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Special Issue on "Future Tele-Infrastructure for Multi-sensory Devices (FIND)"

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The 18th Edition of Strategic Workshop (SW'16) was held in, in Glymur Hotel, Hvalf-jardarsveit, 301 Saurbaer, ICELAND, on May 23–25, 2016. The focus during the active 2-day discussion was, Future Tele-infrastructure for Multi-sensory Devises (FIND) addressing concept, systems, network security, and future strategy.

The theme for the Strategic Workshop 2016 (SW' 16) was Future Tele-infrastructure for Multi-sensory Devises (FIND): Multi-Sensory devices allow the integration and processing of multiple inputs across multiple devices to deliver contextual, connected and viral experiences. In the new era of Information and Communication Technology (ICT) where everyone and everything is connected, devices are no longer terminals for content viewing or data entry, they are transforming in rendering services in education, health-care, entertainment, and business to name few. The list of services relying on the use of Multi-sensory devices is certain to grow, and is limited only by the imaginations of innovative entrepreneurs and Multi-sensory enabling technologies.

Technologies, for instance, Cloud, IoT, Big Data, and Machine Learning are helping us to deliver Multi-Sensory applications quickly and easily. Nevertheless, there are open issues and challenges that demands research and innovation to maximize the efficiency and effectiveness of multi-sensory based applications and related technologies.

This Special Issue features eleven selected papers that concentrate on a wide range of research challenges in Future Tele-infrastructure for Multi-sensory Devises (FIND) as well as addressing issues pertaining to security in the use of Multi-Sensory enabled services, and innovative business models for multi-sensory technologies and associated services.

Selected Topics from the Strategic Workshop, May 23–25, 2016, Glymur Hotel, Hvalfjardarsveit, 301 Saur Baer, Iceland.

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The first paper, "ICN as network infrastructure for multi-sensory devices (Local Domain service Discovery for ICN-based IOT environments)", by Jose Quevedo. Carlos Guimaraes. Rui Ferreira. Daniel Corujo. Rui. This research paper is materializing information centric networking (ICN) and its applicability on broader scale. The author aims to shift the internet from current host centric paradigm towards centered around content approach. This paper also discuss the challenges concerning ICN particularly interest based solutions, impose to service discovery. This work proposes a service discovery mechanism for such a scenarios, relying on an alternative forwarding pipeline for supporting its core operations. The author tells that the applicability of the proposed alternative forwarding pipeline implementation is not exhausted to service discovery scenarios, but may be considered as a general purpose tool for other applications. (For example, packet sniffing application).

The second paper, "Outage Probability of Multiuser Mixed RF/FSO Relay Schemes for Heterogeneous Cloud Radio Access Network (H-CRANs)", by Isiaka. A. Alimi. Paulo P. Monteiro. Antonio L.

This paper presents multiuser mixed Radio-Frequency/Free-space Optical relay schemes for alleviating the stringent requirements of network capacity, Quality of Service (QoS), and network coverage, which are imposed by the high traffic demand by the end-users. The growth in the capacity demand on the internet is ever growing mainly due to the proliferation of mobile devices as well as high bandwidth applications and services. Consequently, resulting in high increase in the broadband connections and associated traffic. This ever growing traffic is referred to as traffic explosion, which is one of the major challenges being experienced by Mobile Network Operators (MNOs), which eventually led to increase in CAPEX and OPEX. This work presents an overview of H-CRAN as well as mixed RF/FSO relay schemes as efficient means of achieving optical-wireless convergence in a dual-hop communication system.

Furthermore, the authors study the end-to-end outage performance of RF/FSO schemes considering pointing errors in the FSO. The simulation results presented can be beneficial in the evaluation, optimization, and prediction of MIMO based mixed RF/FSO dual-hop relay system performance in real life deployment.

The Third paper, "Research challenges, trends and applications for multi-sensory devices in future networked systems", by Liljana Gavrilovska. Valentin Rakovic. Vladimir Atanasovski.

This paper elaborates the current state of research with respect to the multi-sensory devices and supporting ICT technologies, by providing detailed literature overview as well as identifying the current trends and most prominent applications. The paper also presents the open issues and provides a discussion for the possible future directions. As, computing is becoming ubiquitous, everyday items including mobile phones, household appliances, vehicles and personal electronic devices are gaining sophisticated computing, communication and sensory capacities. These devices are increasingly autonomous, connected and capable of sensing a multitude of physical and contextual parameters, and represent the basis of a novel communication paradigm, the multi-sensory communication. Multi-sensory represents a novel ICT concept with multiple-sensory modalities.

Currently research focuses on two different pillars i.e.; research and design of multi-sensory devices. Multi-sensory communication paradigm facilitates the transformation of the sensory devices traditional to smart by ICT technologies and infrastructure. With the passage of time this sensory devices will enhance in growth and put big impact on home and industries, novel technologies are required for reliable communication.

The fourth paper, "Micro operators to boost local service delivery in 5G", by Marja Matinmikko, Matti Latva-aho, Petri Ahokangas, Seppo Yrjola, Timo Koivumaki.

This paper has introduced the new micro operator concept for local service delivery in future 5G mobile communication business ecosystem. Increasing digitalization requires that versatile location and case specific requirements to be met in different environments, with high traffic densities particularly indoors.

Future 5G aim at connecting billions of devices and case specific needs of vertical sectors in parallel with the provisioning of traditional mobile services. The paper depicts the underlying regulatory and technical developments towards 5G and identifies business opportunities for newly proposed micro operators. The first concrete target for the micro operator concept is envisaged to be the local operations in the 3.5 GHz band with locally issued spectrum licenses. Future work is needed to develop contents for the scalable business models that can be timely adapted to the vertical specific conditions and requirements and trial the feasibility of the concept in practice.

The fifth paper, "Mitigation Uplink Interference in Femto-Marco Coexisted Hetero-geneous Network by Using Power Control", by chih-cheng Tseng, Hwang-Cheng Wang, Kuo-Chang ting, Yi-Fan Tsai, Fang-Chang Kuo.

To address the ever growing user demands in terms of high data rate, low-latency and network coverage femtocells technologies have been regarded as on the feasible solutions. A femtocell is a low-cost, low-power, and user-deployed base station called Femtocell Access Point (FAP) or Home eNode-B (HeNB) in LTE-A, which is exclusively designed to improve signal coverage problem in indoor environment and all the associated Femtocell User Equipment (FUE). In the femto-macro coexisted heterogeneous network, the uplink transmission of FUE interferes the Macrocell base satiation, thus deteriorating the capacity of Macrocell User Equipment (MUE). To mitigate this cross-tier interference, a power control mechanism is proposed to adjust transmission power of FUE. The proposed approach derives the minimum transmission power to achieve the required Modulation and Coding Scheme (MCS) requirements and derives the maximum transmission power without violating the maximal tolerable interference of Macrocell base station. By selecting the minimum among the two selected transmission power and the maximum allowable transmission power of FUE, the cross-tier interference is alleviated.

The sixth paper, "Fairness and Rate coverage of symmetric Transmission over Heterogeneous Cellular Networks under Diverse Coupling and association Criteria", by M. Mujtaba Shaikh. M Carmen Aguayo-Torres.

Human communication, received through physical senses, often occurs between two end points which are both similar source of information. For those applications, originated traffic is symmetric. On the other occasions, only certain feedback is needed for multi-sensory communication but even in these cases a minimum through is needed in the uplink for signaling purposes. In this paper the joint uplink 8UL) and downlink (DL) binary rate that can be achieved by realistic spectral efficiencies as signaled by channel quality indicators in LTE have been studied. Specifically, symmetric binary rate gathers both uplink and downlink capacities while forcing them to be reached simultaneously in order to carry the bidirectional information flow. The author assumes two-tier heterogeneous cellular network with macro and Pico Base Station (BS) and User Equipment's (UE) uniformly distributed. Downlink transmission to a UE could be associated to its nearest base station or to the BS from which the average received power is maximum.

The seventh paper, "Advanced Business model Innovation", by Peter Lindgren.

Business models (BM) "represents an important vehicle for innovation" and a "source of Business Model Innovation (BMI) in and of itself". The BM concepts have become a

popular concept in business and management fields. Yet, it is suffering from a paradox between outstanding popularity and severe criticism, which appear to impede the positive development of the scholarly discourse on the BM concept and BMI approach. The development and innovation of Business models to a future tele infrastructure for Multi-sensory devices (FIND) is a complex venture related to adaptability in especially for the business research and praxis community. As numerous types of sensor and wireless technologies are these days being embedded both external and internal human beings, things and business models.

The aim of this paper is to give a conceptual outlook to advanced Business Model Innovation embedded with persuasive technologies. The paper also discuss on behalf of inputs from Strategic Workshop 2016, IEE workshop at NJIT 2016, lab experiments in the MBIT Lab. This paper also gives findings and understanding of advanced business model innovation of tomorrow.

The eight paper, "Privacy and Economics in a 5G environment", by Samant Khajuria, Knud Erik Shouby.

This paper is broadly classified into two parts. The first part discusses the key challenges and two most essential principles "Notice and Choice" associated to the user's personal information when dealing with the online services. Second part of the paper identifies the stakeholders in the value chain and their business objectives dealing with user personal data. 5G network technologies are generally expected to empower wireless communication to enable communication for anybody of anything and anywhere. A generally accepted technology vision is that new services and applications especially related to social networking, and machine to machine communications (M2M/IOT) will be accelerated, underlying the shift to a more user centric application-driven connectivity, transparently deployed over various technologies and infrastructures by users and devices.

The ninth paper, "Human Bond Communication Performance using Cooperative MIMO Architecture", by Maryam Rahimi, Ramjee Prasad.

Human bond communication (HBC) is a novel concept that incorporates sense of smell, sense of taste, and sense of touch that will allow more expressive and holistic sensory information exchange through communication techniques for more human sentiment centric communication. This concept endorses the need of inclusion of other three senses and proposes an innovative approach of holistic communication for future communication network. This paper proposes Continuous Aperture Phase (CAP) algorithm for the HBC transmission to transmit massive amounts of data, which is available due to HBC transmission demands by implementing cooperation among several base stations in Multiple-Input-Multiple-Output (MIMO) architecture to promote the performance of the system. The proposed method is evaluated by conducting simulation tests in ideal channels and by performing measurements at different frequencies in actual propagation environments.

The architecture of HBC includes sense transducers or seducers that convert stimuli into electrical signals for further processing, the human bond sensorium (HBS) that collects and processes the information from seducers to enhance their perceptibility, and a human perceivable transposer (HPT) that transposes the information sent by HBS in in a format that is perceptible to humans and is then transformed into stimuli that can be sensed by an observer.

The tenth paper, "Cyber Security Threats to IOT Applications and Service Domains", by Samuel Tweneboah-Koduah, Knud Erik skouby, Reza Tadayoni.

This paper describes currently living in the post-PC era where smartphones and other wireless handheld devices are changing our environment, making it more interactive, adaptive and informative. Termed as IoT (Internet of things) involving into internet of

everything (IoE), the new ecosystems combines wireless sensor networks (WSNs), cloud computing analytical data, interactive technologies, as well as smart devices, to provision solutions in which the objects are embedded with network connectivity and identifier to enhance object to object interactions. IoT innovations are advancing and provide diverse smart solutions or applications. From e-transport to e-health; smart living to e-manufacturing and many other e-solutions.

The eleventh paper, "Sub-GHz LPWAN network coexistence, management and virtualization: an overview and open research challenges", by Eli De Poorter, Jeroen Hoebeke, Matthias Strobbe, Ingrid Moerman, Steven Latre, Maarten Weyn, Bart Lannoo and Jeroen Famaey.

The IOT domain is characterized by many applications that require low-bandwidth communications over a long range, at a low cost and at low power. LPWANs (Low Power Wide Area Networks) fulfill these requirements by using sub-GHz radio frequencies (typically 433 or 868 MHz) with typical transmission ranges in the order of 1 up to 50 km. As a result, a single base station can cover large areas and can support high number of connected devices (>1000 per base station). Notorious initiatives in this domain are LoRa, sigfox and the upcoming IEEE 802.11ah (or "HaLow") standard. Although these new technologies have the potential to significantly impact many IOT developments, the current market is very fragmented and many challenges exists related to deployment, scalability, management and coexistence aspects, making adaptation of these technologies difficult for many companies.

This paper provides a remedy and proposes a conceptual framework to improve the performance of LPWAN networks through in-network optimization, cross-technology coexistence and cooperation and virtualization of management functions. In addition, the paper gives an overview of state of the art solutions and identifies open challenges for each of these aspects.

Ramjee Prasad is a Professor of Future Technologies for Business Ecosystem Innovation (FT4BI) in the Department of Business Development and Technology, Aarhus University, Denmark. He is the Founder President of the CTIF Global Capsule (CGC). He is also the Founder Chairman of the Global ICT Standardization Forum for India, established in 2009. GISFI has the purpose of increasing of the collaboration between European, Indian, Japanese, North-American and other worldwide standardization activities in the area of Information and Communication Technology (ICT) and related application areas. He has been honored by the University of Rome "Tor Vergata", Italy as a Distinguished Professor of the Department of Clinical Sciences and Translational Medicine on March 15, 2016. He is Honorary Professor of University of Cape Town, South Africa, and University of KwaZulu-Natal, South Africa. He has received Ridderkorset af Dannebrogordenen (Knight of the Dannenberg) in 2010 from the Danish Queen for the internationalization of top-class telecommunication research and education. He has received several international awards such as: IEEE Communications Society Wireless Communications Technical Committee Recognition Award in 2003 for making contribution in the field of "Personal, Wireless and Mobile Systems and Networks", Telenor's Research Award in 2005 for impressive merits, both academic and organizational within the field of wireless and personal communication, 2014 IEEE AESS Outstanding Organizational Leadership Award for: "Organizational Leadership in developing and globalizing the CTIF (Center for TeleInFrastruktur) Research Network", and so on. He has been Project Coordinator of several EC projects namely, MAGNET, MAGNET Beyond, eWALL and so on. He has published more than 30 books, 1000 plus journal and conference publications, more than 15 patents, over 100 Ph.D. Graduates and larger number of Masters (over 250). Several of his students are today worldwide telecommunication leaders themselves.

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