents an evaluation of the capabilities of SPF, the Fog-as-a-Service platform we designed for tactical environments, in supporting a hypothetical but realistic HADR mission in the Helsinki Smart City. The paper demonstrates how the possibilities brought by the integration of SPF with the Open Data services offered by the city of Helsinki can significantly help the work of the emergency team, in particular with regards to the quick detection of clear and congested roads for relief organization and coordination.
pp. 123-128

MA.2 14:10 ***Evaluating LoRaWAN-based IoT Devices for the Tactical Military Environment***
Brian Jalaian and Timothy Gregory (US Army Research Laboratory, USA); Niranjan Suri (US Army Research Laboratory (ARL) & Florida Institute for Human & Machine Cognition (IHMC), USA); Stephen Russell (United States Army Research Laboratory, USA); Laurel Sadler and Michael Lee (US Army Research Laboratory, USA)
The ability to understand, predict, adapt, and exploit the vast array of inter-networked things that will be present in the future battlefield is critical for maintaining and increasing military competitive advantage. In this paper, we present a proof-of-concept architecture for Internet of Things (IoT) in military applications. The proposed architecture utilizes LoRaWAN (Long Range low power Wide Area Network) state-of-the-art commercial off- the-shelf (COTS) technology. The proposed architecture consists of sensors, embedded micro-controllers equipped with LoRaWAN compatible radio, and a LoRaWAN gateway. The primary contributions of this paper are on evaluating the performance and suitability of LoRaWAN for the military environment as well as exploring the challenges of integrating LoRaWAN-based IoT devices into existing Command and Control (C2) systems within the military.
pp. 129-133

MA.3 14:50 ***A Survey of Applicability of Military Data Model Architectures for Smart City Data Consumption and Integration***
Manas Pradhan and Christoph Fuchs (Fraunhofer FKIE, Germany); Frank T. Johnsen (Norwegian Defence Research Establishment (FFI), Norway)
In this paper, we examine how existing data models used in the military domain are suitable to integrate the additional Smart City data into the military information domain. In particular, we focus on standardized data models and distribution methods used in federated mission networking within NATO. This ensures a high compatibility to existing situational awareness and information processing applications that are used by the different NATO nations.
pp. 134-139

T1: Tutorial 1 - Blockchain and Cryptocurrencies

Yong Yuan

Room: 4304 (130)

Blockchain and Cryptocurrencies

Yong Yuan, Institute of Automation, Chinese Academy of Sciences, Beijing, China

Blockchain, as an emerging decentralized architecture and distributed computing paradigm underlying Bitcoin and other cryptocurrencies, has attracted intensive attention in both research and applications recently. Blockchain, especially powered by chain-coded smart contracts, has the full potential of revolutionizing increasingly centralized Cyber-Physical-Social Systems (CPSS) for constructions and applications, and reshaping traditional knowledge automation workflows. The key advantage of blockchain technology lies in the fact that it can enable the establishment of secured, trusted and decentralized autonomous ecosystems for various scenarios, especially for better usage of the legacy devices, infrastructure and resources. Blockchain and smart contracts can be expected to find a wide spectrum of application scenarios in CPSSs, especially the cyber-physical systems with large numbers of IoT (Internet of Things) devices. Actually, blockchain is an elegant solution to IoT, and the novel "blockchain of things (BoT)" can thus lay a solid foundation for connecting the cyber and physical worlds and establishing a decentralized autonomous BoT network. This tutorial will introduce fundamental theories, techniques and possible applications of blockchain and cryptocurrencies. Part 1 of this tutorial is an introduction to Bitcoin and other crypto-currencies. Part 2 presents a hierarchical reference model of the blockchain framework, and discusses its technical details. Part 3 examines the blockchain consensus algorithms. Part 4 discusses the integration of blockchain and IoT, and the framework of the emerging BoT technique. Part 5 lists several potential problems of blockchain. Part 6 presents an illustrative example of blockchain-based intelligent transportation systems. Part 7 concludes, and introduces the future trend of parallel blockchain.

T2: Tutorial 2 - From Research to Innovation in IoT: Why is Technology Transfer So Hard?

Raffaele Giaffreda

Room: 4205 (130)

From Research to Innovation in IoT: Why is Technology Transfer So Hard?

Raffaele Giaffreda, Chief IoT Scientist at FBK, CREATE-NET, Italy

This tutorial will present lessons learnt in more than 6 years of R&D activity in the domain of Internet of Things and it will be structured in three main parts (research, development and business). More in detail, the first part will focus on existing and emerging trends for IoT as it moves out of the Gartner Hype Cycle: Edge Computing for IoT, Analytics and Cognitive IoT, Blockchains for IoT will all be covered amongst other technology oriented research challenges. The second part will illustrate what it takes to transform research ideas and demo prototypes into the development of viable solutions that address real market needs in this highly fragmented and overly-standardised domain. Focus here will be given on IoT platforms for the rapid prototyping and deployment of IoT solutions in Industrial and eHealth contexts. In the third part of the tutorial the presenter will share part of his technology transfer journey focusing on the business aspects and the economic issues one must be ready to tackle in order to bring innovation to fruition in this exciting field.

T3: Tutorial 3 - Lightweight Virtualization on IoT Edge Nodes: Unleash the Value of Container Technologies on Low-Power Devices

Roberto Morabito

Room: 4305 (130)

Lightweight Virtualization on IoT Edge Devices: Unleash the Potential of Container Technologies on Low-Power Nodes

Roberto Morabito, Ericsson Research Finland and Aalto University, Finland

Container-based virtualization has widely spread across the industry and is really making an impact on the development of new generation applications. Although also the IoT world has started benefiting from these emerging technologies, the potential numerous advantages introduced by the use of these tools are still not widely known. The intent of the tutorial is to fill the gap in this respect and to transfer, to a wide IoT audience, the know-how for easily turning container technologies in a powerful IoT tool to be exploited not only in cloud environments. More specifically, the main scope is to provide an exhaustive overview about the aforementioned technologies and at the same time showing how deploying virtualized instances on IoT Edge low-power nodes can lead a disruptive impact, also in resolving two main issues linked to the fragmented IoT world: Heterogeneity and Service Management Complexity. Performance aspect will be also considered, together with concrete demonstrations of how these technologies can be efficiently used in a heterogeneous set of IoT use cases.

UCS: Session on User Centric Security and Privacy for Smart Cities

Room: 4203 (130)
Chair: Antonio Fernando Skarmeta Gomez (University of Murcia, Spain)

VEH: Session on Secure Trust Environment Model for Intelligent Vehicles

Room: 4202 (130)
Chair: Madhusudan Singh (Yonsei Institute of Convergence Technology & Yonsei University, Korea)

WAT: Session on Wireless Access Technologies and Architectures for IoT

Room: 4204 (130)
Chairs: Wibowo Hardjawana (The University of Sydney, Australia), Phee Lep Yeoh (University of Sydney, Australia)

13:30 ***High Precision UWB-IR Indoor Positioning System for IoT Applications***
Rejina Ling Wei Choi, Ankur Gupta, Ankush Vashistha, Manmohan Sharma and Choi Look Law (Nanyang Technological University, Singapore)
This paper presents the design and implementation of an ultra-wideband impulse radio based indoor positioning system and its architecture. The operating mechanism of the complete system along with its hardware and software details are discussed. The system exploits the differential time difference of arrival technique for position estimation. Simulation and experimental results demonstrating the working of this in house developed positioning system are provided. Good positioning accuracy of around 30 cm has been achieved from the implemented system for line-of-sight setting in a 7 m × 7 m indoor office environment.
pp. 140-144

14:10 ***Reference Node Selection for Range-based Localization Using Hierarchical Clustering***
Hayato Nomura, Haruhisa Ichikawa and Yuusuke Kawakita (The University of Electro-Communications, Japan)
Positioning and localization systems are important technologies that provide a variety of location awareness services. Location-related information concerning the nodes constituting a wireless network is useful in various applications. In range-based localization, such as systems based on time of arrival and received signal strength, the selection of the reference node significantly influences the accuracy of position estimation. In this study, we consider situations where the arrangement of the reference nodes is biased as a problem of range-based localization, and propose a method based on hierarchical clustering to narrow down reference nodes used for position estimation by considering the positional bias of the reference nodes. The results of a simulation to test the proposed method show that it can reduce the error in position estimation.
pp. 145-148

14:50 ***WE-Safe: A Wearable IoT Sensor Node for Safety Applications via LoRa***
Fan Wu, Christoph Rüdiger, Jean-Michel Redouté and Mehmet Rasit Yuce (Monash University, Australia)
This paper presents a wearable Internet of Things (IoT) sensor node aimed at monitoring harmful environmental conditions for safety applications via Lora. The proposed sensor node is a newly designed sensor node, which is low-power, supports multiple environmental sensors and is connected to the gateway via Lora network. We mainly focus on monitoring carbon monoxide, carbon dioxide, and some general environmental parameters. Poor environment quality could cause severe health problems to individuals. Therefore, the wearable node is worn by the subject all the time. Surrounding data is gathered by the sensor node in a real-time manner and then transmitted to a remote cloud server. The data is then displayed to authorized users through a web-based application located in cloud server and the device will give alert to the user via mobile application when emergency happens. The experimental results indicate that our safety monitoring network can work reliably with low power consumption.
pp. 149-153

Monday, February 5, 15:30 - 16:00

CB: Coffee Break (Peony Room)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Monday, February 5, 16:00 - 18:00

BMI: Session on Business Model Innovation and IoT

Room: 4303 (130)
Chair: Mirko Alexander Presser (Aarhus University, Denmark)

EES: Session on Energy Efficient Solutions Based on IoT

Room: 4301A+4301B (138)
Chair: Bong Jun David Choi (The State University of New York (SUNY) Korea & Stony Brook University, Korea)

MA: Session on Military Applications of IoT

Room: 4302 (130)
Chair: Niranjan Suri (US Army Research Laboratory (ARL) & Florida Institute for Human & Machine Cognition (IHMC), USA)

T4: Tutorial 4 - Mobile Power for the Internet of Things

Lee Stogner and Soumya Kanti Datta

Room: 4201A+4201B (138)

Mobile Power for the Internet of Things

Lee Stogner, IEEE Consumer Electronics Society, USA
Soumya Kanti Datta, EURECOM, France

Abstract - For most of the past 1,000 years, the storage of electrical energy has not changed. In just the past 20 years, the driving force of Mobile Devices, Electric Vehicles and Renewables for the Electric Grid has driven the market to create battery technologies that go well beyond what was thought possible. This market by 2030 will exceed Trillions of Dollars. This Tutorial will give an overview of what is happening as the world develops the next generation of Energy Storage for the Internet of Things. The Tutorial will break into two major parts. The first part will cover the types of available energy storage that are available for IoT devices. Particular attention will be made to small mobile energy storage devices that can be used in remote locations. The second part will describe the IoT applications that utilize mobile energy storage. Emphasis will be made on the selection of battery chemistries, packages, charging systems and applications that are required.

T6: Tutorial 6 - Algorithms for Cooperative IoT: From Edge Computing to Smart Social Vehicles

Seng W. Loke

Room: 4203 (130)

Algorithms for Cooperative IoT: From Edge Computing to Smart Social Vehicles

Seng W. Loke, IoT Research Group, School of Information Technology, Deakin University, Burwood, Melbourne, Australia

Current technology trends including edge cloud computing, IoT and device mesh, crowd computing, the sharing economy, and collective computing, involve pooling together human and machine resources from crowds of devices and people in interesting ways, via relevant algorithms, in order to achieve better resource utilization and greater capabilities, on-demand. As things get connected, there is increasing opportunity for how they can connect, cooperate and collaborate, more than ever before. The tutorial will provide an overview of current technology trends and how computing with the cloud, the crowd and the Internet-of-Things are interacting, including algorithms for things and crowds cooperating. The following three concepts will be detailed: Crowd+Cloud Machines, Extreme Cooperation for IoT and Smart Vehicles, and Social Links for Crowds and Things. We will discuss and explore algorithms, techniques and paradigms for proactive edge computing, for crowd-computing, and for cooperative things (including, cooperative autonomous vehicles and how cooperation can facilitate parking search and routing to reduce traffic congestion). We will also explore current research in the above areas, and discuss social issues such as privacy and security, ethics and trust, as well as technical challenges and research directions. The tutorial will also aim to provide a forum for discussion about the future of cooperative autonomous IoT, especially when things are increasingly endowed with intelligence and automated decision-making capabilities.

T8: Tutorial 8 - Mobile Edge Cloud: Opportunities and Challenges

Sayed Chhattan Shah

Room: 4204 (130)

Mobile Edge Cloud: Opportunities and Challenges

Sayed Chhattan Shah, Dept. of Information Communication Engineering, Hankuk University of Foreign Studies, South Korea

In mobile edge cloud, multiple mobile and stationary devices interconnected through wireless local area networks are combined to create a small cloud infrastructure at a local physical area such as home. Compared to traditional mobile distributed computing systems such as mobile cloud, mobile edge cloud introduces several complex challenges due to the heterogeneous computing environment, heterogeneous and dynamic network environment, node mobility, and limited battery power. The real time requirements associated with internet of things and cyber physical system applications make the problem even more challenging. In this tutorial, we will discuss the applications and challenges associated with design and development of mobile edge cloud system and an architecture based on a cross layer design approach for effective decision making. In mobile edge cloud, multiple mobile and stationary devices interconnected through wireless local area networks are combined to create a small cloud infrastructure at a local physical area such as home. Compared to traditional mobile distributed computing systems such as mobile cloud, mobile edge cloud introduces several complex challenges due to the heterogeneous computing environment, heterogeneous and dynamic network environment, node mobility, and limited battery power. The real time requirements associated with internet of things and cyber physical system applications make the problem even more challenging. In this tutorial, we will discuss the applications and challenges associated with design and development of mobile edge cloud system and an architecture based on a cross layer design approach for effective decision making.

Tuesday, February 6

Tuesday, February 6, 08:45 - 09:00

OPEN: Opening Remarks and Overview

Room: Plenary: Melati

Tuesday, February 6, 09:00 - 18:00

EXH: Internet of Things Showcase at the Exhibit Hall

Chihhsiong Shih

Room: Exhibit Hall

The 4th IEEE World Forum on Internet of Things features a number of IoT showcases of interest to the attendees at the Exhibit Hall. The Exhibit Hall is located in the Orchard Rooms 4211-4312 at Level 4.

The Exhibit hours are:

Monday, 5 February 2018	06:00 - 21:00 (Welcome Reception)
Tuesday, 6 February 2018	09:00 - 18:00
Wednesday, 7 February 2018	09:00 - 18:00
Thursday, 8 February 2018	09:00 - 13:00

Showcase 1: A Smart Parking Guidance System *Chihhsiong Shih, Tunghai University*

We developed a smart parking guidance system for large scale parking lots. Finding an available empty slots in a busy sector of the city is always an issue for city people. Very often, it takes forever to circle around the parking lot drive way and not being able to find an empty spot. Our system includes sensors such as ultra wave and magnetic sensors mounted on the parking spot and on drive ways. The sensors work with mobile devices to guide the driver toward an empty spot controlled by the central cloud server. The cloud server is in charge of coordinating the complete guiding system. We keep track of the vehicle entering the parking lot. On each turn corner of the drive way, we give the driving direction through the mobile phone in the vocal signals. Once the vehicle parked into the slot, an LED light is turned on indicating the slot is occupied.

Showcase 2: A Smart Exercise Coach for Taichi *Chihhsiong Shih, Tunghai University*

We developed a smart coach IoT system that can guide the Taichi learning process. In a regular Taichi session, the learner generally has to follow the coach's motion in every stroke. However, it is difficult for the coach to correct the learner's stroke in every detail. Learners always miss the tempo or place their limbs in a wrong angle or places without knowing it. We place the 6-axis motion sensors on the arms and limbs of the

learners. These sensors detect the inclination angle of the learners. By comparing the inclination angles to those of the coach, we are able to detect the correctness of the Taichi motion of the learner in real time. Once errors are detected, a vibration signal is given to specific parts of the learner. They then correct their motion accordingly.

Tuesday, February 6, 09:00 - 10:00

KEY: Keynote Speakers: Dr. Yaacob Ibrahim & Bill Ruh

Room: Plenary: Melati

Dr. Yaacob Ibrahim, Plenary Speaker at WF-IoT 2018

Dr. Yaacob Ibrahim is the Minister for Communications & Information, the Minister in charge of Muslim Affairs and the Minister in charge of Cyber Security, Prime Minister's Office, Singapore.

He was a structural engineer at Bylander Meinhardt Partnership before receiving a scholarship to pursue a PhD at Stanford University (US). He then worked as a post-doctoral fellow at Cornell University (US) before joining the National University of Singapore. He is currently on leave of absence from the university as an associate professor.

Dr. Yaacob has been active in community service since his school days and has been involved in the Association of Muslim Professionals, Jamiyah, Majlis Ugama Islam Singapura and the Nature Society (Singapore). Dr. Yaacob also served as a board member of the Civil Service College, the National Heritage Board, STV12 Pte Ltd, and Temasek Polytechnic, and as a trustee of NTUC Income, a union-linked cooperative. He has been associated with Yayasan Mendaki since its formation and has been its Chairman since March 2002.

Dr. Yaacob has been a Member of Parliament (MP) since 1997. He served as the MP for Jalan Besar Group Representation Constituency (GRC) from 1997 to 2011 and Moulmein-Kallang GRC from 2011 to 2015. He is currently the MP for Jalan Besar GRC (Kolam Ayer). He was also the first Mayor of Central Singapore District from April to November 2001.

Dr. Yaacob served as Parliamentary Secretary and Senior Parliamentary Secretary at the Ministry of Communications and Information Technology before he was appointed the Minister of State for Community Development and Sports in November 2001. In March 2002, he was appointed as the Ministry's Acting Minister and Minister-In-Charge of Muslim Affairs. In May the following year, he was promoted to Minister for Community Development and Sports.

In August 2004, Dr. Yaacob was appointed Minister for the Environment and Water Resources. He was re-appointed in the same capacity following the May 2006 elections. Following the May 2011 elections, he was appointed Minister for Information, Communications and the Arts. In November 2012, with the restructuring of ministries, Dr. Yaacob became the Minister for Communications and Information. He was appointed the Minister in charge of Cyber Security in April 2015. He has been re-appointed as the Minister for Communications and Information following the September 2015 elections. He continues to be in charge of Muslim affairs and cyber security.

Dr. Yaacob serves in the People's Action Party's Central Executive Committee as its vice-chairman.

Dr. Yaacob was born in Singapore on 3 October 1955. He is married and has two children: a son and a daughter. He enjoys reading, listening to music, and meeting people.

Bill Ruh - Keynote Speaker at WF-IOT 2018

Bill Ruh is the CEO for GE Digital and Chief Digital Officer for GE. GE Digital provides premier digital software solutions and services through Predix, GE's cloud-based platform for the Industrial Internet. GE Digital supports customers globally with a broad range of Industrial Internet applications, including asset performance management, operations optimization, brilliant manufacturing, platform-as-a-service, cloud and cybersecurity. Ruh's focus is on building advanced software and analytics capabilities, and driving the global strategy, operations and portfolio of software services across all of GE's businesses. He earned a bachelors and masters degree in Computer Science from California State University, Fullerton.

Tuesday, February 6, 10:00 - 10:30

CB: Coffee Break (Exhibit Hall)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Tuesday, February 6, 10:30 - 12:30

ENV: Session on IoT and Smart Environments

Room: 4303 (130)
Chair: Hausi A Muller (University of Victoria & Faculty of Engineering, Canada)

ENV.1 10:30 ***The Virtual User: The Holistic Manager of Our IoT Applications***
Roberto Girau, Virginia Pilloni and Luigi Atzori (University of Cagliari, Italy)
The Internet of Things (IoT) paradigm has evolved towards the creation of a cyber-physical world where everything can be found, activated, probed, interconnected, and updated at both the virtual and the physical levels. Indeed, virtualization of real devices and services has become crucial for most of the IoT applications by augmenting the capabilities of the physical world. We believe that next step of this evolution relies on augmenting the \textit{user} capabilities with virtualization functions so as to make easier and faster her involvement in the needed applications. Accordingly, we introduce the concept of \textit{virtual user} for the IoT, which we define as the trusted digital counterpart of the user it represents, facilitating her integration into the technological digital world reducing the burden of following the tedious processes of setting, configuring and updating IoT applications she is involved in and exploiting at the best the relevant potentialities, taking always into account her quality of life. This paper discusses about this novel concept and presents the foreseen functionalities, which need edge cloud resources. It also presents an use-cases where the introduced advantages are highlighted and an initial analysis of the performance on user's preference prediction is provided.
pp. 154-159

ENV.2 11:00 ***Deep Neural Networks for Activity Recognition with Multi-Sensor Data in a Smart Home***
Park Jiho, Kiyoung Jang and Sung-Bong Yang (Yonsei University, Korea)
Multi-sensor based human activity recognition is one of the challenges in the ambient intelligent environments such as smart home and smart city. Ordinary people in their daily lives usually share a similar and repetitive life pattern, also known as life cycle. Smart home environment and its multi sensors can provide assistance to human by collecting the data sequence of human activities to predict the desired actions. Our goal is to analyze the sequence of activities recorded by a specific resident using deep learning with multiple sensor data. In this paper, we train the multiple sensor data collected by a smart home using several deep neural networks. According to the characteristics of the Recurrent Neural Network (RNN) structure, multiple sensor data of smart home is suitable for RNN because it has a sequence data in time. To support our assumption, we proposed the Residual-RNN architecture to predict future activities of a resident. Furthermore, we also utilized attention module to filter out the meaningless data to have more effective results than the one without. To verify our proposed idea, we used real resident activity in smart home using Massachusetts Institute of Technology (MIT) dataset. After our experiments, our proposed model with attention mechanism outperform the Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) model in terms of predicting the desired activities of a smart home resident.
pp. 160-165

ENV.3 11:30 ***Basket Based Sorting Method for Activity Recognition in Smart Environments***
Zhenzhe Zhong (Orange Labs, France); Zhong Fan (Keele University, United Kingdom (Great Britain)); Fengming Cao (Lenovo)
Activity recognition in smart environments is an important technology for assisted living and e-health. Recently there are growing interests in applying machine learning algorithms to activity recognition tasks. One of the main problems with previous work is that concurrent activities of multiple targets may fail the sensor event based prediction if no proper pre-processing method is used. To address this problem, this paper proposes a new basket based sorting method for multiple target classification in a sensor based smart environment, which can significantly improve activity recognition accuracy in real-time monitoring. The proposed structure and method can be plugged into different machine learning models to achieve good activity recognition performance.
pp. 166-171

ENV.4 12:00 ***Energy Expenditure Estimation Through Daily Activity Recognition Using a Smart-phone***
Maxime De Bois (ECE Paris, France); Hamdi Amroun (University of Paris sud, France); Mehdi Ammi (CNRS-LIMSI - University Paris-Sud, France)
This paper presents a 3-step system that estimates the energy expenditure of an individual in real-time and in a non-intrusive way. First, using the user's smart-phone's sensors, we build a Decision Tree model to recognize his physical activity (running, standing, ...). Then, we use the detected physical activity, the time and the user's speed to infer his daily activity (watching TV, going to the bathroom, ...) through the use of a reinforcement learning environment, the Partially Observable Markov Decision Process framework. Once the daily activities are recognized, we translate this information into energy expenditure using the compendium of physical activities. Successfully detecting 8 physical activities at 90%, we reached an overall accuracy of 80% in recognizing 17 different daily activities. This result leads us to estimate the energy expenditure of the user with a mean error of 26% of the expected estimation.
pp. 172-177

ET1: Session on IoT Enabling Technologies (I)

Room: 4205 (130)

ET1.1 10:30 ***A Study of Distributed Compressive Sensing for the Internet of Things***
Mohamed Shaban (Southern Arkansas University, USA); Ahmed Abdelgawad (Central Michigan University, USA)
Compressive sensing (CS) has been very useful for the Internet of Things (IoT). CS aims to reduce the number of samples acquired and transmitted by a sensor node using a low complex sampling operation.

Furthermore, distributed compressive sensing (DCS) was introduced where the compressively sampled sensors' readings are jointly recovered at the fusion center rather than being recovered separately as in the CS. As a result, a reduction in the number of required measurements as well as the complexity of the sensor nodes is achieved. None of the previous works has studied the performance of DCS for sensed signals with abnormalities caused by sensor malfunctioning, sudden changes in temperature or humidity, etc. (i.e. practical IoT networks). In this paper, we extensively study the performance of DCS when signals with abnormalities are considered. The results show that DCS outperforms CS in successfully recovering signals with abnormalities.
pp. 178-183

ET1.2 11:00 *A cloud-IoT Model for Reconfigurable Radio Sensing: The Radio.Sense Platform*
Stefano Savazzi (Consiglio Nazionale delle Ricerche CNR, Italy); Stephan Sigg (Aalto University, Finland); Monica Nicoli (Politecnico di Milano, Italy); Sanaz Kianoush (National Research Council of Italy (CNR), Italy); Franck Le Gall and Hamza Baqa (Easy Global Market, France); David Remon (Libelium Comunicaciones Distribuidas, Spain)
In this paper we elaborate on the challenges that emerge when designing open IoT models and methods to enable passive radio vision functions within a cloud Platform-as-a-Service (PaaS) environment. Radio vision allows to passively detect and track any moving/fixed object or people, by using radio waves as probe signals that encode a 2D/3D view of the environment they propagate through. View reconstruction from the received radio signals is based on data analytic tools, that combine multiple radio measurements from possibly heterogeneous IoT networks. The goal of the study is to define the baseline specifications that are necessary to integrate this new technology into a cloud-IoT architecture. Next, following emerging semantic interoperability concepts, we propose an expressive ontology model to represent the radio vision concept and allow for interoperability with other models. For accelerated integration of radio vision functions the open Radio.Sense platform is designed as compliant with existing models (oneM2M based ontologies).
pp. 184-190

ET1.3 11:30 *Data Management and Packet Transmission Method Based on Receivers' Attributes*
Tatsuya Demizu and Hirofumi Noguchi (Nippon Telegraph and Telephone Corporation, Japan); Naoto Hoshikawa (NTT Network Service Systems Laboratories & NTT, Japan); Misao Kataoka (NTT, Japan); Yoji Yamato (NTT Corporation, Japan)
New services can be developed by combining some of the huge number of heterogeneous devices connected to a network in the era of the Internet of Things (IoT). However, to develop such services, a mechanism is required to detect devices with appropriate attributes such as functions or locations and to communicate with the devices. In this paper, we propose architecture that enables us to communicate with devices that have desired attributes in the IoT world by reducing the size of tables of devices' attributes by distributing the tables over the whole network. Moreover, we quantitatively describe how small the tables can be compared with centralized management at places such as datacenters and then discuss techniques and problems to make distributed tables a reality.
pp. 191-195

ET1.4 12:00 *A Statistical Sparsity-based Method for Sensor Array Calibration*
Lifan Zhao (Institute for Infocomm Research, A*star, Singapore); Shen Tat Goh (Institute for infocomm research, Singapore); Wee Siong Ng (Institute for Infocomm Research, Singapore)
In Internet-of-Things applications, direction-of-arrival (DOA) techniques play an important role in identifying the direction of the sources. However, the antenna array system is difficult to be precisely calibrated in practical scenarios. In this paper, the DOA estimation problem is considered for the antenna array with unknown errors. In particular, the sparsity in spatial domain is exploited, where the errors are practically assumed to be unknown without any prior information. The proposed algorithm can calibrate the unknown errors in the sensor array and estimate the DOA of the sources simultaneously. Notably, the proposed algorithm is based on a fast sparse Bayesian framework, where the whole process can be carried out with high efficiency. By exploiting sparsity in a statistical manner, the number of sources is not required to be known a priori. The simulated results can validate that the proposed method is capable of obtaining accurate estimation with low computational complexity.
pp. 196-199

H1: Session on IoT and eHealth and AAL (I)

Room: 4204 (130)
Chair: M Saravanan (Ericsson Research India & Ericsson Global India Private Limited, India)

H1.1 10:30 *Fiber Bragg Grating-based Monitoring and Alert System for Care of Residents in Nursing Homes*
Siang Fook Foo, Maniyeri Jayachandran, Phua Jiliang Eugene, Yongwei Zhu and Jianzhong Hao (Institute for Infocomm Research, Singapore)
This paper presents a novel Fiber Bragg Grating (FBG)-based monitoring and alert system for care of residents in nursing homes. Using FBG to design Internet of Things (IoT) sensor devices, a tele-monitoring system was developed to monitor vital signs such as pulse rate, respiratory rate, temperature, movement and bed exit of residents on beds. It is able to measure pulse rate and respiratory rate accurately with mean error below 1 beat per minute, detect sudden onset of high fever and unexpected bed exit during the nights which is crucial to maintain a high quality of care for residents. In cases where any of the patients' health condition deteriorates or abnormal behavior is detected, medical staffs will be notified immediately by the system which provides real time alert on each resident's condition through mobile devices such as mobile phones or tablets. The system also allows residents to alert the medical staffs their need for help through uniquely designed call buttons.
pp. 200-205

H1.2 11:00 *Wearable M-Assessment System for Neurological Disease Patients*
Alar Kuusik (Tallinn University of Technology & Motionmon OU, Estonia); Muhammad Mahtab Alam and Triin Kask (Tallinn University of Technology, Estonia); Katrin Gross-Paju (West-Tallinn Central Hospital, Estonia)
Wearable motion sensors are widely used for monitoring of activities of daily living. Professional wearable motion trackers are also used for clinical gait and motor performance analysis in hospital environment. We developed a motor condition testing system for home use that is targeting clinical level assessment progressive neurodegenerative disease, namely multiple sclerosis, patients. The system consists of wearable sensors and an appropriate assessment methodology. Work describes the technological implementation of the solution and results of patient trials conducted during three years in home and hospital environments.
pp. 206-211

H1.3 11:30 *Early Detection of Mild Cognitive Impairment in Elderly Through IoT: Preliminary Findings*
Hwee-Xian Tan (Singapore Management University, Singapore); Hwee Pink Tan (Singapore Management University & TCS-SMU iCity Lab, Singapore)
Mild Cognitive Impairment (MCI) results in the gradual decline in a person's cognitive abilities, and subsequently an increased risk of developing dementia. Although there is no cure for dementia, timely medical and clinical interventions can be administered to elderly who have been diagnosed with MCI, to decelerate the process of further cognitive decline and prolong the duration that they enjoy quality of life. In this paper, we present our preliminary findings of early detection of MCI in elderly who are living in the community, through the use of Internet of Things (IoT) devices for continuous, unobtrusive sensing. Multi-modal sensors are placed in the residences of elderly, to monitor their Activities of Daily Living (ADL), as well as to detect signs of forgetfulness, which are considered symptoms of MCI. Early results indicate that IoT is a promising technology that can potentially pick up signs of early cognitive decline in the elderly.
pp. 212-217

H1.4 12:00 *MEDIBOX - IoT Enabled Patient Assisting Device*
M Saravanan (Ericsson Research India & Ericsson Global India Private Limited, India); Achsah Mary Marks (VIT University, India)
The health and wellness sector is critical to human society and as such should be one of the first to receive the benefits of upcoming technologies like IoT. Some of the Internet of Medical Things (IoMT) are connected to IoT networks to monitor the day-to-day activities of the patients. Recently there has been attempts to design new medical devices which monitor the medications and help aged people for a better assisted living. In this paper, one such attempt is made to design a multipurpose portable intelligent device named MEDIBOX which helps the patients take their medications at the right time. This box is a proficient system which maintains the parameters like temperature and humidity in a controlled range recommended by the drug manufacturer and thus maintains the potency of the medicines even if the patient is travelling. Related to this, we have developed a Host Management System (HMS) which is capable of cloud-based installation and monitoring that stores and controls the MEDIBOX functionality for further analysis and future modification in design aspects.
pp. 218-223

IFO6: Industry Forum Panel - IOT Security: Issues and Challenges for Mass Market Deployment

Asad Haque, Anand Rajan, Dr. Lily (Lidong) Chen and Dr. Subir Das (Moderator)

Room: 4203 (130)

With estimated 50 billion connected IoT devices to the Internet via heterogeneous networks and cloud platforms by the year 2020, security seems to be the biggest concern in the industry today. One of the major issues is that there is currently no industry wide consensus on how to implement and enforce security in the constrained devices satisfying both mass-market deployment requirements and cost. Traditional Internet-based security techniques and best industry practices require substantial re-engineering to address the device constraints issues and its end-less variety of applications. A large number of industry organizations consisting of silicon vendors, device manufacturers and service providers are working very hard to solve the issues and challenges for last few years.

In this panel, panelists will discuss several such issues: secure onboarding and commissioning, authentication, access control, and Over-the-air (OTA) secure update. Panel will also highlight industry advances and its challenges in providing end-to-end security solution throughout the device life cycle in several vertical IoT markets and its readiness for the mass-market deployment.

This panel consists of IoT security experts from leading industries, service provider and research organizations who are actively involved in researching and developing security solutions targeting the IoT markets. The audience will benefit from knowing the IoT security issues and challenges, industry trends, what to look for before deployment along with the opportunity to interact with the industry experts.

Speakers:

Asad Haque, Comcast, USA

Asad Haque is one of the lead security architects at Comcast. He overseas and provides guidance for end-to-end security of Comcast Xfinity™ Home devices and systems. He has over 25 years of Information Security and Design specializing in IoT ecosystems, security and identity. He is currently leading Blockchain based autonomous authentication and device association for devices and applications.

Anand Rajan, Intel Corporation, USA

Anand Rajan is the Senior Director of the Emerging Security Lab at Intel Labs. He leads a team of researchers whose mission is to investigate novel security features that raise the assurance of platforms across the compute continuum (Cloud to Wearables). The topics covered by his team span Trustworthy Execution Environments (TEE), IoT & Mobile Security, Cryptography, and Security for Emerging Paradigms (e.g. Autonomous Systems, 5G). Anand is a Principal Investigator for Intel's research collaboration with academia, government, and commercial labs on Trustworthy Platforms. He is the mentor for the Security Research Sector of Intel's Corporate Research Council. Anand was an active member of the IEEE WG that crafted the P1363 (public-key crypto) standard. Anand and team developed the Common Data Security Architecture specification that was adopted as a worldwide standard by The Open Group. His team was also instrumental on several security standardization efforts (e.g. PKCS#11, BioAPI, UPnP-Security, & EPID). Prior to joining Intel in 1994, Anand was technical lead for the Trusted-UNIX team at Sequent Computer Systems and worked on development and certification of a TCSEC B1-level Operating System.

Dr. Lily (Lidong) Chen, National Institute of Standards and Technology (NIST), USA

Dr. Lily (Lidong) Chen is a mathematician and the manager of Cryptographic Technology Group in Computer Security Division, NIST. Her areas of research include cryptographic protocols, zero-knowledge proof, special featured digital signature schemes, network security, and security for wireless and mobility. Dr. Chen has actively contributed to cryptography and security standards developed in international and industry

organizations such as ISO/IEC JTC 1 SC27 and IEEE 802 wireless. She co-authored book "Communication System Security" published in 2012 by CRC Press, Taylor & Francis Group. She has been leading NIST cryptography program since 2012.

Dr. Subir Das (Moderator), Vencore Labs, USA

Dr. Subir Das is a Chief Scientist at Vencore Labs (formerly Advanced Technology Solutions, Telcordia Technologies Inc), Basking Ridge, NJ, USA and nearly 25 years of research and development experience. His areas of interests are Mobile Wireless IP Networking, low power Personal Area Networking, Network and Internet of Things (IoT) security. Dr. Das is responsible for developing strategic programs, defining new technologies and transitioning such programs through product development either internally or through customers. Dr. Das is also a leading contributor to various Standards (e.g., IEEE, IETF, 3GPP and ZigBee). He is currently the Chair of IEEE 802.21 and ZigBee Alliance JupiterMesh™ WG targeting the Utility and IoT networks and an executive member of IEEE 802 LAN/MAN Standards Committee. In the past, he held leadership position in IETF working groups. He has published over 75 papers, 5 IETF RFCs and granted thirty US patents. He is the recipient of 2009 IEEE Region I Award for outstanding contribution to Next Generation Wireless Networks, Protocols and its Standardization Efforts. He serves as a member in National Science Foundation, USA, and National Science and Engineering Council, Canada, award review committees. Dr. Das is a frequent speaker and an organizer of Industry Panels in IEEE and other international conferences.

SP1: Session on Security and Privacy for Internet of Things (I)

Room: 4304 (130)

Chair: Rashmi Sahay (Birla Institute of Technology and Sciences, Pilani, Hyderabad Campus, India)

SP1.1 10:30 ***SEABASS: Symmetric-keychain Encryption and Authentication for Building Automation Systems***

Joshua Ng (University of Glasgow, Singapore); Sye Loong Keoh (University of Glasgow, United Kingdom (Great Britain)); Zhaohui Tang (Singapore Institute of Technology, Singapore); Hajoon Ko (Harvard University, USA)

There is an increasing security risk in Building Automation Systems (BAS) in that its communication is unprotected, resulting in the adversary having the capability to inject spurious commands to the actuators to alter the behaviour of BAS. The communication between the Human-Machine-Interface (HMI) and the controller (PLC) are vulnerable in that there is no secret key being used to protect the authenticity, confidentiality and integrity of the sensor data and commands. We propose SEABASS, a lightweight key management scheme to distribute and manage session keys between HMI and PLCs, to provide a secure communication channel between any two communicating devices in BAS in order to encrypt and authenticate the message exchange using symmetric-key based hash-chain. Our scheme facilitates automatic renewal of session keys periodically based on the use of a reversed hash-chain. A prototype was implemented using the BACnet/IP communication protocol and the preliminary results show that the symmetric keychain approach is lightweight and incurs low latency.

pp. 224-229

SP1.2 11:10 ***Chameleon: A Blind Double Trapdoor Hash Function for Securing AMI Data Aggregation***

Heng Chuan Tan and Chun Yang Kelvin Lim (Republic Polytechnic, Singapore); Sye Loong Keoh (University of Glasgow, United Kingdom (Great Britain)); Zhaohui Tang (Singapore Institute of Technology, Singapore); Kok Hong David Leong (Republic Polytechnic, Singapore); Chin-Sean Sum (Wi-SUN Alliance, Singapore)

Data aggregation is an integral part of Advanced Metering Infrastructure (AMI) deployment that is implemented by the concentrator. Data aggregation reduces the number of transmissions, thereby reducing communication costs and increasing the bandwidth utilization of AMI. However, the concentrator poses a great risk of being tampered with, leading to erroneous bills and possible consumer disputes. In this paper, we propose an end-to-end integrity protocol using elliptic curve based chameleon hashing to provide data integrity and authenticity. The concentrator generates and sends a chameleon hash value of the aggregated readings to the Meter Data Management System (MDMS) for verification, while the smart meter with the trapdoor key computes and sends a commitment value to the MDMS so that the resulting chameleon hash value calculated by the MDMS is equivalent to the previous hash value sent by the concentrator. By comparing the two hash values, the MDMS can validate the integrity and authenticity of the data from the concentrator. Compared with the discrete logarithm implementation, the ECC implementation reduces the computational cost of MDMS, concentrator and smart meter by approximately 36.8%, 80%, and 99% respectively. We also demonstrate the security soundness of our protocol through informal security analysis.

pp. 230-235

SP1.3 11:50 ***Autonomous Vehicle Ultrasonic Sensor Vulnerability and Impact Assessment***

Bing Shun Lim (University of Glasgow & A Star, Singapore); Sye Loong Keoh (University of Glasgow, United Kingdom (Great Britain)); Vrizlynn L. L. Thing (Institute for Infocomm Research, Singapore)

Vehicles today are relying more on technologies to bring about fully autonomous features. The conventional wirings within are being simplified into a network of electronic components, and this network is controlled via advanced sensing of the environment to make decisions in real-time. However, with the heavy reliance on the sensor readings, any inaccurate reading from the sensors could result in decisions that may cause life-threatening incidents. As such, this research focuses on the in-depth assessment of potential vulnerabilities of an important and commonly used obstacle sensing device, which is the ultrasonic sensor, in modern as well as autonomous vehicles. This research will help bring awareness to the car manufacturers and AV researchers so as to mitigate such issues.

pp. 236-241

TOP1a: Topical 1 - Security and Privacy Regimes - Part 1

Room: 4302 (130)

Organizers

Co-Chairs David W. Kravitz and Jeffrey Voas

Track Summary

IoT applications and prospective solutions mandate consideration of a broad set of security and privacy requirements. The explosion in the number of connected devices poses a significant challenge, as does the diversity of end uses. The World Forum will address the component and platform implications for IoT in the context of the full life cycle for security and privacy regimes. It will also address the many security architectures and approaches that have emerged from Government organizations around the world, from the Commercial Market space, and from the Research Community. Across the wide spectrum of use cases there is a need to appropriately balance security and privacy, and it is useful to think of classifications that distinguish the levels required. As an example these may be thought of as:

- Highly security-centric "life-and-death" applications such as: critical infrastructure; control systems for connected automobiles, railroads, or aircraft; emergency healthcare
- Intermediate security uses that include: smart home; routine monitoring of facilities; sports and physical exercise activities that involve tracking such as geolocation
- Lower security casual uses such as: games, entertainment, public virtual reality applications, and aspects of social media and general information services

The topics that the Presentations, Panels, and Working Group discussions, for the Track on "Security and Privacy Regimes for IoT" will cover include:

- Achieving secure compose-ability of individually secure devices and components
- Scalability (for massive number of devices, and as contributors to- and consumers of- big data)
- Device-associated robustness levels that also deal with the high variations in heterogeneity (such as stationary and mobile infrastructure, smart phones and user terminals, wearables, the wide range of possible sensors and actuator types, and embedded IoT devices)
- Device ownership and component control (accounting for interoperability, regulatory compliance, governance, audit-ability and risk management)
- Remediation for the reigning confusion caused by the proliferation of standards and certification, and the realization that IoT will create new experiences and a vulnerability surface that is not accounted for
- Testing approaches and procedures that overcome the lack of efficacious and accepted practices — These include: interfacing with and leveraging legacy devices and services; containment against expansion of compromise to other units, systems or networks; effective crypto-agility; defense against advanced threats such as quantum-computing attacks. These also include testing approaches for the differing device lifetimes, and lifecycle support of IoT solutions such as over-the-air firmware and software upgrades

One of the objectives of the Track is to launch future actions and activities that continue beyond the World Forum as part of the IoT Initiative Working Group on "IoT Security and Privacy".

Program

10:30-10:40	***Introduction*** *(David W. Kravitz)*
	Keynotes 1
10:40-11:10	**Thomas Keenan, Professor, Environmental Design and Computer Science, University of Calgary** *"Avoiding the Creep Factor in the Internet of Things"* If we could design the Internet again, from scratch, we'd do lots of things differently. There is a real risk that, in the race to bring products to market, IoT devices and applications will drag us into some very creepy uncharted waters. We've already seen IP cameras and baby monitors conscripted to form a botnet (the 2016 Dyn hack) and data leakage from an Internet connected sex toy (We-Vibe) resulted in a successful class action claim. Starting from a framework developed by the author for the 2014 best-seller Technocreep, we'll explore some of the ways in which IoT devices can be creepy. We'll also look at techniques, from data minimization to blockchain logging that can be used to ensure that the right data, and only the right data, goes to the right people.
11:10-11:40	**Hsiao-Ying Lin, Senior Researcher, Shield Lab, Huawei International** *"Connected Car Security"* Vehicles become intelligent and connected for enhancing driving safety and comfort in the latest decade. Modern vehicles are significantly different from conventional vehicles which are well-contained in an isolated network environment. As more communication technologies are deployed in vehicles to provide new applications, more external interfaces, such as DSRC (dedicated short-range communications), Bluetooth, 3/4G and OBD (on-board diagnostics) interfaces, expose vehicles in publicly accessible networks. As a result, there are multiple potential ways for attackers remotely getting access into vehicles to take control over them. Designing and deploying security mechanisms for connected vehicles is important for not only security but also safety reasons. This talk introduces the attack surface of connected vehicles and mitigation.
11:40-12:10	**Drew Van Duren, Technical Director of IoT Security, OnBoard Security, Inc.** *"Locking Down and Re-Using V2X Security: Lessons for Smart Cities"*

	V2X, a technology years in the making and on the verge of massive deployment, is bringing to the forefront deployment security issues related to application definition, message dictionary clarity, message security authorization, as well as security lifecycle interactions between standards bodies, manufacturers, system operators, and transportation PKIs. In this session, we explore some of the lessons-learned in the U.S. Connected Vehicle pilots as they refine, implement and field new capabilities developed by standards organizations such as IEEE and SAE. We also evaluate the V2X security stack and how its security primitives can be applied in smart city agendas looking to satisfy broader IoT security goals for unmanned aerial systems and other automation paradigms.
12:10-12:30	Panel 1 - Systems of Systems: Balancing Security and Privacy Where We Live and Drive *Moderator: Jeff Voas* *Panelists: Thomas Keenan, Hsiao-Ying Lin, Drew Van Duren, Ulf Lindqvist*
12:30-1:30	Lunch
	Keynotes 2
1:30-2:00	**Ulf Lindqvist, Program Director, Computer Science Laboratory, SRI International** *"Security and Privacy Challenges and Opportunities for IoT in Smart Cities"* The concept of Smart Cities illustrates many of the most difficult security and privacy challenges for IoT: large numbers of devices; secure composition of heterogeneous IoT systems whose interaction is context-dependent; user and device mobility; collection, storage, and analysis of sensitive data; long system lifetimes; critical real-time and safety requirements; emergent future functionality and system interaction unforeseen at design time; and so forth. There are great opportunities to address these challenges and create security and privacy methods and solutions that will benefit not only Smart Cities, but also other IoT applications that face some of the same challenges. This talk describes such challenges and opportunities, based on recent findings from workshops organized by the IEEE Cybersecurity Initiative, and results from research conducted in the IoT Security and Privacy Center at SRI International.
2:00-2:30	**Jeff Voas, Computer Scientist, NIST, USA** *"IoT and Trust"* This talk discusses the underlying and foundational science of IoT and gives the audience a general understanding of what IoT is. In this work, five core primitives belonging to most distributed systems are presented. These primitives form the basic building blocks for a Network of 'Things' (NoT) [NIST SP 800-183], including the Internet of Things (IoT). System primitives allow formalisms, reasoning, simulations, and reliability and security risk-tradeoffs to be formulated and argued. These primitives apply well to systems with large amounts of data, scalability concerns, heterogeneity concerns, temporal concerns, and elements of unknown pedigree with possible nefarious intent. The talk ends by suggesting 25 trust issues, that involve everything from 3rd party certification of 3rd party black-box services and products, to defective 'things', and to deliberate intentions to slow the flow of data in a IoT-based system.
2:30-3:00	**Soon Chia Lim, Director of Technology, Cyber Security Agency, Singapore** *"IoT Security - Enabling Trust and Digital Future"* There have been widespread cyber attacks and pervasive data breaches lately. As our society becomes more connected with the proliferation of IoT, the security challenges would likely gather momentum in terms of scale, frequency and criticality. If this continues, it will erode trust and hamper our pursuit of digital transformation. We need to galvanise efforts in building a next generation of inherently secure IoT ecosystem, so as to create a more secure and safer cyberspace of things.
3:00-3:30	**Tan Guan Hong, Technology Partner, Rekanext Capital Partners** *"In the Digital Economy Using IoT Systems, Data Classification Must be Designed In!"* For the Digital Economy to grow, IoT sensor data sharing will innovate new applications and businesses. Many IoT systems were historically designed as silo information systems for specific use. The sharing of data faces many challenges as the data needs to have classification for its intended use in the system design. Data classification determines the IoT Sensor security implementation with the subsequent CAPEX and OPEX. There are other considerations for IoT Sensor data such as Data Accuracy, Data Reliability and Speed of Sensor Data.
3:30-4:00	Coffee Break
	Keynotes 3
4:00-4:30	**Haojie Zhuang, Director of Research, Cloud Security Alliance APAC** *"Top Challenges to Secure IOT Deployments"* There are many challenges to deploying a secure IOT implementation. Many of the security technologies on the market will play a role in mitigation IOT risks with an enterprise. However, the IOT also introduces new challenges to secure engineering. Many of these would benefit from a targeted research or industry collaboration to determine the optimal Long-term approaches to resolution. The talk will share the CSA's view of the top challenges facing early adopters of the IOT with a mapping to recommended CSA IOT security controls.
4:30-5:00	**Tim Hahn, IBM Distinguished Engineer and Chief Architect for IoT Security, IBM Watson** *"IoT Security: Impending Doom or Rainbows and Unicorns?"* As the Internet of Things is deployed across a wide range of industrial, consumer, and business environments, of special interest and concern is the need to implement IoT solutions with careful attention to security. While many of the challenges in IoT security are similar to the challenges of securing information technology (IT) computing environments, there are special considerations due to the scale, operating conditions, system capabilities, and wide range of device types which are used in IoT solutions. Further, these systems, by connecting the electronic and physical worlds, must address both operations technology (OT) security and information technology (IT) security.
5:00-5:30	**Joe Chan, CEO, Advanced Security Technology and Research Laboratory Company Limited (AdvSTAR Lab)** *"Threat Intelligence for IoT Security"* The opportunity of IoT is huge because of its economic impact and scale. Billions of smart devices from different vendors, working together on the Internet and exchange information closely related to us, opens up new potentials for hackers. To keep IoT devices secure, it is important to maintain an up-to-date understanding of their vulnerabilities. This is difficult for both vendors and end users as there are many technologies being used in IoT devices, such as OS, web servers, wireless communication, data storage, authentication to name a few. Threat intelligence in one way provides the technical data such as malicious IP addresses and malware identifier for IoT infrastructure security, it also enforces better transparency between vendors and end users, ultimately lead to higher standards. In this presentation, we explore threat intelligence for IoT security and its benefits to both vendors and end users.
5:30-6:00	Panel 2 - Clouds and Things: Making Cities and Nations Smart *Moderator: David W. Kravitz* *Panelists: Soon Chia Lim, Tan Guan Hong, Tim Hahn, Joe Chan*

V1: Vertical 1 - Smart Cities and Nations

Room: 4201A+4201B (138)

Organizers

Co-chairs Shawn Chandler and Roberto Saracco

Track Summary

All cities are complex systems, balancing available resources to best exploit the value that can be provided to the population. Technology advances are continuously redefining this balance. At the same time economics and regulatory aspects play a major role in fostering the adoption and deployment of Technology and are a key ingredient in the decision making that translates potential into reality. This Vertical, on Smart Cities and Nations, takes a global view of the current status and discusses the paths forward, taking into account the new possibilities opened by the Internet of Things.

The Internet of Things is proving that the sensing of processes, infrastructure, and city control systems, and the gathering of data is a basis for improvement and innovation. It enables the monitoring of conditions and performance of city functions and the subsequent fact based analyses results in the awareness of the city status. This in turn leads to better planning and the execution of actions that can steer the Cities' evolution, bettering the use of resources and the well being of its citizens.

Session 1: People, Policy and Technology - Setting the Framework for Success

Smart Cities rely on an intersection of people, policy and technology in order to develop future services and infrastructure reflecting the needs of citizens, and to deliver on the promised benefits from sensing, monitoring, and analytics. This session's speakers will address key aspects of development concerning citizen sentiment, practical uses of IoT data, and the necessity of integration of spatio-temporal data collected from the Internet of Things, including novel methods and techniques.

Session 2: Industries and Services - Drawing Systems Together

Smart Cities must keep evolving to respond to the changing needs of citizens, of the environment and to the availability of resources. This requires a strong platform orchestrating the various infrastructures upon which to build services. The citizens themselves have to be seen as resources and as an infrastructure that is both monitoring and placing demand on the city. This session addresses various aspects of a smart city's operation from the point of view of what industry can provide and what kind of services can be deployed with particular attention to their cost of creation, deployment and operation. In this respect reference is made to the FIWare initiative of the European Community being offered and experimented worldwide to make data collection, analyses and exploitation available to third party services, as well as key industry platform offerings for design from Autodesk, and an exploration of a massive IoT system in China concerning water sensing.

Session 3: IoT Technology and Systems - Applications and Operations Making It Happen

Smart Cities require highly capable systems and application architecture to enable effective resource integration and a growing body of smart applications. Applications need to leverage the extensive network of sensors and and devices that make up the Internet of Things. This session will address the application of microservices and a feature driven architecture of systems based on emerging IEEE standards, identify the application of blockchain for smart cities, and explore the concept of integrated transactive systems as they apply to IoT, sensing, and analytics applications.

Program

10:30am	Session 1	**Derrick de Kerckhove, University of Toronto, Canada** *"Sentiment Analysis: From "Smart" City to "Happy" City* Although automated for text analysis since the late 1960s, Sentiment Analysis (SA) has been around since the invention of literature criticism. Henceforth addressed to the audience, not to the text, SA has been developed technically at least since 2002. It has, however, only recently been given prominence, owing to the manifold increase of available data, in particular thanks to social media. What SA amounts to is the new possibility for institutions and businesses to listen to clients, patients, customers and citizens instead of simply imposing regulations, services and products. Of course, SA can offer advantage to various fields including health, municipal affairs, political process and policy evaluation, transportation, banking, insurance, security and business. SA has also become sufficiently affordable and relatively easy to make it valuable, if not mandatory, for public administrations to keep tabs on their charges' feelings about their operation. The idea of the "happy city", albeit naïve, is responding that of the "smart" city, bringing precisely an emotional content to what planners tend to measure in terms of efficiency. SA adds another set of criteria to manage smart cities and make use of available IoT. SA invites different levels of administration to target a significantly higher level of satisfaction within the social body. It is already happening in some cities. I will give examples both from case studies and from artists whose works hint at social emotion. This approach could be particularly useful in the context of Singapore and other Asian cities that have made a great leap forward over European or American cities in terms of maximizing the adroit usage of IoT sensors present in their very large distribution of smartphones and public cameras.
11:00am	Session 1	**Paolo Traverso, FBK** *"Practical Use of IoT Data to Make the City Smarter and Smarter"* The availability of data is huge and it is just going to increase in the coming years. The real challenge for a city planner is how to leverage these data that are owned by different parties and ensure policies that are stimulating data sharing and usage. The talk will address these challenge using the practical experience of the speaker in fostering the evolution of the city of Trento, illustrating the highs and the lows. The presentation will also look into the near future and the plans for steering the IoT deployment in the urban environment ensuring their effectiveness from a city planner viewpoint.
11:30	Session 1	**John Taylor, Georgia Tech** *"Engineering Smart Cities: Integrating IoT into Smart City Digital Twins"* Driven by the challenges of rapid urbanization, cities are implementing advanced socio-technological changes as they evolve to become smarter cities. The success of such an evolution, however, relies on solutions that can combine data from individual infrastructure components (e.g., automobile traffic on roadways, occupants in buildings) to the urbanscale, and vice-versa. A great deal of research and development has focused on developing an in-depth understanding of data analytics at the scale of the city and the scale of an individual infrastructure component. However, there is a gap in our understanding, data collection approaches, and analytical methods to integrate such disparate data if we are to holistically understand a city's states of spatio-temporal flux. This presentation will describe efforts to create a Smart City Digital Twin of the City of Atlanta and how such a platform can enable increased visibility into a cities' human-infrastructure-technology interactions. The presentation will further discuss how spatio-temporal information within a city can be collected from and enabled through virtualization and the connectivity offered by Internet of Things (IoT). As Smart City Digital Twins collect data over time that is integrated across spatial and temporal scales, they will be able to provide critical forward looking insights into a city's smarter performance and growth.
12:00pm	Session 1	**Chin-Sean Sum, Manager of Certification Programs, Wi-SUN Alliance** *"Wi-SUN Alliance: Technology and Certification"* Overview of Wi-SUN Alliance technology and certification for Smart Cities and Utilities.
12:30		Lunch Break
1:30pm	Session 2	**Yang Yang, Shanghai Institute of Fog Computing Technology (SHIFT)** *"Fog Computing for Intelligent Buildings and Smart Services"* Fog computing has emerged as a promising solution for the Internet of Things (IoT) and next generation mobile networks. As an extension to cloud computing, fog computing enables service provisioning along the continuum from the cloud to things for reducing latency and bandwidth demands, and for empowering end users in their vicinity. Such cloud-to-thing continuum requires full technology support in infrastructure, platform, software and service levels. We propose Fog As A Service Technology (FA2ST) and its architecture to underpin a multi-level system of fog computing services for end-to-end support of various IoT applications, especially for intelligent building management and smart services. This talk introduces a hierarchical fog network for seamless service provisioning in future buildings and cities, with practical constraints, design features and experimental results in different use cases.
2:00pm	Session 2	**Lyn Chua, Autodesk** *"Autodesk - Platform Services for Designing the Smart City"*
2:30pm	Session 2	**Yasunori Mochizuchi, NEC** *"FIWARE: the open platform of choice for Truly Smart Cities"* The European Union has invested hundreds of million of Euros over several years in the development of an open platform, FIWare, that can be used in a variety of fields. One of the most important one is Smart Cities. The foreseen investment in the development of applications for Smart Cities over the next 5 years is in the range of billions worldwide and the availability of an open platform promoting re-usability would significantly decrease the investment required and accelerate the deployment. The talk will elaborate on the critical importance of Context Information Modelling as the concrete enabler for Smart Cities and will present worldwide business experiences in deploying and exploiting the FIWare platform. Both technology, service and policy aspects will be addressed.
3:00pm	Session 2	**Roberto Saracco, EIT ICT Labs Association, Italy** *"Creating a Citizens Based Infrastructure"* Information technology and the availability of smartphones plus disseminated IoT allows the empowerment of citizens and careful planning from Municipalities, including education, awareness raising, open data framework can go a long way to leverage on citizenship transforming them into a crucial infrastructure adding to the overall city intelligence and capability. The talk will address the issues in harvesting what is already available and providing the required "glueing" to create an emerging citizens infrastructure. It will be based on concrete experiences derived from EIT Digital Digital Cities effort in Europe and from the IEEE FDC Smart Cities initiative worldwide.
3:30pm		Coffee Break
4:00pm	Session 3	**Francesco Mazzola, T.Net** *"MaaS Microservices Delivered in a Smart Mobility Context"* For cities and territories that want to be really "smart" it's essential to equip themselves with the enabling infrastructures to help the development of intermodal services, support new way of interacting with customers, citizens, service providers and content, but most of all these services should work in a heavy crowded environment where many vehicles contend for bandwidth and where the limit of the 802.11p protocol could be a problem. Storage of large amount of data, service availability through different media make the context really challenging. For this reason, we're developing a smart framework based on Cloud Services, the so called Microservices that may help municipality and motorway concessions to maximize the return of the investment and customer experience. With our IOT4ITS framework we first allow info flowing correctly from the IOT Sensors field to the Transport Management System and ITS Infrastructure. The meteorological models (Wind, Rain, Moisture, etc) and the predictive algorithm on pollutants and weather help the system to forecast for severe weather condition that may cause asphalt slippery so avoiding hydroplaning and wheelspin. Managed Info through the Infobroker Midlleware are sent as messages to vehicles, e.g. to reduce speed in case of poor air quality problems when the amount of air pollutant concentrations and level of noise reaches critical thresholds. One thing more to take into notice when implementing large scale smart cities or nations is to deliver the proper information to the right set of Road Side Unit. The combined use of the Infobroker Midelleware and the Network Defined Software installed on IOT/ITS devices can geobroadcast the packets so that they are sent to the rightly involved Road Side Units (RSU). Using Cloud Microservices makes measurements and info widely available to the uppers levels so that APP developers can use them for many different applications. This framework could be very useful to avoid infrastructures doubling and overhead of sensors and radio object along streets, motorways and expressways and to satisfy market demand that requires development of new technologies and algorithms that use the underlying layers of the network, more and more performing to give quick answers to devices for augmented reality (transactions, info-navigation, emergency calls, essential medical support, etc) to drones and robots for parcels delivery, to self-driving vehicles, to pedestrians and much more.
4:30pm	Session 3	**Dr. Sijie Chen, Electrical Engineering at Shanghai Jiao Tong University** *"Leveraging Block Chain for Smart Cities"* The distribution power system is undergoing a significant transformation with increasing penetration of renewable energy generation and smart loads. Transactions among these prosumers can provide important incentives that drive flexible resources to absorb the uncertainty and variability from renewable energy. The blockchain technology can serve as the underlying transaction and operation platform to ensure trust, transparency, and security. This talk proposes the basic design of a transactive, i.e., transaction-driven, distribution power system based on blockchain.

5:00pm	Session 3	**Shawn Chandler, Navigant Consulting, Inc.** *"Sensing, Analytics and IoT: Potential for Smart Cities"* In this session, we explore technology based strategies and solutions for developing analytics and artificial intelligence solutions for use in *transactive* energy systems to benefit the smart city. Transactive energy systems are relatively new economically based control systems that, when used effectively, can improve reliability and decrease utility costs of service, and integrate the use of distributed energy resources from consumers and energy system aggregators. Finally, this session will explore how transactive systems may serve the smart city to optimize other diverse resources such as electric vehicles and smart buildings, capitalizing on the Internet of Things through diverse sensor networks, and seek to improve quality of life.
5:30pm	Session 3	**Cedric Koh, Rohde and Schwarz** *"Measurement and Testing Certification of IoT Devices"*
6:00pm		End of Vertical 1

V2: Vertical 2 - Public Safety, Emergency Response, and Humanitarian Technologies

Room: 4301A+4301B (138)

Organizers

Co-Chairs Philip Hall, *RelmaTech Limited (UK)* and Thas A Nirmalathas, *Melbourne Networked Society Institute*

Track Summary

Urbanization across the globe and the changing climate are posing significant challenges to citizens, communities, cities and regions, and countries when it comes to their preparedness to face incidents of adverse nature whether be it from man-made disasters, accidents or criminal acts or be it from the rising intensity of extreme weather events resulting from the changing climate. As a community of global citizens, it has become a universal expectation for us to feel safe and secure and to gain assurance from the cities, governments, and countries that we can expect to receive help in a timely manner from agencies charged with such roles. Socio-economic impact of such incidents can be catastrophic to communities and their ability to regain and bounce back to progress is a significant factor sustaining the quality of life and socio-economic viability of a vibrant community.

Rapid deployment of connectivity across the globe is making it possible to contemplate that the deployment of such systems should help us better anticipate, ameliorate, and recover from natural or man-made disasters and accidents. The wide deployment of IoT has the potential to dramatically change our resilience and preparedness in how well we deal with disasters and incidents in the future. The necessary step is a deeper deployment of monitoring and tracking systems, and better sensor networks that warn of an earthquake, a tsunami, a likely volcanic eruption, forest fires, accidental releases of chemicals, or that allow us to forestall a biological epidemic. At the same time, the IoT technologies will also improve our ability to recover from such incidents. More importantly, such a deployment need to foresee a significant degradation of such infrastructure in the face of extreme events and the design of such infrastructure should factor this to enhance the resilience and rapid restoration of key functionalities post incidents. In particular, such response requires a massive coordination between government and international agencies as well as industry organizations with the significant expert knowledge to allow rapid restoration capabilities and services to provide humanitarian responses at time-scales much faster than what we can deal with now. Approaches based on IoT need to factor a diversity of connectivity technologies, communication, sensing and computing devices or platforms and psychological state of people affected to arrive at effective ways to provide humanitarian responses in a responsible, sensitive and effective manner.

Session 1: Keynotes

- Aviation Safety Challenges - The Search for MH370
- Socio-Economic Impact of Extreme Events

Session 2: IoT Approaches for Public Safety, and Emergency and Humanitarian Responses

- Emerging requirements of public safety communications
- Safeguarding public spaces and communities
- Building resilience and protecting critical infrastructure

Panel Session: *"Role of IoT in Emergency and Disaster Relief in a World of Increasingly Frequent Extreme Events"*

Chair: Thas A Nirmalathas

Panelists:

- Dr. Neil Gordon
- Ged Giffin
- Ms. Sonia Aplin
- Professor Palani Palaniswami
- Professor Yu-Hsing Wang
- Ms. Natasha Beschorner

Program

10:30am	Session 1	Keynote 1	**Dr. Neil Gordon, Defense and Technology Group Australia** *"The Search for MH370"* On 7th March 2014 Malaysian Airlines flight MH370 from Kuala Lumpur to Beijing lost contact with Air Traffic Control and was subsequently reported missing. An extensive air and sea search was made around the last reported location of the aircraft in the Gulf of Thailand without success. Signals transmitted by the aircraft's satellite communications terminal to Inmarsat's 3F1 Indian Ocean Region satellite indicated that the aircraft continued to fly for several hours after loss of contact. In this talk I will describe how nonlinear/ non-Gaussian Bayesian time series estimation methods have been used to process the Inmarsat data and produce a probability distribution of MH370 flight paths that defined the search zone in the southern Indian Ocean. I will describe how probabilistic models of aircraft flight dynamics, satellite communication system measurements, environmental effects and radar data were constructed and calibrated. A particle filter based numerical calculation of the aircraft flight path probability distribution will be outlined and the method is demonstrated and validated using data from several previous flights of the accident aircraft. A short book is freely available for download from http://www.springer.com/us/book/9789811003783
11:30am		Keynote 1	**Ins. Ged Griffin, Victoria Police Australia** *"Smart Cities and Public Safety: Public Safety Mobile Broadband - To Bravely Go Where No One Has Gone Before"* This presentation discusses how the Safe Cities community can work with public safety officials to work together to develop the next generation of public safety ecosystem. The presentation will provide an outline of how the public safety community currently accesses information and provides a road path on new developments in public safety mobile broadband.
12:30pm			Lunch Break
1:30pm	Session 2		IoT Technologies in Public Safety and Emergency and Humanitarian Responses
1:30pm		Invited Talk 1	**Ms. Sonia Aplin, Ericsson** *"Telecommunications and Connectivity as the Keystone in Crisis Response"* Based on Ericsson Response's 16 years of experience, telecommunications and connectivity play a crucial role in the management of all crises. Ericsson Response is a volunteer initiative that deploys around 140 trained volunteer employees and telecom equipment to support the UN and other humanitarian organizations in times of disaster and crisis. The Ericsson Response team's main tasks are to set up mobile networks for voice and data communication as well as supporting partners in training and knowledge sharing. We will share how Ericsson Response was able to provide communications expertise, equipment and resources in more than 40 relief efforts in more than 30 countries. We will also discuss how Ericsson Response is helping to transform emergency response, by working with aid agency partners including the UN Office for the Coordination of Humanitarian Affairs (OCHA), the UN World Food Programme (WFP), the UN High Commissioner for Refugees (UNHCR), UNICEF and others. Some of the largest deployments we have had to date include supporting over 90 humanitarian sites, including community care centers and Ebola treatment units, in Sierra Leone, Guinea, and Ghana; supporting the Philippines when super typhoon Haiyan devastated a large part of the country and helping in the aftermath of recent hurricanes in the US and Caribbean.
2:00pm		Invited Talk 2	**Professor Palani Palaniswami, University of Melbourne and Director/Convener Sensor Networks and Information Processing (ISSNIP)** *"Real-time Crowd Behavior Analysis for Public Safety Using Networked Cameras and Cloud Analytics* With increasing population and human activities, it has become essential to monitor public places for effective disaster management. Anomalous events may include a person loitering about a place for unusual amounts of time; people running and causing panic; the size of a group of people growing over time at a particular point of entry or exit etc. A stadium like Melbourne Cricket Ground (MCG) which can accommodate nearly 100,000 spectators for any sporting event, can cause people to panic and break out commotion. It will be a daunting task to control crowd. Hence, continuous monitoring of the behavior of the people moving within the limits of stadium is of utmost importance. Automated detection of such anomalous crowd behavior is still a challenge, given the enormous amount of computation and detection challenges in detecting objects, tracking, and analyzing video in real-time. Current systems offer limited functionality, particularly in their reliance on centralized processing of gathered information. However, the prevalence of

			camera networks for surveillance, together with the decreasing cost of infrastructure, has produced a significant demand for robust monitoring systems. This talk addresses end-to-end system challenges of camera networks, integrating cameras across the spatial, spatiotemporal and decision domains. The talk highlights the nature and complexity of algorithms to monitor MCG (350 networked IP cameras) to deliver unique long-term behavior analysis in highly crowded environments. It highlights the video analytics capabilities to count people, track, and detect suspicious behavior, suitable for crowd management, modelling, and urban planning. It also provides automated analysis of such behaviors to detect and alert the anomalous crowd behavior in almost real-time, which is a necessity for safety and security public using Internet of Things (IoT).
2:30pm		Invited Talk 3	**Professor Yu-Hsing Wang, Department of Civil and Environmental Engineering, Hong Kong University of Science and Technology (HKUST)** *"A Real-Time and Long-Term Scalable IoT-AI Stack for Natural Hazard Resiliency Assessment and Management of Critical Infrastructure* Lifelines and critical infrastructure will be exposed to higher risks of degradations, damages or failures in the coming decades as unprecedented larger scales of typhoons and extreme precipitations are becoming a norm. Such challenging times call for data-enabled decision making through constant monitoring in order to carry out timely maintenance and upgrade works of the lifelines and critical infrastructure. Predictive maintenance of critical infrastructure relies heavily on large-scale and long-term monitoring, particularly vibrations at different parts of the structural elements. In this talk, we will showcase how we build a realtime, long-term scalable operational IoT stack for low-cost dynamic monitoring with reference to our live landslide monitoring operations in Taiwan and Hong Kong since 2014. Linear scalability is the core design principle of the IoT stack as both cost-effectiveness and performance are the major reasons why we stop short of widespread and continuous dynamic monitoring. We then discuss how we deploy AI - deep learning - on these large-scale dynamic observations pouring in by a second for real-time anomaly detections and classifications. With the entire IoT-AI stack facilitating real-time data discovery, evaluations and disseminations of the dynamic performances of the lifelines and critical infrastructure, efficient decision-making and resource allocation through predictive maintenance is now possible.
3:00pm		Invited Talk 4	**Professor Greg Foliente, The University of Melbourne** *"Towards Next-Generation Disaster Management and Public Safety"*
3:30pm			Coffee Break
4:00pm	Panel Session		**Protecting and Safeguarding Communities in Extreme Events - Role of IoT**
5:15pm			End of Vertical 2

V3: Vertical 3 - Logistics

Room: 4202 (130)

Organizers

Chair Gisele Bennett

Track Summary

The movement, distribution, delivery, maintenance, repair, upgrade, and eventual recycling of goods, is a global enterprise that fuels the world economy. The WF will explore how IoT can dramatically improve the degree of synchronization, speed, reliability, and efficiency in this critical industry. With Singapore as one of the large logistics hubs for its region, logistics plays an important role. In this context IoT is an important tool for better managing the multi-modal assets that are needed for improvements in operations and in creating benefits.

Program

10:30-10:35	**Welcome Remarks** *Prof. Gisele Bennett, Chair of the IoT for Logistics Track*
10:35-10:50	**Mr. KC Fung, Senior Manager, IT Planning & Strategy, Information Technology, Airport Authority Hong Kong** *"IoT Applications at HKIA (Hong Kong International Airport)"* HKIA has a vision of becoming a smart airport. One of the technology focus of smart airport is to make use of Internet of Things (IoT) technology to build a digital twin of the airport. The presentation will talk about some of the current IoT applications at HKIA such as RFID based baggage handling and GPS tracking of airfield vehicles; as well as some of the new and planned IoT initiatives.
10:50-11:05	**Prof. CH Cheng, Dept. of Systems Engineering and Engineering Management, The Chinese University of Hong Kong** *"Internet of Things Technologies for Smart Living"* Internet of Things (IoT) has received attention of researchers in smart living technologies in recent years. In this talk, we will explore how IoT technologies may be applied to improve the quality of life in a modern city like Hong Kong. Further, we will discuss our implementation examples in airport services, museum operations, and public safety, etc. Challenges and opportunities in these projects will be shared.
11:05-11:20	**Prof. Kim-Fung Tsang, Department of Electronic Engineering, City University of Hong Kong** *"IoT Tracking of Trolleys for Hong Kong Airport* Current localization schemes often employ GPS at outdoor and other wireless localization techniques at indoor (e.g. Wifi). In general, switching is needed between outdoor and indoor and vice versa. The switching potentially causes a loss of localization accuracy, at least at the transition point. Classically, the transmission range of most commonly available wireless platforms are short range, rendering high latency. LoRa, by nature, appears to be the right candidate for long-range applications in logistics and transportation. A high-performance long-range seamless indoor-outdoor localization system based on LoRa will be designed and implemented to track down trolleys in the Hong Kong airport. Analytics will be performed to help decision making e.g. record/predict the behavior of clients, position of trolleys, …etc. With slight modifications, such a system can be modified to adapt to similar or associated logistics applications which are related to vehicle travel between outdoor and indoor, to upload and unload deliverable between extremities.
11:20-11:35	**Dr. Frank Tong, Director of Research and Technology, Hong Kong LSCM R&D Centre** *"Smart Logistics for e-Commerce through Hong Kong"* Logistics is one of the pillar industries in HK. In the contemporary trends of ASEAN trades and Belt-and-Road Developments, Hong Kong's logistics industry is also striving for new technologies and new practices to meet the challenges. In this talk, I shall be sharing with the audience the smart logistics technology development in HK, particularly about the success case of cross-boundary customs clearance system. Besides, selected examples of smart IT infrastructure for logistics operations and pilot implementations with forward-looking practitioners will be presented.
11:35-12:30	**Panel Discussion: Trends and Challenges in Adopting IoT in Hong Kong** *Moderator:* Mr. Simon Wong, CEO, Hong Kong LSCM R&D Centre *Panelists:* • Mr. KC Fung, Senior Manager, IT Planning & Strategy, Information Technology, Airport Authority Hong Kong • Prof. CH Cheng, Dept. of Systems Engineering and Engineering Management, The Chinese University of Hong • Prof. Kim-Fung Tsang, Department of Electronic Engineering , City University of Hong Kong • Dr. Frank Tong, Director of Research and Technology, Hong Kong LSCM R&D Centre

End Morning Session

12:20-13:30	**Lunch**
13:30-13:55	**Dr. Bernard Leong Chung Wei, AirBus** *"Autonomous Transportation and Its Implications* In the recent years, there has been considerable interest in unmanned aerial vehicles (UAVs) and autonomous vehicles. In this talk, I discussed the challenges in bringing these technologies into the real world, and what it means for the supply chains in urban smart cities, logistics and agriculture.
13:55-14:20	**Prof. Fei-Yue Wang, Vice President and Secretary General of Chinese Association of Automation** *"Parallel Logistics in the Social IoT Era"*

	In this presentation, a new paradigm of logistics, Parallel Logistics, is introduced. Parallel Logistics (PL) aims to tackle the inherent nature of complexity, diversity and uncertainty in socialized logistics, and to provide a solution based on the Parallel System theory and the ACP approach. Following a full view of Parallel System theory in the new Intelligence Technology era, PL's technical framework and applications are illustrated and addressed in detail for building the next generation logistics ecological system.
15:10-15:35	**Dr. NG Poh Khai, Innovation Leader and Senior Manager, Asia Pacific Innovation Center** *"DHL's Journey Towards Digitalization with IoT"* Presentation to include: • Broad overview of DHL's trend approach to innovation and focus (i.e. IoT among other trends) • DHL's approach to IoT as a key innovation trend • Opportunities in the logistics industry - use-cases
15:35-1600	**Afternoon Break**
16:00-16:25	**Dr. Justin Dauwels, Associate Professor of the School of Electrical and Electronic Engineering at the Nanyang Technological University (NTU) in Singapore** *"Towards the Next-Generation Fleet Management Systems"* There is considerable interest related to management of fleet of autonomous vehicles in both academia and industry. Robust and reliable commercial deployment of fleet of autonomous vehicles is impeded by the lack of the following two technologies. First, an integrated approach is lacking that can encompass all different aspects of the problem, including mobility models of vehicles, communication network and application environment, customer demand prediction, and real-time information about the transportation network. Second, autonomous vehicles are still in trial phase, hence sufficient realistic field data may not be available in next few years. An integrated simulator can prove highly useful in bridging that gap. Such simulators would still be highly useful once the technology matures as they would provide an effective platform for developing further applications involving fleets of autonomous vehicles. In this presentation, we will give an overview of our progress in both these directions.
16:25-16:50	**Prof Guanghua Yang, Associate Dean, Institute of Physical Internet, Jinan University** *"Low-Cost Versatile Tracking Device and Technology for Logistics"* With the rapid growth of global business activities, it becomes essential for the firms to manage the logistics flow and to track their goods properly. Continuous monitoring and end-to-end tracking are critical for shipments of high-end goods, such as jewelry, electronic products, and legal documents. In this project, we developed the next-generation tracking devices and technologies, which support continuous, real-time, and ubiquitous goods-level tracking. By leveraging the strengths of different wireless technologies, the project realize the hybrid and collaborative positioning and communication. With the innovative design, the system enjoys a better service availability, lower total cost of ownership, operation and maintenance. The effectiveness of the proposed mechanism were demonstrated by two pilot business projects.
16:50-17:15	**Prof. Zhi Ning, Prof. National University of Singapore** *"RFID Systems and Antennas in IoT"* Radio frequency identification (RFID) technology are being rapidly developed in recent years. In particular, their applications have been widely found in Internet of Things (IoT) such as service industries, distribution logistics, manufacturing companies, product-flow systems and so on. Antenna design for both readers and tags is one of the key factors in all RFID systems. The optimized tag and reader antenna design will greatly benefit to RFID systems with longer reading range, better detection accuracy, lower fabrication cost, and simple system configuration and implementation.
17:15-18:00	**Working Group Discussion** (All Speakers and Audience Members What is working and not working? How can IEEE move the industry forward?

End IoT Logistics Session

Tuesday, February 6, 12:30 - 13:30

LN: Lunch (Peony Room)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Tuesday, February 6, 13:30 - 15:30

DS: Doctoral Symposium

Room: 4303 (130)
Chair: Teng Joon Lim (National University of Singapore, Singapore)

Chair: Teng Joon Lim, National University of Singapore, Singapore

Details:

DS.1 13:30

Paper Title: Software Execution Freeze-Safe Microcontroller Using Power Profile Tracking for IoT-Driven Connected Services

Authors: Hyeongrae Kim (Kyungpook National University, Korea); Daejin Park (Kyungpook National University (KNU), Korea)

When we consider the safety of Internet of Things (IoT), it is quite important that a fault on a single IoT device affects the whole IoT system. If this fault causes isolation at a certain point, the system will freeze. To prevent this, we attempt dynamic monitoring using data samples made from power profile tracking. This paper proposes MCU with low-power monitoring hardware and software using power profile tracking. IoT devices connected with Bluetooth are used to make up a state power map. Then, it is transmitted via Wi-Fi and becomes a system power map, which is stored in LUT, and the monitoring unit watches for whether a fault occurs or not. By the proposed method, we enable low-power, freeze-safe IoT development.

DS.2 14:10

Paper Title: Platform for Industrial Internet and Digital Twin Focused Education Research and Innovation - Ilmatar the Overhead Crane

Author: Juuso Autiosalo (Aalto University, Finland)

The paper presents first experiences on an overhead crane platform targeted for university education, research, and innovation purposes. The main contributions feature a description of projects from the first year after the inauguration of the crane platform. To provide a basic perception on the potential of the platform, the paper presents the basic technical properties as well as opportunities and challenges of the crane platform. Digital Twin concept has been selected as a focus of the research activities on the platform. Hence, the paper reviews status of the term Digital Twin. Results describe experience-based observations on how university should manage an education, research, and innovation platform while collaborating with industry partners.

DS.3 14:50

Paper Title: Statistical Analysis of CO2 Emission Based on Road Grade, Acceleration and Vehicle Specific Power for Public Utility Vehicles: An IoT Application

Authors: Maria Gemel Palconit (University of San Carlos & Cebu Technological University, Philippines); Warren A. Nuñez (University of San Carlos, Philippines)

In the Philippine transport, the public utility vehicles (PUVs) are one of the top emitters of CO2 emissions (CO2e). Moreover, the need of quantifying the CO2e of PUV is important in reducing the emission. Hence, this paper focuses on the statistical evaluation of CO2e of PUV based on the parameters affecting it —road grade, acceleration, and vehicle specific power (VSP). An Internet of Things (IoT) system with onboard CO2 sensors, GPS receivers, wireless communication nodes and a base station, online elevation query, cloud server, and an online IoT monitoring dashboard were used to remotely gather, store and visualize the needed measurements. The correlations of CO2e according to these parameters were analyzed using statistical tools—histograms, box plots, and scatter plots. Results have shown that the correlation of PUV CO2e with respect to downhill roads, uphill roads, and acceleration follows a U-shaped curves with the trough from the ranges of -19% to -3% at -16%, 3% to 22% at around 13% to 16%, and from -4m/s2 to 3m/s2 at -2m/s2, respectively. Likewise, significant changes of CO2e were observed at different levels of VSP. Evidently, the mentioned factors have significantly affected the CO2e of the PUVs.

DS.1 13:30 ***Software Execution Freeze-Safe Microcontroller Using Power Profile Tracking for IoT-Driven Connected Services***
Hyeongrae Kim (Kyungpook National University, Korea); Daejin Park (Kyungpook National University (KNU), Korea)
When we consider the safety of Internet of Things (IoT), it is quite important that a fault on a single IoT device affects the whole IoT system. If this fault causes isolation at a certain point, the system will freeze.

To prevent this, we attempt dynamic monitoring using data samples made from power profile tracking. This paper proposes MCU with low-power monitoring hardware and software using power profile tracking. IoT devices connected with Bluetooth are used to make up a state power map. Then, it is transmitted via Wi-Fi and becomes a system power map, which is stored in LUT, and the monitoring unit watches for whether a fault occurs or not. By the proposed method, we enable low-power, freeze-safe IoT development.
pp. 242-245

DS.2 14:10 ***Platform for Industrial Internet and Digital Twin Focused Education, Research, and Innovation: Ilmatar the Overhead Crane***
Juuso Autiosalo (Aalto University, Finland)
The paper presents first experiences on an overhead crane platform targeted for university education, research, and innovation purposes. The main contributions feature a description of projects from the first year after the inauguration of the crane platform. To provide a basic perception on the potential of the platform, the paper presents the basic technical properties as well as opportunities and challenges of the crane platform. Digital Twin concept has been selected as a focus of the research activities on the platform. Hence, the paper reviews status of the term Digital Twin. Results describe experience-based observations on how university should manage an education, research, and innovation platform while collaborating with industry partners.
pp. 246-249

DS.3 14:50 ***Statistical Analysis of CO2 Emission Based on Road Grade, Acceleration and Vehicle Specific Power for Public Utility Vehicles: An IoT Application***
Maria Gemel Palconit (University of San Carlos & Cebu Technological University, Philippines); Warren A. Nuñez (University of San Carlos, Philippines)
In the Philippine transport, the public utility vehicles (PUVs) are one of the top emitters of CO2 emissions (CO2e). Moreover, the need of quantifying the CO2e of PUV is important in reducing the emission. Hence, this paper focuses on the statistical evaluation of CO2e of PUV based on the parameters affecting it —road grade, acceleration, and vehicle specific power (VSP). An Internet of Things (IoT) system with onboard CO2 sensors, GPS receivers, wireless communication nodes and a base station, online elevation query, cloud server, and an online IoT monitoring dashboard were used to remotely gather, store and visualize the needed measurements. The correlations of CO2e according to these parameters were analyzed using statistical tools—histograms, box plots, and scatter plots. Results have shown that the correlation of PUV CO2e with respect to downhill roads, uphill roads, and acceleration follows a U-shaped curves with the trough from the ranges of -19% to -3% at -16%, 3% to 22% at around 13% to 16%, and from -4m/s2 to 3m/s2 at -2m/s2, respectively. Likewise, significant changes of CO2e were observed at different levels of VSP. Evidently, the mentioned factors have significantly affected the CO2e of the PUVs.
pp. 250-255

ET2: Session on IoT Enabling Technologies (II)

Room: 4205 (130)
Chair: Dirk Pesch (Cork Institute of Technology, Ireland)

ET2.1 13:30 ***Multi-Channel Pure Collective Aloha MAC Protocol with Decollision Algorithm for Satellite Uplink***
David Tung Chong Wong and Qian Chen (Institute for Infocomm Research, Singapore); Xiaoming Peng (Institute for InfoComm Research, Singapore); Francois Chin (Institue for InfoComm Research, Singapore)
One of the key enabling technologies for Internet-of-Things (IoT) is the satellite network. Communications in the uplink segment of a satellite network is achieved using a medium access control (MAC) protocol. This paper proposes an asynchronous Multi-Channel Pure Collective Aloha MAC protocol with a Decollision Algorithm (MC-PCA-DA). The exact theoretical formulation of the throughput is derived in this paper. The theoretical results are verified by simulation results. Numerical results show that the maximum throughput of the MC-PCA-DA MAC protocol can be up to 10 times (10x) for a single frequency channel as compared to that of the asynchronous Pure Aloha MAC protocol in a single frequency channel, up to 20 times (20x) for two frequency channels and up to 40 times (40x) for four frequency channels, respectively. Thus, the proposed MC-PCA-DA MAC protocol can achieve significant throughput gain over the basic Pure Aloha MAC protocol.
pp. 256-261

ET2.2 14:00 ***IoT Fault Management Platform with Device Virtualization***
Yuki Nishiguchi (Fujitsu Laboratories Ltd. & Fujitsu Limited, Japan); Ai Yano (Fujitsu Laboratories Ltd., Japan); Takeshi Ohtani (Fujitsu Limited, Japan); Ryuichi Matsukura (Fujitsu Laboratories Ltd., Japan); Jun Kakuta (Fujitsu Laboratories LTD., Japan)
The Internet of Things (IoT) has been growing. In a Field Area Network (FAN), where various IoT devices with different protocols and data formats are connected, faults can easily occur due to the FAN's instability. In this paper, a novel platform is proposed to provide a fault management function to the complicated FAN. The platform hides the differences between the devices by virtualizing them and provides fault analysis methods flexibly according to the FAN components with a plug-in structure.
pp. 262-267

ET2.3 14:30 ***Adaptive Static Scheduling in IEEE 802.15.4 TSCH Networks***
Xenofon Fafoutis, Atis Elsts, George Oikonomou, Robert J Piechocki and Ian Craddock (University of Bristol, United Kingdom (Great Britain))
TSCH (Time-Slotted Channel Hopping) is a synchronous MAC (Medium Access Control) protocol, introduced with the recent amendments to the IEEE 802.15.4 standard. Due to its channel hopping nature, TSCH is a promising enabling technology for dependable IoT (Internet of Things) infrastructures that are deployed in environments that are prone to interference. In TSCH, medium access is orchestrated by a schedule that is distributed to all the nodes in the network. In this paper, we propose Adaptive Static Scheduling to improve the energy efficiency of TSCH networks. Adaptive Static Scheduling builds on top of static schedules and allows each pair of communicating nodes to adaptively activate a subset of their allocated slots, effectively reducing the idle listening overhead of unused slots. Moreover, the nodes can dynamically activate more slots when they need to support bursts of high traffic, without the need of redistributing new schedules. Simulation results demonstrate that Adaptive Static Scheduling outperforms static scheduling in dynamic environments, operating nearly as efficiently as an oracle with knowledge of the optimal schedule.
pp. 268-273

ET2.4 15:00 ***Extending the Battery Lifetime of Wearable Sensors with Embedded Machine Learning***
Xenofon Fafoutis (University of Bristol, United Kingdom (Great Britain)); Letizia Marchegiani (University of Oxford, United Kingdom (Great Britain)); Atis Elsts, James Pope, Robert J Piechocki and Ian Craddock (University of Bristol, United Kingdom (Great Britain))
Smart health home systems and assisted living architectures rely on severely energy-constrained sensing devices, such as wearable sensors, for the generation of data and their reliable wireless communication to a central location. However, the need for recharging the battery regularly constitutes a maintenance burden that hinders the long-term cost-effectiveness of these systems, especially for health-oriented applications that target people in need, such as the elderly or the chronically ill. These sensing systems generate raw data that is processed into knowledge by reasoning and machine learning algorithms. This paper investigates the benefits of embedded machine learning, i.e. executing this knowledge extraction on the wearable sensor, instead of communicating abundant raw data over the low power network. Focusing on a simple classification task and using an accelerometer-based wearable sensor, we demonstrate that embedded machine learning has the potential to reduce the radio and processor duty cycle by several orders of magnitude; and, thus, substantially extend the battery lifetime of resource-constrained wearable sensors.
pp. 274-279

H2: Session on IoT and eHealth and AAL (II)

Room: 4204 (130)
Chair: Yu Rongshan (Xiamen University, P.R. China)

H2.1 13:30 ***A Complete Internet of Things (IoT) Platform for Structural Health Monitoring (SHM)***
Ahmed Abdelgawad and Kumar Yelamarthi (Central Michigan University, USA); Md Anam Mahmud (CMU, USA)
Structural Health Monitoring (SHM) is becoming a crucial research topic to improve the human safety and to reduce maintenance costs. However, most of the existing SHM systems face challenges performing at real-time due to environmental effects and different operational hazards. Furthermore, the remote and constant monitoring amenities are not established yet, properly. To overcome this, Internet of Things (IoT) can be used, which would provide flexibility to monitor structures (building, bridge) from anywhere. In this paper, a complete IoT SHM platform is proposed. The platform consists of a Raspberry Pi, an analog to digital converter (ADC) MCP3008, and a Wi-Fi module for wireless communication. Piezoelectric (PZT) sensors were used to collect the data from the structure. The MCP3008 is used as an interface between the PZT sensors and the Raspberry Pi. The raspberry pi performs the necessary calculations to determine the SHM status using a proposed mathematical model to determine the damage's location and size if any. The All the data is pushed to the Internet filter using ThingWorx platform. The proposed platform is evaluated and tested successfully.
pp. 280-284

H2.2 14:00 ***Heartbeat Monitoring UWB Sensor Robust to Body Movement***
Yuta Uomoto (The University of Kitakyushu, Japan); Akihiro Kajiwara (University of Kitakyushu, Japan)
A non-contact heartbeat monitoring sensor using stepped-FM UWB scheme is suggested which is robust to body movement. The biological signal should be obtained from periodic chest movement consisting of the heartbeat and respiration movement. However, the heartbeat sensing suffers from body movement because of its smaller displacement relative to breathing motion. Therefore, a stationary subject is assumed for conventional heartbeat monitoring schemes. However, some displacement of body should be presented during the measurement. This paper suggests a heartbeat estimation scheme with high accuracy for some body movement. The estimation performance has been experimentally evaluated for four subjects sitting on the stool using our fabricated sensor. It is found that our proposed system can be achieved with the estimation error less than 2%.
pp. 285-290

H2.3 14:30 ***IoT-enabled Multimodal Sensing Headwear System***
Aung Aung Phyo Wai (Nanyang Technological University, Singapore); Dajiang He and Soon Huat Ng (Institute for Infocomm Research, Singapore)
With the proliferation of Internet of Things (IoT) paradigm, several wearable devices and solutions emerge as enabling technologies to resolve unmet needs from military, automotive to healthcare domains. Particularly, there is growing interests in wearable Brain Computer Interface (BCI) technologies in both commercial and research solutions. Still uphill challenges lie ahead to bring such BCI technologies to mass market due to lack of technical, usability and application aspects. In order to fill this gap, this paper presents design, development and evaluation of multi-modal head-wear system called iMESH. iMESH monitors user's neural, physiological and physical states through direct measurements and derived health parameters. We then develop driving fatigue assessment as application exemplar to illustrate applicability and performance of proposed solution. With initial promising results and ongoing algorithms development, we are hoping to further implement and validate the proposed head-wear system in different use cases.
pp. 291-295

H2.4 15:00 ***A Comprehensive Exploration to the Machine Learning Techniques for Diabetes Identification***
Sidong Wei (Shanghai Jiao Tong University, P.R. China); Xuejiao Zhao and Chunyan Miao (Nanyang Technological University, Singapore)
Diabetes mellitus, known as diabetes, is a group of metabolic disorders and has affected hundreds of millions of people. The detection of diabetes is of great importance, concerning its severe complications. There have been plenty of research studies about diabetes identification, many of which are based on the Pima Indian diabetes data set. It's a data set studying women in Pima Indian population started from 1965, where the onset rate for diabetes is comparatively high. Most of the research studies done before mainly focused on one or two particular complex technique to test the data, while a comprehensive research over many common techniques is missing. In this paper, we make a comprehensive exploration to the most popular techniques (e.g. DNN (Deep Neural Network), SVM (Support Vector Machine), etc.) used to identify diabetes and data preprocessing methods. Basically, we examine these techniques by the accuracy of cross-validation on the Pima Indian data set. We compare the accuracy of each classifier over several ways of data preprocessors and we modify the parameters to improve their accuracy. The best technique we find has 77.86% accuracy using 10-fold cross-validation. We also analyze the relevance between each feature with the classification result.
pp. 296-300

IFO3: Industry Forum Panel - IoT Industrial Deployment

Latif Ladid, University of Luxembourg / IPv6 ForumUniversity of Luxembourg / IPv6 Forum; Lawrence Hughes, Sixscape Communications; Professor Sureswaran Ramadass, APAN (Asia Pacific Advanced Networks); Medel Ramirez, Philippine IPv6 Forum

Room: 4203 (130)

The Industrial deployment of IoT is subjected to a myriad of hurdles:

- Too many IoT Protocols at different layers, non-cohesive and non-harmonized
- Different verticals preaching different approaches
- Consumer IoT products are insecure
- ISPs are not offering IoT services

This session will address the many challenges while IoT seems to be used to sell anything in the market. There are also more important network issues to be addressed such as use of IPv6, Cloud computing, Fog Computing, SDN-NFV and the upcoming 5G.

Speakers

Latif Ladid, University of Luxembourg / IPv6 Forum

- Founder & President, IPv6 FORUM
- Chair, ETSI IPv6 Industry Specification Group
- IEEE Steering Committee Member: 5G, IoT, SDN
- Chair, IEEE ComSoC IoT subcommittee
- Chair, IEEE ComSoC 5G subcommittee

Lawrence Hughes, Sixscape Communications

Lawrence Hughes is the co-founder/CEO of Sixscape Communications. Prior to co-founding Sixscape, he was the co-founder and CTO of Cipher Trust in 2000, and the inventor of the technology there that did a USD273 million exit in 2006. He is also the inventor of Identity Registration Protocol (IRP) and SixChat protocol which were submitted to the Internet Assigned Number Authority (IANA) and both awarded TCP port numbers on the Internet. Lawrence is the co-chair of IPv6 Forum Singapore and he is world class in both cryptographic and IPv6 technologies. Lawrence graduated with a Bachelor Degree in Science (Pure Math) from Florida State University, USA.

Professor Sureswaran Ramadass, Professor Emeritus (Internet Engineering) Malaysia University of Science and Technology and Chief Scientist, Northern Lights

Professor Sureswaran Ramadass was the former Chairman of APAN (Asia Pacific Advanced Networks). He is also a Visiting Professor at the Malaysian University of Science and Technology (MUST) and Chairman of the Board and Executive Director of NLTVC Sdn Bhd. (NLTVC is a next generation communications research and development company).

Prior to this, he was the founding Director and Professor at the National Advanced IPv6 Centre of Excellence (NAV6), Universiti Sains Malaysia.

He obtained his BsEE/CE (Magna Cum Laude) and Masters in Electrical and Computer Engineering from the University of Miami in 1987 and 1990 respectively. He graduated as the top student in the College of Engineering for his Bachelors Degree. He obtained his PhD from Universiti Sains Malaysia (USM) in 2000 while serving as a full time faculty in the School of Computer Sciences.

Medel Ramirez, Philippine IPv6 Forum

- Vice President, Philippine IPv6 Forum
- Bachelor of Science in Electrical Engineering graduate
- Ten (10) years experience in design, planning and implementation of IP network infrastructure using Cisco - routing and switching products as well as PIX Firewalls or FWSM modules and ASA5500

SP2: Session on Security and Privacy for Internet of Things (II)

Room: 4304 (130)

Chair: Huaqun Guo (Institute for Infocomm Research, A*STAR, Singapore)

SP2.1 13:30 *Trust List: Internet-wide and Distributed IoT Traffic Management Using Blockchain and SDN*

Kotaro Kataoka, Saurabh Gangwar and Prashanth Podili (Indian Institute of Technology Hyderabad, India)

As the Internet of Things (IoT) develops and expands, management of IoT communications becomes a major challenge. A large number of IoT devices may be installed anywhere end users wish, then left unattended and be misused to attack others. In edge networks, it is difficult to properly prevent undesired communication without knowledge of the properties of an IoT service and its devices. In this paper, we argue that application service providers, developers, and network operators should 1) verify and know the authenticity of IoT services, devices, and their communications, and 2) prevent unwanted traffic from IoT devices in a trustworthy, scalable, and distributed manner. This paper proposes a Trust List that represents the distribution of trust among IoT-related stakeholders and provides autonomous enforcement of IoT traffic management at the edge networks by integrating blockchains and Software-Defined Networking (SDN). The principle of Trust List is automating the process of doubting, verifying, and trusting IoT services and devices to effectively prevent attacks and abuses. The proof of concept implementation and experiment of the Trust List using both public and private blockchains reveal its good practice and suggest studies for realistic deployment.

pp. 301-306

SP2.2 14:00 *Detecting Anomalies in Metro Systems*

Marcellinus Hendro Adi Wibowo (Nanyang Technological University, Singapore); Huaqun Guo (Institute for Infocomm Research, A*STAR, Singapore); Wang Ling Goh (Nanyang Technological University, Singapore)

In an autonomous vehicle system, a secure control between vehicles and instruments is critical. Particularly, in a metro or underground system, the control is done through a Supervisory Control and Data Acquisition (SCADA) network which is purely wired system. This wired system does not include any wireless connections; hence an outsider attack is very unlikely to happen. However, this does not imply that the system is safe from attack as an attack can come from insider by sending more command or less command. This attack can be detected by comparing the features extracted from the traffic happening to the heuristic and proper data set. The comparison done is not only by comparing the distribution of the data transferred but also looking at the correlation between each instrument. The correlation is needed since several instruments might work dependently while others might work independently. Data that are compared in the analysis are the features of each instrument from the traffic which are number of command transfer, number of handshake transfer, and the ratio of command transfer to the command transfer median from the samples. These three features are then analyzed and the results will show whether there is an anomaly in a certain period.

pp. 307-312

SP2.3 14:30 *Attack Graph - Based Vulnerability Assessment of Rank Property in RPL-6LOWPAN in IoT*

Rashmi Sahay (Birla Institute of Technology and Sciences, Pilani, Hyderabad Campus, India); Geethakumari G (BITS-Pilani, Hyderabad Campus, India); Koushik Modugu (Birla Institute of Technology and Sciences, Pilani, Hyderabad Campus, India)

A significant segment of the Internet of Things (IoT) is the resource constrained Low Power and Lossy Networks (LLNs). The communication protocol used in LLNs is 6LOWPAN (IPv6 over Low-power Wireless Personal Area Network) which makes use of RPL (IPv6 Routing Protocol over Low power and Lossy network) as its routing protocol. In recent times, several security breaches in IoT networks occurred by targeting routers to instigate various DDoS (Distributed Denial of Service) attacks. Hence, routing security has become an important problem in securing the IoT environment. Though RPL meets all the routing requirements of LLNs, it is important to perform a holistic security assessment of RPL as it is susceptible to many security attacks. An important attribute of RPL is its rank property. The rank property defines the placement of sensor nodes in the RPL DODAG (Destination Oriented Directed Acyclic Graphs) based on an Objective Function. Examples of Objective Functions include Expected Transmission Count, Packet Delivery Rate etc. Rank property assists in routing path optimization, reducing control overhead and maintaining a loop free topology through rank based data path validation. In this paper, we investigate the vulnerabilities of the rank property of RPL by constructing an Attack Graph. For the construction of the Attack Graph we analyzed all the possible threats associated with rank property. Through our investigation we found that violation of protocols related to rank property results in several RPL attacks causing topological sub-optimization, topological isolation, resource consumption and traffic disruption. Routing security essentially comprises mechanisms to ensure correct implementation of the routing protocol. In this paper, we also present some observations which can be used to devise mechanisms to prevent the exploitation of the vulnerabilities of the rank property.

pp. 313-318

SP2.4 15:00 *Long Term Key Management Architecture for SCADA Systems*

Hendra Saputra (Singapore Management University, Singapore); Zhigang Zhao (Institute for Infocomm Research, Singapore)

A SCADA key management is required to provide a key management protocol that will be used to secure the communication channel of the SCADA entities. The SCADA key management scheme often uses symmetric cryptography due to resource constraints of the SCADA entities. Normally the use of symmetric cryptography mechanism is in the form of pre-shared keys, which are installed manually and are fixed. Then, these pre-shared keys or long term keys are used to generate session keys. However, it is important that these long term keys can be updated and refreshed dynamically. With the nature of SCADA systems which may consist of hundreds of nodes deployed in different locations, manually updating and refreshing these long term keys is time consuming. Thus, this paper proposes an automatic long term key management method that updates and refreshes these keys efficiently. The proposed method provides a flexibility to refresh the long term keys and reduces the number of keys stored in the SCADA entities.

pp. 319-324

TOP1a: Topical 1 - Security and Privacy Regimes - Part 1

Room: 4302 (130)

Organizers

Co-Chairs David W. Kravitz and Jeffrey Voas

Track Summary

IoT applications and prospective solutions mandate consideration of a broad set of security and privacy requirements. The explosion in the number of connected devices poses a significant challenge, as does the diversity of end uses. The World Forum will address the component and platform implications for IoT in the context of the full life cycle for security and privacy regimes. It will also address the many security architectures and approaches that have emerged from Government organizations around the world, from the Commercial Market space, and from the Research Community. Across the wide spectrum of use cases there is a need to appropriately balance security and privacy, and it is useful to think of classifications that distinguish the levels required. As an example these may be thought of as:

- Highly security-centric "life-and-death" applications such as: critical infrastructure; control systems for connected automobiles, railroads, or aircraft; emergency healthcare
- Intermediate security uses that include: smart home; routine monitoring of facilities; sports and physical exercise activities that involve tracking such as geolocation
- Lower security casual uses such as: games, entertainment, public virtual reality applications, and aspects of social media and general information services

The topics that the Presentations, Panels, and Working Group discussions, for the Track on "Security and Privacy Regimes for IoT" will cover include:

- Achieving secure compose-ability of individually secure devices and components
- Scalability (for massive number of devices, and as contributors to- and consumers of- big data)
- Device-associated robustness levels that also deal with the high variations in heterogeneity (such as stationary and mobile infrastructure, smart phones and user terminals, wearables, the wide range of possible sensors and actuator types, and embedded IoT devices)
- Device ownership and component control (accounting for interoperability, regulatory compliance, governance, audit-ability and risk management)
- Remediation for the reigning confusion caused by the proliferation of standards and certification, and the realization that IoT will create new experiences and a vulnerability surface that is not accounted for
- Testing approaches and procedures that overcome the lack of efficacious and accepted practices — These include: interfacing with and leveraging legacy devices and services; containment against expansion of compromise to other units, systems or networks; effective crypto-agility; defense against advanced threats such as quantum-computing attacks. These also include testing approaches for the differing device lifetimes, and lifecycle support of IoT solutions such as over-the-air firmware and software upgrades

One of the objectives of the Track is to launch future actions and activities that continue beyond the World Forum as part of the IoT Initiative Working Group on "IoT Security and Privacy".

Program

10:30-10:40	***Introduction*** *(David W. Kravitz)*
	Keynotes 1
10:40-11:10	**Thomas Keenan, Professor, Environmental Design and Computer Science, University of Calgary** *"Avoiding the Creep Factor in the Internet of Things"* If we could design the Internet again, from scratch, we'd do lots of things differently. There is a real risk that, in the race to bring products to market, IoT devices and applications will drag us into some very creepy uncharted waters. We've already seen IP cameras and baby monitors conscripted to form a botnet (the 2016 Dyn hack) and data leakage from an Internet connected sex toy (We-Vibe) resulted in a successful class action claim. Starting from a framework developed by the author for the 2014 best-seller Technocreep, we'll explore some of the ways in which IoT devices can be creepy. We'll also look at techniques, from data minimization to blockchain logging that can be used to ensure that the right data, and only the right data, goes to the right people.
11:10-11:40	**Hsiao-Ying Lin, Senior Researcher, Shield Lab, Huawei International** *"Connected Car Security"* Vehicles become intelligent and connected for enhancing driving safety and comfort in the latest decade. Modern vehicles are significantly different from conventional vehicles which are well-contained in an isolated network environment. As more communication technologies are deployed in vehicles to provide new applications, more external interfaces, such as DSRC (dedicated short-range communications), Bluetooth, 3/4G and OBD (on-board diagnostics) interfaces, expose vehicles in publicly accessible networks. As a result, there are multiple potential ways for attackers remotely getting access into vehicles to take control over them. Designing and deploying security mechanisms for connected vehicles is important for not only security but also safety reasons. This talk introduces the attack surface of connected vehicles and mitigation.
11:40-12:10	**Drew Van Duren, Technical Director of IoT Security, OnBoard Security, Inc.** *"Locking Down and Re-Using V2X Security: Lessons for Smart Cities"* V2X, a technology years in the making and on the verge of massive deployment, is bringing to the forefront deployment security issues related to application definition, message dictionary clarity, message security authorization, as well as security lifecycle interactions between standards bodies, manufacturers, system operators, and transportation PKIs. In this session, we explore some of the lessons-learned in the U.S. Connected Vehicle pilots as they refine, implement and field new capabilities developed by standards organizations such as IEEE and SAE. We also evaluate the V2X security stack and how its security primitives can be applied in smart city agendas looking to satisfy broader IoT security goals for unmanned aerial systems and other automation paradigms.
12:10-12:30	Panel 1 - Systems of Systems: Balancing Security and Privacy Where We Live and Drive *Moderator: Jeff Voas* *Panelists: Thomas Keenan, Hsiao-Ying Lin, Drew Van Duren, Ulf Lindqvist*
12:30-1:30	Lunch
	Keynotes 2
1:30-2:00	**Ulf Lindqvist, Program Director, Computer Science Laboratory, SRI International** *"Security and Privacy Challenges and Opportunities for IoT in Smart Cities"* The concept of Smart Cities illustrates many of the most difficult security and privacy challenges for IoT: large numbers of devices; secure composition of heterogeneous IoT systems whose interaction is context-dependent; user and device mobility; collection, storage, and analysis of sensitive data; long system lifetimes; critical real-time and safety requirements; emergent future functionality and system interaction unforeseen at design time; and so forth. There are great opportunities to address these challenges and create security and privacy methods and solutions that will benefit not only Smart Cities, but also other IoT applications that face some of the same challenges. This talk describes such challenges and opportunities, based on recent findings from workshops organized by the IEEE Cybersecurity Initiative, and results from research conducted in the IoT Security and Privacy Center at SRI International.
2:00-2:30	**Jeff Voas, Computer Scientist, NIST, USA** *"IoT and Trust"* This talk discusses the underlying and foundational science of IoT and gives the audience a general understanding of what IoT is. In this work, five core primitives belonging to most distributed systems are presented. These primitives form the basic building blocks for a Network of 'Things' (NoT) [NIST SP 800-183], including the Internet of Things (IoT). System primitives allow formalisms, reasoning, simulations, and reliability and security risk-tradeoffs to be formulated and argued. These primitives apply well to systems with large amounts of data, scalability concerns, heterogeneity concerns, temporal concerns, and elements of unknown pedigree with possible nefarious intent. The talk ends by suggesting 25 trust issues, that involve everything from 3rd party certification of 3rd party black-box services and products, to defective 'things', and to deliberate intentions to slow the flow of data in a IoT-based system.
2:30-3:00	**Soon Chia Lim, Director of Technology, Cyber Security Agency, Singapore** *"IoT Security - Enabling Trust and Digital Future"* There have been widespread cyber attacks and pervasive data breaches lately. As our society becomes more connected with the proliferation of IoT, the security challenges would likely gather momentum in terms of scale, frequency and criticality. If this continues, it will erode trust and hamper our pursuit of digital transformation. We need to galvanise efforts in building a next generation of inherently secure IoT ecosystem, so as to create a more secure and safer cyberspace of things.
3:00-3:30	**Tan Guan Hong, Technology Partner, Rekanext Capital Partners** *"In the Digital Economy Using IoT Systems, Data Classification Must be Designed In!"* For the Digital Economy to grow, IoT sensor data sharing will innovate new applications and businesses. Many IoT systems were historically designed as silo information systems for specific use. The sharing of data faces many challenges as the data needs to have classification for its intended use in the system design. Data classification determines the IoT Sensor security implementation with the subsequent CAPEX and OPEX. There are other considerations for IoT Sensor data such as Data Accuracy, Data Reliability and Speed of Sensor Data.
3:30-4:00	Coffee Break
	Keynotes 3
4:00-4:30	**Haojie Zhuang, Director of Research, Cloud Security Alliance APAC** *"Top Challenges to Secure IOT Deployments"* There are many challenges to deploying a secure IOT implementation. Many of the security technologies on the market will play a role in mitigation IOT risks with an enterprise. However, the IOT also introduces new challenges to secure engineering. Many of these would benefit from a targeted research or industry collaboration to determine the optimal Long-term approaches to resolution. The talk will share the CSA's view of the top challenges facing early adopters of the IOT with a mapping to recommended CSA IOT security controls.
4:30-5:00	**Tim Hahn, IBM Distinguished Engineer and Chief Architect for IoT Security, IBM Watson** *"IoT Security: Impending Doom or Rainbows and Unicorns?"* As the Internet of Things is deployed across a wide range of industrial, consumer, and business environments, of special interest and concern is the need to implement IoT solutions with careful attention to security. While many of the challenges in IoT security are similar to the challenges of securing information technology (IT) computing environments, there are special considerations due to the scale, operating conditions, system capabilities, and wide range of device types which are used in IoT solutions. Further, these systems, by connecting the electronic and physical worlds, must address both operations technology (OT) security and information technology (IT) security.
5:00-5:30	**Joe Chan, CEO, Advanced Security Technology and Research Laboratory Company Limited (AdvSTAR Lab)** *"Threat Intelligence for IoT Security"* The opportunity of IoT is huge because of its economic impact and scale. Billions of smart devices from different vendors, working together on the Internet and exchange information closely related to us, opens up new potentials for hackers. To keep IoT devices secure, it is important to maintain an up-to-date understanding of their vulnerabilities. This is difficult for both vendors and end users as there are many technologies being used in IoT devices, such as OS, web servers, wireless communication, data storage, authentication to name a few. Threat intelligence in one way provides the technical data such as malicious IP

	addresses and malware identifier for IoT infrastructure security, it also enforces better transparency between vendors and end users, ultimately lead to higher standards. In this presentation, we explore threat intelligence for IoT security and its benefits to both vendors and end users.
5:30-6:00	Panel 2 - Clouds and Things: Making Cities and Nations Smart *Moderator: David W. Kravitz* *Panelists: Soon Chia Lim, Tan Guan Hong, Tim Hahn, Joe Chan*

V1: Vertical 1 - Smart Cities and Nations

Room: 4201A+4201B (138)

Organizers

Co-chairs Shawn Chandler and Roberto Saracco

Track Summary

All cities are complex systems, balancing available resources to best exploit the value that can be provided to the population. Technology advances are continuously redefining this balance. At the same time economics and regulatory aspects play a major role in fostering the adoption and deployment of Technology and are a key ingredient in the decision making that translates potential into reality. This Vertical, on Smart Cities and Nations, takes a global view of the current status and discusses the paths forward, taking into account the new possibilities opened by the Internet of Things.

The Internet of Things is proving that the sensing of processes, infrastructure, and city control systems, and the gathering of data is a basis for improvement and innovation. It enables the monitoring of conditions and performance of city functions and the subsequent fact based analyses results in the awareness of the city status. This in turn leads to better planning and the execution of actions that can steer the Cities' evolution, bettering the use of resources and the well being of its citizens.

Session 1: People, Policy and Technology - Setting the Framework for Success

Smart Cities rely on an intersection of people, policy and technology in order to develop future services and infrastructure reflecting the needs of citizens, and to deliver on the promised benefits from sensing, monitoring, and analytics. This session's speakers will address key aspects of development concerning citizen sentiment, practical uses of IoT data, and the necessity of integration of spatio-temporal data collected from the Internet of Things, including novel methods and techniques.

Session 2: Industries and Services - Drawing Systems Together

Smart Cities must keep evolving to respond to the changing needs of citizens, of the environment and to the availability of resources. This requires a strong platform orchestrating the various infrastructures upon which to build services. The citizens themselves have to be seen as resources and as an infrastructure that is both monitoring and placing demand on the city. This session addresses various aspects of a smart city's operation from the point of view of what industry can provide and what kind of services can be deployed with particular attention to their cost of creation, deployment and operation. In this respect reference is made to the FIWare initiative of the European Community being offered and experimented worldwide to make data collection, analyses and exploitation available to third party services, as well as key industry platform offerings for design from Autodesk, and an exploration of a massive IoT system in China concerning water sensing.

Session 3: IoT Technology and Systems - Applications and Operations Making It Happen

Smart Cities require highly capable systems and application architecture to enable effective resource integration and a growing body of smart applications. Applications need to leverage the extensive network of sensors and and devices that make up the Internet of Things. This session will address the application of microservices and a feature driven architecture of systems based on emerging IEEE standards, identify the application of blockchain for smart cities, and explore the concept of integrated transactive systems as they apply to IoT, sensing, and analytics applications.

Program

10:30am	Session 1	**Derrick de Kerckhove, University of Toronto, Canada** *"Sentiment Analysis: From "Smart" City to "Happy" City* Although automated for text analysis since the late 1960s, Sentiment Analysis (SA) has been around since the invention of literature criticism. Henceforth addressed to the audience, not to the text, SA has been developed technically at least since 2002. It has, however, only recently been given prominence, owing to the manifold increase of available data, in particular thanks to social media. What SA amounts to is the new possibility for institutions and businesses to listen to clients, patients, customers and citizens instead of simply imposing regulations, services and products. Of course, SA can offer advantage to various fields including health, municipal affairs, political process and policy evaluation, transportation, banking, insurance, security and business. SA has also become sufficiently affordable and relatively easy to make it valuable, if not mandatory, for public administrations to keep tabs on their charges' feelings about their operation. The idea of the "happy city", albeit naïve, is responding that of the "smart" city, bringing precisely an emotional content to what planners tend to measure in terms of efficiency. SA adds another set of criteria to manage smart cities and make use of available IoT. SA invites different levels of administration to target a significantly higher level of satisfaction within the social body. It is already happening in some cities. I will give examples both from case studies and from artists whose works hint at social emotion. This approach could be particularly useful in the context of Singapore and other Asian cities that have made a great leap forward over European or American cities in terms of maximizing the adroit usage of IoT sensors present in their very large distribution of smartphones and public cameras.
11:00am	Session 1	**Paolo Traverso, FBK** *"Practical Use of IoT Data to Make the City Smarter and Smarter"* The availability of data is huge and it is just going to increase in the coming years. The real challenge for a city planner is how to leverage these data that are owned by different parties and ensure policies that are stimulating data sharing and usage. The talk will address these challenge using the practical experience of the speaker in fostering the evolution of the city of Trento, illustrating the highs and the lows. The presentation will also look into the near future and the plans for steering the IoT deployment in the urban environment ensuring their effectiveness from a city planner viewpoint.
11:30	Session 1	**John Taylor, Georgia Tech** *"Engineering Smart Cities: Integrating IoT into Smart City Digital Twins"* Driven by the challenges of rapid urbanization, cities are implementing advanced socio-technological changes as they evolve to become smarter cities. The success of such an evolution, however, relies on solutions that can combine data from individual infrastructure components (e.g., automobile traffic on roadways, occupants in buildings) to the urbanscale, and vice-versa. A great deal of research and development has focused on developing an in-depth understanding of data analytics at the scale of the city and the scale of an individual infrastructure component. However, there is a gap in our understanding, data collection approaches, and analytical methods to integrate such disparate data if we are to holistically understand a city's states of spatio-temporal flux. This presentation will describe efforts to create a Smart City Digital Twin of the City of Atlanta and how such a platform can enable increased visibility into a cities' human-infrastructure-technology interactions. The presentation will further discuss how spatio-temporal information within a city can be collected from and enabled through virtualization and the connectivity offered by Internet of Things (IoT). As Smart City Digital Twins collect data over time that is integrated across spatial and temporal scales, they will be able to provide critical forward looking insights into a city's smarter performance and growth.
12:00pm	Session 1	**Chin-Sean Sum, Manager of Certification Programs, Wi-SUN Alliance** *"Wi-SUN Alliance: Technology and Certification"* Overview of Wi-SUN Alliance technology and certification for Smart Cities and Utilities.
12:30		Lunch Break
1:30pm	Session 2	**Yang Yang, Shanghai Institute of Fog Computing Technology (SHIFT)** *"Fog Computing for Intelligent Buildings and Smart Services"* Fog computing has emerged as a promising solution for the Internet of Things (IoT) and next generation mobile networks. As an extension to cloud computing, fog computing enables service provisioning along the continuum from the cloud to things for reducing latency and bandwidth demands, and for empowering end users in their vicinity. Such cloud-to-thing continuum requires full technology support in infrastructure, platform, software and service levels. We propose Fog As A Service Technology (FA2ST) and its architecture to underpin a multi-level system of fog computing services for end-to-end support of various IoT applications, especially for intelligent building management and smart services. This talk introduces a hierarchical fog network for seamless service provisioning in future buildings and cities, with practical constraints, design features and experimental results in different use cases.
2:00pm	Session 2	**Lyn Chua, Autodesk** *"Autodesk - Platform Services for Designing the Smart City"*
2:30pm	Session 2	**Yasunori Mochizuchi, NEC** *"FIWARE: the open platform of choice for Truly Smart Cities"*

		The European Union has invested hundreds of million of Euros over several years in the development of an open platform, FIWare, that can be used in a variety of fields. One of the most important one is Smart Cities. The foreseen investment in the development of applications for Smart Cities over the next 5 years is in the range of billions worldwide and the availability of an open platform promoting re-usability would significantly decrease the investment required and accelerate the deployment. The talk will elaborate on the critical importance of Context Information Modelling as the concrete enabler for Smart Cities and will present worldwide business experiences in deploying and exploiting the FIWare platform. Both technology, service and policy aspects will be addressed.
3:00pm	Session 2	**Roberto Saracco, EIT ICT Labs Association, Italy** *"Creating a Citizens Based Infrastructure"* Information technology and the availability of smartphones plus disseminated IoT allows the empowerment of citizens and careful planning from Municipalities, including education, awareness raising, open data framework can go a long way to leverage on citizenship transforming them into a crucial infrastructure adding to the overall city intelligence and capability. The talk will address the issues in harvesting what is already available and providing the required "glueing" to create an emerging citizens infrastructure. It will be based on concrete experiences derived from EIT Digital Digital Cities effort in Europe and from the IEEE FDC Smart Cities initiative worldwide.
3:30pm		Coffee Break
4:00pm	Session 3	**Francesco Mazzola, T.Net** *"MaaS Microservices Delivered in a Smart Mobility Context"* For cities and territories that want to be really "smart" it's essential to equip themselves with the enabling infrastructures to help the development of intermodal services, support new way of interacting with customers, citizens, service providers and content, but most of all these services should work in a heavy crowded environment where many vehicles contend for bandwidth and where the limit of the 802.11p protocol could be a problem. Storage of large amount of data, service availability through different media make the context really challenging. For this reason, we're developing a smart framework based on Cloud Services, the so called Microservices that may help municipality and motorway concessions to maximize the return of the investment and customer experience. With our IOT4ITS framework we first allow info flowing correctly from the IOT Sensors field to the Transport Management System and ITS Infrastructure. The meteorological models (Wind, Rain, Moisture, etc) and the predictive algorithm on pollutants and weather help the system to forecast for severe weather condition that may cause asphalt slippery so avoiding hydroplaning and wheelspin. Managed Info through the Infobroker Midlleware are sent as messages to vehicles, e.g. to reduce speed in case of poor air quality problems when the amount of air pollutant concentrations and level of noise reaches critical thresholds. One thing more to take into notice when implementing large scale smart cities or nations is to deliver the proper information to the right set of Road Side Unit. The combined use of the Infobroker Midelleware and the Network Defined Software installed on IOT/ITS devices can geobroadcast the packets so that they are sent to the rightly involved Road Side Units (RSU). Using Cloud Microservices makes measurements and info widely available to the uppers levels so that APP developers can use them for many different applications. This framework could be very useful to avoid infrastructures doubling and overhead of sensors and radio object along streets, motorways and expressways and to satisfy market demand that requires development of new technologies and algorithms that use the underlying layers of the network, more and more performing to give quick answers to devices for augmented reality (transactions, info-navigation, emergency calls, essential medical support, etc) to drones and robots for parcels delivery, to self-driving vehicles, to pedestrians and much more.
4:30pm	Session 3	**Dr. Sijie Chen, Electrical Engineering at Shanghai Jiao Tong University** *"Leveraging Block Chain for Smart Cities"* The distribution power system is undergoing a significant transformation with increasing penetration of renewable energy generation and smart loads. Transactions among these prosumers can provide important incentives that drive flexible resources to absorb the uncertainty and variability from renewable energy. The blockchain technology can serve as the underlying transaction and operation platform to ensure trust, transparency, and security. This talk proposes the basic design of a transactive, i.e., transaction-driven, distribution power system based on blockchain.
5:00pm	Session 3	**Shawn Chandler, Navigant Consulting, Inc.** *"Sensing, Analytics and IoT: Potential for Smart Cities"* In this session, we explore technology based strategies and solutions for developing analytics and artificial intelligence solutions for use in *transactive* energy systems to benefit the smart city. Transactive energy systems are relatively new economically based control systems that, when used effectively, can improve reliability and decrease utility costs of service, and integrate the use of distributed energy resources from consumers and energy system aggregators. Finally, this session will explore how transactive systems may serve the smart city to optimize other diverse resources such as electric vehicles and smart buildings, capitalizing on the Internet of Things through diverse sensor networks, and seek to improve quality of life.
5:30pm	Session 3	**Cedric Koh, Rohde and Schwarz** *"Measurement and Testing Certification of IoT Devices"*
6:00pm		End of Vertical 1

V2: Vertical 2 - Public Safety, Emergency Response, and Humanitarian Technologies

Room: 4301A+4301B (138)

Organizers

Co-Chairs Philip Hall, *RelmaTech Limited (UK)* and Thas A Nirmalathas, *Melbourne Networked Society Institute*

Track Summary

Urbanization across the globe and the changing climate are posing significant challenges to citizens, communities, cities and regions, and countries when it comes to their preparedness to face incidents of adverse nature whether be it from man-made disasters, accidents or criminal acts or be it from the rising intensity of extreme weather events resulting from the changing climate. As a community of global citizens, it has become a universal expectation for us to feel safe and secure and to gain assurance from the cities, governments, and countries that we can expect to receive help in a timely manner from agencies charged with such roles. Socio-economic impact of such incidents can be catastrophic to communities and their ability to regain and bounce back to progress is a significant factor sustaining the quality of life and socio-economic viability of a vibrant community.

Rapid deployment of connectivity across the globe is making it possible to contemplate that the deployment of such systems should help us better anticipate, ameliorate, and recover from natural or man-made disasters and accidents. The wide deployment of IoT has the potential to dramatically change our resilience and preparedness in how well we deal with disasters and incidents in the future. The necessary step is a deeper deployment of monitoring and tracking systems, and better sensor networks that warn of an earthquake, a tsunami, a likely volcanic eruption, forest fires, accidental releases of chemicals, or that allow us to forestall a biological epidemic. At the same time, the IoT technologies will also improve our ability to recover from such incidents. More importantly, such a deployment need to foresee a significant degradation of such infrastructure in the face of extreme events and the design of such infrastructure should factor this to enhance the resilience and rapid restoration of key functionalities post incidents. In particular, such response requires a massive coordination between government and international agencies as well as industry organizations with the significant expert knowledge to allow rapid restoration capabilities and services to provide humanitarian responses at time-scales much faster than what we can deal with now. Approaches based on IoT need to factor a diversity of connectivity technologies, communication, sensing and computing devices or platforms and psychological state of people affected to arrive at effective ways to provide humanitarian responses in a responsible, sensitive and effective manner.

Session 1: Keynotes

- Aviation Safety Challenges - The Search for MH370
- Socio-Economic Impact of Extreme Events

Session 2: IoT Approaches for Public Safety, and Emergency and Humanitarian Responses

- Emerging requirements of public safety communications
- Safeguarding public spaces and communities
- Building resilience and protecting critical infrastructure

Panel Session: *"Role of IoT in Emergency and Disaster Relief in a World of Increasingly Frequent Extreme Events"*

Chair: Thas A Nirmalathas

Panelists:

- Dr. Neil Gordon
- Ged Giffin
- Ms. Sonia Aplin
- Professor Palani Palaniswami
- Professor Yu-Hsing Wang
- Ms. Natasha Beschorner

Program

10:30am	Session 1	Keynote 1	**Dr. Neil Gordon, Defense and Technology Group Australia**

			"The Search for MH370" On 7th March 2014 Malaysian Airlines flight MH370 from Kuala Lumpur to Beijing lost contact with Air Traffic Control and was subsequently reported missing. An extensive air and sea search was made around the last reported location of the aircraft in the Gulf of Thailand without success. Signals transmitted by the aircraft's satellite communications terminal to Inmarsat's 3F1 Indian Ocean Region satellite indicated that the aircraft continued to fly for several hours after loss of contact. In this talk I will describe how nonlinear/ non-Gaussian Bayesian time series estimation methods have been used to process the Inmarsat data and produce a probability distribution of MH370 flight paths that defined the search zone in the southern Indian Ocean. I will describe how probabilistic models of aircraft flight dynamics, satellite communication system measurements, environmental effects and radar data were constructed and calibrated. A particle filter based numerical calculation of the aircraft flight path probability distribution will be outlined and the method is demonstrated and validated using data from several previous flights of the accident aircraft. A short book is freely available for download from http://www.springer.com/us/book/9789811003783
11:30am		Keynote 1	**Ins. Ged Griffin, Victoria Police Australia** *"Smart Cities and Public Safety: Public Safety Mobile Broadband - To Bravely Go Where No One Has Gone Before"* This presentation discusses how the Safe Cities community can work with public safety officials to work together to develop the next generation of public safety ecosystem. The presentation will provide an outline of how the public safety community currently accesses information and provides a road path on new developments in public safety mobile broadband.
12:30pm			Lunch Break
1:30pm	Session 2		IoT Technologies in Public Safety and Emergency and Humanitarian Responses
1:30pm		Invited Talk 1	**Ms. Sonia Aplin, Ericsson** *"Telecommunications and Connectivity as the Keystone in Crisis Response"* Based on Ericsson Response's 16 years of experience, telecommunications and connectivity play a crucial role in the management of all crises. Ericsson Response is a volunteer initiative that deploys around 140 trained volunteer employees and telecom equipment to support the UN and other humanitarian organizations in times of disaster and crisis. The Ericsson Response team's main tasks are to set up mobile networks for voice and data communication as well as supporting partners in training and knowledge sharing. We will share how Ericsson Response was able to provide communications expertise, equipment and resources in more than 40 relief efforts in more than 30 countries. We will also discuss how Ericsson Response is helping to transform emergency response, by working with aid agency partners including the UN Office for the Coordination of Humanitarian Affairs (OCHA), the UN World Food Programme (WFP), the UN High Commissioner for Refugees (UNHCR), UNICEF and others. Some of the largest deployments we have had to date include supporting over 90 humanitarian sites, including community care centers and Ebola treatment units, in Sierra Leone, Guinea, and Ghana; supporting the Philippines when super typhoon Haiyan devastated a large part of the country and helping in the aftermath of recent hurricanes in the US and Caribbean.
2:00pm		Invited Talk 2	**Professor Palani Palaniswami, University of Melbourne and Director/Convener Sensor Networks and Information Processing (ISSNIP)** *"Real-time Crowd Behavior Analysis for Public Safety Using Networked Cameras and Cloud Analytics* With increasing population and human activities, it has become essential to monitor public places for effective disaster management. Anomalous events may include a person loitering about a place for unusual amounts of time; people running and causing panic; the size of a group of people growing over time at a particular point of entry or exit etc. A stadium like Melbourne Cricket Ground (MCG) which can accommodate nearly 100,000 spectators for any sporting event, can cause people to panic and break out commotion. It will be a daunting task to control crowd. Hence, continuous monitoring of the behavior of the people moving within the limits of stadium is of utmost importance. Automated detection of such anomalous crowd behavior is still a challenge, given the enormous amount of computation and detection challenges in detecting objects, tracking, and analyzing video in real-time. Current systems offer limited functionality, particularly in their reliance on centralized processing of gathered information. However, the prevalence of camera networks for surveillance, together with the decreasing cost of infrastructure, has produced a significant demand for robust monitoring systems. This talk addresses end-to-end system challenges of camera networks, integrating cameras across the spatial, spatiotemporal and decision domains. The talk highlights the nature and complexity of algorithms to monitor MCG (350 networked IP cameras) to deliver unique long-term behavior analysis in highly crowded environments. It highlights the video analytics capabilities to count people, track, and detect suspicious behavior, suitable for crowd management, modelling, and urban planning. It also provides automated analysis of such behaviors to detect and alert the anomalous crowd behavior in almost real-time, which is a necessity for safety and security public using Internet of Things (IoT).
2:30pm		Invited Talk 3	**Professor Yu-Hsing Wang, Department of Civil and Environmental Engineering, Hong Kong University of Science and Technology (HKUST)** *"A Real-Time and Long-Term Scalable IoT-AI Stack for Natural Hazard Resiliency Assessment and Management of Critical Infrastructure* Lifelines and critical infrastructure will be exposed to higher risks of degradations, damages or failures in the coming decades as unprecedented larger scales of typhoons and extreme precipitations are becoming a norm. Such challenging times call for data-enabled decision making through constant monitoring in order to carry out timely maintenance and upgrade works of the lifelines and critical infrastructure. Predictive maintenance of critical infrastructure relies heavily on large-scale and long-term monitoring, particularly vibrations at different parts of the structural elements. In this talk, we will showcase how we build a realtime, long-term scalable operational IoT stack for low-cost dynamic monitoring with reference to our live landslide monitoring operations in Taiwan and Hong Kong since 2014. Linear scalability is the core design principle of the IoT stack as both cost-effectiveness and performance are the major reasons why we stop short of widespread and continuous dynamic monitoring. We then discuss how we deploy AI - deep learning - on these large-scale dynamic observations pouring in by a second for real-time anomaly detections and classifications. With the entire IoT-AI stack facilitating real-time data discovery, evaluations and disseminations of the dynamic performances of the lifelines and critical infrastructure, efficient decision-making and resource allocation through predictive maintenance is now possible.
3:00pm		Invited Talk 4	**Professor Greg Foliente, The University of Melbourne** *"Towards Next-Generation Disaster Management and Public Safety"*
3:30pm			Coffee Break
4:00pm	Panel Session		**Protecting and Safeguarding Communities in Extreme Events - Role of IoT**
5:15pm			End of Vertical 2

V3: Vertical 3 - Logistics

Room: 4202 (130)

Organizers

Chair Gisele Bennett

Track Summary

The movement, distribution, delivery, maintenance, repair, upgrade, and eventual recycling of goods, is a global enterprise that fuels the world economy. The WF will explore how IoT can dramatically improve the degree of synchronization, speed, reliability, and efficiency in this critical industry. With Singapore as one of the large logistics hubs for its region, logistics plays an important role. In this context IoT is an important tool for better managing the multi-modal assets that are needed for improvements in operations and in creating benefits.

Program

10:30-10:35	**Welcome Remarks** *Prof. Gisele Bennett, Chair of the IoT for Logistics Track*
10:35-10:50	**Mr. KC Fung, Senior Manager, IT Planning & Strategy, Information Technology, Airport Authority Hong Kong** *"IoT Applications at HKIA (Hong Kong International Airport)"* HKIA has a vision of becoming a smart airport. One of the technology focus of smart airport is to make use of Internet of Things (IoT) technology to build a digital twin of the airport. The presentation will talk about some of the current IoT applications at HKIA such as RFID based baggage handling and GPS tracking of airfield vehicles; as well as some of the new and planned IoT initiatives.
10:50-11:05	**Prof. CH Cheng, Dept. of Systems Engineering and Engineering Management, The Chinese University of Hong Kong** *"Internet of Things Technologies for Smart Living"* Internet of Things (IoT) has received attention of researchers in smart living technologies in recent years. In this talk, we will explore how IoT technologies may be applied to improve the quality of life in a modern city like Hong Kong. Further, we will discuss our implementation examples in airport services, museum operations, and public safety, etc. Challenges and opportunities in these

	projects will be shared.
11:05-11:20	**Prof. Kim-Fung Tsang, Department of Electronic Engineering, City University of Hong Kong** *"IoT Tracking of Trolleys for Hong Kong Airport* Current localization schemes often employ GPS at outdoor and other wireless localization techniques at indoor (e.g. Wifi). In general, switching is needed between outdoor and indoor and vice versa. The switching potentially causes a loss of localization accuracy, at least at the transition point. Classically, the transmission range of most commonly available wireless platforms are short range, rendering high latency. LoRa, by nature, appears to be the right candidate for long-range applications in logistics and transportation. A high-performance long-range seamless indoor-outdoor localization system based on LoRa will be designed and implemented to track down trolleys in the Hong Kong airport. Analytics will be performed to help decision making e.g. record/predict the behavior of clients, position of trolleys, …etc. With slight modifications, such a system can be modified to adapt to similar or associated logistics applications which are related to vehicle travel between outdoor and indoor, to upload and unload deliverable between extremities.
11:20-11:35	**Dr. Frank Tong, Director of Research and Technology, Hong Kong LSCM R&D Centre** *"Smart Logistics for e-Commerce through Hong Kong"* Logistics is one of the pillar industries in HK. In the contemporary trends of ASEAN trades and Belt-and-Road Developments, Hong Kong's logistics industry is also striving for new technologies and new practices to meet the challenges. In this talk, I shall be sharing with the audience the smart logistics technology development in HK, particularly about the success case of cross-boundary customs clearance system. Besides, selected examples of smart IT infrastructure for logistics operations and pilot implementations with forward-looking practitioners will be presented.
11:35-12:30	**Panel Discussion: Trends and Challenges in Adopting IoT in Hong Kong** *Moderator:* Mr. Simon Wong, CEO, Hong Kong LSCM R&D Centre *Panelists:* • Mr. KC Fung, Senior Manager, IT Planning & Strategy, Information Technology, Airport Authority Hong Kong • Prof. CH Cheng, Dept. of Systems Engineering and Engineering Management, The Chinese University of Hong • Prof. Kim-Fung Tsang, Department of Electronic Engineering , City University of Hong Kong • Dr. Frank Tong, Director of Research and Technology, Hong Kong LSCM R&D Centre

End Morning Session

12:20-13:30	**Lunch**
13:30-13:55	**Dr. Bernard Leong Chung Wei, AirBus** *"Autonomous Transportation and Its Implications* In the recent years, there has been considerable interest in unmanned aerial vehicles (UAVs) and autonomous vehicles. In this talk, I discussed the challenges in bringing these technologies into the real world, and what it means for the supply chains in urban smart cities, logistics and agriculture.
13:55-14:20	**Prof. Fei-Yue Wang, Vice President and Secretary General of Chinese Association of Automation** *"Parallel Logistics in the Social IoT Era"* In this presentation, a new paradigm of logistics, Parallel Logistics, is introduced. Parallel Logistics (PL) aims to tackle the inherent nature of complexity, diversity and uncertainty in socialized logistics, and to provide a solution based on the Parallel System theory and the ACP approach. Following a full view of Parallel System theory in the new Intelligence Technology era, PL's technical framework and applications are illustrated and addressed in detail for building the next generation logistics ecological system.
15:10-15:35	**Dr. NG Poh Khai, Innovation Leader and Senior Manager, Asia Pacific Innovation Center** *"DHL's Journey Towards Digitalization with IoT"* Presentation to include: • Broad overview of DHL's trend approach to innovation and focus (i.e. IoT among other trends) • DHL's approach to IoT as a key innovation trend • Opportunities in the logistics industry - use-cases
15:35-1600	**Afternoon Break**
16:00-16:25	**Dr. Justin Dauwels, Associate Professor of the School of Electrical and Electronic Engineering at the Nanyang Technological University (NTU) in Singapore** *"Towards the Next-Generation Fleet Management Systems"* There is considerable interest related to management of fleet of autonomous vehicles in both academia and industry. Robust and reliable commercial deployment of fleet of autonomous vehicles is impeded by the lack of the following two technologies. First, an integrated approach is lacking that can encompass all different aspects of the problem, including mobility models of vehicles, communication network and application environment, customer demand prediction, and real-time information about the transportation network. Second, autonomous vehicles are still in trial phase, hence sufficient realistic field data may not be available in next few years. An integrated simulator can prove highly useful in bridging that gap. Such simulators would still be highly useful once the technology matures as they would provide an effective platform for developing further applications involving fleets of autonomous vehicles. In this presentation, we will give an overview of our progress in both these directions.
16:25-16:50	**Prof Guanghua Yang, Associate Dean, Institute of Physical Internet, Jinan University** *"Low-Cost Versatile Tracking Device and Technology for Logistics"* With the rapid growth of global business activities, it becomes essential for the firms to manage the logistics flow and to track their goods properly. Continuous monitoring and end-to-end tracking are critical for shipments of high-end goods, such as jewelry, electronic products, and legal documents. In this project, we developed the next-generation tracking devices and technologies, which support continuous, real-time, and ubiquitous goods-level tracking. By leveraging the strengths of different wireless technologies, the project realize the hybrid and collaborative positioning and communication. With the innovative design, the system enjoys a better service availability, lower total cost of ownership, operation and maintenance. The effectiveness of the proposed mechanism were demonstrated by two pilot business projects.
16:50-17:15	**Prof. Zhi Ning, Prof. National University of Singapore** *"RFID Systems and Antennas in IoT"* Radio frequency identification (RFID) technology are being rapidly developed in recent years. In particular, their applications have been widely found in Internet of Things (IoT) such as service industries, distribution logistics, manufacturing companies, product-flow systems and so on. Antenna design for both readers and tags is one of the key factors in all RFID systems. The optimized tag and reader antenna design will greatly benefit to RFID systems with longer reading range, better detection accuracy, lower fabrication cost, and simple system configuration and implementation.
17:15-18:00	**Working Group Discussion** (All Speakers and Audience Members What is working and not working? How can IEEE move the industry forward?

End IoT Logistics Session

Tuesday, February 6, 15:00 - 18:00

JM: IEEE Young Professional and IoTSG Joint Meeting on Internet of Things

Room: 4305 (130)

IoTSG will host a special half a day session with IEEE Young Professionals Singapore on 6th of Feb, addressing advancements and applications of IoT in Healthcare & Industrial Sector.
Agenda

3:00pm-4:00pm	**Enabling Better Healthcare with IoT** Panelists: Binu Azad, Director Analytics, Philips Healthcare Eugene Shum, Chief Corporate Development Officer, Eastern Health Alliance Farhana Nakhooda, Director Healthcre & Services, IBM)
4:00pm-5:00pm	**A Human Touch in Advanced Manufacturing** **Panelists:** **Ravi Singh, VP ICT Solutions Business, Hitachi Asia** **Howe Tian Ho, Director Plantweb IIoT Solutions, Emerson Automation Solutions** **Liang Ying Shun, Solutions Consultant, Dassault Systemes**
5:00pm-7:00pm	**Networking Reception & Quiz**

For more information, visit: https://www.meetup.com/IoT_SG/events/246851643/

Tuesday, February 6, 15:30 - 16:00

CB: Coffee Break (Exhibit Hall)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), Plenary: Melati

Tuesday, February 6, 16:00 - 18:00

ET3: Session on IoT Enabling Technologies (III)

Room: 4205 (130)

Chair: Stefano Savazzi (Consiglio Nazionale delle Ricerche CNR, Italy)

ET3.1 16:00 ***Energy-Throughput Tradeoffs in Ubiquitous Flying Radio Access Network for IoT***

Sara Handouf (ENSEM, Morocco); Essaid Sabir (ENSEM, Hassan II University of Casablanca, Morocco); Mohamed Sadik (ENSEM / UH2C, Morocco)

Nowadays, Wireless communication with Unmanned Aerial Vehicles (UAVs) has become extremely popular thanks to their flexible deployment and higher chance of Line-of-Sight (LoS) links to ground users. Despite the several advantages of using UAVs as flying base stations, still a number of technical challenges arise, including energy limitation. This encourages researchers to investigate the energy optimization challenges. In this paper we consider a finite network of unmanned aerial vehicles (UAVs) acting as areal base stations and serving a number of ground wireless Internet-of-Things (IoT) devices that are deployed according to a homogeneous Poisson Point Process (PPP). Each IoT device is supposed to generate data at some given rate according to its running application. We derive the coverage probability expression as well as the arrival rate for each user. Next, we address the energy efficiency problem by allowing the UAVs to strategically switch off its transceivers keeping the coverage and rate performance above some given thresholds. In order to capture the real areal movement of an UAV, we consider throughout this paper a combination of several implemented mobility models. Detailed description of this mobility model and its associated mobility patterns are also characterized. Interesting throughput-energy tradeoffs have been obtained theoretically and numerically via extensive numerical results.

pp. 325-330

ET3.2 16:30 ***Detection Probabilities for Satellite VHF Data Exchange System with Decollision Algorithm and Spot Beam***

David Tung Chong Wong and Qian Chen (Institute for Infocomm Research, Singapore); Xiaoming Peng (Institute for InfoComm Research, Singapore); Francois Chin (Institue for InfoComm Research, Singapore)

The Internet-of-Things (IoT) is gaining popularity recently. The IoT networks comprise of the wired, the wireless terrestrial and the satellite networks. The Satellite IoT networks can cover areas that are not reachable by the wired IoT networks and the wireless terrestrial networks. A Slot Carrier-sense Time Division Multiple Access (SCTDMA medium access control (MAC) protocol is used for the Satellite VHF Data Exchange System (S-VDES). This paper analyzes and derives the detection probabilities of the ship vessels from a VDES satellite for the S-VDES MAC protocol with a Decollision Algorithm (S-VDES-DA) as well as with Spot Beam (S-VDES-SB) or both (S-VDES-DA-SB). A simple probabilistic model is used to capture the packet error ratios in these schemes. Single-slot and multi-slot messages are also considered. It is shown that the performance gains in the number of ship vessels that can be detected can be up to 92% for the S-VDES-DA MAC protocol with a DA capability of up to 3 packets over a basic S-VDES MAC protocol and up to 88% for the S-VDES-DA-SB MAC protocol with a DA capability of up to 3 packets and with 7 spot beams over the S-VDES-SB MAC protocol, respectively, for a detection probability threshold of 90%. On the other hand, the percentage drops in the detection probabilities of the S-VDES-DA MAC protocol and the S-VDES-DA-SB MAC protocol for detecting up to 3 packets with and without packet error ratios are 4.6% and 4.0%, respectively.

pp. 331-336

ET3.3 17:00 ***Lightweight Energy-Cost-Efficient RAT Association for Internet of Things***

Sara Arabi (ENSEM, Hassan II University, Morocco); Hajar El Hammouti (INPT, Morocco); Essaid Sabir (ENSEM, Hassan II University of Casablanca, Morocco); Halima Elbiaze (University of Quebec at Montreal, Canada); Mohamed Sadik (ENSEM / UH2C, Morocco)

In an Internet of things (IoT) context, the existence of multiple technologies, that ensure communication between each node and the entire network, aims to improve the overall capacity to satisfy the growing number of connected devices. However, to meet a high performance, it is important to assign the right device to the right radio access technology (RAT). In this paper, we are interested in a radio access technology selection in an IoT context. We answer the question how to select the right RAT taking into account two main parameters: energy efficiency and cost to connect to a RAT, and using two different approaches. The first one is a fully distributed approach that allows to devices to autonomously select the best RAT that meets their preference requirement, but also satisfies the RATs access points utilities. The second approach relies on a centralized entity that ensures association between IoT devices and RATs using a binary knapsack optimization problem. The results obtained through simulations show that when it comes to energy efficiency and fairness among devices, the matching approach outperforms the knapsack based scheme.

pp. 337-342

ET3.4 17:30 ***A Practical Dynamic Positioning and Tracking on the Vehicular Ad-Hoc Network***

Tang- Hsien Chang (National Taiwan University, Taiwan); Der-Horng Lee and Siyu Hao (National University of Singapore, Singapore); Chun-Yin Lin (Research Assistant, Taiwan)

This research aims to build a dynamic positioning and tracking method under Ad-Hoc network, to enhance the precision with GPS or compensate the signal while missing GPS situation. The research applies multiple RSSI signals with a novel mathematical algorithm and α-β-γ filter to develop a systematic frame, to locate and track the moving node in reliable range. The results show that, the positioning model for the users has excellent ability for positioning and excellent predictive ability for tracking. This has practical value for potential applications of intelligent transportation systems (ITS), connected vehicles (CV), internet of things (IOT) and automated driving cars.

pp. 343-346

IFO4: Industry Forum Panel - Application of Cyber Physical Systems and IoT in Manufacturing, Transportation, Energy and Healthcare

Soumya Kanti Datta, EURECOM; Hiroshi Yamamoto, IBM; Frank Alexander Reusch, innogy SE; Thinagaran Perumal, Universiti Putra Malaysia

Room: 4203 (130)

Cyber Physical System (CPS) and related Internet of Things (IoT) systems are recognized to have great potentials to develop innovative services and/or to build smart systems in multiple sectors. According to *Framework for Cyber Physical Systems* published by NIST1, CPS is not just able to optimize various systems using feedback-loops between Cyber and Physical, it is to interact with humans in various domains, such as manufacturing, transportation, energy and health care. Thus CPS and IoT potentially will be able to transform the human society.

Currently the CPS and IoT services available in the mentioned domains use non-interoperable platforms, individual data formats. They create data, implementation and security silos, which in turn pose a challenge to create horizontal services. This industry forum panel will address such concerns. Specific focus will be given on (i) human interaction with IoT and CPS services; (ii) novel architecture for such interaction; (iii) achieving interoperability; and (iv) novel application of CPS and IoT in the mentioned domains.

Speakers:

Soumya Kanti Datta, EURECOM

Soumya Kanti Datta is a Research Engineer in EURECOM, France and is working on French and European research projects. He has also co-founded Future Tech Lab, a start-up working on Digital Transformation. His research focuses on innovation, development of next-generation technologies and standardization in Internet of Things, Machine-to-Machine Communication, Mobile Edge Computing, Mobile Applica- tions and Computer Security. He is an active member of IEEE Consumer Electronics Society, its Future Directions Committee and IEEE Communication Society. He has pub- lished more than 40 research papers and articles in top notch IEEE Conferences, Magazines and Journals. Soumya has served as a Track Chair of ICCE 2015 and ICCE 2016, the flagship conference of IEEE CE Society and is serving on the Organizing Committee of WF-IoT 2016, the IEEE flagship conference on IoT. Apart from that he regularly volunteers for IEEE conferences, Journals in many capacities including TPC member, reviewer, session chair. He is a frequent participant of ETSI events and regularly gives tutorials and presentations on IoT at various events including ETSI and IEEE conferences. Currently Soumya is involved in oneM2M standards and W3C Web of Things Interest Group where he is leading the task force on Discovery and Provisioning and actively contributing to their standard development activities. He received his M.Sc. from Telecom ParisTech (EURECOM) in France. In this panel, Soumya will share represent the transportation domain.

Hiroshi Yamamoto, IBM

Hiroshi Yamamoto is a Distinguished Engineer and the Chief Technology Officer (CTO) for the Global Electronics Industry in IBM. His responsibilities include all electronics customers at global level. During his seven years career as a microcode developer for mechatronics system (ATM) in a large electronics company and twenty-five year career (system engineer) in IBM, he developed his technical expertise in both real time systems at micro code level and enterprise level by applying industry standard based Distributed Transactions (CORBA/OTS, JTS/JTA, WS-Transaction) to various production systems including algorithmic trading systems (machine to machine system) in IBM. Those experiences led him appointed as a Distinguished Engineer in 2008. He expanded the horizontal industry skills in industrial sector by designing industry solution such as Meter Data Management system and Video Surveillance system for some large electronics customer which led him appointed as the Global Electronics CTO in 2013. Since then he has been working global customers such as Siemens, Advantech, Toshiba and Mitsubishi Electronics. Since he knows both machine control and enterprise system, his current focus is adapting Internet of Things, Industrie 4.0 and Cyber Physical Systems

to the real customers environment. He was also appointed as a lead technical advisor/architect to IoT CoC in IBM-Japan (renamed as Watson IoT BU in 2016). He was a former member of International Standard Organization / International Electro-technical Commission (ISO/IEC) JTC1 SC38 (Distributed Application Platform and Services) national bodies. He also currently serves as a visiting professor of the graduate school Computer Science of Hosei University in Tokyo and as a member of strategic standard management in Northern Western University in US2 He holds seven patents of the distributed computing technology.

Frank Alexander Reusch, innogy SE

Frank Alexander Reusch studied in Koblenz (Germany) business administration and informatics. In addition, Mr. Reusch has completed a certificate course of the George Washington University in the field of "International Project Leadership". After graduating, he has worked intensively with IT automation in logistics, for example the use of infrared communication in distribution center. In addition to this, he was responsible for complex project management tasks like buildup a car assembly factory for Mercedes-Benz. Since 2001, Mr. Reusch works for RWE as a project manager. There he led among others six years a team of software developers and built a center for automated software tests in Kosice (Slovakia). Mr. Reusch was trained as "PMI Agile Certified Practitioner" and is a certified Innovation Manager. He supported two years as a Senior Product Manager Lemonbeat GmbH, a subsidiary of RWE. In this task, he was responsible for the development of "embedded devices" up to small series production. Additionally he worked in W3C intensively on the standardization of a communication protocol in the group "Web of Things". He gives lectures and presentations around the world regarding the Internet of Things and his practical experience. Today he is Senior Program Manager in innogy SE, the leading company in the RWE group. He is responsible to support Renewable Energies through the use of digitalization.

Thinagaran Perumal, Universiti Putra Malaysia

Thinagaran Perumal is a Senior Lecturer in the Department of Computer Science, Faculty of Computer Science and Information Technology, Universiti Putra Malaysia. THina received his BEng in Computer and Communication Systems from UPM in 2003, and his M.S. and Ph.D. in Intelligent Systems from same university in 2006 and 2012, respectively. Thina is currently serving as Chapter Chair for the IEEE Consumer Electronics Society Malaysia Chapter. He was the recipient of 2014 IEEE Early Career Award from IEEE Consumer Electronics Society for his pioneering contribution in the field of consumer electronics. His research interests are towards interoperability aspects of Cyber-Physical Systems, Internet of Things (IoT), activity recognition and ambient intelligence. His current focus is solving interoperability issues and bridging the gap of consumer-centric Internet of Things in adapting Cyber-Physical Systems for bespoke verticals. He is an active member of IEEE Consumer Electronics Society and its Future Directions Committee on Internet of Things. He has been invited to give several keynote lectures and plenary talk on Internet of Things in various institutions and organizations internationally. He has published several papers in IEEE Conferences and Journals and is serving as TPC member for several reputed IEEE conferences. Currently he is the General Chair for International Symposium on Consumer Electronics 2017 (ISCE 2017).

LPWAN: Session on LPWAN Technologies and IoT

Room: 4304 (130)

Chair: Bala Krishna Maddali (GGS Indraprastha University, New Delhi, India)

LPWAN.1 16:00 *Leveraging BLE and LoRa in IoT Network for Wildlife Monitoring System (WMS)*

Eyuel Debebe Ayele (University of Twente, The Netherlands & University of Dresden, Germany); Kallol Das, Paul Havinga and Nirvana Meratnia (University of Twente, The Netherlands)

In this paper we propose a new dual radio IoT network architecture for wildlife monitoring system (WMS). WMS leverages bluetooth low energy (BLE) in low power wide area networks (LPWANs) by dynamically changing the operating radio based on the proximity among herd of wild animals. This approach will facilitate ultra-low power IoT devices to be deployed for sustainable wildlife monitoring application. In addition we present an analytical model to investigate the performance of the proposed IoT network in terms of energy consumption under a wildlife monitoring use-case. The simulation results show that the dual radio network leads to a higher energy efficiency when compared to the network utilizing only LPWAN. Moreover, our network readily doubles the network life time for various data traffic rates.
pp. 347-353

LPWAN.2 16:30 *Powering the IoT Through Embedded Machine Learning and LoRa*

Vignesh Mahalingam Suresh, Rishi Sidhu, Prateek Karkare, Aakash Patil, Zhang Lei and Arindam Basu (Nanyang Technological University, Singapore)

The Internet of Things (IoT) technology is rapidly changing the way we live and the number of connected devices are increasing at an exponential pace. However, two key challenges are the battery life for off-grid IoT applications and the ability of edge devices to communicate over long range. Raw data transmission poses as a very power hungry activity for any device. The conventional cellular wide area networks are power-hungry and incompatible for battery-operated IoT devices. There is a need for low-power edge computing devices that reduce the transmission payload and integrate Low-Power Wide-Area Network (LPWAN) technologies, which offer a wide range connectivity while still providing a long battery life. One of the most promising LPWAN technologies today is LoRa. In this paper, we present a solution that employs machine learning on the edge device and performs low power transmission through LoRa. We demonstrate the use case of our solution through a field trial conducted in China for sow activity classification. By implementing embedded machine learning with LoRa, we could compress the transmitted data by 512 times and extend the battery life by three times. A very low energy expenditure of 5.1 mJ per classification is achieved.
pp. 354-359

LPWAN.3 17:00 *Analyzing LoRa: a Use Case Perspective*

Muhammad Omer Farooq (Cork Institute of Technology, Nimbus Centre for Embedded Systems Research, Ireland); Dirk Pesch (Cork Institute of Technology, Ireland)

The dawn of low-power wide-area networking (LPWAN) technologies ease deployment and maintenance of low bit rate and long range networks. Such a technology is capable of supporting a large number of Internet of Things (IoT) use cases. There exists several LPWAN technologies, however Long range (LoRa) is the most adopted technology. LoRa provides a range of physical layer communication settings, such as bandwidth, spreading factor, coding rate, and central frequency. These settings impact throughput, reliability, and communication range. Since, IoT use cases have different data generation patterns, therefore it is essential to analyze LoRa's different communication settings impact on real IoT use cases. In this paper, through extensive experimental studies we analyze the communication settings' impact on different IoT use cases, such as smart metering, smart parking, smart street lighting, and vehicle fleet tracking. Our results demonstrate that the LoRa physical layer setting corresponding to the fastest data rate achieves up to 380% higher packet delivery ratio and up to 1/250 times lower energy consumption compared to other evaluated settings, and this setting is suitable for the IoT use cases presented in this paper. However, it covers smaller communication area compared to the slow data rate settings. Our results also hint that using the fastest data rate setting along with a multi-hop LoRa network can cover large area and may still yield a better performance. Moreover, we modified LoRa's Aloha-based channel access mechanism, and our results also demonstrate that the modified channel access mechanism positively impacts LoRa's different communication settings' performance.
pp. 360-365

LPWAN.4 17:30 *A Low-Cost LoRaWAN Testbed for IoT: Implementation and Measurements*

Asif Muhammad Yousuf, Edward Rochester and Majid Ghaderi (University of Calgary, Canada)

One of the challenges in deploying IoT applications is the cost of building and operating the communication infrastructure. This paper studies the feasibility of building a low-cost IoT network based on LoRa, a leading Low-Power Wide-Area Network (LPWAN) technology, using off-the-shelf components and open source software. To this end, we describe our LoRa testbed, which includes gateways, end devices and a variety of sensors. We then present extensive measurement results to characterize the performance of our LoRa network over the 915 MHz unlicensed ISM band in both indoor and outdoor scenarios for various network setups. Our results show that even in a harsh propagation environment, e.g. when the gateway is located inside a concrete building, the low-cost network is able to achieve great coverage. Specifically, we observed that: i) the indoor coverage is sufficient to cover an entire seven-story office building with minimal packet drop, ii) the outdoor coverage is very dependent on the environment, where in our experiments, a communication range of 4.4 km was achieved with only 15% packet drop, iii) network parameters such as spreading factor and packet size greatly affect the coverage; for example, we observed that a payload size of 242 bytes leads to 90% packet drop versus less than 5% drop with a payload size of 1 byte.
pp. 366-371

TOP1a: Topical 1 - Security and Privacy Regimes - Part 1

Room: 4302 (130)

Organizers

Co-Chairs David W. Kravitz and Jeffrey Voas

Track Summary

IoT applications and prospective solutions mandate consideration of a broad set of security and privacy requirements. The explosion in the number of connected devices poses a significant challenge, as does the diversity of end uses. The World Forum will address the component and platform implications for IoT in the context of the full life cycle for security and privacy regimes. It will also address the many security architectures and approaches that have emerged from Government organizations around the world, from the Commercial Market space, and from the Research Community. Across the wide spectrum of use cases there is a need to appropriately balance security and privacy, and it is useful to think of classifications that distinguish the levels required. As an example these may be thought of as:

- Highly security-centric "life-and-death" applications such as: critical infrastructure; control systems for connected automobiles, railroads, or aircraft; emergency healthcare
- Intermediate security uses that include: smart home; routine monitoring of facilities; sports and physical exercise activities that involve tracking such as geolocation
- Lower security casual uses such as: games, entertainment, public virtual reality applications, and aspects of social media and general information services

The topics that the Presentations, Panels, and Working Group discussions, for the Track on "Security and Privacy Regimes for IoT" will cover include:

- Achieving secure compose-ability of individually secure devices and components
- Scalability (for massive number of devices, and as contributors to- and consumers of- big data)
- Device-associated robustness levels that also deal with the high variations in heterogeneity (such as stationary and mobile infrastructure, smart phones and user terminals, wearables, the wide range of possible sensors and actuator types, and embedded IoT devices)
- Device ownership and component control (accounting for interoperability, regulatory compliance, governance, audit-ability and risk management)
- Remediation for the reigning confusion caused by the proliferation of standards and certification, and the realization that IoT will create new experiences and a vulnerability surface that is not accounted for
- Testing approaches and procedures that overcome the lack of efficacious and accepted practices — These include: interfacing with and leveraging legacy devices and services; containment against expansion of compromise to other units, systems or networks; effective crypto-agility; defense against advanced threats such as quantum-computing attacks. These also include testing approaches for the differing device lifetimes, and lifecycle support of IoT solutions such as over-the-air firmware and software upgrades

One of the objectives of the Track is to launch future actions and activities that continue beyond the World Forum as part of the IoT Initiative Working Group on "IoT Security and Privacy".

Program

10:30-10:40	***Introduction*** *(David W. Kravitz)*

	Keynotes 1
10:40-11:10	**Thomas Keenan, Professor, Environmental Design and Computer Science, University of Calgary** *"Avoiding the Creep Factor in the Internet of Things"* If we could design the Internet again, from scratch, we'd do lots of things differently. There is a real risk that, in the race to bring products to market, IoT devices and applications will drag us into some very creepy uncharted waters. We've already seen IP cameras and baby monitors conscripted to form a botnet (the 2016 Dyn hack) and data leakage from an Internet connected sex toy (We-Vibe) resulted in a successful class action claim. Starting from a framework developed by the author for the 2014 best-seller Technocreep, we'll explore some of the ways in which IoT devices can be creepy. We'll also look at techniques, from data minimization to blockchain logging that can be used to ensure that the right data, and only the right data, goes to the right people.
11:10-11:40	**Hsiao-Ying Lin, Senior Researcher, Shield Lab, Huawei International** *"Connected Car Security"* Vehicles become intelligent and connected for enhancing driving safety and comfort in the latest decade. Modern vehicles are significantly different from conventional vehicles which are well-contained in an isolated network environment. As more communication technologies are deployed in vehicles to provide new applications, more external interfaces, such as DSRC (dedicated short-range communications), Bluetooth, 3/4G and OBD (on-board diagnostics) interfaces, expose vehicles in publicly accessible networks. As a result, there are multiple potential ways for attackers remotely getting access into vehicles to take control over them. Designing and deploying security mechanisms for connected vehicles is important for not only security but also safety reasons. This talk introduces the attack surface of connected vehicles and mitigation.
11:40-12:10	**Drew Van Duren, Technical Director of IoT Security, OnBoard Security, Inc.** *"Locking Down and Re-Using V2X Security: Lessons for Smart Cities"* V2X, a technology years in the making and on the verge of massive deployment, is bringing to the forefront deployment security issues related to application definition, message dictionary clarity, message security authorization, as well as security lifecycle interactions between standards bodies, manufacturers, system operators, and transportation PKIs. In this session, we explore some of the lessons-learned in the U.S. Connected Vehicle pilots as they refine, implement and field new capabilities developed by standards organizations such as IEEE and SAE. We also evaluate the V2X security stack and how its security primitives can be applied in smart city agendas looking to satisfy broader IoT security goals for unmanned aerial systems and other automation paradigms.
12:10-12:30	Panel 1 - Systems of Systems: Balancing Security and Privacy Where We Live and Drive *Moderator: Jeff Voas* *Panelists: Thomas Keenan, Hsiao-Ying Lin, Drew Van Duren, Ulf Lindqvist*
12:30-1:30	Lunch
	Keynotes 2
1:30-2:00	**Ulf Lindqvist, Program Director, Computer Science Laboratory, SRI International** *"Security and Privacy Challenges and Opportunities for IoT in Smart Cities"* The concept of Smart Cities illustrates many of the most difficult security and privacy challenges for IoT: large numbers of devices; secure composition of heterogeneous IoT systems whose interaction is context-dependent; user and device mobility; collection, storage, and analysis of sensitive data; long system lifetimes; critical real-time and safety requirements; emergent future functionality and system interaction unforeseen at design time; and so forth. There are great opportunities to address these challenges and create security and privacy methods and solutions that will benefit not only Smart Cities, but also other IoT applications that face some of the same challenges. This talk describes such challenges and opportunities, based on recent findings from workshops organized by the IEEE Cybersecurity Initiative, and results from research conducted in the IoT Security and Privacy Center at SRI International.
2:00-2:30	**Jeff Voas, Computer Scientist, NIST, USA** *"IoT and Trust"* This talk discusses the underlying and foundational science of IoT and gives the audience a general understanding of what IoT is. In this work, five core primitives belonging to most distributed systems are presented. These primitives form the basic building blocks for a Network of 'Things' (NoT) [NIST SP 800-183], including the Internet of Things (IoT). System primitives allow formalisms, reasoning, simulations, and reliability and security risk-tradeoffs to be formulated and argued. These primitives apply well to systems with large amounts of data, scalability concerns, heterogeneity concerns, temporal concerns, and elements of unknown pedigree with possible nefarious intent. The talk ends by suggesting 25 trust issues, that involve everything from 3rd party certification of 3rd party black-box services and products, to defective 'things', and to deliberate intentions to slow the flow of data in a IoT-based system.
2:30-3:00	**Soon Chia Lim, Director of Technology, Cyber Security Agency, Singapore** *"IoT Security - Enabling Trust and Digital Future"* There have been widespread cyber attacks and pervasive data breaches lately. As our society becomes more connected with the proliferation of IoT, the security challenges would likely gather momentum in terms of scale, frequency and criticality. If this continues, it will erode trust and hamper our pursuit of digital transformation. We need to galvanise efforts in building a next generation of inherently secure IoT ecosystem, so as to create a more secure and safer cyberspace of things.
3:00-3:30	**Tan Guan Hong, Technology Partner, Rekanext Capital Partners** *"In the Digital Economy Using IoT Systems, Data Classification Must be Designed In!"* For the Digital Economy to grow, IoT sensor data sharing will innovate new applications and businesses. Many IoT systems were historically designed as silo information systems for specific use. The sharing of data faces many challenges as the data needs to have classification for its intended use in the system design. Data classification determines the IoT Sensor security implementation with the subsequent CAPEX and OPEX. There are other considerations for IoT Sensor data such as Data Accuracy, Data Reliability and Speed of Sensor Data.
3:30-4:00	Coffee Break
	Keynotes 3
4:00-4:30	**Haojie Zhuang, Director of Research, Cloud Security Alliance APAC** *"Top Challenges to Secure IOT Deployments"* There are many challenges to deploying a secure IOT implementation. Many of the security technologies on the market will play a role in mitigation IOT risks with an enterprise. However, the IOT also introduces new challenges to secure engineering. Many of these would benefit from a targeted research or industry collaboration to determine the optimal Long-term approaches to resolution. The talk will share the CSA's view of the top challenges facing early adopters of the IOT with a mapping to recommended CSA IOT security controls.
4:30-5:00	**Tim Hahn, IBM Distinguished Engineer and Chief Architect for IoT Security, IBM Watson** *"IoT Security: Impending Doom or Rainbows and Unicorns?"* As the Internet of Things is deployed across a wide range of industrial, consumer, and business environments, of special interest and concern is the need to implement IoT solutions with careful attention to security. While many of the challenges in IoT security are similar to the challenges of securing information technology (IT) computing environments, there are special considerations due to the scale, operating conditions, system capabilities, and wide range of device types which are used in IoT solutions. Further, these systems, by connecting the electronic and physical worlds, must address both operations technology (OT) security and information technology (IT) security.
5:00-5:30	**Joe Chan, CEO, Advanced Security Technology and Research Laboratory Company Limited (AdvSTAR Lab)** *"Threat Intelligence for IoT Security"* The opportunity of IoT is huge because of its economic impact and scale. Billions of smart devices from different vendors, working together on the Internet and exchange information closely related to us, opens up new potentials for hackers. To keep IoT devices secure, it is important to maintain an up-to-date understanding of their vulnerabilities. This is difficult for both vendors and end users as there are many technologies being used in IoT devices, such as OS, web servers, wireless communication, data storage, authentication to name a few. Threat intelligence in one way provides the technical data such as malicious IP addresses and malware identifier for IoT infrastructure security, it also enforces better transparency between vendors and end users, ultimately lead to higher standards. In this presentation, we explore threat intelligence for IoT security and its benefits to both vendors and end users.
5:30-6:00	Panel 2 - Clouds and Things: Making Cities and Nations Smart *Moderator: David W. Kravitz* *Panelists: Soon Chia Lim, Tan Guan Hong, Tim Hahn, Joe Chan*

UAV: Session on IoT, Drones and UAV

Room: 4303 (130)
Chair: Matthew E. Tolentino (University of Washington, USA)

UAV.1 16:00 ***Drone Services: An Investigation via Prototyping and Simulation***
Majed Alwateer (Latrobe University, Australia); Seng W Loke (Deakin University, Australia); Wenny Rahayu (La Trobe University, Australia)
Although drones are currently used in many outdoor and indoor applications, still there are numerous opportunities to be explored by combining drones with other accessible, adaptable and emerging technologies, for example, cell phones, smartwatches, and Internet-of-Things appliances. In this paper, we propose and investigate an approach to using drones to provide services, one where drones act as servers (edge computing style) in order to collect data, provide Internet access, and process data for mobile users. Our study simulates drones providing services (not restricted to edge computing services). We provide anecdotal experiments on factors affective drone service delivery.
pp. 372-375

UAV.2 16:40 ***A Novel Protocol for Data Links Between Wireless Sensors and UAV Based Sink Nodes***
Yuan Qin, David Boyle and Eric Yeatman (Imperial College London, United Kingdom (Great Britain))
Mobile data collection using Unmanned Aerial Vehicles has the potential to improve device-level energy efficiency and balance network-level energy consumption in comparison with traditional Wireless Sensor

Networks. This approach allows new application areas to be explored, particularly in harsh and remote environments, where creating radio links between each device may be impossible, infrastructure networks do not exist, accessibility is limited, etc. Protocols designed for data collection in traditional low power wireless networks have rarely considered the use of mobile data sinks in a practical sense, typically routing data through the network towards a sink or gateway node. In this paper, we describe and evaluate a simple protocol designed specifically for data collection by an aerial mobile sink from static sensing devices. The protocol uses existing ultra-low power physical and asynchronous medium access control mechanisms, and a lightweight application layer for data collection. We evaluate throughput for a number of realistic experimental conditions, including testing performance under contention for access to the medium and in the presence of packet collisions. We show that data collection is reliable in all cases for moderate UAV speeds, and the efficiency of the protocol decreases linearly with increased node density.
pp. 376-381

UAV.3 17:20 ***Tracking Hazardous Aerial Plumes Using IoT-Enabled Drone Swarms***
Carl Seiber, David Nowlin, Bob Landowski and Matthew E. Tolentino (University of Washington, USA)
Emergency response teams are charged with ensuring citizen safety from life-threatening events such as structural fires, vehicle accidents, and hazardous material spills. While managing such events is dangerous, the release of hazardous materials, such as toxic chemicals, into the atmosphere is particularly challenging. Upon arrival at a scene, response teams must quickly identify the hazardous substance and the contaminated area to limit exposure to nearby population centers. For airborne toxins, this assessment is complicated by environmental conditions, such as changes in wind speed and direction that can cause hazardous, aerial plumes to move dynamically. Without a way to dynamically monitor and assess atmospheric conditions during these events, response teams must conservatively predict the extent of the contaminated area and then orchestrate evacuations and reroute traffic to ensure the safety of nearby populations. In this paper, we propose outfitting swarms of drones with Internet of Things (IoT) sensor platforms to enable dynamic tracking of hazardous aerial plumes. Augmenting drones with sensors enables emergency response teams to maintain safe distances during hazard identification, minimizing first response team exposure. Additionally, we integrate sensor-based particulate detection with autonomous drone flight control providing the capability to dynamically identify and track the boundaries of aerial plumes in real time. This enables first responders to visually identify plume movement and better predict and isolate the impact area. We describe the composition of our prototype IoT-enhanced drone system and describe our initial evaluations.
pp. 382-387

V1: Vertical 1 - Smart Cities and Nations

Room: 4201A+4201B (138)

Organizers

Co-chairs Shawn Chandler and Roberto Saracco

Track Summary

All cities are complex systems, balancing available resources to best exploit the value that can be provided to the population. Technology advances are continuously redefining this balance. At the same time economics and regulatory aspects play a major role in fostering the adoption and deployment of Technology and are a key ingredient in the decision making that translates potential into reality. This Vertical, on Smart Cities and Nations, takes a global view of the current status and discusses the paths forward, taking into account the new possibilities opened by the Internet of Things.

The Internet of Things is proving that the sensing of processes, infrastructure, and city control systems, and the gathering of data is a basis for improvement and innovation. It enables the monitoring of conditions and performance of city functions and the subsequent fact based analyses results in the awareness of the city status. This in turn leads to better planning and the execution of actions that can steer the Cities' evolution, bettering the use of resources and the well being of its citizens.

Session 1: People, Policy and Technology - Setting the Framework for Success

Smart Cities rely on an intersection of people, policy and technology in order to develop future services and infrastructure reflecting the needs of citizens, and to deliver on the promised benefits from sensing, monitoring, and analytics. This session's speakers will address key aspects of development concerning citizen sentiment, practical uses of IoT data, and the necessity of integration of spatio-temporal data collected from the Internet of Things, including novel methods and techniques.

Session 2: Industries and Services - Drawing Systems Together

Smart Cities must keep evolving to respond to the changing needs of citizens, of the environment and to the availability of resources. This requires a strong platform orchestrating the various infrastructures upon which to build services. The citizens themselves have to be seen as resources and as an infrastructure that is both monitoring and placing demand on the city. This session addresses various aspects of a smart city's operation from the point of view of what industry can provide and what kind of services can be deployed with particular attention to their cost of creation, deployment and operation. In this respect reference is made to the FIWare initiative of the European Community being offered and experimented worldwide to make data collection, analyses and exploitation available to third party services, as well as key industry platform offerings for design from Autodesk, and an exploration of a massive IoT system in China concerning water sensing.

Session 3: IoT Technology and Systems - Applications and Operations Making It Happen

Smart Cities require highly capable systems and application architecture to enable effective resource integration and a growing body of smart applications. Applications need to leverage the extensive network of sensors and and devices that make up the Internet of Things. This session will address the application of microservices and a feature driven architecture of systems based on emerging IEEE standards, identify the application of blockchain for smart cities, and explore the concept of integrated transactive systems as they apply to IoT, sensing, and analytics applications.

Program

10:30am	Session 1	**Derrick de Kerckhove, University of Toronto, Canada** *"Sentiment Analysis: From "Smart" City to "Happy" City* Although automated for text analysis since the late 1960s, Sentiment Analysis (SA) has been around since the invention of literature criticism. Henceforth addressed to the audience, not to the text, SA has been developed technically at least since 2002. It has, however, only recently been given prominence, owing to the manifold increase of available data, in particular thanks to social media. What SA amounts to is the new possibility for institutions and businesses to listen to clients, patients, customers and citizens instead of simply imposing regulations, services and products. Of course, SA can offer advantage to various fields including health, municipal affairs, political process and policy evaluation, transportation, banking, insurance, security and business. SA has also become sufficiently affordable and relatively easy to make it valuable, if not mandatory, for public administrations to keep tabs on their charges' feelings about their operation. The idea of the "happy city", albeit naïve, is responding that of the "smart" city, bringing precisely an emotional content to what planners tend to measure in terms of efficiency. SA adds another set of criteria to manage smart cities and make use of available IoT. SA invites different levels of administration to target a significantly higher level of satisfaction within the social body. It is already happening in some cities. I will give examples both from case studies and from artists whose works hint at social emotion. This approach could be particularly useful in the context of Singapore and other Asian cities that have made a great leap forward over European or American cities in terms of maximizing the adroit usage of IoT sensors present in their very large distribution of smartphones and public cameras.
11:00am	Session 1	**Paolo Traverso, FBK** *"Practical Use of IoT Data to Make the City Smarter and Smarter"* The availability of data is huge and it is just going to increase in the coming years. The real challenge for a city planner is how to leverage these data that are owned by different parties and ensure policies that are stimulating data sharing and usage. The talk will address these challenge using the practical experience of the speaker in fostering the evolution of the city of Trento, illustrating the highs and the lows. The presentation will also look into the near future and the plans for steering the IoT deployment in the urban environment ensuring their effectiveness from a city planner viewpoint.
11:30	Session 1	**John Taylor, Georgia Tech** *"Engineering Smart Cities: Integrating IoT into Smart City Digital Twins"* Driven by the challenges of rapid urbanization, cities are implementing advanced socio-technological changes as they evolve to become smarter cities. The success of such an evolution, however, relies on solutions that can combine data from individual infrastructure components (e.g., automobile traffic on roadways, occupants in buildings) to the urbanscale, and vice-versa. A great deal of research and development has focused on developing an in-depth understanding of data analytics at the scale of the city and the scale of an individual infrastructure component. However, there is a gap in our understanding, data collection approaches, and analytical methods to integrate such disparate data if we are to holistically understand a city's states of spatio-temporal flux. This presentation will describe efforts to create a Smart City Digital Twin of the City of Atlanta and how such a platform can enable increased visibility into a cities' human-infrastructure-technology interactions. The presentation will further discuss how spatio-temporal information within a city can be collected from and enabled through virtualization and the connectivity offered by Internet of Things (IoT). As Smart City Digital Twins collect data over time that is integrated across spatial and temporal scales, they will be able to provide critical forward looking insights into a city's smarter performance and growth.
12:00pm	Session 1	**Chin-Sean Sum, Manager of Certification Programs, Wi-SUN Alliance** *"Wi-SUN Alliance: Technology and Certification"* Overview of Wi-SUN Alliance technology and certification for Smart Cities and Utilities.
12:30		Lunch Break
1:30pm	Session 2	**Yang Yang, Shanghai Institute of Fog Computing Technology (SHIFT)** *"Fog Computing for Intelligent Buildings and Smart Services"* Fog computing has emerged as a promising solution for the Internet of Things (IoT) and next generation mobile networks. As an extension to cloud computing, fog computing enables service provisioning along the continuum from the cloud to things for reducing latency and bandwidth demands, and for empowering end users in their vicinity. Such cloud-to-thing continuum requires full technology support in infrastructure, platform, software and service levels. We propose Fog As A Service Technology (FA2ST) and its architecture to underpin a multi-level system of fog computing services for end-to-end support of various IoT applications, especially for intelligent building management and smart services. This talk introduces a hierarchical fog network for

		seamless service provisioning in future buildings and cities, with practical constraints, design features and experimental results in different use cases.
2:00pm	Session 2	**Lyn Chua, Autodesk** *"Autodesk - Platform Services for Designing the Smart City"*
2:30pm	Session 2	**Yasunori Mochizuchi, NEC** *"FIWARE: the open platform of choice for Truly Smart Cities"* The European Union has invested hundreds of million of Euros over several years in the development of an open platform, FIWare, that can be used in a variety of fields. One of the most important one is Smart Cities. The foreseen investment in the development of applications for Smart Cities over the next 5 years is in the range of billions worldwide and the availability of an open platform promoting re-usability would significantly decrease the investment required and accelerate the deployment. The talk will elaborate on the critical importance of Context Information Modelling as the concrete enabler for Smart Cities and will present worldwide business experiences in deploying and exploiting the FIWare platform. Both technology, service and policy aspects will be addressed.
3:00pm	Session 2	**Roberto Saracco, EIT ICT Labs Association, Italy** *"Creating a Citizens Based Infrastructure"* Information technology and the availability of smartphones plus disseminated IoT allows the empowerment of citizens and careful planning from Municipalities, including education, awareness raising, open data framework can go a long way to leverage on citizenship transforming them into a crucial infrastructure adding to the overall city intelligence and capability. The talk will address the issues in harvesting what is already available and providing the required "glueing" to create an emerging citizens infrastructure. It will be based on concrete experiences derived from EIT Digital Digital Cities effort in Europe and from the IEEE FDC Smart Cities initiative worldwide.
3:30pm		Coffee Break
4:00pm	Session 3	**Francesco Mazzola, T.Net** *"MaaS Microservices Delivered in a Smart Mobility Context"* For cities and territories that want to be really "smart" it's essential to equip themselves with the enabling infrastructures to help the development of intermodal services, support new way of interacting with customers, citizens, service providers and content, but most of all these services should work in a heavy crowded environment where many vehicles contend for bandwidth and where the limit of the 802.11p protocol could be a problem. Storage of large amount of data, service availability through different media make the context really challenging. For this reason, we're developing a smart framework based on Cloud Services, the so called Microservices that may help municipality and motorway concessions to maximize the return of the investment and customer experience. With our IOT4ITS framework we first allow info flowing correctly from the IOT Sensors field to the Transport Management System and ITS Infrastructure. The meteorological models (Wind, Rain, Moisture, etc) and the predictive algorithm on pollutants and weather help the system to forecast for severe weather condition that may cause asphalt slippery so avoiding hydroplaning and wheelspin. Managed Info through the Infobroker Midlleware are sent as messages to vehicles, e.g. to reduce speed in case of poor air quality problems when the amount of air pollutant concentrations and level of noise reaches critical thresholds. One thing more to take into notice when implementing large scale smart cities or nations is to deliver the proper information to the right set of Road Side Unit. The combined use of the Infobroker Midelleware and the Network Defined Software installed on IOT/ITS devices can geobroadcast the packets so that they are sent to the rightly involved Road Side Units (RSU). Using Cloud Microservices makes measurements and info widely available to the uppers levels so that APP developers can use them for many different applications. This framework could be very useful to avoid infrastructures doubling and overhead of sensors and radio object along streets, motorways and expressways and to satisfy market demand that requires development of new technologies and algorithms that use the underlying layers of the network, more and more performing to give quick answers to devices for augmented reality (transactions, info-navigation, emergency calls, essential medical support, etc) to drones and robots for parcels delivery, to self-driving vehicles, to pedestrians and much more.
4:30pm	Session 3	**Dr. Sijie Chen, Electrical Engineering at Shanghai Jiao Tong University** *"Leveraging Block Chain for Smart Cities"* The distribution power system is undergoing a significant transformation with increasing penetration of renewable energy generation and smart loads. Transactions among these prosumers can provide important incentives that drive flexible resources to absorb the uncertainty and variability from renewable energy. The blockchain technology can serve as the underlying transaction and operation platform to ensure trust, transparency, and security. This talk proposes the basic design of a transactive, i.e., transaction-driven, distribution power system based on blockchain.
5:00pm	Session 3	**Shawn Chandler, Navigant Consulting, Inc.** *"Sensing, Analytics and IoT: Potential for Smart Cities"* In this session, we explore technology based strategies and solutions for developing analytics and artificial intelligence solutions for use in *transactive* energy systems to benefit the smart city. Transactive energy systems are relatively new economically based control systems that, when used effectively, can improve reliability and decrease utility costs of service, and integrate the use of distributed energy resources from consumers and energy system aggregators. Finally, this session will explore how transactive systems may serve the smart city to optimize other diverse resources such as electric vehicles and smart buildings, capitalizing on the Internet of Things through diverse sensor networks, and seek to improve quality of life.
5:30pm	Session 3	**Cedric Koh, Rohde and Schwarz** *"Measurement and Testing Certification of IoT Devices"*
6:00pm		End of Vertical 1

V2: Vertical 2 - Public Safety, Emergency Response, and Humanitarian Technologies

Room: 4301A+4301B (138)

Organizers

Co-Chairs Philip Hall, *RelmaTech Limited (UK)* and Thas A Nirmalathas, *Melbourne Networked Society Institute*

Track Summary

Urbanization across the globe and the changing climate are posing significant challenges to citizens, communities, cities and regions, and countries when it comes to their preparedness to face incidents of adverse nature whether be it from man-made disasters, accidents or criminal acts or be it from the rising intensity of extreme weather events resulting from the changing climate. As a community of global citizens, it has become a universal expectation for us to feel safe and secure and to gain assurance from the cities, governments, and countries that we can expect to receive help in a timely manner from agencies charged with such roles. Socio-economic impact of such incidents can be catastrophic to communities and their ability to regain and bounce back to progress is a significant factor sustaining the quality of life and socio-economic viability of a vibrant community.

Rapid deployment of connectivity across the globe is making it possible to contemplate that the deployment of such systems should help us better anticipate, ameliorate, and recover from natural or man-made disasters and accidents. The wide deployment of IoT has the potential to dramatically change our resilience and preparedness in how well we deal with disasters and incidents in the future. The necessary step is a deeper deployment of monitoring and tracking systems, and better sensor networks that warn of an earthquake, a tsunami, a likely volcanic eruption, forest fires, accidental releases of chemicals, or that allow us to forestall a biological epidemic. At the same time, the IoT technologies will also improve our ability to recover from such incidents. More importantly, such a deployment need to foresee a significant degradation of such infrastructure in the face of extreme events and the design of such infrastructure should factor this to enhance the resilience and rapid restoration of key functionalities post incidents. In particular, such response requires a massive coordination between government and international agencies as well as industry organizations with the significant expert knowledge to allow rapid restoration capabilities and services to provide humanitarian responses at time-scales much faster than what we can deal with now. Approaches based on IoT need to factor a diversity of connectivity technologies, communication, sensing and computing devices or platforms and psychological state of people affected to arrive at effective ways to provide humanitarian responses in a responsible, sensitive and effective manner.

Session 1: Keynotes

- Aviation Safety Challenges - The Search for MH370
- Socio-Economic Impact of Extreme Events

Session 2: IoT Approaches for Public Safety, and Emergency and Humanitarian Responses

- Emerging requirements of public safety communications
- Safeguarding public spaces and communities
- Building resilience and protecting critical infrastructure

Panel Session: *"Role of IoT in Emergency and Disaster Relief in a World of Increasingly Frequent Extreme Events"*

Chair: Thas A Nirmalathas

Panelists:

- Dr. Neil Gordon
- Ged Giffin
- Ms. Sonia Aplin
- Professor Palani Palaniswami
- Professor Yu-Hsing Wang
- Ms. Natasha Beschorner

Program

10:30am	Session 1	Keynote 1	**Dr. Neil Gordon, Defense and Technology Group Australia** *"The Search for MH370"* On 7th March 2014 Malaysian Airlines flight MH370 from Kuala Lumpur to Beijing lost contact with Air Traffic Control and was subsequently reported missing. An extensive air and sea search was made around the last reported location of the aircraft in the Gulf of Thailand without success. Signals transmitted by the aircraft's satellite communications terminal to Inmarsat's 3F1 Indian Ocean Region satellite indicated that the aircraft continued to fly for several hours after loss of contact. In this talk I will describe how nonlinear/ non-Gaussian Bayesian time series estimation methods have been used to process the Inmarsat data and produce a probability distribution of MH370 flight paths that defined the search zone in the southern Indian Ocean. I will describe how probabilistic models of aircraft flight dynamics, satellite communication system measurements, environmental effects and radar data were constructed and calibrated. A particle filter based numerical calculation of the aircraft flight path probability distribution will be outlined and the method is demonstrated and validated using data from several previous flights of the accident aircraft. A short book is freely available for download from http://www.springer.com/us/book/9789811003783
11:30am		Keynote 1	**Ins. Ged Griffin, Victoria Police Australia** *"Smart Cities and Public Safety: Public Safety Mobile Broadband - To Bravely Go Where No One Has Gone Before"* This presentation discusses how the Safe Cities community can work with public safety officials to work together to develop the next generation of public safety ecosystem. The presentation will provide an outline of how the public safety community currently accesses information and provides a road path on new developments in public safety mobile broadband.
12:30pm			Lunch Break
1:30pm	Session 2		IoT Technologies in Public Safety and Emergency and Humanitarian Responses
1:30pm		Invited Talk 1	**Ms. Sonia Aplin, Ericsson** *"Telecommunications and Connectivity as the Keystone in Crisis Response"* Based on Ericsson Response's 16 years of experience, telecommunications and connectivity play a crucial role in the management of all crises. Ericsson Response is a volunteer initiative that deploys around 140 trained volunteer employees and telecom equipment to support the UN and other humanitarian organizations in times of disaster and crisis. The Ericsson Response team's main tasks are to set up mobile networks for voice and data communication as well as supporting partners in training and knowledge sharing. We will share how Ericsson Response was able to provide communications expertise, equipment and resources in more than 40 relief efforts in more than 30 countries. We will also discuss how Ericsson Response is helping to transform emergency response, by working with aid agency partners including the UN Office for the Coordination of Humanitarian Affairs (OCHA), the UN World Food Programme (WFP), the UN High Commissioner for Refugees (UNHCR), UNICEF and others. Some of the largest deployments we have had to date include supporting over 90 humanitarian sites, including community care centers and Ebola treatment units, in Sierra Leone, Guinea, and Ghana; supporting the Philippines when super typhoon Haiyan devastated a large part of the country and helping in the aftermath of recent hurricanes in the US and Caribbean.
2:00pm		Invited Talk 2	**Professor Palani Palaniswami, University of Melbourne and Director/Convener Sensor Networks and Information Processing (ISSNIP)** *"Real-time Crowd Behavior Analysis for Public Safety Using Networked Cameras and Cloud Analytics* With increasing population and human activities, it has become essential to monitor public places for effective disaster management. Anomalous events may include a person loitering about a place for unusual amounts of time; people running and causing panic; the size of a group of people growing over time at a particular point of entry or exit etc. A stadium like Melbourne Cricket Ground (MCG) which can accommodate nearly 100,000 spectators for any sporting event, can cause people to panic and break out commotion. It will be a daunting task to control crowd. Hence, continuous monitoring of the behavior of the people moving within the limits of stadium is of utmost importance. Automated detection of such anomalous crowd behavior is still a challenge, given the enormous amount of computation and detection challenges in detecting objects, tracking, and analyzing video in real-time. Current systems offer limited functionality, particularly in their reliance on centralized processing of gathered information. However, the prevalence of camera networks for surveillance, together with the decreasing cost of infrastructure, has produced a significant demand for robust monitoring systems. This talk addresses end-to-end system challenges of camera networks, integrating cameras across the spatial, spatiotemporal and decision domains. The talk highlights the nature and complexity of algorithms to monitor MCG (350 networked IP cameras) to deliver unique long-term behavior analysis in highly crowded environments. It highlights the video analytics capabilities to count people, track, and detect suspicious behavior, suitable for crowd management, modelling, and urban planning. It also provides automated analysis of such behaviors to detect and alert the anomalous crowd behavior in almost real-time, which is a necessity for safety and security public using Internet of Things (IoT).
2:30pm		Invited Talk 3	**Professor Yu-Hsing Wang, Department of Civil and Environmental Engineering, Hong Kong University of Science and Technology (HKUST)** *"A Real-Time and Long-Term Scalable IoT-AI Stack for Natural Hazard Resiliency Assessment and Management of Critical Infrastructure* Lifelines and critical infrastructure will be exposed to higher risks of degradations, damages or failures in the coming decades as unprecedented larger scales of typhoons and extreme precipitations are becoming a norm. Such challenging times call for data-enabled decision making through constant monitoring in order to carry out timely maintenance and upgrade works of the lifelines and critical infrastructure. Predictive maintenance of critical infrastructure relies heavily on large-scale and long-term monitoring, particularly vibrations at different parts of the structural elements. In this talk, we will showcase how we build a realtime, long-term scalable operational IoT stack for low-cost dynamic monitoring with reference to our live landslide monitoring operations in Taiwan and Hong Kong since 2014. Linear scalability is the core design principle of the IoT stack as both cost-effectiveness and performance are the major reasons why we stop short of widespread and continuous dynamic monitoring. We then discuss how we deploy AI - deep learning - on these large-scale dynamic observations pouring in by a second for real-time anomaly detections and classifications. With the entire IoT-AI stack facilitating real-time data discovery, evaluations and disseminations of the dynamic performances of the lifelines and critical infrastructure, efficient decision-making and resource allocation through predictive maintenance is now possible.
3:00pm		Invited Talk 4	**Professor Greg Foliente, The University of Melbourne** *"Towards Next-Generation Disaster Management and Public Safety"*
3:30pm			Coffee Break
4:00pm	Panel Session		**Protecting and Safeguarding Communities in Extreme Events - Role of IoT**
5:15pm			End of Vertical 2

V3: Vertical 3 - Logistics

Room: 4202 (130)

Organizers

Chair Gisele Bennett

Track Summary

The movement, distribution, delivery, maintenance, repair, upgrade, and eventual recycling of goods, is a global enterprise that fuels the world economy. The WF will explore how IoT can dramatically improve the degree of synchronization, speed, reliability, and efficiency in this critical industry. With Singapore as one of the large logistics hubs for its region, logistics plays an important role. In this context IoT is an important tool for better managing the multi-modal assets that are needed for improvements in operations and in creating benefits.

Program

10:30-10:35	**Welcome Remarks** *Prof. Gisele Bennett, Chair of the IoT for Logistics Track*
10:35-10:50	**Mr. KC Fung, Senior Manager, IT Planning & Strategy, Information Technology, Airport Authority Hong Kong** *"IoT Applications at HKIA (Hong Kong International Airport)"*

	HKIA has a vision of becoming a smart airport. One of the technology focus of smart airport is to make use of Internet of Things (IoT) technology to build a digital twin of the airport. The presentation will talk about some of the current IoT applications at HKIA such as RFID based baggage handling and GPS tracking of airfield vehicles; as well as some of the new and planned IoT initiatives.
10:50-11:05	**Prof. CH Cheng, Dept. of Systems Engineering and Engineering Management, The Chinese University of Hong Kong** *"Internet of Things Technologies for Smart Living"* Internet of Things (IoT) has received attention of researchers in smart living technologies in recent years. In this talk, we will explore how IoT technologies may be applied to improve the quality of life in a modern city like Hong Kong. Further, we will discuss our implementation examples in airport services, museum operations, and public safety, etc. Challenges and opportunities in these projects will be shared.
11:05-11:20	**Prof. Kim-Fung Tsang, Department of Electronic Engineering, City University of Hong Kong** *"IoT Tracking of Trolleys for Hong Kong Airport* Current localization schemes often employ GPS at outdoor and other wireless localization techniques at indoor (e.g. Wifi). In general, switching is needed between outdoor and indoor and vice versa. The switching potentially causes a loss of localization accuracy, at least at the transition point. Classically, the transmission range of most commonly available wireless platforms are short range, rendering high latency. LoRa, by nature, appears to be the right candidate for long-range applications in logistics and transportation. A high-performance long-range seamless indoor-outdoor localization system based on LoRa will be designed and implemented to track down trolleys in the Hong Kong airport. Analytics will be performed to help decision making e.g. record/predict the behavior of clients, position of trolleys, …etc. With slight modifications, such a system can be modified to adapt to similar or associated logistics applications which are related to vehicle travel between outdoor and indoor, to upload and unload deliverable between extremities.
11:20-11:35	**Dr. Frank Tong, Director of Research and Technology, Hong Kong LSCM R&D Centre** *"Smart Logistics for e-Commerce through Hong Kong"* Logistics is one of the pillar industries in HK. In the contemporary trends of ASEAN trades and Belt-and-Road Developments, Hong Kong's logistics industry is also striving for new technologies and new practices to meet the challenges. In this talk, I shall be sharing with the audience the smart logistics technology development in HK, particularly about the success case of cross-boundary customs clearance system. Besides, selected examples of smart IT infrastructure for logistics operations and pilot implementations with forward-looking practitioners will be presented.
11:35-12:30	**Panel Discussion: Trends and Challenges in Adopting IoT in Hong Kong** *Moderator:* Mr. Simon Wong, CEO, Hong Kong LSCM R&D Centre *Panelists:* • Mr. KC Fung, Senior Manager, IT Planning & Strategy, Information Technology, Airport Authority Hong Kong • Prof. CH Cheng, Dept. of Systems Engineering and Engineering Management, The Chinese University of Hong • Prof. Kim-Fung Tsang, Department of Electronic Engineering , City University of Hong Kong • Dr. Frank Tong, Director of Research and Technology, Hong Kong LSCM R&D Centre

End Morning Session

12:20-13:30	**Lunch**
13:30-13:55	**Dr. Bernard Leong Chung Wei, AirBus** *"Autonomous Transportation and Its Implications* In the recent years, there has been considerable interest in unmanned aerial vehicles (UAVs) and autonomous vehicles. In this talk, I discussed the challenges in bringing these technologies into the real world, and what it means for the supply chains in urban smart cities, logistics and agriculture.
13:55-14:20	**Prof. Fei-Yue Wang, Vice President and Secretary General of Chinese Association of Automation** *"Parallel Logistics in the Social IoT Era"* In this presentation, a new paradigm of logistics, Parallel Logistics, is introduced. Parallel Logistics (PL) aims to tackle the inherent nature of complexity, diversity and uncertainty in socialized logistics, and to provide a solution based on the Parallel System theory and the ACP approach. Following a full view of Parallel System theory in the new Intelligence Technology era, PL's technical framework and applications are illustrated and addressed in detail for building the next generation logistics ecological system.
15:10-15:35	**Dr. NG Poh Khai, Innovation Leader and Senior Manager, Asia Pacific Innovation Center** *"DHL's Journey Towards Digitalization with IoT"* Presentation to include: • Broad overview of DHL's trend approach to innovation and focus (i.e. IoT among other trends) • DHL's approach to IoT as a key innovation trend • Opportunities in the logistics industry - use-cases
15:35-1600	**Afternoon Break**
16:00-16:25	**Dr. Justin Dauwels, Associate Professor of the School of Electrical and Electronic Engineering at the Nanyang Technological University (NTU) in Singapore** *"Towards the Next-Generation Fleet Management Systems"* There is considerable interest related to management of fleet of autonomous vehicles in both academia and industry. Robust and reliable commercial deployment of fleet of autonomous vehicles is impeded by the lack of the following two technologies. First, an integrated approach is lacking that can encompass all different aspects of the problem, including mobility models of vehicles, communication network and application environment, customer demand prediction, and real-time information about the transportation network. Second, autonomous vehicles are still in trial phase, hence sufficient realistic field data may not be available in next few years. An integrated simulator can prove highly useful in bridging that gap. Such simulators would still be highly useful once the technology matures as they would provide an effective platform for developing further applications involving fleets of autonomous vehicles. In this presentation, we will give an overview of our progress in both these directions.
16:25-16:50	**Prof Guanghua Yang, Associate Dean, Institute of Physical Internet, Jinan University** *"Low-Cost Versatile Tracking Device and Technology for Logistics"* With the rapid growth of global business activities, it becomes essential for the firms to manage the logistics flow and to track their goods properly. Continuous monitoring and end-to-end tracking are critical for shipments of high-end goods, such as jewelry, electronic products, and legal documents. In this project, we developed the next-generation tracking devices and technologies, which support continuous, real-time, and ubiquitous goods-level tracking. By leveraging the strengths of different wireless technologies, the project realize the hybrid and collaborative positioning and communication. With the innovative design, the system enjoys a better service availability, lower total cost of ownership, operation and maintenance. The effectiveness of the proposed mechanism were demonstrated by two pilot business projects.
16:50-17:15	**Prof. Zhi Ning, Prof. National University of Singapore** *"RFID Systems and Antennas in IoT"* Radio frequency identification (RFID) technology are being rapidly developed in recent years. In particular, their applications have been widely found in Internet of Things (IoT) such as service industries, distribution logistics, manufacturing companies, product-flow systems and so on. Antenna design for both readers and tags is one of the key factors in all RFID systems. The optimized tag and reader antenna design will greatly benefit to RFID systems with longer reading range, better detection accuracy, lower fabrication cost, and simple system configuration and implementation.
17:15-18:00	**Working Group Discussion** (All Speakers and Audience Members What is working and not working? How can IEEE move the industry forward?

End IoT Logistics Session

Wednesday, February 7, 08:30 - 10:00

KEY: Keynote Speakers: Jan Rabaey, Maciej Kranz & Tim Hahn

Jan Rabaey, Donald O. Pederson Distinguished Porfessor at University of California at Berkeley; Maciej Kranz, VP of Corporate Strategic Innovations, Cisco; Tim Hahn, IBM

Room: Plenary: Melati

Jan Rabaey - Plenary Speaker at WF-IOT 2018

Jan Rabaey holds the Donald O. Pederson Distinguished Professorship at the University of California at Berkeley. He is a founding director of the Berkeley Wireless Research Center (BWRC) and the Berkeley Ubiquitous SwarmLab, and is currently the Electrical Engineering Division Chair at Berkeley.

Prof. Rabaey has made high-impact contributions to a number of fields, including advanced wireless systems, low power integrated circuits, sensor networks, and ubiquitous computing. His current interests include the conception of the next-generation integrated wireless systems over a broad range of applications, as well as exploring the interaction between the cyber and the biological world.

He is the recipient of major awards, amongst which the IEEE Mac Van Valkenburg Award, the European Design Automation Association (EDAA) Lifetime Achievement award, and the Semiconductor Industry Association (SIA) University Researcher Award. He is an IEEE Fellow, a member of the Royal Flemish Academy of Sciences and Arts of Belgium, and has received honoray doctorates from Lund (Sweden), Antwerp (Belgium) and Tampere (Finland). He has been involved in a broad variety of start-up ventures.

Presentation: IoT++ - The Living Network of Everyone and Everything

The Internet of Things (IoT) or Swarm vision, formulated more than 2 decades ago, presented a transformational model on how the physical and cyber worlds would be interlinked, enabled by a network of trillions of motor-sensory nodes distributed throughout our physical world. Many of the envisioned concepts are now truly happening, and are migrating into the consumer, commercial and industrial domain.

A new leap forward is about to happen. While the current incarnation of IoT is rather static, moving entities such as robots, drones, cars and UAVs are becoming more ubiquitous, forming networks that are far more dynamic. Even more, miniaturization of motor-sensory functions enables the Swarm to encompass the human body ("The Human Intranet") opening the potential of true augmentation, and fundamentally changing how we humans interact with ourselves and with the world around us. The resulting networks of everyone and everything create entirely new options in so many areas such as human-machine interaction, augmented reality, tactile inter-networking, distributed manufacturing and smart cities.

Turning these opportunities into reality however poses challenges on so many fronts, some of which will be outlined in the presentation.

Maciej Kranz - Plenary Speaker at WF-IOT 2018

Maciej Kranz is a business leader, frequent keynote speaker, and the author of the New York Times Best Seller, Building the Internet of Things. Kranz brings 30 years of computer networking experience to his current position as Vice President of the Corporate Strategic Innovation Group at Cisco Systems. He leads the team focused on incubating new businesses, accelerating internal innovation, and driving co-innovation with customers, partners and startups through a global network of Cisco Innovation Centers. Prior to this role, he was general manager of Cisco's Connected Industries Group, where he drove the Internet of Things (IoT) business for key industrial markets. In his book, Building the Internet of Things, Kranz cuts through the hype to provide the first practical guide for business decision-makers on how to start their IoT journey. The book provides all the ingredients for IoT transformation, including case studies, step-by-step plans, fast paths to payback, cultural changes, standards, security, and much more.

Tim Hahn, Plenary Speaker at WF-IoT 2018

Tim Hahn is a IBM Distinguished Engineer and has been with IBM since 1990. He is the Chief Architect for Internet of Things Security within the IBM Watson Internet of Things division. He is responsible for strategy, architecture, and design for IBM Watson Internet of Things offerings. These offerings, coupled with others from across IBM, enable customers to design, build, experiment, run, manage, and operate solutions involving diverse sensor data coming from connected devices. These solutions leverage IBM's strengths in cloud, cognitive, analytics, mobile, social, and security.

Wednesday, February 7, 09:00 - 18:00

EXH: Internet of Things Showcase at the Exhibit Hall

Chihhsiong Shih

Room: Exhibit Hall

The 4th IEEE World Forum on Internet of Things features a number of IoT showcases of interest to the attendees at the Exhibit Hall. The Exhibit Hall is located in the Orchard Rooms 4211-4312 at Level 4.

The Exhibit hours are:

Monday, 5 February 2018	06:00 - 21:00 (Welcome Reception)
Tuesday, 6 February 2018	09:00 - 18:00
Wednesday, 7 February 2018	09:00 - 18:00
Thursday, 8 February 2018	09:00 - 13:00

Showcase 1: A Smart Parking Guidance System *Chihhsiong Shih, Tunghai University*

We developed a smart parking guidance system for large scale parking lots. Finding an available empty slots in a busy sector of the city is always an issue for city people. Very often, it takes forever to circle around the parking lot drive way and not being able to find an empty spot. Our system includes sensors such as ultra wave and magnetic sensors mounted on the parking spot and on drive ways. The sensors work with mobile devices to guide the driver toward an empty spot controlled by the central cloud server. The cloud server is in charge of coordinating the complete guiding system. We keep track of the vehicle entering the parking lot. On each turn corner of the drive way, we give the driving direction through the mobile phone in the vocal signals. Once the vehicle parked into the slot, an LED light is turned on indicating the slot is occupied.

Showcase 2: A Smart Exercise Coach for Taichi *Chihhsiong Shih, Tunghai University*

We developed a smart coach IoT system that can guide the Taichi learning process. In a regular Taichi session, the learner generally has to follow the coach's motion in every stroke. However, it is difficult for the coach to correct the learner's stroke in every detail. Learners always miss the tempo or place their limbs in a wrong angle or places without knowing it. We place the 6-axis motion sensors on the arms and limbs of the learners. These sensors detect the inclination angle of the learners. By comparing the inclination angles to those of the coach, we are able to detect the correctness of the Taichi motion of the learner in real time. Once errors are detected, a vibration signal is given to specific parts of the learner. They then correct their motion accordingly.

Wednesday, February 7, 10:00 - 10:30

CB: Coffee Break (Exhibit Hall)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Wednesday, February 7, 10:30 - 12:30

ET4: Session on IoT Enabling Technologies (IV)

Room: 4204 (130)
Chair: Giancarlo Fortino (University of Calabria, Italy)

ET4.1 10:30 ***Energy Efficient Wireless Sensor Networks Utilizing Adaptive Dictionary in Compressed Sensing***
Amarlingam Madapu (IIT HYDERABAD, India); Pradeep Mishra and P Rajalakshmi (Indian Institute of Technology Hyderabad, India); Mukesh Giluka (Indian Institute Of Technology Hyderabad, India); Bheemarjuna Reddy Tamma (IIT Hyderabad, India)
Wireless Sensor Networks (WSNs) are fundamental blocks of Internet of Things (IoT) which made it to proliferate into many real-time diversified applications. Typically, WSN nodes are small and battery powered devices. Hence, energy efficient data aggregation method which maximizes the network lifetime is the paramount importance. Compressed Sensing (CS) is one of the approaches proves to be very promising for energy efficient data aggregation in WSN. The sparsity of the sensor data can change significantly due to their time varying nature and it affects the recovery of the measured signal. Most of the existing CS aided data aggregation methods for WSN are neither optimized nor address the issue of change in data sparsity, which demands additional energy to maintain low reconstruction accuracy. Thus, variation in the sparsity of the sensor data makes data aggregation to be energy inefficient that inherently reduces network lifetime. To overcome this, we propose an optimal method for CS-WSN where we use a dictionary as a sparsifier that learns with adaptive sparse training data. The proposed method achieves minimum reconstruction error by accounting changes in the data sparsity while data can be delivered to the sink with

low energy consumption thereby improving energy efficiency.
pp. 388-393

ET4.2 11:00 *A Protocol Development Kit for Wireless Systems*
Thomas G McGiffen, Sharanya Srinivas and Daniel W. Bliss (Arizona State University, USA)
The popularity of Wi-Fi and cellular demonstrate the demand for, and usefulness of wireless systems. Both are designed specifically for their applications; which can be loosely described as an indoor/outdoor solution offering a high data rate. Multiple other applications to be served by wireless systems exist, such as those requiring a lower data rate solution, lower cost, and/or lower power. But, the extreme cost and time spent to develop Wi-Fi and cellular protocols are prohibitive, partic- ularly for applications serving less lucrative markets or those demanding rapid development. We seek to reduce these burdens through automated protocol design, opening up new markets and applications. In this paper, we present a protocol development kit (PDK). This PDK starts with general requirements, such as desired range, data rate, etc. The PDK then recommends a viable protocol for that scenario, and demonstrates the protocol in a wireless simulation. The intent of our PDK is to automate, and therefore greatly reduce both the workload and the time to develop a new wireless protocol, facilitating wireless deployment in new applications.
pp. 394-399

ET4.3 11:30 *An Enhanced EAB Algorithm to Reduce RACH Congestion Due to IoT Traffic in LTE-A Networks*
Mukesh Giluka (Indian Institute Of Technology Hyderabad, India); Tathagat Priyadarshi (Sri Jayachamarajendra College of Engineering, India); Shakti Kumar (R V College of Engineering, Bengaluru, India); Antony Franklin A (Indian Institute of Technology Hyderabad, India); Bheemarjuna Reddy Tamma (IIT Hyderabad, India)
Increasing IoT traffic in LTE-A networks imposes several issues such as RACH congestion due to large number of devices accessing the network at the same time. EAB (extended access barring) based solutions have been proven to be efficient methods of giving instant relief from RACH congestion in the network. But current EAB solutions are not suitable for the scenario where network traffic is from mixture of light, moderate, and high delay tolerant IoT devices. As a result, these solutions may lead to unnecessary barring of some of the IoT devices. In this paper, we have proposed a noble EAB algorithm which pro-actively monitors the congestion in the network and avoids collective barring of IoT devices. The algorithm has been evaluated based on various metrics such as success rate, average delay, and average backoff. Apart from this, the paper analyses the performance of H2H and M2M devices when medium congestion reduction methods such as Long-Backoff method, Separate Preamble method, and Slotted Access method are merged with the proposed EAB algorithm.
pp. 400-405

ET4.4 12:00 *Long-term Location Pattern Based Forwarding Scheme in Opportunistic Networks*
Kiyoung Jang, Park Jiho and Sung-Bong Yang (Yonsei University, Korea)
Opportunistic networks (OPPNET) are a form of mobile ad-hoc networks. In OPPNET, the communications intermittently occur when one node contacts another node. For this reason, in order for nodes to forward message to destination, they not only need to transfer messages but also store and carry messages as relay nodes. The forwarding algorithms in opportunistic networks need to exploit human and social characteristics such as mobility pattern and social relationship. There are existing algorithms that exploit the location information of a node. However, these algorithms only concentrate on the difference between short-term locations, ignoring the long-term location patterns. To improve the analysis of location pattern, it is necessary to use the long-term movement of a node. In this paper, we propose long-term location Pattern based Forwarding scheme (LTLP). In the proposed scheme, each nodes records its own location pattern and analyze the pattern of its movement. After the analysis of movement pattern is finished, we create location tree of nodes to forward the message to destination. We analyze the proposed scheme on the NS-2 network simulator with the home-cell community-based mobility model (HCMM). Experimental results show that the proposed scheme outperforms most known forwarding schemes in balancing network traffic and transmission delay.
pp. 406-411

ID: Session on IoT Identification

Room: 4205 (130)
Chair: Yu Rongshan (Xiamen University, P.R. China)

ID.1 10:30 *Autonomous Device Identification Architecture for Internet of Things*
Hirofumi Noguchi and Tatsuya Demizu (Nippon Telegraph and Telephone Corporation, Japan); Naoto Hoshikawa (NTT Network Service Systems Laboratories & NTT, Japan); Misao Kataoka (NTT, Japan); Yoji Yamato (NTT Corporation, Japan)
A wide variety of devices is being installed in various environments such as homes, factories, and streets with the rapid expansion of the Internet of Things (IoT). To properly and securely use IoT devices, the states of various devices that have different properties and protocols must be managed. However, it is difficult to understand the consistency of an individual device when its installation place or software changes, since many individual IoT devices do not have unique identifiers. In this paper, we propose an architecture that estimates individual devices by analyzing and combining multiple pieces of information that can be obtained from the device. This architecture estimates individual device identity based on the time change pattern of the feature amount extracted from a signal transmitted by a device. Results of a simulation revealed that this architecture could identify the individual devices to find the correct device.
pp. 412-416

ID.2 11:00 *Identity/Identifier-Enabled Networks (IDEAS) for Internet of Things (IoT)*
Bin Da (Beijing Huawei Digital Technologies Co., Ltd., P.R. China); Padma Esnault (Huawei Technologies, USA); Patrick Hu (Haidian District Bejing, P.R. China); Chuang Wang (Huawei Corporation, P.R. China)
Future Networks have proposed many Identifier/Locator Split (ILS) schemes in the past decade, and these ILS solutions are being recently considered for diverse IoT applications. Meanwhile, the split of identity and identifier should be of interest for IoT as well. However, nowadays there does not have any unified identify/identifier/locator split framework or system architecture, as a common control mechanism or plane for interoperation of heterogeneous identity/identifier-enabled networks. Thus, this unified framework is our current focus that is under development, while this paper will present some initial efforts from various aspects. Particularly, many identity/identifier-based value-added services will be briefly explored for customized usage in IoT applications. Overall, this paper aims to promote a common ID-based control plane for unifying identity-identifier-locator split in IoT environment.
pp. 417-420

ID.3 11:30 *Barcode Fingerprinting: Unique Identification of Commercial Products with Their JAN/EAN/UCC Barcode*
Rina Ueno and Jin Mitsugi (Keio University, Japan)
This paper proposes a method to uniquely identify commercial products with an item level barcode, specifically JAN/EAN/UCC, with which we usually cannot distinguish individual products. This research is motivated by the industrial and consumer needs for first-in-first-out operations of their inventories in the environment, where serial level barcodes, such as GS1-128 and SGTIN, or RFID are still not available. The proposal, referred to as Barcode Fingerprinting, utilizes the microscopic features of printed barcode stripes to discriminate each other. We zoom in a particular portion of a barcode image and apply SURF Algorithms and RANSAC Algorithms, to extract the microscopic features. The features are stored with the barcode ID and the time stamp for the future comparisons. We examined the feasibility of the proposal method by processing 100 barcodes of single brand PET bottles. The experiment reveals that we can uniquely identify each of the 100 barcodes by using Barcode Fingerprinting with a proper preprocessing of images.
pp. 421-425

ID.4 12:00 *Leveraging Social Notions to Improve ID-to-locator Mapping in IoT Identity Oriented Networks*
Luigi Atzori (University of Cagliari, Italy); Claudia Campolo (University Mediterranea of Reggio Calabria, Italy); Bin Da (Beijing Huawei Digital Technologies Co., Ltd., P.R. China); Antonio Iera (University Mediterranea of Reggio Calabria, Italy); Giacomo Morabito (University of Catania, Italy); Padma Esnault (Huawei Technologies, USA); Salvatore Quattropani (University of Catania, Italy)
In this paper, a novel approach is conceived to address one of the major drawbacks of the current Internet, i.e., the need for splitting the unique host identifier (ID) from the locator used at the network layer for routing purposes that may change over time. The proposal relies on the introduction of social notions to support networking functions and improve the ID-to-locator splitting procedures in the context of an Identity Oriented Networking (ION) framework for Internet of Things (IoT). At the so-called "ID layer", an architecture based on the Social Internet of Things paradigm is proposed, which relies on distributed repositories that store for each device the ID of their "friends" to significantly facilitate the ID-to-locator lookup. Simulation results are provided to assess the performance of the proposal when considering the peculiarities of social interactions among objects.
pp. 426-431

IFO2: Industry Session on IoT IC Design

Dr. Shiwei Wang (Session Chair), Managing Partner of Roth Asia Partners and a Board Director of MPRC; Annamalai Arasu, Head of Integrated Circuit & Systems, IME, A*STAR, Singapore; David Wilson, Director of System Architecture, Kinetic Technologies, USA; Dr. Wen-Hu Zhao, CEO, Chiptel Microelectronics Ltd., China

Room: 4203 (130)

Anticipated wide deployments of Internet of Things (IoT) applications would significantly stimulate demand for microcontrollers, sensors, connectivity, processors, memory, chips, and I/O interfaces. Unlike the mobile space, IoT applications are more versatile and in most cases autonomous. Nature of such brings challenges to IoT chip design ranging from cost (scale of economy), reusability, low power consumption, battery life, security/privacy, to market development.

This session provides to the audience an overview on the design challenges and solutions of various IC components used in IoT applications. The speakers will share their view and present work addressing challenges in achieving always-on wearable devices, commercialization of sensor technologies, and promoting IP core design. An open discussion panel will be held at the end to facilitate Q&A and dialogues among speakers and participants.

Speakers

Annamalai Arasu, Head of Integrated Circuit & Systems, IME, A*STAR, Singapore

M. Annamalai Arasu leads the Integrated Circuit and Systems lab at Institute of Microelectronics (IME), Singapore, which is engaged in the design of low power integrated circuits for sensor signal acquisition, digital processing, wireless communication and power management for industrial and bio-medical applications. He has been with IME since 2004, and has led the development of CMOS RF IC transceivers for wireless communication in UWB, Ku-band, 2.4GHz, and Sub-GHz bands. He is currently leading the development of fully integrated voltage regulators. Previously he has been with Intel, Wipro Technologies and Centre for Development of Telematics, in India, working on Analog / RF circuits, and sub-systems for wireless communication.

Presentation: Integrated Circuit Architectures for IoT Devices

IoT devices span diverse applications, in consumer, industrial, and automotive sectors. The diversity in applications present a wide range of sensing, computation and wireless communication needs. However, the requirements of low power / energy consumption and low cost are common across IoT devices, especially so in battery operated and energy harvested devices. The architectures of the integrated circuits that perform sensor readout, signal processing and wireless communication have to continuously evolve to take advantage of advancements in semiconductor technologies and signal processing algorithms, to provide energy efficient and low cost system solutions for IoT. This talk will cover the trends in integrated circuits that aim to deliver energy efficient intelligent solutions for the IoT devices.

Ping-Lung Shieh, Senior Director, Realtek Singapore Pte. Ltd.

Presentation: Low Power BT/WIFI IoT Design Challenges

David Wilson, Director of System Architecture, Kinetic Technologies, USA

Dave worked for many years as an audio guru making psychoacoustic equipment, music synthesizers, and building audio systems at companies such as Apple, Sony, Lucent, Palm, and Leapfrog. His diverse interests and training at Harvard University naturally led from an audio focus into a broad range of scientific, industrial, musical, and consumer products. In recent years, Dave has been developing products with a focus on wireless power delivery combined with wireless communication techniques. When integrated with sensing and output transducers, these systems embrace many essential elements of IoT functionality. Dave is a well known expert in the Wireless Power Consortium (WPC) responsible for practical realization of the global Qi standard (recently adopted by Samsung, LG, and Apple), as well as a leader working with IKEA and others to bring wireless power into an increasingly wide range of home and infrastructure products. Most recently, Dave has been working at Kinetic Technologies with a continued focus in wireless and wired system level products that combine power and data into seamless, cost effective solutions that are a natural enabler of a wide range of IoT devices and products.

Presentation: Endless Power - Always On IoT & Wearable Devices

IoT and wearable devices are required to be always on and accessible to the users on the go. Typically, these devices are continuously monitoring, measuring, collecting data, and providing information to the user or on behalf of the user in real time. Such uninterrupted service is enabled through use of rechargeable batteries, and the only way to ensure endless battery life is to receive more energy than is used. This requires a ubiquitous and compatible energy source wherever you go, which is now rapidly becoming a reality through Qi based Wireless Power. Now dramatically accelerated by Apple's adoption of Qi, this wireless power ecosystem is rapidly expanding beyond select Starbucks coffee shops to become widely available in the public infrastructure, commonly found in homes, and a must-have feature in automobiles.

Dr. Wen-Hu Zhao, CEO, Chiptel Microelectronics Ltd., China

Presentation: Promoting IP Design Innovation to Welcome the Changes, Challenges and Chances in IoT

In the presentation, it will give the present status of IP design firstly. Then an analysis for the changes, challenges and chances in IoT will be presented. To welcome the technology era of IoT in smart cities and nations, we need promote the IP design innovation for brand-new IC products in IoT. It will cover the IP design conception, IP design direction and IP design flow. Finally, towards these innovation elements, the solutions and practical experiences in Chiptel will be shared.

INF: Session on IoT Infrastructure

Room: 4304 (130)
Chair: Corinna Schmitt (University of Zurich, Switzerland)

INF.1 10:30 *A Semantic Sensor Mashup Platform for Internet of Things*
Sungkwang Eom, Wonwoo Ro and Kyong-Ho Lee (Yonsei University, Korea)
With the rapid advancement of the Internet of Things (IoT), a number of sensors are constantly deployed and connected to the Web, generating a large amount of real-time streaming data. Such sensor streams may include contextual events, which indicate meaningful information on our environment. For this reason, Web applications which are developed for IoT should embrace sensor streams. Hence, there is a need for a sensor mashup tool to compose multiple sensors for effectively processing sensor streams. However, existing models for sensor mashup does not support complex events included in sensor streams. In this paper, we propose a virtual complex sensor (VCS) model that enables users to combine various existing sensors and formula-based knowledge. In addition, we propose a method of automatically generating multiple VCSs according to a user's configuration. We also provide a graphical user interface for building a VCS mashup and processing complex events. Experimental results on the proposed semantic sensor mashup platform show that the proposed approach is reasonable and applicable to various IoT application domains.
pp. 432-437

INF.2 11:00 *A Risk Aware Development and Deployment Methodology for Cloud Enabled Internet-of-Things*
Javeria Samad (Deakin University Melbourne, Australia); Seng W Loke (Deakin University, Australia); Karl Reed (LaTrobe University, Australia)
Internet of things (IoT) is predicted to be the future of networking and presents virtually limitless potential opportunities for it's application anywhere from the industries to even ordinary houses. Where connecting billions of devices together provides unlimited opportunities, it also opens the gates to many challenges. Risk analysis is the mandatory action that users must perform addressing the security, privacy, performance and reliability requirements among many. To ensure that risk analysis and mitigation is implemented correctly, an automated and systematic approach is often recommended. In addition, the complexity and dynamism of IoT systems further adds to the need of specialized and context awareness of the risk management. In this paper, we present a risk aware development and deployment methodology for IoT systems that can help in focused decision making for proactive risk analysis and management, in a context aware manner.
pp. 438-443

INF.3 11:30 *Efficient Device Group Management in oneM2M*
Hung-Chi Chen and Fuchun Joseph Lin (National Chiao Tung University, Taiwan)
With an increasingly large number of devices in the IoT/M2M systems, device management has become a very challenging task. This is especially true when an IoT/M2M server needs to handle each and every device individually via a gateway. In this research, we propose a new way of realizing "group management" defined in oneM2M to efficiently handle a large number of devices behind a gateway. To achieve this efficient group management for devices, we not only have to leverage the flexible group management in oneM2M but also extend OMA LWM2M device management with the group management capability. This paper reports our research results in integrating oneM2M group management and device management.
pp. 444-449

INF.4 12:00 *OTIoT - A Browser-based Object Tracking Solution for the Internet of Things*
Corinna Schmitt, Jan Meier and Matthias Diez (University of Zurich, Switzerland); Burkhard Stiller (University of Zürich, Switzerland)
Today more and more users are interested in tracking their personal belongings (e.g., bikes or drawings), but do not want to buy special and costly hardware, pay for user-unfriendly services, and establish contracts with service providers. Further, commercial solutions support limited opportunities for individual settings (e.g., when to send position information or alarm). Thus, the proposed solution OTIoT (Object Tracking solution for the Internet of Things) offers a user-friendly, browser-based front-end to save mobile device resources, scales to different screen sizes, and allows for individual settings to track tagged objects in real-time. These tags use GPS information to locate devices and use the new communication technology LoRa to transmit data via "The Things Network" to the back-end, which allows for further processing of location informations (e.g., storage, access via OTIoT). Functional front-end evaluations show that the prototype fulfills major user requests and extends existing approaches.
pp. 450-456

SC1: Session on Smart Cities (I)

Room: 4303 (130)
Chair: Hausi A Muller (University of Victoria & Faculty of Engineering, Canada)

SC1.1 10:30 *Leveraging Existing Sensor Networks as IoT Devices for Smart Buildings*
Brian Ramprasad (York University, Canada); Jennifer McArthur (Ryerson University, Canada); Marios Fokaefs and Cornel Barna (York University, Canada); Mark Damm (Fuseforward Solutions Group Ltd., Canada); Marin Litoiu (York University, Canada)
As the Internet of Things (IoT) grows and data analytics mature, their application to new buildings is proved a significant opportunity for improved building performance at reduced energy costs. In existing buildings, however, the cost to re-place existing Building Management Systems (BMS) with IoT-compatible devices poses a barrier to adoption. Further, the limited data storage on these existing systems further precludes data analytics for optimization. This research responds to this need by presenting a novel approach to pre-process and stream the BMS data to a cloud-based database on a private network. Afterwards, in the centralized data warehouse, larger scale and more complex analytics can be performed. This paper presents the development of both the new database architecture and supporting infrastructure to support the streaming of BMS, as well as the pre-processing to optimize big data analytics and visualization. A proof-of-concept visualization for a 14,000m2 student learning center is presented to demonstrate the application of this architecture.
pp. 457-462

SC1.2 11:00 *Exploring Smart City IoT for Disaster Recovery Operations*
Niranjan Suri (US Army Research Laboratory (ARL) & Florida Institute for Human & Machine Cognition (IHMC), USA); Zbigniew Zielinski (Military University of Technology, Poland); Mauro Tortonesi (University of Ferrara, Italy); Christoph Fuchs and Manas Pradhan (Fraunhofer FKIE, Germany); Konrad Wrona (NATO Communications and Information Agency, The Netherlands); Janusz Furtak (Military University of Technology, Poland); Bogdan Vasilache (NCI Agency, The Netherlands); Michael D Street (NATO Communications and Information Agency, The Netherlands); Vincenzo Pellegrini (IDS - Ingegneria dei Sistemi SpA, Italy); Giacomo Benincasa and Alessandro Morelli (Florida Institute for Human & Machine Cognition, USA); Cesare Stefanelli (University of Ferrara, Italy); Enrico Casini (Florida Institute for Human & Machine Cognition, USA); Michał Dyk (Military University of Technology, Poland)
Disaster recovery operations are extremely challenging and place significant demands on multiple resources, including local and international emergency response personnel, non-governmental organizations, and the military. In the immediate aftermath of a disaster, one of the most pressing requirements is for situational awareness (SA) so that resources, including personnel and supplies, may be prioritized to have the most impact and help those in the most need. As the recovery operations continue, the SA needs to be continuously updated based on changing conditions in the affected areas. There are many sources of information to provide situational awareness, including reporting by the victims of the disaster as well as observations made by responding personnel. This SA can be significantly enhanced via information obtained from Internet of Things (IoT) devices, especially in a smart city environment. This paper explores the potential to exploit Smart City IoT capabilities to help with disaster recovery operations.
pp. 463-468

SC1.3 11:30 *HAMRA - A Middleware for Data Traffic Management in Public Safety Networks*
Daniel Abujabra Merege (CityTech & Institute for Technological Research of São Paulo State (IPT), Brazil); Eduardo Takeo Ueda (Institute for Technological Research of the State of São Paulo, Brazil)
Global society, for years, has been witnessing natural disasters of different magnitudes. The integrated work of disasters response teams requires a huge capacity of information exchange in its networks. Software-Defined Network (SDN) has been applied in this context, mainly because it separates the control and the data planes of a network. This paper introduces middleware HAMRA, that elevates the level of abstraction of network traffic management in SDN networks applied in Public Safety Network context, based on Emergency Management's states. Its performance is evaluated from an emulated network, considering metrics as rules' install time and data overhead. The emulation shows that HAMRA responds effectively to the network state change, traveling essential control packets to configure SDN network, without inserting new packets, and so avoiding overload of data. These results make HAMRA a prototype and an initial reference for the evolution of SDN applied to Emergency Management.
pp. 469-474

SC1.4 12:00 *Practical Experience with Smart Cities Platform Design*
Wee Siong Ng and Ang Loon Chan (Institute for Infocomm Research, Singapore); Gim Guan Chua (Institute for Infocomm Research (I2R), A*STAR, Singapore); Chua Desmond Zhen Liang, Shuqiao Guo, Min Chim Lim and Mun Thye Mak (Institute for Infocomm Research, Singapore)
A successful smart nation is one in which uses information and Internet of things (IoT) technology in a seamless integrated form to enhance transport, healthcare and other public services to improve the quality of life for citizens. In this paper we present our practical experience with smart cities platform design: A*DAX which is a powerful framework for extracting insight from heterogeneous, real-time and complex data sets. In fact, A*DAX has been successfully deployed at the multi-agency Jurong Lake District ("JLD") Smart City Test-Bed in Singapore, with integration to a shared sensor network of close to 1,000 urban sensors and video analytics of more than 25 video sensors. The vision for JLD is to be a leading model for developing a mixed-used urban area that is sustainable, smart and connected. Through the A*DAX data exchange portal and repository, test bed users will be able to access real-time and historical environmental data collected by the sensors, as well as video analytics from the camera streams and benefit from a

variety of Smart Nation solutions providing real-time sensing and analytics.
pp. 475-480

TOP1b: Topical 1 - Security and Privacy Regimes - Part 2

Room: 4302 (130)

Organizers

Co-Chairs David W. Kravitz and Jeffrey Voas

Track Summary

IoT applications and prospective solutions mandate consideration of a broad set of security and privacy requirements. The explosion in the number of connected devices poses a significant challenge, as does the diversity of end uses. The World Forum will address the component and platform implications for IoT in the context of the full life cycle for security and privacy regimes. It will also address the many security architectures and approaches that have emerged from Government organizations around the world, from the Commercial Market space, and from the Research Community. Across the wide spectrum of use cases there is a need to appropriately balance security and privacy, and it is useful to think of classifications that distinguish the levels required. As an example these may be thought of as:

- Highly security-centric "life-and-death" applications such as: critical infrastructure; control systems for connected automobiles, railroads, or aircraft; emergency healthcare
- Intermediate security uses that include: smart home; routine monitoring of facilities; sports and physical exercise activities that involve tracking such as geolocation
- Lower security casual uses such as: games, entertainment, public virtual reality applications, and aspects of social media and general information services

The topics that the Presentations, Panels, and Working Group discussions, for the Track on "Security and Privacy Regimes for IoT" will cover include:

- Achieving secure compose-ability of individually secure devices and components
- Scalability (for massive number of devices, and as contributors to- and consumers of- big data)
- Device-associated robustness levels that also deal with the high variations in heterogeneity (such as stationary and mobile infrastructure, smart phones and user terminals, wearables, the wide range of possible sensors and actuator types, and embedded IoT devices)
- Device ownership and component control (accounting for interoperability, regulatory compliance, governance, audit-ability and risk management)
- Remediation for the reigning confusion caused by the proliferation of standards and certification, and the realization that IoT will create new experiences and a vulnerability surface that is not accounted for
- Testing approaches and procedures that overcome the lack of efficacious and accepted practices — These include: interfacing with and leveraging legacy devices and services; containment against expansion of compromise to other units, systems or networks; effective crypto-agility; defense against advanced threats such as quantum-computing attacks. These also include testing approaches for the differing device lifetimes, and lifecycle support of IoT solutions such as over-the-air firmware and software upgrades

One of the objectives of the Track is to launch future actions and activities that continue beyond the World Forum as part of the IoT Initiative Working Group on "IoT Security and Privacy".

Program

	Keynotes 4
10:30-11:00	**Sean Smith, Professor, Department of Computer Science, Dartmouth University** *"Securing the IoT: Critical Research Challenges"* In the current Internet of Computers (IoC), paradigms and techniques have emerged to manage security risks, at least somewhat. However, the Internet of Things is different from the IoC, and these differences cause many of these paradigms to stop working. With the deep embedding of the IoT in the physical world, the consequences may have significant physical impact. This talk surveys some areas—zero days, authentication, lifetime mismatches, and connectivity complexity—where we need new research driven by academic and industrial partnerships. Vulnerabilities seem to be inevitable in software; in the IoT, how do we reduce and manage the risk of zero days? How do we manage good software hygiene when physical devices can outlive the "use-safely-by" date of software, and maybe even the software vendors themselves? (How do we keep zero-days from turning into forever-days?) As communication channels become more open, how do we secure them—and how do we establish a key infrastructure that captures operational requirements?
11:00-11:30	**Vrizlynn Thing, Lead - Cyber Security Cluster, Institute for Infocomm Research (I2R), Agency for Science, Technology and Research (A*STAR)** *"Security in IoT"* With the growing trend of IoT device deployment and the accompanied huge market size, there is an increasing observation and occurrence of cyber-attacks by exploiting security vulnerabilities across the various highly connected devices. Security has now become the top concern for such deployment in both the consumer segment, enterprise environment and industrial settings. In this talk, I will share the key focus areas in the emerging IoT domain, highlight the security challenges, and suggest future research directions. I will also highlight some of the current and planned future IoT security works at Institute for Infocomm Research, A*STAR.
11:30-12:00	**Joe Jarzombek, Director for Government, Aerospace & Defense Programs, Synopsys, Inc.** *"IoT Supply Chain Management: Reducing Attack Vectors & Enabling Cybersecurity Assurance"* As the cyber threat landscape evolves and external dependencies grow more complex, managing risk in the IoT supply chain must focus on the entire lifecycle. IoT is contributing to a massive proliferation of a variety of types of software-reliant, connected devices throughout critical infrastructure sectors. With IoT increasingly dependent upon third-party software of unknown provenance and pedigree, software composition analysis and other forms of testing are needed to determine 'fitness for use' and trustworthiness. Application vulnerability management should leverage automated means for detecting weaknesses, vulnerabilities, and exploits. Addressing supply chain dependencies enables enterprises to harden their attack surface by: comprehensively identifying exploit targets; understanding how assets are attacked, and providing more responsive mitigations. Security automation tools and services, and testing and certification programs now provide means upon which organizations can use to reduce risk exposures attributable to exploitable software in IoT devices.
12:00-12:30	**Biplab Sikdar, Associate Professor, Department of Electrical and Computer Engineering, National University of Singapore** *"Security Solutions for the Internet of Things"* The Internet of Things (IoT) represents a great opportunity to connect people, information, and things, which will in turn cause a paradigm shift in the way we work, interact, and think. The IoT is envisioned as the enabling technology for smart cities, power grids, health care, and control systems for critical installments and public infrastructure. This diversity, increased control and interaction of devices, and the fact that IoT systems use public networks to transfer large amounts of data make them a prime target for cyber attacks. In addition, IoT devices are usually small, low cost and have limited resources. Therefore, any protocol designed for IoT systems should not only be secure but also efficient in terms of usage of chip area, energy, storage, and processing. This presentation will start by highlighting the unique security requirements of IoT devices and the inadequacy of existing security protocols and techniques of the Internet in the context to IoT systems. Next, we will focus on security solutions for the IoT, with special focus on protection against physical and side channel attacks. In particular, we will focus on mutual authentication protocols for IoT devices based on security primitives that exploit hardware level characteristics of IoT devices.
12:30-1:30	Lunch
1:30-2:00	Panel 3 - Managing: Keys, Risky Things, Cyber- and Physical- Attacks, and the IoT Supply Chain *Moderator: David W. Kravitz* *Panelists: Sean Smith, Biplab Sikdar, Joe Jarzombek, Vrizlynn Thing*
	Keynotes 5
2:00-2:30	**Rainer Matischek, Senior Staff Research Engineer, Infineon Technologies Austria AG** *"Hardware-Based IoT Security: From Research to Practical Applications"* The Internet of Things (IoT) offers countless new opportunities by interconnecting all sorts of physical devices from machines through cars to smart sensors and smart home appliances. However, the more data we share and devices connected, the greater the risk of theft and manipulation. This has recently been shown by the early rollout of insufficiently secured first-generation IoT devices. The subsequent attacks and negative headlines could have been prevented by using adequate security design. Therefore, this talk raises the awareness of future IoT system designers and device manufacturers for the following fact: The success of smart homes, connected cars and smart factories hinges on user confidence in robust, easy-to-use, fail-safe security capabilities. Furthermore, solution providers need to envision a lifecycle management of IoT devices, including secured commissioning, re-configuration and updates. To address these challenges, this talk proposes the integration and proper use of hardware-based security in future IoT devices. To finally increase and combine IoT system security and usability, proper IoT application design is necessary. Therefore, this presentation discusses useful approaches derived from state of the art research and findings of our ongoing feasibility studies.
2:30-3:00	**Jorge Guajardo Merchan, Principal Scientist and Manager, Security and Privacy Group, Robert Bosch Research and Technology Center North America** *"Towards a More Secure Internet of Everything"* The Internet of Things promises to create environments in which sensors, actuators, and people will interact seamlessly to the benefit of society. Such smart environments are also expected to create very attractive business opportunities. Yet, it is widely acknowledge that the incredible promise of the IoT will only become reality if we are able to solve the security and privacy challenges implied by the unprecedented scale of IoT systems. In this talk, I will discuss three particular technologies that my team is developing and that tackle the security and privacy challenges of the IoT in three different areas: hardware security at the sensor level, key agreement in automotive networks, and security and privacy for data outsourcing to the cloud.
3:00-3:30	**Kang Wei Woo, Executive Director, QuantumCIEL** *"IoT Security for Smart Nation - Challenges & Solutions"* With increasing connectivity through digitalization and IoT, security cannot be an afterthought; Singapore Smart Nation IoT Technical Committee has a new Technical Reference (TR) on IoT security which will be published in 2018 and highlights of this TR will be shared as part of the presentation.
3:30-4:00	Coffee Break

	Keynotes 6
4:00-4:30	**Jason Cooper, Principal Systems Architect, DarkMatter Group's Cryptographic Research & Development Division** *"Enforcing Dynamic Trust: Mimicking the Natural World"* Human instinct guides each of us. Do I know this person? Does someone I trust vouch for them? Should I continue to trust someone who betrayed me? These trust models arise naturally and change over time in response to stimuli. Our trust takes on different levels over a variety of contexts. I might trust an app with my work emails, but I don't necessarily trust it with photos of my family. We trust an online store with our banking details, until it gets hacked. We'd like to still do business with them, but without entrusting our bank information to them. The world of machines is similar. The sensors, actuators, interfaces and servers that make up a system today are configured with static trust relationships. When the server gets hacked, our systems need to adapt to the changed behavior and alter trust on the fly. The systems we design and build must be a dynamic ecosystem tolerant of failures and changing environment. Compromise of one or a few components shouldn't lead to catastrophic failure of the system. The process of creating resilient systems evolves its own tools and techniques. In the development of Darkmatter's DMLedger SDK, we've formulated many of our own. Crypto-algorithm Agility, Off-chain Asynchronous Authentication and Transaction Expiration are just a few. We'll also discuss (and, time permitting, demo) open-source tools for stress-testing and fuzzing your code, as well as how to integrate such open-ended tests into your regression test cycle.
4:30-5:00	**Angelos Stavrou, Professor and Director of the Center for Assurance Research and Engineering, George Mason University** *"Leveraging Blockchain-based protocols in IoT systems"* The Internet of Things (IoT) encompasses a wide range of processes: sensing, computation, communication, time, context, and data, to name only a few. How does all of these function as a system when using commercially available components that can be purchased from anywhere and at a low cost, and with little or no component pedigree available? To provide some practical answers to the these questions, we purchased components and created a set of small use cases to see how it all interoperated. In this talk, we will focus on use cases where the application of cryptography is not done properly or the cryptographic libraries employed exhibit security flaws. To that end, we demonstrate the need for mechanisms that will allow low-resource sensors to authenticate and exchange data in a way that does not rely on heavy cryptographic operations. We believe the need for group authentication and message integrity can be adequately satisfied using modified blockchain protocols that rely on proof-of-storage for some of the sensor operations creating groups of networked sensors that prove their membership not only using key material but also historical transactional data. Our work shows how blockchain protocols can be applied in IoT systems in a meaningful manner solving an actual need without the burden of complex operations that usually accompany the blockchain concept.
5:00-5:30	Panel 4 - Hardware, Tracking, and Transaction Immutability: From Sensors on Up *Moderator: Jeff Voas* *Panelists: Rainer Matischek, Jorge Guajardo Merchan, Kang Wei Woo, Jason Cooper, Angelos Stavrou*
5:30-6:00	Working Group - Actuation: Motivating What's Next *Moderator: David W. Kravitz*

TOP3: Topical 3 - Best Practices, Standards and Open Source - Part 1

Room: 4301A+4301B (138)

Organizers

Co-Chair Srikanth Chandrasekaran, *Senior Director - Standards & Technology, IEEE India and IEEE Senior Member*

Track Summary

The economics of IoT solutions depend on the ability to operate at scale with common components and common infrastructure that work in the same way anywhere in the world. To achieve such scale it is important to create practices, standards, and de-facto mechanisms such as open source that result in long-lived protocols and interfaces. At the same time there are significant technical challenges in developing new technologies that work across verticals and can reliably deal with the complexity inherent to IoT. The objective of the sessions on this subject is to identify areas where the IEEE can most effectively contribute to effective development of horizontal platforms and frameworks.

Program

10:30-12:30	**SDO Panel** *Moderator: Oleg Logvinov, President and CEO, IoTecha* *Panelists: Steve Olshansky, ISOC; Dale Seed, OneM2M; Rudolf Brandner, DKE; Dr. Bilel Jamoussi, ITU; Mr. Tim McGarr, BSI*
12:30-13:30	Lunch
13:30-15:30	**Technologies Session and Smart Cities Use Case** **Session Chair: Dennis Brophy, Mentor Graphics (Siemens)** **Zhao Yi, Huawei** *"Open Standards, Open Source, and Digital Transformation"* This presentation will discuss the value propositions of open standards and open source, and the challenges to align open standards and open source together. An IoT related open standards and open source landscape will be described. Views and practice on applying open standards and open source to digital transformation will be presented. **Chien Siang Yu, Certis CISCO** *"Future of IoT with Embedded AI and Its New Security Implications"* This presentation will focus on the rapid developments of new cognitive chips for running embedded AI via Deep Learning and how they will soon become mainstream capabilities for IoT, via the emergence of AI powered smart cameras, robotic and drone autonomous controls and finally next generation devices for smart building maintenance and facility management. These self learning, adaptive low power systems will revolutionise IoT systems, as they will not only be able to deliver low cost intelligence at the edge but also can collaborate well with each other by exploiting smart agents and cloud AI backends. The talk will also share performance and cost expectations, as well as new findings about how such narrow AI can make mistakes, leading to possible safety and security issues. Thus, there is a need for new standards to manage embedded AI. **Chris Steck, Cisco Systems** *"Managing 50 Billion Things"* Today, each IT person in the enterprise manages, on average, less than 250 devices. With the advent of IoT, that ratio needs to grow closer to one million to one to be manageable. This presentation will discuss how we'll get there utilizing standardized interoperable technologies in security, device management, and automated onboarding. **Koizumi Akimasa L. Crown Ltd** *"IIoT platform from Japan. Connected Industries 5.0"* Japan aims to achieve "Society 5.0" through the full utilization of technological innovation including IIoT. Japanese government has announced "Connected Industries 5.0," as a new concept framework. L.CROWN provides software platform for easy connected communication. L.CROWN focus on the Edge side so that it can collaborate with major cloud providers such as Microsoft, Amazon,GE, Siemens and Japanese IIoT vendors. Performance of existing IIoT systems in use today is "spec in" on installation and thus faces many challenges in upgrading. L.CROWN leaves troublesome information analysis to AI and human to make judgment to call on important issues. The ability of L.Crown to adapt and grow with operation as well as system needs in the most significant advantages.
15:30-16:00	Lunch
16:00-18:00	**Standards Session** **Session Chair: Sri Chandrasekaran, IEEE-SA** **Dr. William Miller, MACT-USA Inc** *"IEEE P1451-99: Standard for Harmonisation of IoT Devices and Systems"* Transducers are sensors and actuators for the Internet of Things (IoT) and encryption is a method of trust that can assure confidence. It is a challenge to deliver reliable data for decision making and control actions. This has become a concern as IoT devices are used in Smart Cities and critical applications. It is imperative that a device delivers data with the correct characteristics can be trusted. In this presentation, we discuss how encryption can be used to validate a device so data can be read or a control action can be made reliably. This is particularly important since many IoT devices today do not perform this validation. The transport layer can be encrypted, however, the data from a sensor and control of a actuator may be incorrect. This discussion also offers information needed for use of transducers in Blockchains. IoT Harmonization must address this capability since numerous devices do not offer this function. It can be added as part of device provisioning. This action with encryption can also utilize compression to conserve memory and provide assurance of the device characteristics and data integrity. This is extremely important for Smart Cities when utilizing for Transactive Energy (TE), Blockchain, Big Data, Data Analytics, and in Artificial Intelligence (AI). **Gerry Hayes, Wireless Research Center**

	"IEEE P2510: Standard for Establishing Quality of Data Sensor Parameters in the IoT Environment" Due to the rapid convergence of connectivity and the ubiquitous deployment of IoT devices, the harmonization of sensor system interoperability is needed to enhance innovation. In close collaboration with industry and academic partners, IEEE has launched two initiatives to facilitate the Harmonization of Connectivity of the Digital Citizen and the Harmonization of Sensor System Performance. This session presents an overview of the IEEE P2510 efforts that examine Sensors and Sensor Systems and the IEEE Industry Connection project that examines the Digital Citizen's connectedness from personal area networks and sensors to metropolitan scale connectedness within a Smart, Immersive City environment. **Oleg Logvinov, President and CEO, IoTecha** *"IEEE P2413: Standard for an Architectural Framework for the Internet of Things (IoT)"* The IEEE 2413 standard defines an architectural framework for the Internet of Things (IoT), including descriptions of various IoT domains, definitions of IoT domain abstractions, and identification of commonalities between different IoT domains. The architectural framework for IoT provides a reference model that defines relationships among various IoT verticals (e.g., transportation, healthcare, etc.) and common architecture elements. This standard uses the architecture description approach defined in the IEEE 42010 standard. **Steve Olshansky, ISOC** *"Internet of Things Security and Privacy: Challenges and Opportunities* The IoT is having a substantial and rapidly growing impact on the Internet and its users. Security and privacy are challenging and multi-dimensional problems as this arena expands. Attacks on devices, applications and services threaten the safety and privacy of users and their data, and attacks on IoT within critical infrastructure threaten the delivery of critical services. The IoT ecosystem is in many ways quite fragmented, and proprietary vs. open and interoperable solutions are competing in the marketplace. Standards and certification organizations are working at various levels, but codification and standardization of processes and implementations in the IoT space is an ongoing challenge. And as is often the case, technology is ahead of associated regulation and policy. This presentation will address the issues and challenges in the IoT Ecosystem, especially related to security and privacy, and potential approaches to addressing them. **Charles Despins, IEEE Green ICT** *"Green ICT: From Standards to a Green Label Certification"* The IEEE Green ICT initiative's mission statement is to build a holistic approach to sustainability by incorporating green metrics in various IEEE technical domains. This presentation will focus on the standards activity within the initiative. Current green ICT standards development within the initiative will be discussed as well as the broader goal of an IEEE green label certification.
18:00	End of Day

TOP4: Topical 4 - BlockChains and Applications

Room: 4202 (130)

Organizers

Raymond E. Cline, Jr., PhD, Lancium, LLC and Pindar Wong, VeriFi (Hong Kong) Ltd.

Track Summary

The relatively new technology behind block chains promises to create new offerings in the IoT space that dis-intermediate many of the current business models that require third party aggregators to function. The track on Block Chains is intended to provide information about developments in this new area and practical examples of applications that can benefit from the technology. Topics to be covered include:

- Block chain use in data sharing environments
- Hardening and security of block chains and IoT systems
- Novel block chain approaches for IoT
- Challenges to the adoption of block chain technology
- Infrastructure solution for block chain
- Real-world applications of block chain

In addition, there will be a presentation on a newly formed IEEE Block Chain Initiative and a working discussion on future directions and possible activities in the block chain IoT space.

Program

10:30	**Raymond E. Cline, Jr., PhD, Lancium, LLC and Pindar Wong, VeriFi (Hong Kong) Ltd.** *"Introduction*
10:35	**Pindar Wong, VeriFi (Hong Kong) Ltd.** *"How to Loan Money to Machines, Part 2"*
11:00	**Bill Tonti, IEEE Future Directions** *"Hardening the Internet of Things"* The Internet of Things (IOT) is poised to revolutionize the computing platform placing a new computing engine at both physical and virtual edges. This is in stark contrast to a current centralized cloud or decentralized server platform. The robust end to end computing model used by cloud or server models has to be made available in IOT based edge computing. One must develop a trusted computing methodology for mission critical IOT (MCIOT). MCIOT decision making and hardening from a computing perspective are the subject of this paper.
11:25	**Lewis Freiberg** *"IOTA"*
11:50	**David Tennenhouse, Chief Research Officer, VMware** *"Blockchain and IoT"* Blockchain offers the potential to re-engineer and increase the efficiency of every exchange of value that crosses organizational boundaries. How can blockchain speed the deployment and impact of IoT — and how can IoT help enable novel blockchain applications? This presentation will first discuss how blockchains can be used to enable the federation of enterprises and the creation of shared, immutable ledgers. It will then identify the key "enterprise strength" properties that are not readily supported by crypto-currency blockchains (low latency, high throughput, counterparty transparency, energy-efficiency, etc.) and how they can be attained. With that groundwork in place, the focus will shift to the intersection of IoT with federated ledgers, through the exploration of multiple opportunities for these two technologies to leverage each other's strengths. With those applications in mind, the presentation will wrap up by identifying some of the key considerations related to the operationalization of blockchain.
12:20	**Pindar Wong, Bill Tonti, Lewis Freiberg, David Tennenhouse** *"Round Table"*
12:30	Lunch
13:30	**Igor Chugunov, CEO and Founder CREDITS Blockchain Platform** *"CREDITS- A New Blockchain Generation"* CREDITS is an open blockchain platform with autonomous smart contracts and an internal cryptocurrency. The platform is designed to create services for blockchain systems using self-executing smart contracts and public data registry. CREDITS platform is the first completely autonomous blockchain system. The platform offers a new, extended application programming interface (API) that utilizes a Turing system capable of creating services using cycles, schedules, and unique functions. No other platform offers smart contract execution speeds near those of CREDITS. We believe that blockchain technology is suitable for financial and loan services, trade, medicine, identification, exchanges, Internet of things (IoT) services, and many other applications, some of which cannot yet be imagined. CREDITS unique blockchain technology offers paradigm-shifting capabilities to industries, applications, and users who require unmatched scalability. The addressable market for these services is estimated to be worth trillions of dollars.
13:50	**Angelos Stavrou, George Mason University** *"Leveraging Blockchain-Based Protocols in IoT Systems"*

14:10	**Asst. Prof. Greg Adamson, Enterprise Fellow in Cyber Security at the University of Melbourne School of Engineering** *"IoT, Blockchain, and Principles of Identity"* A founding characteristic of the Internet was the inability to determine who you are communicating with, captured in the 1993 meme "On the Internet nobody knows you're a dog". Before an adequate solution to this emerged, the challenge had broadened to machine-to-machine and then thing-to-thing communications. Today we have no agreed, sufficient, comprehensive, respectful solution in place, creating challenges for security, and also for dignity. This presentation will examine factors that make this challenge unique to the Internet, conditions which must be met to achieve broad if not universal adoption of any solution, and a selection of the many initiatives currently underway.
14:30	**Dr. Patrick Hung, Co-founder and CEO of Velosti Technology** *"Secure IoT Cloud Sharing with Blockchain Technology"* Storage clouds are a very efficient and convenient means to store information for many IoT applications. For example, home monitoring system may store real time video data on storage clouds. The video data are constantly analysed by Artificial Intelligence cloud, issuing alerts if there is any burglary or accident at home. Yet, our cloud data are not completely private and might be accessed by cloud providers, foreign government agencies, malicious hackers and competition. This can create very serious security and privacy issues in the future. In this talk, we will present an efficient and flexible secure storage cloud sharing scheme. The private data are encrypted on the device side using high-performance USB 3.1 hardware chip. Each data stream is encrypted and protected with a different encryption key. Using our proxy re-encryption scheme, each data stream is efficiently shared with its intended recipients only. To ensure system integrity, the certificate authority is run on blockchain technology. This secure cloud sharing technology will find important applications for many Smart City and Industry 4.0 applications.
14:50	**Adrian Kemp, Founding Partner, HoustonKemp Economists** *"Blockchain to Enhance Criminal Intelligence Information Sharing"* Adrian will be presenting on the development of a blockchain solution for the Australian criminal intelligence sector set to revolutionise how information is security shared, controlled and used between organisations. At its core, this new blockchain platform facilitates collaboration on intelligence between organisations, through sophisticated digital information controls, identity management, matching algorithms, and search and indexing tools. It creates the ideal backbone for the sharing of information when control and integrity is paramount - such as within our financial and criminal intelligence agencies. The platform uses blockchain in combination with decentralised file storage, to allow information assets to be shared, tracked, searched, matched and valued. Natural language algorithms combined with machine learning techniques facilitate collaboration between users without compromising security or need-to-know protocols.
15:10	**Igor Chugunov, Angelos Stavrou, Greg Adamson, Patrick Hung, Adrian Kemp** *"Round Table"*
15:30	Coffee Break
16:00	**Madhusudan Singh, Research Professor, Yonsei Institute of Convergence Technology (YICT), Yonsei University, Korea** *"Blockchain Oriented Trust Environment for Intelligent Autonomous Vehicle Communication"* As we know, Intelligent vehicles are almost in market and very soon, it will replace the human drivers worldwide. The intelligent vehicles are internet-connected vehicles, which is also communicating and data sharing between vehicle-to-vehicle (V2V), vehicles-to-infrastructure (V2I), and within vehicles. In such vehicle communication, they use CALM, DSRC and WAVE communication channels. This kind of machine has many security vulnerabilities such as data security, privacy, legality, trust between vehicles etc. They need a strong security mechanism to solve these challenges. However, the Intelligent vehicles are making secured through the traditional security mechanism similar to information technology security standards (ISO 27000 and family), but a risk of attacks will reach new levels of interoperability, and the independent decision-making will begin to embed complexity, security loopholes and potential "black swan" events. This type of research need to be built-in security and architectural design to protect emerging threats. However, Blockchain technology will break this traditional mechanism for data validation and facilitate a trustworthy environment creation for Intelligent vehicles. Blockchain is a secure decentralized distributed ledger. The intelligent vehicles with Blockchain can create and maintain a continuously growing data transaction blocks of cryptographically secured data records against fraudulence and tamper. Blockchain can also reduce the cost of data and unpredictability of working edge devices or connecting machines. It simplifies the development of cost-effective data transaction, where anything can be tracked and exchanged, without requiring a central body. However, security is big challenge for intelligent vehicles. This presentation will introduce the automotive cyber security: perspective, challenges, and discuss how can blockchain can provide a secure trust environment for the intelligent vehicles. Where unknown vehicles can communicate and share the data with each other's without disclosing any personal information. We have tried to present a secure trust environment model for Intelligent machines based on blockchain.
16:20	**Raymond E. Cline, Jr., PhD, Chief Mining Officer, Lancium, LLC** *"Lancium - Addressing Challenges in Infrastructure"* Lancium is working to solve two of the most prominent problems in the emerging technology space at this time. Global demand for electric power and the desire to meet this demand with "greener" generation has driven down the cost and greatly increased the deployment of renewable energy generation. The increase in renewable generation has produced in some geographies greater instabilities and resulted in increases in energy waste. Simultaneously, block chain, IoT, and general information technology infrastructure are requiring a tremendous amount of energy, at an increasing rate. Dr. Cline will present Lancium's approach to providing infrastructure solutions that balance both the needs of an increasing deployment of distributed renewable generation and providing needed capacity for block chain, IoT, information technology, and other energy demanding endeavors.
16:40	**Jim Fitzsimmons, Control Risks** *"Control Risks - A View on Block Chain Risks"*
17:00	**Madhusudan Singh, Raymond E. Cline, Jr., Jim Fitzsimmons** *"Roundtable"*
17:20	**Angelos Stavrou and Raymond E. Cline, Jr.** *"IEEE Block Chain Initiative"*
17:30	**Working Session**
18:00	**Adjourn**

TOP5: Topical 5 - Automation and Artificial Intelligence

Room: 4201A+4201B (138)
Chair: Joern Ploennigs (IBM Research, Ireland)

Organizers

Chair Joern Ploennigs

Track Summary

Artificial Intelligence and Machine Learning are essential technologies to scale with the exponential growth of IoT generated data. They enable to learn not only time series data, but, also enable new levels of audio, image, and video analytics. The devices to autonomously derive actionable insights trough contextual reasoning. In combination with novel speech and gesture based user interfaces they can support users in a new natural way in their tasks. The compact factor of IoT devices allow to add value to new application areas and the added value of AI enable novel applications and business models. This all makes this are a quickly evolving area in research and industry.

Program

	Technologies and Trends
10:30	**Joern Ploennigs, IBM Research - Ireland** *"AI for Automating IoT"* The exponential growth of IoT is creating new challenges in designing, deploying and, operating IoT systems. Machine learning and AI allow to process the data and to extract new level of insights. Scaling these solutions is challenging due to the high requirements on both methodological and domain knowledge. The talk will focus on how AI can be used to automated these processes in the life cycle of a IoT systems and create a cognitive digital twin that allows people to access insights in natural ways.
11:00	**Andy Chun, City University of Hong Kong** *"Logistics Optimization with IoT, Digital Twin, AI and Blockchains"*

	The logistics and transportation sector can benefit greatly from further optimization of operations to cope with growing and dynamic needs of the new Industry 4.0 world. Dr. Chun talks about potential benefits from the convergence of several fast developing technologies, such as IoT, digital twin, artificial intelligence, and blockchains. Dr. Chun will also present case studies from Hong Kong and Singapore.
11:30	**Simon See, Nvidia AI Technology Center Singapore** *"End-to-End AI Computing"* AI and IOT has been progressing very fast over the last few years. There are many applications which have adopted AI such as medical, automotive, robotics, finance and many others. Some of these reside on the edge of IOT while others are being computed in the backend. In this talk, the author will discussed the computing aspect of AI to support the diverse needs of different AI applications.
12:15	Panel Discussion
12:30	Lunch Break
	Challenges and Opportunities
13:30	**Jiewen Wu, A*STAR Artificial Intelligence Programme, and Institute for InfoComm Research** *"Artificial Intelligence for IoT Analytics: Challenges and Opportunities"* In this talk, I will give an overview of how typical Artificial Intelligence (AI) techniques are used for IoT analytics. As an example, I will elaborate how machine learning and knowledge representation can be leveraged for one case of smart transportation. In particular, semantically represented data are indispensable for explanations in predictive modelling. To sum up, I will highlight a few challenges that need to be addressed, together with opportunities for researching AI in the field of IoT analytics.
14:00	**C.K. Vishwakarma, AllThingsConnected** *"I or A.I.- Should I fear Artificial Intelligence?"* With advancements in Artificial Intelligence, Machine learning and their applications, most of the professionals, organizations and leaders are warning against the use of AI. In this talk we shall together try to find out which side you should take. Speaker will share practical examples from industry how he thinks we shall adopt power of AI with a human touch.
14:30	**Laura Wynter, IBM Research - Singapore** *"Artificial Intelligence and Automation in an IoT-equipped World"* We will discuss some of the challenges and our solutions to the problem of developing AI-based systems to solve real-world problems. Examples shall be taken from some of the projects we have done in Singapore and around the world.
15:00	Panel Discussion
15:30	Coffee Break
	Application and Ethics
16:00	**Hironobu Takagi, IBM Research - Japan** *"Realworld Accessibility* Computers have been changing the lives of the persons with disabilities. Synthesized voice helped the blind to access online services and dramatically increased their information source. Now, the new AI technologies are reaching the point where computers can help in sensing, recognizing, and understanding our living world, real-world. I will first introduce the concept of cognitive assistant for the blind, which will help them to explore surroundings and enjoy city environment by assisting their missing visual sense with integrated AI technologies. I will then introduce the latest technologies including precise navigation, and computer vision technologies, followed by a prediction of future progress with AI.
16:30	**Pamela Finckenberg-Broman and Morgan M. Broman, The RAiLE© Project** *"Human-Robotics/AI Interaction, The RAiLE© Project"* The key component of our presentation is to create a discussion around the need to establish a global, internationally relevant definition for a legal entity, that can be utilized to establish a consistent legal position for a future, more autonomous, combined Robotics/AI Legal Entity (RAiLE©). The question is will this RAiLE© - an autonomous "Robotics/AI Legal Entity" - be seen as a form of human, a machine or something else under international law? Through our initial research we have seen a growing need to look at first at the legal aspects of the interaction between two, often separate areas of our human lives affected by the technological developments within Robotics and AI, these are the workplace and the family unit. The importance of this is accentuated by the growing diversification in the interaction between Robotics/AI entities and humans in daily life, where the new technological solutions are capable of multiple different roles in our society's daily life. While our ongoing research into the legal aspects of this subject matter cannot provide all the answers, it is intended to look at the creation of a legal framework of definitions for future legislation to avoid or mitigate future potential legal disruption - i.e. when laws relating to technology usage is outpaced by the actual use of it and has a need to be adjusted and/or redefined. We want to initiate a more contextual cross-science debate around how to define, for use in legislation, the future merging of Robotics/AI into one integrated, autonomous entity. In conclusion, we propose this presentation as a platform for further discussions on the future legal aspects of Human-Robotics/AI interaction.
17:00	**Yong Liang Guan, Nanyang Technological University and NTU-NXP Smart Mobility Lab and Schaeffler Hub for Advanced Research (SHARE) at NTU** *"NTU-NXP Smart Mobility Test-Bed: A Campus-Wide Infrastructure for Connected Cars"* V2X (vehicle to everything) communication refers to a new vehicular WiFi technology that allows moving cars to communicate not just directly with each other, but also with "access points" installed on lamp poles or roadside infrastructure. This technology promises to enhance road safety, cut driving time, save fuel, augment GPS, drive big data, and enable new road pricing. International standards have been defined. Market products have emerged. In this talk, I will give an overview of a campus-wide V2X test-bed jointly developed by NTU and NXP that conforms to the IEEE WAVE standard suite, the full-stack applications that the test-bed is capable of supporting, the V2X standardization landscape, and outline some research projects related to this program.
17:30	Panel Discussion

Wednesday, February 7, 12:30 - 13:30

LN: Lunch (Peony Room)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Wednesday, February 7, 13:30 - 15:30

ET5: Session on IoT Enabling Technologies (V)

Room: 4204 (130)
Chair: Dirk Pesch (Cork Institute of Technology, Ireland)

ET5.1 13:30 ***Cooperative Reinforcement Learning for Adaptive Power Allocation in Device-to-Device Communication***
Muhidul Islam Khan and Muhammad Mahtab Alam (Tallinn University of Technology, Estonia); Yannick Le Moullec (TTU, Estonia); Elias Yaacoub (Arab Open University, Lebanon)
Mobile devices are an intrinsic part of the Internet of Things (IoT) paradigm. Device-to-device (D2D) communication is emerging as one of the viable solutions for the radio resource optimization in an IoT infrastructure. However, it also comes with the challenges associated with power allocation as it causes severe interference by reusing the spectrum with the cellular users in an underlay model. Therefore, efficient techniques are required to reduce the interference with proper power allocation. In this paper, we propose a cooperative reinforcement learning algorithm for adaptive power allocation in D2D communication which helps to provide better system throughput as well as D2D throughput with less interference. We perform cooperation by sharing the value function between devices and incorporating a neighboring factor. We design our states for reinforcement learning with appropriate application-defined variables which provide a longer observation space. We compare our work with the existing distributed reinforcement learning method and random allocation of resources. Simulation results show that the proposed algorithm outperforms the distributed reinforcement learning and the random allocation both in terms of overall system throughput as well as D2D throughput and quality of service (QoS) by adaptive power allocation.
pp. 481-486

ET5.2 14:00 ***Performance of Video Processing at the Edge for Crowd-Monitoring Applications***
Camille Ballas, Mark Marsden, Dian Zhang, Noel E O'Connor and Suzanne Little (Dublin City University, Ireland)
Video analytics has a key role to play in smart cities and connected community applications such as crowd counting, activity detection, event classification, traffic counting etc. Using a cloud-centric approach where data is funnelled to a central processor presents a number of key problems such as available bandwidth, real-time responsiveness and personal data privacy issues. With the development of edge

computing, a new paradigm for smart data management is emerging. Raw video feeds can be pre-processed at the point of capture while integration and deeper analytics is performed in the cloud. In this paper we explore the capacity of video processing at the edge and shown that basic image processing can be achieved in near real-time on low-powered gateway devices. We have also investigated deep learning model capabilities for crowd counting in this context showing that its performance is highly dependent on the input size and rescaling video frames can optimise processing and performance. Increased edge processing resolves a number of issues in video analytics for crowd monitoring applications.
pp. 487-492

ET5.3 14:30 ***Opportunistic Cyberphysical Services: A Novel Paradigm for the Future Internet of Things***
Giancarlo Fortino (University of Calabria, Italy); Wilma Russo (University of Calabria, Argentina); Claudio Savaglio (University of Calabria, Italy); Mirko Viroli (Alma Mater Studiorum - Università di Bologna, Italy); Mengchu Zhou (New Jersey Institute of Technology, USA)
Services have a paramount importance for unfolding the potential of the future Internet of Things (IoT), a dense, open, cyberphysical ecosystem in which humans, conventional computing systems and daily objects straightforwardly interoperate. By summarizing our previous contributions in such novel research context, this paper promotes our vision of "Opportunistic IoT Services" and a full-fledged approach to their modeling according to their opportunistic properties. Its effectiveness and flexibility is illustrated by means of two case studies, related to the Industrial IoT and Smart City scenarios.
pp. 493-497

ET5.4 15:00 ***Contention Resolution Algorithm for Industrial Internet-of-Things Networks***
Yan Maraden (University of Sydney, Australia); Wibowo Hardjawana (The University of Sydney, Australia); Branka Vucetic (University of Sydney, Australia)
The Industrial Internet-of-Things (IIoT) networks consists a large number of wireless sensor nodes. As the wireless spectrum available for IIoT networks is limited, there will be access contention nodes. The access contention causes collision, forcing them to retransmit the same packet multiple times and to continuously sense the channel to determine the suitable time for retransmission. As a consequence, each device will have high energy consumption and transmission latency. We propose a contention resolution (CR) algorithm that replaces continuous sensing with one slot sensing time and reduces the number of retransmission time to improve transmission latency and energy consumption of the nodes. Simulation results indicate that our proposed algorithm improves the energy efficiency, throughput and latency by 1600 times, 35% and 47%, respectively as compared to other schemes in the literature.
pp. 498-503

EXP1: Session on IoT Experimental Results and Deployment Scenarios (I)

Room: 4205 (130)
Chair: Matthew E. Tolentino (University of Washington, USA)

EXP1.1 13:30 ***Towards the Internet of Everything: Deployment Scenarios for a QoO-aware Integration Platform***
Antoine Auger (ISAE-SUPAERO & Université de Toulouse, France); Ernesto Exposito (UNIV PAU & PAYS ADOUR, France); Emmanuel Lochin (Université de Toulouse & ISAE-SUPAERO, France)
Built upon the Internet of Things (IoT), the Internet of Everything (IoE) acknowledges the importance of data quality within sensor-based systems, alongside with people, processes and Things. Nevertheless, the impact of many technologies and paradigms that pertain to the IoE is still unknown regarding Quality of Observation (QoO). This paper proposes to study experimental results from three IoE-related deployment scenarios in order to promote the QoO notion and raise awareness about the need for characterizing observation quality within sensor-based systems. We specifically tailor the definition of QoO attributes to each use case, assessing observation accuracy within Smart Cities, observation rate for virtual sensors and observation freshness within post-disaster areas. To emulate these different experiments, we rely on a custom-developed integration platform for the assessment of QoO as a service called iQAS. We show that QoO attributes should be used to specify what is an observation of "good quality", that virtual sensors may have specific and limiting capabilities impacting QoO and that network QoS and QoO are two complementary quality dimensions that should be used together to improve the overall service provided to end-users.
pp. 504-509

EXP1.2 14:00 ***Characterizing the Impact of Topology on IoT Stream Processing***
Anindya Dey, Kim Stuart and Matthew E. Tolentino (University of Washington, USA)
The Internet of Things (IoT) extends traditional cyber-physical systems by linking sensor based edge devices to network accessible services and resources. In most current IoT deployments, sensor data is streamed from edge devices to servers for storage. Analytical pipelines are then used to translate this raw sensor data into actionable information in real-time. As additional IoT devices are deployed, the volume and rate of data received on the server side can increase dramatically. This has a possibility of offsetting the response latencies beyond acceptable limits for the IoT analytical system. In this paper, we compare the impact of alternative server-side stream processing topologies for ingesting and analyzing IoT sensor data in real-time. We use real building sensor data with our real-time IoT platform called Namatad. We have characterized and analyzed the latency and QoS impact due to the different levels of granularity of the ingestion and routing process by which we transmit data into the analytical pipelines. Our results show that as IoT systems continue to scale in density, server-side topology management for IoT data streams is critical for latency-sensitive control and analysis applications.
pp. 510-515

EXP1.3 14:30 ***Machine Learning Based Electric Load Forecasting for Short and Long-term Period***
Tomas Vantuch (VSB-TU Ostrava, Czech Republic); Aurora González-Vidal, Alfonso Ramallo and Antonio Fernando Skarmeta Gomez (University of Murcia, Spain); Stanislav Misak (VSB - Technical University of Ostrava, Czech Republic)
Electricity is currently the most important energy vector in the domestic sector and industry. Unlike fuels, electricity is hard (and expensive) to store, what has always originated in the need of precise coupling between generation and demand. In addition, the transmission lines of electric power, need also to be sized for a given maximum power, and overloading them may result in blackout or electrical accidents. For these reasons, the energy consumption forecast is vital, but depending on who is doing this prediction, the time scale might be completely different. Grid operators have to predict the electricity demand for the next day, to program the generation accordingly. Grid designers have to predict energy consumption at the scale of years, to ensure that the infrastructure is sufficient. On the other hand, smart grid controllers with almost instant response time may need a prediction on the order of minutes. We have seen that changing the time scale in electricity load forecasting changes completely the problem, and that depending on the scale different methods should be used to ensure the highest accuracy with the smallest computational cost. We show here how forecasting accuracy decreases with increase of time scale due to impossibility of using of all variables. Several well established computational models were compared on tree different regression based criteria and the results revealed how boosting model were able to outperform their competitors in most of the comparisons.
pp. 516-521

EXP1.4 15:00 ***Understanding Crowd Density with A Smartphone Sensing System***
Kai Li (CISTER Research Unit, Portugal); Chau Yuen (Singapore University of Technology and Design, Singapore); Salil S Kanhere (The University of New South Wales, Australia); Kun Hu, Wei Zhang, Fan Jiang and Xiang Liu (Peking University, P.R. China)
In this paper, we demonstrate a proof-of-concept prototype of a lightweight indoor crowd monitoring system. The system utilizes off-the-shelf sensors which sniff probe requests periodically polled by people's smartphones in a passive manner. We propose a spatial-temporal data processing algorithm to study crowd density in a given area and their daily routine, based on a passive collection of the probe requests from their smartphones. Moreover, we carry out experiments to show the effect of the transmission interval of probe requests on the network traffic. We also undertake extensive experiments in real-world settings, i.e., one lab room in the university to observe office hours of researchers, and four closely located classrooms on the SUTD University campus to understand room occupancy.
pp. 522-527

IFO1a: Industry Forum Panel - Investment and Entrepreneurship in IoT (I)

Dr. ShiWei Wang, managing partner of Roth Asia Partners and a board director of MPRC; Jesse Pichel, Managing Director, ROTH Capital Partners USA; Chad Keck, Vice Chairman, Needham & Company, LLC. USA; Dr. Alan Lin, Director, Strategic Business Development, Tatung Co. Taiwan

Room: 4203 (130)

A recent Verizon study found the Internet of Things (IoT) has gained significant momentum in 2016, with accelerating investment in 2017. It reported 20-85% growth between 2016 and 2017 in various markets including smart cities/communities, energy, transportation/distribution, and manufacturing. McKinsey estimated that the Internet of Things could generate $4 trillion to $11 trillion in value globally in 2025.

During 2016-2017 the IoT industry has also seen billions of dollars in M&A and private placement. Aimed to provide a quick yet informative sketch on the IoT investment skyline, this session features speakers from the investment and entrepreneurship communities to present their interests, portfolios, and activities on IoT from strategic and investment perspectives. An open discussion panel will be held at the end to facilitate Q&A and dialogues among speakers and participants.

Narrator:Dr. ShiWei Wang, Managing Partner of Roth Asia Partners and a Board Director of MPRC

Dr. Shiwei Wang is the managing partner of Roth Asia Partners and a board director of MPRC. He was a senior vice president of China Resources Microelectronics group in charge of strategy, research and development as well as product marketing for business units in wafer production, packaging and design. He was a senior advisor for Carlyle Investment Group's buyout fund leading investments in the technology sector. Prior to that, he served as vice president for world leading electronics corporations like the Compal Computer Group, Delta Electronics Group, and Wistron Group. He also was the vice president of engineering in the Financial and Continental Business Group of the Institute of Information Industry. He was a associated professor in National Chiao-Tung University and advisor to ITRI. Earlier, Dr. Wang worked in IBM T. J. Watson Research Center on supercomputer projects RP3 and Deep Blue. Dr. Wang received his Ph.D. degree from Harvard University, M.S. from Columbia University, and B.S. from California Institute of Technology. He holds more than 40 patents in communication, semiconductor device, chip architecture, and software.

Speakers

Jesse Pichel, Managing Director, ROTH Capital Partners USA

Jesse Pichel joined ROTH Capital Partners in June 2013 as Managing Director in Investment Banking. Prior to joining ROTH, Mr. Pichel was a Managing Director, Global Head of Clean Technology Research for Jefferies Group Inc. Jesse has 18+ years of capital markets experience and is recognized as one of the first research analysts to focus on Solar and New Energy Technologies. He co-founded Piper Jaffray's CleanTech practice in 2004, and previously worked at Needham and Company and Unterberg Towbin as a Research Analyst in the Semiconductor, Electronic Manufacturing, and Emerging Technology sectors. Pichel has received numerous stock picking and earnings accuracy awards including those given by Institutional Investor (II), Forbes, FT/StarMine, and has been ranked as a top analyst and "Top Gun" by the The Wall Street Journal Best on the Street Analyst Survey. He was most recently ranked as a top analyst in the 2012 II All American Team for Alternative Energy, and was runner up two times previously. Pichel is a founding member of the Sierra Club's Clean Tech Council, and is on the board of other nonprofits promoting Sustainability and the Environment. Pichel earned his B.S. from Cornell University, and his MBA from Fordham University.

Presentation:

The growth in IOT has been exponential. Inexpensive IT and bandwidth is enabling a profusion of new IoT applications and uses. This and the resulting big data have brought new efficiencies, and also very substantial vulnerabilities. This applies to people, companies, communities, and governments. As a US IPO firm, we look for leading IOT companies all over the globe. The US stock market is the preferred listing location for Alibaba and most other great technology age companies, because US investors have the greatest appetite and experience in technology innovation businesses. Our discussion will focus on what sorts of IOT related companies are of particularly high.

Chad Keck, Vice Chairman, Needham & Company, LLC. USA

Chad's finishes his investment banking career as Vice Chairman of Needham & Company for whom he worked for more than 25 years. At Needham & Company, Chad served as founder of the West Coast Office, Co-head of Corporate Finance, Head of the Investment Banking Committee and leader of Needham's Investment Banking Activities in China. During this period he worked on more than 200 Investment Banking Transactions

including 50 Initial Public Offerings all for technology based companies. As a specialist in the semiconductor sector, Chad worked with many of the nation's leading companies in semiconductor equipment, Electronic Design Automation and semiconductor devices. He counts as friends and clients many of the entrepreneurs and financiers that enabled the PC revolution and the internet and the mobile solutions that play such an important part of today's life style.

Presentation: The IoT Revolution - Playing the Derivatives

I will discuss the methodologies for identifying investment opportunities that result from IoT. I will focus on several segments and give examples, concluding with a discussion of how to value the players.

Dr. Alan Lin, Director, Strategic Business Development, Tatung Co. Taiwan

Dr. Alan Lin (Chih-Yin Lin) is the Director of Strategic Business Development in System Business Group, Tatung Company. He leads the planning, coordination, and execution of worldwide business development activities for advanced and smart energy solutions such as micro grid, smart meter, AMI, solar energy system and engineering, building EMS, IoT, and smart city applications.

Previously, Dr. Lin was with Quanta Computer Inc. He was the Head of Product Planning in Quanta Research Institute and Associate Director of Marketing, Sales and Services in Business Unit 12, where he led product and market strategies, ecosystem partnership management, and product marketing of video communications, healthcare and IoT product lines. Before joining Quanta, he was a software engineer and project manager in Industrial Technology Research Institute. In addition to lead software projects for digital rights management and utility computing, he was a CMMI process reengineering specialist, and an information security management consultant to the industry. He was an Assistant Professor teaching in several universities in Taiwan. During 2005-2006, He was a Visiting Scientist in Massachusetts Institute of Technology, where he focused in research areas of trusted computing and distributed file systems.

Dr. Lin received a Bachelor degree in Computer Science and Information Engineering from Catholic Fu-Jen University, and a Ph.D. degree in Information Management from National Chiao Tung University. He won three top prices of European Satellite Navigation Competition in 2008 and 2009. He has published more than fifteen research papers and has received eight USPTO invention patents.

Presentation: IoT and the Future of Energy

The energy industry and the world economic are now in a paradigm shift due to the emerging of renewable energy and distributed power grids. It's by far creating the most powerful impact ever since the industry revolution. While the economists, politicians, and experts in the world are speaking on the big issues, in this talk a few small changes happening at this moment are addressed. Some imply significant challenges for the industry to move on, and some are new opportunities with IOT flavors waiting to be explored.

SC2: Session on Smart Cities (II)

Room: 4303 (130)
Chair: Marin Litoiu (York University, Canada)

SC2.1 13:30 *Low Complexity Probabilistic Demand-side Bidding Strategies for Singapore Electricity Market*
Chin Choy Chai (Institute for Infocomm Research, Singapore)
In double-sided energy markets, both the generation side and the demand side submit bids to the energy market for market clearing. It creates opportunities for load aggregators or energy retailers to earn incentives from by demand response (DR). However, the opportunity to participate in the energy market also poses challenges to energy retailers that appropriate bidding strategies must be applied to avoid penalty in case the promised load shifting cannot be achieved. In this paper, the DR programme in the wholesale energy market of Singapore is briefly introduced. Under such scenario, we propose bidding strategies for energy retailers to manage demand side resources and participate in the DR programs to maximise the expected profit. Our proposed optimal bidding algorithm is solved using the Gaussian approximation algorithm, which is of very low complexity as it is independent of the number of loads. The proposed algorithm has low communication requirements because only data concentrators and smart meters are required in the implementation.
pp. 528-533

SC2.2 14:00 *Energy Theft Detection in Advanced Metering Infrastructure*
Sandeep Kumar Singh (Indian Institute of Technology Delhi, India); Ranjan Bose (Indian Institute of Technology, India); Anupam Joshi (UMBC, USA)
Energy theft is one of the key concern in Advanced Metering Infrastructure (AMI). In developed and developing countries, the financial losses due to energy theft are billions of dollar per year. In this paper, we have proposed a Principal Component based Theft Detection scheme to detect energy theft in AMI. Principal components have been found using consumers' consumption data. Mahalanobis distance is calculated between transformed testing samples and historical consumption data. If the Mahalanobis distance is outside the predefined threshold range, the testing sample is considered as malicious. The proposed method is tested under different attack scenarios using real smart meter data. The experimental results show that the proposed scheme detects energy theft attacks with high detection rate.
pp. 534-539

SC2.3 14:30 *An Efficient Feature Matrix for Urban Noise Annoyance Measurement*
Ying Song (Institute for infocomm research, Singapore)
Traditionally the noise measurement and monitoring are based on the averaged A-weighting sound pressure level. However it is not adequate to use this feature only to evaluate sound induced annoyance as human noise tolerance is subjective to sound type and its characteristics. In this paper, we propose an efficient noise annoyance measurement methodology for online/onsite evaluation. We use a set of sound features and analyze their influence to the annoyance using forward iterative method. We develop an algorithm for feature significance evaluation with correlation indicator as benchmark tool. The analysis results show that the 90 percentile instantaneous loudness and the minimum value of the 3rd component of tonality are the two most significant features for annoyance measurement. The new two dimensional feature matrix effectively reduce the computational complexity for urban noise annoyance level evaluation. The effectiveness of proposed annoyance matrix is verified using regression methods.
pp. 540-544

SC2.4 15:00 *Dynamic Route Planning Framework for Minimal Air Pollution Exposure in Urban Road Transportation Systems*
Bandla Vamshi (Indian Institute Of Information Technology Chittoor, Sri City, India); Rajavaraprasad Yerra (IIT Hyderabad & Mhrd, India)
Personal human exposure to air pollution in urban areas and route planning to minimize it is a subject that has attracted much research interest in the last decades. Increase in Vehicle density and greedy route planning algorithms considering only shortest distance might result in dense traffic junctions in an urban scenario. Increasing exposure of air pollution at these congested traffic junctions to the commuters is an essential factor of consideration for developing next-generation routing algorithms. In this paper, a dynamic route planning algorithm for an urban scenario is proposed to distribute the traffic density in real time to other low dense traffic junctions. The proposed framework tries to minimize the number of congested traffic junctions by uniformly distributing the real time traffic using diversion suggestions and thereby reducing dense air pollution at traffic junctions. Proposed integrated suggestion framework rely on Internet of Things (IoT) architecture for the real time data information and geographical datasets to reduce the amount of air pollution and time of exposure to the commuters passing through that junctions. The cost function based approach is proposed with pollution levels, junction connectivity and road type as the key parameters without neglecting the possible shortest distance metric. This framework provides alternate routes as suggestions with a trade-off of additional distance but less pollution to the commuters thereby minimizing the overall cost function of time, distance and pollution.
pp. 545-550

SP3: Session on Security and Privacy for Internet of Things (III)

Room: 4304 (130)
Chair: Sin Teo (Institute for Infocomm Research, Singapore)

SP3.1 13:30 *Cyber Physical Surveillance System for Internet of Vehicles*
Dhananjay Singh (Hankuk University of Foreign Studies, Korea); Gaurav Tripathi (Bharat Electronics Limited, India); Sayed Chhattan Shah (Hankuk University of Foreign Studies, South Korea, Korea); Rodrigo Righi (Unisinos, Brazil)
Internet of Vehicle (IoV) is an essential part of the Intelligent Transportation system (ITS) which is growing exponentially for the research on the automotive industry. IoV share traffic, safety and several other vehicle-related information between vehicles and end user. In recent years, the number of connected vehicles has increased all-over the world. Although IoV has lots of advantage it also faces a challenging task in the cybersecurity-related matters. The future consists of crowded places in an interconnected world through wearable's, sensors, smart phones etc. We are converging towards IoV technology and interactions with crowded space of connected peoples. However, this convergence demands high-security mechanism from the connected crowd as-well-as other connected vehicles to safeguard of proposed IoV system. In this paper, we coin the term of smart people crowd (SPC) and the smart vehicular crowd (SVC) for the Internet of Vehicles (IoV). These specific crowds of SHC and SVC are the potential cyber attackers of the smart IoV. People connected to the internet in the crowded place are known as a smart crowd. They have interfacing devices with sensors and the environment. A smart crowd would also consist of the random number of smart vehicles. We present a novel cyber-physical surveillance system (CPSS) framework to tackle the security threats in the crowded environment for the smart automotive industry and provide the cyber security mechanism in the crowded places. We also describe an overview of use cases and their security challenges on the Internet of Vehicles.
pp. 551-556

SP3.2 14:00 *Security-Reliability Trade-off in Cyber-Physical Cooperative Systems with Non-Ideal Untrusted Relaying*
Ali Kuhestani and Abbas Mohammadi (Amirkabir University of Technology, Iran); Phee Lep Yeoh (University of Sydney, Australia)
In this paper, we examine the security-reliability trade-off (SRT) in a cyber-physical cooperative system where a source transmits to a destination assisted by a non-ideal untrusted amplify-and-forward (AF) relay with hardware impairments. We analyze the SRT under the following two transmission protocols: 1) Destination-based cooperative jamming (DBCJ) where the untrusted relay retransmits a combination of information signals from the source and jamming signals from the destination, and 2) conventional direct transmission (DT) where the relay is not used for information transmission but is treated as an eavesdropper. We accurately characterize the SRT of the two protocols based on novel closed-form expressions derived for the connection outage probability (COP) and the intercept probability (IP). Our theoretical results reveal that non-ideal AF relaying can improve the system security such that for transmission rates above a given threshold the IP is equal to zero. Numerical results highlight that non-ideal relaying improves the SRT of DT and degrades the SRT of DBCJ.
pp. 557-562

SP3.3 14:30 *Taxonomy on Malware Evasion Countermeasures Techniques*
Chandra Veerappan (Singapore Institute of Technology, Singapore); Peter Loh (SIT, Singapore); Zhaohui Tang and Su-Lim Tan (Singapore Institute of Technology, Singapore)
one of the major threats on Internet is Malware - malicious software which intends to harm IT infrastructures and systems. In the context of Internet-of-Things (IoT), the public attention has been particularly drawn to the growing number of malware programs targeting IoT devices and related security incidents in the recent years. Increasingly the malware, being polymorphic or metamorphic, changes behavior or remains inactive until a specific environment changes. These behaviors are the malware's detection evasion techniques to avoid detection and capture. Such highly evasive malicious programs are on the rise, resulting in extensive research efforts needed on evasion countermeasures. However, there is still a lack of a comprehensive and useful taxonomy to classify the existing countermeasures. This work fills the gap by presenting a survey on available malware evasion countermeasures from both academia and industry. Our main goal of proposing this taxonomy is to help build a scalable classification of evasion countermeasures to help support malware analysis and classification as well as to guide the design of future evasion countermeasures.
pp. 563-568

SP3.4 15:00 *Lightweight Gait Based Authentication Technique for IoT Using Subconscious Level Activities*
Pratik Musale (State University of New York, Korea & Stony Brook University, USA); Duin Baek (Stony Brook University); Bong Jun David Choi (The State University of New York (SUNY) Korea & Stony Brook University, Korea)
With the rapid growth of IoT market, it is expected that a large number of IoT devices will be deployed in the future networked systems. However, traditional user authentication techniques may be too heavy

and not be applicable to the IoT devices that have low computation and communication resources. To address such potential limitation, we propose a light-weight user authentication technique for IoT systems, called Li-GAT (Lightweight Gait Authentication Technique) that exploits various information collected from IoT devices, namely the subconscious level of user activities, to effectively authenticate users with high accuracy while reducing the resource consumption. In Li-GAT, we authenticate users by extracting and identifying different walking patterns of users (gait). We implement our technique on an Android platform to collect and analyze the accelerometer data from different users. The user authentication is done on a selected number of features using various machine learning classifiers. Our experiment results show that Li-GAT successfully authenticates users with high accuracy (96.69%) comparable to the existing techniques while using only the half number of features.
pp. 569-572

TOP1b: Topical 1 - Security and Privacy Regimes - Part 2

Room: 4302 (130)

Organizers

Co-Chairs David W. Kravitz and Jeffrey Voas

Track Summary

IoT applications and prospective solutions mandate consideration of a broad set of security and privacy requirements. The explosion in the number of connected devices poses a significant challenge, as does the diversity of end uses. The World Forum will address the component and platform implications for IoT in the context of the full life cycle for security and privacy regimes. It will also address the many security architectures and approaches that have emerged from Government organizations around the world, from the Commercial Market space, and from the Research Community. Across the wide spectrum of use cases there is a need to appropriately balance security and privacy, and it is useful to think of classifications that distinguish the levels required. As an example these may be thought of as:

- Highly security-centric "life-and-death" applications such as: critical infrastructure; control systems for connected automobiles, railroads, or aircraft; emergency healthcare
- Intermediate security uses that include: smart home; routine monitoring of facilities; sports and physical exercise activities that involve tracking such as geolocation
- Lower security casual uses such as: games, entertainment, public virtual reality applications, and aspects of social media and general information services

The topics that the Presentations, Panels, and Working Group discussions, for the Track on "Security and Privacy Regimes for IoT" will cover include:

- Achieving secure compose-ability of individually secure devices and components
- Scalability (for massive number of devices, and as contributors to- and consumers of- big data)
- Device-associated robustness levels that also deal with the high variations in heterogeneity (such as stationary and mobile infrastructure, smart phones and user terminals, wearables, the wide range of possible sensors and actuator types, and embedded IoT devices)
- Device ownership and component control (accounting for interoperability, regulatory compliance, governance, audit-ability and risk management)
- Remediation for the reigning confusion caused by the proliferation of standards and certification, and the realization that IoT will create new experiences and a vulnerability surface that is not accounted for
- Testing approaches and procedures that overcome the lack of efficacious and accepted practices — These include: interfacing with and leveraging legacy devices and services; containment against expansion of compromise to other units, systems or networks; effective crypto-agility; defense against advanced threats such as quantum-computing attacks. These also include testing approaches for the differing device lifetimes, and lifecycle support of IoT solutions such as over-the-air firmware and software upgrades

One of the objectives of the Track is to launch future actions and activities that continue beyond the World Forum as part of the IoT Initiative Working Group on "IoT Security and Privacy".

Program

	Keynotes 4
10:30-11:00	**Sean Smith, Professor, Department of Computer Science, Dartmouth University** *"Securing the IoT: Critical Research Challenges"* In the current Internet of Computers (IoC), paradigms and techniques have emerged to manage security risks, at least somewhat. However, the Internet of Things is different from the IoC, and these differences cause many of these paradigms to stop working. With the deep embedding of the IoT in the physical world, the consequences may have significant physical impact. This talk surveys some areas—zero days, authentication, lifetime mismatches, and connectivity complexity—where we need new research driven by academic and industrial partnerships. Vulnerabilities seem to be inevitable in software; in the IoT, how do we reduce and manage the risk of zero days? How do we manage good software hygiene when physical devices can outlive the "use-safely-by" date of software, and maybe even the software vendors themselves? (How do we keep zero-days from turning into forever-days?) As communication channels become more open, how do we secure them—and how do we establish a key infrastructure that captures operational requirements?
11:00-11:30	**Vrizlynn Thing, Lead - Cyber Security Cluster, Institute for Infocomm Research (I2R), Agency for Science, Technology and Research (A*STAR)** *"Security in IoT"* With the growing trend of IoT device deployment and the accompanied huge market size, there is an increasing observation and occurrence of cyber-attacks by exploiting security vulnerabilities across the various highly connected devices. Security has now become the top concern for such deployment in both the consumer segment, enterprise environment and industrial settings. In this talk, I will share the key focus areas in the emerging IoT domain, highlight the security challenges, and suggest future research directions. I will also highlight some of the current and planned future IoT security works at Institute for Infocomm Research, A*STAR.
11:30-12:00	**Joe Jarzombek, Director for Government, Aerospace & Defense Programs, Synopsys, Inc.** *"IoT Supply Chain Management: Reducing Attack Vectors & Enabling Cybersecurity Assurance"* As the cyber threat landscape evolves and external dependencies grow more complex, managing risk in the IoT supply chain must focus on the entire lifecycle. IoT is contributing to a massive proliferation of a variety of types of software-reliant, connected devices throughout critical infrastructure sectors. With IoT increasingly dependent upon third-party software of unknown provenance and pedigree, software composition analysis and other forms of testing are needed to determine 'fitness for use' and trustworthiness. Application vulnerability management should leverage automated means for detecting weaknesses, vulnerabilities, and exploits. Addressing supply chain dependencies enables enterprises to harden their attack surface by: comprehensively identifying exploit targets; understanding how assets are attacked, and providing more responsive mitigations. Security automation tools and services, and testing and certification programs now provide means upon which organizations can use to reduce risk exposures attributable to exploitable software in IoT devices.
12:00-12:30	**Biplab Sikdar, Associate Professor, Department of Electrical and Computer Engineering, National University of Singapore** *"Security Solutions for the Internet of Things"* The Internet of Things (IoT) represents a great opportunity to connect people, information, and things, which will in turn cause a paradigm shift in the way we work, interact, and think. The IoT is envisioned as the enabling technology for smart cities, power grids, health care, and control systems for critical installments and public infrastructure. This diversity, increased control and interaction of devices, and the fact that IoT systems use public networks to transfer large amounts of data make them a prime target for cyber attacks. In addition, IoT devices are usually small, low cost and have limited resources. Therefore, any protocol designed for IoT systems should not only be secure but also efficient in terms of usage of chip area, energy, storage, and processing. This presentation will start by highlighting the unique security requirements of IoT devices and the inadequacy of existing security protocols and techniques of the Internet in the context to IoT systems. Next, we will focus on security solutions for the IoT, with special focus on protection against physical and side channel attacks. In particular, we will focus on mutual authentication protocols for IoT devices based on security primitives that exploit hardware level characteristics of IoT devices.
12:30-1:30	Lunch
1:30-2:00	Panel 3 - Managing: Keys, Risky Things, Cyber- and Physical- Attacks, and the IoT Supply Chain *Moderator: David W. Kravitz* *Panelists: Sean Smith, Biplab Sikdar, Joe Jarzombek, Vrizlynn Thing*
	Keynotes 5
2:00-2:30	**Rainer Matischek, Senior Staff Research Engineer, Infineon Technologies Austria AG** *"Hardware-Based IoT Security: From Research to Practical Applications"* The Internet of Things (IoT) offers countless new opportunities by interconnecting all sorts of physical devices from machines through cars to smart sensors and smart home appliances. However, the more data we share and devices connected, the greater the risk of theft and manipulation. This has recently been shown by the early rollout of insufficiently secured first-generation IoT devices. The subsequent attacks and negative headlines could have been prevented by using adequate security design. Therefore, this talk raises the awareness of future IoT system designers and device manufacturers for the following fact: The success of smart homes, connected cars and smart factories hinges on user confidence in robust, easy-to-use, fail-safe security capabilities. Furthermore, solution providers need to envision a lifecycle management of IoT devices, including secured commissioning, re-configuration and updates. To address these challenges, this talk proposes the integration and proper use of hardware-based security in future IoT devices. To finally increase and combine IoT system security and usability, proper IoT application design is necessary. Therefore, this presentation discusses useful approaches derived from state of the art research and findings of our ongoing feasibility studies.
2:30-3:00	**Jorge Guajardo Merchan, Principal Scientist and Manager, Security and Privacy Group, Robert Bosch Research and Technology Center North America** *"Towards a More Secure Internet of Everything"* The Internet of Things promises to create environments in which sensors, actuators, and people will interact seamlessly to the benefit of society. Such smart environments are also expected to create very attractive business opportunities. Yet, it is widely acknowledge that the incredible promise of the IoT will only become reality if we are able to solve the security and privacy challenges implied by the unprecedented scale of IoT systems. In this talk, I will discuss three particular technologies that my team is developing and that tackle the security and privacy challenges of the IoT in three different areas: hardware security at the sensor level, key agreement in automotive networks, and security and privacy for data outsourcing to the cloud.
3:00-3:30	**Kang Wei Woo, Executive Director, QuantumCIEL** *"IoT Security for Smart Nation - Challenges & Solutions"*

	With increasing connectivity through digitalization and IoT, security cannot be an afterthought; Singapore Smart Nation IoT Technical Committee has a new Technical Reference (TR) on IoT security which will be published in 2018 and highlights of this TR will be shared as part of the presentation.
3:30-4:00	Coffee Break
	Keynotes 6
4:00-4:30	**Jason Cooper, Principal Systems Architect, DarkMatter Group's Cryptographic Research & Development Division** *"Enforcing Dynamic Trust: Mimicking the Natural World"* Human instinct guides each of us. Do I know this person? Does someone I trust vouch for them? Should I continue to trust someone who betrayed me? These trust models arise naturally and change over time in response to stimuli. Our trust takes on different levels over a variety of contexts. I might trust an app with my work emails, but I don't necessarily trust it with photos of my family. We trust an online store with our banking details, until it gets hacked. We'd like to still do business with them, but without entrusting our bank information to them. The world of machines is similar. The sensors, actuators, interfaces and servers that make up a system today are configured with static trust relationships. When the server gets hacked, our systems need to adapt to the changed behavior and alter trust on the fly. The systems we design and build must be a dynamic ecosystem tolerant of failures and changing environment. Compromise of one or a few components shouldn't lead to catastrophic failure of the system. The process of creating resilient systems evolves its own tools and techniques. In the development of Darkmatter's DMLedger SDK, we've formulated many of our own. Crypto-algorithm Agility, Off-chain Asynchronous Authentication and Transaction Expiration are just a few. We'll also discuss (and, time permitting, demo) open-source tools for stress-testing and fuzzing your code, as well as how to integrate such open-ended tests into your regression test cycle.
4:30-5:00	**Angelos Stavrou, Professor and Director of the Center for Assurance Research and Engineering, George Mason University** *"Leveraging Blockchain-based protocols in IoT systems"* The Internet of Things (IoT) encompasses a wide range of processes: sensing, computation, communication, time, context, and data, to name only a few. How does all of these function as a system when using commercially available components that can be purchased from anywhere and at a low cost, and with little or no component pedigree available? To provide some practical answers to the these questions, we purchased components and created a set of small use cases to see how it all interoperated. In this talk, we will focus on use cases where the application of cryptography is not done properly or the cryptographic libraries employed exhibit security flaws. To that end, we demonstrate the need for mechanisms that will allow low-resource sensors to authenticate and exchange data in a way that does not rely on heavy cryptographic operations. We believe the need for group authentication and message integrity can be adequately satisfied using modified blockchain protocols that rely on proof-of-storage for some of the sensor operations creating groups of networked sensors that prove their membership not only using key material but also historical transactional data. Our work shows how blockchain protocols can be applied in IoT systems in a meaningful manner solving an actual need without the burden of complex operations that usually accompany the blockchain concept.
5:00-5:30	Panel 4 - Hardware, Tracking, and Transaction Immutability: From Sensors on Up *Moderator: Jeff Voas* *Panelists: Rainer Matischek, Jorge Guajardo Merchan, Kang Wei Woo, Jason Cooper, Angelos Stavrou*
5:30-6:00	Working Group - Actuation: Motivating What's Next *Moderator: David W. Kravitz*

TOP3: Topical 3 - Best Practices, Standards and Open Source - Part 1

Room: 4301A+4301B (138)

Organizers

Co-Chair Srikanth Chandrasekaran, *Senior Director - Standards & Technology, IEEE India and IEEE Senior Member*

Track Summary

The economics of IoT solutions depend on the ability to operate at scale with common components and common infrastructure that work in the same way anywhere in the world. To achieve such scale it is important to create practices, standards, and de-facto mechanisms such as open source that result in long-lived protocols and interfaces. At the same time there are significant technical challenges in developing new technologies that work across verticals and can reliably deal with the complexity inherent to IoT. The objective of the sessions on this subject is to identify areas where the IEEE can most effectively contribute to effective development of horizontal platforms and frameworks.

Program

10:30-12:30	**SDO Panel** *Moderator: Oleg Logvinov, President and CEO, IoTecha* *Panelists: Steve Olshansky, ISOC; Dale Seed, OneM2M; Rudolf Brandner, DKE; Dr. Bilel Jamoussi, ITU; Mr. Tim McGarr, BSI*
12:30-13:30	Lunch
13:30-15:30	**Technologies Session and Smart Cities Use Case** **Session Chair: Dennis Brophy, Mentor Graphics (Siemens)** **Zhao Yi, Huawei** *"Open Standards, Open Source, and Digital Transformation"* This presentation will discuss the value propositions of open standards and open source, and the challenges to align open standards and open source together. An IoT related open standards and open source landscape will be described. Views and practice on applying open standards and open source to digital transformation will be presented. **Chien Siang Yu, Certis CISCO** *"Future of IoT with Embedded AI and Its New Security Implications"* This presentation will focus on the rapid developments of new cognitive chips for running embedded AI via Deep Learning and how they will soon become mainstream capabilities for IoT, via the emergence of AI powered smart cameras, robotic and drone autonomous controls and finally next generation devices for smart building maintenance and facility management. These self learning, adaptive low power systems will revolutionise IoT systems, as they will not only be able to deliver low cost intelligence at the edge but also can collaborate well with each other by exploiting smart agents and cloud AI backends. The talk will also share performance and cost expectations, as well as new findings about how such narrow AI can make mistakes, leading to possible safety and security issues. Thus, there is a need for new standards to manage embedded AI. **Chris Steck, Cisco Systems** *"Managing 50 Billion Things"* Today, each IT person in the enterprise manages, on average, less than 250 devices. With the advent of IoT, that ratio needs to grow closer to one million to one to be manageable. This presentation will discuss how we'll get there utilizing standardized interoperable technologies in security, device management, and automated onboarding. **Koizumi Akimasa L. Crown Ltd** *"IIoT platform from Japan. Connected Industries 5.0"* Japan aims to achieve "Society 5.0" through the full utilization of technological innovation including IIoT. Japanese government has announced "Connected Industries 5.0," as a new concept framework. L.CROWN provides software platform for easy connected communication. L.CROWN focus on the Edge side so that it can collaborate with major cloud providers such as Microsoft, Amazon,GE, Siemens and Japanese IIoT vendors. Performance of existing IIoT systems in use today is "spec in" on installation and thus faces many challenges in upgrading. L.CROWN leaves troublesome information analysis to AI and human to make judgment to call on important issues. The ability of L.Crown to adapt and grow with operation as well as system needs in the most significant advantages.
15:30-16:00	Lunch
16:00-18:00	**Standards Session** **Session Chair: Sri Chandrasekaran, IEEE-SA** **Dr. William Miller, MACT-USA Inc** *"IEEE P1451-99: Standard for Harmonisation of IoT Devices and Systems"* Transducers are sensors and actuators for the Internet of Things (IoT) and encryption is a method of trust that can assure confidence. It is a challenge to deliver reliable data for decision making and control actions. This has become a concern as IoT devices are used in Smart Cities and critical applications. It is imperative that a device delivers data with the correct characteristics can be trusted. In this presentation, we discuss how encryption can be used to validate a device so data can be read or a control action can be made reliably. This is particularly important since many IoT devices today do not perform this validation. The transport layer can be encrypted, however, the data from a sensor and control of a actuator may be incorrect. This discussion also offers information

	needed for use of transducers in Blockchains. IoT Harmonization must address this capability since numerous devices do not offer this function. It can be added as part of device provisioning. This action with encryption can also utilize compression to conserve memory and provide assurance of the device characteristics and data integrity. This is extremely important for Smart Cities when utilizing for Transactive Energy (TE), Blockchain, Big Data, Data Analytics, and in Artificial Intelligence (AI). **Gerry Hayes, Wireless Research Center** *"IEEE P2510: Standard for Establishing Quality of Data Sensor Parameters in the IoT Environment"* Due to the rapid convergence of connectivity and the ubiquitous deployment of IoT devices, the harmonization of sensor system interoperability is needed to enhance innovation. In close collaboration with industry and academic partners, IEEE has launched two initiatives to facilitate the Harmonization of Connectivity of the Digital Citizen and the Harmonization of Sensor System Performance. This session presents an overview of the IEEE P2510 efforts that examine Sensors and Sensor Systems and the IEEE Industry Connection project that examines the Digital Citizen's connectedness from personal area networks and sensors to metropolitan scale connectedness within a Smart, Immersive City environment. **Oleg Logvinov, President and CEO, IoTecha** *"IEEE P2413: Standard for an Architectural Framework for the Internet of Things (IoT)"* The IEEE 2413 standard defines an architectural framework for the Internet of Things (IoT), including descriptions of various IoT domains, definitions of IoT domain abstractions, and identification of commonalities between different IoT domains. The architectural framework for IoT provides a reference model that defines relationships among various IoT verticals (e.g., transportation, healthcare, etc.) and common architecture elements. This standard uses the architecture description approach defined in the IEEE 42010 standard. **Steve Olshansky, ISOC** *"Internet of Things Security and Privacy: Challenges and Opportunities* The IoT is having a substantial and rapidly growing impact on the Internet and its users. Security and privacy are challenging and multi-dimensional problems as this arena expands. Attacks on devices, applications and services threaten the safety and privacy of users and their data, and attacks on IoT within critical infrastructure threaten the delivery of critical services. The IoT ecosystem is in many ways quite fragmented, and proprietary vs. open and interoperable solutions are competing in the marketplace. Standards and certification organizations are working at various levels, but codification and standardization of processes and implementations in the IoT space is an ongoing challenge. And as is often the case, technology is ahead of associated regulation and policy. This presentation will address the issues and challenges in the IoT Ecosystem, especially related to security and privacy, and potential approaches to addressing them. **Charles Despins, IEEE Green ICT** *"Green ICT: From Standards to a Green Label Certification"* The IEEE Green ICT initiative's mission statement is to build a holistic approach to sustainability by incorporating green metrics in various IEEE technical domains. This presentation will focus on the standards activity within the initiative. Current green ICT standards development within the initiative will be discussed as well as the broader goal of an IEEE green label certification.
18:00	End of Day

TOP4: Topical 4 - BlockChains and Applications

Room: 4202 (130)

Organizers

Raymond E. Cline, Jr., PhD, Lancium, LLC and Pindar Wong, VeriFi (Hong Kong) Ltd.

Track Summary

The relatively new technology behind block chains promises to create new offerings in the IoT space that dis-intermediate many of the current business models that require third party aggregators to function. The track on Block Chains is intended to provide information about developments in this new area and practical examples of applications that can benefit from the technology. Topics to be covered include:

- Block chain use in data sharing environments
- Hardening and security of block chains and IoT systems
- Novel block chain approaches for IoT
- Challenges to the adoption of block chain technology
- Infrastructure solution for block chain
- Real-world applications of block chain

In addition, there will be a presentation on a newly formed IEEE Block Chain Initiative and a working discussion on future directions and possible activities in the block chain IoT space.

Program

10:30	**Raymond E. Cline, Jr., PhD, Lancium, LLC and Pindar Wong, VeriFi (Hong Kong) Ltd.** *"Introduction*
10:35	**Pindar Wong, VeriFi (Hong Kong) Ltd.** *"How to Loan Money to Machines, Part 2"*
11:00	**Bill Tonti, IEEE Future Directions** *"Hardening the Internet of Things"* The Internet of Things (IOT) is poised to revolutionize the computing platform placing a new computing engine at both physical and virtual edges. This is in stark contrast to a current centralized cloud or decentralized server platform. The robust end to end computing model used by cloud or server models has to be made available in IOT based edge computing. One must develop a trusted computing methodology for mission critical IOT (MCIOT). MCIOT decision making and hardening from a computing perspective are the subject of this paper.
11:25	**Lewis Freiberg** *"IOTA"*
11:50	**David Tennenhouse, Chief Research Officer, VMware** *"Blockchain and IoT"* Blockchain offers the potential to re-engineer and increase the efficiency of every exchange of value that crosses organizational boundaries. How can blockchain speed the deployment and impact of IoT — and how can IoT help enable novel blockchain applications? This presentation will first discuss how blockchains can be used to enable the federation of enterprises and the creation of shared, immutable ledgers. It will then identify the key "enterprise strength" properties that are not readily supported by crypto-currency blockchains (low latency, high throughput, counterparty transparency, energy-efficiency, etc.) and how they can be attained. With that groundwork in place, the focus will shift to the intersection of IoT with federated ledgers, through the exploration of multiple opportunities for these two technologies to leverage each other's strengths. With those applications in mind, the presentation will wrap up by identifying some of the key considerations related to the operationalization of blockchain.
12:20	**Pindar Wong, Bill Tonti, Lewis Freiberg, David Tennenhouse** *"Round Table"*
12:30	Lunch
13:30	**Igor Chugunov, CEO and Founder CREDITS Blockchain Platform** *"CREDITS- A New Blockchain Generation"* CREDITS is an open blockchain platform with autonomous smart contracts and an internal cryptocurrency. The platform is designed to create services for blockchain systems using self-executing smart contracts and public data registry. CREDITS platform is the first completely autonomous blockchain system. The platform offers a new, extended application programming interface (API) that utilizes a Turing system capable of creating services using cycles, schedules, and unique functions. No other platform offers smart contract execution speeds near those of CREDITS. We believe that blockchain technology is suitable for financial and loan services, trade, medicine, identification, exchanges, Internet of things (IoT) services, and many other applications, some of which cannot yet be imagined. CREDITS unique blockchain technology offers paradigm-shifting capabilities to industries, applications, and users who require unmatched scalability. The addressable market for these services is estimated to be worth trillions of dollars.

13:50	**Angelos Stavrou, George Mason University** *"Leveraging Blockchain-Based Protocols in IoT Systems"*
14:10	**Asst. Prof. Greg Adamson, Enterprise Fellow in Cyber Security at the University of Melbourne School of Engineering** *"IoT, Blockchain, and Principles of Identity"* A founding characteristic of the Internet was the inability to determine who you are communicating with, captured in the 1993 meme "On the Internet nobody knows you're a dog". Before an adequate solution to this emerged, the challenge had broadened to machine-to-machine and then thing-to-thing communications. Today we have no agreed, sufficient, comprehensive, respectful solution in place, creating challenges for security, and also for dignity. This presentation will examine factors that make this challenge unique to the Internet, conditions which must be met to achieve broad if not universal adoption of any solution, and a selection of the many initiatives currently underway.
14:30	**Dr. Patrick Hung, Co-founder and CEO of Velosti Technology** *"Secure IoT Cloud Sharing with Blockchain Technology"* Storage clouds are a very efficient and convenient means to store information for many IoT applications. For example, home monitoring system may store real time video data on storage clouds. The video data are constantly analysed by Artificial Intelligence cloud, issuing alerts if there is any burglary or accident at home. Yet, our cloud data are not completely private and might be accessed by cloud providers, foreign government agencies, malicious hackers and competition. This can create very serious security and privacy issues in the future. In this talk, we will present an efficient and flexible secure storage cloud sharing scheme. The private data are encrypted on the device side using high-performance USB 3.1 hardware chip. Each data stream is encrypted and protected with a different encryption key. Using our proxy re-encryption scheme, each data stream is efficiently shared with its intended recipients only. To ensure system integrity, the certificate authority is run on blockchain technology. This secure cloud sharing technology will find important applications for many Smart City and Industry 4.0 applications.
14:50	**Adrian Kemp, Founding Partner, HoustonKemp Economists** *"Blockchain to Enhance Criminal Intelligence Information Sharing"* Adrian will be presenting on the development of a blockchain solution for the Australian criminal intelligence sector set to revolutionise how information is security shared, controlled and used between organisations. At its core, this new blockchain platform facilitates collaboration on intelligence between organisations, through sophisticated digital information controls, identity management, matching algorithms, and search and indexing tools. It creates the ideal backbone for the sharing of information when control and integrity is paramount - such as within our financial and criminal intelligence agencies. The platform uses blockchain in combination with decentralised file storage, to allow information assets to be shared, tracked, searched, matched and valued. Natural language algorithms combined with machine learning techniques facilitate collaboration between users without compromising security or need-to-know protocols.
15:10	**Igor Chugunov, Angelos Stavrou, Greg Adamson, Patrick Hung, Adrian Kemp** *"Round Table"*
15:30	Coffee Break
16:00	**Madhusudan Singh, Research Professor, Yonsei Institute of Convergence Technology (YICT), Yonsei University, Korea** *"Blockchain Oriented Trust Environment for Intelligent Autonomous Vehicle Communication"* As we know, Intelligent vehicles are almost in market and very soon, it will replace the human drivers worldwide. The intelligent vehicles are internet-connected vehicles, which is also communicating and data sharing between vehicle-to-vehicle (V2V), vehicles-to-infrastructure (V2I), and within vehicles. In such vehicle communication, they use CALM, DSRC and WAVE communication channels. This kind of machine has many security vulnerabilities such as data security, privacy, legality, trust between vehicles etc. They need a strong security mechanism to solve these challenges. However, the Intelligent vehicles are making secured through the traditional security mechanism similar to information technology security standards (ISO 27000 and family), but a risk of attacks will reach new levels of interoperability, and the independent decision-making will begin to embed complexity, security loopholes and potential "black swan" events. This type of research need to be built-in security and architectural design to protect emerging threats. However, Blockchain technology will break this traditional mechanism for data validation and facilitate a trustworthy environment creation for Intelligent vehicles. Blockchain is a secure decentralized distributed ledger. The intelligent vehicles with Blockchain can create and maintain a continuously growing data transaction blocks of cryptographically secured data records against fraudulence and tamper. Blockchain can also reduce the cost of data and unpredictability of working edge devices or connecting machines. It simplifies the development of cost-effective data transaction, where anything can be tracked and exchanged, without requiring a central body. However, security is big challenge for intelligent vehicles. This presentation will introduce the automotive cyber security: perspective, challenges, and discuss how can blockchain can provide a secure trust environment for the intelligent vehicles. Where unknown vehicles can communicate and share the data with each other's without disclosing any personal information. We have tried to present a secure trust environment model for Intelligent machines based on blockchain.
16:20	**Raymond E. Cline, Jr., PhD, Chief Mining Officer, Lancium, LLC** *"Lancium - Addressing Challenges in Infrastructure"* Lancium is working to solve two of the most prominent problems in the emerging technology space at this time. Global demand for electric power and the desire to meet this demand with "greener" generation has driven down the cost and greatly increased the deployment of renewable energy generation. The increase in renewable generation has produced in some geographies greater instabilities and resulted in increases in energy waste. Simultaneously, block chain, IoT, and general information technology infrastructure are requiring a tremendous amount of energy, at an increasing rate. Dr. Cline will present Lancium's approach to providing infrastructure solutions that balance both the needs of an increasing deployment of distributed renewable generation and providing needed capacity for block chain, IoT, information technology, and other energy demanding endeavors.
16:40	**Jim Fitzsimmons, Control Risks** *"Control Risks - A View on Block Chain Risks"*
17:00	**Madhusudan Singh, Raymond E. Cline, Jr., Jim Fitzsimmons** *"Roundtable"*
17:20	**Angelos Stavrou and Raymond E. Cline, Jr.** *"IEEE Block Chain Initiative"*
17:30	**Working Session**
18:00	**Adjourn**

TOP5: Topical 5 - Automation and Artificial Intelligence

Room: 4201A+4201B (138)
Chair: Joern Ploennigs (IBM Research, Ireland)

Organizers

Chair Joern Ploennigs

Track Summary

Artificial Intelligence and Machine Learning are essential technologies to scale with the exponential growth of IoT generated data. They enable to learn not only time series data, but, also enable new levels of audio, image, and video analytics. The devices to autonomously derive actionable insights trough contextual reasoning. In combination with novel speech and gesture based user interfaces they can support users in a new natural way in their tasks. The compact factor of IoT devices allow to add value to new application areas and the added value of AI enable novel applications and business models. This all makes this are a quickly evolving area in research and industry.

Program

	Technologies and Trends
10:30	**Joern Ploennigs, IBM Research - Ireland** *"AI for Automating IoT"* The exponential growth of IoT is creating new challenges in designing, deploying and, operating IoT systems. Machine learning and AI allow to process the data and to extract new level of insights. Scaling these solutions is challenging due to the high requirements on both methodological and domain knowledge. The talk will focus on how AI can be used to automated these processes in the life cycle of a IoT systems and create a cognitive digital twin that allows people to access insights in natural ways.

11:00	**Andy Chun, City University of Hong Kong** *"Logistics Optimization with IoT, Digital Twin, AI and Blockchains"* The logistics and transportation sector can benefit greatly from further optimization of operations to cope with growing and dynamic needs of the new Industry 4.0 world. Dr. Chun talks about potential benefits from the convergence of several fast developing technologies, such as IoT, digital twin, artificial intelligence, and blockchains. Dr. Chun will also present case studies from Hong Kong and Singapore.
11:30	**Simon See, Nvidia AI Technology Center Singapore** *"End-to-End AI Computing"* AI and IOT has been progressing very fast over the last few years. There are many applications which have adopted AI such as medical, automotive, robotics, finance and many others. Some of these reside on the edge of IOT while others are being computed in the backend. In this talk, the author will discussed the computing aspect of AI to support the diverse needs of different AI applications.
12:15	Panel Discussion
12:30	Lunch Break
	Challenges and Opportunities
13:30	**Jiewen Wu, A*STAR Artificial Intelligence Programme, and Institute for InfoComm Research** *"Artificial Intelligence for IoT Analytics: Challenges and Opportunities"* In this talk, I will give an overview of how typical Artificial Intelligence (AI) techniques are used for IoT analytics. As an example, I will elaborate how machine learning and knowledge representation can be leveraged for one case of smart transportation. In particular, semantically represented data are indispensable for explanations in predictive modelling. To sum up, I will highlight a few challenges that need to be addressed, together with opportunities for researching AI in the field of IoT analytics.
14:00	**C.K. Vishwakarma, AllThingsConnected** *"I or A.I.- Should I fear Artificial Intelligence?"* With advancements in Artificial Intelligence, Machine learning and their applications, most of the professionals, organizations and leaders are warning against the use of AI. In this talk we shall together try to find out which side you should take. Speaker will share practical examples from industry how he thinks we shall adopt power of AI with a human touch.
14:30	**Laura Wynter, IBM Research - Singapore** *"Artificial Intelligence and Automation in an IoT-equipped World"* We will discuss some of the challenges and our solutions to the problem of developing AI-based systems to solve real-world problems. Examples shall be taken from some of the projects we have done in Singapore and around the world.
15:00	Panel Discussion
15:30	Coffee Break
	Application and Ethics
16:00	**Hironobu Takagi, IBM Research - Japan** *"Realworld Accessibility* Computers have been changing the lives of the persons with disabilities. Synthesized voice helped the blind to access online services and dramatically increased their information source. Now, the new AI technologies are reaching the point where computers can help in sensing, recognizing, and understanding our living world, real-world. I will first introduce the concept of cognitive assistant for the blind, which will help them to explore surroundings and enjoy city environment by assisting their missing visual sense with integrated AI technologies. I will then introduce the latest technologies including precise navigation, and computer vision technologies, followed by a prediction of future progress with AI.
16:30	**Pamela Finckenberg-Broman and Morgan M. Broman, The RAiLE© Project** *"Human-Robotics/AI Interaction, The RAiLE© Project"* The key component of our presentation is to create a discussion around the need to establish a global, internationally relevant definition for a legal entity, that can be utilized to establish a consistent legal position for a future, more autonomous, combined Robotics/AI Legal Entity (RAiLE©). The question is will this RAiLE© - an autonomous "Robotics/AI Legal Entity" - be seen as a form of human, a machine or something else under international law? Through our initial research we have seen a growing need to look at first at the legal aspects of the interaction between two, often separate areas of our human lives affected by the technological developments within Robotics and AI, these are the workplace and the family unit. The importance of this is accentuated by the growing diversification in the interaction between Robotics/AI entities and humans in daily life, where the new technological solutions are capable of multiple different roles in our society's daily life. While our ongoing research into the legal aspects of this subject matter cannot provide all the answers, it is intended to look at the creation of a legal framework of definitions for future legislation to avoid or mitigate future potential legal disruption - i.e. when laws relating to technology usage is outpaced by the actual use of it and has a need to be adjusted and/or redefined. We want to initiate a more contextual cross-science debate around how to define, for use in legislation, the future merging of Robotics/AI into one integrated, autonomous entity. In conclusion, we propose this presentation as a platform for further discussions on the future legal aspects of Human-Robotics/AI interaction.
17:00	**Yong Liang Guan, Nanyang Technological University and NTU-NXP Smart Mobility Lab and Schaeffler Hub for Advanced Research (SHARE) at NTU** *"NTU-NXP Smart Mobility Test-Bed: A Campus-Wide Infrastructure for Connected Cars"* V2X (vehicle to everything) communication refers to a new vehicular WiFi technology that allows moving cars to communicate not just directly with each other, but also with "access points" installed on lamp poles or roadside infrastructure. This technology promises to enhance road safety, cut driving time, save fuel, augment GPS, drive big data, and enable new road pricing. International standards have been defined. Market products have emerged. In this talk, I will give an overview of a campus-wide V2X test-bed jointly developed by NTU and NXP that conforms to the IEEE WAVE standard suite, the full-stack applications that the test-bed is capable of supporting, the V2X standardization landscape, and outline some research projects related to this program.
17:30	Panel Discussion

V4: Vertical 4 - Industrial IoT (Part 1)

Room: 4305 (130)

Organizers

Co-Chairs Chung-Min Chen, Sr. Director, iconectiv, Telcordia Technologies and Ranga Rao Venkatesha Prasad (VP)

Track Summary

The digitization and automation of industrial enterprises promises to create new ways in which the cycle from concept to goods in service produces value. At the same time the application of IoT technologies also promises to significantly change the way we maintain goods and equipment in service and commensurately the use and accompanying business models. The WF will explore the ways in which IoT will impact Industrial organizations and the technologies that are likely to drive the greatest changes.

Program

13:30-15:30	Session 1. IOT State of the Industry, What's Happening	**Speakers** **Frederik Troester, BOSCH** *"Overall Architectures for Industrial IoT Implementations - Mid-Level View. A Bosch Perspective"* An overview of how Bosch sees the opportunities in IoT and the overall approach - big picture. Overall Architectures for Industrial IoT Implementations - mid-level view. Examples of Industrial IoT Applications - a drill down addressing requirements for success and value. Summary of challenges - what works and what doesn't. **Kan Siew Leong, Nanyang Polytechnic** *"Co-create & Co-innovate Industrial IoT Solutions with Industry"* While the benefits of implementing IoT in manufacturing is obvious, it remains a challenge for local SMEs to create and develop unique selling points for their Industrial IoT (IIOT) services fast, while solving IoT system interoperability issues and mitigating IoT security concerns of their customers.

		This presentation covers an introduction of IoT in manufacturing, the challenges faced by SMEs in creating and adopting them, and how several National Centres of Excellence band together to provide an eco-system service in co-creating and co-innovate customised IIoT solutions for SME. We will share some of the IIoT projects developed and adopted by SME, the unique IP created in enhancing security and location tracking of IoT nodes in manufacturing, and our experiences in executing the projects. **Seeram Ramakrishna, National University of Singapore** *"IoT and Circular Economy"* Since the first industrial revolution generations of people used to linear economy (LE) i.e. produce, use and throw. The LE model depletes materials, energy and water resources. Moreover the undesirable effects of LE on the living environment is evident around the world. Growing consumerism and urbanization raised concerns about the sustainability for future generations. Call for legislative pressure, stricter environmental laws, and coordinated efforts to move away from the LE to circular economy, CE is gaining momentum. New legislations in Europe, China, Japan, USA and Singapore put pressure on industries and businesses to bear the responsibility for environmental impacts of their products over the entire life cycles. China studied the best practices of pioneering EU countries, and passed laws to promote CE. CE oriented industrial system involves the use of renewable energy, elimination of use of toxic chemicals, elimination of waste through superior design of products, resources efficiency, re-manufacture products, recover resources at the end of service life, and innovative business models. Circular Economy (CE) concept is trending around the world with major consulting firms Accenture, Deloitte, Ernest & Young, and McKinsey publishing reports in the last two years. Accenture estimates an economic opportunity of five trillion dollars for businesses moving to the Circular Economy. Internet of Things (IoT) coupled with new technologies such as sensors, big data analytics, artificial intelligence (AI), machine learning, cloud computing, cyber physical systems, automation, and nanotechnology is an enabler of the circular economy. For example, IoT, sensors, and big data analytics help to monitor, diagnose, preventive maintenance, and reduce harmful emissions in the transportation sector. New approaches include re-design of vehicles and materials selection with environment in mind, and processes to ensure complete recycling of used vehicles. Application of augmented reality, virtual manufacturing and smart manufacturing or digital manufacturing to shorten lead-time, reduce cost, improve productivity and quality. This is applicable to land, sea, and aerospace transport systems. Similar examples are emerging in plastics, wood, paper, construction, water use, solid waste handling, clean energy generation and use, resources efficiency and productivity of manufacturing processes, agriculture, farm produce, food packaging, beverages, textiles, supply chains, and services sectors. Using these technologies garments company Zara designs and stock an outfit in its stores around the world in 20 days! Urban farming enabled by these technologies reduces the water consumption and fertilizer consumption while improving the yield and quality. More over these improved practices contribute to lowering of carbon foot print of products. New approaches integrate environmental factors to realize sustainable product design and manufacturing, and eco-friendliness of products and uses. Hybrid technologies involving IoT and CE are to increase net welfare gains with minimal negative impact on the environment and human well-being. They are expected to transform the production systems, business models, economic growth, employment, living, and sustainability. They enable the vision of smart, green and livable cities. This lecture examines how the IoT associated technologies and CE concepts will impact the industry and environment? Other questions that will be addressed include which sectors of the economy will have the most impact? Which industries and businesses will be benefited and who will be affected? What are the opportunities for innovation? What are the best practices around the world, and examples to emulate? What are the changes needed in engineering education to nurture future engineers? **Panel Discussion**
15:30-16:00		Break
16:00-18:00	Session 2. IoT Challenges	**Speakers** **Greg Bollella, VMware** *"IoT Infrastructure: What is it? How big is it? How are we going to monitor, manage, and secure it?"* When I first started looking into The IoT four years ago for VMware the community, System Integrators deploying complete IoT solutions with technologies from multiple vendors, IoT analytic solution providers, IoT PaaS providers, etc., had given only a passing thought to the compute, networking, and storage infrastructure, external to the data center, necessary to collect, filter, and transport data to analytic engines, collectively, as enterprise-grade infrastructure. I, and VMware, firmly believe then as we do now that the functional and physical components of such infrastructure must be monitored, managed, and secured just as any other component of compute, networking, and storage anywhere across an enterprise. It's become clear that IoT will change our industry in two fundamental way: 1. We'll need physical systems (currently known as IoT gateways) to de-couple the sensor, machine, or 'Thing' network from the WAN (public Internet or Enterprise WAN), and 2., the predominant direction of data flow will reverse 180 degrees (from data center-to-user to 'Thing' network-to-(a system where analytic engines can consume and analyze the data and produce value for an organization). I purposely did not use the term 'data center' in the latter part of the previous statement as many now believe that 'compute will move to the Edge'. This talk will explore both of these topics and give solid technical, financial, and business reasons that support these two fundamental shifts in our industry. Also, I'll discuss how we at VMware are producing products that will help our customers, the IT organizations of all major world-wide enterprises, be ready for the fundamental changes wrought by IoT. Ready to secure, monitor, and manage their IoT infrastructure and extract maximum ROI from IoT solutions they deploy by positioning systems at optimal locations relative to the source of IoT data streams. **Dirk Pesch, CIT, Ireland** *"Challenges for Interoperability in the Industrial Internet of Things"* Interoperability is a major challenge for the Internet of Things. A plethora of machine to machine communication standards, data formats and representations, and IoT platforms exist that are all essentially not (fully) interoperable. Each M2M standard comes with its own protocols, message formats and data representations. A number of standards bodies and industry associations are trying to standardize aspects of the Internet of Things space. However, due to the fast developing area and commercial opportunities, many companies move ahead with their own developments in the hope that they will achieve sufficient adoption of their technology so that they do not have to worry about standards. This talk will summarize the current state of the art in machine to machine communication, data formats and representations, IoT platforms and the challenges that this and other constraints pose for a wide spread adoption of the IoT in industry. We will then explore possible solutions to the interoperability issues and suggest possible paths forward. **Olivier Pfeiffer, ID Quantique SA** *"Why Quantum Technologies Matter in Critical Infrastructure and IoT"* As devices and systems in our critical infrastructures become ever more interconnected, it is increasingly important to ensure that they have adequate cryptographic protections. This is particularly challenging - yet even more essential - given the potential scalability of the attack vectors in this hyper-connected world. Action is required now, both to ensure current security, but also to prepare upgrade paths for future technology advances. The presentation will review how the emergence of new quantum technologies will impact IoT cryptographic security - both creating in new threat vectors, such as a quantum computer, as well as providing some immediate solutions. **Panel Discussion**

Wednesday, February 7, 15:30 - 16:00

CB: Coffee Break (Exhibit Hall)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Wednesday, February 7, 16:00 - 18:00

ET6: Session on IoT Enabling Technologies (VI)

Room: 4204 (130)
Chair: Manuel Eugenio Morocho Cayamcela (Kumoh National Institute of Technology, Korea)

ET6.1 16:00 ***An Artificially Structured Step-Index Metasurface for 10GHz Leaky Waveguides and Antennas***
Manuel Eugenio Morocho Cayamcela, Stephen Ryan Angsanto, Angela Caliwag and Wansu Lim (Kumoh National Institute of Technology, Korea)
Metasurfaces can be engineered to guide surface waves in a homogeneous path, where sub-wavelength size printed patches are etched on a grounded high-frequency laminate. When the homogeneity of the patches is compromised or it is inappropriately excited, leakage takes place. This effect can be exploited to design leaky-wave antennas for a wide range of applications, starting for Internet of Things (IoT) to Smart Factories. Step-index waveguides and antennas are engineered to work by introducing perturbations on the pattern so radiation occur in a controlled manner. The aim of this paper is to propose certain candidate antenna designs. The engineering method to derive effective refractive index is comprehensively investigated to guide and radiate surface waves at a centre operating frequency of 10GHz as a validation of the theory proposed.
pp. 573-578

ET6.2 16:30 ***An Analysis of Energy Consumption Under Various Memory Mappings for FRAM-based IoT Devices***
Mirae Kim (Hanyang University, Korea)
Internet of Things (IoT) devices are powered by an independent power supply like battery and energy harvester, which provide limited energy. Batteries require charging and replacement due to their limited lifetime. Energy harvesters have a semi-permanent lifetime but are environmentally constrained and irregularly supplied, which can cause power failure problems. Reducing the energy consumption of IoT devices can alleviate problems caused by independent power supplies. In general, the memory of IoT device is used for storing programs and data, executing tasks, and so on. The consistent access to the memory occurs while the IoT device is operating. Thus, the energy savings in accessing memory reduce the average IoT device energy consumption. This can help alleviate the problem of independent power supplies. In this paper, we analyze the energy consumption pattern according to memory mapping of tasks using a FRAM-based embedded device. We also analyzed the energy consumption of the low-power mode according to the memory mapping. Considering the overhead of data migration depending on the task, we confirmed that an average of 50% energy saving is possible when the proper memory mapping is selected.
pp. 579-584

ET6.3 17:00 ***Scalable Distributed-Sensing Scheme with Prioritized Reporting for Multi-Band WLANs***

Rui Teng (Advanced Telecommunications Research Institute International, Japan); Kazuto Yano and Tomoaki Kumagai (ATR, Japan)

To support the increasing number of wireless devices for Internet of Things (IoT), wireless LAN (WLAN) is envisioned to provide both wide spatial coverage and sufficient spectrum resources. Multi-band WLAN allows flexible use of multiple frequency bands. To efficiently monitor wireless resources in IoT-enabled multi-band WLAN, station (STA) based distributed sensing system is considered. Distributed sensing alleviates sensing constraints at access points (APs) and expands sensing coverage area. This paper addresses the problem of how to efficiently collect the necessary information of wireless resources. We propose a scalable distributed-sensing scheme to efficiently collect the wireless resource information such as channel occupancy ratio from STAs. A key feature of the proposed approach is that a prioritized reporting process is employed at each STA for collection of sensing results with high scalability. The reporting process is automatically managed based on report time, sensing result as well as the reports from other STAs. Evaluation results show that the proposed approach keeps a small report number and results in a high scalability with the large number of STAs.

pp. 585-590

ET6.4 17:30 ***Internet of Underground Things: Sensing and Communications on the Field for Precision Agriculture***

Mehmet Can Vuran, Abdul Salam, Rigoberto Wong and Suat Irmak (University of Nebraska-Lincoln, USA)

The projected increases in World population and need for food have recently motivated adoption of information technology solutions in crop fields within precision agriculture approaches. Internet of underground things (IOUT), which consists of sensors and communication devices, partly or completely buried underground for real-time soil sensing and monitoring, emerge from this need. This new paradigm facilitates seamless integration of underground sensors, machinery, and irrigation systems with the complex social network of growers, agronomists, crop consultants, and advisors. In this paper, state-of-the-art communication architectures are reviewed, and underlying sensing technology and communication mechanisms for IOUT are presented. Recent advances in the theory and applications of wireless underground communication are also reported. Major challenges in IOUT design and implementation are identified.

pp. 591-596

EXP2: Session on IoT Experimental Results and Deployment Scenarios (II)

Room: 4205 (130)

Chair: Yu Rongshan (Xiamen University, P.R. China)

EXP2.1 16:00 ***Evaluating an Augmented Remote Assistance Platform to Support Industrial Applications***

Mark Rice, Keng-Teck Ma and Hong Huei Tay (Institute for Infocomm Research, Singapore); Joyce Kaliappan (Temasek Polytechnic, Singapore); Wei Ling Koh (Nanyang Technological University, Singapore); Wah Pheow Tan (Temasek Polytechnic, Singapore); Jamie Ng (Institute for Infocomm Research, Singapore)

Remote assistance provides a communication bridge for users engaged in different locations. However, understanding how to design such systems in IoT is a challenging issue given digital representations are not the same as sharing a physical space. In this paper, we present a Remote Assistance Platform (RAP) that is designed to facilitate task guidance between an instructor and one or more remote operators. This includes the support of visual communication using a suite of annotation tools that augment information on a live video stream. Two user studies were performed to evaluate co-located and remote interaction. In the first study, dyads interacted with paper-based instructions while situated in the same location. In the second study, different dyads remotely performed the same tasks, assisted by using a smartphone or smart glass display. Overall, our findings found significant differences in the communication behaviour based on the type of collaborative environment and information modality used. A short review of these results is discussed.

pp. 597-602

EXP2.2 16:30 ***Bayesian Maximum Entropy and Interacting Multiple Model Based Automatic Sensor Drift Detection and Correction in an IoT Environment***

Punit Rathore (The University of Melbourne, Australia & TATA STEEL LTD, Jamshedpur, India); Dheeraj Kumar (Purdue University, USA); Sutharshan Rajasegarar (Deakin University, Australia); Marimuthu Palaniswami (The University of Melbourne, Australia)

With the advancement in the Internet of Things (IoT) technologies, a variety of sensors including inexpensive, low-precision sensors with sufficient computing and communication capabilities are increasingly deployed for monitoring large geographical areas. One of the problems with the use of inexpensive sensors is the drift that they develop over time. These drifting sensors need to be calibrated automatically for continuous and reliable monitoring. In this paper, we present a new methodology to automatically detect and correct both the smooth and steep drifts by employing Bayesian Maximum Entropy and Interacting Multiple Model based techniques. The evaluation on real IoT data gathered from an indoor and an outdoor deployment reveals the superiority and applicability of our method in correctly identifying and correcting the smooth and abrupt (sensor) drifts in the IoT environment.

pp. 603-608

EXP2.3 17:00 ***Energy-Aware Services Composition for Internet of Things***

Osama Alsaryrah (Yuan Ze University, Taiwan); Ibrahim Mashal (Aqaba University of Technology, Jordan); Tein Yaw Chung (Yuan Ze University, Taiwan)

Internet of Things (IoT) are going to change our daily live in the near future. As IoT services prevail, many edge server, gateways, sensors and actuators etc. will be widely available in cities and smart spaces. Thus, how do we exploit these resources to provide rich and green services to users has become a very critical issue. In the past, researchers have developed QoS-based service composition schemes for IoT. However, they fail to consider energy efficiency in service composition. This paper extended previous QoS-based scheme to consider power consumption when linking various objects in the IoT environment based on users' demand. Simulation results show that our algorithm performs efficiently regarding computation complexity and energy efficiency in comparison with existing QoS-based algorithms.

pp. 609-613

EXP2.4 17:30 ***A Low Power IoT Network for Smart Agriculture***

Soumil K Heble (Indian Institute of Technology Hyderabad, India); Ajay Yaduvanshi (Indian Institute of Technology, Hyderabad, India); Durga Prasad K v v (IITH, India); Soumya Samirana (IIT Hyderabad, India); P Rajalakshmi (Indian Institute of Technology Hyderabad, India); Uday B Desai (IIT Hyderabad, India)

Traditional agriculture is transforming into smart agriculture due to the prominence of the Internet of Things (IoT). Low-cost and low-power are the key factors to make any IoT network useful and acceptable to the farmers. In this paper, we have proposed a low-power, low-cost IoT network for smart agriculture. For monitoring the soil moisture content, we have used an in-house developed sensor. In the proposed network, the IITH mote is used as a sink and sensor node which provides low-power communication. We have evaluated our network with state of the art networks, proposed for agriculture monitoring. Power and cost are the two metrics used for evaluation of these networks. Results show that the proposed network consumes less power and has on average 83 prolonged lifetime at a lower cost compared to previously proposed network in the agriculture field.

pp. 614-619

IFO1b: Industry Forum Panel - Investment and Entrepreneurship in IoT (II)

Chung-Min Chen, Sr. Director of Data Science & Analytics at iconectiv, a subsidiary of Ericsson; Lee Stogner, Partner and SVP, Liquidax Capital, USA; Joel Myers, CEO, DOMILA Limited, Ireland; Dr. Ren Wu, CEO and Founder, NovuMind Inc., USA; Bay McLaughlin, Co-Founder & COO, Brinc

Room: 4203 (130)

A recent Verizon study found the Internet of Things (IoT) has gained significant momentum in 2016, with accelerating investment in 2017. It reported 20-85% growth between 2016 and 2017 in various markets including smart cities/communities, energy, transportation/distribution, and manufacturing. McKinsey estimated that the Internet of Things could generate $4 trillion to $11 trillion in value globally in 2025.

During 2016-2017 the IoT industry has also seen billions of dollars in M&A and private placement. Aimed to provide a quick yet informative sketch on the IoT investment skyline, this session features speakers from the investment and entrepreneurship communities to present their interests, portfolios, and activities on IoT from strategic and investment perspectives. An open discussion panel will be held at the end to facilitate Q&A and dialogues among speakers and participants.

Narrator: Chung-Min Chen, Sr. Director of Data Science & Analytics at iconectiv, a subsidiary of Ericsson

Chung-Min Chen is Sr. Director of Data Science & Analytics at iconectiv, a subsidiary of Ericsson. Dr. Chen is a recognized expert in big data, analytics, and mobile networks with over 60 research papers published in IEEE and ACM periodicals. At iconectiv, he leads development of machine learning solutions that help operators detect telecom frauds, predict customer satisfaction, churns, and discover market insights. Prior to that, he was with Applied Research of Telcordia for many years, driving research and consulting in data management, mobile networks, connected vehicles, secure and private data indexing, and quantitative financial data analysis. Dr. Chen was an Adjunct Professor with National Taiwan University during 2007-2010. He holds a Ph.D. in Computer Science from University of Maryland, College Park and B.Eng. in Computer Science from NTU.

Speakers

Lee Stogner, Partner and SVP, Liquidax Capital, USA

Lee Stogner serves in Executive Positions in several corporations that drive improved business performance using technologies that include Business Innovation, Digital Transformation, Project Management, Internet of Things and Artificial Intelligence. Lee has over 35 years of design, consulting, project management and business development experience across a range of industries. Lee has driven growth at companies that include Digital Equipment, Fluor Corporation, Rockwell International and Liquidax Capital. Customers around the world have benefited from Lee's expertise and leadership.Throughout his working career, Lee has been active in both local and international professional activities. Lee is the Chair of the Carolinas' Engineering Cluster and a past Director of the IEEE Board of Directors. Today, Lee is active in promoting the development of the Internet of Things through his participation in the IEEE Smart Grid Initiative, the IEEE Transportation Electrification Committee and as a Member of the IEEE Internet of Things Initiative, IoT. Lee can be contacted at stogner@ieee.org.

Presentation: The IEEE Entrepreneur Network

The IEEE Entrepreneurship community is at the forefront of turning ideas into successful businesses. We make it priority to help our members not just launch, but grow their ventures and facilitate the networking and mentoring of those who have the passion to translate their vision into reality.

Joel Myers, CEO, DOMILA Limited, Ireland

Leading technologist specializing in the creation and development of innovation technology solutions in the communications and management of services in Cultural Heritage, Tourism, and since 2015 in Business Networking.

Over the past 30 years, he has worked with museums and archaeological worldwide, including the Colosseum, Roman Forum and Pompei in Italy, the Courtauld Institute in London, and The Frick Museum and Metropolitan Museum in New York. His projects in cultural heritage and tourism have covered solutions in digital photo-archiving, reconstructions of sites using 3D virtual reality, augmented reality, and audio-visual mobile applications. In 2008, Joel Myers led a team of developers in partnership with Google Inc. (Mountainview, California) and the Universities of Virginia and UCLA in the creation of Google Earth's first historical city layer, ancient Rome, launched with Michael Jones (CTO, Google Inc. in 2008) under the Italian Ministry of Cultural Heritage and Activities and Tourism and hosted by On. Gianni Alemanno, the Mayor of the Municipality of Rome in 2008.

He is currently working on the commercialisation of a mobile application called HoozAround. This App offers very close-proximity networking for users to carry out academic, business and social networking based on profile matching needs or interests in real-time, indoors and outdoors. Its aim is to bring people together that would otherwise never meet, face-to-face, in order to create new opportunities to grow academically, in business and socially. The HoozAround app has been made available to all participants of the IEEE: World Forum on Internet of Things and will be part of the panel discussion held by Joel Myers and Nahum Gershon, The MITRE Corp., as a first example solution of an Internet of People approach to Smart Cities.

The work carried out by Joel Myers has been published in international newspapers and journals such as the BBC, New York Nimes, Hong Times, the Hindu Times, Wired, and Forbes Magazine.

Presentation: HoozAround: Building an Internet of People City

The presentation makes the case for an *Internet of People (IoP)*. Whilst fully accepting that the *Internet of Technology (IoT)* has been and will continue to be a prime mover in the development of technology and universal communication, it demonstrates how the Internet and human communications through virtual communities has led to serious issues in human relationships and how technology has forgotten the importance of *face-to-face (F2F)* dialogue and contact. As technology advances, people should become the focus of molding our technology needs. The author is concerned that otherwise the future developments in technology, especially in virtual communities and AI will fail to serve the real needs of humanity. It is important that the IoP is developed and acts in balance to the IoT.

The presentation also introduces a new mobile app, **Hoozaround**, which was inspired by the IoP principles. Using proximity awareness and profile matching, it connects people face-to-face with similar interests in their immediate vicinity both indoors and outdoors, in real-time. The app is the basis for a new model for developing people-driven smart cities, called *People-Connected Cities*.

Dr. Ren Wu, CEO and Founder, NovuMind Inc., USA

Dr. Ren Wu is the Founder and CEO of NovuMind Inc, where he is leading the effort to push the frontier of artificial intelligence (AI) via high-performance and heterogeneous computing. His dream is to improve people's life using NovuMind's AI technologies.

He was the distinguished scientist at Baidu Research where he and his team have designed and built a supercomputer dedicate for deep learning, and have achieved world's best results on many image recognition tasks.

Prior to joining Baidu, Ren served as chief software architect of Heterogeneous System Architecture (HSA) at AMD. Earlier, he was the principal investigator of CUDA Research Center at HP Labs, where he is widely known for his pioneering work in using GPUs to accelerate big data analytics and large-scale machine learning algorithms.

Ren is also known for his early work on artificial intelligence. His Xiangqi (Chinese chess) program was twice world champion and have dominated computer Xiangqi field for more than a decade. He was the first person to perform systematic research computationally on Xiangqi endgames with astonishing discoveries.

Presentation: I2oT - The Era Of Intelligent Devices

New development in Artificial Intelligence has been making big headlines across many different fields lately. In computer vision for example, using techniques inspired by the human brain, Deep learning based AI system, powered by custom-designed supercomputer and trained with massive number of examples are gaining the ability to recognize objects as accurately as humans can. Artificial intelligence is more capable than it was ever before.

On the other hand, the Internet has been evolving from mobile Internet to the Internet of Things (IoT). Connected everything is changing our lives again.

The development of AI and IoT posed a serious challenge yet excellent opportunity for all of us. In this talk, Dr. Ren Wu will highlight how big data, deep learning, and high-performance/heterogeneous computing can work together - we are entering the era of intelligent devices.

Bay McLaughlin, Co-Founder & COO, Brinc

Bay is a Co-Founder of Brinc, a global IoT accelerator, manufacturing studio, and online hardware community based in Hong Kong with offices in Shenzhen, Guangzhou, London, Barcelona, and Bahrain. Having spent half of his career in or founding startups, he now brings his experience and operations abilities to connect the dots from Asia to Silicon Valley for IoT companies from around the world. He currently holds equity positions in 32 companies in 12 countries, serves on the board of Soundbrenner and Brinc, and is a contributor for Forbes and a KOL for Huawei.

Bay has supported technology startups for the last decade. Over half of this time was spent at Apple as a founding team member of their global SMB channel and as the founder of their first Entrepreneurship Evangelism channel. To support startups at Apple, Bay partnered with the world's best founders, venture capitalists, incubators and accelerators to identify and solve their most pressing strategic issues. His division at Apple has grossed more than $300M USD in sales and is still the best team globally in Apple SMB's division. The other half of his career has been spent inside of or founding startups, two of which failed, one of which exited successfully. As a regular mentor for Chinaccelerator, the Thiel Foundation, and other startup ecosystems in Asia, Bay is passionate about investing in founders with a global vision. He speaks regularly at conferences, most recently at Web Summit, Echelon, RISE, LAUNCH, SXSW, Big Salad and more.

Presentation: Why IoT Matters?

The rise of IoT and AI will fundamentally change our personal health, lifestyle, habits, environment and everything in between. By unlocking the data in the physical world, we can solve problems that have plagued humanity for generations. This means that hardware, IoT, and AI companies that help us connect and make sense of the physical world are creating the future… maybe even saving it! From issues like diabetes to car accidents and deforestation and medical adherence, IoT companies will connect and help every single human on Earth. A valuable asset that governments, corporations and investors can keep in mind to help create value to the society as a whole. This is Why IoT Matters NOW!

SC3: Session on Smart Cities (III)

Room: 4303 (130)
Chair: Marin Litoiu (York University, Canada)

SC3.1 16:00 ***On Cooperative Autonomous Vehicles in the Urban Environment: Issues and Challenges for Dropping-Off and Parking***
Seng W Loke (Deakin University, Australia); Ali Aliedani (Latrobe University, Australia)
Autonomous vehicles are set to have massive impact on our lives and urban environments. However, they are not without issues, e.g., from potentially increasing vehicles on the road to how they can cooperate for good as well as for bad. This paper examines how cooperation can be useful for dealing with congestion during drop-offs for autonomous vehicles, but could raise issues with current car parking designs.
pp. 620-623

SC3.2 16:30 ***Querying IoT Services: A Smart Carpark Recommender Use Case***
Alireza Hassani (University of Monash, Australia); Pari Delir Haghighi (Monash University, Australia); Prem Prakash Jayaraman (Swinburne University of Technology, Australia); Arkady Zaslavsky (CSIRO, Australia); Sea Ling (Monash University, Australia)
IoT-as-a-Service (IoTaaS) has emerged as a new paradigm fueled by increased deployments of Internet of Things (IoT) devices. An IoT-service is an integral part of IoTaaS that enables the interaction with the physical world. A key factor that will underpin the success of future IoT applications in order to provide greater benefits to customers is the ability of applications and IoT devices (machines) to seamlessly advertise, query, discover and combine IoT-services. In this paper, we propose an IoT-Service Description Language (ISDL), and an IoT-Service Matchmaking (ISM) approach. ISDL is an abstract IoT-Service description language and supports the definition of services in terms of their semantic signature, service characteristics, and contextual behavior specification. Further, by utilizing ISDL and ISM, we developed a framework, called IoT-as-a-Service (IoTaaS). IoTaaS enables applications to provide and consume IoT-services seamlessly without requiring manual integration of IoT silos. We exemplify and evaluate the usage of the proposed IoTaaS, via a smart city use case that highlights how IoTaaS can be utilized to discover and consume IoT-services.
pp. 624-629

SC3.3 17:00 ***A Novel Autonomous Taxi Model for Smart Cities***
N s Rajput (IIT BHU, India); Ashutosh Mishra (Indian Institute of Technology (BHU), Varanasi, India); Ilya Makarov (National Research University Higher School of Economics, Russia); Mukesh Deogune (IIT BHU, India); Amit Kumar (Iit (bhu) Varanasi, India)
Autonomous taxies are in high demand for smart city scenario. Such taxies have a well specified path to travel. Therefore, these vehicles only required two important parameters. One is detection parameter and other is control parameter. Further, detection parameters require turn detection and obstacle detection. The control parameters contain steering control and speed control. In this paper a novel autonomous taxi model has been proposed for smart city scenario. Deep learning has been used to model the human driver capabilities for the autonomous taxi. A hierarchical Deep Neural Network (DNN) architecture has been utilized to train various driving aspects. In first level, the proposed DNN architecture classifies the straight and turning of road. A parallel DNN is used to detect obstacle at level one. In second level, the DNN discriminates the turning i.e. left or right for steering and speed controls. Two multi layered DNNs have been used on Nvidia Tesla K 40 GPU based system with Core i-7 processor. The mean squared error (MSE) for the detection parameters viz. speed and steering angle were 0.018 and 0.0248 percent, respectively, with 15 milli seconds of real-time response delay.
pp. 630-633

SC3.4 17:30 ***Optimal Rebalancing with Waiting Time Constraints for a Fleet of Connected Autonomous Taxi***
Seong Ping Chuah and Shili Xiang (Institute for Infocomm Research, Singapore); Huayu Wu (Institute for Infocomm Research (I2R), A*STAR, Singapore)
A fleet of cooperative autonomous taxi is an emerging application of IoT in transportation industry. Unlike manned taxis that cruise on roads uncoordinated and often compete for passengers, autonomous vehicle can move cooperatively to transport passengers more efficiently. In this paper, we present a case study on an IoT application of new cooperative management technique for a fleet of autonomous taxi. In transportation network, optimal rebalancing allows sustainable flow of vehicle with a minimum number of vehicle to transport passengers flows in uneven directions. However, long waiting time to board a taxi during peak hours degrades quality of service. To tackle this issue, we extend recent advances in autonomous mobility-on-demand solution to incorporate waiting time policy. Specifically, we introduce stability and control of passenger's queues in the optimal rebalancing to confine the queues (thus waiting time in queues) to a specified range. We validate our new technique via data-driven simulations of a fleet of autonomous taxi by leveraging on Singapore's taxi dataset. Data-driven simulations demonstrate promising results of the new technique in ensuring efficient and low waiting time of taxi service for passengers.
pp. 634-639

SP4: Session on Security and Privacy for Internet of Things (IV)

Room: 4304 (130)
Chair: Antonio Fernando Skarmeta Gomez (University of Murcia, Spain)

SP4.1 16:00 ***Exploring Cyclic Prefix for Secret Data Transmission over LTE Networks***
Ajay Kumar Nain (Indian Institute of Technology Hydrabad, India); P Rajalakshmi (Indian Institute of Technology Hyderabad, India)
The OFDM has become a promising technology in the field of digital communication and it is adopted by multiple communication standards such as LTE, WiFi. The secure transmission of secret data through wireless channel is a desirable task in all of these communication standards. Multiple encryption based techniques have been proposed to secure the communication. However, in some scenarios, it is required to hide the mere existence of the transmission which cannot be ensured by conventional encryption based approaches due to the accessibility to encrypted text by the adversary. In this paper, we have analyzed the modification of cyclic prefix to communicate secretly over the downlink channel of LTE. The simulation results show that the cyclic prefix modification without power normalization results in large bit error rate in the main channel. The simulation results over realistic fading channel show that the secret data cannot be decoded correctly without using any spreading technique due to ISI effect with high data rate. We have proposed a new FFT based method for secret data transmission by exploring cyclic prefix and the proposed method is suitable for a realistic fading channel.
pp. 640-645

SP4.2 16:40 ***Test-based Risk Assessment and Security Certification Proposal for the Internet of Things***
Sara Nieves Matheu García (University of Murcia, Spain); José Luis Hernandez Ramos (European Commission & Joint Research Centre, Italy); Antonio Fernando

Skarmeta Gomez (University of Murcia, Spain)
This work provides a design of a certification methodology for IoT, paying attention to the test-based risk assessment phase to empower testers with the ability to assess security solutions for large-scale IoT deployments. The resulting approach is an instantiation of the Risk-based Security Assessment presented by ETSI based on the ISO 31000, and it is built on top of different technologies and approaches for security testing and risk assessment adapted to the IoT landscape. The proposed methodology is intended to be used for the different experiments that are proposed in the scope of the ARMOUR project for assessing the fulfilment of several security aspects. It is expected to be used as a baseline to build a new security certification and labelling approach for IoT devices.
pp. 646-651

SP4.3 17:20 ***Privacy-Preserving Survey by Crowdsourcing with Smartphones***
Sin Teo, Narayanan Amudha and Jianneng Cao (Institute for Infocomm Research, Singapore)
In this paper we propose a solution for privacy-preserving survey. We assume a crowdsourcing platform with a big number of registered smartphones. The platform works as a coordinator between data owners and service requestors (i.e., survey users). It shifts most workload to the smartphones of data owners, and thus is lightweighted and scalable. For privacy protection, we apply cryptography techniques to ensure that the service requestors will get aggregated survey results, but will not learn personal information of any individual data owner. At the same time, the crowdsourcing platform will learn neither the information of individuals nor the aggregated survey results. In addition, different from existing work, by which data owners pass their data to survey agency and lose control on their data, our solution stores data at their owners' smartphones and allow the owners to control how their data will be used.
pp. 652-656

TOP1b: Topical 1 - Security and Privacy Regimes - Part 2

Room: 4302 (130)

Organizers

Co-Chairs David W. Kravitz and Jeffrey Voas

Track Summary

IoT applications and prospective solutions mandate consideration of a broad set of security and privacy requirements. The explosion in the number of connected devices poses a significant challenge, as does the diversity of end uses. The World Forum will address the component and platform implications for IoT in the context of the full life cycle for security and privacy regimes. It will also address the many security architectures and approaches that have emerged from Government organizations around the world, from the Commercial Market space, and from the Research Community. Across the wide spectrum of use cases there is a need to appropriately balance security and privacy, and it is useful to think of classifications that distinguish the levels required. As an example these may be thought of as:

- Highly security-centric "life-and-death" applications such as: critical infrastructure; control systems for connected automobiles, railroads, or aircraft; emergency healthcare
- Intermediate security uses that include: smart home; routine monitoring of facilities; sports and physical exercise activities that involve tracking such as geolocation
- Lower security casual uses such as: games, entertainment, public virtual reality applications, and aspects of social media and general information services

The topics that the Presentations, Panels, and Working Group discussions, for the Track on "Security and Privacy Regimes for IoT" will cover include:

- Achieving secure compose-ability of individually secure devices and components
- Scalability (for massive number of devices, and as contributors to- and consumers of- big data)
- Device-associated robustness levels that also deal with the high variations in heterogeneity (such as stationary and mobile infrastructure, smart phones and user terminals, wearables, the wide range of possible sensors and actuator types, and embedded IoT devices)
- Device ownership and component control (accounting for interoperability, regulatory compliance, governance, audit-ability and risk management)
- Remediation for the reigning confusion caused by the proliferation of standards and certification, and the realization that IoT will create new experiences and a vulnerability surface that is not accounted for
- Testing approaches and procedures that overcome the lack of efficacious and accepted practices — These include: interfacing with and leveraging legacy devices and services; containment against expansion of compromise to other units, systems or networks; effective crypto-agility; defense against advanced threats such as quantum-computing attacks. These also include testing approaches for the differing device lifetimes, and lifecycle support of IoT solutions such as over-the-air firmware and software upgrades

One of the objectives of the Track is to launch future actions and activities that continue beyond the World Forum as part of the IoT Initiative Working Group on "IoT Security and Privacy".

Program

	Keynotes 4
10:30-11:00	**Sean Smith, Professor, Department of Computer Science, Dartmouth University** *"Securing the IoT: Critical Research Challenges"* In the current Internet of Computers (IoC), paradigms and techniques have emerged to manage security risks, at least somewhat. However, the Internet of Things is different from the IoC, and these differences cause many of these paradigms to stop working. With the deep embedding of the IoT in the physical world, the consequences may have significant physical impact. This talk surveys some areas—zero days, authentication, lifetime mismatches, and connectivity complexity—where we need new research driven by academic and industrial partnerships. Vulnerabilities seem to be inevitable in software; in the IoT, how do we reduce and manage the risk of zero days? How do we manage good software hygiene when physical devices can outlive the "use-safely-by" date of software, and maybe even the software vendors themselves? (How do we keep zero-days from turning into forever-days?) As communication channels become more open, how do we secure them—and how do we establish a key infrastructure that captures operational requirements?
11:00-11:30	**Vrizlynn Thing, Lead - Cyber Security Cluster, Institute for Infocomm Research (I2R), Agency for Science, Technology and Research (A*STAR)** *"Security in IoT"* With the growing trend of IoT device deployment and the accompanied huge market size, there is an increasing observation and occurrence of cyber-attacks by exploiting security vulnerabilities across the various highly connected devices. Security has now become the top concern for such deployment in both the consumer segment, enterprise environment and industrial settings. In this talk, I will share the key focus areas in the emerging IoT domain, highlight the security challenges, and suggest future research directions. I will also highlight some of the current and planned future IoT security works at Institute for Infocomm Research, A*STAR.
11:30-12:00	**Joe Jarzombek, Director for Government, Aerospace & Defense Programs, Synopsys, Inc.** *"IoT Supply Chain Management: Reducing Attack Vectors & Enabling Cybersecurity Assurance"* As the cyber threat landscape evolves and external dependencies grow more complex, managing risk in the IoT supply chain must focus on the entire lifecycle. IoT is contributing to a massive proliferation of a variety of types of software-reliant, connected devices throughout critical infrastructure sectors. With IoT increasingly dependent upon third-party software of unknown provenance and pedigree, software composition analysis and other forms of testing are needed to determine 'fitness for use' and trustworthiness. Application vulnerability management should leverage automated means for detecting weaknesses, vulnerabilities, and exploits. Addressing supply chain dependencies enables enterprises to harden their attack surface by: comprehensively identifying exploit targets; understanding how assets are attacked, and providing more responsive mitigations. Security automation tools and services, and testing and certification programs now provide means upon which organizations can use to reduce risk exposures attributable to exploitable software in IoT devices.
12:00-12:30	**Biplab Sikdar, Associate Professor, Department of Electrical and Computer Engineering, National University of Singapore** *"Security Solutions for the Internet of Things"* The Internet of Things (IoT) represents a great opportunity to connect people, information, and things, which will in turn cause a paradigm shift in the way we work, interact, and think. The IoT is envisioned as the enabling technology for smart cities, power grids, health care, and control systems for critical installments and public infrastructure. This diversity, increased control and interaction of devices, and the fact that IoT systems use public networks to transfer large amounts of data make them a prime target for cyber attacks. In addition, IoT devices are usually small, low cost and have limited resources. Therefore, any protocol designed for IoT systems should not only be secure but also efficient in terms of usage of chip area, energy, storage, and processing. This presentation will start by highlighting the unique security requirements of IoT devices and the inadequacy of existing security protocols and techniques of the Internet in the context to IoT systems. Next, we will focus on security solutions for the IoT, with special focus on protection against physical and side channel attacks. In particular, we will focus on mutual authentication protocols for IoT devices based on security primitives that exploit hardware level characteristics of IoT devices.
12:30-1:30	Lunch
1:30-2:00	Panel 3 - Managing: Keys, Risky Things, Cyber- and Physical- Attacks, and the IoT Supply Chain *Moderator: David W. Kravitz* *Panelists: Sean Smith, Biplab Sikdar, Joe Jarzombek, Vrizlynn Thing*
	Keynotes 5
2:00-2:30	**Rainer Matischek, Senior Staff Research Engineer, Infineon Technologies Austria AG** *"Hardware-Based IoT Security: From Research to Practical Applications"* The Internet of Things (IoT) offers countless new opportunities by interconnecting all sorts of physical devices from machines through cars to smart sensors and smart home appliances. However, the more data we share and devices connected, the greater the risk of theft and manipulation. This has recently been shown by the early rollout of insufficiently secured first-generation IoT devices. The subsequent attacks and negative headlines could have been prevented by using adequate security design. Therefore, this talk raises the awareness of future IoT system designers and device manufacturers for the following fact: The success of smart homes, connected cars and smart factories hinges on user confidence in robust, easy-to-use, fail-safe security capabilities. Furthermore, solution providers need to envision a lifecycle management of IoT devices, including secured commissioning, re-configuration and updates. To address these challenges, this talk proposes the integration and proper use of hardware-based security in future IoT devices. To finally increase and combine IoT system security and usability, proper IoT application design is necessary. Therefore, this presentation discusses useful approaches derived from state of the art research and findings of our ongoing feasibility studies.
2:30-3:00	**Jorge Guajardo Merchan, Principal Scientist and Manager, Security and Privacy Group, Robert Bosch Research and Technology Center North America**

	"Towards a More Secure Internet of Everything" The Internet of Things promises to create environments in which sensors, actuators, and people will interact seamlessly to the benefit of society. Such smart environments are also expected to create very attractive business opportunities. Yet, it is widely acknowledge that the incredible promise of the IoT will only become reality if we are able to solve the security and privacy challenges implied by the unprecedented scale of IoT systems. In this talk, I will discuss three particular technologies that my team is developing and that tackle the security and privacy challenges of the IoT in three different areas: hardware security at the sensor level, key agreement in automotive networks, and security and privacy for data outsourcing to the cloud.
3:00-3:30	**Kang Wei Woo, Executive Director, QuantumCIEL** *"IoT Security for Smart Nation - Challenges & Solutions"* With increasing connectivity through digitalization and IoT, security cannot be an afterthought; Singapore Smart Nation IoT Technical Committee has a new Technical Reference (TR) on IoT security which will be published in 2018 and highlights of this TR will be shared as part of the presentation.
3:30-4:00	Coffee Break
	Keynotes 6
4:00-4:30	**Jason Cooper, Principal Systems Architect, DarkMatter Group's Cryptographic Research & Development Division** *"Enforcing Dynamic Trust: Mimicking the Natural World"* Human instinct guides each of us. Do I know this person? Does someone I trust vouch for them? Should I continue to trust someone who betrayed me? These trust models arise naturally and change over time in response to stimuli. Our trust takes on different levels over a variety of contexts. I might trust an app with my work emails, but I don't necessarily trust it with photos of my family. We trust an online store with our banking details, until it gets hacked. We'd like to still do business with them, but without entrusting our bank information to them. The world of machines is similar. The sensors, actuators, interfaces and servers that make up a system today are configured with static trust relationships. When the server gets hacked, our systems need to adapt to the changed behavior and alter trust on the fly. The systems we design and build must be a dynamic ecosystem tolerant of failures and changing environment. Compromise of one or a few components shouldn't lead to catastrophic failure of the system. The process of creating resilient systems evolves its own tools and techniques. In the development of Darkmatter's DMLedger SDK, we've formulated many of our own. Crypto-algorithm Agility, Off-chain Asynchronous Authentication and Transaction Expiration are just a few. We'll also discuss (and, time permitting, demo) open-source tools for stress-testing and fuzzing your code, as well as how to integrate such open-ended tests into your regression test cycle.
4:30-5:00	**Angelos Stavrou, Professor and Director of the Center for Assurance Research and Engineering, George Mason University** *"Leveraging Blockchain-based protocols in IoT systems"* The Internet of Things (IoT) encompasses a wide range of processes: sensing, computation, communication, time, context, and data, to name only a few. How does all of these function as a system when using commercially available components that can be purchased from anywhere and at a low cost, and with little or no component pedigree available? To provide some practical answers to the these questions, we purchased components and created a set of small use cases to see how it all interoperated. In this talk, we will focus on use cases where the application of cryptography is not done properly or the cryptographic libraries employed exhibit security flaws. To that end, we demonstrate the need for mechanisms that will allow low-resource sensors to authenticate and exchange data in a way that does not rely on heavy cryptographic operations. We believe the need for group authentication and message integrity can be adequately satisfied using modified blockchain protocols that rely on proof-of-storage for some of the sensor operations creating groups of networked sensors that prove their membership not only using key material but also historical transactional data. Our work shows how blockchain protocols can be applied in IoT systems in a meaningful manner solving an actual need without the burden of complex operations that usually accompany the blockchain concept.
5:00-5:30	Panel 4 - Hardware, Tracking, and Transaction Immutability: From Sensors on Up *Moderator: Jeff Voas* *Panelists: Rainer Matischek, Jorge Guajardo Merchan, Kang Wei Woo, Jason Cooper, Angelos Stavrou*
5:30-6:00	Working Group - Actuation: Motivating What's Next *Moderator: David W. Kravitz*

TOP3: Topical 3 - Best Practices, Standards and Open Source - Part 1

Room: 4301A+4301B (138)

Organizers

Co-Chair Srikanth Chandrasekaran, *Senior Director - Standards & Technology, IEEE India and IEEE Senior Member*

Track Summary

The economics of IoT solutions depend on the ability to operate at scale with common components and common infrastructure that work in the same way anywhere in the world. To achieve such scale it is important to create practices, standards, and de-facto mechanisms such as open source that result in long-lived protocols and interfaces. At the same time there are significant technical challenges in developing new technologies that work across verticals and can reliably deal with the complexity inherent to IoT. The objective of the sessions on this subject is to identify areas where the IEEE can most effectively contribute to effective development of horizontal platforms and frameworks.

Program

10:30-12:30	**SDO Panel** *Moderator: Oleg Logvinov, President and CEO, IoTecha* *Panelists: Steve Olshansky, ISOC; Dale Seed, OneM2M; Rudolf Brandner, DKE; Dr. Bilel Jamoussi, ITU; Mr. Tim McGarr, BSI*
12:30-13:30	Lunch
13:30-15:30	**Technologies Session and Smart Cities Use Case** **Session Chair: Dennis Brophy, Mentor Graphics (Siemens)** **Zhao Yi, Huawei** *"Open Standards, Open Source, and Digital Transformation"* This presentation will discuss the value propositions of open standards and open source, and the challenges to align open standards and open source together. An IoT related open standards and open source landscape will be described. Views and practice on applying open standards and open source to digital transformation will be presented. **Chien Siang Yu, Certis CISCO** *"Future of IoT with Embedded AI and Its New Security Implications"* This presentation will focus on the rapid developments of new cognitive chips for running embedded AI via Deep Learning and how they will soon become mainstream capabilities for IoT, via the emergence of AI powered smart cameras, robotic and drone autonomous controls and finally next generation devices for smart building maintenance and facility management. These self learning, adaptive low power systems will revolutionise IoT systems, as they will not only be able to deliver low cost intelligence at the edge but also can collaborate well with each other by exploiting smart agents and cloud AI backends. The talk will also share performance and cost expectations, as well as new findings about how such narrow AI can make mistakes, leading to possible safety and security issues. Thus, there is a need for new standards to manage embedded AI. **Chris Steck, Cisco Systems** *"Managing 50 Billion Things"* Today, each IT person in the enterprise manages, on average, less than 250 devices. With the advent of IoT, that ratio needs to grow closer to one million to one to be manageable. This presentation will discuss how we'll get there utilizing standardized interoperable technologies in security, device management, and automated onboarding. **Koizumi Akimasa L. Crown Ltd** *"IIoT platform from Japan. Connected Industries 5.0"* Japan aims to achieve "Society 5.0" through the full utilization of technological innovation including IIoT. Japanese government has announced "Connected Industries 5.0," as a new concept framework. L.CROWN provides software platform for easy connected communication. L.CROWN focus on the Edge side so that it can collaborate with major cloud providers such as Microsoft, Amazon,GE, Siemens and Japanese IIoT vendors. Performance of existing IIoT systems in use today is "spec in" on installation and thus faces many challenges in upgrading. L.CROWN leaves troublesome information analysis to AI and human to make judgment to call on important issues. The ability of L.Crown to adapt and grow with operation as well as system needs in the most significant advantages.
15:30-16:00	Lunch
16:00-18:00	**Standards Session** **Session Chair: Sri Chandrasekaran, IEEE-SA**

	Dr. William Miller, MACT-USA Inc *"IEEE P1451-99: Standard for Harmonisation of IoT Devices and Systems"* Transducers are sensors and actuators for the Internet of Things (IoT) and encryption is a method of trust that can assure confidence. It is a challenge to deliver reliable data for decision making and control actions. This has become a concern as IoT devices are used in Smart Cities and critical applications. It is imperative that a device delivers data with the correct characteristics can be trusted. In this presentation, we discuss how encryption can be used to validate a device so data can be read or a control action can be made reliably. This is particularly important since many IoT devices today do not perform this validation. The transport layer can be encrypted, however, the data from a sensor and control of a actuator may be incorrect. This discussion also offers information needed for use of transducers in Blockchains. IoT Harmonization must address this capability since numerous devices do not offer this function. It can be added as part of device provisioning. This action with encryption can also utilize compression to conserve memory and provide assurance of the device characteristics and data integrity. This is extremely important for Smart Cities when utilizing for Transactive Energy (TE), Blockchain, Big Data, Data Analytics, and in Artificial Intelligence (AI). **Gerry Hayes, Wireless Research Center** *"IEEE P2510: Standard for Establishing Quality of Data Sensor Parameters in the IoT Environment"* Due to the rapid convergence of connectivity and the ubiquitous deployment of IoT devices, the harmonization of sensor system interoperability is needed to enhance innovation. In close collaboration with industry and academic partners, IEEE has launched two initiatives to facilitate the Harmonization of Connectivity of the Digital Citizen and the Harmonization of Sensor System Performance. This session presents an overview of the IEEE P2510 efforts that examine Sensors and Sensor Systems and the IEEE Industry Connection project that examines the Digital Citizen's connectedness from personal area networks and sensors to metropolitan scale connectedness within a Smart, Immersive City environment. **Oleg Logvinov, President and CEO, IoTecha** *"IEEE P2413: Standard for an Architectural Framework for the Internet of Things (IoT)"* The IEEE 2413 standard defines an architectural framework for the Internet of Things (IoT), including descriptions of various IoT domains, definitions of IoT domain abstractions, and identification of commonalities between different IoT domains. The architectural framework for IoT provides a reference model that defines relationships among various IoT verticals (e.g., transportation, healthcare, etc.) and common architecture elements. This standard uses the architecture description approach defined in the IEEE 42010 standard. **Steve Olshansky, ISOC** *"Internet of Things Security and Privacy: Challenges and Opportunities* The IoT is having a substantial and rapidly growing impact on the Internet and its users. Security and privacy are challenging and multi-dimensional problems as this arena expands. Attacks on devices, applications and services threaten the safety and privacy of users and their data, and attacks on IoT within critical infrastructure threaten the delivery of critical services. The IoT ecosystem is in many ways quite fragmented, and proprietary vs. open and interoperable solutions are competing in the marketplace. Standards and certification organizations are working at various levels, but codification and standardization of processes and implementations in the IoT space is an ongoing challenge. And as is often the case, technology is ahead of associated regulation and policy. This presentation will address the issues and challenges in the IoT Ecosystem, especially related to security and privacy, and potential approaches to addressing them. **Charles Despins, IEEE Green ICT** *"Green ICT: From Standards to a Green Label Certification"* The IEEE Green ICT initiative's mission statement is to build a holistic approach to sustainability by incorporating green metrics in various IEEE technical domains. This presentation will focus on the standards activity within the initiative. Current green ICT standards development within the initiative will be discussed as well as the broader goal of an IEEE green label certification.
18:00	End of Day

TOP4: Topical 4 - BlockChains and Applications

Room: 4202 (130)

Organizers

Raymond E. Cline, Jr., PhD, Lancium, LLC and Pindar Wong, VeriFi (Hong Kong) Ltd.

Track Summary

The relatively new technology behind block chains promises to create new offerings in the IoT space that dis-intermediate many of the current business models that require third party aggregators to function. The track on Block Chains is intended to provide information about developments in this new area and practical examples of applications that can benefit from the technology. Topics to be covered include:

- Block chain use in data sharing environments
- Hardening and security of block chains and IoT systems
- Novel block chain approaches for IoT
- Challenges to the adoption of block chain technology
- Infrastructure solution for block chain
- Real-world applications of block chain

In addition, there will be a presentation on a newly formed IEEE Block Chain Initiative and a working discussion on future directions and possible activities in the block chain IoT space.

Program

10:30	**Raymond E. Cline, Jr., PhD, Lancium, LLC and Pindar Wong, VeriFi (Hong Kong) Ltd.** *"Introduction*
10:35	**Pindar Wong, VeriFi (Hong Kong) Ltd.** *"How to Loan Money to Machines, Part 2"*
11:00	**Bill Tonti, IEEE Future Directions** *"Hardening the Internet of Things"* The Internet of Things (IOT) is poised to revolutionize the computing platform placing a new computing engine at both physical and virtual edges. This is in stark contrast to a current centralized cloud or decentralized server platform. The robust end to end computing model used by cloud or server models has to be made available in IOT based edge computing. One must develop a trusted computing methodology for mission critical IOT (MCIOT). MCIOT decision making and hardening from a computing perspective are the subject of this paper.
11:25	**Lewis Freiberg** *"IOTA"*
11:50	**David Tennenhouse, Chief Research Officer, VMware** *"Blockchain and IoT"* Blockchain offers the potential to re-engineer and increase the efficiency of every exchange of value that crosses organizational boundaries. How can blockchain speed the deployment and impact of IoT — and how can IoT help enable novel blockchain applications? This presentation will first discuss how blockchains can be used to enable the federation of enterprises and the creation of shared, immutable ledgers. It will then identify the key "enterprise strength" properties that are not readily supported by crypto-currency blockchains (low latency, high throughput, counterparty transparency, energy-efficiency, etc.) and how they can be attained. With that groundwork in place, the focus will shift to the intersection of IoT with federated ledgers, through the exploration of multiple opportunities for these two technologies to leverage each other's strengths. With those applications in mind, the presentation will wrap up by identifying some of the key considerations related to the operationalization of blockchain.
12:20	**Pindar Wong, Bill Tonti, Lewis Freiberg, David Tennenhouse** *"Round Table"*
12:30	Lunch
13:30	**Igor Chugunov, CEO and Founder CREDITS Blockchain Platform** *"CREDITS- A New Blockchain Generation"*

	CREDITS is an open blockchain platform with autonomous smart contracts and an internal cryptocurrency. The platform is designed to create services for blockchain systems using self-executing smart contracts and public data registry. CREDITS platform is the first completely autonomous blockchain system. The platform offers a new, extended application programming interface (API) that utilizes a Turing system capable of creating services using cycles, schedules, and unique functions. No other platform offers smart contract execution speeds near those of CREDITS. We believe that blockchain technology is suitable for financial and loan services, trade, medicine, identification, exchanges, Internet of things (IoT) services, and many other applications, some of which cannot yet be imagined. CREDITS unique blockchain technology offers paradigm-shifting capabilities to industries, applications, and users who require unmatched scalability. The addressable market for these services is estimated to be worth trillions of dollars.
13:50	**Angelos Stavrou, George Mason University** *"Leveraging Blockchain-Based Protocols in IoT Systems"*
14:10	**Asst. Prof. Greg Adamson, Enterprise Fellow in Cyber Security at the University of Melbourne School of Engineering** *"IoT, Blockchain, and Principles of Identity"* A founding characteristic of the Internet was the inability to determine who you are communicating with, captured in the 1993 meme "On the Internet nobody knows you're a dog". Before an adequate solution to this emerged, the challenge had broadened to machine-to-machine and then thing-to-thing communications. Today we have no agreed, sufficient, comprehensive, respectful solution in place, creating challenges for security, and also for dignity. This presentation will examine factors that make this challenge unique to the Internet, conditions which must be met to achieve broad if not universal adoption of any solution, and a selection of the many initiatives currently underway.
14:30	**Dr. Patrick Hung, Co-founder and CEO of Velosti Technology** *"Secure IoT Cloud Sharing with Blockchain Technology"* Storage clouds are a very efficient and convenient means to store information for many IoT applications. For example, home monitoring system may store real time video data on storage clouds. The video data are constantly analysed by Artificial Intelligence cloud, issuing alerts if there is any burglary or accident at home. Yet, our cloud data are not completely private and might be accessed by cloud providers, foreign government agencies, malicious hackers and competition. This can create very serious security and privacy issues in the future. In this talk, we will present an efficient and flexible secure storage cloud sharing scheme. The private data are encrypted on the device side using high-performance USB 3.1 hardware chip. Each data stream is encrypted and protected with a different encryption key. Using our proxy re-encryption scheme, each data stream is efficiently shared with its intended recipients only. To ensure system integrity, the certificate authority is run on blockchain technology. This secure cloud sharing technology will find important applications for many Smart City and Industry 4.0 applications.
14:50	**Adrian Kemp, Founding Partner, HoustonKemp Economists** *"Blockchain to Enhance Criminal Intelligence Information Sharing"* Adrian will be presenting on the development of a blockchain solution for the Australian criminal intelligence sector set to revolutionise how information is security shared, controlled and used between organisations. At its core, this new blockchain platform facilitates collaboration on intelligence between organisations, through sophisticated digital information controls, identity management, matching algorithms, and search and indexing tools. It creates the ideal backbone for the sharing of information when control and integrity is paramount - such as within our financial and criminal intelligence agencies. The platform uses blockchain in combination with decentralised file storage, to allow information assets to be shared, tracked, searched, matched and valued. Natural language algorithms combined with machine learning techniques facilitate collaboration between users without compromising security or need-to-know protocols.
15:10	**Igor Chugunov, Angelos Stavrou, Greg Adamson, Patrick Hung, Adrian Kemp** *"Round Table"*
15:30	Coffee Break
16:00	**Madhusudan Singh, Research Professor, Yonsei Institute of Convergence Technology (YICT), Yonsei University, Korea** *"Blockchain Oriented Trust Environment for Intelligent Autonomous Vehicle Communication"* As we know, Intelligent vehicles are almost in market and very soon, it will replace the human drivers worldwide. The intelligent vehicles are internet-connected vehicles, which is also communicating and data sharing between vehicle-to-vehicle (V2V), vehicles-to-infrastructure (V2I), and within vehicles. In such vehicle communication, they use CALM, DSRC and WAVE communication channels. This kind of machine has many security vulnerabilities such as data security, privacy, legality, trust between vehicles etc. They need a strong security mechanism to solve these challenges. However, the Intelligent vehicles are making secured through the traditional security mechanism similar to information technology security standards (ISO 27000 and family), but a risk of attacks will reach new levels of interoperability, and the independent decision-making will begin to embed complexity, security loopholes and potential "black swan" events. This type of research need to be built-in security and architectural design to protect emerging threats. However, Blockchain technology will break this traditional mechanism for data validation and facilitate a trustworthy environment creation for Intelligent vehicles. Blockchain is a secure decentralized distributed ledger. The intelligent vehicles with Blockchain can create and maintain a continuously growing data transaction blocks of cryptographically secured data records against fraudulence and tamper. Blockchain can also reduce the cost of data and unpredictability of working edge devices or connecting machines. It simplifies the development of cost-effective data transaction, where anything can be tracked and exchanged, without requiring a central body. However, security is big challenge for intelligent vehicles. This presentation will introduce the automotive cyber security: perspective, challenges, and discuss how can blockchain can provide a secure trust environment for the intelligent vehicles. Where unknown vehicles can communicate and share the data with each other's without disclosing any personal information. We have tried to present a secure trust environment model for Intelligent machines based on blockchain.
16:20	**Raymond E. Cline, Jr., PhD, Chief Mining Officer, Lancium, LLC** *"Lancium - Addressing Challenges in Infrastructure"* Lancium is working to solve two of the most prominent problems in the emerging technology space at this time. Global demand for electric power and the desire to meet this demand with "greener" generation has driven down the cost and greatly increased the deployment of renewable energy generation. The increase in renewable generation has produced in some geographies greater instabilities and resulted in increases in energy waste. Simultaneously, block chain, IoT, and general information technology infrastructure are requiring a tremendous amount of energy, at an increasing rate. Dr. Cline will present Lancium's approach to providing infrastructure solutions that balance both the needs of an increasing deployment of distributed renewable generation and providing needed capacity for block chain, IoT, information technology, and other energy demanding endeavors.
16:40	**Jim Fitzsimmons, Control Risks** *"Control Risks - A View on Block Chain Risks"*
17:00	**Madhusudan Singh, Raymond E. Cline, Jr., Jim Fitzsimmons** *"Roundtable"*
17:20	**Angelos Stavrou and Raymond E. Cline, Jr.** *"IEEE Block Chain Initiative"*
17:30	**Working Session**
18:00	**Adjourn**

TOP5: Topical 5 - Automation and Artificial Intelligence

Room: 4201A+4201B (138)
Chair: Joern Ploennigs (IBM Research, Ireland)

Organizers

Chair Joern Ploennigs

Track Summary

Artificial Intelligence and Machine Learning are essential technologies to scale with the exponential growth of IoT generated data. They enable to learn not only time series data, but, also enable new levels of audio, image, and video analytics. The devices to autonomously derive actionable insights trough contextual reasoning. In combination with novel speech and gesture based user interfaces they can support users in a new natural way in their tasks. The compact factor of IoT devices allow to add value to new application areas and the added value of AI enable novel applications and business models. This all makes this are a quickly evolving area in research and industry.

Program

	Technologies and Trends

10:30	**Joern Ploennigs, IBM Research - Ireland** *"AI for Automating IoT"* The exponential growth of IoT is creating new challenges in designing, deploying and, operating IoT systems. Machine learning and AI allow to process the data and to extract new level of insights. Scaling these solutions is challenging due to the high requirements on both methodological and domain knowledge. The talk will focus on how AI can be used to automated these processes in the life cycle of a IoT systems and create a cognitive digital twin that allows people to access insights in natural ways.
11:00	**Andy Chun, City University of Hong Kong** *"Logistics Optimization with IoT, Digital Twin, AI and Blockchains"* The logistics and transportation sector can benefit greatly from further optimization of operations to cope with growing and dynamic needs of the new Industry 4.0 world. Dr. Chun talks about potential benefits from the convergence of several fast developing technologies, such as IoT, digital twin, artificial intelligence, and blockchains. Dr. Chun will also present case studies from Hong Kong and Singapore.
11:30	**Simon See, Nvidia AI Technology Center Singapore** *"End-to-End AI Computing"* AI and IOT has been progressing very fast over the last few years. There are many applications which have adopted AI such as medical, automotive, robotics, finance and many others. Some of these reside on the edge of IOT while others are being computed in the backend. In this talk, the author will discussed the computing aspect of AI to support the diverse needs of different AI applications.
12:15	Panel Discussion
12:30	Lunch Break
	Challenges and Opportunities
13:30	**Jiewen Wu, A*STAR Artificial Intelligence Programme, and Institute for InfoComm Research** *"Artificial Intelligence for IoT Analytics: Challenges and Opportunities"* In this talk, I will give an overview of how typical Artificial Intelligence (AI) techniques are used for IoT analytics. As an example, I will elaborate how machine learning and knowledge representation can be leveraged for one case of smart transportation. In particular, semantically represented data are indispensable for explanations in predictive modelling. To sum up, I will highlight a few challenges that need to be addressed, together with opportunities for researching AI in the field of IoT analytics.
14:00	**C.K. Vishwakarma, AllThingsConnected** *"I or A.I.- Should I fear Artificial Intelligence?"* With advancements in Artificial Intelligence, Machine learning and their applications, most of the professionals, organizations and leaders are warning against the use of AI. In this talk we shall together try to find out which side you should take. Speaker will share practical examples from industry how he thinks we shall adopt power of AI with a human touch.
14:30	**Laura Wynter, IBM Research - Singapore** *"Artificial Intelligence and Automation in an IoT-equipped World"* We will discuss some of the challenges and our solutions to the problem of developing AI-based systems to solve real-world problems. Examples shall be taken from some of the projects we have done in Singapore and around the world.
15:00	Panel Discussion
15:30	Coffee Break
	Application and Ethics
16:00	**Hironobu Takagi, IBM Research - Japan** *"Realworld Accessibility* Computers have been changing the lives of the persons with disabilities. Synthesized voice helped the blind to access online services and dramatically increased their information source. Now, the new AI technologies are reaching the point where computers can help in sensing, recognizing, and understanding our living world, real-world. I will first introduce the concept of cognitive assistant for the blind, which will help them to explore surroundings and enjoy city environment by assisting their missing visual sense with integrated AI technologies. I will then introduce the latest technologies including precise navigation, and computer vision technologies, followed by a prediction of future progress with AI.
16:30	**Pamela Finckenberg-Broman and Morgan M. Broman, The RAiLE© Project** *"Human-Robotics/AI Interaction, The RAiLE© Project"* The key component of our presentation is to create a discussion around the need to establish a global, internationally relevant definition for a legal entity, that can be utilized to establish a consistent legal position for a future, more autonomous, combined Robotics/AI Legal Entity (RAiLE©). The question is will this RAiLE© - an autonomous "Robotics/AI Legal Entity" - be seen as a form of human, a machine or something else under international law? Through our initial research we have seen a growing need to look at first at the legal aspects of the interaction between two, often separate areas of our human lives affected by the technological developments within Robotics and AI, these are the workplace and the family unit. The importance of this is accentuated by the growing diversification in the interaction between Robotics/AI entities and humans in daily life, where the new technological solutions are capable of multiple different roles in our society's daily life. While our ongoing research into the legal aspects of this subject matter cannot provide all the answers, it is intended to look at the creation of a legal framework of definitions for future legislation to avoid or mitigate future potential legal disruption - i.e. when laws relating to technology usage is outpaced by the actual use of it and has a need to be adjusted and/or redefined. We want to initiate a more contextual cross-science debate around how to define, for use in legislation, the future merging of Robotics/AI into one integrated, autonomous entity. In conclusion, we propose this presentation as a platform for further discussions on the future legal aspects of Human-Robotics/AI interaction.
17:00	**Yong Liang Guan, Nanyang Technological University and NTU-NXP Smart Mobility Lab and Schaeffler Hub for Advanced Research (SHARE) at NTU** *"NTU-NXP Smart Mobility Test-Bed: A Campus-Wide Infrastructure for Connected Cars"* V2X (vehicle to everything) communication refers to a new vehicular WiFi technology that allows moving cars to communicate not just directly with each other, but also with "access points" installed on lamp poles or roadside infrastructure. This technology promises to enhance road safety, cut driving time, save fuel, augment GPS, drive big data, and enable new road pricing. International standards have been defined. Market products have emerged. In this talk, I will give an overview of a campus-wide V2X test-bed jointly developed by NTU and NXP that conforms to the IEEE WAVE standard suite, the full-stack applications that the test-bed is capable of supporting, the V2X standardization landscape, and outline some research projects related to this program.
17:30	Panel Discussion

V4: Vertical 4 - Industrial IoT (Part 1)

Room: 4305 (130)

Organizers

Co-Chairs Chung-Min Chen, Sr. Director, iconectiv, Telcordia Technologies and Ranga Rao Venkatesha Prasad (VP)

Track Summary

The digitization and automation of industrial enterprises promises to create new ways in which the cycle from concept to goods in service produces value. At the same time the application of IoT technologies also promises to significantly change the way we maintain goods and equipment in service and commensurately the use and accompanying business models. The WF will explore the ways in which IoT will impact Industrial organizations and the technologies that are likely to drive the greatest changes.

Program

13:30-15:30	Session 1. IOT State of the Industry, What's Happening	**Speakers** **Frederik Troester, BOSCH** *"Overall Architectures for Industrial IoT Implementations - Mid-Level View. A Bosch Perspective"* An overview of how Bosch sees the opportunities in IoT and the overall approach - big picture. Overall Architectures for Industrial IoT Implementations - mid-level view. Examples of

		Industrial IoT Applications - a drill down addressing requirements for success and value. Summary of challenges - what works and what doesn't. **Kan Siew Leong, Nanyang Polytechnic** *"Co-create & Co-innovate Industrial IoT Solutions with Industry"* While the benefits of implementing IoT in manufacturing is obvious, it remains a challenge for local SMEs to create and develop unique selling points for their Industrial IoT (IIOT) services fast, while solving IoT system interoperability issues and mitigating IoT security concerns of their customers. This presentation covers an introduction of IoT in manufacturing, the challenges faced by SMEs in creating and adopting them, and how several National Centres of Excellence band together to provide an eco-system service in co-creating and co-innovate customised IIoT solutions for SME. We will share some of the IIoT projects developed and adopted by SME, the unique IP created in enhancing security and location tracking of IoT nodes in manufacturing, and our experiences in executing the projects. **Seeram Ramakrishna, National University of Singapore** *"IoT and Circular Economy"* Since the first industrial revolution generations of people used to linear economy (LE) i.e. produce, use and throw. The LE model depletes materials, energy and water resources. Moreover the undesirable effects of LE on the living environment is evident around the world. Growing consumerism and urbanization raised concerns about the sustainability for future generations. Call for legislative pressure, stricter environmental laws, and coordinated efforts to move away from the LE to circular economy, CE is gaining momentum. New legislations in Europe, China, Japan, USA and Singapore put pressure on industries and businesses to bear the responsibility for environmental impacts of their products over the entire life cycles. China studied the best practices of pioneering EU countries, and passed laws to promote CE. CE oriented industrial system involves the use of renewable energy, elimination of use of toxic chemicals, elimination of waste through superior design of products, resources efficiency, re-manufacture products, recover resources at the end of service life, and innovative business models. Circular Economy (CE) concept is trending around the world with major consulting firms Accenture, Deloitte, Ernest & Young, and McKinsey publishing reports in the last two years. Accenture estimates an economic opportunity of five trillion dollars for businesses moving to the Circular Economy. Internet of Things (IoT) coupled with new technologies such as sensors, big data analytics, artificial intelligence (AI), machine learning, cloud computing, cyber physical systems, automation, and nanotechnology is an enabler of the circular economy. For example, IoT, sensors, and big data analytics help to monitor, diagnose, preventive maintenance, and reduce harmful emissions in the transportation sector. New approaches include re-design of vehicles and materials selection with environment in mind, and processes to ensure complete recycling of used vehicles. Application of augmented reality, virtual manufacturing and smart manufacturing or digital manufacturing to shorten lead-time, reduce cost, improve productivity and quality. This is applicable to land, sea, and aerospace transport systems. Similar examples are emerging in plastics, wood, paper, construction, water use, solid waste handling, clean energy generation and use, resources efficiency and productivity of manufacturing processes, agriculture, farm produce, food packaging, beverages, textiles, supply chains, and services sectors. Using these technologies garments company Zara designs and stock an outfit in its stores around the world in 20 days! Urban farming enabled by these technologies reduces the water consumption and fertilizer consumption while improving the yield and quality. More over these improved practices contribute to lowering of carbon foot print of products. New approaches integrate environmental factors to realize sustainable product design and manufacturing, and eco-friendliness of products and uses. Hybrid technologies involving IoT and CE are to increase net welfare gains with minimal negative impact on the environment and human well-being. They are expected to transform the production systems, business models, economic growth, employment, living, and sustainability. They enable the vision of smart, green and livable cities. This lecture examines how the IoT associated technologies and CE concepts will impact the industry and environment? Other questions that will be addressed include which sectors of the economy will have the most impact? Which industries and businesses will be benefited and who will be affected? What are the opportunities for innovation? What are the best practices around the world, and examples to emulate? What are the changes needed in engineering education to nurture future engineers? **Panel Discussion**
15:30-16:00		Break
16:00-18:00	Session 2. IoT Challenges	**Speakers** **Greg Bollella, VMware** *"IoT Infrastructure: What is it? How big is it? How are we going to monitor, manage, and secure it?"* When I first started looking into The IoT four years ago for VMware the community, System Integrators deploying complete IoT solutions with technologies from multiple vendors, IoT analytic solution providers, IoT PaaS providers, etc., had given only a passing thought to the compute, networking, and storage infrastructure, external to the data center, necessary to collect, filter, and transport data to analytic engines, collectively, as enterprise-grade infrastructure. I, and VMware, firmly believe then as we do now that the functional and physical components of such infrastructure must be monitored, managed, and secured just as any other component of compute, networking, and storage anywhere across an enterprise. It's become clear that IoT will change our industry in two fundamental way: 1. We'll need physical systems (currently known as IoT gateways) to de-couple the sensor, machine, or 'Thing' network from the WAN (public Internet or Enterprise WAN), and 2., the predominant direction of data flow will reverse 180 degrees (from data center-to-user to 'Thing' network-to-(a system where analytic engines can consume and analyze the data and produce value for an organization). I purposely did not use the term 'data center' in the latter part of the previous statement as many now believe that 'compute will move to the Edge'. This talk will explore both of these topics and give solid technical, financial, and business reasons that support these two fundamental shifts in our industry. Also, I'll discuss how we at VMware are producing products that will help our customers, the IT organizations of all major world-wide enterprises, be ready for the fundamental changes wrought by IoT. Ready to secure, monitor, and manage their IoT infrastructure and extract maximum ROI from IoT solutions they deploy by positioning systems at optimal locations relative to the source of IoT data streams. **Dirk Pesch, CIT, Ireland** *"Challenges for Interoperability in the Industrial Internet of Things"* Interoperability is a major challenge for the Internet of Things. A plethora of machine to machine communication standards, data formats and representations, and IoT platforms exist that are all essentially not (fully) interoperable. Each M2M standard comes with its own protocols, message formats and data representations. A number of standards bodies and industry associations are trying to standardize aspects of the Internet of Things space. However, due to the fast developing area and commercial opportunities, many companies move ahead with their own developments in the hope that they will achieve sufficient adoption of their technology so that they do not have to worry about standards. This talk will summarize the current state of the art in machine to machine communication, data formats and representations, IoT platforms and the challenges that this and other constraints pose for a wide spread adoption of the IoT in industry. We will then explore possible solutions to the interoperability issues and suggest possible paths forward. **Olivier Pfeiffer, ID Quantique SA** *"Why Quantum Technologies Matter in Critical Infrastructure and IoT"* As devices and systems in our critical infrastructures become ever more interconnected, it is increasingly important to ensure that they have adequate cryptographic protections. This is particularly challenging - yet even more essential - given the potential scalability of the attack vectors in this hyper-connected world. Action is required now, both to ensure current security, but also to prepare upgrade paths for future technology advances. The presentation will review how the emergence of new quantum technologies will impact IoT cryptographic security - both creating in new threat vectors, such as a quantum computer, as well as providing some immediate solutions. **Panel Discussion**

Thursday, February 8

Thursday, February 8, 08:30 - 10:00

KEY: Distinguished Panel on Smart Cities and Regulations

Moderated by Prof. Low Teck Seng

Room: Plenary: Melati

Plenary Panel on Policy and Regulation for IoT

The Internet-of-Things (IoT) offers immense opportunities for automation, connectivity, disintermediation and data collection, forming a cornerstone of many Smart City initiatives in both the developed and developing worlds. The increasing ubiquity of IoT applications has thrown up important issues around data rights and ownership, privacy, security, and interoperability. The impact of IoT technology on daily lives and commerce will depend on governments' and regulators' abilities to successfully navigate these issues through mechanisms like regulation, standardisation, public messaging and the use of mitigating technologies. This panel will explore common and envisaged Smart City applications of IoT, identify salient issues that might impede their uptake, and discuss next steps and regimes for resolving these issues.

Low Teck Seng - Plenary Panelist Chair at WF-IOT 2018

Professor Low Teck Seng is the Chief Executive Officer of the National Research Foundation, Prime Minister's Office, Singapore. He was previously the Managing Director of A*STAR (2010 - 2012). Professor Low was also the founding principal of Republic Polytechnic (2002 - 2008), as well as the Dean of the Faculty of Engineering in the National University of Singapore (1998 - 2000). He was the founding Executive Director of A*STAR's Data Storage Institute (1992 - 1998).

Professor Low was awarded the National Science and Technology Medal in 2004 - the highest honour bestowed on an individual who has played a strategic role in the development of Singapore through the promotion and management of R&D. He was also awarded the Public Administration Medal (Gold) in 2007 for his merit and service to Singapore. Professor Low is a Fellow of the Institute of Electrical and Electronics Engineering (IEEE) and an International Fellow of the Royal Academy of Engineering, UK.

Adam Beck - Plenary Panelist at WF-IOT 2018

Adam is Founding Executive Director of Smart Cities Council Australia New Zealand, an organisation dedicated to accelerating sustainability outcomes in cities and towns through the adoption of technology, data and intelligent design. In this role, Adam works with its member companies to help build a comprehensive smart cities policy framework for the region, accelerate the pipeline of smart cities investments, and build capacity within the marketplace.

Adam is also an Ambassador with Portland-based thinktank EcoDistricts, where he was previously Director of Innovation. During his time in the United States, Adam worked with over 55 cities to advance sustainable district development projects using a collaborative governance model to build resilience, equity and sustainability throughout North America. Before moving to the United States, Adam was Executive Director at the Green Building Council of Australia, where he was lead architect of the Green Star Communities certification system.

Before entering the mission-driven sector, Adam spent 15 years with global consulting firms, including almost a decade at Arup. He was also lecturer and studio lead in social impact assessment and community engagement at the University of Queensland for three years.

Dr. Jong-Sung Hwang - Plenary Panelist at WF-IOT 2018

Dr. Jong-Sung Hwang is a lead researcher at the National Information Society Agency, in charge of developing intelligent technology strategies such as smart city and Government 3.0. He also serves as a member of the Special Committee for Smart City, Presidential Committee for the Fourth Industrial Revolution. He was a member of the Gov3.0 Committee of the Korean government from 2014 to 2017, which designs and coordinates government innovation initiatives at a vice-ministerial level. Dr. Hwang also had worked as a Chief Information Officer of the Seoul Metropolitan Government from 2011 to 2013 and a Secretary General of the World e-Governments Organization of Cities and Local Governments (WeGO). As a CIO of Seoul, he launched the Smart Seoul 2015 initiatives in 2011 and has made Seoul the best model case for smart city recommended by the ITU. He was awarded the Order of Civil Merit, Camellia Medal by the Korean government in 2016. Dr. Hwang holds a Master's degree and a Doctoral degree in Political Science from Yonsei University in Korea.

Yasser Helmy - Plenary Panelist at WF-IOT 2018

Yasser Helmy is Head of Smart Cities Sales and Business Development for Cisco in Asia Pacific and Japan. He joined Cisco in 2005 for the creation of the Connected Real Estate business in the Middle East and was a founding member of the global Smart+Connected initiative at Cisco. Yasser has been involved in Smart City projects across Dubai, Sao Paolo, Barcelona, Nice, Jaipur, and Kyoto. Prior to joining Cisco, Yasser held management and sales roles with Hewlett-Packard, Fastlane, and SITA.

Throughout his international career, Yasser has lived in seven countries, across 4 continents. He holds a B.Sc. degree in Electrical and Electronics Engineering and speaks four languages fluently. In January 2018, Yasser relocated to Singapore from Germany with his family.

Tan Kok Yam - Plenary Panelist at WF-IOT 2018

Mr. Tan Kok Yam is the Deputy Secretary of the Smart Nation and Digital Government Office (SNDGO), in the Prime Minister's Office. In this role, he is responsible for the plans to realise impactful projects for Smart Nation, raise quality and inter-operability of Government IT and Smart systems, grow ICT-related capabilities for Government, and engage citizens and businesses to be part of the Smart Nation journey.

Mr Tan is also a Deputy Secretary in Strategy Group and oversees issues related to data, technology and climate change.

Prior to his current post, Mr Tan served in a number of other Ministries within the Singapore Public Service. As the Director of Manpower in the Ministry of Defence, he was in charge of both the human resource and national service policies of the Singapore Armed Forces. He also served previously in the Ministry of National Development and the Ministry of Education, dealing with public housing and higher education policies respectively.

Mr. Tan is an engineer by training, having graduated from the University College London in 1997 with a Bachelor in Electrical and Electronic Engineering and a Master of Science in Telecommunications. He also completed the 1-year Sloan Program at the Stanford Graduate School of Business as a Fulbright Scholar.

Mr. Rana Sen - Plenary Panelist at WF-IOT 2018

Rana is a managing director in Deloitte Consulting LLP's Public Sector practice, leading Deloitte's smart city initiative in the US and supporting Deloitte's smart city work globally. He has more than 18 years of experience in implementing and leading major government transformation initiatives in public health, human services, transportation, and finance and administration. His work with government agencies includes the development of strategic smart city roadmaps, implementation of smart transportation solutions, operations and maintenance of one of the largest civilian financial administration solutions for the federal government, and automation of long-term care case management.

Thursday, February 8, 09:00 - 13:00

EXH: Internet of Things Showcase at the Exhibit Hall

Chihhsiong Shih

Room: Exhibit Hall

The 4th IEEE World Forum on Internet of Things features a number of IoT showcases of interest to the attendees at the Exhibit Hall. The Exhibit Hall is located in the Orchard Rooms 4211-4312 at Level 4.

The Exhibit hours are:

Monday, 5 February 2018	06:00 - 21:00 (Welcome Reception)
Tuesday, 6 February 2018	09:00 - 18:00
Wednesday, 7 February 2018	09:00 - 18:00
Thursday, 8 February 2018	09:00 - 13:00

Showcase 1: A Smart Parking Guidance System *Chihhsiong Shih, Tunghai University*

We developed a smart parking guidance system for large scale parking lots. Finding an available empty slots in a busy sector of the city is always an issue for city people. Very often, it takes forever to circle around the parking lot drive way and not being able to find an empty spot. Our system includes sensors such as ultra wave and magnetic sensors mounted on the parking spot and on drive ways. The sensors work with mobile devices to guide the driver toward an empty spot controlled by the central cloud server. The cloud server is in charge of coordinating the complete guiding system. We keep track of the vehicle entering the parking lot. On each turn corner of the drive way, we give the driving direction through the mobile phone in the vocal signals. Once the vehicle parked into the slot, an LED light is turned on indicating the slot is occupied.

Showcase 2: A Smart Exercise Coach for Taichi *Chihhsiong Shih, Tunghai University*

We developed a smart coach IoT system that can guide the Taichi learning process. In a regular Taichi session, the learner generally has to follow the coach's motion in every stroke. However, it is difficult for the coach to correct the learner's stroke in every detail. Learners always miss the tempo or place their limbs in a wrong angle or places without knowing it. We place the 6-axis motion sensors on the arms and limbs of the learners. These sensors detect the inclination angle of the learners. By comparing the inclination angles to those of the coach, we are able to detect the correctness of the Taichi motion of the learner in real time. Once errors are detected, a vibration signal is given to specific parts of the learner. They then correct their motion accordingly.

Thursday, February 8, 10:00 - 10:30

CB: Coffee Break (Exhibit Hall)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Thursday, February 8, 10:30 - 12:30

AS1: Session on IoT Application and Services (I)

Room: 4303 (130)

Chair: Ahmed Khaled (University of Florida & Mobile & Pervasive Computing Laboratory, USA)

AS1.1 10:30 ***Vehicle Positioning Using WIFI Fingerprinting in Urban Environment***

Chee Wei Ang (Institute for Infocomm Research, Singapore)

Automatic vehicle navigation is commonly used in today's world with the proliferation of low-cost GNSS receivers. However, positioning inaccuracies inherent to GNSS-based positioning can reduce the application coverage. Areas such as urban canyons with limited satellite view and poor PDOP (position dilution of precision) could cause significant positioning errors. To complement the inefficacy of positioning in such urban environment, we conducted a study into the effectiveness of using WIFI fingerprinting technology to complement GNSS-based positioning for vehicle positioning in an urban environment. WIFI fingerprinting positioning complements well with GNSS-based positioning in that although there is limited satellite view in urban environment, there are an abundance of WIFI signals. In this paper, we present the results of our study conducted in the Singapore Jurong Lake District. Data collection of WIFI signals were performed using an Android APP running on a mobile device by driving around the area. The WIFI signal data are then processed and stored in a WIFI fingerprint database. A navigation APP was developed to compute the vehicle position based on measured WIFI signals and WIFI fingerprint data from the database. The vehicle position can then be displayed on a map live, just like a GNSS-based navigation device. We studied two methods of fingerprinting-based positioning. The first method uses the kNN method in which WIFI signal strengths information are taken into the positioning computation. The second method uses a simpler approach without using signal strengths. The positioning accuracies obtained using these two methods of WIFI fingerprinting are discussed. The results showed that WIFI fingerprinting-based positioning may be a feasible complement to GNSS in providing positioning for vehicle navigation in an urban environment.

pp. 657-662

AS1.2 11:00 *A Social Relationship-aware Mobility Model*
Dat Van Anh Duong and Seokhoon Yoon (University of Ulsan, Korea)
The human movement pattern is important for validating the performance of IoT services and wireless networks. Since collection of human movements in a real life requires a high cost and is not feasible at a very large scale, a lot of synthetic models of human movements are studied. However, most human mobility models were based on simple ideas and could not reflect realistic human movements. A few human mobility model tried to capture human movement characteristics that flights, inter-contact times (ICTs), and pause-times follow the truncated power-law distributions. Unfortunately, even such models could not fully reflect realistic human movements due to lack of consideration for social relationships among people. To address this limitation, we propose a novel human mobility model, social relationship-aware mobility model (SRMM), which considers the social relationships among people as well as the human movement characteristics. SRMM takes a social graph as an input and forms social user groups. The movements of users are determined taking into consideration users' social group and the distribution of visiting places. The proposed model is compared with a real trace and other mobility models, and the results show that SRMM can reflect both social relationships and human movement characteristics.
pp. 663-668

AS1.3 11:30 *IoT Lighting Towards a Connected Building Eco-System*
Ashish Pandharipande and Meng Zhao (Philips Research Laboratories, The Netherlands); Emmanuel Frimout and Paul Thijssen (Philips Lighting, The Netherlands)
Greater adoption of light emitting diodes and integration of information and communication technologies (ICT) is transforming lighting into the Internet-of-Things (IoT) era. In this paper, we outline the role IoT lighting can play in a connected building eco-system. We present a generic IoT lighting system architecture, and explain how lighting systems can serve as a provider of both lighting and non-lighting data. A system control and data web services model is then proposed through which a third-party can access lighting system data. We finally provide examples of new applications and services enabled with IoT lighting data.
pp. 669-674

AS1.4 12:00 *A Framework for Inter-Thing Relationships for Programming the Social IoT*
Ahmed Khaled (University of Florida & Mobile & Pervasive Computing Laboratory, USA); Sumi Helal (Lancaster University, United Kingdom (Great Britain))
We argue that for the realization of innovative IoT scenarios, the application development environment should not be based only on the things' services but also on the relationships that may tie these services together opportunistically. In this paper, we propose an inter-thing relationships programming framework as basis for a distributed programming ecosystem. The framework broadens the thing-level relationships of the evolving social IoT paradigm and extends the limited set of relationships utilized in current technology with a set of service-level relationships. Such relationships describe how thing services can be combined to build meaningful IoT applications. We discuss prerequisite roles for thing, vendor and developer as the three main actors of the framework and finally demonstrate the features of the framework through a proof-of-concept application.
pp. 675-680

LOC: Session on Location and IoT

Room: 4204 (130)
Chair: David W Kravitz (DarkMatter, USA)

LOC.1 10:30 *Understanding the Quality of Calibrations for Indoor Localisation*
Ryan McConville, Dallan Byrne, Ian Craddock, Robert J Piechocki, James Pope and Raul Santos-Rodriguez (University of Bristol, United Kingdom (Great Britain))
The efficient and effective deployment of Internet of Things (IoT) systems in real world scenarios remains a challenge, particularly in applications such as indoor localisation. Various methods have been proposed recently to calibrate localisation systems, ranging from precise but time consuming processes to those involving little explicit calibration based on a crowdsourced collection of data over time. However it is not clear how to estimate and compare the quality of a specific instance of a calibration. In this paper we present a simple yet effective method of calibrating a Smart Home in a Box (SHiB) together with a framework to combine calibrations while assessing their quality. Our empirical results demonstrate that our calibration method can be performed by untrained users in a short period of time yet is capable of up to 92% accuracy in room level localisation on free living experimental data.
pp. 681-686

LOC.2 11:10 *Single LED Ceiling Lamp Based Indoor Positioning System*
Ayesha Naz (Comsats Institute Of Information And Technology & Lahore University of Management Sciences, Pakistan); Naveed Ul Hassan and Muhammad Adeel Pasha (Lahore University of Management Sciences, Pakistan); Hafiz Asif (Comsats Institute of Information Technology Lahore, Pakistan); Tariq M Jadoon (Lahore University of Management Sciences, Pakistan); Chau Yuen (Singapore University of Technology and Design, Singapore)
In this paper, we propose a novel visible light communication (VLC) based indoor positioning system (IPS). In such systems, to minimize the harmful flickering effects due to intensity modulation of LED lamps, our proposed design only requires a single LED ceiling lamp and multiple photodiodes (PDs) at the receiver. We propose an ON/OFF switching frequency pattern of our single LED ceiling lamp that allows the use of time difference of arrival (TDOA) based positioning algorithm. The localization accuracy achieved by our proposed design is very high and the error in the estimated position of a receiver is only few millimeters (mm). This performance is comparable to the IPS systems that rely on multiple LED lamps. We also consider different arrangements of photodiodes at the receiver. Simulation results reveal that in terms of localization accuracy, circular arrangement of PDs outperforms all other considered configurations.
pp. 687-692

LOC.3 11:50 *Self Calibration of the Anchor Nodes for UWB-IR TDOA Based Indoor Positioning System*
Ankush Vashistha, Ankur Gupta and Choi Look Law (Nanyang Technological University, Singapore)
The problem of anchor nodes placement in indoor positioning systems is labour intensive and time consuming process. A novel self calibrating scheme is proposed to determine the position of the anchor nodes using Ultra-Wide band impulse radio (UWB-IR). These position can be further used to determine the position of the target nodes. The time difference of arrival measurement technique is employed to self calibrate the anchor nodes. The proposed scheme is verified with the simulation results, as well as with an in house designed sensor nodes experimental setup.
pp. 693-698

TM1: Session on Broadly Applicable IoT Techniques and Methods (I)

Room: 4304 (130)
Chair: Shili Xiang (Institute for Infocomm Research, Singapore)

TM1.1 10:30 *A Low Cost Omnidirectional Relative Localization Sensor for Swarm Applications*
Anton Kohlbacher (Lulea University of Technology & Monash University, Sweden); Kevin Acres (Monash University, Australia); Jens Eliasson (Luleå University of Technology, Sweden); Hoam Chung and Jan Carlo Barca (Monash University, Australia)
By enabling coordinated task execution and movement, robotic swarms can achieve efficient exploration of unknown environments. In this paper, we propose a relative localization sensor system using Ultra-wideband (UWB) radio technology for ranging. This system is light-weight and relatively indifferent to the types of surrounding environments. Infrastructure dependency such as the requirement of beacons at known locations is eliminated by making an array of sensors on a swarm agent. In this paper, a novel algorithm is implemented on hardware with limited resources and compared to a more traditional trilateration approach. Both utilize Particle Swarm Optimization (PSO) to be more robust against noise and to achieve similar accuracy. The experimental results show that the proposed algorithm runs up to ten times faster than the existing trilateration approach. The sensor array which forms the localization system weighs only 56g, and achieves around 0.5m RMSE with a 10Hz update rate. Experiments show that the accuracy can be further improved if the rotational bias observed in the UWB devices are compensated for.
pp. 699-704

TM1.2 11:00 *Budget-Hub: A Low Cost IoT Hub Selection and Neighbor Assignment Scheme*
Deepika Pethaperumal and Yang Peng (University of Washington Bothell, USA); Hua Qin (Hunan City University, P.R. China)
In cloud-based IoT systems, gateway devices (hubs) are central to connect front-end IoT devices and back-end cloud services. Traditionally, research on hub selection and configuration focused on optimizing the network energy consumption for long-term operations; however, the billing cost on using cloud services has became a pressing problem for sustainable operation of an IoT system with cloud computing back-end. In this paper, we formalize this problem as a cost-minimization neighborhood configuration problem and prove its NP-completeness. To solve this problem, we propose a novel solution called Budget-Hub, which can make economical decisions on selecting hub devices from an IoT network and assigning neighbor devices to each hub, so that the long-term billing cost on using cloud services can be reduced and the desired network connectivity can be maintained. Extensive simulation experiments have been conducted to evaluate the Budget-Hub scheme, and the results demonstrate that the proposed scheme can significantly reduce the overall system billing cost under different network settings and cloud service billing models.
pp. 705-710

TM1.3 11:30 *Towards Low-Energy, Low-Cost and High-Performance IoT-based Operation of Interconnected Systems*
Benjamin Karg and Sergio Lucia (Technische Universität Berlin & Einstein Center Digital Future, Germany)
The advent of new communication standards for the Internet of Things (IoT), such as Sigfox or NB-IoT, opens a new set of possibilities that enable low-power communication between a large number of devices. New challenges such as very low data-rates are associated to these new technologies. This work shows that the combination of limited low-power communications and low-cost microcontrollers does not necessarily mean that simple, suboptimal strategies should be used to operate the cyber-physical-systems on which IoT devices are installed such as smart buildings and smart cities. In particular, predictive approaches based on numerical optimization, efficiently implemented on low-cost microcontrollers, counteract some of the shortcomings of low-power communication technologies and can enable the full potential of the internet of things. We present how low-power, low-cost solutions running advanced control and operation algorithms could be deployed and show the advantages of the proposed idea using Sigfox communication and simulation results for the temperature control of a smart building.
pp. 711-716

TM1.4 12:00 *Optimization Based Self-Localization for IoT Wireless Sensor Networks*
Paul Beuchat (ETH Zurich, Switzerland); Henrik Hesse (University of Glasgow, Singapore); Alexander Domahidi (Embotech GmbH, Switzerland); John Lygeros (ETH Zurich, Switzerland)
In this paper we propose an embedded optimization framework for the simultaneous self-localization of all sensors in wireless sensor networks making use of range measurements from ultra-wideband (UWB) signals. Low-power UWB radios, which provide time-of-arrival measurements with decimeter accuracy over large distances, have been increasingly envisioned for real-time localization of IoT devices in GPS-denied environments and large sensor networks. In this work, we therefore explore different non-linear least-squares optimization problems to formulate the localization task based on UWB range measurements. We solve the resulting optimization problems directly using non-linear-programming algorithms that guarantee convergence to locally optimal solutions. This optimization framework allows the consistent comparison of different optimization methods for sensor localization. We finally propose and demonstrate the best optimization approach for the self-localization of sensors equipped with off-the-shelf microcontrollers using state-of-the-art code generation techniques for the plug-and-play deployment of the optimal localization algorithm. Numerical results indicate that the proposed approach improves localization accuracy and decreases computation times relative to existing iterative methods.
pp. 717-722

TOP2: Topical 2 - Smart Cities and Nations (Policy and Regulations)

Room: 4201A+4201B (138)

Organizers

Co-Chairs Shawn Chandler and Roberto Saracco

Track Summary

All cities are complex systems, balancing available resources to best exploit the value that can be provided to the population. Technology advances are continuously redefining this balance. At the same time economics and regulatory aspects play a major role in fostering the adoption and deployment of Technology and are a key ingredient in the decision making that translates potential into reality. This Vertical, on Smart Cities and Nations, takes a global view of the current status and discusses the paths forward, taking into account the new possibilities opened by the Internet of Things.

The Internet of Things is proving that the sensing of processes, infrastructure, and city control systems, and the gathering of data is a basis for improvement and innovation. It enables the monitoring of conditions and performance of city functions and the subsequent fact based analyses results in the awareness of the city status. This in turn leads to better planning and the execution of actions that can steer the Cities' evolution, bettering the use of resources and the well being of its citizens.

Session 4: Smart Cities Policy and Regulation I

Smart City data collection from fixed sensor networks, mobile platforms and other sources will benefit residents through direct improvements to operations, including enhanced planning between agencies, and methods to permit industry and residents to inform and set expectations about factors influencing quality of life. This session will address improvements and best practices for services, including public safety, distribution networks, environmental monitoring, and planning.

Session 5: Smart Cities Policy and Regulation II

Smart Cities are collections of people, technology, and infrastructure working together to deliver many benefits. Ideally, guiding the delivery of these benefits are a set of standards to align technology and reduce costs, as well as allow for the novel creation of new services and spurring innovation that is usable and compatible with other systems over time. This session will address standards for IoT, applications for Smart Cities, as well as an extended panel discussion with audience participation about the Internet of People, concerning the intersection of smart cities and social networking.

Session 6: IEEE Internet of Things - Smart Cities Working Group Meeting

This session is the foundational session of the IEEE IoT Smart Cities Working Group, developing an agenda for Working Group matters of discussion, and laying out a roadmap for future activities. You are invited to join and become an active member of the Working Group!

Program

10:30am	Session 4	**Mirko Florindo, BT Global Services** *"Smart Safety in Smart Cities: A Concrete Solution"* "Smart Safety in Smart Cities", based on BT-Comunica Italia Alert System, is able to collect data from multiple sources, correlate them, define the risk level and quickly alert security forces and/or citizens in case of crisis situations such as natural disasters or terrorist attacks, and also manage timely assistance. The talk leverages on experiences from the field and aims at showing practical approaches to this crucial aspect.
11:00am	Session 4	**Professor Woon-Seng Gan, Centre for Infocomm Technology in the School of Electrical and Electronic Engineering in Nanyang Technological University** *"Smart Audio Sensing for Environmental Deployment"* With the availability of low-cost, sensing and processing components, we are seeing deployment of smart audio sensors in outdoor environmental monitoring. Audio information provides another dimension to surveillance and monitoring. For example, audio events give extra information on specific incidents; know the precise moment specific sound event happens; and allows us to trigger camera nearest to the incident. In this work, we developed a web-based audio intelligence monitoring at the edge (AI-ME) that can be deployed in indoor environment to recognize activities of elderly staying in alone or in elderly home. AI-ME uses acoustic signal processing with deep learning techniques to learn and understand everyday sound patterns (just like human learn to recognize sound from examples). In addition, putting the AI-ME technology into edge devices means that audio analytic do not have to rely on central server, saving on cost, increasing flexibility and scalability; also can retrofit on legacy devices, like camera. Additional video bandwidth can be saved as there is no need to stream in full high quality all the time; only when a desired sound is detected.
11:30am	Session 4	**Ghee Leng Ooi, Data-Enabled Scalable Research Laboratory, HKUST** *"The Four Pillars of a Smart City: Agreements, Trusts, Agnostic Infrastructure and Audit Trails"* Smart City is not about money; if it is, the future would have been already here, considering the amount of resources nations already threw at the vision. In this talk, we delve into the very reasons why Smart City is hard to implement, and contend that if nations want their cities smart, they should find their Smart City blueprints on top of the four pillars: agreements, trusts, agnostic infrastructure and audit trails. The first pillar solves the incentive misalignments among sensor vendors, contractors and back-end service providers through service level agreements, binding all parties to deliver a long-term, well-maintained and integrated physical and digital solutions. The second pillar solves the potential security threats lurking behind a connected city through end-to-end root-of-trusts in the infrastructure, with suggestions on how nations can assume the role of an overseer of public security from the ground up. The third pillar solves the scalability problems of customized data collection backends and protocols through a flexible and agnostic data collection infrastructure, so that cost and manpower do not get exponentially expensive as deployment scales. The final pillar deals with the assumption that once collected, every data point carries its legal weight. Therefore, we implemented a spatio-multitemporal database to document an immutable audit trail of all processes, from data creation to ingestion to transformation to queries, so that every single commit and change is recorded and version-controlled. All the experiences shared will be referenced to our works with different government bureaus and institutions in Hong Kong and Taiwan for the past 6 years. We contend that when all parties are bound to agreements, when data collection backend is flexible enough to accommodate deployment scaling, when the data collected are trustworthy and leave immutable audit trails, then will Smart City be truly maintainable and secure.
12:00pm	Session 4	**Dale Seed, InterDigital, Inc.** *"Future Proof Planning for Smart City Deployments"* Smart Cities represent one of the most challenging IoT deployment use cases. A typical Smart City consists of a diverse collection of sub-systems (traffic, emergency services, water and sewer, parking, etc). Interworking these sub-systems together with one another such that information can be shared between them is a key requirement for enabling more innovative Smart Cities use cases. However, there are several challenges to interworking these different sub-systems together. For example, in many cities each sub-system typically has its own legacy platform that is used to manage the sub-system. These legacy platforms are deployed separate and independent of each other, making interworking between them difficult. In addition, the large investment in these legacy platforms and high cost to replace them prevents city planners from swapping them out for newer technologies. oneM2M is a horizontal service layer standard that supports interworking different legacy technologies together with one another. Hence oneM2M provides a fast-track and future proof solution for IoT deployments that enables interworking of Smart City sub-systems together with one another. This talk will elaborate on the value propositions that the oneM2M standard provides for Smart Cities and will present some real-world deployment experiences of deploying the oneM2M standard within InterDigital's Chordant IoT platform.
12:30pm		Lunch Break
1:30pm	Session 5	**Bilel Jamoussi, International Telecommunication Union** *"Standards for the Internet of Things - Applications for Smart Cities"*
2:00pm	Session 5	**Nahum Gershom, The Mitre Corporation and Joel Meyers, HoozAround** *"The Internet of People: How Smart Cities and the IoT Can Provide a New Model for Business and Social Networking"* **1 Hour Session**
3:30pm		Coffee Break
4:00pm	Session 6	**IEEE IoT Smart Cities Working Group Meeting** *Moderator: Shawn Chandler, Navigant Consulting, Inc.* This session is the foundational session of the IEEE IoT Smart Cities Working Group, developing an agenda for Working Group matters of discussion, and laying out a roadmap for future activities. You are invited to join and become an active member of the Working Group!

TOP3: Topical 3 - Best Practices, Standards and Open Source - Part 2

Room: 4301A+4301B (138)

Organizers

Co-Chair Srikanth Chandrasekaran, *Senior Director - Standards & Technology, IEEE India and IEEE Senior Member*

Track Summary

The economics of IoT solutions depend on the ability to operate at scale with common components and common infrastructure that work in the same way anywhere in the world. To achieve such scale it is important to create practices, standards, and de-facto mechanisms such as open source that result in long-lived protocols and interfaces. At the same time there are significant technical challenges in developing new technologies

that work across verticals and can reliably deal with the complexity inherent to IoT. The objective of the sessions on this subject is to identify areas where the IEEE can most effectively contribute to effective development of horizontal platforms and frameworks.

Program

	Smart Cities Use Cases
10:30-12:30	**Session Chair: Dennis Brophy, Mentor Graphics (Siemens)** **Fahd A Banakhr, Yanbu Research Center (Saudi Arabia)** *"Royal Commission of Yanbu Build a Better Connected Smart City"* Yanbu Industrial City is the 3rd largest global refining hub with a capacity more than 1.1 million barrels per day and largest oil shipping port on the Red Sea. The Industrial production capacity of 131 MMtones/year, and the average annual growth rate of private sector investment is 18%. This paper will discuss the development of Yanbu Industrial City to become the first Smart City in Saudi Arabia and how build a better connected active network. Moreover, the paper will discuss the using the Internet of Things (IoT) in its Colleges as a Smart Campuses. **Terence Siau, Cloud Security Alliance (Singapore)** *Cyber Security Guidelines for Smart City Technology Adoption* A smart city is an urban area that uses different types of electronic data collection sensors to supply information used to manage assets and resources efficiently. This includes data collected from citizens, devices, and assets that is processed and analyzed to monitor and manage traffic and transportation systems, power plants, water supply networks, waste management, law enforcement, information systems, schools, libraries, hospitals, and other community services. The smart city concept integrates ICT, and various physical devices connected to the network to optimize the efficiency of city operations and services and connect to citizens. This talk will share the CSA's view on the Cyber Security Guidelines for Smart City Technology Adoption. **Dr. Nestor Michael Tiglao** *"Transactive Energy Infrastructure for Quezon City, Philippine"* Transactive Energy (TE) is a promising mechanism to support bidirectional communications and maintain a reliable and efficient energy balance in a Smart Grid. In this talk, we will present the vision and the proposed architecture for a TE infrastructure in Quezon City, Philippines. We will also discuss the main issues and challenges related to TE deployment. **Cathy Yeh, Microsoft Inc.** *"Accelerating Industrial 4.0 with Connected IoT Ecosystem"* Asia used to be hub of manufacturing, recently the most manufactures are facing dramatically challenges and keen to change the production models from mass production to mass customization and the interoperability is key in the new digital era. During this session, we'll address Microsoft's strategy on realizing digitalization transformation in manufacturing with supporting OPC UA, also sharing our practices on OT/IT integration in commercial and public segments.

V4: Vertical 4 - Industrial IoT (Part 2)

Room: 4202 (130)

Organizers

Co-Chairs Chung-Min Chen, Sr. Director, iconectiv, Telcordia Technologies and Ranga Rao Venkatesha Prasad (VP)

Track Summary

The digitization and automation of industrial enterprises promises to create new ways in which the cycle from concept to goods in service produces value. At the same time the application of IoT technologies also promises to significantly change the way we maintain goods and equipment in service and commensurately the use and accompanying business models. The WF will explore the ways in which IoT will impact Industrial organizations and the technologies that are likely to drive the greatest changes.

Program

10:30-12:30	Session 3. IIOT vs. Industry 4.0	**Aaron Voon-Yew Thean, National University of Singapore** *"How's IoT Different from Internet and How It May Be the Same: A Technologist's View"* We assume that as hardware and data communication technologies become increasingly accessible and commoditized, the embedment of these technologies into all things of our lives should naturally follow. Billions of connected devices serving up massive quantity of data would allow us to optimize with high precision, our resources, productivity, and work. Although IoT will improve society technologically, do we really understand the business model to fuel the movement? Technology diversity tend to come with increased accessibility. Hardware-wise, the Internet-of-Things is inherently more fragmented and diverse than our current Internet technologies. It seems that low-cost high-mix electronics dominate the edge applications. Technology businesses that fueled the internet infrastructure growth, like Semiconductor and Electronics Manufacturing, may find it challenging to capitalize on this growth with their traditional high-volume manufacturing approaches. Hence, we see a growing call for platforms, standards and ecosystems to be defined. These will likely have to be in the context of new internet services, enabled by these connected devices. In this presentation, we will look at some of the key technology convergences that led to the acceleration of the Internet before IoT and how new convergences (E.g. Machine Learning, 5G Communications, Smart City, Precision Medicine, Wearables, Etc.) may lead similarly the IoT acceleration. Looking at the value chain of the Internet today, online services provide significant business opportunities. Will this be different or the same with IoT? How will hardware technology keep up while being commoditized and who will make the money? New IoT services enabled by new hardware and software innovation will likely be necessary to drive the IoT economy. We will examine selected technologies (E.g. Semiconductors, Wireless, Artificial Intelligence, Wearables, Etc.) and their potentials towards a new convergence and the technological challenges still to be overcome. **Sumei Sun, Institute for Infocomm Research, A*STAR** *"Cognitive Industrial Internet of Things"* Industrial internet of things (IIoT), by providing connectivity to machines, robots, and sensors, etc, enables data intelligence-assisted information technology (IT) and operation technology (OT) convergence, and is a key technology in industry 4.0. In IIoT, multi-disciplinary research on communications, storage, computing and data analysis, control and management, and security, as well as cross-disciplinary system-level design optimization is needed, with built-in autonomous learning and adaptation capabilities. In this talk, we will start with a brief introduction to IIoT, and then share the IIoT research and design challenges. A design approach will then be proposed to overcome these challenges, under the theme of cognitive IIoT in which the device and the network will build up learning capabilities for context-aware resource, interference, and mobility management, automated fault detection and recovery, and robust connectivity; multi-modal security detection capability is incorporated into the device and network for real-time anomaly and security detection and management. The interactive and cooperative edge-cloud analytics will also be introduced to enable low-latency real-time actionable insight and robust feature engineering. **Shigeyoshi Shimotsuji, Software & AI Technology Center, Toshiba Digital Solutions** *"Industrial AI: Route to the Next Stage of IoT"* Industries are digitally transforming like never before and at record speed. One of key drivers is IoT, which collects digital data and converts them to user's value. The first wave of IoT visualized the state of machines and realized new applications such as condition-based maintenance to manage and operate them efficiently. It was applicable to only expensive devices and machines because of the balance between system investment and returns. The evolution of IoT technologies, particularly AI, expands applications from an individual expensive machine and group of devices in a premise to cities and communities to solve social issues such as urbanization, energy/CO2 issues, aging and labor shortage. This session will share how IoT technologies accelerate the transformation in industry segments and highlights how AI technologies expand of the transformation along with a couple of examples. **Panel Discussion**
12:30-13:30		Lunch
13:30-15:30	Session 4. IOT Case Studies, Lessons Learnt	**Speakers** **Po-Chou Lin, Chunghwa Telecom** *"IoT Development in Chunghwa Telecom (CHT)"* In the next presentation, Dr. Lin will give a talk about the IoT Development in Chunghwa telecom. First the IoT policy of Taiwan government is introduced. IoT Opportunities and Challenges for telecom companies are analyzed. CHT also develops its own IoT platform to build up the ecosystem. In the end, several IoT applications based on this IoT platform are discussed. **Michael Karner, VIRTUAL VEHICLE Research Center, Graz, Austria** *"Smart Wireless Solutions - Building Trust in the Internet of Things"* *The first part of the presentation will give a comprehensive summary of use cases, results, and expected socio-economic impacts of the DEWI project.* Smart wireless systems (wireless sensor and actuators networks, WSNs) have a number of explicit advantages over wired solutions. However, wired technologies still dominate, mainly due to the lack of dependability of wireless networks.

		Therefore, in 2014 the large pan-European R&D project DEWI was launched, focussing on dependable solutions for WSNs and short-range communication (TRL 4-5). With its four industrial domains (Aeronautics, Automotive, Rail, and Building) and 21 industry-driven use cases / applications, DEWI aimed at providing and demonstrating key solutions for wireless seamless connectivity and interoperability, by considering everyday physical environments of citizens in buildings, cars, trains and airplanes. DEWI, with 58 industrial and research partners from 11 European countries, created a universal cross-domain reference architecture, fully compliant with international standards (ISO/IEC) and thus fostering reusability, scalability, and interoperability of DEWI solutions (and beyond). Besides creating 30 re-useable technical building blocks, DEWI focussed on the scalability of all its solutions. Key results of DEWI were made tangible via 20 attractive real-life demonstrators all over Europe. *The second part of the presentation will give an overview of the SCOTT project, will highlight issues of trust and trustability in the Internet of Things, and will present first project results.* Creating trust in wireless solutions and increasing their social acceptance are major challenges to achieve the full potential of the Internet of Things. Therefore, SCOTT - Secure COnnected Trustable Things, a pan-European effort with 57 key partners from 12 countries (EU and Brazil), will provide comprehensive cost-efficient solutions of wireless, end-to-end secure, trustworthy connectivity and interoperability (Technology Readiness Level 6-7) to bridge the last mile to market implementation. SCOTT will not just deal with ‚things that are connected', but with ‚trustable things that securely communicate', i.e. things interconnected by dependable wireless technology and valuing the end-users' privacy rules. SCOTT uses a standardized multi-domain reference architecture, created in a predecessor project (DEWI and its "Bubble concept") and being fully compliant with ISO 29182 - Sensor Network Reference Architecture, which fosters reusability, scalability, and interoperability of SCOTT solutions. SCOTT also utilizes a clearly use-case driven approach with 15 use cases from different areas of high relevance to European society and industry; a specific focus will be put on cross-domain use cases and heterogeneous environments, emphasizing 5G and cloud computing aspects to build up digital ecosystems to achieve a broader market penetration. Use Cases will be further substantiated by the development and utilization of nearly 50 technical building blocks for security/safety, distributed cloud integration, energy efficiency/ autonomy of devices and reference architecture/implementations, which are all necessary to realize the SCOTT use cases and facilitate composability of systems as well as cross-domain sharing of trustable wireless technologies and services. SCOTT will open up new market opportunities for industry, will significantly reduce time to market and decrease costs for trustable wireless solutions on the market, in particular by using new designs and technical building blocks. SCOTT will develop methods and tools capable of meeting prospect use-case requirements on reliability, robustness, security and functional safety even in harsh and/or not trusted environments. SCOTT will build up and apply a comprehensive, dedicated Trusted System Development Framework to all its use cases to significantly foster acceptance of SCOTT solutions on the market, and to unleash the full potential of the Internet of Things. **Nirupam Sannagowdara Dasappa, Senior Scientist & Programme Director, IoT Energy Research Institute at NTU, and Co-Founder & CTO Printed Power Pte Ltd** *"The 'How' Industrial IoT - Setting Yourself Up for Success"* Internet of things (IoT) is a smart technology that connects anything anywhere at any time. Such ubiquitous nature of IoT is responsible for draining out energy from its resources. Therefore, the energy efficiency of IoT resources has emerged as a major research and development issue. In this talk, sharing an information on implementation effort of proposed energy-efficient architecture for IoT, which consists of several layers, namely, sensing and control, information processing, and presentation. The architectural design allows the system to integrate energy harvesting/self powered battery, ultra-low power sensors, robust radio's etc. This mechanism allows the energy-efficient utilization of all the IoT resources. The experimental and deployment results show a significant amount of energy saving in the case of sensor nodes and improved resource utilization of cloud resources. Also, outlining the challenges related to edge computing, connectivity, data visualization, modeling and deployment of IoT applications and potential research directions in resolving these challenges.
15:30-16:00		Break
16:00-18:00	Session 5. Round Table Discussions	**All Speakers and Participants** 1. Unlocking Digital Transformation through Industrial IoT 2. Embracing Innovation Across Industrial IoT 3. IIoT and its future: Research, Developments, Products & Service

V5: Vertical 5 - IoT for Agriculture

Room: 4302 (130)

Organizers

Mehmet Can (Jon) Vuran

Track Summary

The growth of the World Population is projected to exceed 10 Billion people by 2035, That combined with the increasing affluence of our planet's inhabitants indicates that by 2035 the demand for food will roughly double. The WF will explore how IoT technologies can contribute to meet the food demand of the world's population through improvements in yield and efficiency. Agriculture is a vertical that has many aspects and many specialties where IoT is important. The aspects include the operation of agricultural equipment; hydrology and irrigation; pest and invasive species control; management of facilities; and preservation of land and soil. Examples of specialties include arable crops; animal husbandry; aquaculture and fisheries; forestry; natural materials for consumer and industrial products; cash crops; and fruits and vegetables.

Program

10:30-11:15	**Mehmet Can Vuran** *"Overview in IoT in Agriculture"*
11:15-11:45	**Jack Ng, CEO of Sky Greens Pte Ltd** *"Farm to Table - From a Yuppie Trend to a Future Norm"* • An introduction of Sky Greens - a pioneering vertical farming technology • Current IoT application in SMART greenhouses • How IoT and change in consumer buying behavior will shape farming landscape and overcome food loss challenge
12:00-12:30	**Panel Discussion** *"Opportunities in Challenges in IoT for Agriculture"*
12:30-13:30	Lunch
13:30-14:00	**Silvia Maria Fonseca Silveira Massruhá, General Director of Embrapa Agricultural Informatics** *" IOT Perspectives in Brazilian Agriculture: From Biotechnology to Big Data for Sustainable and Smart Agriculture* The Brazilian Agricultural Research Corporation, Embrapa, was founded in 1973,and is under the aegis of the Brazilian Ministry of Agriculture, Livestock, and Food Supply. Since the foundation and with partners from the National Agricultural Research System, they have taken on the challenge to develop a genuinely Brazilian model of tropical agriculture and livestock to overcome the barriers that limited the production of food, fiber, and fuel for their country. This effort has helped to change Brazil. Nowadays, Brazil's agriculture is one of the most efficient and sustainable ones in the planet. This presentation will include implementation strategy of how Brazil will introduce IOT in tropical Agriculture, what are some of the new technologies developed by Embrapa (Brazilian Agricultural Research Corporation), and new cooperative initiatives.
14:00-14:30	**Vladimir Crnojevic, BioSense Institute** *"Internet of Agriculture"* Data is the new gold - new economy is the data economy and this holds for agriculture as well. Over the last century we have gone from 1B people on the planet to 7B, primarily due to abundance of food caused by two revolutions in agriculture - machinery and chemicals. This trend is continuing and expected population of 10B requires new revolution - Agriculture 4.0, based on Industry 4.0 where data plays the major role. New sources of data, connectivity and storage, and new processing algorithms give completely new perspective on the future of agriculture and food sector. The internet of things (IoT) has revolutionary potential. A smart web of sensors, actuators, cameras, robots, drones and other connected devices allows for an unprecedented level of control and automated decision-making. Over the last decade agricultural machines became valuable sources of data. Still, data from sensors were sparsely distributed for two reasons - lack of connectivity and high price of sensor with their limited capabilities. With penetration of IoT in agriculture, this situation is changing rapidly. Improved connectivity is not only providing access to the in-field data but is also driving the innovation in sensor technology, which should result in price cut, versatility, reliability and user-friendliness. With the help of IoT technologies higher yields and better quality produce should be expected. Pesticide and fertilizer use will drop and overall efficiency will be optimized. IoT technologies also enable better traceability of food, leading to increased food safety. One of the major efforts for systematic approach to R&D in IoT application in agri-food domain is the flagship project IoF2020 - Internet of Food and Farm, which explores the potential of IoT-technologies for the European food and farming industry. The goal is ambitious: to make precision farming a reality and to take a vital step towards a more sustainable food value chain. The aim of IoF2020 is to build a lasting innovation ecosystem that fosters the uptake of IoT technologies. For this purpose key stakeholders along the food value chain are involved in IoF2020 together with technology service providers, software companies and academic research institutions. Nineteen use-cases organised around five sectors (arable, dairy, fruits, meat and vegetables) develop, test

	and demonstrate IoT technologies in an operational farm environment all over Europe.
14:30-15:00	**Ganesh Subramanian, Panimalar Institute of Technology, Chennai** *"Drones/UAVs for Aerial surveillance -The Indian Perspective"* The farming industry will become arguably more important than ever before in the next few decades. The IoT is set to push the future of farming to the next level. Smart agriculture is already becoming more commonplace among farmers, and high tech farming is quickly becoming the standard thanks to agricultural drones and sensors. The world will need to produce 70% more food in 2050 than it did in 2006 in order to feed the growing population of the Earth, according to the UN Food and Agriculture Organization. The main goal of this presentation is to focus on the impact of drones in precision farming and implement a Smart irrigation system through various networking technologies and their integration with IoT.
15:00-15:30	**Tom Penning, Irrometer Co., Inc.** *"Presentation: Is IoT the future of Ag?"* To feed an expected world population of 9.1 billion by 2050, an increase of 1.5 billion from current levels, food production will also need to increase to meet this growing demand. Even though this represents a 34% increase in population growth, because of swelling urban sprawls, increasing income levels, producer demographics and expanded use of crops for bio-energy and other industrial purposes, crop production will need to be increased by more than 70% to satisfy all these needs. To achieve this projected growth target in crop production, agriculture will have to rely on technology more than ever. Technology has already been integrated into farming methods to make farming more efficient. For example, farming is relying on sensors to trace, detect and diagnose issues with soils, crops, livestock machinery, etc. Similarly, remote sensing and precision agriculture are already optimizing farm inputs. However, these technologies might not be enough and will need to become more efficient in order to meet the exponential growth in crop production demand. It is therefore vital that we think of ways in which this could be possible. The Internet of Things (IoT) could be the catalyst that could make some of these existing technologies even more efficient. An IoT platform will allow for various and numerous devices in the field to exchange data efficiently and economically so that near real-time recommendations and prescriptions could be generated by systems such as Farm Management Information Systems (FMIS), making farming much more efficient. This paper will describe a use case of how an IoT platform and communication technologies, focused primarily on collection of soil moisture data from agricultural fields, can be used. This data will be standardized so that exchange between irrigation management systems is seamless. AgGateway's Precision Ag Irrigation Language (PAIL) and Standardized Precision Ag Data Exchange format (SPADE) will be used as the standardization and exchange tool respectively.
15:30-16:00	Coffee Break
16:00-16:30	**Dr. Wuxiong Zhang, Associate Professor, Shanghai Research Center for Wireless Communications** *"Massive IoT Monitoring System for the South-to-North Water Diversion Project in China* This talk introduces the design and implementation challenges of distinctive IoT technologies for the world longest water monitoring system of the South-to-North Water Diversion Project in China. This system consists of a variety of advanced sensors for monitoring weather, geological features, infrastructure health, water quality and quantity, and security. In particular, three key problems have been addressed: (1) real-time processing of large volume of mixed structured and unstructured sensing data from 100K+ sensors; (2) multi-hop data transmission over heterogeneous wireless networks (WSN/WLAN/GPRS/3G/4G) with strict constraints in end-to-end delay performance (less than 3 seconds) and connection reliability (greater than 99.9%) for over 1430KM distance; and (3) web-based data integration and visualization in a comprehensive system for remote monitoring, dispatching, command and control functions at all times and all situations. Currently, this impressive IoT monitoring system covers the entire 1432 KM drainage basin from Danjiangkou Water Reservoir in Hunan Province to Beijing and Tianjin cities. It is providing crucial real-time information for day-to-day surveillance, operation and management of the world longest water diversion system.
16:30-17:30	**Working Group Round Table**

Thursday, February 8, 12:30 - 13:30

LN: Lunch (Peony Room)

Rooms: 4201A+4201B (138), 4202 (130), 4203 (130), 4204 (130), 4205 (130), 4301A+4301B (138), 4302 (130), 4303 (130), 4304 (130), 4305 (130), Plenary: Melati

Thursday, February 8, 13:30 - 15:30

AS2: Session on IoT Application and Services (II)

Room: 4303 (130)
Chair: Duong Nguyen (University Of British Columbia, Canada)

AS2.1 13:30 *Smart Cup for Festival Alcohol Consumption Awareness*
Maxence Bobin and Hamdi Amroun (LIMSI-CNRS, France); Mehdi Boukallel (CEA-LIST, France); Margarita Anastassova (CEA LIST, France); Mehdi Ammi (CNRS-LIMSI - University Paris-Sud, France)
This paper presents a platform prototype to monitor alcohol consumption for festival's attendees. The platform also aims to raise awareness about alcohol consumption in order to help people control or even reduce their alcohol consumption. The platform consists of a self-contained smart cup which the attendee uses during the day. This platform allows to easily follow the user's alcohol intake based on a model in order to display alerts if necessary. The smart cup embeds sensors to detect the liquid level and its movements. In addition, activity recognition is performed from the collected data in order to recognize when the user drinks and enhance the alcohol intake assessment. The smart cup also embeds LEDs visual displays that provides information about the alcohol intake estimation. This paper presents the design concept of the smart cup along with the technical implementation. Then, the data processing and analysis is presented for the alcohol intake estimation method using activity recognition with a Support Vector Machine classifier. An experiment have also been carried out and shows a good level of recognition above 90% for the "drinking" activity. Next, the feedback identification for the alcohol intake estimation is detailed in the last section. Finally, perspectives for the detection of abnormal behavior based on the alcohol intake assessment and the movements of the cup are introduced.
pp. 723-728

AS2.2 14:10 *Smart Work-Assisting Gear*
Projjal Gupta, Swaroop Belur, Chirag Parmar and Shashank Bharadwaj (SRM University, India)
This paper describes the use of IoT hardware and protocols to build a smart device which assists factory workers and employers. The proposed system has a micro-processor acting as the central server, and micro-controllers link together for data transmission and perform various tasks. One of the micro-controllers acts as the master, which controls the other MCUs. The master glove contains an LCD screen with a GUI and a few buttons. This can control the other sensors, and read the data in real time. The gloves contain safety features so that the workers are unable to use any dangerous power tools without wearing proper equipment and can also restrict the access to the tools which are being used during a particular time-frame. The entire data is logged by the central server and various other sensors and actuators can be attached and monitored by the master glove. The system can also analyze the tone of the workers when a user shouts in pain so that they can be attended to medically. A camera module is attached to the central server to record and live-stream whenever any power tool is switched on. This system proliferates the safety of a worker in a workspace.
pp. 729-733

AS2.3 14:50 *An Adaptive Method for Data Reduction in the Internet of Things*
Yasmin Fathy, Payam Barnaghi and Rahim Tafazolli (University of Surrey, United Kingdom (Great Britain))
Enormous amounts of dynamic observation and measurement data are collected from sensors in Wireless Sensor Networks (WSNs) for the Internet of Things (IoT) applications such as environmental monitoring. However, continuous transmission of the sensed data requires high energy consumption. Data transmission between sensor nodes and cluster heads (sink nodes) consumes much higher energy than data sensing in WSNs. One way of reducing such energy consumption is to minimise the number of data transmissions. In this paper, we propose an Adaptive Method for Data Reduction (AM-DR). Our method is based on a convex combination of two decoupled Least-Mean-Square (LMS) windowed filters with differing sizes for estimating the next measured values both at the source and the sink node such that sensor nodes have to transmit only their immediate sensed values that deviate significantly (with a pre-defined threshold) from the predicted values. The conducted experiments on a real-world data show that our approach has been able to achieve up to 95% communication reduction while retaining a high accuracy (i.e. predicted values have a deviation of ± 0.5 from real data values).
pp. 734-740

IFO5: Industry Forum Panel - Exponential Changes of Industrial IoT Space, Now and Future

Christoph Theisinger, Vice President, Enterprise Presales, Asia Pacific & Japan at Dell EMC (Moderator); Muralidhar, M.S.K、Senior Partner, Deloitte Consulting South East Asia; Paul Marriott, Chief Operating Officer at SAP Asia Pacific Japan; Shigeyoshi Shimotsuji, Executive Director and GM of Software & AI Technology Center, Toshiba Digital Solutions

Room: 4203 (130)

The Internet of Things, IoT, drives Industries digitally transforming exponentially. IoT is all about connecting things and going beyond the connectivity. Things have been collecting data, but now they are doing it more accurately and frequently in order for us to extract better values.

One of key drivers for the value creation is Artificial Intelligence. AI is rapidly permeating our economies and societies. It complements IoT to create a range of intelligent products and services. The panel presents practical cases on how AI is used to enhance IoT products and services to make the Internet of Things smarter.

Another drive is human-centric solution for transformation enabled by IoT. Rather than approaching technologies as a replacement to human, this panel will explore alternatives to leveraging technologies to augment the human workforce and decision-making by examples illustrating how state-of-the-art IoT technologies is being applied to IoT space and insights on what is available today and what to expect over the next few

years.

Speakers

Christoph Theisinger, Vice President, Enterprise Presales, Asia Pacific and Japan at Dell EMC ***(Moderator)***

Christoph Theisinger leads the Presales team to architect our client's IT transformation to deliver both innovative and practical technology solutions. He is responsible for driving growth, market share and continuously high customer satisfaction levels.

Muralidhar, M.S.K、Senior Partner, Deloitte Consulting South East Asia

Murali is the manufacturing sector leader for Deloitte Consulting. His role helps clients transform their business and operating models to address the emergence of digital technologies. For nearly 25 years he has worked with clients in the high technology, automotive, industrial products and med-tech industry to shape and execute options for growth and operations improvement programs across all major economies in Asia Pacific.

Paul Marriott, Chief Operating Officer at SAP Asia Pacific Japan

Paul Marriott has spent the last 8 years with SAP Asia Pacific helping his customers and partners leverage innovative SAP solutions, which are the leading Cloud driving transformation of business through SAP HANA. He delivers business value by his IT experience with both SAP and Oracle solutions.

Shigeyoshi Shimotsuji, Executive Director and GM of Software and AI Technology Center, Toshiba Digital Solutions

Shigeyoshi Shimotsuji is Executive Director of Toshiba Digital Solutions Corp, which drives the digital transformation in energy, social infrastructure and building facility business segments. He runs Technology Center on IoT and Artificial Intelligence. The technologies of his division have realized new value for Toshiba IoT solutions.

IL: Session on Indoor Location

Room: 4204 (130)
Chair: Kumbesan Sandy Sandrasegaran (University of Technology, Sydney, Australia)

IL.1 13:30 ***Indoor Localization for IoT Applications Using Fingerprinting***
Priyath Fonseka (UTS, Australia); Kumbesan Sandy Sandrasegaran (University of Technology, Sydney, Australia)
Fingerprinting method is one of the preferred methods used for indoor localization using Wi-Fi signals because of its low complexity and its ability to accommodate RF propagation effects. This paper proposes an indoor localization algorithm using fingerprinting method that is suitable for an indoor IoT application. The proposed algorithm combines the results from two different approaches, deterministic and probabilistic, to estimate the target location. The proposed algorithm was tested for different parameters: stationary and moving IoT targets, LOS and non-LOS indoor environments. The results showed the proposed combined algorithm performed better in terms of localization accuracy, precision and robustness than deterministic and probabilistic methods.
pp. 741-746

IL.2 14:00 ***A Novel Fusion Methodology for Indoor Positioning in IoT-based Mobile Applications***
Ramla Ijaz, Muhammad Adeel Pasha and Naveed Ul Hassan (Lahore University of Management Sciences, Pakistan); Chau Yuen (Singapore University of Technology and Design, Singapore)
We present a novel fusion-based Indoor Positioning System (IPS) that fuses the sensory data of three popular smartphone sensor technologies i.e. WiFi, Bluetooth Low Energy (BLE) and Pedestrian Dead Reckoning (PDR) to achieve a superior indoor localization accuracy. The proposed system can be used for a broad base of Internet of Things (IoT) related applications that involve mobility and localization. In our approach, we first compare the indoor positioning accuracy of fingerprinting schemes using WiFi and BLE through their Received Signal Strength (RSS) values. In this comparison, we use these two technologies both separately and in combination, and show that the combined fingerprints of WiFi/BLE sensors give better results than individual fingerprints. We then fuse the combined fingerprinting results of WiFi/BLE sensors with the PDR using two methods: (i) segment-based fusion and (ii) the Kalman Filter (KF). In this experiment, we show that the fusion of WiFi, BLE and PDR using the KF gives 23% improvement in average error over WiFi/PDR fusion and 25% improvement in average error over BLE/PDR fusion while all these different techniques are superior than simple PDR-based localization. We, therefore, conclude that WiFi/BLE/PDR fusion is a promising approach to be considered for future IPSs being designed for personalized IoT-based smart systems.
pp. 747-752

IL.3 14:30 ***A Location-Based Smart Shopping System with IoT Technology***
Javad Rezazadeh (University of Technology Sydney & University Technology Sydney, Australia); Kumbesan Sandy Sandrasegaran and Xiaoying Kong (University of Technology, Sydney, Australia)
Localization is one important part of Internet of Things(IoT) where the Location of Everything (LoE) system plays a important role to improve most services in IoT area. On the other hand, data mining techniques are essential analyses when we have big data from IoT platforms. Indeed, integration of location-based methods and data mining analysis process can make a smart system service for IoT scenarios and applications. For this purpose, we design a smart shopping platform including four components, location of everything component, data collection component, data filtering/analysing component and data mining component. Then a novel accurate localization scheme named "location orbital" is developed that estimates the current location of mobile objects (users or everything) based on both its current and historical previous locations. Finally, an implementation of the experiment in a shopping mall is conducted to practically examine performance evaluation of the location-based scheme. The experimental results show that the proposed scheme could achieve significant higher precision than other localization techniques.
pp. 753-758

IL.4 15:00 ***A Novel System Architecture for Real-time, Robust and Accurate Step Detection for PDR Based Indoor Localization***
M. P. R. S. Kiran and P Rajalakshmi (Indian Institute of Technology Hyderabad, India); Mukesh Giluka (Indian Institute Of Technology Hyderabad, India); Bheemarjuna Reddy Tamma (IIT Hyderabad, India)
Indoor localization is currently of good interest concerning both business viability and end user experience. In this paper, we propose an accurate and robust step detection algorithm for smartphone based pedestrian dead reckoning (PDR) systems. The developed algorithm makes use of the acceleration measured from the smartphone and uses a statistical threshold based classification to detect the steps accurately. The statistical thresholds used are derived from extensive field trials with subjects of different age groups and found to provide good accuracy when used in real-time. For analyzing the performance of the proposed algorithm, we have implemented the algorithm on Android platform and performed extensive field trials. The analysis proves that the proposed algorithm identifies the user steps in real-time with an accuracy of more than 99% with minimum memory requirements.
pp. 759-764

TM2: Session on Broadly Applicable IoT Techniques and Methods (II)

Room: 4304 (130)
Chair: Nikos Kouvelas (Delft University of Technology, The Netherlands)

TM2.1 13:30 ***On Inferring How Resources are Shared in IoT Ecosystems a Graph Theoretic Approach***
Nikos Kouvelas and Venkatraman Balasubramanian (Delft University of Technology, The Netherlands); Artemios G. Voyiatzis (SBA Research, Austria); Venkatesha Prasad (Delft University of Technology, The Netherlands); Dirk Pesch (Cork Institute of Technology, Ireland)
The Internet of Things (IoT) is an enabler for the digital transformation of our era, dictating new needs and trends in the domains of business and technology. Ecosystems of IoT devices are often organized in networks, using wireless technology and sharing access infrastructure. These networks are used to monitor a wide range of systems, from simple house- hold activities to fully-interconnected smart cities. In many usage scenarios, the IoT devices are resource- constrained. Thus, energy scavenging is utilized to meet their expanding longevity requirements. In this paper, we study the local resource dynamics of IoT devices in an ecosystem, i.e., a set of different IoT devices that co-exist in spatiotemporal level to coordinate the use of available common resources for their individual goals. To this end, we model an ecosystem of IoT devices as a time-varying graph and provide a theoretical foundation for resource distribution using Graph Theory. We show that simple graph-theoretic metrics, such as, the clustering coefficient and degree distribution, can provide rich information about the priority pol- icy that is followed for the distribution of resources among different IoT devices. We take the case of micro grids; with some nodes having harvesting potential and smart meters measuring the current consumption/generation. In our example use-case, with enough harvested energy, even one link per node can describe an ecosystem as a connected component with more than 60% of its total energy needs covered. Additionally, the nodes presenting harvesting potential are formed into unipartite graphs of affiliation networks. Studying their clustering coefficient we infer the priority policy that is applied when excess energy is shared within their ecosystem.
pp. 765-771

TM2.2 14:00 ***Dynamic Scheduling for Pickup and Delivery with Time Windows***
Shudong Liu (Institute of Infocomm Research, Singapore); Sumei Sun, Peng Hui Tan, Ernest Kurniawan and Peng Zhang (Institute for Infocomm Research, Singapore)
We consider the dynamic scheduling of a pickup and delivery system in which mobile robots are used to transport materials among a set of places. With the help of Internet of Thing, the system has real-time information for demands of transportation and status of robots. How to dynamically scheduling the robots to fulfill the transportation tasks is a key challenge. We propose a method for it in which an innovative and adaptive mixed integer programming model (MIP) is developed. This MIP model can be called in a periodic or event-driven or hybrid way. Numerical results show it can solve real problems fast and significantly reduce transportation cost, comparing with a heuristic policy.
pp. 772-775

TM2.3 14:30 ***Sequential Context Modeling for Smart Devices by Collaborative Hidden Markov Model***
Miao Lin (Institute for Infocomm Research, Singapore); Vincent Zheng (Advanced Digital Sciences Center, Singapore); Shili Xiang (Institute for Infocomm Research, Singapore)
Smart devices are prevalent in our daily lives these days, as the advancement of mobile networks, sensor technologies and distributed computing. They easily collect rich context information (e.g., time, GPS location, Wifi info, app usage, etc.) from the device owner (i.e., the users). Modeling such sequential context data is important -- it not only helps to profile the user, but also enables many context-aware applications, such as location-based services with the next location prediction and app usage prediction. However, context modeling is challenging, because the context data is heterogeneous and high-dimensional in terms of the huge number of possible contexts.In this paper, we propose a novel Collaborative Hidden Markov Model (CHMM). CHMM extends the sequential generative model HMM to a collaborative setting, such that only those users sharing similar behaviors can pool their data together to build a reliable model.We evaluate CHMM with real-world data for both next location prediction and app usage prediction, and the results show that CHMM outperforms the baselines in both cases.
pp. 776-782

TM2.4 15:00 ***Towards Comfortable Cycling: A Practical Approach to Monitor the Conditions in Cycling Paths***
Nipun Wijerathne (Singapore University of Technology and Deisgn, Singapore); Sanjana Viswanath, Marakkalage Hasala, Victoria Beltran, Chau Yuen and Hock Lim (Singapore University of Technology and Design, Singapore)
This is a no brainer. Using bicycles to commute is the most sustainable form of transport, is the least expensive to use and are pollution-free. Towns and cities have to be made bicycle-friendly to encourage their wide usage. Therefore, cycling paths should be more convenient, comfortable, and safe to ride. This paper investigates a smartphone application, which passively monitors the road conditions during cyclists ride. To overcome the problems of monitoring roads, we present novel algorithms that sense the rough cycling paths, locate road bumps, and detect any sudden braking events. Each event is detected in real

time to improve the user friendliness of the application. Cyclists may keep their smartphones at any random orientation and placement. Moreover, different smartphones sense the same incident dissimilarly and hence report discrepant sensor values. We further address the aforementioned difficulties that limit such crowd-sourcing application. We evaluate our sensing application on cycling paths in Singapore and show that it can successfully detect such bad road conditions.
pp. 783-788

TOP2: Topical 2 - Smart Cities and Nations (Policy and Regulations)

Room: 4201A+4201B (138)

Organizers

Co-Chairs Shawn Chandler and Roberto Saracco

Track Summary

All cities are complex systems, balancing available resources to best exploit the value that can be provided to the population. Technology advances are continuously redefining this balance. At the same time economics and regulatory aspects play a major role in fostering the adoption and deployment of Technology and are a key ingredient in the decision making that translates potential into reality. This Vertical, on Smart Cities and Nations, takes a global view of the current status and discusses the paths forward, taking into account the new possibilities opened by the Internet of Things.

The Internet of Things is proving that the sensing of processes, infrastructure, and city control systems, and the gathering of data is a basis for improvement and innovation. It enables the monitoring of conditions and performance of city functions and the subsequent fact based analyses results in the awareness of the city status. This in turn leads to better planning and the execution of actions that can steer the Cities' evolution, bettering the use of resources and the well being of its citizens.

Session 4: Smart Cities Policy and Regulation I

Smart City data collection from fixed sensor networks, mobile platforms and other sources will benefit residents through direct improvements to operations, including enhanced planning between agencies, and methods to permit industry and residents to inform and set expectations about factors influencing quality of life. This session will address improvements and best practices for services, including public safety, distribution networks, environmental monitoring, and planning.

Session 5: Smart Cities Policy and Regulation II

Smart Cities are collections of people, technology, and infrastructure working together to deliver many benefits. Ideally, guiding the delivery of these benefits are a set of standards to align technology and reduce costs, as well as allow for the novel creation of new services and spurring innovation that is usable and compatible with other systems over time. This session will address standards for IoT, applications for Smart Cities, as well as an extended panel discussion with audience participation about the Internet of People, concerning the intersection of smart cities and social networking.

Session 6: IEEE Internet of Things - Smart Cities Working Group Meeting

This session is the foundational session of the IEEE IoT Smart Cities Working Group, developing an agenda for Working Group matters of discussion, and laying out a roadmap for future activities. You are invited to join and become an active member of the Working Group!

Program

10:30am	Session 4	**Mirko Florindo, BT Global Services** *"Smart Safety in Smart Cities: A Concrete Solution"* "Smart Safety in Smart Cities", based on BT-Comunica Italia Alert System, is able to collect data from multiple sources, correlate them, define the risk level and quickly alert security forces and/or citizens in case of crisis situations such as natural disasters or terrorist attacks, and also manage timely assistance. The talk leverages on experiences from the field and aims at showing practical approaches to this crucial aspect.
11:00am	Session 4	**Professor Woon-Seng Gan, Centre for Infocomm Technology in the School of Electrical and Electronic Engineering in Nanyang Technological University** *"Smart Audio Sensing for Environmental Deployment"* With the availability of low-cost, sensing and processing components, we are seeing deployment of smart audio sensors in outdoor environmental monitoring. Audio information provides another dimension to surveillance and monitoring. For example, audio events give extra information on specific incidents; know the precise moment specific sound event happens; and allows us to trigger camera nearest to the incident. In this work, we developed a web-based audio intelligence monitoring at the edge (AI-ME) that can be deployed in indoor environment to recognize activities of elderly staying in alone or in elderly home. AI-ME uses acoustic signal processing with deep learning techniques to learn and understand everyday sound patterns (just like human learn to recognize sound from examples). In addition, putting the AI-ME technology into edge devices means that audio analytic do not have to rely on central server, saving on cost, increasing flexibility and scalability; also can retrofit on legacy devices, like camera. Additional video bandwidth can be saved as there is no need to stream in full high quality all the time; only when a desired sound is detected.
11:30am	Session 4	**Ghee Leng Ooi, Data-Enabled Scalable Research Laboratory, HKUST** *"The Four Pillars of a Smart City: Agreements, Trusts, Agnostic Infrastructure and Audit Trails"* Smart City is not about money; if it is, the future would have been already here, considering the amount of resources nations already threw at the vision. In this talk, we delve into the very reasons why Smart City is hard to implement, and contend that if nations want their cities smart, they should find their Smart City blueprints on top of the four pillars: agreements, trusts, agnostic infrastructure and audit trails. The first pillar solves the incentive misalignments among sensor vendors, contractors and back-end service providers through service level agreements, binding all parties to deliver a long-term, well-maintained and integrated physical and digital solutions. The second pillar solves the potential security threats lurking behind a connected city through end-to-end root-of-trusts in the infrastructure, with suggestions on how nations can assume the role of an overseer of public security from the ground up. The third pillar solves the scalability problems of customized data collection backends and protocols through a flexible and agnostic data collection infrastructure, so that cost and manpower do not get exponentially expensive as deployment scales. The final pillar deals with the assumption that once collected, every data point carries its legal weight. Therefore, we implemented a spatio-multitemporal database to document an immutable audit trail of all processes, from data creation to ingestion to transformation to queries, so that every single commit and change is recorded and version-controlled. All the experiences shared will be referenced to our works with different government bureaus and institutions in Hong Kong and Taiwan for the past 6 years. We contend that when all parties are bound to agreements, when data collection backend is flexible enough to accommodate deployment scaling, when the data collected are trustworthy and leave immutable audit trails, then will Smart City be truly maintainable and secure.
12:00pm	Session 4	**Dale Seed, InterDigital, Inc.** *"Future Proof Planning for Smart City Deployments"* Smart Cities represent one of the most challenging IoT deployment use cases. A typical Smart City consists of a diverse collection of sub-systems (traffic, emergency services, water and sewer, parking, etc). Interworking these sub-systems together with one another such that information can be shared between them is a key requirement for enabling more innovative Smart Cities use cases. However, there are several challenges to interworking these different sub-systems together. For example, in many cities each sub-system typically has its own legacy platform that is used to manage the sub-system. These legacy platforms are deployed separate and independent of each other, making interworking between them difficult. In addition, the large investment in these legacy platforms and high cost to replace them prevents city planners from swapping them out for newer technologies. oneM2M is a horizontal service layer standard that supports interworking different legacy technologies together with one another. Hence oneM2M provides a fast-track and future proof solution for IoT deployments that enables interworking of Smart City sub-systems together with one another. This talk will elaborate on the value propositions that the oneM2M standard provides for Smart Cities and will present some real-world deployment experiences of deploying the oneM2M standard within InterDigital's Chordant IoT platform.
12:30pm		Lunch Break
1:30pm	Session 5	**Bilel Jamoussi, International Telecommunication Union** *"Standards for the Internet of Things - Applications for Smart Cities"*
2:00pm	Session 5	**Nahum Gershom, The Mitre Corporation and Joel Meyers, HoozAround** *"The Internet of People: How Smart Cities and the IoT Can Provide a New Model for Business and Social Networking"* **1 Hour Session**
3:30pm		Coffee Break
4:00pm	Session 6	**IEEE IoT Smart Cities Working Group Meeting** *Moderator: Shawn Chandler, Navigant Consulting, Inc.* This session is the foundational session of the IEEE IoT Smart Cities Working Group, developing an agenda for Working Group matters of discussion, and laying out a roadmap for future activities. You are invited to join and become an active member of the Working Group!

V4: Vertical 4 - Industrial IoT (Part 2)

Room: 4202 (130)

Organizers

Co-Chairs Chung-Min Chen, Sr. Director, iconectiv, Telcordia Technologies and Ranga Rao Venkatesha Prasad (VP)

Track Summary

The digitization and automation of industrial enterprises promises to create new ways in which the cycle from concept to goods in service produces value. At the same time the application of IoT technologies also promises to significantly change the way we maintain goods and equipment in service and commensurately the use and accompanying business models. The WF will explore the ways in which IoT will impact Industrial organizations and the technologies that are likely to drive the greatest changes.

Program

10:30-12:30	Session 3. IIOT vs. Industry 4.0	**Aaron Voon-Yew Thean, National University of Singapore** *"How's IoT Different from Internet and How It May Be the Same: A Technologist's View"* We assume that as hardware and data communication technologies become increasingly accessible and commoditized, the embedment of these technologies into all things of our lives should naturally follow. Billions of connected devices serving up massive quantity of data would allow us to optimize with high precision, our resources, productivity, and work. Although IoT will improve society technologically, do we really understand the business model to fuel the movement? Technology diversity tend to come with increased accessibility. Hardware-wise, the Internet-of-Things is inherently more fragmented and diverse than our current Internet technologies. It seems that low-cost high-mix electronics dominate the edge applications. Technology businesses that fueled the internet infrastructure growth, like Semiconductor and Electronics Manufacturing, may find it challenging to capitalize on this growth with their traditional high-volume manufacturing approaches. Hence, we see a growing call for platforms, standards and ecosystems to be defined. These will likely have to be in the context of new internet services, enabled by these connected devices. In this presentation, we will look at some of the key technology convergences that led to the acceleration of the Internet before IoT and how new convergences (E.g. Machine Learning, 5G Communications, Smart City, Precision Medicine, Wearables, Etc.) may lead similarly the IoT acceleration. Looking at the value chain of the Internet today, online services provide significant business opportunities. Will this be different or the same with IoT? How will hardware technology keep up while being commoditized and who will make the money? New IoT services enabled by new hardware and software innovation will likely be necessary to drive the IoT economy. We will examine selected technologies (E.g. Semiconductors, Wireless, Artificial Intelligence, Wearables, Etc.) and their potentials towards a new convergence and the technological challenges still to be overcome. **Sumei Sun, Institute for Infocomm Research, A*STAR** *"Cognitive Industrial Internet of Things"* Industrial internet of things (IIoT), by providing connectivity to machines, robots, and sensors, etc, enables data intelligence-assisted information technology (IT) and operation technology (OT) convergence, and is a key technology in industry 4.0. In IIoT, multi-disciplinary research on communications, storage, computing and data analysis, control and management, and security, as well as cross-disciplinary system-level design optimization is needed, with built-in autonomous learning and adaptation capabilities. In this talk, we will start with a brief introduction to IIoT, and then share the IIoT research and design challenges. A design approach will then be proposed to overcome these challenges, under the theme of cognitive IIoT in which the device and the network will build up learning capabilities for context-aware resource, interference, and mobility management, automated fault detection and recovery, and robust connectivity; multi-modal security detection capability is incorporated into the device and network for real-time anomaly and security detection and management. The interactive and cooperative edge-cloud analytics will also be introduced to enable low-latency real-time actionable insight and robust feature engineering. **Shigeyoshi Shimotsuji, Software & AI Technology Center, Toshiba Digital Solutions** *"Industrial AI: Route to the Next Stage of IoT"* Industries are digitally transforming like never before and at record speed. One of key drivers is IoT, which collects digital data and converts them to user's value. The first wave of IoT visualized the state of machines and realized new applications such as condition-based maintenance to manage and operate them efficiently. It was applicable to only expensive devices and machines because of the balance between system investment and returns. The evolution of IoT technologies, particularly AI, expands applications from an individual expensive machine and group of devices in a premise to cities and communities to solve social issues such as urbanization, energy/CO2 issues, aging and labor shortage. This session will share how IoT technologies accelerate the transformation in industry segments and highlights how AI technologies expand of the transformation along with a couple of examples. **Panel Discussion**
12:30-13:30		Lunch
13:30-15:30	Session 4. IOT Case Studies, Lessons Learnt	**Speakers** **Po-Chou Lin, Chunghwa Telecom** *"IoT Development in Chunghwa Telecom (CHT)"* In the next presentation, Dr. Lin will give a talk about the IoT Development in Chunghwa telecom. First the IoT policy of Taiwan government is introduced. IoT Opportunities and Challenges for telecom companies are analyzed. CHT also develops its own IoT platform to build up the ecosystem. In the end, several IoT applications based on this IoT platform are discussed. **Michael Karner, VIRTUAL VEHICLE Research Center, Graz, Austria** *"Smart Wireless Solutions - Building Trust in the Internet of Things"* *The first part of the presentation will give a comprehensive summary of use cases, results, and expected socio-economic impacts of the DEWI project.* Smart wireless systems (wireless sensor and actuators networks, WSNs) have a number of explicit advantages over wired solutions. However, wired technologies still dominate, mainly due to the lack of dependability of wireless networks. Therefore, in 2014 the large pan-European R&D project DEWI was launched, focussing on dependable solutions for WSNs and short-range communication (TRL 4-5). With its four industrial domains (Aeronautics, Automotive, Rail, and Building) and 21 industry-driven use cases / applications, DEWI aimed at providing and demonstrating key solutions for wireless seamless connectivity and interoperability, by considering everyday physical environments of citizens in buildings, cars, trains and airplanes. DEWI, with 58 industrial and research partners from 11 European countries, created a universal cross-domain reference architecture, fully compliant with international standards (ISO/IEC) and thus fostering reusability, scalability, and interoperability of DEWI solutions (and beyond). Besides creating 30 re-useable technical building blocks, DEWI focussed on the scalability of all its solutions. Key results of DEWI were made tangible via 20 attractive real-life demonstrators all over Europe. *The second part of the presentation will give an overview of the SCOTT project, will highlight issues of trust and trustability in the Internet of Things, and will present first project results.* Creating trust in wireless solutions and increasing their social acceptance are major challenges to achieve the full potential of the Internet of Things. Therefore, SCOTT - Secure COnnected Trustable Things, a pan-European effort with 57 key partners from 12 countries (EU and Brazil), will provide comprehensive cost-efficient solutions of wireless, end-to-end secure, trustworthy connectivity and interoperability (Technology Readiness Level 6-7) to bridge the last mile to market implementation. SCOTT will not just deal with ‚things that are connected', but with ‚trustable things that securely communicate', i.e. things interconnected by dependable wireless technology and valuing the end-users' privacy rules. SCOTT uses a standardized multi-domain reference architecture, created in a predecessor project (DEWI and its "Bubble concept") and being fully compliant with ISO 29182 - Sensor Network Reference Architecture, which fosters reusability, scalability, and interoperability of SCOTT solutions. SCOTT also utilizes a clearly use-case driven approach with 15 use cases from different areas of high relevance to European society and industry; a specific focus will be put on cross-domain use cases and heterogeneous environments, emphasizing 5G and cloud computing aspects to build up digital ecosystems to achieve a broader market penetration. Use Cases will be further substantiated by the development and utilization of nearly 50 technical building blocks for security/safety, distributed cloud integration, energy efficiency/ autonomy of devices and reference architecture/implementations, which are all necessary to realize the SCOTT use cases and facilitate composability of systems as well as cross-domain sharing of trustable wireless technologies and services. SCOTT will open up new market opportunities for industry, will significantly reduce time to market and decrease costs for trustable wireless solutions on the market, in particular by using new designs and technical building blocks. SCOTT will develop methods and tools capable of meeting prospect use-case requirements on reliability, robustness, security and functional safety even in harsh and/or not trusted environments. SCOTT will build up and apply a comprehensive, dedicated Trusted System Development Framework to all its use cases to significantly foster acceptance of SCOTT solutions on the market, and to unleash the full potential of the Internet of Things. **Nirupam Sannagowdara Dasappa, Senior Scientist & Programme Director, IoT Energy Research Institute at NTU, and Co-Founder & CTO Printed Power Pte Ltd** *"The 'How' Industrial IoT - Setting Yourself Up for Success"* Internet of things (IoT) is a smart technology that connects anything anywhere at any time. Such ubiquitous nature of IoT is responsible for draining out energy from its resources. Therefore, the energy efficiency of IoT resources has emerged as a major research and development issue. In this talk, sharing an information on implementation effort of proposed energy-efficient architecture for IoT, which consists of several layers, namely, sensing and control, information processing, and presentation. The architectural design allows the system to integrate energy harvesting/self powered battery, ultra-low power sensors, robust radio's etc. This mechanism allows the energy-efficient utilization of all the IoT resources. The experimental and deployment results show a significant amount of energy saving in the case of sensor nodes and improved resource utilization of cloud resources. Also, outlining the challenges related to edge computing, connectivity, data visualization, modeling and deployment of IoT applications and potential research directions in resolving these challenges.
15:30-16:00		Break

16:00-18:00	Session 5. Round Table Discussions	**All Speakers and Participants** 1. Unlocking Digital Transformation through Industrial IoT 2. Embracing Innovation Across Industrial IoT 3. IIoT and its future: Research, Developments, Products & Service

V5: Vertical 5 - IoT for Agriculture

Room: 4302 (130)

Organizers

Mehmet Can (Jon) Vuran

Track Summary

The growth of the World Population is projected to exceed 10 Billion people by 2035, That combined with the increasing affluence of our planet's inhabitants indicates that by 2035 the demand for food will roughly double. The WF will explore how IoT technologies can contribute to meet the food demand of the world's population through improvements in yield and efficiency. Agriculture is a vertical that has many aspects and many specialties where IoT is important. The aspects include the operation of agricultural equipment; hydrology and irrigation; pest and invasive species control; management of facilities; and preservation of land and soil. Examples of specialties include arable crops; animal husbandry; aquaculture and fisheries; forestry; natural materials for consumer and industrial products; cash crops; and fruits and vegetables.

Program

10:30-11:15	**Mehmet Can Vuran** *"Overview in IoT in Agriculture"*
11:15-11:45	**Jack Ng, CEO of Sky Greens Pte Ltd** *"Farm to Table - From a Yuppie Trend to a Future Norm"* • An introduction of Sky Greens - a pioneering vertical farming technology • Current IoT application in SMART greenhouses • How IoT and change in consumer buying behavior will shape farming landscape and overcome food loss challenge
12:00-12:30	**Panel Discussion** *"Opportunities in Challenges in IoT for Agriculture"*
12:30-13:30	Lunch
13:30-14:00	**Silvia Maria Fonseca Silveira Massruhá, General Director of Embrapa Agricultural Informatics** *" IOT Perspectives in Brazilian Agriculture: From Biotechnology to Big Data for Sustainable and Smart Agriculture* The Brazilian Agricultural Research Corporation, Embrapa, was founded in 1973,and is under the aegis of the Brazilian Ministry of Agriculture, Livestock, and Food Supply. Since the foundation and with partners from the National Agricultural Research System, they have taken on the challenge to develop a genuinely Brazilian model of tropical agriculture and livestock to overcome the barriers that limited the production of food, fiber, and fuel for their country. This effort has helped to change Brazil. Nowadays, Brazil's agriculture is one of the most efficient and sustainable ones in the planet. This presentation will include implementation strategy of how Brazil will introduce IOT in tropical Agriculture, what are some of the new technologies developed by Embrapa (Brazilian Agricultural Research Corporation), and new cooperative initiatives.
14:00-14:30	**Vladimir Crnojevic, BioSense Institute** *"Internet of Agriculture"* Data is the new gold - new economy is the data economy and this holds for agriculture as well. Over the last century we have gone from 1B people on the planet to 7B, primarily due to abundance of food caused by two revolutions in agriculture - machinery and chemicals. This trend is continuing and expected population of 10B requires new revolution - Agriculture 4.0, based on Industry 4.0 where data plays the major role. New sources of data, connectivity and storage, and new processing algorithms give completely new perspective on the future of agriculture and food sector. The internet of things (IoT) has revolutionary potential. A smart web of sensors, actuators, cameras, robots, drones and other connected devices allows for an unprecedented level of control and automated decision-making. Over the last decade agricultural machines became valuable sources of data. Still, data from sensors were sparsely distributed for two reasons - lack of connectivity and high price of sensor with their limited capabilities. With penetration of IoT in agriculture, this situation is changing rapidly. Improved connectivity is not only providing access to the in-field data but is also driving the innovation in sensor technology, which should result in price cut, versatility, reliability and user-friendliness. With the help of IoT technologies higher yields and better quality produce should be expected. Pesticide and fertilizer use will drop and overall efficiency will be optimized. IoT technologies also enable better traceability of food, leading to increased food safety. One of the major efforts for systematic approach to R&D in IoT application in agri-food domain is the flagship project IoF2020 - Internet of Food and Farm, which explores the potential of IoT-technologies for the European food and farming industry. The goal is ambitious: to make precision farming a reality and to take a vital step towards a more sustainable food value chain. The aim of IoF2020 is to build a lasting innovation ecosystem that fosters the uptake of IoT technologies. For this purpose key stakeholders along the food value chain are involved in IoF2020 together with technology service providers, software companies and academic research institutions. Nineteen use-cases organised around five sectors (arable, dairy, fruits, meat and vegetables) develop, test and demonstrate IoT technologies in an operational farm environment all over Europe.
14:30-15:00	**Ganesh Subramanian, Panimalar Institute of Technology, Chennai** *"Drones/UAVs for Aerial surveillance -The Indian Perspective"* The farming industry will become arguably more important than ever before in the next few decades. The IoT is set to push the future of farming to the next level. Smart agriculture is already becoming more commonplace among farmers, and high tech farming is quickly becoming the standard thanks to agricultural drones and sensors. The world will need to produce 70% more food in 2050 than it did in 2006 in order to feed the growing population of the Earth, according to the UN Food and Agriculture Organization. The main goal of this presentation is to focus on the impact of drones in precision farming and implement a Smart irrigation system through various networking technologies and their integration with IoT.
15:00-15:30	**Tom Penning, Irrometer Co., Inc.** *"Presentation: Is IoT the future of Ag?"* To feed an expected world population of 9.1 billion by 2050, an increase of 1.5 billion from current levels, food production will also need to increase to meet this growing demand. Even though this represents a 34% increase in population growth, because of swelling urban sprawls, increasing income levels, producer demographics and expanded use of crops for bio-energy and other industrial purposes, crop production will need to be increased by more than 70% to satisfy all these needs. To achieve this projected growth target in crop production, agriculture will have to rely on technology more than ever. Technology has already been integrated into farming methods to make farming more efficient. For example, farming is relying on sensors to trace, detect and diagnose issues with soils, crops, livestock machinery, etc. Similarly, remote sensing and precision agriculture are already optimizing farm inputs. However, these technologies might not be enough and will need to become more efficient in order to meet the exponential growth in crop production demand. It is therefore vital that we think of ways in which this could be possible. The Internet of Things (IoT) could be the catalyst that could make some of these existing technologies even more efficient. An IoT platform will allow for various and numerous devices in the field to exchange data efficiently and economically so that near real-time recommendations and prescriptions could be generated by systems such as Farm Management Information Systems (FMIS), making farming much more efficient. This paper will describe a use case of how an IoT platform and communication technologies, focused primarily on collection of soil moisture data from agricultural fields, can be used. This data will be standardized so that exchange between irrigation management systems is seamless. AgGateway's Precision Ag Irrigation Language (PAIL) and Standardized Precision Ag Data Exchange format (SPADE) will be used as the standardization and exchange tool respectively.
15:30-16:00	Coffee Break
16:00-16:30	**Dr. Wuxiong Zhang, Associate Professor, Shanghai Research Center for Wireless Communications** *"Massive IoT Monitoring System for the South-to-North Water Diversion Project in China* This talk introduces the design and implementation challenges of distinctive IoT technologies for the world longest water monitoring system of the South-to-North Water Diversion Project in China. This system consists of a variety of advanced sensors for monitoring weather, geological features, infrastructure health, water quality and quantity, and security. In particular, three key problems have been addressed: (1) real-time processing of large volume of mixed structured and unstructured sensing data from 100K+ sensors; (2) multi-hop data transmission over heterogeneous wireless networks (WSN/WLAN/GPRS/3G/4G) with strict constraints in end-to-end delay performance (less than 3 seconds) and connection reliability (greater than 99.9%) for over 1430KM distance; and (3) web-based data integration and visualization in a comprehensive system for remote monitoring, dispatching, command and control functions at all times and all situations. Currently, this impressive IoT monitoring system covers the entire 1432 KM drainage basin from Danjiangkou Water Reservoir in Hunan Province to Beijing and Tianjin cities. It is providing crucial real-time information for day-to-day surveillance, operation and management of the world longest water diversion system.
16:30-17:30	**Working Group Round Table**

Thursday, February 8, 15:30 - 16:00

CB: Coffee Break (Garden Terrace)

Thursday, February 8, 16:00 - 18:00

AS3: Session on IoT Application and Services (III)

Room: 4303 (130)
Chair: Muhidul Islam Khan (Tallinn University of Technology, Estonia)

AS3.1 16:00 ***An Unsupervised Degradation Estimation Framework for Diagnostics and Prognostics in Cyber-Physical System***
Zhenyu Wu, Hao Luo, Yunong Yang, Xinning Zhu and Xiaofeng Qiu (Beijing University of Posts and Telecommunications, P.R. China)
In order to learn the performance degradation mode of machines for diagnostics and prognostics in Cyber-Physical System (CPS), it is necessary to analyze observed sensor data to find the internal run-to-failure states of a system. In this paper, the research goal focuses on learning the internal state and transition of the degraded states from original data, which has some advantages to reveal the working dynamics of the system. Due to the existence of unlabeled data, the paper proposes an unsupervised framework based on clustering and Hidden Markov Model, named Cluster-based Hidden Markov Model (cHMM). The cHMM aims at converting raw sensory stream into a sequence of symbols as the initial observation and hidden state sequences, and then an extended Viterbi algorithm based on Hidden Markov Model (HMM) is used to discover the final stable hidden states and transitional rules in a dynamic programming way. Based on the learned model and expert's knowledge, performance degradation failure and the root-cause could be predicted and reasoned. Finally, experiments and proof-of-concept demonstration are given to validate the feasibility and effectiveness of the framework based on C-MAPSS turbofan engine dataset.
pp. 789-794

AS3.2 16:40 ***WebRTC Based Invariant Scattering Convolution Network for Automated Validation of Ultrasonic Videos for IoT Enabled Tele-Sonography***
Ramkrishna Bharath (Indian Institute of Technology, India); P Rajalakshmi (Indian Institute of Technology Hyderabad, India)
Tele-sonography works on inherent assumption that the transmitted medical ultrasound videos scanned from remote patients contain the representative data for doing the diagnosis. Due to the high subjectivity involved in scanning and semi-skilled nature of the operating person, this assumption may not always be valid. The remotely scanned ultrasound video contains a lot of redundant information, which is not useful for diagnosis. Transmitting redundant and large volumes of medical data to the expert end for analysis may lead to faulty diagnosis, associated with high transmission cost, and also poses serious challenges on data storage, processing, infrastructure, etc. Addressing these issues, we propose a novel WebRTC based framework to detect representative frames in the ultrasound video and transmit only those frames to the remote sonographer for getting a diagnosis. Detection of representative frames in ultrasound video is done with invariant scattering convolution network. The entire framework is developed using WebRTC, which enables the browser to browser communication thus reducing the computation on end ultrasound scanner and ensures ubiquitous and secured connectivity between technician and the sonographer. The proposed video validation algorithm achieved an accuracy of 96.5and nonrepresentative frames in the ultrasound video.
pp. 795-800

AS3.3 17:20 ***Group-based Incentive and Penalizing Schemes for Proactive Participatory Data Sensing in IoT Networks***
Bala Krishna Maddali (USICT, Guru Gobind Singh Indrasprastha University, New Delhi, India)
Quality of Information in IoT network is based on the fair degree of cooperation between the crowd sensing nodes, crowdsourcing nodes, mobile social nodes and cloud application servers. The constraints such as service reliability, node interaction credibility and data confidentiality impact the performance of data sensing systems. Incentive mechanisms encourage the active IoT nodes to transmit reliable data and secure the network. In this regard, this article proposes the GRoup-based Incentive and Penalizing Schemes for Proactive Participatory Data Sensing (GRIPS-PPDS) in IoT Network. GRIPS-PPDS applies the minimum set cover theorem to select the nodes that further sense and aggregate the data with high accuracy rate, consistency and reliability. The proposed model implements the rigid and relaxed modes for proactive data sensing in IoT network. Based on attributes such as quality of information, data accuracy rate, consistency, reliability and node trustworthiness, the GRIPS-PPDS scheme defines the incentive and penalizing factors to optimize the coverage region, minimize the energy consumption and secure the network. Simulation results indicate that the proposed model optimizes the coverage levels with enhanced data sensing and incentive cost for the relaxed mode PPDS as compared to the rigid mode PPDS.
pp. 801-806

EFC: Session on Edge/Fog/Cloud Computing and IoT

Room: 4204 (130)
Chair: Stefano Savazzi (Consiglio Nazionale delle Ricerche CNR, Italy)

EFC.1 16:00 ***Edge Computing Resource Procurement: An Online Optimization Approach***
Duong Nguyen (University Of British Columbia, Canada); Long Bao Le (INRS, University of Quebec, Canada); Vijay Bhargava (University of British Columbia, Canada)
The openness of the next generation communication network architecture offers tremendous potential and endless opportunities for business innovation by allowing new players to enter the network edge ecosystem. In this paper, we propose a novel model for edge computing resources procurement in which a marketplace (platform) is established between sellers (i.e., resource contributors) and buyers (i.e., resource purchasers). Each buyer has a certain budget for his procurement campaign. The sellers arrive to the platform in an online fashion and offer their computing capacities along with prices that they want to be compensated for their service. Upon the arrival of a new offer, the platform has to make an irrevocable decision to accept the offer or not and to allocate the accepted resource to a selected buyer. We present an efficient online optimization method to enable the platform to maximize the total profit of the buyers with guaranteed performance. Indeed, the developed model can be applied to other interesting settings such as edge caching and content delivery with slight modifications. Finally, numerical studies are conducted to illustrate the effectiveness of the proposed solution approach.
pp. 807-812

EFC.2 16:30 ***CEFIoT: A Fault-Tolerant IoT Architecture for Edge and Cloud***
Asad Javed (Aalto University, School of Science, Finland); Keijo Heljanko (Aalto University and HIIT, Finland); Andrea Buda (Aalto University, Finland); Kary Främling (Aalto University & ControlThings Oy Ab, Finland)
Internet of Things (IoT), the emerging computing infrastructure that refers to the networked interconnection of physical objects, incorporates a plethora of digital systems that are being developed by means of a large number of applications. Many of these applications administer data collection on the edge and offer data storage and analytics capabilities in the cloud. This raises the following problems: (i) the processing stages in IoT applications need to have separate implementations for both the edge and the cloud, (ii) the placement of computation is inflexible with separate software stacks, as the optimal deployment decisions need to be made at runtime, and (iii) unified fault tolerance is essential in case of intermittent long-distance network connectivity problems, malicious harming of edge devices, or harsh environments. This paper proposes a novel fault-tolerant architecture CEFIoT for IoT applications by adopting state-of-the-art cloud technologies and deploying them also for edge computing. We solve the data fault tolerance issue by exploiting the Apache Kafka publish/subscribe platform as the unified high-performance data replication solution offering a common software stack for both the edge and the cloud. We also deploy Kubernetes for fault-tolerant management and the advanced functionality allowing on-the-fly automatic reconfiguration of the processing pipeline to handle both hardware and network connectivity based failures.
pp. 813-818

EFC.3 17:00 ***Fog Assisted Application Support for Animal Behaviour Analysis and Health Monitoring in Dairy Farming***
Mohit Taneja (Waterford Institute of Technology & Telecommunications Software and Systems Group, Ireland); John Byabazaire and Alan Davy (Waterford Institute of Technology, Ireland); Cristian Olariu (IBM Ireland Limited & Innovation Exchange, Ireland)
With the exponential growth rate of technology, the future of all activities, including dairy farming involves an omnipresence of widely connected devices. Internet of things (IoT), fog computing, cloud computing and data analytics together offer a great opportunity to increase productivity in the dairy industry. In this paper, we present a fog computing assisted application system for animal behaviour analysis and health monitoring in a dairy farming scenario. The sensed data from sensors is sent to a fog based platform for data classification and analysis, which includes decision making capabilities. The solution aims towards keeping track of the animals' well-being by delivering early warning alerts generated through behavioural analytics, thus aiding the farmer to monitor the health of their livestock and the capability to identify potential diseases at an early stage, thereby also helping in increasing milk yield and productivity. The proposed system follows a service based model, avoids vendor lock-in, and is also scalable to add new features such as the detection of calving, heat, and issues like lameness.
pp. 819-824

EFC.4 17:30 ***Extending Scalability of IoT/M2M Platforms with Fog Computing***
Chih-Lung Tseng and Fuchun Joseph Lin (National Chiao Tung University, Taiwan)
As more and more IoT/M2M devices are connected to the Internet, the IoT/M2M platforms normally deployed in the Cloud are increasingly overloaded with a large amount of data traffic. Though more resources in the cloud may be allocated to alleviate such overloading issues, this research proposes the alternative of utilizing Fog computing to extend the scalability of IoT/M2M platforms in the cloud. The Fog is used not only to offload the over congested cloud but also to provide low latency required by critical applications. Our first step is to migrate oneM2M, a global IoT/M2M platform, to a Fog computing architecture in which the middle nodes of oneM2M are organized into a highly scalable hierarchical container-based Fog nodes. We then design a mechanism to dynamically scale in/out the serving instances of the middle nodes in order to make the whole IoT/M2M platform more scalable. The paper illustrates our system design and demonstrates our system scalability capacity using an industrial IoT (IIoT) use case. Finally, we compare the performance of our dynamic scaling mechanism with those based on a static and fixed pool of serving instances.
pp. 825-830

SCM: IEEE-SA IoT Steering Committee Meeting

Room: 4301A+4301B (138)

TOP2: Topical 2 - Smart Cities and Nations (Policy and Regulations)

Room: 4201A+4201B (138)

Organizers

Co-Chairs Shawn Chandler and Roberto Saracco

Track Summary

All cities are complex systems, balancing available resources to best exploit the value that can be provided to the population. Technology advances are continuously redefining this balance. At the same time economics and regulatory aspects play a major role in fostering the adoption and deployment of Technology and are a key ingredient in the decision making that translates potential into reality. This Vertical, on Smart Cities and

Nations, takes a global view of the current status and discusses the paths forward, taking into account the new possibilities opened by the Internet of Things.

The Internet of Things is proving that the sensing of processes, infrastructure, and city control systems, and the gathering of data is a basis for improvement and innovation. It enables the monitoring of conditions and performance of city functions and the subsequent fact based analyses results in the awareness of the city status. This in turn leads to better planning and the execution of actions that can steer the Cities' evolution, bettering the use of resources and the well being of its citizens.

Session 4: Smart Cities Policy and Regulation I

Smart City data collection from fixed sensor networks, mobile platforms and other sources will benefit residents through direct improvements to operations, including enhanced planning between agencies, and methods to permit industry and residents to inform and set expectations about factors influencing quality of life. This session will address improvements and best practices for services, including public safety, distribution networks, environmental monitoring, and planning.

Session 5: Smart Cities Policy and Regulation II

Smart Cities are collections of people, technology, and infrastructure working together to deliver many benefits. Ideally, guiding the delivery of these benefits are a set of standards to align technology and reduce costs, as well as allow for the novel creation of new services and spurring innovation that is usable and compatible with other systems over time. This session will address standards for IoT, applications for Smart Cities, as well as an extended panel discussion with audience participation about the Internet of People, concerning the intersection of smart cities and social networking.

Session 6: IEEE Internet of Things - Smart Cities Working Group Meeting

This session is the foundational session of the IEEE IoT Smart Cities Working Group, developing an agenda for Working Group matters of discussion, and laying out a roadmap for future activities. You are invited to join and become an active member of the Working Group!

Program

10:30am	Session 4	**Mirko Florindo, BT Global Services** *"Smart Safety in Smart Cities: A Concrete Solution"* "Smart Safety in Smart Cities", based on BT-Comunica Italia Alert System, is able to collect data from multiple sources, correlate them, define the risk level and quickly alert security forces and/or citizens in case of crisis situations such as natural disasters or terrorist attacks, and also manage timely assistance. The talk leverages on experiences from the field and aims at showing practical approaches to this crucial aspect.
11:00am	Session 4	**Professor Woon-Seng Gan, Centre for Infocomm Technology in the School of Electrical and Electronic Engineering in Nanyang Technological University** *"Smart Audio Sensing for Environmental Deployment"* With the availability of low-cost, sensing and processing components, we are seeing deployment of smart audio sensors in outdoor environmental monitoring. Audio information provides another dimension to surveillance and monitoring. For example, audio events give extra information on specific incidents; know the precise moment specific sound event happens; and allows us to trigger camera nearest to the incident. In this work, we developed a web-based audio intelligence monitoring at the edge (AI-ME) that can be deployed in indoor environment to recognize activities of elderly staying in alone or in elderly home. AI-ME uses acoustic signal processing with deep learning techniques to learn and understand everyday sound patterns (just like human learn to recognize sound from examples). In addition, putting the AI-ME technology into edge devices means that audio analytic do not have to rely on central server, saving on cost, increasing flexibility and scalability; also can retrofit on legacy devices, like camera. Additional video bandwidth can be saved as there is no need to stream in full high quality all the time; only when a desired sound is detected.
11:30am	Session 4	**Ghee Leng Ooi, Data-Enabled Scalable Research Laboratory, HKUST** *"The Four Pillars of a Smart City: Agreements, Trusts, Agnostic Infrastructure and Audit Trails"* Smart City is not about money; if it is, the future would have been already here, considering the amount of resources nations already threw at the vision. In this talk, we delve into the very reasons why Smart City is hard to implement, and contend that if nations want their cities smart, they should find their Smart City blueprints on top of the four pillars: agreements, trusts, agnostic infrastructure and audit trails. The first pillar solves the incentive misalignments among sensor vendors, contractors and back-end service providers through service level agreements, binding all parties to deliver a long-term, well-maintained and integrated physical and digital solutions. The second pillar solves the potential security threats lurking behind a connected city through end-to-end root-of-trusts in the infrastructure, with suggestions on how nations can assume the role of an overseer of public security from the ground up. The third pillar solves the scalability problems of customized data collection backends and protocols through a flexible and agnostic data collection infrastructure, so that cost and manpower do not get exponentially expensive as deployment scales. The final pillar deals with the assumption that once collected, every data point carries its legal weight. Therefore, we implemented a spatio-multitemporal database to document an immutable audit trail of all processes, from data creation to ingestion to transformation to queries, so that every single commit and change is recorded and version-controlled. All the experiences shared will be referenced to our works with different government bureaus and institutions in Hong Kong and Taiwan for the past 6 years. We contend that when all parties are bound to agreements, when data collection backend is flexible enough to accommodate deployment scaling, when the data collected are trustworthy and leave immutable audit trails, then will Smart City be truly maintainable and secure.
12:00pm	Session 4	**Dale Seed, InterDigital, Inc.** *"Future Proof Planning for Smart City Deployments"* Smart Cities represent one of the most challenging IoT deployment use cases. A typical Smart City consists of a diverse collection of sub-systems (traffic, emergency services, water and sewer, parking, etc). Interworking these sub-systems together with one another such that information can be shared between them is a key requirement for enabling more innovative Smart Cities use cases. However, there are several challenges to interworking these different sub-systems together. For example, in many cities each sub-system typically has its own legacy platform that is used to manage the sub-system. These legacy platforms are deployed separate and independent of each other, making interworking between them difficult. In addition, the large investment in these legacy platforms and high cost to replace them prevents city planners from swapping them out for newer technologies. oneM2M is a horizontal service layer standard that supports interworking different legacy technologies together with one another. Hence oneM2M provides a fast-track and future proof solution for IoT deployments that enables interworking of Smart City sub-systems together with one another. This talk will elaborate on the value propositions that the oneM2M standard provides for Smart Cities and will present some real-world deployment experiences of deploying the oneM2M standard within InterDigital's Chordant IoT platform.
12:30pm		Lunch Break
1:30pm	Session 5	**Bilel Jamoussi, International Telecommunication Union** *"Standards for the Internet of Things - Applications for Smart Cities"*
2:00pm	Session 5	**Nahum Gershom, The Mitre Corporation and Joel Meyers, HoozAround** *"The Internet of People: How Smart Cities and the IoT Can Provide a New Model for Business and Social Networking"* **1 Hour Session**
3:30pm		Coffee Break
4:00pm	Session 6	**IEEE IoT Smart Cities Working Group Meeting** *Moderator: Shawn Chandler, Navigant Consulting, Inc.* This session is the foundational session of the IEEE IoT Smart Cities Working Group, developing an agenda for Working Group matters of discussion, and laying out a roadmap for future activities. You are invited to join and become an active member of the Working Group!

V4: Vertical 4 - Industrial IoT (Part 2)

Room: 4202 (130)

Organizers

Co-Chairs Chung-Min Chen, Sr. Director, iconectiv, Telcordia Technologies and Ranga Rao Venkatesha Prasad (VP)

Track Summary

The digitization and automation of industrial enterprises promises to create new ways in which the cycle from concept to goods in service produces value. At the same time the application of IoT technologies also promises to significantly change the way we maintain goods and equipment in service and commensurately the use and accompanying business models. The WF will explore the ways in which IoT will impact Industrial organizations and the technologies that are likely to drive the greatest changes.

Program

10:30-12:30	Session 3. IIOT vs. Industry 4.0	**Aaron Voon-Yew Thean, National University of Singapore**

		"How's IoT Different from Internet and How It May Be the Same: A Technologist's View" We assume that as hardware and data communication technologies become increasingly accessible and commoditized, the embedment of these technologies into all things of our lives should naturally follow. Billions of connected devices serving up massive quantity of data would allow us to optimize with high precision, our resources, productivity, and work. Although IoT will improve society technologically, do we really understand the business model to fuel the movement? Technology diversity tend to come with increased accessibility. Hardware-wise, the Internet-of-Things is inherently more fragmented and diverse than our current Internet technologies. It seems that low-cost high-mix electronics dominate the edge applications. Technology businesses that fueled the internet infrastructure growth, like Semiconductor and Electronics Manufacturing, may find it challenging to capitalize on this growth with their traditional high-volume manufacturing approaches. Hence, we see a growing call for platforms, standards and ecosystems to be defined. These will likely have to be in the context of new internet services, enabled by these connected devices. In this presentation, we will look at some of the key technology convergences that led to the acceleration of the Internet before IoT and how new convergences (E.g. Machine Learning, 5G Communications, Smart City, Precision Medicine, Wearables, Etc.) may lead similarly the IoT acceleration. Looking at the value chain of the Internet today, online services provide significant business opportunities. Will this be different or the same with IoT? How will hardware technology keep up while being commoditized and who will make the money? New IoT services enabled by new hardware and software innovation will likely be necessary to drive the IoT economy. We will examine selected technologies (E.g. Semiconductors, Wireless, Artificial Intelligence, Wearables, Etc.) and their potentials towards a new convergence and the technological challenges still to be overcome. **Sumei Sun, Institute for Infocomm Research, A*STAR** *"Cognitive Industrial Internet of Things"* Industrial internet of things (IIoT), by providing connectivity to machines, robots, and sensors, etc, enables data intelligence-assisted information technology (IT) and operation technology (OT) convergence, and is a key technology in industry 4.0. In IIoT, multi-disciplinary research on communications, storage, computing and data analysis, control and management, and security, as well as cross-disciplinary system-level design optimization is needed, with built-in autonomous learning and adaptation capabilities. In this talk, we will start with a brief introduction to IIoT, and then share the IIoT research and design challenges. A design approach will then be proposed to overcome these challenges, under the theme of cognitive IIoT in which the device and the network will build up learning capabilities for context-aware resource, interference, and mobility management, automated fault detection and recovery, and robust connectivity; multi-modal security detection capability is incorporated into the device and network for real-time anomaly and security detection and management. The interactive and cooperative edge-cloud analytics will also be introduced to enable low-latency real-time actionable insight and robust feature engineering. **Shigeyoshi Shimotsuji, Software & AI Technology Center, Toshiba Digital Solutions** *"Industrial AI: Route to the Next Stage of IoT"* Industries are digitally transforming like never before and at record speed. One of key drivers is IoT, which collects digital data and converts them to user's value. The first wave of IoT visualized the state of machines and realized new applications such as condition-based maintenance to manage and operate them efficiently. It was applicable to only expensive devices and machines because of the balance between system investment and returns. The evolution of IoT technologies, particularly AI, expands applications from an individual expensive machine and group of devices in a premise to cities and communities to solve social issues such as urbanization, energy/CO2 issues, aging and labor shortage. This session will share how IoT technologies accelerate the transformation in industry segments and highlights how AI technologies expand of the transformation along with a couple of examples. **Panel Discussion**
12:30-13:30		Lunch
13:30-15:30	Session 4. IOT Case Studies, Lessons Learnt	**Speakers** **Po-Chou Lin, Chunghwa Telecom** *"IoT Development in Chunghwa Telecom (CHT)"* In the next presentation, Dr. Lin will give a talk about the IoT Development in Chunghwa telecom. First the IoT policy of Taiwan government is introduced. IoT Opportunities and Challenges for telecom companies are analyzed. CHT also develops its own IoT platform to build up the ecosystem. In the end, several IoT applications based on this IoT platform are discussed. **Michael Karner, VIRTUAL VEHICLE Research Center, Graz, Austria** *"Smart Wireless Solutions - Building Trust in the Internet of Things"* *The first part of the presentation will give a comprehensive summary of use cases, results, and expected socio-economic impacts of the DEWI project.* Smart wireless systems (wireless sensor and actuators networks, WSNs) have a number of explicit advantages over wired solutions. However, wired technologies still dominate, mainly due to the lack of dependability of wireless networks. Therefore, in 2014 the large pan-European R&D project DEWI was launched, focussing on dependable solutions for WSNs and short-range communication (TRL 4-5). With its four industrial domains (Aeronautics, Automotive, Rail, and Building) and 21 industry-driven use cases / applications, DEWI aimed at providing and demonstrating key solutions for wireless seamless connectivity and interoperability, by considering everyday physical environments of citizens in buildings, cars, trains and airplanes. DEWI, with 58 industrial and research partners from 11 European countries, created a universal cross-domain reference architecture, fully compliant with international standards (ISO/IEC) and thus fostering reusability, scalability, and interoperability of DEWI solutions (and beyond). Besides creating 30 re-useable technical building blocks, DEWI focussed on the scalability of all its solutions. Key results of DEWI were made tangible via 20 attractive real-life demonstrators all over Europe. *The second part of the presentation will give an overview of the SCOTT project, will highlight issues of trust and trustability in the Internet of Things, and will present first project results.* Creating trust in wireless solutions and increasing their social acceptance are major challenges to achieve the full potential of the Internet of Things. Therefore, SCOTT - Secure COnnected Trustable Things, a pan-European effort with 57 key partners from 12 countries (EU and Brazil), will provide comprehensive cost-efficient solutions of wireless, end-to-end secure, trustworthy connectivity and interoperability (Technology Readiness Level 6-7) to bridge the last mile to market implementation. SCOTT will not just deal with ‚things that are connected', but with ‚trustable things that securely communicate', i.e. things interconnected by dependable wireless technology and valuing the end-users' privacy rules. SCOTT uses a standardized multi-domain reference architecture, created in a predecessor project (DEWI and its "Bubble concept") and being fully compliant with ISO 29182 - Sensor Network Reference Architecture, which fosters reusability, scalability, and interoperability of SCOTT solutions. SCOTT also utilizes a clearly use-case driven approach with 15 use cases from different areas of high relevance to European society and industry; a specific focus will be put on cross-domain use cases and heterogeneous environments, emphasizing 5G and cloud computing aspects to build up digital ecosystems to achieve a broader market penetration. Use Cases will be further substantiated by the development and utilization of nearly 50 technical building blocks for security/safety, distributed cloud integration, energy efficiency/ autonomy of devices and reference architecture/implementations, which are all necessary to realize the SCOTT use cases and facilitate composability of systems as well as cross-domain sharing of trustable wireless technologies and services. SCOTT will open up new market opportunities for industry, will significantly reduce time to market and decrease costs for trustable wireless solutions on the market, in particular by using new designs and technical building blocks. SCOTT will develop methods and tools capable of meeting prospect use-case requirements on reliability, robustness, security and functional safety even in harsh and/or not trusted environments. SCOTT will build up and apply a comprehensive, dedicated Trusted System Development Framework to all its use cases to significantly foster acceptance of SCOTT solutions on the market, and to unleash the full potential of the Internet of Things. **Nirupam Sannagowdara Dasappa, Senior Scientist & Programme Director, IoT Energy Research Institute at NTU, and Co-Founder & CTO Printed Power Pte Ltd** *"The 'How' Industrial IoT - Setting Yourself Up for Success"* Internet of things (IoT) is a smart technology that connects anything anywhere at any time. Such ubiquitous nature of IoT is responsible for draining out energy from its resources. Therefore, the energy efficiency of IoT resources has emerged as a major research and development issue. In this talk, sharing an information on implementation effort of proposed energy-efficient architecture for IoT, which consists of several layers, namely, sensing and control, information processing, and presentation. The architectural design allows the system to integrate energy harvesting/self powered battery, ultra-low power sensors, robust radio's etc. This mechanism allows the energy-efficient utilization of all the IoT resources. The experimental and deployment results show a significant amount of energy saving in the case of sensor nodes and improved resource utilization of cloud resources. Also, outlining the challenges related to edge computing, connectivity, data visualization, modeling and deployment of IoT applications and potential research directions in resolving these challenges.
15:30-16:00		Break
16:00-18:00	Session 5. Round Table Discussions	**All Speakers and Participants** 1. Unlocking Digital Transformation through Industrial IoT 2. Embracing Innovation Across Industrial IoT 3. IIoT and its future: Research, Developments, Products & Service

V5: Vertical 5 - IoT for Agriculture

Room: 4302 (130)

Organizers

Mehmet Can (Jon) Vuran

Track Summary

The growth of the World Population is projected to exceed 10 Billion people by 2035, That combined with the increasing affluence of our planet's inhabitants indicates that by 2035 the demand for food will roughly double. The WF will explore how IoT technologies can contribute to meet the food demand of the world's population through improvements in yield and efficiency. Agriculture is a vertical that has many aspects and many specialties where IoT is important. The aspects include the operation of agricultural equipment; hydrology and irrigation; pest and invasive species control; management of facilities; and preservation of land and soil. Examples of specialties include arable crops; animal husbandry; aquaculture and fisheries; forestry; natural materials for consumer and industrial products; cash crops; and fruits and vegetables.

Program

10:30-11:15	**Mehmet Can Vuran** *"Overview in IoT in Agriculture"*
11:15-11:45	**Jack Ng, CEO of Sky Greens Pte Ltd** *"Farm to Table - From a Yuppie Trend to a Future Norm"* • An introduction of Sky Greens - a pioneering vertical farming technology • Current IoT application in SMART greenhouses • How IoT and change in consumer buying behavior will shape farming landscape and overcome food loss challenge
12:00-12:30	**Panel Discussion** *"Opportunities in Challenges in IoT for Agriculture"*
12:30-13:30	Lunch
13:30-14:00	**Silvia Maria Fonseca Silveira Massruhá, General Director of Embrapa Agricultural Informatics** *" IOT Perspectives in Brazilian Agriculture: From Biotechnology to Big Data for Sustainable and Smart Agriculture* The Brazilian Agricultural Research Corporation, Embrapa, was founded in 1973,and is under the aegis of the Brazilian Ministry of Agriculture, Livestock, and Food Supply. Since the foundation and with partners from the National Agricultural Research System, they have taken on the challenge to develop a genuinely Brazilian model of tropical agriculture and livestock to overcome the barriers that limited the production of food, fiber, and fuel for their country. This effort has helped to change Brazil. Nowadays, Brazil's agriculture is one of the most efficient and sustainable ones in the planet. This presentation will include implementation strategy of how Brazil will introduce IOT in tropical Agriculture, what are some of the new technologies developed by Embrapa (Brazilian Agricultural Research Corporation), and new cooperative initiatives.
14:00-14:30	**Vladimir Crnojevic, BioSense Institute** *"Internet of Agriculture"* Data is the new gold - new economy is the data economy and this holds for agriculture as well. Over the last century we have gone from 1B people on the planet to 7B, primarily due to abundance of food caused by two revolutions in agriculture - machinery and chemicals. This trend is continuing and expected population of 10B requires new revolution - Agriculture 4.0, based on Industry 4.0 where data plays the major role. New sources of data, connectivity and storage, and new processing algorithms give completely new perspective on the future of agriculture and food sector. The internet of things (IoT) has revolutionary potential. A smart web of sensors, actuators, cameras, robots, drones and other connected devices allows for an unprecedented level of control and automated decision-making. Over the last decade agricultural machines became valuable sources of data. Still, data from sensors were sparsely distributed for two reasons - lack of connectivity and high price of sensor with their limited capabilities. With penetration of IoT in agriculture, this situation is changing rapidly. Improved connectivity is not only providing access to the in-field data but is also driving the innovation in sensor technology, which should result in price cut, versatility, reliability and user-friendliness. With the help of IoT technologies higher yields and better quality produce should be expected. Pesticide and fertilizer use will drop and overall efficiency will be optimized. IoT technologies also enable better traceability of food, leading to increased food safety. One of the major efforts for systematic approach to R&D in IoT application in agri-food domain is the flagship project IoF2020 - Internet of Food and Farm, which explores the potential of IoT-technologies for the European food and farming industry. The goal is ambitious: to make precision farming a reality and to take a vital step towards a more sustainable food value chain. The aim of IoF2020 is to build a lasting innovation ecosystem that fosters the uptake of IoT technologies. For this purpose key stakeholders along the food value chain are involved in IoF2020 together with technology service providers, software companies and academic research institutions. Nineteen use-cases organised around five sectors (arable, dairy, fruits, meat and vegetables) develop, test and demonstrate IoT technologies in an operational farm environment all over Europe.
14:30-15:00	**Ganesh Subramanian, Panimalar Institute of Technology, Chennai** *"Drones/UAVs for Aerial surveillance -The Indian Perspective"* The farming industry will become arguably more important than ever before in the next few decades. The IoT is set to push the future of farming to the next level. Smart agriculture is already becoming more commonplace among farmers, and high tech farming is quickly becoming the standard thanks to agricultural drones and sensors. The world will need to produce 70% more food in 2050 than it did in 2006 in order to feed the growing population of the Earth, according to the UN Food and Agriculture Organization. The main goal of this presentation is to focus on the impact of drones in precision farming and implement a Smart irrigation system through various networking technologies and their integration with IoT.
15:00-15:30	**Tom Penning, Irrometer Co., Inc.** *"Presentation: Is IoT the future of Ag?"* To feed an expected world population of 9.1 billion by 2050, an increase of 1.5 billion from current levels, food production will also need to increase to meet this growing demand. Even though this represents a 34% increase in population growth, because of swelling urban sprawls, increasing income levels, producer demographics and expanded use of crops for bio-energy and other industrial purposes, crop production will need to be increased by more than 70% to satisfy all these needs. To achieve this projected growth target in crop production, agriculture will have to rely on technology more than ever. Technology has already been integrated into farming methods to make farming more efficient. For example, farming is relying on sensors to trace, detect and diagnose issues with soils, crops, livestock machinery, etc. Similarly, remote sensing and precision agriculture are already optimizing farm inputs. However, these technologies might not be enough and will need to become more efficient in order to meet the exponential growth in crop production demand. It is therefore vital that we think of ways in which this could be possible. The Internet of Things (IoT) could be the catalyst that could make some of these existing technologies even more efficient. An IoT platform will allow for various and numerous devices in the field to exchange data efficiently and economically so that near real-time recommendations and prescriptions could be generated by systems such as Farm Management Information Systems (FMIS), making farming much more efficient. This paper will describe a use case of how an IoT platform and communication technologies, focused primarily on collection of soil moisture data from agricultural fields, can be used. This data will be standardized so that exchange between irrigation management systems is seamless. AgGateway's Precision Ag Irrigation Language (PAIL) and Standardized Precision Ag Data Exchange format (SPADE) will be used as the standardization and exchange tool respectively.
15:30-16:00	Coffee Break
16:00-16:30	**Dr. Wuxiong Zhang, Associate Professor, Shanghai Research Center for Wireless Communications** *"Massive IoT Monitoring System for the South-to-North Water Diversion Project in China* This talk introduces the design and implementation challenges of distinctive IoT technologies for the world longest water monitoring system of the South-to-North Water Diversion Project in China. This system consists of a variety of advanced sensors for monitoring weather, geological features, infrastructure health, water quality and quantity, and security. In particular, three key problems have been addressed: (1) real-time processing of large volume of mixed structured and unstructured sensing data from 100K+ sensors; (2) multi-hop data transmission over heterogeneous wireless networks (WSN/WLAN/GPRS/3G/4G) with strict constraints in end-to-end delay performance (less than 3 seconds) and connection reliability (greater than 99.9%) for over 1430KM distance; and (3) web-based data integration and visualization in a comprehensive system for remote monitoring, dispatching, command and control functions at all times and all situations. Currently, this impressive IoT monitoring system covers the entire 1432 KM drainage basin from Danjiangkou Water Reservoir in Hunan Province to Beijing and Tianjin cities. It is providing crucial real-time information for day-to-day surveillance, operation and management of the world longest water diversion system.
16:30-17:30	**Working Group Round Table**