IEEE Internet of Things

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2014 IEEE World Forum on Internet of Things (WF-IoT) Program

Time	Seoul	Rome	Berlin
Thursday, March 6			
08:00	Tutorial: *Application Architectures for Internet of Things: State-of-the-art and Research Directions*	Tutorial: *The Convergence of Social Networks and the Internet of Things: Opportunities Technologies, and Challenges*	Tutorial: *IoT/M2M Service Platforms and Related International Standards*
10:45	*Opening Ceremony (Olympia)*		
11:00	Keynote (Olympia): *Paving the Way to Internet of Things*		
11:45	Keynote (Olympia): *Internet of Things: Journey to Success*		
12:30	*Lunch (Arirang, 2F)*		
13:30	*Experiments - Platforms*	*Management of IoT Systems*	*Web of Objects*
15:30	*Coffee Break*		
16:00	*Discovery and Positioning*	*Challenge on IoT, IPv6 and Smart Objects: An EU and Korean perspective*	*Societal Impacts*
18:30	*Welcome Reception (Olympia)*		
Friday, March 7			
08:00	Poster Presentations: *Technology - Software*	Poster Presentations: *Technology - Network*	Poster Presentations: *Services*
09:15	Keynote (Seoul): *Orchestrating the Smarter Planet in the World of Internet of Things*		
10:00	*Experiments - Radio*	*Internet of Vehicles*	*Standards 1*
12:00	*Lunch (Café, 1F)*		
13:00	*Poster Display (Athens)*		
13:30	*Critical Services*	*Platforms*	*Standards 2*
15:30	*Coffee Break*		
16:00	*Transport and Energy Management*	*Mobile Networks*	*Standards 3*
18:30	*Banquet (Olympia)*		

Saturday, March 8

08:00	*Service Scenarios and Platforms*	*IoT and Cloud Computing*	*Social IoT*
09:00			*Routing / Protocols*
10:00	*Energy*	*Software Architectures*	
12:00	*Lunch (Arirang, 2F)*		
13:30	*Experiments - Technologies*	*Semantic / Analytic for IoT*	
15:30	*Closing Ceremony (Seoul)*		

Thursday, March 6

08:00 - 10:30

Tutorial: Application Architectures for Internet of Things: State-of-the-art and Research Directions

Roch Glitho (Concordia University, Canada)

Room: Seoul

Internet of Things (IoT), aims at enabling interactions between devices ranging from wireless sensors/actuators to smart meters, with little or no human intervention. This tutorial proposes an overview of IoT application architectures and discusses the related research issues. It comprises two parts. In the first part, we give background information. The standard system architectures proposed so far for IOT (e.g. ETSI M2M architecture, Wimax M2M architecture) are introduced along with the standard communications and networking technologies (IEEE 802.15.4, Zigbee, 6LoWPAN) on which they rely. We also discuss concrete IOT application use cases, gives insights in the application architecture related - challenges, and derive requirements. In the second part, the body of knowledge in application architectures is reviewed in light of the requirements. The review includes the middleware proposed so far (e.g. RESTful Web services based - middleware). It also includes the applications layer protocols being developed (e.g, IETF CoAP) for IOT. In addition the emerging cloud architectures (e.g. virtualization architectures for cost efficient IoT application provisioning) and 4G Evolved Packet Core (EPC) architectures (e.g. differentiated QoS architectures for IoT applications) are introduced. Concrete use cases are presented for illustration purpose. Strengths and weaknesses are assessed. Related research directions are identified.

Tutorial: IoT/M2M Service Platforms and Related International Standards

Fuchun Joseph Lin (National Chiao Tung University, Taiwan); Ming Lai (Applied Communication Sciences, USA)

Room: Berlin

The need for a common service platform for IoT/M2M applications is becoming increasingly critical. Though many IoT/M2M services, such as smart home, smart energy, eHealth and connected vehicle, already exist for several years, they involve complex effort in design and development of underlying network control such as authentication, access control, information storage and retrieval, device connection and application logic. To make it worse, this effort is often tied to a specific type of device, network, and application in a vertical market. Consequently, the same or similar effort needs be repeated again when developing the IoT/M2M services with a different type of device, network, or application. This tutorial addresses this critical need of the IoT/M2M. We will first introduce to the audience the current landscape and new trends of the IoT/M2M, then articulate the needs and requirements of a common IoT/M2M platform. In order for such a common service platform to be useful, an international standard is required to facilitate interoperability and build economies of scale. Thus, we will give a survey of the effort in international standards for IoT/M2M common service platforms. Finally, we will present the experiments of developing IoT/M2M applications over a standard common service platform at NCTU.

Tutorial: The Convergence of Social Networks and the Internet of Things: Opportunities Technologies, and Challenges

Antonio Iera (University Mediterranea of Reggio Calabria, Italy); Luigi Atzori (University of Cagliari, Italy); Giacomo Morabito (University of Catania, Italy)

Room: Rome

This Tutorial focuses on the convergence of the Internet of Things (IoT) and Social Network paradigms towards the deployment of a social network wherein things establish social links as humans do. This concept is fast gaining ground as demonstrated by scientific studies and commercial platforms developed by companies, such as Ericsson, Evrythng and Paraimpu. The tutorial addresses the scalable discovery and search of Things and relevant services, privacy and security of information handled by Things, heterogeneity of Things, interactions among heterogeneous Internet resources, and new communication paradigms applicable to the Internet of trillions of objects. In this context, social networks provide powerful solutions to create a social structure among members that guarantees network navigability and enables effective service discovery while guaranteeing scalability. The social links also constitute a remarkable basis for the management of the Things trustworthiness. Additionally, the social network is proven to be a very influential way for making visible each node in a network of trillions of members. Within the Tutorial, all the different aspects of the cited topic will be thoroughly addressed by finalizing them to the constitution of the background for the definition of new paradigms for data networking in the future Internet.

10:45 - 11:00

Opening Ceremony (Olympia)

11:00 - 11:45

Keynote (Olympia): Paving the Way to Internet of Things

Kyungwhoon Cheun, Senior Vice President, Samsung Electronics DMC R&D Center

The advent of low-cost, low-profile electronic components is rendering more objects around us to gain intelligence and the ability to communicate via the Internet, hence the Internet of Things (IoT). Business analysts estimate that up to a trillion devices will be equipped with connectivity by 2020, contributing to IoT market potential in the range of tens of trillion of dollars. Meanwhile, Samsung has been driving the IoT revolution through innovations in key components such as CPU, flash, and wireless network equipments for LTE and Wi-Fi. Moreover, Samsung remains one of the leading providers for devices such as Smartphones, Smart TVs, and Wearables, which collectively represent a significant portion of the "Things". For vertical market solutions, Samsung is actively involved across a wide spectrum of topics such as Smart home, Connected cars, Connected health, Digital signage, and Smart retail. In this talk, we will first assess the current IoT technology, identify key issues and challenges and conclude by illustrating the future R&D direction.

11:45 - 12:30

Keynote (Olympia): Internet of Things: Journey to Success

Vida Ilderem, Vice President of Intel Labs and Director of the Integrated Platform Research for Intel Corporation

Tens of billions of interconnected devices by 2020, a prediction that is both exciting and challenging that provides rich opportunities for innovation. The technology industry at large is mobilizing and realizing a greater vision for Internet of Things, one that encompasses sensing and sensing platforms, mobile and fixed gateways, analytics and big data, security, manageability, and interoperability. To realize this vision, we need to innovate in many disciplines and drive for common frameworks and standards. This talk will focus on IoT technology innovation challenges and

opportunities for this segment of the embedded market.

12:30 - 13:30

Lunch (Arirang, 2F)

13:30 - 15:30

Experiments - Platforms

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

Challenges From the Identities of Things
Ingo Friese (Deutsche Telekom Laboratories, Germany); Jörg Heuer (Deutsche Telekom Laboratories, Germany); Ning Kong (CNNIC, P.R. China)
The Internet of Things (IoT) becomes reality. But its restrictions become obvious as we try to connect solutions of different vendors and communities. Apart from communication protocols new identity management mechanisms are crucial for a growing IoT. The recently founded Identities of Things Discussion Group within Kantara Initiative will work on open issues and solutions to manage "Identities of Things" as an enabler for a fast growing eco-system.

The Internet of Things as Greenfield Model
Helmut Zuerner (Verizon, Germany)
Prognoses predict the number of smart devices building the Internet of Things (IoT) to range between 30 and 50 billions in 2020, in the most conservative outlook triplicating today's numbers of devices connected to the Internet in just 7 years. While hardware developments and new standards for network and application protocols are progressing well, there is little consensus about how such heterogeneous, wide-scale networks should be planned, administrated and integrated with traditional networks, but also cloud computing infrastructure in a holistic, end-to-end fashion. Thousands of different vendor hardware and software options and incompatible technological lifecycle time spans for smart things will result in serious challenges for device orchestration, management and network scaling. The framework for data collection, transmission and storage is already being raised as an elementary question when aspects of social acceptance and regulatory transparency are being discussed. In this paper we propose a basic, holistic categorization model for devices building the IoT which aims at addressing some of the challenges described by introducing an universal, simple, high-level labeling scheme which contains different flags specifying possible application or use cases, data flow and storage options, economic and ecologic parameters as well as management and control elements.

Design and Implementation of a WiFi Sensor Device Management System
Xuejun Cai (Ericsson, P.R. China); Yan Wang (Ericsson Communications Co. Ltd., P.R. China); Xiuyong Zhang (Ericsson, P.R. China); Lu Luo (Ericsson China Communications Company Ltd., P.R. China)
In this paper, we described the design for a device management system of 802.11 based sensors. In this management system, the management functions are separated from IoT services and put into a logically centralized management entity. The management entity manages the sensors through a lightweight management protocol which is based on IETF CoAP protocol. In addition, the management entity provides north bound interface to IoT services. According to the design, we have implemented a PoC system which includes the 802.11 based sensors, the management entity and a sample IoT service. The PoC system has proved the feasibility and effectiveness of our design.

Horizontal M2M Platforms Boost Vertical Industry: Effectiveness Study for Building Energy Management Systems
Martin Floeck (NEC Laboratories Europe, Germany); Apostolos Papageorgiou (NEC Laboratories Europe, Germany); Anett Schülke (NEC Laboratories Europe, Germany); JaeSeung Song (Sejong University, Korea)
Machine-To-Machine (M2M) is seen as driving enabler for smart solutions for future smart cities. Specialized vertical M2M solutions approaching the markets with the challenges to meet sustainable business solutions. However, it is essential to develop standard based horizontal service platforms in the domain of M2M industry to achieve the M2M vision, i.e., connecting all different types of devices to communicate with one another. This paper reviews M2M platforms from vertical domains as well as M2M related standardizations. While vertical proprietary M2M solutions provides some value to their vertical sectors, most challenges are identified in scalability and interoperability. Specifically, we perform an analysis centered on a building management M2M system(CAMPUS21) and two M2M standards(ETSI M2M and HGI) platforms. Identified gaps, e.g., incompatibilities on data model, dependencies on multiple vendors and restricted resource sharing are addressed with three major steps: (i) defining and sharing common terminologies, (ii) enabling to add semantic information, and (iii) exchanging semantic meaning instead of raw data. As solution, we suggest a required extension of horizontal M2M architecture in order to provide interconnection between proprietary M2M systems and standardized M2M systems, and draw lessons for conclusion in the future direction to realize the vision of horizontal M2M system.

Using Unity 3D to Facilitate Mobile Augmented Reality Game Development
Sung Lae Kim (Ajou University, Korea); Teemu H Laine (Ajou University, Korea); Hae Jung Suk (Ajou University, Korea); Joonas Westlin (Ajou University, Korea); Jun Mo Jung (Ajou University, Korea); Jeong Hwa Kang (Ajou University, Korea)
Mobile augmented reality (mobile AR) enables virtual content such as 3D models, animations and annotations to be placed on top of a real world objects in any context. We applied mobile AR to develop the Calory Battle AR exergame to tackle worldwide childhood obesity. In this game the player finds and defuses virtual calory bombs in a real world environment. Specifically, we present the development of two game versions. First prototype was created without a third party game engine and it led to many challenges. To explore solutions to these challenges, we created a new version of game with the Unity 3D game engine. Using the Unity 3D, the game development process was simplified. A mixed-method usability evaluation on children and university students indicated that especially interaction with AR content and user interface clarity were improved in the Unity 3D version. This study produced three important contributions: 1) a novel mobile AR exergame to motivate children to move; 2) reimplementation of the game using the Unity 3D; and 3) results of a usability evaluation comparing two game versions. We expect that game engines such as the Unity 3D will become essential for AR game development in the future.

Management of IoT Systems

Room: Rome
Chair: Yacine Ghamri-Doudane (University of la Rochelle, France)

A Standard Compliant Security Framework for IEEE 802.15.4 Networks
Giuseppe Piro (Politecnico di Bari, Italy); Gennaro Boggia (Politecnico di Bari, Italy); Luigi Alfredo Grieco (Politecnico di Bari, Italy)
The IEEE 802.15.4 standard is widely recognized as one of the most successful enabling technologies for short range low rate wireless communications. It covers all the details related to the MAC and PHY layers of the protocol stack. In addition, it supports the possibility to protect MAC packets by using symmetric-key cryptography techniques and it offers several security options. But, at the same time, the standard relies on upper layers to orchestrate the usage of the plethora of security profiles and configuration settings it makes available, as well as to handle the creation and the exchange of encryption keys. In support of this functionality, this work describes a standard compliant security framework aimed at proposing: (i) different kind of security architectures, (ii) an efficient mechanism for initializing a secure IEEE 802.15.4 domain, and (iii) a lightweight mechanism to negotiate link keys among devices.

Low-Power Semantic Fault-Detection in Multi-Sensory Mobile Health Monitoring Systems
Vishwa Goudar (University of California, Los Angeles, USA); Miodrag Potkonjak (University of California at Los Angeles, USA)
Multi-Sensory mobile health monitoring systems promise substantial improvements in the quality of healthcare. However, large-scale trials are uncovering key areas that inhibit long-term large-scale deployments, including power consumption and lifetime issues, and high communication overhead. Traditional techniques can efficiently resolve these issues while maintaining semantic fidelity of the sensed medical signal, but also amplify the signal's sensitivity to sensor faults, thereby reducing system safety. We propose a set of statistical techniques to optimize system power and bandwidth consumption, while adhering to signal fidelity and sensor fault diagnosis requirements. By defining signal fidelity in terms of its semantic value, and formulating the problem as a sensor subset selection wherein mutual information rather than aggregate signal quality is maximized, we show that power consumption in a wireless human gait monitoring system can be reduced by up to 78% while accurately estimating many functional gait assessment metrics and precisely diagnosing semantic faults.

Pseudo Random Number Generator and Hash Function for Embedded Microprocessors
Hwajeong Seo (Pusan National University, Korea); Jongseok Choi (PUSAN, Korea); Hyunjin Kim (Pusan National University, Korea); Taehwan Park (Pusan National University, Korea); Ho Won Kim (Pusan National University, Korea)
Embedded microprocessors are commonly used for future technologies such as Internet of Things(IoT), RFID and Wireless Sensor Networks(WSN). However, the microprocessors have limited computing power and storage so straight-forward implementation of traditional services on resource constrained devices is not recommenced. To overcome this problem, lightweight implementation techniques should be concerned for practical implementations. Among various requirements, security applications should be conducted on microprocessors for secure and robust service environments. In this paper, we presented a light weight implementation techniques for efficient Pseudo Random Number Generator(PRNG) and Hash function. To reduce memory consumption and accelerate performance, we adopted AES accelerator based implementation. This technique is firstly introduced in INDOCRYPT'12, whose idea exploits peripheral devices for efficient hash computations. With this technique, we presented block cipher based light-weight pseudo random number generator and simple hash function on embedded microprocessors.

Bridging SCADA Systems and GI Systems
Simon Back (Salzburg University of Applied Sciences, Austria); Simon Kranzer (Salzburg University of Applied Sciences, Austria); Thomas

Heistracher (Salzburg University of Applied Sciences, Austria); Thomas Lampoltshammer (University of Salzburg, Austria)
Supervisory Control and Data Acquisition (SCADA) systems are omnipresent in production operation worldwide. Failure detection within these systems remains a challenging task as the level of granularity in terms of location-based identification is low. The systems are able to identify and display failing components, but the situation becomes even more severe in case one of the failing components is not an electronic component but a structural component with a spatial extent such as a pipeline system. In consequence, the process of detection and repair of such components remains a time-consuming and cost-intensive task. To provide a generic solution for this kind of issues, the authors present a conceptualization and a first prototypical implementation of a software adapter bridging a SCADA system and a Geographic Information System (GIS). The authors employ international standards from both domains to enable an information exchange between these systems. The resulting autonomous software adapter thus extends SCADA systems with GIS capabilities.

Decentralized Fault Tolerance Mechanism for Intelligent IoT/M2M Middleware
Penn Su (National Taiwan University, Taiwan); Chi-Sheng Shih (National Taiwan University, Taiwan); Jane Hsu (National Taiwan University, Taiwan); Kwei Jay Lin (UniversityCalifornia, Irvine, USA); Yu-Chung Wang (National Taiwan University, Taiwan)
Failover for service-oriented distributed networks is a prerequisite to enabling Internet-of-Things (IoT) in the sense of "deploy-once, run forever." Resource reconfiguration is required to achieve failover mechanisms upon replacement of devices or failure of services. It can be particularly challenging when services in applications have more than end-to-end transmissions between devices that are heterogeneous or versatile, for which duplications can be costly and redundant. Specifically, a device with a failed service shall be taken over by another service peer, instead of a device counterpart to recover application as a whole. Strip is introduced to store a list of duplicated services, and, each service peer maintains a consistent view of strips. In combination with the heartbeat protocol which was widely applied for failure detection, recovery from failure can be achieved by manipulating strips in a distributed manner. Experiments using Arduino Mega 2560 compatible devices show that our approach is capable of failover in small networks, whereas experiments in larger networks are underway. Future research directions include addressing the scalability issue, network partitions and tackling simultaneous failures.

Towards the Era of Wireless Keys: How the IoT Can Change Authentication Paradigm
Vitaly Petrov (Tampere University of Technology, Finland); Sviatoslav Edelev (University of Goettingen, Germany); Maria Komar (Yaroslavl State University, Russia); Yevgeni Koucheryavy (Tampere University of Technology, Finland)
In this paper, a new paradigm of user authentication called "wireless key" is described. Following this concept, a novel many-to-many authentication scheme based on passive NFC tags is proposed. In contradiction to existing solutions that assume a wireless key to be a battery-powered device with considerable computational power, we suggest to use a passive NFC tag in order to minimise the key size and significantly reduce the costs. The security of all the information on the tag is guaranteed by a specific data encryption scheme constructed on top of strong cryptographic primitives. In our approach, all the computations are performed by the service user is authenticating in, and thus no computational power and no battery on the key side is needed. This comes to an user-friendly, secure and cost-efficient solution. Moreover, the system core - proposed encryption scheme - could be easily applied to any other carrier technologies, as, for example, to Bluetooth Low Energy or Wireless USB. Having generalised our solution to hold an integrity property, it can also be used for another emerging application - secure documents storage.

13:30 - 15:00

Web of Objects

Room: Berlin
Chair: Il Young Chong (Hankuk University of Foreign Studies, Korea)

Short Paper: MPOT: 3D Mote Placement Optimization Tool for Wireless Sensor Networks
Tamer Ali (Cairo University, Egypt); Rabie Ramadan (Cairo University, Egypt); Mohamed Khairy (Elec. and Comm. Dept., Faculty of Eng., Cairo Univ, Egypt)
The area of Wireless Sensor Networks (WSNs) have attracted many researchers lately. The applications of WSNs have been widely spread in different fields including battle and health monitoring fields. In addition, smart environment became one of the important applications of the WSNs. However, the current simulators are still limited to cover all of the applications of WSNs, especially the ones that require deployment in three dimensions (3D) such as smart home, smart classroom, smart city, and smart University. In this paper, we introduce our vision and implementation of the first 3D WSN simulator, to the best of our knowledge. In addition, we present the concept of multimodal WSNs where a Motes may involve different sensing devices. Some parts of our simulator, named Mote Placement Optimization Tool (MPOT), are built on of-the-shelf components with some modifications. Throughout the paper, we report our experience and progress in building such 3D simulator. This work is part of Web of Object project sponsored by ITEA 2 (UK) and ITIDA (Egypt).

Short Paper: Mote Deployment Algorithms in 3D WSNs
Rabie Ramadan (Cairo University, Egypt); Tamer Ali (Cairo University, Egypt); Mohamed Khairy (Elec. and Comm. Dept., Faculty of Eng., Cairo Univ, Egypt)
This With the advances of hardware technology, WSNs have been utilized in many critical application. Some of these applications are battle field monitoring , health care monitoring , structure health monitoring, and many other applications. However, there are some other applications that require Three Dimension (3D) deployment such as smart home , smart classroom, and/or even smart city or smart University. Few researchers have studied such applications and one of their problems is the 3D deployment. Most of them use a deterministic deployment method and build all of the network measurements and consideration based on such deployment. In addition, there is a lack of 3D simulators that handles such deployment including the 3D environment , 3D channel models , and 3D optimization objectives. This paper briefly introduces a 3D Mote Placement Optimization tool (MPOT) ; however, the main focus will be in two out of four deployment algorithms that already implemented and tested in addition to the Random Deployment algorithm. The other two 3D deployment algorithms will be discussed in another research articles once finalized. The may provide a base for the WSNs researchers to lookup 3D applications of WSNs.

Short Paper: Object Collaboration Model to Create Joint Knowledge in WoO Environment
Sang Hum Lee (Hankuk University of Foreign Studies, Korea); Il Young Chong (Hankuk University of Foreign Studies, Korea)
Advancing services provided by IoT are considering essential capability which could provide user with smart services that is suited for their needs. The Semantic Ontology models representing device, resource and service model into virtual objects to interconnect and transmit data and attributes of each various things will create the knowledge. This paper will provide the Semantic Ontology model and use case with collaboration of objects to create service knowledge in WoO Environment.

Short Paper: Context-aware Adaptive Streaming in Web of Objects Environments
Dongchil Kim (Kwangwoon University, Korea); Dooyeol Yun (Kwangwoon University, Korea); Kwangsue Chung (Kwangwoon University, Korea)
The proliferation of various objects and explosive development of the Internet technologies such as Web of Objects (WoO) have contributed to an increasing demand for multimedia streaming applications. The adaptation of multimedia content according to context information is essential to supporting these applications in the WoO environments. In this study, we design a context-aware adaptive streaming framework. The proposed framework seamlessly manages multimedia content inputs from multimedia sensors. It also controls the quality of multimedia content based on the various context information such as content, device, and network. The implementation result shows that our framework adaptively transmits multimedia content to various mobile devices.

Short Paper: WoO Approach General Overview. Business Context, Innovative Features and Proposed Framework
Mihaela Brut (Theresis, Thales Services S.A., France); Patrick Gatellier (Theresis, Thales Services S.A., France); Il Young Chong (Hankuk University of Foreign Studies, Korea)
In order to pave the way towards the emerging business perspective of the IoT-based applications, the "Web of Objects" project contributes to the development/establishment of the application layer on the top of the IoT-related technologies, enabling to include in complex business applications various devices that are connected to Internet by means of IoT technologies. More precisely, the WoO project provide solutions for ensuring the interoperability of heterogeneous devices in such application, for developing semantic-based service composition and reasoning functionalities, as well as for ensuring the devices privacy. For considering Smartphone as a device example, its sensors are capitalized by the WoO approach both for making Smartphone as an actor in IoT business applications and for extending the scope of Smartphone integrated applications.

15:30 - 16:00

Coffee Break

16:00 - 17:30

Challenge on IoT, IPv6 and Smart Objects: An EU and Korean perspective

Room: Rome
Chairs: Latif Ladid (University of Luxembourg / IPv6 Forum, Luxemburg), Sebastien Ziegler (Mandat International, Switzerland)

A Decentralized Approach for Security and Privacy Challenges in the Internet of Things
Antonio Fernando Skarmeta Gomez (University of Murcia, Spain); José Luis Hernandez Ramos (University of Murcia, Spain); María Victoria Moreno Cano (University of Murcia, Spain)
The strong development of the Internet of Things (IoT) is dramatically changing traditional perceptions of the current Internet towards an integrated vision of smart objects interacting

with each other. While in recent years many technological challenges have already been solved through the extension and adaptation of wireless technologies, security and privacy still remain as the main barriers for the IoT deployment on a broad scale. In this emerging paradigm, typical scenarios manage particularly sensitive data, and any leakage of information could severely damage the privacy of users. This paper provides a concise description of some of the major challenges related to these areas that still need to be overcome for a full acceptance of all IoT stakeholders. In addition, we propose a distributed capability-based access control mechanism which is built on public key cryptography to cope with some of these challenges. Specifically, our solution is based on the design of a lightweight token used for access to CoAP Resources, and an optimized implementation of the Elliptic Curve Digital Signature Algorithm (ECDSA) inside the smart object. The results obtained from our experiments demonstrate the feasibility of the proposal and show promising in order to cover more complex scenarios in the future.

A Process-Based Internet of Things

Socrates Varakliotis (University College London, United Kingdom); Peter Kirstein (University College London, United Kingdom); Antonio J. Jara (HES-SO, Switzerland); Antonio Fernando Skarmeta Gomez (University of Murcia, Spain)

The Internet of Things (IoT) is envisaged as a unified network of 'smaller' networks that live on the fringes of the Internet, such as systems that monitor and control buildings, industrial plants, the power grid, etc. The Internet Protocol (IP) has been promoted as the transport glue that implements this vision. Although we observe a converged view from the various application domains that their gateways should adopt IP, it is clear that the path to full adoption is long. The gateways may impose very specific requirements of security, resilience to failures, ease of maintenance and upgrade. We present the design goals of an enhanced architecture for the IoT that can reduce such concerns, paving the way for faster adoption of IP in the IoT. We argue that the functions one needs to perform in IoT networks of various application domains can be summarised in a small group of basic request-response operations, which traverse gateways and act as the transport layer. We describe how more complex functions, abstracted into server-based processes, can then be executed by the basic transport operations. With this approach we aim to reduce the technology-specific functions of IoT gateways, which now even become transparent, at best.

Designing IoT Architecture(s) - A European Perspective

Srdjan Krco (DunavNET & University of Belgrade, Faculty of Organizational Sciences, Serbia); Boris Pokric (DunavNET, Serbia); Francois Carrez (University of Surrey, United Kingdom)

Internet of Things (IoT) domain has attracted a lot of interest over the last few years, to a large extent due to its applicability across a plethora of application domains. This variety of application domains resulted in a variety of requirements that IoT systems should comply with. Due to the heterogeneity of the domains, the requirements varied significantly, and demanding more or less complex systems with varied performance expectations. This situation affected the architecture design and resulted in a range of IoT architectures with not only varied set of components and functionalities, but also varied terminologies used. It resulted in limited interoperability between the systems which in turn hampered development of the complete domain. To address these issues, to ensure a common understanding by providing a framework catering for different applications and eventually enable reuse of the existing work across the domains, reference architectures are an appropriate tool. This paper presents an overview of the activities done in Europe towards definition of such a common framework together with how it is being used and a potential outlook for these efforts.

Semantic Open IoT Service Platform Technology

Dong-Hwan Park (Electronics and Telecommunications Research Institute, Korea); HyoChan Bang (ETRI, Korea); Cheol Sig Pyo (ETRI, Korea); Soon Ju Kang (Kyungpook National University, Korea)

This paper focuses on how technologies contributes to improving interoperability between IoT devices, and making easily use of IoT devices. The proposed platform technology provides semantic-based IoT information services, and semantic interoperability of IoT devices. This service platform can be applicable to a lot of semantic IoT services: collecting invisible information in real environment by smart devices, providing smart life services by sharing, participating, distributing open sensing information.

OpenIoT: An Open Service Framework for the Internet of Things

Jaeho Kim (Korea Electronics Technology Institute, Korea); Jang-Won Lee (Yonsei University, Korea)

The Internet of Things (IoT) has been a hot topic for the future of computing and communication. It will not only have a broad impact on our everyday life in the near future, but also create a new ecosystem involving a wide array of players such as device developers, service providers, software developers, network operators, and service users. In this paper, we present an open service framework for the Internet of Things, facilitating entrance into the IoT-related mass market, and establishing a global IoT ecosystem with the worldwide use of IoT devices and softwares. We expect that the open IoT service framework we proposed will play an important role in the widespread adoption of the Internet of Things in our everyday life, enhancing our quality of life with a large number of innovative applications and services, but also offering endless opportunities to all of the stakeholders in the world of information and communication technologies.

16:00 - 18:00

Discovery and Positioning

Room: Seoul

Chair: Ingo Friese (Deutsche Telekom Laboratories, Germany)

Sensor Discovery and Configuration Framework for the Internet of Things Paradigm

Charith Perera (The Australian National University & Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia); Prem Prakash Jayaraman (CSIRO, Australia); Arkady Zaslavsky (CSIRO, Australia); Dimitrios Georgakopoulos (CSIRO, Australia); Peter Christen (The Australian National University, Australia)

Internet of Things (IoT) will comprise billions of devices that can sense, communicate, compute and potentially actuate. The data generated by the Internet of Things are valuable and have the potential to drive innovative and novel applications. The data streams coming from these devices will challenge the traditional approaches to data management and contribute to the emerging paradigm of big data. One of the most challenging tasks before collecting and processing data from these devices (e.g. sensors) is discovering and configuring the sensors and the associated data streams. In this paper, we propose a tool called SmartLink that can be used to discover and configure sensors. Specifically, SmartLink, is capable of discovering sensors deployed in a particular location despite their heterogeneity (e.g. different communication protocols, communication sequences, capabilities). SmartLink establishes the direct communication between the sensor hardware and cloud-based IoT middleware. We address the challenge of heterogeneity using a plugin architecture. Our prototype tool is developed on Android platform. We evaluate the significance of our approach by discovering and configuring 52 different types of Libelium sensors.

Exploring the Use of DNS as a Search Engine for the Web of Things

Andreas Kamilaris (University of Cyprus, Cyprus); Koula Papakonstantinou (University of Cyprus, Cyprus); Andreas Pitsillides (University of Cyprus, Cyprus)

Sensor technology is becoming pervasive in our everyday lives, measuring the real world around us. The Internet of Things enables sensor devices to become active citizens of the Internet, while the Web of Things envisions interoperability between these devices and their services. An important problem remains the need for discovering these devices and services globally, in real-time, within acceptable time delays. Attempting to solve this problem using the existing Internet infrastructure, we explore the exploitation of the Domain Name System (DNS) as a scalable and ubiquitous directory mechanism for embedded devices. We examine the feasibility of this approach by performing a simulation involving up to one million embedded devices, to test system performance and scalability. Finally, we discuss about practical issues and the overall potential of this approach.

Semantic Positioning Via Structured Sparsity Models

Giuseppe Destino (CWC, University of Oulu, Finland); Davide Macagnano (Centre for Wireless Communications, University of Oulu, Finland)

Semantic positioning is a new paradigm emerging with the Internet-of-Things (IoT) technology and its application to context-aware services in smart-spaces. Specifically, it refers to the problem of detecting user actions and locations based on prior characterization of the space and sensed data. Differently from classic positioning, input data are measurements of the interaction between human and sensors and location information is not a vector of coordinates but a a point in a topological map. In this paper, we tackle this challenge with a mere passive monitoring system in order to preserve user privacy, handle device heterogeneity, energy efficiency and utilizing low-complexity sensors that are able to capture events generated by human actions. We develop a structured sparsity model based on the notion of discrete Radon transforms on homogeneous space in order to construct mappings from events to actions and from actions to semantic locations. We propose algorithms for human activity detection and semantic positioning. Specifically, the Least Absolute Residual and Shrinkage Operator (LARSO) for human action detection, and a mixed-norm optimization to perform semantic positioning. Simulation results are shown to validate the proposed model and compare different algorithms.

An Online Sequential Extreme Learning Machine Approach to WiFi Based Indoor Positioning

Han Zou (EXQUISITUS, Centre for E-City, School of Electrical and Electronics Engineering, Nanyang Technologic & Berkeley Education Alliance for Research in Singapore Limited, Singapore); Hao Jiang (Nanyang Technological University, Singapore); Xiaoxuan Lu (Nanyang Technological University, Singapore); Lihua Xie (University of Nanyang Technological University, Singapore)

Developing Indoor Positioning System (IPS) has become an attractive research topic due to the increasing demands on Location Based Service (LBS) in indoor environment recently. WiFi technology has been studied and explored to provide indoor positioning service for years since existing WiFi infrastructures in indoor environment can be used to greatly reduce the deployment costs. A large body of WiFi based IPSs adopt the fingerprinting approach as the localization algorithm. However, these WiFi based IPSs suffer from two major problems: the intensive costs on manpower and time for offline site survey and the inflexibility to environmental dynamics. In this paper, we propose an indoor localization algorithm based on online sequential extreme learning machine (OS-ELM) to address these problems accordingly. The fast learning speed of OS-ELM can reduce the time and manpower costs for the offline site survey, and more importantly, its online sequential learning ability enables the proposed localization algorithm to automatically and timely adapt to the environmental dynamics. The experimental results show that the proposed localization algorithm can provide higher localization accuracy than traditional approaches due to its fast adaptation to various environmental changes.

Indoor Positioning: a Key Enabling Technology for IoT Applications

Davide Macagnano (Centre for Wireless Communications, University of Oulu, Finland); Giuseppe Destino (CWC, University of Oulu, Finland); Giuseppe Abreu (Jacobs University Bremen, Germany)

Motivated by the recent advances on internet of things (IoT) and the importance that location information has on many application scenarios, this article offers references to theoretical

and localization-algorithmic tools that can be utilised in connection with IoT. We develop this discussion from basic to sophisticated localization techniques covering also some less-intuitive notions of localization, e.g. semantic positioning, for which we provide a novel solution which overcome the problem of privacy. We analyze the localization problem from a mathematical perspective; reviewing the most common and best-performing class of localization methods based on optimization and algebraic approaches and we discuss benefits of location information in a wireless system. In this regard we discuss few concrete applications scenario currently under investigation in the largest EU project on IoT, namely the FP-7 Butler project, how location information is one of the key enabling technology in the IoT. In addition to the theoretical aspect, this article provides references to the pervasive localization system architecture using the smart sensors developed within the Butler project.

Performance Evaluation and Optimization of Neighbor Discovery Implementation Over Contiki OS

Mohamed Seliem (Cairo University, Egypt); Khaled Elsayed (Cairo University, Egypt); Ahmed Khattab (Cairo University, Egypt)

IPv6 Neighbor Discovery (ND) based on RFC4861 is not designed for non-transitive wireless links. Its heavy use of multicast transmission makes it inefficient and sometimes impractical for IPv6 over Low power Wireless Personal Area Networks (6LoWPAN). Recently, some optimizations have been proposed by Internet Engineering Task Force (IETF) to make ND more suitable for 6LoWPAN. In this paper, we provide an implementation of the most prominent features of the new optimized ND protocol based on RFC 6775 over the Contiki OS. First, we evaluate the performance of the basic non-optimized IPv6 ND protocol, and analyze its implemented functions to set up a good foundation for our implementation and to maintain compatibility. Then, we implement the new optimized Router Solicitation (RS) and Router Advertisement (RA) messaging scheme that reduces the effect of multicasting and unfavorable periodic RA messages. Our results show that the optimized ND protocol reduces the number of the exchange radio messages in the network by 60-80%. Such optimization alleviates network congestion and saves more power.

Localization with Heterogeneous Information

Davide Macagnano (Centre for Wireless Communications, University of Oulu, Finland); Giuseppe Destino (Centre for Wireless Communications, University of Oulu, Finland); Giuseppe Abreu (Jacobs University Bremen, Germany)

Although during the last decade considerable efforts have been invested in the integration of different wireless technologies, a new surge of interest is arising due to the upcoming internet of things (IoT) in which many relevant application scenarios rely on location information. However, due to the heterogeneity of the devices, ergo the heterogeneity of information available, novel indoor positioning algorithms capable to account for different types of information must be designed. Differently from the vast majority of localization solutions currently available which rely on one specific type of observation, \emph{e.g.} range information only, in this article we consider the localization problem of multiple sources from range and angle measurements. To this end we first study the benefit of heterogeneous information via the rigidity theory and the Cram\`{e}r-Rao Lower Bound (CRLB) and then we show how to utilize an extension of the Euclidean-kernel, i.e. the Edge-kernel, to perform robust positioning under Non-Line-of- Sight (NLOS) conditions. In particular with reference to the latter contribution it is shown how to exploit the robust principal component analysis theory to improve the edge-kernel recovery and in turn the estimated target's locations.

Societal Impacts

Room: Berlin

Chair: Roch Glitho (Concordia University, Canada)

Learning From Tracking Waste: How Transparent Trash Networks Affect Sustainable Attitudes and Behavior

David Lee (Massachusetts Institute of Technology & Senseable City Lab, USA); Dietmar Offenhuber (Massachusetts Institute of Technology, USA); Assaf Biderman (MIT, USA); Carlo Ratti (Massachusetts Institute of Technology, USA)

Building on top of an experiment in tracking the movement of trash, we tested whether viewing this sensor data would change peoples' sustainability attitudes and behaviors. We showed subjects real-time maps of trash tagged with networked GPS sensors, and surveyed them before and after seeing this information. Our results show that subjects did not significantly change their behavior in the long run, but they reported better understanding of where their trash went and how tracking technologies worked. Those who participated in deploying sensors reacted differently on some questions from those who had not volunteered. This study illustrates both limits and new opportunities for the Internet of Things to improve sustainability outreach and action at the grassroots level.

Improve the Sustainability of Internet of Things Through Trading-based Value Creation

Charith Perera (The Australian National University & Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia); Arkady Zaslavsky (CSIRO, Australia)

Internet of Things (IoT) has been widely discussed over the past few years in technology point of view. However, the social aspects of IoT are seldom studied to date. In this paper, we discuss the IoT in social point of view. Specifically, we examine the strategies to increase the adoption of IoT in a sustainable manner. Such discussion is essential in today's context where adoption of IoT solutions by non-technical community is slow. Specially, large number of IoT solutions making their way into the market every day. We propose an trading-based value creation model based on sensing as a service paradigm in order to fuel the adoption of IoT. We discuss the value creation and its impact towards the society especially to households and their occupants. We also present results of two different surveys we conducted in order to examine the potential acceptance of the proposed model among the general public.

User Role in IoT-based Systems

María Victoria Moreno Cano (University of Murcia, Spain); José Luis Hernandez Ramos (University of Murcia, Spain); Antonio Fernando Skarmeta Gomez (University of Murcia, Spain)

Currently, in the paradigm of the Internet of Things (IoT) there is a novel strategy to experiment from the human centric perspective whereby the users are the owners of the rules operating smart things. As members of an IoT ecosystem, users inform about their needs and desires, and provide feedback within a networked intelligence to jointly improve their individual ability to rule the actuators of the system at their service. In this paper, we propose an example of a user-centric IoT system in the smart buildings field, in which energy saving is achieved because users behavior aspects are considered for the management of the buildings' infrastructures. An important aim of our user-centric building management system is to bring user role in the loop of the operation system. This platform has been deployed in an office which is a real case of smart building. Experimental tests have been carried out to assess the energy saving derived from considering a user-centric management. The first experimental stages of this system already reflect energy saving of about 23.12% respect with the energy consumption associated to previous periods with similar context conditions.

A Framework for Evaluating Internet-of-Things Platforms: Application Provider Viewpoint

Oleksiy Mazhelis (University of Jyväskylä & University of Jyväskylä, Finland); Pasi Tyrväinen (University if Jyväskylä, Finland)

Widespread adoption of Internet of Things (IoT) applications assumes a sustainable ecosystem of firms creating, distributing, and using these applications. Such an ecosystem often forms around a platform that offers commonly used functionality for creating applications and services. In IoT, such platform may be materialized in a form of a cloud platform that supports the management of connected devices, and the development and use of the applications based on them. A number of cloud IoT platforms are available in the market; to prosper, they need to assist application providers in designing and developing applications, as well as in deploying and operating the application software. In this paper, a framework for evaluating IoT platforms from the perspective of how widely they cover the potential needs of the application providers is introduced. Based on the framework, the maturity of the available IoT platforms is evaluated, by using the publicly available information about the platforms' features and supporting services. As the results of this analysis suggest, none of the platforms today offers the comprehensive support. This can be seen as a factor contributing to a slow adaption of the IoT platforms, and therefore to the slower-than-expected takeoff of the IoT ecosystem in general.

Techno-economic Feasibility Analysis of Constrained Application Protocol

Mahya Ilaghi Hosseini (Aalto University, Finland); Tapio Levä (Aalto University, Finland); Miika K.T. Komu (Helsinki University of Technology, Finland)

Constrained Application Protocol (CoAP) has been developed as an alternative to the HyperText Transfer protocol (HTTP) to connect resource-limited devices to the Web. In addition to technical advantages, the success of Internet protocols depends also on their economic feasibility for the stakeholders involved in protocol deployment. Therefore, this paper studies the techno-economic feasibility of CoAP by applying a methodological framework. Based on literature review and nine expert interviews, the paper identifies potential deployment challenges of CoAP and suggests solutions to them. The results can be used to facilitate the deployment of CoAP and to guide the potential adopters in decision-making.

Human Data Interaction in IoT: The Ownership Aspect

Afra Mashhadi (Bell Laboratories, Ireland); Fahim Kawsar (Bell Labs & Lancaster University, Belgium); Utku Günay Acer (Alcatel-Lucent Bell Laboratories, Belgium)

As Internet of Things (IoT) becomes a growing reality, more ubiquitous devices are embedded in our daily lives, serving us in a broad range of purposes from: personal healthcare to large scale traffic monitoring. These devices primarily collect data that is about or produced by people, be it street noise level of a neighbourhood, or the energy footprint of an individual's home or his location for social application purposes. As this unprecedented amount of data is collected, we are challenged with one fundamental research question: who owns this data and who should have access to it? Specifically, the emergent of the Human Data Interaction (HDI) topic which aims to put the human at the centre of the data driven industry, calls attention to the IoT community to address the data ownership aspect more carefully. In this note, we offer a reflection on the challenges that IoT faces in regards to the data ownership in HDI and advocate the roles that both ordinary people and industries must play to best answer those challenges in shaping IoT landscape.

18:30 - 20:30

Welcome Reception (Olympia)

Friday, March 7

08:00 - 09:15

Poster Presentations: Services

Room: Berlin
Chair: Yong-Hoon Choi (Kwangwoon University, Korea)

Short Paper: Vehicle Emission Control in Smart Cities
Milos Tesanovic (Fujitsu Laboratories of Europe Ltd., United Kingdom); Sunil Vadgama (Fujitsu Laboratories of Europe Ltd, United Kingdom)
This paper describes a novel pollution-aware approach for intelligent switching between electric and conventional propulsion in hybrid electric vehicles (HEVs). The switching is based on pollution information and pollution control zones location and size, combined with travel route and destination information, estimated travel distance on current charge level of battery and, in certain instances, with traffic congestion information, thereby enabling the journey to be completed such that adequate battery charge is available to transit all relevant pollution control zones in Smart Cities of the future. Additionally we outline a method for inferring the mode (specific combination of power or fuel sources) an HEV is running in, using roadside thermal cameras, enabling efficient enforcement of low-emission zones in future Smart Cities.

Short Paper: Surveillance System with Light Sensor
Hwajeong Seo (Pusan National University, Korea); Jongseok Choi (PUSAN, Korea); Hyunjin Kim (Pusan National University, Korea); Taehwan Park (Pusan National University, Korea); Ho Won Kim (Pusan National University, Korea)
Traditional surveillance system is enabled by closed-circuit television(CCTV) monitoring each district in real time. However, this approach should install expensive CCTV to every destination and collected images or videos should go through complex post-processing to get useful and meaningful information. Furthermore nowadays CCTV violates people's private life, which is crucial problem in modern society. If our goal is secure and robust street, more simple and cheap approaches could be favorable. In this paper, we present a novel surveillance system using light sensor which is commonly available in embedded processors or modern smart-phones. On the contrast to the traditional method, light sensor is cheap module and easy to install and process the information. After processing, we can determine the secure or insecure places with derived information. For practical evaluation, we made micro test-bed in our campus. First we collected light information from several locations in different time domains. And then secure or insecure places are determined in each time domain. We defined bright and dark places as secure and insecure places, respectively. The evaluation shows that our approach is unprecedented ultra light-weight approach and cost effective method to improve security in our society.

Short Paper: Affect Classification of Web Comportments
Fatima Isiaka (University of Manchester, United Kingdom); Adamu Mailafiya Ibrahim (University of Leeds, United Kingdom)
The Affective aspect of user behaviour on web applications have been the focus of investigations in recent times. Organization and gathering of web resources are made accessible through availability of web tools inform of visual content. The user experience of browsing is mostly studied through direct measures which often are qualitative, there is need for the affective aspect of users. Here, a novel and general approach to Skin Conductance Response (SCR) and Eye tracking analysis is presented, derived from signal processing and psychophysiology that estimates emotional response by synchronization of SCR and pupil changes from the eye movement behaviour of users to interpret perception. Analysis conducted shows significant relationship in latency of the sensors, and pupil changes.

Short Paper: Using BSN for Tele-Health Application in Upper Limb Rehabilitation
Benedict Tan (HutCabb Consulting, Singapore); Oliver Tian (Singapore Industrial Automation Association & HutCabb Consulting, Singapore)
Improved upper limb rehabilitation requires careful and re-constructed information around stroke patients' muscle activation characteristics and kinematic features in functional movement. Body Sensor Networks (BSN) are deployed to provide an immersive engagement of the rehabilitation exercise and translation into an augmented reality world for a higher order of analytics and consultation by medical consultants. Results of the analysis generate contextual intelligence to improve therapy programs in order of an increased magnitude with derived information on model schemas, pattern deviation and effectiveness of diagnostics.

Short Paper: Calory Battle AR: An Extensible Mobile Augmented Reality Exergame Platform
Joonas Westlin (Ajou University, Korea); Teemu H Laine (Ajou University, Korea)
We proposed an extensible mobile augmented reality exergame platform which utilizes augmented reality and sensors to connect virtual game content to the real world. We analyzed the current state of augmented reality and exergaming research before describing the Calory Battle AR concept along with its technical details. Extensibility of the platform is threefold: 1) players can create and share game maps; 2) developers can create new task types for game maps; and 3) developers can create context-sensing modules based on wearable technologies.

Short Paper: Sensors Data Fusion for Smart Cities with KNIME: A Real Experience in the SmartSantander Testbed
Antonio J. Jara (HES-SO, Switzerland); Dominique Genoud (Hesso//Wallis - IIG, Switzerland); Yann Bocchi (Haute Ecole Spécialisée de Suisse Occidentale, Switzerland)
Big Data is conceived as the powerful tool to exploit all the potential of the Internet of Things and the Smart Cities. A new dimension of understanding about the human behaviours is expected to be reached through all the gathered data in the emerging smart environment. This work analyses the data from the European Project SmartSantander. In particular, this work has correlated the traffic behaviour with respect to the temperature in the Santander City. This has been presented as the evolution of both flows present a similar behaviour. In particular, they present a fine grain correlation of over the 57\%. Finally, it has been also presented as the traffic distribution, aggregated by temperature bins, follows up a Poisson distribution model. Thereby, allowing interpolate and predict complex behaviours based on simple measures such as the temperature.

Poster Presentations: Technology - Network

Room: Rome
Chair: KyungHi Chang (Inha University, Korea)

Short Paper: A Human Mobility Pattern-based Routing Protocol for Delay Tolerant Networks
Junyeop Lee (Yonsei University, Korea); Sun Kyum Kim (Yonsei University, Korea); JinHee Jo (Yonsei University, Korea); JiHyeun Yoon (Yonsei University, Korea); SungBong Yang (Yonsei University, Korea)
Delay tolerant networks generally use the epidemic routing protocol because stable routing paths can hardly be maintained. However, the epidemic scheme leads to much network overheads because the messages are delivered to all the devices. In this paper, we propose an efficient protocol based on the human mobility patterns. In the proposed protocol, a message is delivered to several devices that are expected to deliver well the message to the destination. The proposed protocol relies on the human mobility patterns that contain the regularity. The simulation demonstrates that the proposed protocol reduces the network overheads, while maintaining reasonable delay time.

Short Paper: Wireless Sensor Network Management for Sustainable Internet of Things
Jaewoo Kim (Yonsei University, Korea); Seok Yu (Yonsei University, Korea); Jaiyong Lee (Yonsei University, Korea)
Conventional network management was based on wired network, which is unsuitable for resource constrained devices. WSNs consist Internet of Things (IoT) can be large scale networks, and it is impossible to manage each node individually. In this paper, we propose a network management protocol for WSNs to reduce management traffic.

Short Paper: Study on Cognitive Radio in IEEE 802.15.4 Wireless Sensor Networks
Chi-Ming Wong (Jinwen University of Science and Technology, Taiwan); Wen-Pin Hsu (Chung Chou University of Science and Technology, Taiwan)
Most of the proposed cognitive radio sensor networks (CRSNs) are not really based on the IEEE 802.15.4. In this paper, we introduce the proposed IEEE 802.15.4 based zb-CRSN framework which can perform spectrum sensing in the inactive portion. The spectrum decision algorithm of first detected idle channel first (FDIC) and shorter idle time first (SITF) are proposed to aid in selecting available licensed channel for sensor nodes from more than one spectrum sensing results.

Short Paper: Overcoming IoT Fragmentation Through Standard Gateway Architecture
Romano Fantacci (University of Florence, Italy); Tommaso Pecorella (Università di Firenze & CNIT, Italy); Roberto Viti (Università degli Studi di Firenze & CNIT - Consorzio Nazionale Interuniversitario per le Telecomunicazion, Italy); Camillo Carlini (Telecom Italia, Italy)
Vertical approach still largely dominates smart device systems. Even in IoT, proprietary backend systems and protocols are still common. The presented solution aims at harmonizing different standards and architectures, improving sustainability and security. It also allows to use a SaaS approach to further enhance the sensor networks business model.

Short Paper: Time-dependent Power Load Disaggregation with Applications to Daily Activity Monitoring
Hao Song (Toshiba Research Europe Limited, United Kingdom); Georgios Kalogridis (Toshiba Research Europe Ltd, United Kingdom); Zhong Fan (Toshiba Research Europe, United Kingdom)
In this paper we explore the possibility of inferring activities of daily life (ADLs) from aggregate power load signatures of people's homes, which has many applications including e-healthcare. Such power load data are available from smart meters that will be widely deployed in many countries by utilities or customers, creating an infrastructure at the forefront of the Internet of Things (IoT). The main contribution of this work is a time-dependent factorial hidden Markov model to extract behaviour related features linked with individual appliance usage. The results show that the introduced time-dependent structure can improve the performance while also provide a probability distribution related to ADLs. These results further provide a promising indication of appliance usage connotations of e-health, and a foundation for further research.

Short Paper: Design of a Dielectrophoresis-based Portable Device for Monitoring Pollution in Water Deposits
Martha S Lopez-de la Fuente (Universidad de Monterrey, Mexico)
Pollution in water deposits for human consumption is a great health issue, from large cities to distant communities. Portable devices installed in water deposits to form a nationwide, real time, pollution monitoring system would be of great help. Recent research has demonstrated the use of dielectrophoresis (DEP) in pollution analysis, where particle manipulation is

required. A portable, programmable, device for manipulating pollutant particles has been developed, so data or images of samples can be analyzed, transmitted and centered in a data base. The system includes a signal generator for electrical stimulation, an electro-kinetically driven microfluidic device, a particle detection sub-system, and a data transmitter. The system can be programmed to detect and manipulate a specific type of particles; after manipulation it senses resistivity or takes an image of the fluid sample where target particles are already separated, and transmit the obtained image or data to a central data base. Data analysis such as particle count or comparison to expected pattern is made after transmission. A portable open-source prototype is achieved, which can be installed in any water deposit and programmed to perform regular fluid samples and analysis, to maintain a web-based, real time data center of the water system.

Poster Presentations: Technology - Software

Room: Seoul

Chair: JaeSeung Song (Sejong University, Korea)

Short Paper: More Than the End to Information Overflow - How IBM Watson Will Turn Upside Down Our View on Information Devices

Stefan Holtel (BrightONE, Germany)

In early 2011, the IBM computing system »Watson« competed against the world's best Jeopardy champions - and won. This event marked a year-long research effort in dramatically raising the reliability and accuracy of Question and Answering systems to a new level. From our current understanding, we consider Watson as a new, unprecedented category of information processing systems. We suppose that Watson might become a tipping point for a new way to exploit unstructured data in information-rich environments. Thus, we ask how information appliances will change if they will adapt more and more capabilities that were first introduced by Watson. For that purpose we undertake the effort to categorize information appliance capabilities to the extent that they reflect different levels of human thinking. We then show how such categorizations might provide a guiding principle for the design of future information appliances in data-driven working environments. Finally, we provide three possible consequences that might unfold if Watson-technology will gradually trickle down to commodity information appliances.

Short Paper: Seamless File Sharing for Android Device

Minseok Jeon (Yonsei University, Korea); Sun Kyum Kim (Yonsei University, Korea); JiHyeun Yoon (Yonsei University, Korea); JinHee Jo (Yonsei University, Korea); SungBong Yang (Yonsei University, Korea)

The performance of mobile devices, especially smart phones, has been quickly improved for the last few years. Most users take advantage of highly efficient smart phones, and consume the contents in the smart phones longer time than other devices usage time. As a result, users frequently share the contents and the needs of file sharing via smart phones have been increased considerably. Existing peer-to-peer sharing frequently incurs disconnections and retransmissions. A web hard-based sharing needs to pay expensive cost for using high-volume file servers as well. In order to overcome such problems, we propose an application for seamless file sharing for the Android devices. The seamless service manager and the file manager in the proposed application share files seamlessly by choosing faster and more stable network automatically— one of the Bluetooth and the WIFI. We expect that the proposed application could be a cost effective and reliable solution for file sharing among mobile devices.

Short Paper: A Model Based Framework for Effective Web of Things Development

Roberto Manione (Media on Line, Italy)

This paper discusses the adoption of a Model Based approach in the Web of Things development as a way to simplify the task. A set of primitives is introduced to handle the http protocol at the model level directly so that application designers need not know programming and networking details. A Model Based Integrated Development Environment, TaskScript, has been extended with such primitives: first results are reported, demonstrating the feasibility and effectiveness of the approach, particularly with OS-less systems using low cost and low energy consumption 8-bit microcontrollers: real case applications have been effectively developed in matter of hours.

Short Paper: A Scripting-Free Control Logic Editor for the Internet of Things

Markus Jung (Vienna University of Technology, Austria); Esad Hajdarevic (Vienna University of Technology, Austria); Wolfgang Kastner (TU Vienna (Wien), Austria); Antonio J. Jara (HES-SO, Switzerland)

The Internet of Things scales the Internet to billions of embedded nodes and allows to link physical and cyber systems to form complex control systems. Current research focuses mainly on the networking and communication protocols and leaves the application layer aspects like the engineering process and creation of control logic out of scope. Existing approaches are mainly based on using scripting languages to create control logic for the Internet of Things, which is a problem for non-technical users. This paper presents Obelix which is a generic user interface and graphical control logic editor for the Internet of Things. The system requirements to enable a scripting-free creation of control logic are stated and a concrete system fulfilling these requirements together with a proof of concept implementation and evaluation are presented.

Short Paper: Semantic URI-based Event-driven Physical Mashup

Sejin Chun (Yonsei University, Korea); Jooik Jung (Yonsei University, Korea); Xiongnan Jin (Yonsei University, Korea); Gunhee Cho (Yonsei University, Korea); Jinho Shin (Department of Computer Science, Yonsei University, Korea); Kyong-Ho Lee (Yonsei University, Korea)

To enhance the integration of different IoT application domains, we propose a two-layered IoT information model that consists of domain-independent and domain-specific models. In addition, for the meaningful composition of things and their services, a semantic URI as a unique identifier is allocated to a thing. Finally, a modeling approach of constructing physical mashups is proposed for the event-driven composition of IoT services. In order to show the efficiency of the proposed event-driven physical mashup approach, an energy management scenario in u-campus is demonstrated as a case study.

Short Paper: Harmonizing Heterogeneous Components in SeSaMe

Luciano Baresi (Politecnico di Milano, Italy); Guinea Sam (Politecnico di Milano, Italy); Adnan Shahzada (Politecnico di Milano, Italy)

This paper describes SeSaMe, an RDF-enriched self-adaptive middleware for highly dynamic and autonomic complex systems. Semantic technologies make components of a system mutually interoperable and enable them to exchange information even when they are developed and deployed on different platforms. SeSaMe uses semantics to achieve dynamic component discovery and self-configurability in the network of Things, and to support the communication among heterogeneous Things. The paper exemplifies its contribution for harmonizing heterogeneous components in the context of a smart greenhouse scenario.

09:15 - 10:00

Keynote (Seoul): Orchestrating the Smarter Planet in the World of Internet of Things

Chung-Sheng Li, Director of Commercial Systems, IBM T.J. Watson Research Center

The introduction of pervasive and ubiquitous instrumentation within a smarter planet and internet of things leads to unprecedented real-time visibility of the power grid, traffic, transportation, water, oil & gas, and personal health. Interconnecting those distinct physical, people, and business worlds through ubiquitous instrumentation, even though still in its embryonic stage, has the potential to unleash a planet that is much greener, more efficient, more comfortable, and safer.

In this talk, we will describe the opportunities and challenges after applying intelligence on interconnected and instrumented worlds and call out the system of systems trend on interconnecting these distinct but interdependent worlds. It has become increasingly crucial that digital representations of these distinct worlds (a.k.a. models) need to be created as a pre-requisite in order to assess the complexity, maneuver through uncertain environments and eventually achieve the predicted outcome.

The starting point of such an Internet of Things solution is always the real world itself - whether it is smarter grids, buildings, supply chains or water systems. The instrumentation provides a mechanism to facilitate high-fidelity capture of the real world into the observed world, which is often based on models of the real world. These digital representations (or models) facilitate stitching together or assimilating the data captured from the instrumented world and enable interpolation and extrapolation of those areas where data were not available or contaminated. In many cases, these models allow the generation of the most plausible hypothesis to explain the available information. From these models, the expected outcome is generated through simulation and/or predictive analysis. The course of actions based on the models are then taken for command and control (or actuating) the real world.

A smarter planet solution requires optimal or near optimal orchestration of the control flow and information flow. The "music notes" of the orchestration really came from the behavior models assimilated from the real-world information. Consequently, developing models at the behavior levels is often necessary to facilitate the optimal orchestration of the generation, management, and continuous assurance of the business outcome.

10:00 - 12:00

Experiments - Radio

Room: Seoul

Chair: Amir Shahbazian (California State University at Long Beach (CSULB) & Linkviva, USA)

UHF RFID Transmission with Soft-Input BCH Decoding

Daniel Merget (Technische Universität München, Germany); Grzegorz Smietanka (Technical University Dortmund, Germany); Jürgen Götze (TU Dortmund University, Germany)

Radio Frequency Identification (RFID) is a wireless communication method mostly used in a rough indoor environment. In such an environment Forward Error Correction (FEC) is a popular method to improve the transmission quality. However, the common RFID protocol (EPCglobal) only provides an error detection based on Cyclic Redundancy Check (CRC) codes. The replacement of this code with an arithmetically similar FEC code improves the transmission and requires only minor changes of the protocol structure. A BCH code fulfills this requirement. Nevertheless, this code has the disadvantage that it uses only hard-coded bits for the decoding process.This work presents a BCH decoding using the Chase algorithm which also takes the soft information of the received sequence into account. It is shown that a coding gain of 1 dB is achievable in an RFID transmission application, compared to a transmission with a common BCH code.

Comparison of IEEE 802.15.4e MAC Features

Jianwei Zhou (Texas Instruments Inc., USA); Ariton Xhafa (Texas Instruments Inc., USA); Ramanuja Vedantham (Texas Instruments Inc., USA); Ryan Nuzzaci (Texas Instruments Inc., USA); Arvind Kandhalu (Texas Instruments, USA); Xiaolin Lu (Texas Instruments, Inc., USA)

Time synchronized channel hopping (TSCH) and coordinated sampled listening (CSL) are two of the main features of IEEE 802.15.4e designed for wireless sensor networks (WSNs). In this paper, we compare the power and latency performance of TSCH and CSL for various scenarios. Our results show that while TSCH outperforms CSL in terms of power, its latency is higher.

Peer to Peer Signal Strength Characteristic Between IoT Devices for Distance Estimation

JoonYoung Jung (ETRI, Korea); Dong-oh Kang (ETRI, Korea); Chang Seok Bae (ETRI, Korea)

The Received Signal Strength Indication (RSSI) value of Bluetooth can be used to estimate distance between Internet of Things (IoT) devices. The characteristic of Bluetooth RSSI value is different as environments. IoT devices, within Wireless Body Area Network (WBAN) area, can recognize each other in office environment automatically. Peer to peer distance estimation using the RSSI of Bluetooth is difficult because of large deviation of RSSI value. This paper provides the experimental results of RSSI measurement between IoT devices in office environment. And it applies the Low Pass Filter (LPF) to reduce the deviation of RSSI value. So, we can estimate distance using Bluetooth RSSI LPF data whether the IoT device is within WBAN area or not.

Analytical Model of Adaptive CSMA/CA MAC for Reliable and Timely Clustered Wireless Multi-hop Communication

Rajavaraprasad Yerra (IIT Hyderabad & Mhrd, India); Pachamuthu Rajalakshmi (Indian Institute of Technology Hyderabad, India)

Reliability and delay of a single cluster wireless network is well analysed in the literature. Multi-hop communication over the number of clusters is essential to scale the network. Analytical model for reliability and end-to-end delay optimization for multi-hop clustered network is presented in this paper. Proposed model is a three dimensional markov chain. Three dimensions of markov model are the adaptable mac parameters of CSMA/CA. Model assumes wakeup rates for each cluster. Results show that reliability and delay are significantly improved than previous analytical models proposed. It has been observed that overall reliability of multi-hop link is improved, with reduction in end-to- end delay is reduced even at lower wakeup rates of a cluster.

An Empirical Path Loss Model for Wireless Sensor Network Deployment in a Sand Terrain Environment

Abdulaziz Alsayyari (Florida Institute of Technology, USA); Ivica N. Kostanic (Florida Institute of Technology, USA); Carlos Otero (Florida Institute of Technology, USA); Mohammed Almeer (Florida Institute of Technology, USA); Kusay Rukieh (Florida Institute of Technology, USA)

This paper presents a WSN model for predicting signal propagation in terrains characterized by sandy surfaces. To create the model, RF measurements were collected through wireless sensor nodes deployed in a sand terrain environment. From the actual measurements, the parameters of the log-normal shadowing model are fine-tuned to develop an accurate path loss model of WSN deployment in sand terrain environments. In addition, the presented RF measurements and empirical path loss model are compared with measurements and models obtained from long-grass and sparse-tree environments, which were presented in a previous work. The results from the comparison of such different terrains show differences in path loss and empirical models' parameters. Such dissimilarity is due to the differences that exist in the wireless channel of each environment. This observation reveals the significance of the in-field studies and the examination of RF propagation for various WSN potential outdoor deployment scenarios. Furthermore, the proposed model is also compared with Free Space Path Loss (FSPL) and Two-Ray models to demonstrate the inaccuracy of these theoretical models in predicting path loss between wireless sensor nodes deployed in a sand terrain environment.

Internet of Vehicles

Room: Rome

Chair: Abdelmajid Khelil (Huawei European Research Center, Germany)

On the Suitability of Device-to-Device Communications for Road Traffic Safety

Abdelmajid Khelil (Huawei European Research Center, Germany); David Soldani (Huawei Technologies Duesseldorf GmbH & European Research Centre, Germany)

In this paper, we explore recent Device-to-Device (D2D) research efforts and review their suitability to safety-critical Internet of Vehicles (IoV) applications such as cooperative or autonomous driving. Typical for the IoV environment is the high node mobility along with the strict Quality of Service (QoS) requirements, especially in terms of latency and reliability. In addition, IoV applications require geomessaging capabilities with high accurate proximity awareness. Accordingly, we qualitatively assess the effectiveness of D2D approaches to cope with high mobility and precise geomessaging. We found out that high relative node mobility and accurate proximity measurements have been ignored by current approaches. Subsequently, we identified crucial research challenges, especially, those related to maintaining the required QoS level despite the highly fluctuating D2D link quality. This work is meant to be a roadmap towards adopting the emerging D2D technique for critical IoV communications.

A Networking Perspective on Self-Organizing Intersection Management

Christoph Sommer (University of Innsbruck, Austria); Florian Hagenauer (University of Innsbruck, Austria); Falko Dressler (University of Innsbruck, Austria)

We explore the networking aspects of realizing self- organized intersection management. Inter-Vehicle Communication (IVC) based on DSRC/WAVE is expected to complement other communication technologies including Wi-Fi and 3G/4G. Applications range from road traffic efficiency to critical safety situations, intersection management being one of the most compelling applications. The Virtual Traffic Light (VTL) system is envisioned to replace or to complement physical traffic lights in order to reduce costs and to optimize the road traffic flow in urban environments. VTL, developed at Carnegie Mellon University, outlines the general capabilities of such a system. The VTL system heavily relies on coordinating clusters of cars and the communication among them. We developed a DSRC/WAVE based communication protocol for the management of these clusters, carefully investigating all the networking aspects related to this management and the communication between the cluster leaders. Comparing VTL to physical traffic lights, we are able to show a speedup of up to 35 % in realistic environments. Looking at the packet loss on the wireless link, we can show that even in high communication load scenarios, the speedup remains stable.

Connected Vehicle Safety - Science, System, and Framework

Kuan-Wen Chen (Intel-NTU Connected Context Computing Center, Taiwan); Hsin-Mu Tsai (National Taiwan University, Taiwan); Chih-Hung Hsieh (Intel-NTU Connected Context Computing Center, Taiwan); Shou-De Lin (National Taiwan University, Taiwan); Chieh-Chih Wang (National Taiwan University, Taiwan); Shao-Wen Yang (Intel Corporation, Taiwan); Shao-Yi Chien (National Taiwan University, Taiwan); Chia-Han Lee (Academia Sinica, Taiwan); Yu-Chi Su (National Taiwan University, Taiwan); Chun-Ting Chou (National Taiwan University, Taiwan); Yuh-Jye Lee (National Taiwan University of Science and Technology, Taiwan); Hsing-Kuo Pao (National Taiwan University of Science and Technology, Taiwan); Ruey-Shan Guo (National Taiwan University , Taiwan); Chung-Jen Chen (National Taiwan University , Taiwan); Ming-Hsuan Yang (University of California, Merced, USA); Bing-Yu Chen (National Taiwan University, Taiwan); Yi-Ping Hung (National Taiwan University, Taiwan)

In this paper, we propose a framework to develop an M2M-based (machine-to-machine) proactive driver assistance system. Unlike traditional approaches, we take the benefits of M2M in intelligent transportation system (ITS): 1) expansion of sensor coverage, 2) increase of time allowed to react, and 3) mediation of bidding for right of way, to help driver avoiding potential traffic accidents. To develop such a system, we divide it into three main parts: 1) driver behavior modeling and prediction, which collects grand driving data to learn and predict the future behaviors of drivers; 2) M2M-based neighbor map building, which includes sensing, communication, and fusion technologies to build a neighbor map, where neighbor map mentions the locations of all neighboring vehicles; 3) design of passive information visualization and proactive warning mechanism, which researches on how to provide user-needed information and warning signals to drivers without interfering their driving activities.

Internet of Vehicles: From Intelligent Grid to Autonomous Cars and Vehicular Clouds

Mario Gerla (University of California at Los Angeles, USA); Eun-Kyu Lee (UCLA, USA); Giovanni Pau (UPMC - LIP6 & UCLA, USA); Uichin Lee (KAIST, Korea)

Traditionally, the vehicle has been the extension of the man's ambulatory system, docile to the driver's commands. Recent advances in communications, controls and embedded systems have changed this model, paving the way to the Intelligent Vehicle Grid. The car is now a formidable sensor platform, absorbing information from the environment (and from other cars) and feeding it to drivers and infrastructure to assist in safe navigation, pollution control and traffic management. The next step in this evolution is just around the corner: the Internet of Autonomous Vehicles. Pioneered by the Google car, the Internet of Vehicles will be a distributed transport fabric capable to make its own decisions about driving customers to their destinations. Like other important instantiations of the Internet of Things (e.g., the smart building), the Internet of Vehicles will have communications, storage, intelligence and learning capabilities to anticipate the customers' intentions. The concept that will help transition to the Internet of Vehicles is the Vehicular Cloud, the equivalent of Internet cloud for vehicles, providing all the services required by the autonomous vehicles. In this article, we discuss the evolution from Intelligent Vehicle Grid to Autonomous, Internet-connected Vehicles and Vehicular Cloud.

Trustworthy Communications in Vehicular Ad Hoc Networks

Serna Jetzabel (Technical University of Catalonia, Spain); Roberto Morales (Universitat Politècnica de Catalunya, Spain); Manel Medina (Technical University of Catalonia, Spain); Jesus Luna (Barcelona Digital CT, Spain)

Vehicular Ad-Hoc NETworks (VANETs), a pillar for the Internet of Vehicles, aim to improve road safety by preventing and reducing traffic accidents. While VANETs offer a great variety of promising applications based on the vehicles' networking, there remain a number of security and privacy research challenges that must be addressed. This paper contributes with a framework to address security and privacy issues in vehicular communications, consisting of an inter-domain authentication system able to provide a near real-time certificate status

service, and a mechanism to quantitatively evaluate the trust level of a CA in order to establish on-the-fly an inter-operability relationship, and a privacy enhancing model, which, addresses privacy in terms of linkability and vehicle tracking.

Standards 1

Room: Berlin
Chairs: Oleg Logvinov (STMicroelectronics, USA), Mary Nielsen (IEEE Standards Association, USA)

Opportunity and Strategy for Future IoT Business
Myung Keun Lee (SKT, Korea)
The objective of this session is to discuss the opportunities and keys to success in the IoT service sector. To initiate discussion, SK Telecom would like to present its experience with successful business cases. These experiences will form the basis for the presentation of market condition changes and a roadmap of the market evolution. By redefining the IoT application fields and examining the representative solutions in field, business opportunities are defined. Finally the eco-system is discussed to shed light on how a successful business strategy could be formulated.

Panel: Standardization Activities in the IoT Universe
Mary Nielsen (IEEE Standards Association, USA)
Panelists: Ingo Friese (Kantara Initiative, Germany); Duncan Bees (HGI, Canada); Minsoo Lee (LG, Korea). The technical areas covered by IoT are vast, and the work occurring for IoT standards is occurring in many places and in many ways. This panel will present views on key consensus activities related to the Internet of Things from the Home Gateway Initiative, LG Electronics and the IEEE P2200 Mobile Video standard, and identity the Kantara Initiative.

12:00 - 13:00

Lunch (Café, 1F)

13:00 - 13:30

Poster Display (Athens)

Chair: Seong-Ho Jeong (Hankuk University of Foreign Studies, Korea)

13:30 - 15:30

Critical Services

Room: Seoul
Chair: Peter Kirstein (University College London, United Kingdom)

Adaptive Rule Engine Based IoT Enabled Remote Health Care Data Acquisition and Smart Transmission System
Malyala Pavana Ravi Sai Kiran (IIT Hyderabad, India); Pachamuthu Rajalakshmi (Indian Institute of Technology Hyderabad, India); Krishna Bharadwaj (IIT Hyderabad, India); Amit Acharyya (IIT HYDERABAD, India)
In the remote health care monitoring applications, the collected medical data from bio-medical sensors should be transmitted to the nearest gateway for further processing. Transmission of data contributes to a significant amount of power consumption by the transmitter and increase in the network traffic. In this paper we propose a low complex rule engine based health care data acquisition and smart transmission system architecture, which uses IEEE 802.15.4 standard for transferring data to the gateway. The power consumed and the network traffic generated by the device can be reduced by event based transmission rather than continuous transmission of data. We developed two different rule engines: static rule engine and adaptive rule engine, which decides whether to transmit the collected data based on the important features extracted from the data, thereby achieving power saving. In this paper, ECG data acquisition and transmission architecture is considered. The metrics used for performance analysis are the amount of power saving and reduction in network traffic. It is shown that the proposed rule engine gives a significant reduction in energy consumption and network traffic generated.

When Devices Become Collaborative. Supporting Device Interoperability and Behaviour Reconfiguration Across Emergency Management Scenario
Mihaela Brut (Theresis, Thales Services S.A., France); Patrick Gatellier (Theresis, Thales Services S.A., France); Ismail Salhi (Université Paris-Est, France); Sylvain Cherrier (Université Paris-Est, France); Yacine Ghamri-Doudane (University of la Rochelle, France); David Excoffier (Sogeti High Tech, France); Nicolas Dumont (Thales Communications and Security, France); Mario Lopez Ramos (Thales Communications and Security, France)
Emergency management is a highly critical domain where the information transmission in real-time to the appropriate stakeholders is essential. Based on the results of the "Web of Objects" ITEA 2 project, this paper presents an IoT-based devices collaboration solution across an emergency management workflow, where the exchanged messages are semantically enriched. This solution includes innovative strategies for addressing the three involved issues: ensuring the device management into an interoperable manner and based on a suitable distributed architecture; setting up different workflows for device collaboration while ensuring their autonomy; establishing a suitable format for exchanged data between devices.

Cardea: Cloud Based Employee Health and Wellness, an Integrated Wellness Application with a Wearable Device and the HCM Data Store
Elizabeth Lingg (Oracle, USA); Garrett Leone (Oracle, USA); Kent Spaulding (Oracle, USA); Reza B'Far (Oracle, USA)
This paper discusses an experimental integrated wellness application that syncs with a wearable device and with a human capital management database to provide a full picture of health and wellness. Wellness is measured at the individual level as well as at the group level. This application uses domain specific algorithms, which are based on scientific research and analysis of biometric data. We investigate the effect of this application on user behavior and wellness habits. We also look for correlations between companies' policies, culture, management practices, and wellness.

A Cost Effective and Sustainable Relief Material Supply Visibility System for Devastated Areas
Shigeya Suzuki (Keio University, Japan); Yuki Sato (Keio University, Japan); Takehiro Yokoishi (Keio University, Japan); Jin Mitsugi (Keio University, Japan)
n this paper, we propose a cost effective and sustainable relief material visibility system. In an evacuation site such as the one prepared on a disastrous event such as the Tohoku earthquake, we have observed three issues on relief goods supply management: discrepancy between demands and supplies, difficulty of sorting and picking of relief material, and storage strategy to maintain optimal capacity and delivery time. To ease these issues, we developed a system which supports fulfillment by product category. Also, we implemented the system as a "evacuee support mode" of a traceability system to share both software and hardware assets. By deploying as a dual-mode system, the system can be cost-effective and sustainable. We have developed a prototype system alongside with an agricultural e-commerce system with traceability support. We experimented the prototype at a disaster drill session to see effectiveness of the design.

Platforms

Room: Rome
Chair: Noel Crespi (Institut Mines-Télécom, Télécom SudParis, France)

A Quality-based Semantic Service Broker Using Reachability Indexes
Yenting Lee (Oakland University, USA); Chingseh Wu (Oakland University, USA)
Cloud computing based on the loosely coupled service-oriented architecture facilitates the process of application integration from existing software. As there is a growing demand for cloud computing techniques and applications across a wide range of domains; selecting the best from many services which provide similar functionality remains an elusive task. In this paper, we propose a quality-based semantic service broker using reachability indexes. This broker uses semantic concepts to model services in a conceptual aggregation graph. In addition, the broker also creates reachability labels for each vertex in the conceptual aggregation graph to speed up composition discovery. During the service discovery and composition, all possible solutions are found and ranked by the service consumer's quality requirements. Even if no solution matches the quality requirements, a suggested solution from the similarity distance relaxation is provided.

A Semantic Service Creation Platform for Social IoT
Maria Victoria Beltran (Institut Telecom, France); Antonio M. Ortiz (Institut Mines-Telecom, Telecom SudParis, France); Dina Hussein (Institut

Mines-Telecom, Telecom SudParis, France); Noel Crespi (Institut Mines-Télécom, Télécom SudParis, France)
The Social Internet of Things (SIoT) is aimed at integrating devices into users' daily life by taking advantage of the interconnectivity and user-friendliness of Social Networks (SNs). To ensure the success of SIoT, we need to provide new attractive services that engage people to socialize their devices. To this end, automated and value-added applications are necessary in order to actually make devices social. On the other hand, Web services can be described through ontologies so as to enable the automatic invocation and composition of such services.We envisage semantic Web services as a means to provide users with automated value-added applications for SIoT. We propose a SN that can achieve a synergy between the SIoT and semantic Web services based on RESTful principles and ontologies. The proposed SN is a converging point for a user's friends, devices and web services of interest. Moreover, this SN is a service creation environment through which users can define their own event-triggered services involving devices and Web services.

A Survey of Internet-of-Things: Future Vision, Architecture, Challenges and Services
Dhananjay Singh (Hankuk University of Foreign Studies, Korea); Gaurav Tripathi (Bharat Electronics Limited, India); Antonio J. Jara (HES-SO, Switzerland)
Internet-of-Things (IoT) is the convergence of Internet with RFID, Sensor and smart objects. IoT can be defined as "things belonging to the Internet" to supply and access all of real-world information. Billions of devices are expected to be associated into the system and that shall require huge distribution of networks as well as the process of transforming raw data into meaningful inferences. IoT is the biggest promise of the technology today, but still lacking a novel mechanism, which can be perceived through the lenses of Internet, things and semantic vision. The proposed architecture introduces the use of Smart Semantic framework to encapsulate the processed information from sensor networks. The smart embedded system is having semantic logic and semantic value based Information to make the system an intelligent system. This paper presents a discussion on Internet oriented applications, services, visual aspect and challenges for Internet of things using 6lowpan and sensor networks and a novel architecture model for IoT with the help of Semantic Fusion Model (SFM).

Internet of Things for Designing Smart Objects
Daniele Mazzei (University of Pisa, Italy); Gabriele Montelisciani (University of Pisa, Italy); Gualtiero Fantoni (University of Pisa, Italy); Giacomo Baldi (Errequadro Srl, Italy)
Internet has formerly been used to link ideas, then people and now it is starting to connect things together. IoT constitutes a good paradigm to enable people to design and modify things, and then sharing their designs and modifications. Through the internet, things are nowadays able to exchange raw data and information thus enabling the development of a new class of interconnected smart objects. In this paper a web platform for the design, co-design and sharing of smart objects is presented. The platform represents a design environment where physical shapes, sensing and actuation features, as well as functioning logics are integrated in a user friendly framework. A platform test has been performed in the context of the Maker Faire Rome 2013 demonstrating how the developed infrastructure acts as design enabler for both makers and mainstream users.

Dynamic Services Selection Approach for the Composition of Complex Services in the Web of Objects
Amal Kouicem (Laboratory of Medical Computing (LIMED), University of Bejaia,06000 Bejaia, Algeria, France); Abdelghani Chibani (LISSI Lab., France); Abdelkamel Tari (Bejaia University, Algeria); Yacine Amirat (University of Paris 12, France); Zahir Tari (RMIT University, Australia)
Mobile cloud computing is a typical environment for offloading computation issues that are required for handling composition and orchestration of services provided by objects running on actuators, sensors, robots or any physical object with limited computing resources. Composing composite services in such an environment poses several challenges, such as adaptability, performance and scalability. In this paper, we focus on the optimization of service selection as the key operation in dynamic service composition by using multi-agent architecture that achieves an online generation and rescheduling of the optimal services execution workflow by using a heuristic planning technique. The simulation results of composition scenarios show clearly the performance of the selection and how the composition is well adapted for large-scale ubiquitous environment in terms of a timely fashion handling in of the fluctuation and variation of user context and quality of service.

A Big Data Correlation Orchestrator for Internet of Things
Mohammad Mozumdar (California State University, Long Beach, USA); Amir Shahbazian (California State University at Long Beach (CSULB) & Linkviva, USA); Nhat-Quang Ton (CSULB, USA)
In this paper, we introduce BigCO, a big data correlation orchestrator for internet of things. This orchestrator is implemented in a micro cloud server whose role is to manage centralized as well as distributed wireless sensor nodes. Extensive research has been done on introducing single purpose gateways or orchestrators; as of yet none are able to dynamically choose suitable algorithms (such as path optimization or Markov random field for 3D-data pattern recognition) to combine heterogeneous data into a 3D model for compression and optimized database analysis (using 3D vector vs. relational database queries). What differentiates our approach is in our data pattern recognition and point cloud mathematical modeling of real data; we observed that multiple data types can be mapped in a 3D graph (for example comfort level by cooling in summer can be mapped into humidity and temperature) by utilizing advanced algorithms discussed in this paper, We provide a fast and in-expensive decision support mechanism over an extremely small storage footprint, suitable for the majority of wireless sensor networks.

Standards 2

Room: Berlin
Chairs: Oleg Logvinov (STMicroelectronics, USA), Mary Nielsen (IEEE Standards Association, USA)

IoT-Based Smart Green City Technology
Daekyo Jung (Korea Telecom, Korea)
In the future, due to increases in water- and energy-management-based IoT technology because of climate change, the issues related to CO2 emission will be increased. IoT technology will help manage electrical and CO2 emissions in cities. This presentation will introduce the Korean microgrid project in Sejong City.

Panel: Convergence of Smart Home and Building Architectures
Oleg Logvinov (STMicroelectronics, USA)
Panelists: Sascha Dern (Lantiq, Germany), Oleg Logvinov (STMicroelectronics, USA). The current limitations and issues using today's standard residential gateway home connectivity technologies (Ethernet, USB and Wi-Fi) for the use of IoT are presented. As a next step, connectivity technologies that have to be integrated in the future into the gateways for the sole purpose of IoT are identified. The potential issues that will come with them are highlighted, and an approach to tackle the challenges to make it work is suggested.

IEEE-SA: the Platform for the 21st Century
Bruce Kraemer (IEEE-SA President-Elect, USA)
The IEEE Standards Association (IEEE-SA) works with thought leaders, companies, and institutions in about 90 countries on consensus programs and global standards. More than 1600 IEEE individual and entity standards are now in effect or under development. This keynote will cover the opportunities offered by the IEEE Standards Association, including its support of Open Stand (www.openstand.org).

15:30 - 16:00

Coffee Break

16:00 - 18:00

Mobile Networks

Room: Rome
Chair: Hyukjoon Lee (Kwangwoon University, Korea)

Analyzing the Overload of 3GPP LTE System by Diverse Classes of Connected-Mode MTC Devices
Oleg Dementev (Tampere University of Technology, Finland); Olga Galinina (Tampere University of Technology, Finland); Mikhail Gerasimenko (Tampere University of Technology, Finland); Tuomas Tirronen (Ericsson Research, Finland); Johan Torsner (Ericsson Research, Finland); Sergey Andreev (Tampere University of Technology, Finland); Yevgeni Koucheryavy (Tampere University of Technology, Finland)
As massive deployments of autonomous MTC devices jeopardize current mobile access networks with their excessive signaling, wireless industry is taking decisive steps to protect future technology from such overloads. Whereas efficient mechanisms for overload control of 3GPP Long Term Evolution (LTE) system are now in place when the devices are connecting to the network, we investigate the situation when the connection has already been established and a large number of devices send their meaningful data. In this paper, we intend to identify whether a surge in simultaneous transmission attempts by numerous connected-mode MTC devices actually threatens 3GPP LTE and characterize an overloaded scenario with a mixture of diverse device classes (e.g., low and high priority devices). Our approach combines both analysis and protocol-level simulations to conclude that appropriate overload control mechanisms may also be necessary for connected-mode devices.

Class Based Dynamic Priority Scheduling for Uplink to Support M2M Communications in LTE
Mukesh Giluka (Indian Institute Of Technology Hyderabad, India); Nitish Rajoria (IIT Hyderabad, India); Ashish C Kulkarni (Visvesvaraya Technological University & PES Institute of Technology Bangalore, India); Vanlin Sathya (Indian Institute of Technology Hyderabad, India);

Bheemarjuna Reddy Tamma (IIT Hyderabad, India)
Machine-to-Machine (M2M) communications has emerged as a key technology with huge market potential for cellular service providers deploying 4G LTE networks. Addition of enormous number of M2M devices into the cellular networks poses a heavy competition to existing Human-to-Human (H2H) devices for getting radio resources, thereby affecting the performance of the H2H communications. But, one can not treat all M2M sessions as low priority and schedule them after H2H sessions, as there are many M2M applications like e-healthcare and tracking which are of high importance and delay-intolerant. Hence, there is a need for class based priority scheduling of the traffic of M2M and H2H sessions in the network. In this paper, we propose a class based dynamic priority scheduling algorithm for uplink to allocate radio resources efficiently to support M2M communications with least affecting H2H communications. The performance of the algorithm is evaluated by various parameters such as H2H throughput, system throughput etc. and compared with existing schedulers.

White Space Radio: Towards an Active Database-Centred Topology
Odysseas Pappas (University of Bristol, United Kingdom); Tom Barratt (University of Bristol, United Kingdom); Michael Collett (University of Bristol, United Kingdom); Kibrom Gebremicael (University of Bristol, United Kingdom); Paul Worgan (University of Bristol, United Kingdom)
The following paper presents and discusses the state of the art in White Space radio topologies. A possible system architecture combining database stations and active sensing is also presented. Some of the main challenges associated with such architectures are discussed and notes are made with regard to database design, sensing requirements and antenna specifications. The discussion could inform the development of distributed device networks which are needed to enable the Internet of Things.

Delivering Uniform Connectivity and Service Experience to Converged 5G Wireless Networks
Sergey Andreev (Tampere University of Technology, Finland)
With this overview paper, we consider a comprehensive set of technology innovations to (i) dramatically improve the available cellular network capacity, (ii) provide a uniform wireless connectivity experience, and (iii) deliver a higher level of service quality and user satisfaction. To achieve these ambitious goals, we explore the emerging concepts of enhanced spectral reuse via device cooperation, intelligent use of multiple radio access technologies, and improved power efficiency of, primarily, small-scale mobile devices. We believe that these directions will significantly benefit the uniform connectivity and service experience in the face of growing application, data, and device volume. The complex research summarized by this work is expected to result in both theoretical innovations and practical applications, as the topic itself may lead to rethinking the architecture of contemporary wireless networks. The outcomes of this work are primarily intended for academic experts and industry professionals, with the purpose to shed light on the most recent advances in fifth generation (5G) wireless networks.

16:00 - 18:10

Standards 3

Room: Berlin
Chairs: Oleg Logvinov (STMicroelectronics, USA), Mary Nielsen (IEEE Standards Association, USA)

3D Medical Standard: Over the Horizon
Young Lae Moon (IEEE Working Group Practical Applications of 3D Medical Modeling, Korea)
Standardization of medical 3D images is urgently needed for designing medical devices that use 3D models, for evaluating the stability of medical instruments that use the 3D models, or for evaluation of content and software producing or using medical 3D models. This presentation will highlight the efforts of the IEEE working group sponsored by the IEEE Computer Society, Practical Applications of 3D Medical Modeling, which is investigating technical standards for medical 3D images, including medical 3D modeling, visualization, simulation, data storage, and related fields.

Where Are the Business Opportunities in IoT?
Gary Stuebing (Cisco, USA)
The Internet of Everything, the Internet of Things; why are these things important to me? Business is naturally evolving to a connected environment where everything changes. The world as we know it is changing. What will this mean to me? Gary will explore the changes and why business needs to change with it.

Internet of Things and its Growing Business
Michimasa Aramaki (Panasonic, Japan)
Keynote address

Sensors and the Internet of Things Can Help Us Live Longer
Oleg Logvinov (STMicroelectronics, USA)
Among the promises of the Internet of Things is better access to better healthcare all across the globe. Whether the patient is in New York, New Delhi, or the middle of the Australian Outback, network-connected sensors and actuators will allow authorized caregivers to monitor a patient's health and provide guidance and services remotely in a multitude of ways. While many of the sensing and actuator technologies are available today, a critical missing component is standardization—at many important levels. Attend this session to understand what is missing, how the IEEE-SA can contribute to its creation, and ultimately, how this "healthcare supply train" will help us live longer.

16:00 - 18:00

Transport and Energy Management

Room: Seoul
Chair: Abdelmajid Khelil (Huawei European Research Center, Germany)

Study on the Reduction Effect of Traffic Accident by Using Analysis of Internet Survey
Masahiro Miyaji (Aichi Prefectural University & InfoTOYOTA, LTD, Japan)
Traffic fatalities in Japan have declined for twelve years by the comprehensive counter-measure. The efforts include enhancement of vehicle safety performance in passive and preventive safety area. As to passive safety, major reduction effect was brought by airbag system, seat belt and crashworthiness of vehicle. For further reduction of the traffic accident, preventive safety may play more important role. Recently driver's psychosomatic state adaptive driving support system has been highlighted to reduce the traffic accident. For that reason reduction effect of psychosomatic adaptive safety function should be clarified to foster its penetration into the market. Statistical analysis of the traffic incident is highly expected to evaluate reduction effect of the traffic accident of psychosomatic adaptive safety function. To execute the challenge, this study introduced Internet survey by delivering questionnaires to respondents. From the analysis of collected answer, major psychosomatic state of driver is hasty and distraction. As a first step this study focused driver's distraction, which may cause traffic accidents. By using pattern recognition, the detection accuracy of driver's distraction was acquired. The reduction effect of the driver's distraction in the traffic accident was estimated by referring the reduction rate of both ASV (Advanced Safety Vehicle) and Intelligent Transportation Systems.

Multi-Player Gaming in Public Transport Crowd: Opportunities and Challenges
Saumay Pushp (KAIST, Korea); Chi Harold Liu (IBM Research, P.R. China); Fangming Liu (Huazhong University of Science and Technology, P.R. China); Junehwa Song (KAIST, Korea)
Smart devices are supporting emerging types of location-based gaming applications to attain collaborations among collocated users in public places like transports. However, they are facing many challenges like the timely performance of back-end game servers for runtime game operation, unreliable cellular network connections, and opportunistic and dynamic local environment. To address these limitations, in this paper, we propose "CrowdMoG", a Crowd based Mobile Gaming platform, to identify and match the nearby passengers on the move according to their associated gaming preferences, and provides the smooth session handoff to enable the continuity of existing game plays when participants leave the game due to different mobility patterns. We therefore describe the potential, along with challenges and opportunities that open up the new dimension for the entire research community to redesign and examine a tradition problem, fundamentally transforming it into a new era of mobile gaming experience.

A Modular Framework for Cost Optimization in Smart Grid
Muhammad Raisul Alam (Carleton University, Canada); Marc St-Hilaire (Carleton University, Canada); Thomas Kunz (Carleton University, Canada)
A smart power grid transforms the traditional electric grid into a user centric, intelligent power network. This paper addresses the cost optimization problem in the smart grid from the users' perspective. A home owner can install diverse energy generators and storage devices to reduce the dependency on external energy sources. The widespread utilization of green energy sources creates uncertainty in energy generation due to their unpredictable nature. A user can collaborate with the neighbors to participate in energy trading. The utility indirectly controls the energy consumption and generation in the system by utilizing a demand-oriented time varying price signal. The relationships between the participating components represent a complex unified system because of uncertain energy consumption and power generation disruption. Computational intelligence plays an essential role to coordinate the participating components. This paper proposes a cost optimization framework that breaks the dependencies between the components. The framework transforms the complex unified model into a simpler modular framework. Each module can be solved using different optimization approach which implies a simple, flexible and traceable strategy for practical implementation.

Controlling Electric Vehicle Charging in the Smart Grid
Wang Xiang (Carleton University, Canada); Thomas Kunz (Carleton University, Canada); Marc St-Hilaire (Carleton University, Canada)

Efficient scheduling and coordination algorithms controlling Electric Vehicle (EV) charging operations can potentially lead to energy consumption reduction and/or load balancing, in conjunction with different electricity pricing methods used in smart grid programs. In order to easily implement different algorithms and evaluate and compare their efficiency against other ideas, a flexible simulation framework is proposed. This simulation framework focuses on demand-side residential energy consumption coordination in response to different pricing methods. It is equipped with an appliance consumption library using realistic values to closely represent the average usage of different types of appliances including EVs. In this paper, a prototype program is developed and used to analyze EV charging and coordination algorithm impacts. The simulation run from the program gives a complete picture of the households' power consumption profile. Some results, analysis, and implications are presented in this paper demonstrating how the proposed tool can be used to study the impact of policy decisions.

Application of RFID Technology and the Maximum Spanning Tree Algorithm for Solving Vehicle Emissions in Cities on Internet of Things

Chi-Man Vong (Unversity of Macau, Macao); Pak-Kin Wong (University of Macau, Macao); Zi-Qian Ma (University of Macau, Macao); Ka-In Wong (University of Macau, Macao)

The proportion of air pollution which is caused by the cars is increasing. In order to solve this serious problem, many countries and regions have presented a series of emissions standards. However, these actions have not brought about a striking effect as we expect. There are also some situations to fail implement these emissions standards in many cities. In this paper, a new system, wireless inspected the vehicle emissions through the concept of Internet of Things (IoT) is proposed. By applying the system, it is possible to smoothly realize a green traffic network. In this system, Radio frequency identification (RFID) technology as a low-cost and mature wireless communication method is adopted to collect and transmit some sensor signals of vehicles (emissions information). The RFID devices need to be installed on the traffic lights so that reliable reading of emissions signals from a vehicle can be interrogated when the vehicles stop in front of the red light. Meanwhile, an efficient and innovative maximum spanning tree algorithm is also presented to select suitable traffic lights aim to reduce the number of RFID devices and guaranteed the whole urban cars can be monitored.

Design and Implementation of Vehicle Tracking System Using GPS/GSM/GPRS Technology and Smartphone Application

SeokJu Lee (Kettering University, USA); Girma Tewolde (Kettering University, USA); Jaerock Kwon (Kettering University, USA)

An efficient vehicle tracking system is designed and implemented for tracking the movement of any equipped vehicle from any location at any time. The system makes good use of a popular technology that combines a Smartphone application and a microcontroller. This will be inexpensive solution compared to others. The designed in-vehicle device works using GPS/GSM/GPRS technology that is one of the most common ways for vehicle tracking. The device is embedded inside a vehicle whose position is to be tracked in real-time. A microcontroller is used to control the GPS and GSM/GPRS modules. The vehicle tracking system uses the GPS to get geographic coordinates while the GSM/GPRS module is used to transmit and update the vehicle location to a database. A Smartphone application is used for continuously monitoring the vehicle location. The Google Maps API is used to display the vehicle on the map in the Smartphone application. Users will be able to continuously monitor a moving vehicle on demand from their Smartphone and can determine the estimated distance and time for the vehicle to arrive at a given destination. This paper demonstrates the feasibility and effectiveness of the system using successful experimental results.

Developing a NovaGenesis Architecture Model for Service Oriented Future Internet and IoT: An Advanced Transportation System Scenario

Antonio M Alberti (National Institute of Telecommunications, Brazil); Dhananjay Singh (Hankuk University of Foreign Studies, Korea)

We are designing a NovaGenesis Architecture Model to support Future Internet services, which are going to address some fundamental issues of the Internet of Things, such as address resolution, mobility, routing, scalability, security, and network control. The aim is to support trillion of things connect to the Internet. In NovaGenesis, we have presented a set of distributed systems where any information processing is seen as service. Services organize themselves based on names and agreements to meet semantics rich goals, policies, regulations, etc. Even networking functionalities are considered as services. Every existence could have one or more names: natural language names or self-certifying names. All the communication, processing, and storage are name-oriented. The protocol stacks are built on-demand in a contract-based way. Hence, we can state that Nova-Genesis architecture could be an alternative solution for cur-rent internet oriented innovations in a scalable manner. The aim of this architecture is the coverage of Internet and sensors orient-ed smart objects. The paper discusses the proposed model in the context of an Advanced Rural Transportation System.

18:30 - 21:30

Banquet (Olympia)

19:00 - 19:20 SK Telecom's IoT Biz and R&D: Realizing a Smarter World

Alex Jinsung Choi (Executive Vice President and Head of ICT R&D Division, SK Telecom)

IoT is comprised of smart machines interacting and communicating with other machines, objects, environments and infrastructures and then will encompass all aspects for our lives. As a result huge volumes of data are being generated, and that data being processed into useful actions that can make our lives much easier and safer. It requires total convergence of overall technologies-from sensing, embedded processing and connectivity to platform software and applications in order to become a reality. IoT also has a highly fragmented market, especially hundreds of IoT-related applications being considered and identified by different industries: Automotive & Transportation, Wellness & Care, Moving Asset, Facility & Building, Utility & Energy, Safety & Security, Commerce Retail, Consumer Electronics, and Environment & Agriculture. For a wide variety of these services IoT requires low energy consumption, cost-effectiveness, quality and reliability as well as sophisticated processing that can track of all of connected devices, communicate with them and translate their functionality into useful applications. More than all, full security is essentially needed across the entire signal path. All these requirements mean no one company can develop full solutions. IoT-based innovations will require a broad, rich ecosystem of partner companies working together to bring IoT services to the market. Regarding these points SK telecom's IoT Biz strategy and R&D status will be addressed in this talk.

Saturday, March 8

08:00 - 10:00

IoT and Cloud Computing

Room: Rome

Chair: Fuyuki Ishikawa (National Institute of Informatics, Japan)

Interoperability Enhancement for Virtualization of Sensors for Smart Cities

Hiroyuki Maeomichi (NTT Network Innovation Laboratories, Japan); Akihiro Tsutsui (NTT Network Innovation Laboratories, Japan)

We discuss interoperability enhancement for sensor virtualization for smart cities. We propose a model of metadata and data conversion components for interoperability enhancement and introduce our research approach.

Abstracting IoT Devices Using Virtual Machine for Wireless Sensor Nodes

Takayuki Suyama (NTT Communication Science Laboratories, Japan); Yasue Kishino (NTT Communication Science Laboratories, Japan); Futoshi Naya (NTT Communication Science Laboratories, Japan)

In the field of IoT, abstracting of IoT devices is one of the important technologies. In order to abstract IoT devices, We have developed a virtual machine (VM) for wireless sensor nodes. Since the VM is based on Common Language Infrastructure of .NET Framework, users can develop a program on the IoT devices using Microsoft development environment (Visual Studio) and the languages such as Visual C# or C++. In addition, users can update the program on the IoT devices through the wireless sensor network. They don't need to collect the sensor nodes in the environment for changing the behavior of the sensor network. In this paper, we introduce our sensor network system using the VM and the use cases.

ClouT: Cloud of Things for Empowering the Citizen Clout in Smart Cities

Kenji Tei (National Institute of Informatics, Japan); Levent Gurgen (CEA French Alternative Energies and Atomic Energy Commission, France)

ClouT is a collaborative project that leverages Cloud Computing as an enabler to bridge Internet of Things with Internet of People via Internet of Services. The project is based on a strong partnership of leading European and Japanese industry as well as universities and research centers. ClouT will have the following major outputs: i) a smart city infrastructure with a near to infinity processing and storage capacity of data from trillions of things and people that are integrated via virtual services in the Cloud while keeping their universal interoperability; ii) a set of platform level tools and services aiming at facilitating IoT application development, deployment and supervision iii) secure data access and processing mechanisms that can handle big data acquired from the heterogeneous sources in quasi real-time; iv) innovative city applications and field trials in four pilot cities: Santander and Genova in Europe, Mitaka and Fujisawa in Japan. Thus the ClouT project provides unified efforts on individual techniques, the whole vision integrating them, and attractive applications in cities.

Monitoring Dependability of City-scale IoT Using D-Case

Hideyuki Tokuda (Keio University, Japan); Takuro Yonezawa (Keio University, Japan); Jin Nakazawa (Keio University, Japan)

City-scale IoT, a fundamental infrastructure for smart cities, requires to sense a range of ubiquitous entities in a city including humans, objects, and spaces. Ubiquitous sensor networks (USN) is the key technology to this. However, failures of a USN may result in hazards in our daily lives in smart cities. Monitoring of USN, rapid detection of faults and failures, and recovery from them are thus important for better applications of USN. This paper proposes a means to do so comprehensively by using Dependability Cases (D-Case). Since USN is a system composed of variety of components such ash wireless sensor nodes, database servers, and network appliances, we need a tool that can target them in common. Our tool enables to execute monitoring programs on a D-Case diagram, which is represented with Goal Structuring Notation (GSN), so that it can target a variety of devices and services.

Sharing User IoT Devices in the Cloud

Yazid Benazzouz (CEA-LETI, France); Christophe Munilla (CEA-LETI, France); Ozan Gunalp (CEA-LETI, France); Mathieu Gallissot (CEA-

LETI, France); Levent Gurgen (CEA French Alternative Energies and Atomic Energy Commission, France)
Internet of Things (IoT) is the set of technologies that can interconnect anything, from daily life objects to more sophisticated networked devices. The IoT paradigm is constantly increasing the number of devices owned by end-users. Following the social networks paradigm, IoT-centric social networks would allow sharing of devices between users that would provide useful information captured by sensor devices or giving ways to make remote actions on user devices. This paper proposes an IoT centric social device network based on a Cloud computing model which provides a virtual execution environment thanks to its decentralized nature, high reliability and accessibility from anywhere and at any time. The paper describes an approach that allows easily reusing highly distributed IoT resources by building services on top of them. Applications are built by composing those services and deploying into service platforms distributed and hosted in the Cloud that grants secure access to the data shared by these devices in compliance.

IoT and Cloud Convergence: Opportunities and Challenges
MD Abdur Rahim (Create-Net International Research Centre, Italy); Raffaele Giaffreda (Create-Net, Italy)
The success of the IoT world requires service provision attributed with ubiquity, reliability, high-performance, efficiency, scalability. In order to accomplish this attribution, future business and research vision is to merge the Cloud Computing and IoT concepts, i.e., enable an "Everything as a Service" model: specifically, a Cloud ecosystem, encompassing novel functionality and cognitive-IoT capabilities, will be provided. The introduction of cognition was the first step for the IoT success, as it brought essential self-management/awareness and knowledge-management functionality. Hence the paper will propose an innovative IoT centric Cloud smart infrastructure that will address the computational as well as IoT data management challenges in cloud through different services (e.g. devices as a services, infrastructure as a services and software as a services) at infrastructure and services levels.

Service Scenarios and Platforms

Room: Seoul
Chair: Markus Jung (Vienna University of Technology, Austria)

An Infrastructure for Robotic Applications as Cloud Computing Services
Carla Mouradian (Concordia University, Canada); Fatima Zahra Errounda (Concordia University, Canada); Fatna Belqasmi (Concordia University, Canada); Roch Glitho (Concordia University, Canada)
Robotic applications are becoming ubiquitous. They are widely used in several areas (e.g., healthcare, disaster management, and manufacturing). However, their provisioning still faces several challenges such as cost and resource usage efficiency. Cloud computing is an emerging paradigm that may aid in tackling these challenges. It has three main facets: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). This paper focuses on the IaaS aspects of robotic applications as cloud computing services. It proposes an architecture that enables cost efficiency through virtualization and dynamic task delegation to robots, including robots that might belong to other clouds. Overlays and RESTful Web services are used as cornerstones. A prototype is built using LEGO Mindstorms NXT as the robotic platform, and JXTA as the overlay middleware. Related work is reviewed, the functional entities and interfaces of the architecture are described, and the prototype architecture is presented along with the implemented scenario.

Objects That Agree on Task Frequency in the IoT: a Lifetime-Oriented Consensus Based Approach
Giuseppe Colistra (University of Cagliari, Italy); Virginia Pilloni (University of Cagliari, Italy); Luigi Atzori (University of Cagliari, Italy)
Some key features of the end-systems impact on the way communications happen within the IoT: available objects' resources are limited, different objects may provide the same information (e.g. sense the same physical measure), the number of nodes in the IoT is quickly overcoming the number of Internet hosts with greater reliability issues. This entails for a new paradigm of communication with respect to those characterizing the traditional Internet. Before providing the required information about the physical world, objects coordinate with the other objects in groups and provide a unified service to the external world (the application that requires the service), with the intent to distribute the load of the requested services according to specific community defined rules, which could be: lifetime extension, QoS (Quality of Service) maximization, reward maximization, or others. In this paper other than describing the characteristics of this new communication paradigm and challenges it is called to address, we also propose a first solution for its implementation that relies on a distributed optimization protocol based on the consensus algorithm. Results of simulations and real experiments are also presented that show the viability in implementing the new communication model in a distributed way.

User-centric Service Environment for Context Aware Service Mash-up
Hoan Suk Choi (Hanbat National University, Korea); Jun-Young Lee (Hanbat National University, Korea); Na-Ri Yang (Hanbat National University, Korea); Woo-Seop Rhee (Hanbat National University, Korea)
The existing service mash-up environment enables user to create context aware services. It is able to build services by recombining ready-made building blocks and connection operations. But a non-technical user is difficult to create context aware service. Because, they don't know principles of service offering (e.g., service platform architecture, concept of ontology, criteria of context, required sensor type and etc.) To solve this problem, we propose the user-centric service environment. It consists of service mash-up process and the web-based service composition user interface. The user can create target context aware service through easily step-by-step progress. Also, we propose the ontology based semantic sensor data processing. It removes heterogeneity of sensor data and processes the object data to the context information.

Ubiquitous Clerk and Virtual Planning Office
Shunsuke Fujita (Saitama University, Japan); Takaaki Hasegawa (Saitama University, Japan); Tetsuya Manabe (Saitama University, Japan)
This paper describes the virtual planning office "VPO" from the viewpoint of the quality of spatial comfort "QoSC" toward supplying attractive products for consumers, and constructs a prototype of the VPO system. In addition, the validity of the actual products' effects the VPO focuses on is verified through the prototype. The VPO is a new concept that sends consumers' preference on actual products to suppliers. The VPO has two agents. One agent is the ubiquitous clerk to extract consumers' preference on actual products in a shop. The other is the virtual designer that provides the consumers' preference information to the suppliers in a real planning office. In verification experiments, subjects draw designs of favorite T-shirts under different conditions, i.e., with/without actual T-shirts. After that, the each subject evaluates which design reflects the subject's preference best. The results show most subjects draw preferable designs with actual products rather than without them ($p < 0.01$). Additionally, it is found that 88% of the subjects feel that actual products are useful to express their preference from answers of a post-test questionnaire. Consequently, significance of actual products and the VPO's potential to realize supplying preferable products are presented.

An Integrated Device and Service Discovery with UPnP and ONS to Facilitate the Composition of Smart Home Applications
Jin Mitsugi (Keio University, Japan); Yuki Sato (Keio University, Japan); Miyuki Ozawa (Keio University, Japan); Shigeya Suzuki (Keio University, Japan)
This paper proposes a device and capability discovery protocol with integrated Universal Plug and Play (UPnP) and Object Naming Service (ONS). The protocol automatically establishes a list of available devices -- sensors, actuators and electronic apparatus -- in our home. Since each device is identified with a globally unique Electronic Product Code (EPC) in the protocol, the capability of discovered device can be obtained through ONS without implementing a complex capability description exchange protocol in the device. The up-to-dated list of all the available devices facilitates the compositions of smart home applications. This paper overviews the device and capability discovery protocol. Illustrative smart home applications in our campus enabled by the proposed protocol are also reported.

08:00 - 09:00

Social IoT

Room: Berlin
Chair: Srdjan Krco (DunavNET & University of Belgrade, Faculty of Organizational Sciences, Serbia)

Network Navigability in the Social Internet of Things
Michele Nitti (University of Cagliari, Italy); Luigi Atzori (University of Cagliari, Italy); Irena Pletikosa Cvijikj (ETH Zürich, Switzerland)
The Internet of Things is expected to be overpopulated by a very large number of objects, with intensive interactions, heterogeneous communications and millions of services. Consequently, scalability issues will arise from the search of the right object that can provide the desired service. A new paradigm known as Social Internet of Things has been introduced and proposes the integration of social networking concepts into the Internet of Things. The underneath idea is that every object can look for the desired service using its friendships, in a distributed manner. However, in the resulting network, every object will still have to manage a large number of friends, slowing down the search of the services. In this work, we intend to address this issue by analyzing possible strategies to drive the objects to select the appropriate links for the benefit of overall network navigability.

Semi-autonomous, Context-Aware Agent Using Behaviour Modelling and Reputation Systems to Authorize Data Operation in the Internet of Things
Bertrand Copigneaux (Inno TSD, France)
In this paper we address the issue of gathering the "informed consent" of a end user in the Internet of Things. We start by evaluating the legal importance and some of the problems linked with this notion of informed consent in the specific context of the Internet of Things. From this assessment we propose an approach based on a semi-autonomous, rule based agent that centralize all authorization decisions on the personal data of a user and that is able to take decision on his behalf. We complete this initial agent by integrating context-awareness, behavior modeling and community based reputation system in the algorithm of the agent. The resulting system is a "smart" application, the "privacy butler" that can handle data operations on behalf of the end-user while keeping the user in control. We finally discuss some of the potential problems and improvements of the system.

Towards Zero-Configuration in Device Collaboration Using Device Sociality
Jang-Ho Choi (Electronics and Telecommunications Research Institute, Korea); Kyuchang Kang (ETRI, Korea); Dong-oh Kang (ETRI, Korea); Sangkeun Yoo (ETRI, Korea); Chang Seok Bae (ETRI, Korea)
Collaboration of smart devices often requires troublesome configuration and management, involving human interventions. In order to reduce these burdens, smart devices should be able to configure and manage themselves in device collaboration, self-understanding high-level information such as social relationship between the owners. We propose a concept called, device sociality, which aims automatic configurations in device collaboration via self-constructing social relationships. Device sociality describes social relationships of devices,

which can be identified by analyzing machine-level communication data and human social data. We conducted an initial experiment to show that devices can self-identify their social relationship with minimum human intervention. We verified the result with user survey, providing that devices are able to collaborate autonomously with device sociality.

09:00 - 12:00

Routing / Protocols

Room: Berlin

An Inter-Device Communication Protocol for Modular Smart-Objects

Riccardo Brama (CMC Labs, Italy); Piergiuseppe Tundo (CMC Labs, Italy); Armando Della Ducata (CMC Labs, Italy); Angelo Malvasi (CMC Labs, Italy)

The ability to gather and analyze distributed data adding value to extracted information is a core concept in the Internet of Things. Smart-Objects with multi-sensor capability further enhance environmental awareness with coherent and meaningful information. In this paper we first investigate a modular architecture or multi-sensors Smart-Objects allowing to ease their customization and maintainability. Then, we introduce and detail an efficient and flexible inter-device communication protocol: flexSPI. Built on top of SPI, the proposed approach allows reducing routing overhead and enabling modularity by exploiting packet-oriented messaging. To achieve these improvements, SPI bus is completely shared between connected devices avoiding conflicts by keeping free (i.e. in input direction) the SOMI signal and occupying it only after proper, advanced addressing. Low power and high bandwidth characteristics of SPI bus are maintained while enabling smart features such as hot-pluggability, link diagnosis, devices discovery, synchronization and master solicitation.

A Secure Multi-Hop Routing for IoT Communication

Ruen Chze Loh (Nanyang Polytechnic, Singapore); Siew Leong Kan (Nanyang Polytechnic, Singapore)

This paper introduces a multi-hop routing protocol that enables IoT devices to communicate securely. The routing protocol enables the IoT devices to authenticate among themselves before forming a new network or joining an existing network. The authentication uses multi-layer information to enhance the security of the IoT devices' communication. The proposed routing protocol embeds the security information into the routing algorithm, thus combining the authentication and routing processes without incurring significant overheads. The IoT devices are only allowed to communicate if they are identified with a unique User-Controllable Identification, running users' pre-agreed application(s), and are in the list of permitted devices, thus saving resources by maintaining smaller routing information. Experimental and field tests were conducted with results showing that our secure multi-hop routing is suitable to be deployed for IoT communication.

Towards Synchronous Deterministic Channels for the Internet of Things

Wilfried Steiner (TTTech Computertechnik AG, Austria); Flavio Bonomi (IoXWorks, Inc., USA); Hermann Kopetz (Technical University of Vienna, Austria)

Embedded systems are omnipresent in our daily lives and rapidly gain more and more importance with performance improvements and technological evolutions on several scales. One of the most promising directions of their evolution is in their interconnection. Already today there is a broad variety of use cases for interconnected embedded systems (automobiles, airplanes, automated production halls, etc.) and the most cutting edge ones demand the distributed embedded systems to tightly couple their operation. As a direct implication from this tight coupling, immediately stringent requirements on the underlying communication network arise. The Internet-of-Things (IoT) as a discipline and movement to systematically connect distributed embedded systems on a large or even Internet-like scales promises a new generation of systems and system of systems. In order to enable tight coupling of embedded systems also in the IoT, there is a need for deterministic communication channels with predictable and low communication latency and jitter. In this paper we discuss how synchronous deterministic channels can be developed for the IoT by application of the time-triggered communication paradigm and other technology standards currently under development.

Fault-Tolerant RPL Through Context Awareness

Bassam Sharkawy (Cairo University, Egypt); Ahmed Khattab (Cairo University, Egypt); Khaled Elsayed (Cairo University, Egypt)

The Routing Protocol for Low power and Lossy Networks (RPL) has recently been considering as the standard routing protocol for wireless sensor networks (WSN). RPL builds routes between nodes based on specific metrics that reflect arbitrary optimization objectives through the RPL Objective Functions (OFs). In this paper, we propose a Context-Aware Objective Function (CAOF) that takes into account the limited resources of the sensor nodes and their temporal changes. The proposed CAOF optimizes the power exploitation as a critical resource by taking the battery level into consideration in the routing decision. Simulation results show that our CAOF increases the network lifetime by up to 44% compared to non-context-aware OFs of RPL. Furthermore, CAOF ensures fairness in the exploitation of the batteries of the different nodes in the network. In addition, CAOF achieves slightly higher delivery ratio than that achieved by OF0.

IoT Routing Architecture with Autonomous Systems of Things

Soochang Park (Institut Mines-Télécom, Télécom SudParis, France); Noel Crespi (Institut Mines-Télécom, Télécom SudParis, France); Hosung Park (Chungnam National University, Korea); Sang-Ha Kim (Chungnam National University, Korea)

This article presents the routing architecture for the Internet of Things (IoT) future-driven. This IoT routing architecture involves a new concept regarding a set of things with the same routing and service polices, denoted by an autonomous system of things (ASoT). In IoT, an ASoT would be connected not only to the others but legacy autonomous systems (ASs) for the Internet in a wide variety of scenarios. Hence, this article firstly addresses classification of diverse features of ASoTs, and then explores new challenges especially on inter-domain routing.

Low Power Routing and Channel Allocation Method of Wireless Video Sensor Networks for Internet of Things (IoT)

HyungWon Kim (Chungbuk National University & College of Electrical and Computer Engineering, Korea)

We propose a new method of multi-channel allocation and routing for wireless mesh networks where each node generates event-driven video sensor data. Battery powered video camera sensors are often connected wirelessly to cover a large area. Such wireless video sensor networks are considered as major applications of Internet of Things (IoT). We analyze the power consumption model for wireless video sensor network. We then propose an algorithm to route the sensor nodes and allocate channels in a way that minimizes the overall power consumption while satisfying the required data transmission. We developed a wireless video sensor network simulator to prove the performance advantage of the proposed algorithm. Simulation results are provided with wireless sensor networks of various sizes.

Deployment Adviser Tool for Wireless Sensor Networks

Amarlingam Madapu (IIT HYDERABAD, India); Adithyan I (Indian Institute Of Technology Hyderabad, India); Pachamuthu Rajalakshmi (Indian Institute of Technology Hyderabad, India); Yasutaka Nishimura (KDDI R&D Laboratories Inc., Japan); Masaya Yoshida (KDDI R&D Laboratoeies, Inc., Japan); Kiyohito Yoshihara (KDDI R&D Laboratories Inc., Japan)

This paper presents a system for the purpose of field deployment of nodes in wireless sensor networks. We propose a mobile phone based deployment adviser tool which is robust as well as practically implementable. The tool advises a layman deployer to create a optimized wireless sensor network by placing of the nodes according to application requirements. The tool is presented here as logically linked sub-modules. Each sub-modules are described in detail. Also we propose an algorithm which helps in distributing the power consumption among the nodes in the network, thus, increasing the network lifetime. The adviser tool has been verified by implementing it in IITH mote. The tool we propose has significant implication since it greatly eases, but more importantly extracts the best performance possible while deploying the wireless sensor networks.

A Novel Anti-collision Scheme for RFID Systems

Shoufeng Wang (China Mobile Group Design Institute Co., Ltd., P.R. China); Dongchen Zhang (CCMC, P.R. China); Xiaoyan Xu (CCMC, P.R. China); Shumeng Shi (CCMC, P.R. China); Tinglan Wang (CMCC, P.R. China)

Because of low cost and easy-to-use feature for RFID cards, more and more operators adopt RFID technique to identify their goods. When there are many goods with RFID cards put together, collision happens when trying to identify each good from the other. Some tree-based schemes are proposed to solve this problem. However, tree-based schemes have long identification time, and they need much data exchange. A novel anti-collision scheme for RFID systems is proposed in this paper. Theoretical analysis proves that the proposed scheme decreases the identification time as well as minimizing data exchange.

Depth First Forwarding for Low Power and Lossy Networks: Application and Extension

Jiazi Yi (LIX, Ecole Polytechnique, France); Thomas Heide Clausen (Ecole Polytechnique, France); Ulrich Herberg (Fujitsu Laboratories of America, USA)

Data delivery across a multi-hop low-power and lossy networks is a challenging task: devices participating in such a network have strictly limited computational power, and the communication channels are with high loss rates. Consequently, routing protocols finding paths through such a network must be frugal in their control traffic and state requirements, as well as in algorithmic complexity - and even once paths have been found, these may be usable only intermittently, or for a very short time due to changes on the channel. Routing protocols exist for such networks, balancing reactivity to topology and channel variation with frugality in resource requirements. Complementary component to routing protocols for such LLNs exist, intended not to manage global topology, but to react rapidly to local data delivery failures and (attempt to) successfully deliver data while giving a routing protocol time to recover globally from such a failure. Specifically, this paper studies the "Depth-First Forwarding (DFF) in Unreliable Networks" protocol, standardised within the IETF in June 2013. Moreover, this paper proposes optimisations to that protocol, denoted DFF++, for improved performance and reactivity whilst remaining fully interoperable with DFF as standardised, and incurring neither additional data sets nor protocol signals to be generated.

10:00 - 12:00

Energy

Room: Seoul

Chair: Gi-Joon Nam (IBM Research, USA)

Leveraging Human Gait Characteristics Towards Self-Sustained Operation of Low-Power Mobile Devices

Vishwa Goudar (University of California, Los Angeles, USA); James B Wendt (UCLA, USA); Miodrag Potkonjak (University of California at Los Angeles, USA); Zhi Ren (University of California, Los Angeles, USA); Paul Brochu (University of California, Los Angeles, USA); Qibing Pei (University of California, Los Angeles, USA)

The proliferation of mobile ubiquitous devices faces a hurdle in the form of high resource consumption rates that restrict longevity. Several low-power devices and application designs and optimization techniques have been proposed. Simultaneously, energy harvesting technologies are increasingly being viewed as a complementary technique to drive down resource consumption rates and even achieve self-sustenance. Towards this end, we propose a foot-strike powered harvester array composed of a novel high-energy density material called Dielectric Elastomers. To compensate for their control parameter sensitivity, we propose an adaptive closed-loop control algorithm based on general characteristics of human gait. From experimentally collected datasets of human plantar pressure and detailed characterization of DE behavior, we show that our algorithm yields enough accuracy to produce upwards of 85\% of the maximum energy harvestable by the DE array. We also show that, in many cases, this is sufficient to fully drive low-power mobile ubiquitous applications.

Portable Low-Power IR-UWB System

Choi Look Law (Nanyang Technological University, Singapore)

Indoor environments are typically complex wireless propagation channels with numerous multi-paths created by closely spaced scattering object. The ability to resolve these multi-paths is very important for good ranging resolution and positioning accuracy. Impulse-Radio Ultra-Wideband (IR-UWB) is a promising technology to fulfill these usage requirements in indoor cluttered environment. A portable low-power IR-UWB system for indoor channel characterization and time of arrival ranging measurements is presented in this paper. The system consists of battery powered transmitters and a four channel receiver array system powered from the USB port of a notebook computer. A novel repetitive coding and stroboscopic sampling technique is used to reduce power consumption while maintaining precise ranging using time of arrival based technique. The repetitive coding also enables data communication capability through the same wireless channel. Power saving and precision ranging is achieved by optimization of the circuit design for ultra short pulses as well as system architecture and operation. The transmitted pulse is captured by low-cost energy-detection receivers with analogue to digital converters running at around 3.2MHz rate. Measurement in a 20m×20m typical indoor environment is currently being conducted and results should be ready in the final paper.

Sensor Dispatching Methods for Gathering Data in Rechargeable Wireless Mobile Sensor Networks

Shih-Chang Huang (National Formosa University, Taiwan); Hong-Yi Chang (National Chiayi University, Taiwan); Jen-Yi Pan (National Chung Cheng University, Taiwan)

this paper proposes two methods for dispatching sensors to gather data in the rechargeable wireless mobile sensor networks. Sensors are random deployed and move to the anchoring locations for gathering data. Sensors can restore their energy at the recharging dock. In the first method, each anchoring location is assigned at least one sensor. The random deployed sensors move to them. One sensor monitors the environment, and the others become the backup sensors. The backup sensors replace the active one when its energy exhausts so that the monitoring task can be continued. In the second method, the sensor's mobile ability is utilized. All backup sensors are collected in the recharging docks. When a sensor in an anchoring location runs out of energy, one of the sensors in the recharging dock will move to replace it. The simulation results show that utilizing the mobile ability for dispatching high-energy sensors to replace the low-energy ones can prolong the network operation and save more remaining covered grids after time passes.

A SystemC-Based Framework for the Simulation of Appliances Networks in Energy-Aware Smart Spaces

Alessandro Nacci (Politecnico di Milano, Italy); Giovanni Bettinazzi (Politecnico di Milano, Italy); Christian Pilato (Politecnico di Milano, Italy); Vincenzo Rana (Politecnico di Milano, Italy); Marco D Santambrogio (MIT & Politecnico di Milano, USA); Donatella Sciuto (Politecnico di Milano, Italy)

The efficient energy management of buildings is nowadays a crucial point to move toward a sustainable planet. Unfortunately, the design of smart buildings able to optimize their energy consumption is a quite complex task. Since this exploration cannot be performed on the field, simulation methodologies are usually adopted to study the behavior of buildings and their energy sustainability during the design phase. This paper proposes a simulation framework based on SystemC to easily evaluate different policies to control the energy consumption of a smart space. In particular, SystemC makes it possible to obtain a flexible representation of the system, allowing the designer to easily evaluate different configurations of appliances and policies, and it directly works with the commonly-used C programming language.

Adaptive Radio Duty Cycling in ContikiMAC: Proposal and Analysis

Moataz Youssef (Cairo University & VALEO, Egypt); Khaled Elsayed (Cairo University, Egypt); Ahmed Zahran (Nile University, Egypt)

Wireless sensor networks (WSN) face several challenges in field deployments due to strict limitations in nodes hardware capabilities and battery capacities. In addition, several environmental factors should be considered while designing or testing a WSN. Energy-efficient operation is one of the prominent challenges for successful deployment of WSN's. In this paper, we consider energy-efficient operation of WSN nodes implementation based on the Contiki real-time operating system. We inspect the effect of applying spatial configuration for the radio duty-cycle (RDC) frequencies of WSN nodes running ContikiMAC. We also propose two temporal update mechanisms namely: a distributed mechanism in which a WSN sink node collects network-wide statistics and broadcasts a threshold value to the nodes to adjust their duty cycles and an autonomous mechanism in which each node individually updates its duty-cycle based on its battery capacity level. Our simulation results show significant gains in network life time while maintaining network delivery ratio at the same level compared with static schemes.

Novel Sampling Algorithm for Levy-Walk Based Mobile Phone Sensing

Thejaswini M (IIT Hyderabad, India); Pachamuthu Rajalakshmi (Indian Institute of Technology Hyderabad, India); Uday B Desai (IIT Hyderabad, India)

Mobile phones or smart phones equipped with different communication technologies and sensors have become pervasive application development platform for opportunistic and human-centric sensing. Optimisation of battery energy consumption and opportunistic sensing coverage are important issues under mobile phone sensing. This paper proposes a simple sampling algorithm based on human-walk velocity for mobile phone sensing. We analyse the impact of human-walk velocity on battery energy consumption and spatial coverage for mobile phone sensing by considering general regular sampling of sensors and proposed sampling method. When Levy walk mobility parameter = 1, the proposed sampling algorithm shows better performance in terms of both spatial coverage and reduction of battery energy consumption for mobile phone sensing activity.

Software Architectures

Room: Rome

Chair: Sanghyun Ahn (University of Seoul, Korea)

WirelessCHARM: An Open System Low Cost Wireless Marshalling Module for Industrial Environments

Song Han (University of Connecticut, USA); Thomas Lin (AwiaTech Corporation, USA); Deji Chen (Emerson Process Management, USA); Mark Nixon (Emerson Process Management, USA)

Using wireless communication for sensor networks in industrial settings is now common practice. There are now thousands of industrial wireless sensor and control networks deployed. So the next questions are, "How far can we extend the reach of wireless technologies?" and "Can we utilize the same wireless technology to facilitate the coming of IoT in the industrial settings?" To address both of these questions wireless needs to leverage the wide range of existing sensors and devices that are already in the market. The solution should also be flexible. We report in this paper WirelessCHARM that enables different sensors and actuators to communicate wirelessly in an industrial setting. We describe the design and implementation of WirelessCHARM. A demonstration is built to integrate various types of devices into a commercial distributed control system.

Knowledge Request-Broker Architecture: A Possible Foundation for A Resource-Constrained Dynamic and Autonomous Global System

Hamed Khandan (RIKEN Advanced Institute for Computational Science, Japan); Kenji Ono (RIKEN Advanced Institute for Computational Science, Japan)

Significant gap between software programming model and execution model is one major slowing factor in the development of the emerging field of Internet-of-Things. It is also one of the main reasons why software systems often lag behind hardware technologies and fail to capture the full potentials of modern day hardware infrastructure, which is mostly parallel and distributed. We need to change the way we think about software fundamentally, and make it, at its most basic level, to work like the physical world works: distributed, parallel, loosely connected, and asynchronous. KnoRBA, first introduced in 2010, achieves this by making the basic components of any program, even if it is a common word processor, to be asynchronous mobile agents. Then through provision of implementation and location transparency it establishes integration across a distributed environment. This extended abstract is an early introduction to the new revision of KnoRBA that makes it efficient in a domain like sensor networks where power and bandwidth are critical factors.

A Scalable Distributed Architecture Towards Unifying IoT Applications

Chayan Sarkar (Delft University of Technology, The Netherlands); Akshay Uttama Nambi (TU Delft, The Netherlands); R Venkatesha Prasad (TU Delft, India); MD Abdur Rahim (Create-Net International Research Centre, Italy)

The advent of Internet of Things (IoT) has kindled the possibility of umpteen number of applications. One of the major challenges in the realization of IoT applications is interoperability among various IoT entities. Thus, the need for a new architecture - comprising of smart control and actuation - has been identified by many researchers. In this article, we propose a distributed, interoperable architecture for IoT, which will overcome most of the obstacles in the process of large scale expansion of IoT. It specifically addresses heterogeneity of IoT devices, and allows for new devices to be added seamlessly across applications. We propose a layered architecture that provides various levels of abstraction to tackle scalability, heterogeneity and interoperability. Using a comprehensive study of a use-case, comprised of elements from multiple-application domains, we illustrate the usability of the proposed architecture.

An IoT Gateway Centric Architecture to Provide Novel M2M Services

Soumya Kanti Datta (EURECOM, France); Christian Bonnet (EURECOM, France); Navid Nikaein (Eurecom, France)

This paper proposes an innovative Internet of Things (IoT) architecture that allows real time interaction between mobile clients and smart/legacy things (sensors and actuators) via a wireless gateway. The novel services provided are: (i) dynamic discovery of M2M device and endpoints by the clients, (ii) managing connection with non-smart things connected over modbus, (iii) associate metadata to sensor and actuator measurements using Sensor Markup Language (SenML) representation and (iv) extending the current capabilities of SenML to

support actuator control from mobile clients. These clients are equipped with an end-user application that initiates the discovery phase to learn about the devices and endpoints (sensors and actuators) connected to the wireless gateway. Then the user can select desired sensors to receive and display sensor metadata and control actuators from the mobile device. Prototypes of the mobile application and the wireless gateway have been implemented to validate the entire architecture. The gateway is implemented using RESTful web services and currently runs in a Google App Engine. Two real life scenarios are discussed that can be implemented using the architecture. Finally overall contributions and future research scopes are summarized.

Improving Energy Efficiency in IoT with Re-configurable Virtual Objects

Matti Eteläperä (VTT Technical Research Centre of Finland, Finland); Massimo Vecchio (Create-Net, Italy); Raffaele Giaffreda (Create-Net, Italy)

In this paper we present a method for re-configuring Virtual Objects (VO) during run-time. VOs are semantic descriptions of ICT objects and the associated physical objects and phenomena they observe. VOs also include software modules to expose ICT object functionalities as IoT services for re-use. In our case study we show, by using an analytical model, how the energy efficiency of a wireless battery powered weather station (WS) can be improved. We introduce descriptions of the available operating modes and store them in the WS semantic description. These operating modes of the WS's VO are linked with the ability of the ICT object to change the compression method used to transmit information during run-time. We evaluate the energy efficiency and latency of three operating modes, namely uncompressed, lossy and lossless modes. The results show that the possibility to re-configure the operating mode during run-time from uncompressed to lossy mode lowers the total energy for transmission to 47.9%

Making IT All Work Together

Ian Thomas (Fujitsu Enabling Software Technologies, United Kingdom); Sebastien Ziegler (Mandat International, Switzerland); Cedric Crettaz (Mandat International, Switzerland); Lou Fedon (RunMyProcess, France); Sébastien Gaïde (RunMyProcess, France)

Over the last few years the rise of cloud, mobile and social technologies has driven the influence of the Web into traditional value chains, digitizing many transactional and social interactions and opening up opportunities for new business mod-els. At the same time new initiatives such as 6LoWPAN and CoAP are pushing the edges of the Web even further out, opening up opportunities to digitize and socialize the millions of sensors and other physical devices operating at the edge of the network. Without some form of convergence in the platforms necessary to leverage these new components, however, such developments will struggle to hit critical mass with peer to peer arrangements alone unable to cope with the complexities of integrating a wide and highly divergent set of resources. In this paper we discuss the ways in which we have been extending our cloud platform within the framework of the IoT6 European research project to enable the seamless integration of these new components as they join the global network

12:00 - 13:30

Lunch (Arirang, 2F)

13:30 - 15:30

Experiments - Technologies

Room: Seoul

Chair: Enrico Scarrone (Telecom Italia LAB, Italy)

Fault-recovery and Coherence in Internet of Things Choreographies

Sylvain Cherrier (Université Paris-Est, France); Yacine Ghamri-Doudane (University of la Rochelle, France); Stephane Lohier (University of Paris-Est, France); Gilles Roussel (Université Paris-Est, France)

Facilitating the creation of Internet of Things (IoT) applications is a major concern to increase its development. D-LITe, our previous work, is a framework for that purpose. In D-LITe, Objects are considered as part of a whole application. They offer a REST web service that describes Object capabilities, receives the logic to be executed, and interacts with other stakeholders. Then, the complete application is seen as a choreography dynamically deployed on various objects. But the main issue of choreographies is the loss of coherence. Because of their unreliability, some networks used in IoT may introduce de-synchronization between Objects, leading to errors and failures. In this paper, we propose a solution to re-introduce coherence in the application, in order to keep the advantages of choreography while dealing with this main issue. An overlay of logical check-points at the application layer defines links between the coherent states of a set of objects and triggers re-synchronization messages. Correcting statements are thus spread through the network, which enables fault recovery in Choreographies. This paper ends with a comparison between the checking cost and the reliability improvement.

Cognitive Management Framework for Internet of Things - A Prototype Implementation

Swaytha Sasidharan (Create-Net & Create-Net, Italy); Andrey Somov (CREATE-NET, Italy); Abdur Rahim (CREATE-NET, Italy); Raffaele Giaffreda (Create-Net, Italy)

In the domain of Internet of Things (IoT), applications are modeled to understand and react based on existing contextual and situational parameters. This work implements a management flow for the abstraction of Real World Objects (RWOs) and virtual composition of those objects to provide IoT services. We also present a real world knowledge model that aggregates constraints defining a situation, which is then used to detect and anticipate future potential situations. It is implemented based on reasoning and machine learning mechanisms. This work showcases a prototype implementation of the architectural framework in a smart home scenario, targeting two functionalities: actuation and automation based on the imposed constraints and thereby responding to situations and also adapting to the user behavior. It thus provides a productive integration of heterogeneous devices, IoT platforms, and cognitive technologies to improve the services provided to the user.

DPWSim: A Simulation Toolkit for IoT Applications Using Devices Profile for Web Services

Son N. Han (Institut Mines-Telecom, Telecom SudParis, France); Gyu Myoung Lee (Institut TELECOM, TELECOM SudParis, France); Noel Crespi (Institut Mines-Télécom, Télécom SudParis, France); Van Luong Nguyen (Institut Mines-Telecom, Telecom Sudparis, France); Heo Kyoungwoo (ETRI, Korea); Mihaela Brut (Theresis, Thales Services S.A., France); Patrick Gatellier (Theresis, Thales Services S.A., France)

The OASIS standard Devices Profile for Web Services (DPWS) enables the use of Web services on smart and resource-constrained devices, which are the cornerstones of the Internet of Things (IoT). DPWS sees a perspective of being able to build service-oriented and event-driven IoT applications on top of these devices with secure Web service capabilities and a seamless integration into existing World Wide Web infrastructure. We introduce DPWSim, a simulation toolkit to support the development of such applications. DPWSim allows developers to prototype, develop, and test IoT applications using the DPWS technology without the presence of physical devices. It also can be used for the collaboration between manufacturers, developers, and designers during the new product development process.

An Implementation of Light-Weight Compression Algorithm for Wireless Sensor Network Technology in Structure Health Monitoring

Chia-Hao Hsu (National Taiwan University, Taiwan); Chih-Ting Lin (National Taiwan University, Taiwan); Hui Ping Tserng (Department of Civil Engineering, National Taiwan University, Taiwan); Jen-Yu Han (Department of Civil Engineering, National Taiwan University, Taiwan)

Internet-of-Thing (IoT) has been identified as one of the next generation technologies from different aspects. Among different technologies for IoT, wireless-sensor-network (WSN) is one of key technologies to be developed. To demonstrate WSN capabilities in applications, this work developed self-developed sensor node (Super-Node) and applied the device into a on-field structure health monitoring (SHM) task. The developed WSN system achieved requirements of SHM applications, i.e. 128Hz sampling rate with tri-axial acceleration data within one sensor node. By acquired data, the developed system can make the predication of structure status. In addition, a local-data- processing node and algorithm was also implemented to promote usability of WSN system in SHM applications. With Huffman code implemented, the wireless transmission payload was reduced by 60% and the node capacity can be increased by 3 times. This work not only demonstrated the capability of WSN technologies in on-field SHM applications but also provided a better solution for IoT development.

Undervolting in WSNs - A Feasibility Analysis

Ulf Kulau (Technische Universität Braunschweig, Germany); Felix Büsching (Technische Universität Braunschweig, Germany); Lars C Wolf (Technische Universität Braunschweig, Germany)

The energy consumption of electric circuits depends on the applied voltage level. This is used by dynamic voltage scaling approaches where the voltage is lowered up to a datasheet specified level. To reduce the energy consumption even further, it would be possible to power the electric circuits below the specified voltage levels. Considering Wireless Sensor Nodes, this 'undervolting' would save a substantial amount of energy and, hence, would lead to a significant longer lifetime of nodes and networks. Contrariwise, operating processors or nodes outside their specifications adds some extra incertitude to the system. In this paper, we analyze the effects of undervolting for a typical wireless sensor node in theory and practice. A prototype implementation is used to characterize the influence of lower-than-recommended voltage levels on the MCU. In addition, the impact of different temperatures is considered as well as the behaviour of an undervolted transceiver unit and, therefore, the effects on the wireless communication. While classical computer applications may contain too many hazards to outweigh the improved energy consumption when using undervolting, we show that it is particularly suitable for WSNs with a huge potential of saving energy and the opportunity of novel power management approaches on every layer.

13:30 - 15:00

Semantic / Analytic for IoT

Room: Rome

Chair: Gyu Myoung Lee (Institut TELECOM, TELECOM SudParis, France)

Enrich Machine-to-Machine Data with Semantic Web Technologies for Cross-Domain Applications

Amelie Gyrard (Eurecom, France); Christian Bonnet (Institut Eurecom, France); Karima Boudaoud (University of Nice Sophia Antipolis, France)

The Internet of Things, more specifically, the Machine-to-Machine (M2M) standard enables machines and devices such as sensors to communicate with each other without human intervention. The M2M devices provide a great deal of M2M data, mainly used for specific M2M applications such as weather forecasting, healthcare or building automation. Existing applications are domain-specific and use their own descriptions of devices and measurements. A major challenge is to combine M2M data provided by these heterogeneous domains and by different projects. It is really a difficult task to understand the meaning of the M2M data to later reason about them. We propose a semantic-based approach to automatically combine, enrich and reason about M2M data to provide promising cross-domain M2M applications. A proof-of-concept to validate our approach is published online (http://sensormeasurement.appspot.com/).

ANGELS for Distributed Analytics in IoT

Arijit Mukherjee (Tata Consultancy Services, India); Himadri Sekhar Paul (Tata Consultancy Services, India); Swarnava Dey (Tata Consultancy Service Limited, India); Ansuman Banerjee (Indian Statistical Institute, India)

The current global emphasis on "Internet of Things (IoT)" have highlighted the extreme importance of sensor-based intelligent and ubiquitous systems which are more commonly known as "cyber-physical systems." The technology has the potential to create a network of smart devices and things to an extent that has never been envisaged before, far outnumbering the number of devices connected in the Internet as we know today. The sheer number of such connected ubiquitous devices is likely to give rise to a hitherto unforeseen volume of data of different types with a demand for execution of analytical algorithms over the data. On the success of these analytic processes will depend the actual "smartness" of the "Intelligent Infrastructures" which now form the crux of the IoT paradigm. Apart from the servers in the data centres, we potentially have a huge pool of compute resources if we think about the smart devices in and around our homes collectively, which remain relatively idle. In this paper, we present a proposal where we claim that in an IoT framework, the smart devices such as mobile phones, home gateways etc. can be utilised for execution of data-parallel analytic jobs.

Multi-resolution Data Communication in Wireless Sensor Networks

Frieder Ganz (Centre for Communication Systems Research, University of Surrey, United Kingdom); Payam Barnaghi (University of Surrey, United Kingdom); Francois Carrez (University of Surrey, United Kingdom)

There is an increasing trend in using data collected by sensor devices to enable better understanding of the physical world for humans and support the creation of pervasive environments for a wide range of applications in different domains such as smart cities, and intelligent transportation. However, the deluge of data created and communicated and the low-processing capabilities of the used sensor devices lead to bottlenecks in the processing and interpreting of the data. We introduce a data reduction approach that submits high-granular data in times of high activity in the sensor readings and low-granular data in times of low activity. We consider and discuss different methods to measure activity in the data and modify the symbolic aggregate approximation algorithm that uses a fixed window length to adapt the length according to the data activity for ultimately less data communication between sensor node and sink/gateway. We evaluate our approach over real-world data sets and show that reduction of data size while maintaining the features of the data can be achieved.

A Unified Semantic Knowledge Base for IoT

Akshay Uttama Nambi (TU Delft, The Netherlands); Chayan Sarkar (Delft University of Technology, The Netherlands); R Venkatesha Prasad (TU Delft, India); MD Abdur Rahim (Create-Net International Research Centre, Italy)

In the Internet of Things (IoT), interoperability among heterogeneous entities is an important issue. Semantic modeling is a key catalyst to support interoperability. In this work, we present a unified semantic knowledge base for IoT that uses ontologies as the building blocks. Most of the current ontologies for IoT mainly focus on resources, services and location information. We build upon the current state-of-the-art ontologies to provide contextual information and set of policies to execute services. Our knowledge base consists of several ontologies viz, resource, location, context & domain, policy and service ontologies. This helps in building a unified knowledge representation for IoT entities. In our knowledge base, we specifically model dynamic environments in which IoT entities operate. Our knowledge base also facilitates service- composition, discovery and modeling for IoT in dynamic environments.

15:30 - 16:00

Closing Ceremony (Seoul)