27th International Telecommunication Networks and Applications Conference (ITNAC)

	Tuesday, November 21	Wednesday, November 22		Thursday, November 23		Friday, November 24	
8:30 - 8:40							
8:40 - 9:00							
9:00 - 10:40		S2: *Session 2: SDN*	S1: *Session 1: IoT*		S9: *Session 9: Wireless Sensor Networks* S10: *Session 10: Wireless*	S13: *Session 13: Quality and Performance* S14: *Session 14: Transmission*	
10:40 - 11:00		MT1: *Morning Tea*			MT2: *Morning Tea*	MT3: *Morning Tea*	
11:00 - 11:40		K1: *Keynote 1: Elementary Channels for Quantization, Neural Networks and Molecular Information Exchange*			K2: *Keynote 2*	K4: *Keynote 4*	
11:40 - 12:00		K6: *Keynote 6: Super fast broadband - the NZ experience*			K3: *Keynote 3*	K5: *Keynote 5*	
12:00 - 13:00		L1: *Lunch*		L2: *Lunch*		L3: *Lunch*	
13:00 - 14:00		S3: *Session 3: Policy* S4: *Session 4: Security*		S11: *Session 11: Networking* S12: *Session 12: Security and Location services*		S16: *Session 16: Optical Networks* S15: *Session 15: Traffic Management*	
14:00 - 14:30		S5: *Session 5: Transmission* S6: *Session 6: MANET*		AT2: *Afternoon Tea*		S17: *Session 17: Security* S18: *Session 18: General*	
14:30 - 15:20				C1: *Conference Tour*			
15:20 - 15:40		AT1: *Afternoon Tea*				AT3: *Afternoon Tea*	
15:40 - 17:00		S7: *Session 7: Energy efficiency* S8: *Session 8: Wireless*				S20: *Session 20: Wireless Cellular and General* S19: *Session 19: Second International Workshop on Data Intensive Computing and Communications for Sustainable Development*	
17:00 - 17:30							
17:30 - 17:40							
17:40 -						CR: *Closing Remarks*	

W2: *Session W2: Amateur Radio Communications Workshop*

W3: *Session W3: Software Defined Networking Workshop*

17:45							
17:45 - 18:00							
18:00 - 20:00	WR: *Welcome Reception*			D1: *ITNAC 2017 Dinner*			
20:00 - 23:00							

Tuesday, November 21

Tuesday, November 21, 18:00 - 20:00

WR: Welcome Reception

Room: Grand Vestibule
Chair: Mark A. Gregory (RMIT University, Australia)

Wednesday, November 22

Wednesday, November 22, 08:40 - 10:40

S2: Session 2: SDN

Room: Ballroom B
Chair: Katrina L. Neville (RMIT University, Australia)

08:40 *Handover Management for Distributed Mobility Management in SDN-based Mobile Networks*
Battulga D (National University of Mongolia & SEAS, Mongolia); Ankhzaya J and Ankhbayar B (National University of Mongolia, Mongolia); Ganbayar U (National Research Council /CNR/, Italy); Sodbileg SH (SEAS, National University of Mongolia, Mongolia)

Centralized mobility management (CMM) is widely used in current long-term evolution (LTE) networks. The rapidly-growing number of mobile subscribers has led to the creation of a large number of signaling messages. This makes it difficult to efficiently manage mobile networks and the mobility of subscribers simultaneously. One of the problems related to CMM is a single point of failure. To solve the problems of CMM, the Internet Engineering Task Force has developed distributed mobility management (DMM) as a solution, in which mobility is handled via the nearest mobility anchor. The LTE architecture provides software-defined networking (SDN) to meet the requirements of 5G networks and to forward massive mobile data traffic. The SDN solution proposes separation of the control and data planes of a network. In this paper, we propose a DMM solution with handover operations for SDN-enabled LTE networks. The advantage of the proposed solution is that intra and inter handover procedures are defined with the data buffering and forwarding processes between base stations and mobility anchors. We adopt a simulation model to evaluate and compare the proposed solution with the existing solution in terms of handover latency and packet loss.

pp. 1-6

09:00 *Flow-based Load Balancing of Web Traffic using OpenFlow*
Anees Al-Najjar and Samuel Teed (University of Queensland, Australia); Jadwiga Indulska (The University of Queensland, Australia); Marius Portmann (University of Queensland, Australia)

In this paper, we explore the concept of flow-based load balancing of network traffic on multi-homed hosts. In contrast to existing approaches such as MPTCP, our approach is a client-side-only solution, and can therefore easily be deployed. We specifically explore flow-based load balancing for the web traffic use case. Experimental evaluations of our OpenFlow-based load balancer demonstrate the potential of flow-based load balancing.

pp. 7-12

09:20 *High-Level Concepts for Northbound APIs: An Interview Study*
Andrew Curtis-Black, Matthias Galster and Andreas Willig (University of Canterbury, New Zealand)

There is little work which empirically analyses network management practice with respect to policy creation and maintenance. To address this gap we carried out five semistructured interviews of network administrators at a diverse range of enterprises. Analysis of the results led us to make the following contributions: We introduce a number of high-level orthogonal concepts (dimensions) for representing network policy; we identify a set of real-world network policies; and show how each of these may be represented by these dimensions. There are a number of use cases for our work: Engineers or researchers looking to create or refine high-level network management frameworks (such as northbound APIs for SDN); Network administrators looking to document their network policy in a consistent format; Researchers looking to develop empirical studies in this area.

pp. 13-20

09:40 *Adaptive Error Control Code Implementation Framework for Software Defined wireless Sensor Network (SDWSN)*
Rajan Kadel (Melbourne Institute of Technology, Australia); Khandakar E Ahmed (Victoria University, Australia); Anuj Nepal (Melbourne Institute of Technology, Australia)

We propose an adaptive error control implementation framework for software defined wireless sensor network (SDWSN). This scheme exploits the features provided by both software defined network (SDN) and forward error correction (FEC). The framework supports adaptability at both transmitter and receiver. Additionally, the scheme allowed using different FECs in different sections of a network or a link. Therefore, the framework is flexible to support heterogeneous wireless sensor networks (WSNs). The adaptability and flexibility offered by the proposed scheme leads to reduce energy consumptions at energy-constrained nodes in WSN. The scheme also exploits energy-constrained properties of nodes in data-centric storage network. The framework offered to use both iterative and non-iterative codes depending on the demand. The use of iterative codes provides more flexibility and adaptability than non-iterative codes due to features provided by iterative codes.

pp. 21-26

10:00 *Updating Guaranteed Bandwidth in Multi-Domain Software Defined Networks*
Franciscus Xaverius Ari Wibowo and Mark A. Gregory (RMIT University, Australia)

The rapid growth of data transmission over digital networks, especially of delay sensitive traffic, has meant that research into improved network control and management has increased. Network domain boundaries are key points in the network where service provisioning, flow control, and management occur between organizations. This paper presents a flexible automated approach that utilizes Software Defined Networking (SDN) to carry out provisioning, control and management functions at domain boundaries. We propose a multi-domain SDN provisioning framework and a domain boundary bandwidth update algorithm to improve link performance between domains. Simulations were carried out using data captured from a carrier to enterprise network link. The simulation results show that the proposed algorithm provides improved service fulfillment and lower packet loss probability compared to other approaches.

pp. 27-32

10:20 *Dynamic Attack Mitigation using SDN*

Sharon Ezekiel (National University of Singapore, Singapore); Dinil Mon Divakaran (Singtel, Singapore); Mohan Gurusamy (National University of Singapore, Singapore)

Security threats in the Internet have been ever increasing, in number, type and means used for attacks. In the face of large-scale attacks, such as DDoS attacks, networks take unacceptable time to respond and mitigate the attacks, resulting in disruption to connections and the losses due to it. In this work, we look into the problem of dynamically mitigating attacks from the perspective of an ISP. An ISP also needs to adapt its network while mitigating attacks. We exploit the software defined networking (SDN) paradigm, and propose to provide mitigation as a service to ISP's customers. Towards this goal, we formulate the problem of dynamically providing multiple mitigation services as an optimization problem. We carry out simulation studies to evaluate the solution, in terms of service delivered and the number of path disruptions caused to legitimate traffic due to mitigation services.

pp. 33-38

Wednesday, November 22, 09:00 - 10:40

S1: Session 1: IoT

Room: Ballroom A

Chair: James Kang (Melbourne Institute of Technology, Australia)

09:00 *Proposal and Development of TCP Multi-Pathization Method with SDN by IoT Devices*

Kaori Iwata and Yoshihiro Ito (Nagoya Institute of Technology, Japan)

This paper proposes a method of TCP multi--pathization for IoT network by SDN. The method distributes packets according to the congestion between paths and IP packet length. Since it is performed over SDN, no changes of existing protocols and devices are required. The authors implement the method by actual IoT devices and evaluate QoS by experiment. The results of the experiment show that the TCP throughput of the proposed method is higher than that of normal TCP when the difference in delay between multi--paths is low; but they also indicate that the TCP throughput of the proposal goes lower than that of normal TCP. To solve the problem, the authors proposes two modified methods. One is to switch the forwarding scheme according to the difference in delay between the paths. The other is to give delay to the path which has small delay. The paper shows the effectiveness of the modified proposed method by supplementary experiments.

pp. 39-44

09:20 *Agriculture Internet of Things: AG-IOT*

Muhammad Ammad-uddin (Lab STICC, ENSTA Bretagne, France); Ali Mansour (ENSTA, France); Denis Le Jeune (ENSTA Bretagne, France); el-Hadi M. Aggoune (University of Tabuk & Director of Sensor Networks and Cellular System (SNCS) Research Center, Saudi Arabia)

The Internet of Things (IoT) for agriculture is a rapidly emerging technology where seamless connected sensors devices make it possible to monitor and control crop parameters to get quality and quantity of food. This research proposes a new dynamic clustering and data gathering scheme for harnessing the IoT in agriculture. In this paper an Unmanned Aerial Vehicle (UAV) is used to locate and assists ground IoT devices to form themselves in clusters formation then establish a reliable uplink communications backbone for data transmission. Use of multi-frequency, multi power transmission, and mobile sink make it possible to reduce power utilization of IoT devices as much as possible. The proposed scheme is evaluated using simulation models and practical experiments. It is found working outclass as compare to all existing systems

pp. 45-50

09:40 *Toward a programmable software-defined IoT architecture for sensor service provision on demand*

Chau Nguyen (University of Technology, Sydney, Australia); Doan B Hoang (University of Technology Sydney, Australia); Thanh Dang (University of Technology, Sydney, Australia)

In the age of IoT, sensors form a foundational component of IoT services, yet they are rigid with little capability for programmable configuration or reusability as they are application-specific, manufacturer-specific. Emerging IoT applications often deploy a vast number of sensors which may serve multiple applications. Programmability is thus essential but not found in legacy or current generation sensors. It is challenging to effectively utilize heterogeneity of resources to handle a large number of application demands. Software defined networking and network functions virtualization have proved effective paradigms for provisioning services on-demand and managing network functions and their life cycles. This paper proposes a software defined IoT architecture that captures the spirit of SDN and NFV where a software-defined Internet of Things (SD-IoT) controller can provide services as requested by an application and also manage heterogeneous physical sensors through their virtual representation called software-defined virtual sensor (SD-VSensor) autonomously. In particular, the paper presents the design of a streamline SD-IoT controller, a lightweight and reconfigurable SD-VSensor, and the communication protocol (S-MANAGE) between them. The proposed architecture enables heterogeneous application-specific WSN systems to be recognized and effectively utilized by diverse IoT applications under the orchestration of the SD-IoT controller. Moreover, heterogeneity of sensor nodes or IoT devices can be programmed to achieve sensor services on demand. The preliminary implementation results demonstrate the feasibility and efficiency of the proposed architecture.

pp. 51-56

10:00 *An Augmented Smart Home System based on the Internet of People Concept*

Yinjun Tu, Yudong Lei and Hanxuan Li (Darkspede Pty Ltd, Australia); Yifu Wang (DARKSPEDE PTY. LTD., Australia); Yifeng Chen (Darkspede Pty Ltd, Australia)

In this study, a concept of Internet of People based augmented smart home system is proposed. Compared with the standard smart house concept, an electronic smart care taker is introduced into this system as a virtual family member to care of family members and house. The care taker monitors the house status and reports to users. He also intuitively provides reminder and suggestion mechanism for users by creating communication channels between users. More importantly, the care taker changes and completes tasks through analyzing the updated information of users and house. This system is initially simulated and modelled in unity3D and it will be implemented in hardware in the future.

pp. 57-59

10:20 *Latency Optimal Broadcasting in Noisy Wireless Mesh Networks*

Qin Xin (University of the Faroe Islands, Faroe Islands); Xia Yan (University of Hunan, College of Computer Science and Engineering, P.R. China)

Wireless Mesh Networking (WMN) has been considered as an emerging communication paradigm to enable resilient, cost-efficient and reliable services for the future-generation wireless networks. We study here mainly on the minimum-latency communication primitive of broadcasting (one-to-all communication) in known topology WMNs, i.e., the size and the topology of the given Wireless Mesh Network (WMN) is known in advance. A distinguished source mesh node in the WMN initially holds a message and the objective is to design a

minimum-latency schedule such that the source mesh node distributes its message to all other mesh nodes. The problem of computing a minimum-latency broadcasting schedule for a given WMN is NP-hard, hence it is only possible to get a polynomial approximation algorithm. In this paper, we adopt a new noisy wireless network model introduced very recently by Censor-Hillel {\sl et al.} in [ACM PODC 2017, \cite{CHHZ17}]. More specifically, for a given noise parameter $p\in [0,1],$ any sender has a probability of p of transmitting noise or any receiver of a single transmission in its neighborhood has a probability p of receiving noise. In this paper, we first propose a new asymptotically latency-optimal approximation algorithm (under faultless model) that can complete single-message broadcasting task in $D+O(\log^2 n)$ time units in any WMN of size $n,$ and diameter D. We then show this diameter-linear broadcasting algorithm remains robust under the noisy wireless network model and also improves the currently best known result in \cite{CHHZ17} by a $\Theta(\log\log n)$ factor. In this paper, we also further extend our robust single-message broadcasting algorithm to k multi-message broadcasting scenario and show it can broadcast k messages in $O(D+k\log n+\log^2 n)$. This new robust multi message broadcasting scheme is not only optimal but also answers affirmatively the problem left open in \cite{CHHZ17} on the existence of an algorithm that is robust to sender and receiver faults and can broadcast k messages in $O(D+k\log n + polylog(n))$.

pp. 60-66

Wednesday, November 22, 10:40 - 11:00

MT1: Morning Tea

Room: Attrium

Wednesday, November 22, 11:00 - 11:40

K1: Keynote 1: Elementary Channels for Quantization, Neural Networks and Molecular Information Exchange

Professor Rudolf Mathar

Room: Ballroom B
Chair: Mark A. Gregory (RMIT University, Australia)

Basic concepts of information theory, namely entropy, mutual information and capacity of channels, are universal tools which can also be applied to analyze information processing of biological systems. The main intention of this talk is to demonstrate the usefulness of information theoretic approaches to neural networks. We will briefly discuss biological neural networks and the functionality principles of neurons. Corresponding idealizing models will include linear, binary threshold, rectifying, censoring and sigmoid neurons. These can be interpreted as information channels, which opens the door to the field of information theory. The capacity and corresponding bounds will be derived providing interesting insight into the control and behavior of neurons. We will also investigate the underlying molecular information exchange by a Poissonian diffusion model.

Wednesday, November 22, 11:40 - 12:00

K6: Keynote 6: Super fast broadband - the NZ experience

Dr Murray Milner

Room: Ballroom B
Chair: Mark A. Gregory (RMIT University, Australia)

Wednesday, November 22, 12:00 - 13:00

L1: Lunch

Room: Attrium

Wednesday, November 22, 13:00 - 14:00

S3: Session 3: Policy

Room: Ballroom A
Chair: Robert Hunjet (DST Group, Australia)

13:00 *Competition, regulation and institutional framework in telecommunications, implications for NGN in Mexico*

Oscar Saenz de Miera Berglind (Centro de Estudios Instituto Federal de Telecomunicaciones, Mexico)

When analyzing competition in telecommunication markets it is fundamental to take into account their specific characteristics. This has to be done both by using an appropriate indicator of competition, and by including its various determinants. In this sense, basing the analysis on concentration indicators is questionable from the theoretical point of view, and in practice it can lead to misleading conclusions. For these reasons the present study analyzes competition in mobile telecommunications, measured through the Lerner Index, and explains its evolution through the influence of regulation and the institutional framework. Mexico is used as a case study, because it is a noteworthy example given its recent efforts to promote competition in telecommunications services. The results show an improvement in competition associated with recent regulatory reforms. Based on them the paper presents key challenges to foster competition in the development of NGN.

pp. 67-72

13:20 *Topic Modeling for Situation Understanding in Telecommunication Networks*

H. Joe Steinhauer (School of Informatics, University of Skövde, Sweden); Tove Helldin, Alexander Karlsson and Gunnar Mathiason (University of Skövde, Sweden)

Decreasing network downtime for wireless telecommunication systems is becoming more and more important. Therefore, degrading system performance needs to be identified long before key performance indicators pick up on it. As a lot of information about what is going on in the telecommunication network can be found in counter readings, exploratory data analysis, such as unsupervised clustering algorithms and statistical methods, can be used to assist the telecommunication operator by grouping scenarios that appear to be similar. In this paper we apply clustering in the area of telecommunication networks. The method is known from the area of topic modeling and is usually used to find out what topics are included in a collection of text documents. In our approach, counters are treated as words and a group of counter readings at a point in time is treated as a document. The results show that the method is capable of identifying statistical relationships between counter readings and could be used by telecommunication operators to investigate the relationships between counters; and hence increase the operators' understanding of ongoing network traffic situations.

pp. 73-78

13:40 *Extrapolation of Customer Demand, and Implications for Broadband Access Network Design*

Bob Warfield (University of Melbourne & Access Research Company, Australia)

A simple model for extrapolating customer demand for high bitrate broadband access services is introduced. It is proposed that customers' perception of the value of their time can be used to model demand for the bitrate of access services, and also the availability of those access services. Implications for the possible future roadmap of the Australian National Broadband Network are explored. Sample analysis is provided to illustrate the proposition that widespread rollout of FTTP (or similar technology) in Australia may be delayed as a result of the use of wireless internet access to supplement FTTN by some Retail Service Providers.

pp. 79-83

S4: Session 4: Security

Room: Ballroom B

Chair: James Kang (Melbourne Institute of Technology, Australia)

13:00 *Dynamic Attack Detection and Mitigation in IoT using SDN*

Suman Sankar Bhunia and Mohan Gurusamy (National University of Singapore, Singapore)

With the advent of smart devices and lowering prices of sensing devices, adoption of Internet of Things (IoT) is getting momentum. These IoT devices come with greater threat of being attacked or compromised that could be lead to Denial of Service (DoS) and Distributed Denial of Service (DDoS). This threat increases manifold for large deployments of IoT devices. The high volume of IoT devices with high level of heterogeneity, magnify the possibility of security threats. So far, there is no protocol to guarantee the security of IoT devices. But to enable resilience, continuous monitoring is required along with adaptive decision making.These challenges can be addressed with the help of Software Defined Networking (SDN) which can effectively handle the security threats to the IoT devices in dynamic and adaptive manner without enforcing any burden on the IoT devices. In this paper, we propose an SDN-based secure IoT framework called SoftThings which will detect abnormal behaviors and attacks as early as possible and mitigate as appropriate. Machine Learning is used at SDN controller to monitor and learn the behavior of IoT devices over time. We have conducted experiments on Mininet emulator. Initial results show that this framework is capable to detect attacks on IoT with around 98% precision.

pp. 84-89

13:20 *Pain Modelling in an Artificial Immune System based MANET*

Lincy Elizebeth Jim and Mark A. Gregory (RMIT University, Australia)

The dynamic topology of a Mobile Ad Hoc Network (MANET) can introduce operational performance constraints. Cells in the human body use pain to indicate a sense of stress or discomfort. This paper conceptualizes pain in a MANET. As MANET is a collection of mobile nodes that may be acting as a source, destination or relay there is an inherent instantaneous variability in the MANET, and this affects performance. At times, nodes may not be willing to consume energy to act as a relay, which would be for the benefit of the other MANET nodes, and this action reduces the MANET performance thereby introducing the concept of pain. We consider critical parameters like trust, effective node energy and the energy cost associated with each packet at a node. In this paper, we model MANET performance as pain utilizing the principles of an Artificial Immune System (AIS). In the Human Immune System (HIS), cells can distinguish between a variety of problems including foreign body attacks and cellular senescence. This paper presents a pain model and imparts pain reduction to stabilize the network using an AIS based approach that mimics the HIS.

pp. 90-95

13:40 *Application of Bayesian Network to Data-Driven Cyber-Security Risk Assessment in SCADA Networks*

Kaixing Huang and Chunjie Zhou (Huazhong University of Science and Technology, P.R. China); Yu-Chu Tian (Queensland University of Technology, Australia)

Supervisory control and data acquisition (SCADA) systems are the key driver for critical infrastructures and industrial facilities. Cyber-attacks to SCADA networks may cause equipment damage or even fatalities. Identifying risks in SCADA networks is critical to ensuring the normal operation of these industrial systems. In this paper we propose a Bayesian network-based cyber-security risk assessment model to dynamically and quantitatively assess the security risk in SCADA networks. The major distinction of our work is that the proposed risk assessment method can learn model parameters from historical data and then improve assessment accuracy by incrementally learning from online observations. Furthermore, our method is able to assess the risk caused by unknown attacks. The simulation results demonstrate that the proposed approach is effective for SCADA security risk assessment.

pp. 96-101

Wednesday, November 22, 14:00 - 15:20

S5: Session 5: Transmission

Room: Ballroom A

Chair: Bob Warfield (University of Melbourne & Access Research Company, Australia)

14:00 *Adaptive Data Transfer Methods via Policy Evolution for UAV Swarms*

Phillip Smith (Monash University, Australia); Robert Hunjet (DST Group, Australia); Aldeida Aleti and Jan Carlo Barca (Monash University, Australia)

This paper presents an adaptive robotic swarm of Unmanned Aerial Vehicles (UAVs) enabling communications between separated non-swarm devices. The swarm nodes utilise machine learning and hyper-heuristic policy evolution to provide agility within the swarm, enabling each swarm member to select the most appropriate mobility policy for the environment given the swarm's abilities. The swarm evolution process of this study is found to successfully create different data transfer methods depending on the separation of non-swarm devices and the communication range of the swarm members. These methods are either human-designed, which the swarm

adopts when most appropriate, or are novel hybridisations that the swarm creates for the problem. This paper also tests the swarm with individuals being removed during deployment. It is found that the swarm is immune to most alterations, though removal of specialised members of the heterogeneous swarm leads to temporary failure. The swarm evolution can then correct this failure by adjusting the swarm behaviour.

pp. 102-109

14:20 *Beyond Line-of-Sight Range Extension in Contested Environments with OPAL using Autonomous Unmanned Aerial Vehicles*

Asanka Kekirigoda (Defence Science and Technology Group, Australia); Ping Hui (Defence Science and Technology Organisation, Australia); Damien J Phillips (Defence Science and Technology Group, Australia)

Tactical military communication networks operate in highly complex environments. The survivability and the range of these networks, especially the mobile wireless segments, are and will be a challenge for the present and future defence forces. OPAL, an autonomous system, has been previously presented where it extended the range and improved the survivability of tactical military networks using unmanned aerial vehicles (UAVs). In this paper, we extend that system to operate in a contested electromagnetic environment caused by jammers. OPAL is shown through emulation to be robust in maintaining effective communications between the nodes in such a scenario.

pp. 110-114

14:40 *On the Symbol Error Probability for QPSK with Quantized Observations*

Hewa Halpage Samiru Gayan, Rajitha Senanayake and Jamie S Evans (University of Melbourne, Australia)

We consider a single-input-single-output (SISO) system with quadrature phase shift keying (QPSK) modulation and derive an easy-to-evaluate expression for the symbol error probability (SEP) when a general n−bit phase quantization is used at the receiver. We further evaluate the expressions asymptotically to characterize the diversity order and the quantization penalty at high signal-to-noise ratios (SNRs). We observe that the system with n−bit phase quantization achieves full diversity order of one when n > 2. Numerical examples are used to verify the analysis.

pp. 115-120

15:00 *Antenna Selection Based on Kronecker Channel Modeling in Massive MIMO using NON-Central Principal Component Analysis*

Muhammad Tausif Afzal, Rana, Rein Vesilo and Ahsan Saadat (Macquarie University, Australia)

Massive multi-user multiple-input-multiple-output (MU-MIMO) is an emerging fifth-generation (5G) wireless communication technology. However, the deployment of large number of antennas and radio frequency (RF) chains needed at the base stations (BS) in massive MIMO brings challenges of high system complexity and hardware energy consumption. By using Kronecker channel modeling, a simple stochastic MIMO model for a narrowband channel is developed that uses the correlation matrices at the mobile station (MS) and BS. In this paper, two semi-heuristic techniques are proposed for practical antenna selection considering Kronecker channel modeling in a MU-MIMO broadcast system using principal component analysis (PCA). Therefore, the number of RF chains needed in massive MU-MIMO is reduced by removing the antennas that contribute least to the system sum capacity. A precoding technique of Zero Forcing is used and each user is equipped with a single antenna. Using analytic methods PCA eigenvalues are decomposed into two components: the mean channel gain component and the channel correlation component. Our simulation results show that the proposed antenna selection technique performs much better than mean channel gain selection, and show how antenna selection depends on the channel matrix structure.

pp. 121-127

S6: Session 6: MANET

Room: Ballroom B

Chair: Jerzy Konorski (Gdansk University of Technology, Poland)

14:00 *A Credit-aware Clustering Scheme for the Proximate Sharing of Geo Data Downloading*

Chung-Ming Huang, Duy-Tuan Dao and Ping-Yi Lu (National Cheng Kung University, Taiwan)

Mobile Social Network (MSN) can enable many services, such as letting people in an MSN share some useful information during the touring journey. In this work, a clustering scheme is proposed to allow a group of persons, who are in the same MSN and are within the Wi Fi hot spot' signal coverage of the cluster leader who enables his handheld device's Wi Fi hot spot function, to share the nearby Point Of Interests' (POIs') data that are downloaded by the cluster leader through his handheld device's 3G/3.5G/4G cellular network interface. That is, it belongs to the proximate sharing of Location-based Service (LBS) data downloading. This work adopts an MSN-based mechanism to organize touring groups in which each group's leader can share his downloaded POIs' data with his group members. A credit-based clustering scheme was proposed to organize a group of users who belong to the MSN and are nearby with each other for a while during their touring journey. In this way, the group leader can get some credits and each group member needs to pay some credits to motivate persons to have the sharing and reach the goal of fairness. Our proposed scheme not only can reach the fairness for the credit concern but also can more evenly distribute power consumption and reduce the power consumption according to the performance analysis.

pp. 128-133

14:20 *Can Observed Entropy Detect Congestion in Ad-Hoc Networks?*

Xiaojie Liu and Ulrich Speidel (University of Auckland, New Zealand)

Congestion presents a significant challenge in ad hoc networks due to their unstructured and distributed nature. In most congestion detection schemes for such networks, the affected node itself detects whether it is congested or not. The detection approach proposed in this paper performs detection with information estimators from neighbouring uncongested nodes that may be able to relieve the congestion. The type of information estimator studied here is the entropy of the difference between subsequent sequence numbers of TCP packets sent to or via the node under congestion monitoring. Using the hidden node problem as background, this paper argues that entropy estimates are as sensitive to congestion as the observed retransmission rate, but easier to compute.

pp. 134-139

14:40 *IEEE 802.11 HCCA for Tactile Applications*

Ye Feng, Chamil Jayasundara, Ampalavanapillai Nirmalathas and Elaine Wong (The University of Melbourne, Australia)

The Tactile Internet refers to the communication networks that have a closed control loop of tactile input and audio and/or visual feedback. Example applications include tele-rehabilitation and virtual training. To ensure that these applications have unnoticeable latencies and thus satisfied quality-of-service and quality-of-experience requirements, the Tactile Internet needs to guarantee round-trip latencies of approximately 1-10 ms. Such a stringent requirement cannot be met by today's technologies. In this paper, we investigate the potential of the IEEE 802.11 standards, which is one of the primary wireless solution of household users, to support the Tactile Internet applications. In particular, we analyze the wireless queueing latency from a tactile user device to an access point using one of the latest IEEE 802.11 media access control (MAC) protocols. Based on our model, a close-form expression of the latency is derived and

analytical results are compared with simulations. More importantly, our work emphasizes the tradeoff between achievable latency performance and throughput of the MAC reference design. Our model can be used as a guidance to strategically select appropriate HCCA parameters to meet the required latency performance.

pp. 140-142

15:00 *Priority Based Resource Allocation for LTE-A Femtocell Networks*

Abdullah Omar Arafat and Mark A. Gregory (RMIT University, Australia)

The femtocell is a promising technology that can be employed to enhance next generation wireless network coverage. It possesses the potential to reduce network deployment risk, improve network operation efficiency and capacity. By utilizing femtocells spectrum utilization can be improved. Due to its key features, including low cost, high speed, and plug and play capability, network operators should employ femtocells in next generation mobile cellular networks. Femtocell deployment is complicated in dense deployment scenarios due to the potential for coverage gaps. In this paper, a coverage optimization algorithm is proposed that reduces the coverage gaps, overshooting femtocells and improves SNR. The coverage optimization algorithm includes two power allocation approaches that continuously update the network transmission power level based on network performance. Results show that the proposed algorithm improves the overall network performance by reducing coverage gaps and femtocell overshooting.

pp. 143-148

Wednesday, November 22, 15:20 - 15:40

AT1: Afternoon Tea

Room: Attrium

Wednesday, November 22, 15:40 - 17:00

S7: Session 7: Energy efficiency

Room: Ballroom A

Chair: Bob Warfield (University of Melbourne & Access Research Company, Australia)

15:40 *A Disaster Recovery System for Location Identification-based Low Power Wide Area Networks (LPWAN)*

James Kang (Melbourne Institute of Technology, Australia); Sasan Adibi (Deakin University, Australia); Iryna Khodasevych (Melbourne Institute of Technology, Australia)

Low Power Wide Area Networks (LPWAN) are used in a number of applications, including disaster monitoring and recovery networks. LPWAN sensors capture data bits and transmit them via dedicated gateways, which are connected to public carrier networks (e.g., cellular networks). One of the challenges encountered in disaster management scenarios revolves around the carry/forward sensed data and geographical location information dissemination to the disaster relief operatives (Disaster Relief Agency; DRA) to identify, characterise, and prioritise the affected areas. There are network topology options, including cellular, circuit switched, and peer-to-peer networks to reach the destination. From the disaster natural disaster predictions point of view, collecting geographical location data and timestamp is vital. This paper proposes the usage of Pseudo A Number (PAN), that is, the calling party address, which is used by every network to include the location information instead of the actual calling party address of the gateway in LPWAN. This PAN information can further be analysed by the DRA to identify the affected areas as well as to predict the complications of the disaster impacts in addition to the past history of the damages. This paper aims to propose a solution that can predict disaster proceedings based on propagation and the velocity of impact using vector calculation of location data and timestamp, which are transmitted by sensors through PAN of gateway in LPWAN.

pp. 149-154

16:00 *Cost Effective Charging Infrastructure Placement for Electric Vehicle in Smart Cities*

Waleed Ejaz (Ryerson University, Canada); Muhammad Naeem (COMSATS Institute of Information Technology, Wah, Pakistan & Ryerson University, Canada); Muhammad Rashid Ramzan (COMSAT Wah, Pakistan); Farkhund Iqbal (Zayed University, United Arab Emirates); Alagan Anpalagan (Ryerson University, Canada)

Electric Vehicles (EVs) can be considered as a step forward towards the green environment and economical transportation. Moreover, EVs offer fuel economy, clean environment, and less cost of vehicle charging as compared to gasoline refilling. These are the main motivations towards the adaptation of EVs by the users. In order to increase the penetration of EVs into the transportation system, the EV charging stations become necessary to fulfill the charging needs. The charging stations can be placed considering different scenarios and objectives. Placement of charging stations in the service area requires a huge amount of budget and their locations are critical to select. In this paper, we formulate an optimization problem with an objective to minimize the overall cost of the charging infrastructure placement subject to the constraint on charging requirements in the service area. The proposed problem is solved using the branch and bound algorithm. Simulations results show the effectiveness of proposed placement strategy to minimize overall placement cost.

pp. 155-160

16:20 *Inverse pulse position modulation schemes for simultaneous visible light wireless information and power transfer*

Ryota Kimoto (Tokyo University of Science, Japan); Yusuke Kozawa (Ibaraki University, Japan); Yohtaro Umeda (Tokyo University of Science, Japan); Hiromasa Habuchi (Ibaraki University, Japan)

In this paper, for a constructing flexible underwater wireless sensor network, we discussed an underwater visible light communication and wireless power transfer system. This system simultaneously transmits information and power by using laser diode (LD) as a transmitter and solar panel as a receiver. For compatibility between communication and power transfer, we discussed AC/DC separation filter design. We analyzed bit error rate (BER) and power transfer performance in this system with the designed AC/DC separation filter using on-off keying (OOK), pulse position modulation (PPM) and inverted pulse position modulation (IPPM). By comparing the performances of OOK, PPM and IPPM, we discussed about the modulation scheme to obtain the high performance. As a result, PPM, IPPM not including low frequency components are suitable for obtaining high performances in this system. Among of them, PPM is suitable for obtaining high communication performance, and IPPM is suitable for obtaining more stable power.

pp. 161-166

16:40 *Optimal Pricing Strategy for 5G in Rural Areas with Unmanned Aerial Vehicles and Large Cells*

Luca Chiaraviglio (University of Rome Tor Vergata, Italy); William Liu and Jairo A Gutierrez (Auckland University of Technology, New Zealand); Nicola Blefari-Melazzi (University of Rome "Tor Vergata", Italy)

We propose a business model to compute the monthly subscription fee for users served by an innovative 5G network architecture that is designed to serve rural zones. We consider two possible options to deploy the 5G cells. In the first case, the connectivity is provided by means of small cells mounted on top of Unmanned Aerial Vehicles (UAVs). In the second case, large cells, covering wider portions of territory, are used. In both cases, we assume that the electricity can be sourced also from solar panels and batteries, which are installed on each cell site. We then propose an economic framework that, given the considered scenario and the equipment costs, is able to: i) compute the number of batteries and the solar panels power for each site, ii) estimate the number of cells to ensure coverage and to guarantee the service to the users, and iii) compute the monthly subscription fee to be charged to users, as well as the CAPEX and OPEX costs. Our results, obtained over the sampling areas of Frascati (Italy), Benevides (Brazil) and Rotorua (New Zealand), show that the proposed 5G architecture is feasible, i.e., the monthly subscription fee per user can be set less than 10 [EUR/month] for Frascati and Rotorua, and less than 2 [EUR/month] for Benevides.

pp. 167-173

S8: Session 8: Wireless

Room: Ballroom B

Chair: Robert Hunjet (DST Group, Australia)

15:40 *On the study of Interference Mitigation and QoS Protocol for Wireless Body Area Networks using Hard Real-time Scheduling*

Da-Ren Chen (National Taichung University of Science and Technology, Taiwan); Ping-Feng Wang (Institute for Information Industry Republic of China, Taiwan)

In a wireless body area networks (WBAN) with integrated sensor hubs, the proposed MAC protocol is a TDMA-based schedule used in active superframe interleaving and beacon shifting defined by the IEEE 802.15.6 standard. It considers the human dynamics and traffic information to meet the different QoS requirements of each sensor, improve bandwidth utilization and reduces packet collisions within networks. We applies a quality-of-service (QoS) resource allocation method to share limited bandwidth among multiple WBANs. In the proposed scheduling, the required service rate and maximum packet inter-arrival time for each WBAN are parameterized. The inter-arrival times of WBAN packets regarded as periodic tasks are then transformed to avoid scheduling jitters, thus increasing predictability and reducing packet collisions.

pp. 174-179

16:00 *Maximizing Communication Opportunity for Collaborative Spectrum Sensing in Cognitive Radio Networks*

Tomohiro Nishida, Masahiro Sasabe and Shoji Kasahara (Nara Institute of Science and Technology, Japan)

In cognitive radio networks, secondary users (SUs) must accurately sense the spectrum of primary user (PU) to acquire their own communication opportunities without interfering PU's communication. Collaborative spectrum sensing (CSS) among SUs can improve the probability to detect PU's communication, compared to non-collaborative spectrum sensing, where each SU senses signal independently. In this paper, we propose a communication opportunity maximization scheme for CSS in multiple PUs cognitive radio networks. First, we define an objective function that represents SU's communication opportunity and a constraint on miss detection probability. In the proposed scheme, each SU forms a group with other SUs to meet the constraint and maximize its own communication opportunity according to the objective function and the constraint. Through simulation experiments with a two-PU scenario, we show that the proposed scheme can improve the ratio of winning SUs, that can use PU's channel, to the whole SUs, in comparison with the non-collaborative spectrum sensing. We also show that it can quickly increase the overall throughput of winning SUs up to the theoretical upper bound.

pp. 180-185

16:20 *Experimental Evaluation of Mutual Interference in Co-located IEEE 802.15.4-based Wireless Body Sensor Networks*

Amirhossein Moravejosharieh and Kourosh Ahmadi (Auckland Institute of Studies, New Zealand)

The noticeable performance degradation of IEEE 802.15.4-based wireless body sensor networks (WBSNs) caused by the mutual interference has recently drawn the attention of research communities. Frequency-adaptation is to some extent an effective solution to reduce the impact of mutual interference on WBSN's performance. However, as the number of WBSNs becomes larger, this scheme is destined to fail. In this paper, a new scheme called "dynamic-phase-shifting" is proposed in which a WBSN is able to shift its beacon packets to other phases (time slot) in order to finally settle down in a phase with reasonably higher performance gain. A set of performance measures is used to provide performance comparison between the dynamic-phase-shifting scheme and a baseline scheme (that follows IEEE 802.15.4 standard). The results indicate that the dynamic- phase-shifting scheme is not only feasible to be implemented on real sensor devices but also it outperforms IEEE 802.15.4 standard in terms of the considered performance measures.

pp. 186-191

16:40 *Effect of the Number of Participating Nodes on Recovery of WSN Coverage Holes*

Ali Rafiei and Mehran Abolhasan (University of Technology Sydney, Australia); Daniel R Franklin (University of Technology, Sydney, Australia); Farzad Safaei (ICT Research Institute, University of Wollongong, Australia); Stephen Smith (Macquarie University, Australia); Wei Ni (CSIRO, Australia)

Large scale coverage holes (CHs) due to the correlated node failures, if not appropriately addressed in a timely manner, not only disrupt network's operation but also can compromise its integrity. In the absence of centralised control, distributed node relocation can be an effective solution to recover CHs. Devised node relocation algorithms are mainly applied to all nodes to increase networks' coverage and address unbalanced node deployments that is not efficient as notifying and moving nodes beyond a certain distance and depth from the CHs does not significantly contribute to recovery of CHs. Here, the effects of the number of participating nodes and movement iterations on recovery of CHs are examined in two Voronoi-based and one force-based node relocation algorithms.

pp. 192-199

Thursday, November 23, 08:30 - 12:00

W2: Session W2: Amateur Radio Communications Workshop

RMIT University Building 10 Level 10 Room 29

Thursday, November 23, 09:00 - 10:40

S9: Session 9: Wireless Sensor Networks

Room: Ballroom A
Chair: Da-Ren Chen (National Taichung University of Science and Technology, Taiwan)

09:00 *Secure Low Energy AODV Protocol for Wireless Sensor Networks*
Ewa Niewiadomska-Szynkiewicz (Warsaw University of Technology & Research and Academic Computer Network (NASK), Poland); Filip Nabrdalik (Neofonie Mobile GmbH, Poland)
Recently, a tremendous interest has been concentrated on the design and development of wireless sensor networks (WSNs) -- distributed systems comprised of numerous wireless, smart sensor devices deployed densely in a sensing area. Battery powered sensors need efficient management due to limited energy resources, and energy conservation is a vital design issue that needs to be boosted in order to increase the lifetime of the network. The main contribution of this paper is the design and implementation in testbed networks an energy aware routing protocol SLE-AODV developed based upon Ad hoc On-Demand Distance Vector (AODV) and Low Energy Adaptive Clustering Hierarchy (LEACH). SLE-AODV allows for secure communication in a wide area wireless sensor network. The results of experiments conducted in the laboratory confirm significant energy savings that lead to network lifetime increase.
pp. 200-205

09:20 *Design and Field Test of An Autonomous IoT WSN Platform for Environmental Monitoring*
Fan Wu, Christoph Rüdiger and Mehmet Rasit Yuce (Monash University, Australia)
An autonomous Internet of Things (IoT) wireless sensor network (WSN) powered by a solar energy harvester with low power electronics is presented in this paper. Power supply is a critical challenge for IoT sensors as many of them normally have limited lifetime due to the battery with limited capacity used. The sensor network system, sensor node electronics, and the energy harvesting techniques are configured to achieve a continuous energy source and low power consumption for the sensor network. The IoT network system has been deployed in Monash University Clayton campus, Melbourne, for monitoring temperature, relative humidity, carbon dioxide and carbon monoxide data. The sensor network uses multiple XBee wireless modules and successfully monitors the useful data for six months. This work demonstrates that energy harvesting enables an IoT sensor platform to become always active and reliable for long-term, providing many opportunities and applications.
pp. 206-211

09:40 *Latency Estimation for Fog-based Internet of Things*
Jianhua Li, Tiehua Zhang and Jiong Jin (Swinburne University of Technology, Australia); Yingying Yang (University of Technology Sydney, Australia); Dong Yuan (The University of Sydney, Australia); Longxiang Gao (Deakin University, Australia)
Low latency is critical for delay-sensitive applications such as video surveillance, live streaming, and online data analytics. Fog computing enables the emergence of the latency-sensitive internet of things (IoT) network to support real-time applications. While the distance between sensing and processing is minimized in the fog network, the cross-fog latency is yet to be determined. In this paper, we study the components of network delays and develop a latency estimation framework for fog-based IoT. The proposed framework, in particular, precisely predicts the end-to-end inter-node delay along the cloud-fog-things continuum. We investigate the benefits and use cases based on latency estimated by the proposed framework. A case study is further conducted to illustrate the validation and advantages, followed by future research directions.
pp. 212-217

10:00 *Automated Parking Lot Management System using Embedded Robot Type Smart Car based on Wireless Sensors*
YeJi Kang, Doyeon Jung and Inshil Doh (Ewha Womans University, Korea)
As the population of vehicles worldwide continues to increase, parking lots become indispensable for vehicle owners. For convenient parking, parking lot users need information such as the number of seats left in the parking lot to keep their vehicles. However, due to the lack of status information in the parking lot, the car owners have suffered. In order to solve this inconvenience, researches have been carried out to check the internal state of the parking lot using various methods. However, existing researches have limitations in that space is limited or a large amount of equipment is required and thus the cost is high. Therefore, this paper describes an automated parking lot management system based on wireless sensors that can be applied to anywhere with low cost using embedded robot type smart car. Our ultimate goal is to build a fully automated parking management system with only one smart car, no matter wherever the parking lot is. Smart car explores the parking lot, detects vehicles around it and intelligently divides them into three types: normally parked vehicles, illegally parked vehicles, and poorly parked vehicles. In order to distinguish the vehicle, smart car detects the situation inside the parking lot, judges the route to be taken by itself, grasps the condition of the vehicle stopped around according to its route, and sends the status information in parking lot to the user application in real-time. To construct this system, we used infrared and ultrasonic sensors built in smart car. With this system, it is possible to build a location-independent, fully automated parking management system.
pp. 218-223

10:20 *Software Defined Industry Automation Networks*
Khandakar E Ahmed (Victoria University, Australia); Nazmus Shaker Nafi (RMIT University, Australia); Jan Blech (Royal Melbourne Institute of Technology, Australia); Mark A. Gregory (RMIT University, Australia); Heinz Schmidt (RMIT, Australia)
The recent advancement of industry automation is underpinned by the continuous development of the industrial network. This exponential growth is driving the fourth generation industry revolution (FGIR). To meet the requirement of FGIR, there is an ongoing evolution of industrial network from Fieldbus to Ethernet that has emerged a new opportunity to integrate Software Defined Networking (SDN) technique. In this paper, we propose a network architecture called Software Defined Industry Automation Network (SDIAN) to enable highly flexible and robust network. The proposed architecture promises to provide real-time communication, online dynamic

configuration and flexible adaptation to changes in the connections and locations of the manufacturing entities. To validate the merit of the proposed framework, we also report on an ongoing testbed implementation on an experimental food processing plant demonstrator featuring Raspberry PIs (RPIs) instead of traditional Programmable Logic Controllers (PLCs). Our demonstrator exemplifies the characteristics of SDIAN.

pp. 224-226

S10: Session 10: Wireless

Room: Ballroom B

Chair: Leith Campbell (University of Melbourne, Australia)

09:00 *On Energy and Data Delivery in Wireless Local Area Networks with RF Charging Nodes*

Kwan-Wu Chin (University of Wollongong, Australia)

Wireless charging is now a reality. Low-power devices with sensing capabilities deployed within a building for example can now be powered wirelessly via Radio Frequency (RF) transmissions from existing Access Points (APs) that form a Wireless Local Area Network (WLAN). However, an AP cannot transmit frequently to charge devices as it may starve other nearby APs operating on the same channel. Consequently, there is a need to schedule the transmissions of APs to ensure their data queues remain short whilst charging energy-harvesting devices. We present a finite-horizon Markov Decision Process (MDP) to capture the queue states at APs and also channel conditions to nodes. The reward to be optimized is the amount of delivered energy and data. We investigate the following queue selection rules: max weight, max queue, best channel state and random. Our results show that APs that select the best queue in each time slot according to the max weight rule yields a transmission schedule that has the best reward; i.e., highest delivered packets and energy. Moreover, the obtained reward has the smallest gap to the optimal/exact reward.

pp. 227-233

09:20 *Performance of MDPolSK with Estimation of Inclined Polarization Axes over Atmospheric Turbulence Channel*

Yusuke Ito and Kouji Ohuchi (Shizuoka University, Japan)

Multilevel polarization shift keying (MPolSK) is an optical modulation scheme, in which the state of polarization changes according to transmission data. When either the transmitter or the receiver is not fixed, the mismatched polarization axes is caused. It significantly degrades the communication performance. To overcome this problem Multilevel Differential PolSK (MDPolSK) was proposed, in which we perform differential encoding on a pair of successive transmission symbols. Because the decoding process needs two successive symbols and they are affected by independent noises, MDPolSK is sensitive to noises. In this paper, to reduce the noise influence in MDPolSK, we propose a method to estimate the inclined polarization axes. By using the estimation method the SER of MDPolSK can approach that of MPolSK, even in the case of the mismatched polarization axes. In addition, we study the intensity fluctuation caused by the atmospheric turbulence channel and show its influence on the SER of MDPolSK. The intensity fluctuation is modeled by the lognormal distribution.

pp. 234-239

09:40 *Use of Coordinated Multipoint Transmission /Reception for Enhanced Backhauling in Nomadic Relay*

Khalid Hasan (Aalto University, Finland); Nazmus Shaker Nafi (RMIT University, Australia); Khandakar E Ahmed (Victoria University, Australia); Mark A. Gregory (RMIT University, Australia); Edward Mutafungwa (Aalto University, Finland)

One of the promising enhanced features introduced in LTE-Advanced is relaying. Coverage extensions as well as enhanced throughput gain are attractive from the perspective of network operators. While functioning in the macro-overlaid network, relay offers the flexibility of random deployment (nomadic relay) at places where the communication link is congested due to an occasional event (e.g. festival) or in the emergency response scenario. This nomadic relay deployment helps to improve coverage and capacity in targeted areas based on a temporary but immediate demand. However, peak achievable throughput at the access link is limited by the backhaul link rate. The backhaul link becomes a bottleneck if the aggregated access link throughput exceeds the backhaul link rate. To avoid this bottleneck, it is desirable to identify means to maintain the backhaul link rate above the aggregated access link capacity. To that end, another promising technology is Coordinated Multipoint Transmission/Reception (COMP) where joint transmission from multiple base station or coordinated base stations offer enhanced throughput. In this study, two types of COMP technique namely Dynamic Point Blanking (DPB) and Quantized Co-Phasing (QCP) have been applied at relay backhaul to reduce the impact of the backhaul bottleneck. This study is performed through analyzing two case scenarios such as 3GPP 5x5 building grid model and realistic building layout. Finally, it is shown that Inter-QCP provides the best output in both cases (3GPP and realistic building layout) at the backhaul link and access link.

pp. 240-245

10:00 *A pathway to solving the Wi-Fi Tragedy of the Commons in apartment blocks*

Frank den Hartog (DoVes Research, Australia); Pia Kempker and Bert Boltjes (TNO, The Netherlands); Alessandro Raschellà and Faycal Bouhafs (Liverpool John Moores University, United Kingdom (Great Britain)); Mirghiasaldin Seyedebrahimi (Birmingham City University, United Kingdom (Great Britain))

Surprisingly little research has quantified the severity of Wi-Fi congestion in densely populated areas. We performed a high-fidelity 3D simulation of the performance of a realistic Wi-Fi deployment in a typical apartment block. Our results show that congestion leads to significant loss of performance, and that current channel selection procedures have only little effect. Also the strategy that is mostly applied today, i.e. to deploy additional repeaters and access points (APs), fails. As this is a typical example of the "Tragedy of the Commons", some form of collaboration between AP operators is needed to solve the problem. New channel selection algorithms that optimize Wi-Fi performance on a system level then become possible which, for instance, minimize the mutual interference impact on all APs involved. We validate that such an algorithm indeed leads to an optimized as well as fair assignment, which is a necessary first step towards solving the Tragedy.

pp. 246-251

10:20 *LED-WSN: Light weight Edge computed Dynamic Wireless Sensor Network Routing Protocol*

Craig G Walker (Auckland University of Technology & iMonitor Ltd, New Zealand); Adnan Al-Anbuky (AUT University, New Zealand)

Modern cities are blanketed with Wi-Fi Hotspots. Such network access points can be utilised by Internet of Thing devices to enable wireless sensor network data mining deployments to report to the cloud. Vehicles are such devices that can provide valuable data sensing platforms for both internal operational properties such as speed, fuel and engine heat as well as external environmental features including but not limited to traffic, weather, road conditions and even possible road events such as accidents and approaching emergency services. This paper suggests a network routing resolving method to enable large moving groups of vehicles with embedded devices to route data to fix infrastructural access points. The core of this routing resolving and network healing concept is based on establishing network connections locally without the participation of a controlling arbitrator or centralised router. Further properties put forward focus on objective function for router selection, using properties specific to wireless sensor networks. The proposed routing method LED-WSN (Light weight Edge computed Dynamic Wireless Sensor Network) routing protocol is documented and tested in a

simulation environment and on development kit hardware. Assumptions made are listed and possible functionality and drawbacks details. Early concept testing shows encouraging results towards dynamic clustering of vehicular networks and demonstrates lessons learnt in protocol design.

pp. 252-259

Thursday, November 23, 10:40 - 11:00

MT2: Morning Tea

Room: Attrium

Thursday, November 23, 11:00 - 11:40

K2: Keynote 2

Visible light communications: a solution to the spectrum crunch?
Professor Jean Armstrong

Room: Ballroom B
Chair: Mark A. Gregory (RMIT University, Australia)

Standard white lighting LEDs unlike conventional forms of lighting can be modulated at megahertz frequencies. As a result every LED light has the potential to transmit high speed data. This is the basis of important new forms of visible light communications (VLC) and visible light positioning (VLP). This talk will outline the key findings of our research on VLC and VLP and that of other leading groups around the world. The huge potential of this emerging field to deliver very high speed data and accurate indoor positioning will be explained. The many research challenges that still have to be overcome to turn this potential into reality will be outlined. VLC, particularly one form called LiFi, has attracted a lot of media attention. This talk will separate the facts from the hype.

Thursday, November 23, 11:40 - 12:00

K3: Keynote 3

Enterprise and Cloud
Mr Andrew McGee

Room: Ballroom B
Chair: Mark A. Gregory (RMIT University, Australia)

The keynote will describe the latest developments in enterprise and cloud network design and implementation, including how Huawei is working to bring about improvements to traffic flows and reducing latency.

Thursday, November 23, 12:00 - 13:00

L2: Lunch

Room: Attrium

Thursday, November 23, 13:00 - 14:00

S11: Session 11: Networking

Room: Ballroom A
Chair: Leith Campbell (University of Melbourne, Australia)

13:00 *A Testbed Implementation of a Trust-Aware RPL Routing Protocol*
David Osemeojie Airehrour and Jairo A Gutierrez (Auckland University of Technology, New Zealand); Sayan Kumar Ray (Manukau Institute of Technology, New Zealand)

The RPL routing protocol has gained prominence as the standard IoT routing protocol. However, it faces like many other routing protocols diverse attacks. Many studies have been proposed to secure the RPL protocol, and simulation studies have been put forward as the main research method. A disadvantage with simulation studies is, their potential divergence from the results obtained using real-world scenarios. Therefore, it becomes imperative to not only propose simulation studies on securing the RPL protocol from attacks, but to perform testbed experiments that will validate the simulation study. This study is a follow up research work to validate our simulation study that addressed Blackhole attacks in RPL protocol. In this study, we have implemented a testbed using IoT motes and embedded our proposed Trust-based RPL protocol and the standard RPL protocol in a smart environment configuration. Based on the test experiments, we provide a proof-of-concept of the validity of our claim that our Trust-based RPL protocol provides a comprehensive defense (simulation and testbed) against Blackhole attacks.

pp. 260-265

13:20 *A Universal IoT Joining Protocol for DIY Applications*
Tyler Steane and Pj Radcliffe (RMIT University, Australia)

Previous work has developed a remarkably low cost method which allows IoT devices to securely join domestic WiFi networks. Implementation of this method has uncovered a weakness in that only controllers (usually smart phones) capable of programmatically

controlling hotspot mode can successfully implement the protocol. It is demonstrated that this weakness greatly compromises the open nature of this protocol and is unacceptably incompatible with a significant number of popular devices. This paper reorients the original protocol to move the hotspot functionality to the IoT device. This updated protocol allows any WiFi capable device to act as a joining agent and controller for a household full of IoT devices, achieving universal compatibility with all popular devices.

pp. 266-268

13:40 *Fast and Efficient Physical Layer Authentication for 5G HetNet Handover*

Ting MA (Southwest Petroleum University, P.R. China); Feng Hu (Sintelligent Technology, P.R. China); Maode Ma (Nanyang Technological University, Singapore)

The forthcoming fifth generation (5G) wireless network is envisioned as highly heterogeneous that can support future applications demanding seamless coverage, low latency and high throughput. These requirements pose stringent challenges on the handover authentication design. In this article, we present a fast and efficient physical layer authentication scheme for software-defined-radio (SDN) enabled 5G heterogeneous network (HetNet). In the scheme, we propose to perform the handover authentication with Kolmogorov-Smirnov (K-S) hypothesis test. The K-S based authentication is fast, efficient, and more suitable for physical layer attributes with diverse distribution forms.

pp. 269-271

S12: Session 12: Security and Location services

Room: Ballroom B

Chair: Khandakar E Ahmed (Victoria University, Australia)

13:00 *Fake VIP Attacks and Their Mitigation via Double-Blind Reputation*

Jerzy Konorski (Gdansk University of Technology, Poland)

In a generic setting subsuming communication networks, resource sharing systems, and multi-agent communities, a client generates objects of various classes, to which a server assigns class-dependent service quality. We identify a class of Fake VIP attacks as false declarations of a high class to acquire undue service quality, with an awareness that a defense via object signature detection is costly and so invoked reluctantly. We show that, unexpectedly, such attacks can be mitigated by a double-blind reputation scheme at the server side. We offer a minimum-information framework for Fake VIP attacks and a stochastic analysis of a two-player Stackelberg game to find optimum at-tack and defense strategies, as well as to identify regions of opera-tion where both the client and the server find the reputation scheme beneficial.

pp. 272-279

13:20 *Detecting IoT Zombie Attacks on Web Servers*

Sujatha Sivabalan and Pj Radcliffe (RMIT University, Australia)

Internet of Things (IoT) devices pose a serious threat to the web as poorly configured or faulty devices can be used for massive Distributed Denial of Service attacks. High jacked IoT devices that act like real users are a particular problem that present significant difficulties for traditional detection methods. An adaptive, real time scoring system for detecting such attacks is proposed that does not punish profitable flash crowds as do current methods. This system employs an energy efficient architecture and thus web server system power usage is reduced.

pp. 280-282

13:40 *A Deep Learning Approach to Fingerprinting Indoor Localization Solutions*

Linchen Xiao, Arash Behboodi and Rudolf Mathar (RWTH Aachen University, Germany)

Fingerprinting localization solutions enjoy huge popularity due to their good performance and minimal environment information requirement. Considered as a data-driven approach, many modern data analytics can be used to improve its performance. In this paper, we propose a deep learning architecture which is trained using training fingerprint measurements to learn a propagation function that outputs the estimated location from the measured fingerprints. In this way, the run-time complexity is significantly reduced where the localization is done by forward propagation through the neural network. We also utilize those fingerprints in the training phase that are not labelled with a precise location but only contain information about proximity to specific training positions. The neural network based algorithm is compared with the standard Euclidean distance based fingerprinting as well as Support Vector Machine (SVM) approach which we also develop to explore advantages of our approach.

pp. 283-289

Thursday, November 23, 14:00 - 14:30

AT2: Afternoon Tea

Room: Attrium

Thursday, November 23, 14:30 - 17:30

C1: Conference Tour

Conference Tour

Room: Rendezvous Hotel

Chair: Mark A. Gregory (RMIT University, Australia)

Conference tour leaving Rendezvous Hotel at 2.30pm and walking to MCG. If you do not wish to walk, take the train to Jolimont Station. Arrive at Gate 3 of the MCG by 3pm Tour of the MCG followed by the National Museum of Sport continues to 5pm. Walk or train back to Rendezvous Hotel.

Thursday, November 23, 18:00 - 23:00

D1: ITNAC 2017 Dinner

Annual Dinner

Room: HopHaus Restaurant

Chair: Mark A. Gregory (RMIT University, Australia)

The conference dinner commences at 6pm at the HopHaus Restaurant on Level 1 in Southbank, just across the river from the Rendezvous Hotel.

Friday, November 24, 09:00 - 10:40

S13: Session 13: Quality and Performance

Room: Heritage room

Chair: Ewa Niewiadomska-Szynkiewicz (Warsaw University of Technology & Research and Academic Computer Network (NASK), Poland)

09:00 *PAVIF: A Passive Aggressive Visual Information Fidelity for Full Reference Image Quality Assessment*

Xiaoyu Ma and Xiuhua Jiang (Communication University of China, P.R. China)

Measurement of visual quality is of significant importance to many image processing tasks. The target of image quality assessment (IQA) is to design effective computational models in order to automatically predict the quality of images in a perceptual consistent manner. We propose a full reference (FR) IQA metric based on information-theoretic IQA framework and passive aggressive learning algorithm. We model the image distortion process with a signal attenuation matrix and an additive noise matrix in wavelet domain. The ridge regression is employed to get the initial attenuation matrix. The passive aggressive algorithm is then utilized in order to learn the particular attenuation matrix of each image block. Then we can measure the perceptual quality of each subband in wavelet domain by quantifying the loss of visual information through an information-theoretic IQA framework. At last, a regression tool is utilized to nonlinearly combine the visual information loss of each subband into a final objective quality score. Experimental results demonstrate that our proposed IQA metric is competitive with many state-of-the-art IQA metrics; moreover, cross-validation and cross-database validation both show that our proposed IQA metric has a satisfying generalization ability.

pp. 290-295

09:20 *A QoE-Driven Optimization Strategy for Dynamic Adaptive Streaming Over HTTP*

Ziwei Wang and Xiuhua Jiang (Communication University of China, P.R. China)

In this paper, we first propose a Quality of Experience (QoE) evaluation model for dynamic adaptive streaming over HTTP (DASH) services. The proposed model predicts the perceived quality of user based on segment media quality, playback continuity and perceptual quality fluctuations caused by bitrate switching. Large quantities of subjective mean-opinion-score (MOS) tests demonstrate that our QoE evaluation model can evaluate users' perception on DASH services quality accurately. Based on the model, we further propose a dynamic selection mechanism of adaptive algorithms. In the case where the network bandwidth fluctuated, the mechanism determine next segment through selecting the optimal adaptive algorithm. At the end of the paper, we conduct experiment in various different environment of bandwidth so as to verify the performance of the mechanism. The mechanism is proved to have very good effect on improving QoE in different network environment.

pp. 296-302

09:40 *Optimisation of Relay-Assisted Wireless Systems in Quasi-Static Environments using Ray Tracing*

Ash Bellett and Gayathri Kongara (Monash University, Australia)

This paper presents a ray tracing approach to optimise the position of a relay in a static environment such that the signal-to-noise ratio (SNR) is maximised at the receiver. The underlying principles behind the ray tracing wireless channel model are summarised. An implementation of a ray tracing algorithm is developed in MATLAB to calculate the channel state information (CSI) of a relay-assisted communication system. This information is applied to determine the path loss of the wireless channel. The simulated results are compared with experimental data from software-defined radio (SDR) measurements to assess the model's validity.

pp. 303-308

10:00 *A new ensemble model for multivariate medical data*

Mohammad Rajib Hasan, Hamid GholamHosseini and Nurul I Sarkar (Auckland University of Technology, New Zealand)

Ensemble classifier systems are considered as one of the most capable classifiers in medical data classification and the performance of decision tree classifier can be increased by the ensemble method as it is proven to be better than single classifiers. However, ensemble performance depends on the data quality and missing values. This study reveals that classification accuracy often suffers from overfitting and biased results due to multivariate and missing values. Medical professionals do not believe in filling the missing values by any of the statistical methods because each case is different. Hence, this study proposed a new ensemble model that is able to achieve better accuracy of more than 96% without filling up missing values; that do not suffer for over fitting and bias. The new ensemble model has been validated by two popular statistical methods: Ggraph and box plot analysis.

pp. 309-314

10:20 *An Analysis of Personal Wireless Network Security in Tonga: A study of Nuku'alofa*

Paula Lutui (Auckland University of Technology, New Zealand); 'Osai Tete'imoana and George Maeakafa (Christ's University in Pacific, Tonga)

This study evaluates the current state of wireless network security in the CBD of Nuku'alofa. Wireless Networks have grown significantly since their introduction. Security protocols supplied with the wireless equipment have reached a level of strong and robust security. However, security remains a problem; this study aims to answer two questions. What is the status of wireless network growth and security in Tonga? and what can be done to improve wireless network security in Tonga. The war-drive results of Nuku'alofa produced comprehensive data which clearly shows the number of networks, both company and home networks. An exploratory research approach is employed to guide the design of the study. The results show that there is a significant growth in terms of WLAN usage since the implementation of the fiber optic network. However, this study concludes that WLAN security in Nuku'alofa is still in its early stages.

pp. 315-318

S14: Session 14: Transmission

Room: Presidents Room

Chair: Richard J Harris (Massey University, New Zealand)

09:00 *Tactical Line-of-Sight MIMO Communication System for Contested Networks*

Asanka Kekirigoda (Defence Science and Technology Group, Australia); Ping Hui (Defence Science and Technology Organisation, Australia)

Tactical communications networks need to be able to operate in contested radio frequency environments. Thus, to fulfil military missions in a timely manner, it is of paramount importance to ensure the communications survivability of wireless segments of these networks. Smart antenna systems using multiple-input-multiple-output (MIMO) techniques can improve communications network's survivability compared to single antenna systems. This paper presents a novel tactical MIMO communications system which enhances the capacity of the network, reduces the bit-error-rate and mitigates the interference from multiple, distributed jammers compared to other MIMO systems. Simulation results are presented to verify the advantages of this system in contested environments.

pp. 319-324

09:20 *Analysis of a Semi Blind Pilot Decontamination Method in Massive MIMO*

Nusrat Fatema (Deakin University & Deakin University, Australia); Yong Xiang and Iynkaran Natgunanathan (Deakin University, Australia)

Recently, a semi-blind pilot decontamination based method is proposed for multicell multiuser massive multi-input multi-output (MIMO) systems. In that paper, to reduce the effect of the pilot contamination, a semiblind channel estimation method that does not require cell cooperation or statistical information of the channels is proposed. The blind pilot decontamination method in that paper is reformulated as a constrained optimization problem. The constrained minimization problem of the mixing matrix is then carried out by a generalized robust independent component analysis (ICA) based deflation method. The key demerit of the proposed deflation method is that it suffers from error accumulation. In this paper, we investigate semi blind pilot decontamination method aiming to analyze the role of the deflation technique used in this method. Our analysis reveals that the error accumulation is a major drawback found in this algorithm. Furthermore, the overall performance improves without the deflation method in the semi blind pilot decontamination. The effectiveness of our analysis is verified by extensive simulations considering different noise levels.

pp. 325-330

09:40 *Towards Optimal Sensitivity-Based Anonymization for Big Data*

Mohammed Al-Zobbi, Seyed Shahrestani and Chun Ruan (Western Sydney University, Australia)

Datasets containing private and sensitive information are useful for data analytics. Data owners cautiously release such sensitive data using privacy-preserving publishing techniques. Personal re-identification possibility is much larger than ever before. For instance, social media has dramatically increased the exposure to privacy violation. One well-known technique of k-anonymity proposes a protection approach against privacy exposure. K-anonymity tends to find k equivalent number of data records. The chosen attributes are known as Quasi-identifiers. This approach may reduce the personal re-identification. However, this may reduce the usefulness of information gained. The value of k should be carefully determined, in order to compromise both security and information gained. Unfortunately, there is no any standard procedure to define the value of k. The problem of the optimal k-anonymization is NP-hard. In this paper, we propose a greedy-based heuristic approach that provides an optimal value for k. The approach evaluates the empirical risk with the respect to our Sensitivity-Based Anonymization method. Our approach is derived from the fine-grained access and business role anonymization for big data, which forms our framework.

pp. 331-336

10:00 *SCDMA Capability of High-Density Code-Shift Keying using Dual MPOMs in Optical-Wireless Channel*

Takashi Tokunaga, Hiromasa Habuchi, Yusuke Kozawa and Ran Sun (Ibaraki University, Japan)

The high density code-shift-keying (CSK) using Pseudo Noise (PN) codes generated by modified pseudo orthogonal M-sequence sets (MPOMs) and bi-orthogonal code has been proposed. In this paper, synchronous code division multiple access (SCDMA) capability of the proposed system is clarified under the optical-wireless channel. Consequently, simulation results are in good agreement with theoretical calculation results. In the proposed system, it is found that the performance deterioration is considerably small when the number of users <= 3. Moreover, the proposed system remarkably outperforms the conventional system when the number of users >= 2.

pp. 337-342

10:20 *Experimental Investigation of Cascaded SMF-MMF-Dithering Technique for Nonlinear Compensation in Fiber-Wireless system*

Thavamaran Kanesan and Hizamel M. Hizan (Telekom Malaysia (TM) Research & Development, Malaysia); Sajaa Kh. Sadon (TMR&D Innovation Centre, Malaysia); Gee-Kung Chang (Georgia Tech, USA)

In order to effectively extend the coverage of an eNodeB (eNB), a simple relay node (RN) is the efficient solution with fiber-wireless connectivity as the interface between eNB and RN. The optimum coverage enhancement can be achieved by connecting many RNs to a single eNB, which requires high splitting ratio at the optical access layer. Therefore, high optical launch power (OLP) is a primary requirement to compensate the loss induced by optical splitters with high splitting ratio. The only drawback in this situation is the underlying nonlinearity induced by high OLP within optical fiber, prominently stimulated Brillouin scattering (SBS). Two well-known solutions were proposed in the past, the first solution was based on Frequency Dithering, and the second solution was by applying specialty fibers with enhanced effective area. Both methods were effective, however, not evaluated under the same conditions, hence the optimum method remains unknown. Furthermore, in order to achieve a more effective method, this paper proposes a unique way to combine both the solutions by cascading multimode fiber (MMF) with traditional single mode fiber (SMF) network and concurrent integration of the Dithering technique, termed as SMF-MMF-Dithering techniques. By applying the unique technique, SBS is further suppressed and provided ~8 to ~10 dB of additional power budget.

pp. 343-345

Friday, November 24, 09:00 - 17:00

W3: Session W3: Software Defined Networking Workshop

RMIT University Building 10 Level 10 Room 29

Chair: Franciscus Xaverius Ari Wibowo (RMIT University, Australia)

Friday, November 24, 10:40 - 11:00

MT3: Morning Tea

Room: Upper Vestibule

Friday, November 24, 11:00 - 11:40

K4: Keynote 4

Network Cloudification: SDN-NFV and 5G-MEC with Edge and Fog Computing

Professor Ying-Dar Lin

Room: Heritage room
Chair: Shui Yu (Deakin University, Australia)

The second wave of cloud computing, named network cloudification, in the forms of SDN (Software Defined Networking), NFV (Network Function Virtualization), and 5G-MEC (Mobile Edge Computing), is to centralize and virtualize networking into data centers. It enables operators to offer NaaS (Networking as a Service) with much lower CAPEX and OPEX with larger flexibility because devices become simpler, the number of administrators is less, and service orchestration is easier. It turns parts of communications currently done in hardware into computing done in software. However, the host of these data centers would not be Google-like super data centers as they are too far away from subscribers. The latency requirement of 10ms and 1ms decentralizes cloud computing down to edge and fog computing with CORD (central offices re-architected as data centers) and cellular base stations for SDN-NFV and 5G-MEC, respectively. In this talk, we first argue why, where and when SDN, NFV, 5G-MEC would prevail, and then illustrate how to make it happen with OpenFlow, SC (Service Chaining), NSH (Network Service header), etc. Then we examine how latency requirement dominates this virtualization game by listing key questions to answer in resource allocation in the architectures of SDN, NFV, and 5G-MEC. Their answers are mostly unknown now but would benefit the architects and developers of OpenFlow switches, SDN controllers, SDN-NFV apps, NFV data centers, MEC-enabled base stations, and operator's infrastructure in general.

Friday, November 24, 11:40 - 12:00

K5: Keynote 5

Viability of 5G for Rural Communications
Dr Luca Chiaraviglio

Room: Heritage room
Chair: William Liu (Auckland University of Technology, New Zealand)

Nowadays, at least two billion people are experiencing a complete lack of wireless cellular coverage. Such users live in rural areas and low-income regions, where the network operators are not keen to invest, mainly due to high Capital Expenditure (CapEx) and Operational Expenditure (OpEx) costs, as well as the scarcity of electricity from the grid. We tackle this challenge by proposing a 5G network explicitly designed to serve rural and low-income areas. Our solution exploits Remote Radio Heads (RRHs) mounted on top of Unmanned Aerial Vehicles (UAVs), as well as Large Cells (LCs) to increase the coverage range. In addition, 5G-nodes are powered by solar panels and batteries. Preliminary results, obtained over three representative case studies (located in Italy, Cook Islands, and Zimbabwe) show that providing connectivity in rural and low-income areas by means of the proposed 5G architecture is feasible. At the same time, we also show that the monthly subscription fee paid by the users can be kept sufficiently low, e.g., less than 1 [EUR/month] in low-income areas, and less than 10 [EUR/month] in rural regions.

Friday, November 24, 12:00 - 13:00

L3: Lunch

Room: Attrium

Friday, November 24, 13:00 - 14:00

S16: Session 16: Optical Networks

Room: Heritage room
Chair: Richard J Harris (Massey University, New Zealand)

13:00 *A CDMA-Based Dynamic Power and Bandwidth Allocation (DPBA) Scheme for Multiclass EPON*
Elie Naim Inaty and Robert Joseph Raad (University of Balamand, Lebanon)

Multiclass systems with different Quality of Service (QoS) requirements are essential in nowadays Ethernet passive optical networks (EPON). In this paper, we propose a code division multiple access (CDMA) enabled dynamic power and bandwidth allocation (DPBA) algorithm for multiclass system. The novelty of the proposed algorithm is the resource allocation components: power control (PC) and bandwidth allocation (BA). Both resources are related and optimized through the weights of the Weighted Round Robin (WRR) scheduler in a way to meet both the physical layer signal to interference ratio (SIR) and the network layer packet delay (PD) requirements for every class of users. It is shown that the proposed algorithm can greatly enhance the network performance in terms of packet delay, throughput, and queue size management while guaranteeing the QoS requirements for all classes.

pp. 346-353

13:20 *Proposal of Optical Wireless Turbo Coded APPM System*
Ran Sun, Hiromasa Habuchi and Yusuke Kozawa (Ibaraki University, Japan)

In optical wireless communication, because of the attenuation of light and the shadowing of the channel, partial erasure channel, which means failing to receive a part of transmitted light steams, may raise. It is of importance to design a system compatible with partial erasure channel. In this paper, a new turbo coded APPM system is proposed. APPM is a modulation technique combining with amplitude-shift keying and binary pulse position system. The bit error rate performances of the proposed system is evaluated through computer simulation in both optical-wireless standard channel and partial erasure channel. Moreover, the bit error rate performance is compared with the conventional turbo coded binary pulse position modulation system. As results, in standard channel, the proposed system shows the same bit error rate performance as the conventional system. In partial erasure channel, the proposed system outperforms the conventional system far.

pp. 354-358

13:40 *A Game-Theoretic Approach to Network Slicing*

Xu Yang and Yue Liu (Macao Polytechnic Institute, Macao); Ka Seng Chou (Information Systems Research Centre, Macao); Laurie Cuthbert (Information Systems Research Centre MPI, Macao)

In this paper, we discuss using a game-theoretic approach for Network Slicing (in particular RAN Slicing) that enables fully dynamic allocation of spectrum. The algorithm allows radio resources from across the whole spectrum to be allocated to users from different slices, so avoiding the inefficiencies of fixed slices. By using game theory, we can apply to constraints on the resources allocated to individual users, or users from particular slices, to meet the requirements of the operator. The scenario adopted is a multi-cell OFDMA network and the resource allocation is performed using a non-cooperative game. Simulation results show why such an approach leads to more efficient and fairer networks.

pp. 359-362

S15: Session 15: Traffic Management

Room: Presidents Room

Chair: Keshav Sood (Deakin University & Victoria University, Australia)

13:00 *Recurrence Behaviour of BGP Traffic*

Bahaa Al-Musawi (School of Software and Electrical Engineering, Swinburne University of Technology, Melbourne, Australia); Philip Branch and Grenville Armitage (Swinburne University of Technology, Australia)

The Border Gateway Protocol (BGP) is an Internet routing protocol responsible for exchanging network reachability information between Autonomous Systems (ASes). Monitoring and mining BGP traffic are important aspects to understand and improve the stability of the Internet. However, identifying the characteristics of BGP traffic is much harder than it seems at a first glance where BGP traffic has been identified as complex, voluminous, and noisy. In this paper, we show that BGP traffic can be understood as an aggregation of oscillations of different frequencies from different ASes. Using linear and nonlinear statistical analysis, show that BGP traffic shows recurrent behaviour. The source of this behaviour is unsynchronised periodic behaviour from a set of ASes.

pp. 363-369

13:20 *Optimal-Coherent and Adaptive Software defined Inference Of Network traffics (OCcASION)*

Mehdi Malboubi (University of California, Davis, USA)

Fine grained network flow measurement is central in many different applications in networking. However, under hard constraints of network measurement resources, this is a challenging task. In this paper, since SNMP link-load measurements are readily and reliably available, flow estimation problem is modeled as a Traffic Matrix (TM) estimation problem where the main goal is estimating the traffic flows from SNMP link-loads. Here, by the flexibility provided by the Software Defined Networking (SDN), first in the learning phase, the Optimal Observation Matrix (OOM) of SNMP link-loads is estimated. Then in the measurement and inference phase, the OOM is used to coherently find the minimum-norm estimate of the unknown TM. This method is called Optimal-Coherent Inference (OCI) technique and, in the context of under-determined linear inverse problems, it is introduced for the very first time, here. Accordingly, a new framework for TM measurement and estimation, called OCcASION, is presented which are applied under both non-adaptive and adaptive scenarios. The performance of OCcASION framework is evaluated using synthetic and practical traffic traces with real network topologies. Also, to show the practical feasibility of the framework, a prototype of OCcASION is implemented in mininet. It is shown that, comparing with regular minimum-norm estimation, this framework can significantly improve the accuracy of the TM estimation; for example, on Geant network the estimation error is approximately reduced by 83%.

pp. 370-376

13:40 *Traffic engineering cooperating with traffic monitoring for the case with incomplete information*

Kodai Satake, Tatsuya Otoshi, Yuichi Ohsita and Masayuki Murata (Osaka University, Japan)

Traffic Engineering (TE) accommodates traffic efficiently by dynamically configuring the routes so as to follow the traffic changes. If the traffic changes frequently and drastically, the interval to perform the route reconfiguration should be set to a short value, to follow the traffic changes. To shorten the interval, obtaining the traffic information becomes a problem; the accurate traffic information of the whole network, which is required to calculate the suitable route, is difficult to be obtained in a short interval, due to the overhead to monitor and collect the traffic information. We have proposed the framework of the TE for the case that only a part of traffic information can be obtained at each time slot. This framework was inspired by the human brain mechanism. In this framework the conditional probability is considered to make decisions. In this framework, a controller is deployed. The controller (1) obtains a limited number of traffic information, (2) estimates and predicts the probability distribution of the traffic, (3) configures the routes considering the probability distribution of the predicted future traffic, and (4) selects the traffic to be monitored at the next period considering the performance of the route reconfiguration using the traffic information obtained at the next period. In this paper, we discuss the details of the each step of our framework. Then, we evaluate our framework.

pp. 377-383

Friday, November 24, 14:00 - 15:20

S17: Session 17: Security

Room: Heritage room

Chair: Anthony Krzesinski (Stellenbosch University, South Africa)

14:00 *Experimental Evaluation of the Impact of DoS Attacks in SDN*

Talal Alharbi and Siamak Layeghy (The University of Queensland, Australia); Marius Portmann (University of Queensland, Australia)

Software Defined Networking (SDN) provides a simpler and more efficient approach to manage computer networks. This is achieved by decoupling the control functionality from the forwarding elements, and placing it into a logically centralised controller. This centralised architecture makes SDN susceptible to a range of Denial of Service (DoS) attacks. In this paper we investigate a range of DoS attacks against OpenFlow-based SDN, both against the control plane and data plane, and quantify the impact of the attacks via experiments. In particular, we compare the impact on three key SDN controller platforms, i.e. ONOS, Floodlight and Ryu. Our results show that with relatively limited resources, an attacker can cause a significant disruption against an SDN.

pp. 384-389

14:20 *A Smart City Cyber Security Platform for Narrowband Networks*

Asmaa Elsaeidy (University of Canberra, Australia); Ibrahim Elgendi (Canberra University, Australia); Kumudu S Munasinghe and Dharmendra Sharma (University of Canberra, Australia); Abbas Jamalipour (University of Sydney, Australia)

Smart city is gaining a significant attention all around the world. Narrowband technologies would have strong impact on achieving the smart city promises to its citizens with its powerful and efficient spectrum. The expected diversity of applications, different data structures and high volume of connecting devices for smart cities increase the persistent need to apply narrowband technologies. However, narrowband technologies have recognized limitations regarding security which make them an attractive target to cyber-attacks. In this paper, a novel platform architecture to secure smart city against cyber attackers is presented. The framework is providing a threat deep learning-based model to detect attackers based on users' data behavior. The proposed architecture could be considered as an attempt toward developing a universal model to identify and block Denial of Service (DoS) attackers in a real time for smart city applications.

pp. 390-395

14:40 *Distance-Based Location Privacy Protection in Social Networks*

MohammadReza Nosouhi, Youyang Qu, Shui Yu, Yong Xiang and Damien Manuel (Deakin University, Australia)

The current privacy protection methods adopted by social network providers rely on restricting users' access rights. They force a user to rigidly divide other users into two categories only: friends and strangers. Based on this classification, they prevent non-friends from accessing to the user's data while provide full access for friends regardless of how close they are to her. However, the level of privacy protection can be increased gradually and smoothly rather than firmly like a zero/one function. Moreover, the utility of social networks is reduced if we prevent data miners from computing global statistics by applying rigid privacy policies. In this paper, we present a distance-based location privacy protection system (DBLP2) to preserve location privacy of social network users based on their friendship distance. Whenever a user wants to see another user's location (in her profile or from spatiotemporal tags on her posts), the system returns a differentially private response based on their friendship distance. In our proposed system, a user's location information provided for other users is more generalized as the friendship distance increases. In other words, family members and close friends receive a more accurate response than casual friends and strangers. Through analysis, we show that our proposed system makes the process of location privacy protection more flexible in terms of friendship distances.

pp. 396-401

15:00 *Evaluating Network Intrusion Detection Systems for High-Speed Networks*

Qinwen Hu, Muhammad Rizwan Asghar and Nevil Brownlee (The University of Auckland, New Zealand)

Network Intrusion Detection Systems (NIDSs) play a crucial role in detecting malicious activities within the networks. Basically, an NIDS monitors network flows and compares it with the pre-defined suspicious patterns. To be effective, different intrusion detection algorithms and packet capturing methods have been implemented. With rapidly increasing network speeds, NIDSs face a challenging problem of monitoring large and diverse traffic volumes; in particular, the high packet drop rate has a significant impact on detection accuracy. In this work, we investigate three popular open-source NIDSs: Snort, Suricata, and Bro along with their comparative performance benchmarks. We investigate key factors (including system resource usage, packet processing speed and packet drop rate) that limit applicability of NIDSs to large-scale networks. Moreover, we also analyse and compare the performance of NIDSs when configurations and traffic volumes are changed.

pp. 402-407

S18: Session 18: General

Room: Presidents Room

Chair: Keshav Sood (Deakin University & Victoria University, Australia)

14:00 *A Multi-Level Hybrid Chaotic System with a Novel Damping Approach to Achieve Variable Rates*

Ammar Moufak Dukhan, Dhammika Jayalath, Bouchra Senadji and Jasmine Banks (Queensland University of Technology, Australia)

Recent advances in chaotic communications have paved the way for the implementation of matched filter based receivers to detect chaotic signals generated by hybrid-chaotic oscillators. These oscillators offer an exact analytic solution given their fixed basis function. This paper extends the hybrid-chaotic oscillator concept and presents a novel hybrid-chaotic oscillator for multilevel chaotic modulation. This is created by combining a data dependent discrete system and a continuous chaotic system with a novel damping factor approach to achieve variable rates. Lower complexity is achieved by multilevel modulation at the transmitter and a matched filter at the receiver. An exact analytic solution for the output of the matched filter was also derived. A comprehensive set of simulations were carried out to evaluate the performance of the novel system in Additive White Gaussian Noise (AWGN) channels and to compare it with that of conventional communication systems. The results demonstrate that the proposed system can realize multi-level chaotic communication system with acceptable bit error rate performance.

pp. 408-413

14:20 *Increased block size and Bitcoin blockchain dynamics*

Anthony Krzesinski (Stellenbosch University, South Africa); Johannes Goebel (University of Hamburg, Germany)

Bitcoin is a peer to peer electronic payment system where encrypted payment transactions are stored in a data structure named the blockchain which is maintained by a community of participants. The Bitcoin Core protocol limits blocks to 1 MB in size. Each block contains at most some 4,000 transactions. Blocks are added to the blockchain on average every 10 minutes, therefore the transaction rate is limited to some 7 transactions per second (TPS). This is much less than the transaction rate offered by competing financial transaction processing systems. The Bitcoin TPS can be increased by increasing the block size and/or by decreasing the block discovery interval. Both of these interventions will increase the end-to-end block transmission delay, which in turn will increase the probability that different participants momentarily record different versions of the blockchain, so that the consensus protocol will discard an increasing number of blocks. The net effect is that the real increase in the TPS is not proportional to the increase (decrease) in the block size (block discovery rate). Our simulation experiments show that large block sizes, if accompanied by large end-to-end block transmission delays, give rise to the frequent appearance of inconsistent blockchain copies, to the detriment of the TPS. We present a simulation analysis of Bitcoin-Next Generation where blocks (key blocks) stripped of transactions propagate rapidly through the peer-to-peer network. Once a key block is mined, only the miner of the key block is entitled to broadcast small microblocks of transactions until the next key block is mined and another miner is selected to broadcast microblocks. Initial simulation experiments show that Bitcoin-NG can sustain substantially larger transaction rates than Bitcoin Core.

pp. 414-419

14:40 *On cycle based schedulers with time alternating priorities*

Wojciech Burakowski and Maciej Sosnowski (Warsaw University of Technology, Poland)

The paper discusses new scheduling algorithms that are modifications of classical cycle based scheme, named the cycle based algorithm with time alternating priorities and time guard. The classical cycle based algorithm assumes that a given packet stream can be served only in predefined periods while it is not entitled to receive service in the periods dedicated to serve other packet streams. This property leads to non-work conserving behavior of the system and, as a consequence, rather poor packet transfer characteristics (expressed by packet delay and packet loss ratio in the case of system with a finite buffer). On the other hand, the important advantage of this algorithm is that it guarantees performance isolation among different packet streams. The proposed modification assumes that in the

periods dedicated for service of a given packet stream the scheduler can also serve the packets belonging to other streams but with assigned lower priorities. In this way we transform the behavior of the cycle based algorithm to the form of nearly work conserving. In the paper we provide exemplary simulation results showing the effectiveness of the proposed algorithms in terms of packet delay characteristics and guarantees about performance isolation. Finally, we show the application of the studied scheme to the IIP System with virtualized network infrastructure requiring isolation among virtual links sharing a given link capacity.

pp. 420-425

15:00 *MPTCP Energy Enhancement Paradox: A Q-Learning Approach*

Mohammad Javad Shamani (University of New South Wales, Australia); Saeid Rezaei (West Tehran Islamic Azad University, Iran); Guillaume Jourjon (Data61-CSIRO, Australia); Aruna Seneviratne (University of New South Wales, Australia)

Leveraging multi-path transmission in an energy efficient manner is of great importance for mobile devices in heterogeneous wireless networks. Recently, Multi-path TCP (MPTCP) has been introduced as a potential solution that could leverage this path diversity, but making it energy efficient not only depends on the end-user's observed interface capacity but also on the other competitors' decision. We discuss about the paradox of energy saving in MPTCP for mobile devices. Then we propose, hereafter, a new algorithm to enhance the MPTCP energy efficiency in a resource-shared wireless network context by exploiting a newly introduced Q-learning framework. Based on large scale simulation, we demonstrate that our proposed algorithm could save up to 36%, energy compared to vanilla MPTCP.

pp. 426-429

Friday, November 24, 15:20 - 15:40

AT3: Afternoon Tea

Room: Upper Vestibule

Friday, November 24, 15:40 - 17:40

S20: Session 20: Wireless Cellular and General

Room: Heritage room

Chair: Anthony Krzesinski (Stellenbosch University, South Africa)

15:40 *Energy and Rate Modeling of Data Download over LTE with respect to Received Signal Characteristics*

Kübra Uludağ (Marmara University); Omer Korcak (Marmara University, Turkey)

Estimating energy consumption and data rate in LTE networks is a critical issue for some recently proposed applications such as collaborative Internet access and energy-aware cellular data scheduling. In this study, after collecting data via empirical measurements, we provide realistic modeling with respect to LTE signal parameters such as RSRP, RSRQ and SINR. We applied various regression methods after careful data analysis and appropriate transformations to avoid biased estimations. We provide several formulas for energy and throughput estimations, and analyze their goodness of fit values. Resulting models could be utilized in current applications as well as they would provide a benchmark to compare energy efficiency of new studies in the context of upcoming 5G networks and beyond.

pp. 430-435

16:00 *Green Topological Potential-based Optimization for Power and Spectral Efficiency Tradeoff in LTE HetNets*

Takoua Ghariani (Institut Telecom / Telecom SudParis, France); Badii Jouaber (Institut TELECOM - Telecom SudParis & cnrs UMR-SAMOVAR, France)

As the data traffic demand increases continuously, LTE Heterogeneous Networks (HetNets) with macro-cells and small-cells seems to be the best solution to enhance the quality of user experience by increasing the coverage and capacity of cellular networks. One of the important challenges in such networks is the user association problem. Several approaches have been proposed for this purpose: based for instance on spectral efficiency or load balancing. However, since many factors impact the power consumption of the eNodeBs and therefor the total energy consumption in the cell, defining new rules and approaches to reduce the power consumption in LTE HetNets is needed. In this paper we propose a power efficient user association scheme. Our solution aims to achieve a trade-off between user quality of experience and power efficiency in such heterogeneous cellular networks taking into account user mobility. For this to happen, we introduce a new metric: the Green Topological Potential approach (GTP). It combines energy efficiency (EE) and spectral efficiency (SE) metrics when selecting the target cell. Simulation results show that a power gain can be achieved compared to path-loss based and received power based algorithms while maintaining acceptable spectral efficiency.

pp. 436-441

16:20 *Hardware Accelerator for Coordinated Radio-Resource Scheduling in 5G Ultra-High-density Distributed Antenna Systems*

Yuki Arikawa, Takeshi Sakamoto and Shunji Kimura (NTT, Japan)

This paper presents a novel radio-resource scheduler with a hardware accelerator for coordinated scheduling in 5G ultra-high-density distributed antenna systems. In 5G mobile communications systems, the transmission weight and the overall system throughputs for a huge number of possible combinations of antennas and user equipment have to be computed. To accelerate the scheduling, the new scheduler executes the computation using dedicated hardware. Moreover, it reduces the computational complexity. Experimental results show that the scheduler performs the computation 126 times faster than without acceleration. Simulated results reveal that the scheduler is able to find an optimal combination that achieves the higher system throughput even in a system with a large number of antennas and user equipment. The new scheduler enables a future practical 5G system.

pp. 442-447

16:40 *Practical Service Allocation in Mobile Edge Computing Systems*

Sung-Yeon Kim (InterDigital Asia, LLC, Korea); Xavier de Foy (InterDigital Communications, LLC, Canada); Alex Reznik (Hewlett-Packard Enterprise, USA)

Mobile edge computing is an emerging technology required to meet the very low latency requirement of 5G communication systems, where application resources are embedded within access networks. Edge computing resources can be deployed very close to end users, e.g., attachment points (AP). In such cases, the edge servers are likely to have a relatively smaller computing capacity than servers deeper in the network. This can be partially compensated by the density and scale of deployment of edge servers. To leverage such deployment, it is important to allocate services efficiently at the edge. For example, neighbor edge servers may serve users attached to

a distant AP, as long as the network topology, usage, and edge application requirements, e.g., latency, enables it. In this context, user mobility is important. The user session with the edge should be migrated when needed to ensure that a mobile user continues to be served with a proper Quality of Service (QoS), typically linked to latency. In this paper, we study a service instance allocation algorithm focusing on maintaining QoS for end users, using service migration as a tool to achieve this goal. We propose a globally optimum allocation algorithm, derive a practical algorithm from it, and evaluate its use versus a heuristic and a reference algorithm.

pp. 448-453

17:00 *Sustainable Massive Data Dissemination by Using Software Defined Connectivity Approach*

Rashmi Munjal, William Liu, Xue Jun Li and Jairo A Gutierrez (Auckland University of Technology, New Zealand); Marija Furdek (KTH Royal Institute of Technology, Sweden)

The traditional world has transformed into digital society where almost anything can be accessed from anywhere. However, this digital society is responsible for an explosive growth of high-volume, high-velocity and high-variety information assets, with high demand for "Big Data". The Software Defined Connectivity (SDC) is an emerging paradigm, which promises to simplify network management, to provide the flexibility to program the network through centralized network control by providing new abstractions in networking with all real objects for reliable and energy efficient data transmission. In SDC architecture, connectivity controller decides the forwarding rules as per the demands and objective of user to transmit it to the intended destination through either internet or existing transport infrastructure. The key idea is flexibility of network to utilize existing transport infrastructure to shift traffic from internet towards public bus services as per the current need and urgency of data of individual user. The numerical studies reported in this paper confirm that this new opportunity helps to achieve efficient resource utilization, high performance with significant saving of energy.

pp. 454-459

17:20 *Demand Management using Utility based Real Time Pricing for Smart Grid with a New Cost Function*

Khandakar Ahmed and Md. Nabid Hasan (Bangladesh University of Engineering and Technology, Bangladesh); Md. Farhad Hossain (Bangladesh University of Engineering and Technology (BUET), Bangladesh); Kumudu S Munasinghe (University of Canberra, Australia); Abbas Jamalipour (University of Sydney, Australia)

Considering the time-varying power consumption of users and cost of generation over a day, demand side management (DSM) has become essential to meet the excessive need of users with the limited source of power. In this paper, we propose a utility based optimal Real-Time Pricing (RTP) mechanism for the future smart grid communication systems such that the electricity price corresponds to the optimum system welfare. Here, we formulate a distributed algorithm which is based on the two-way communication among users, decision maker, and energy provider through the exchange of control messages, and determine the optimal price maintaining the equality between the total demand and the offered generation. We also propose a novel cost function for energy provider exhibiting how it reduces the impact of the change in user number to electricity price, unlike a previously proposed cost function. Simulation results confirm that the proposed algorithm is favorable for both the users and energy provider in terms of electricity price and generation cost respectively. It is also demonstrated that our new cost function makes the RTP algorithm user-adaptive and offers a better welfare to both the users and the energy provider.

pp. 460-465

S19: Session 19: Second International Workshop on Data Intensive Computing and Communications for Sustainable Development

Room: Presidents Room

Chairs: Luca Chiaraviglio (University of Rome Tor Vergata, Italy), William Liu (Auckland University of Technology, New Zealand)

15:40 *A Sustainable Vehicular Based Energy Efficient Data Dissemination Approach*

Salman Naseer (Auckland University of Technology, New Zealand & University of the Punjab Lahore, Pakistan); William Liu, Nurul I Sarkar, Peter Han Joo Chong and Edmund Lai (Auckland University of Technology, New Zealand); Venkatesha Prasad (Delft University of Technology, The Netherlands)

One of the main issues in smart cities is the data aggregation from various data sources that are densely deployed throughout the city to the central control units for storage and analysis. While the core networks are winding up progressively over-burden, the cost of keeping up and extending the networks to oblige the big data of these smart cities stays high. Moreover, the utilization of these systems continues expanding the energy consumption. Consequently, the carbon emission amid this procedure could at long last wind up genuinely hurting the environment. To overcome the problems of energy consumption and carbon emissions, we propose an energy efficient data dissemination framework. The idea is to utilize the city existing public transport infrastructure to pick up and deliver big data from designated pick-up points and data centers. Two numerical studies evaluated in this paper confirm the noteworthy cost and energy savings can be obtained by utilizing the existing vehicle volume on the road for big data dissemination in the smart city. The analysis of energy cost and carbon emissions using the traditional min-cost flow problem is also included.

pp. 466-473

16:00 *NTaaS: Network Trustworthiness as a Service*

Ming Xiang, William Liu and Quan Bai (Auckland University of Technology, New Zealand); Adnan Al-Anbuky (AUT University, New Zealand); Jinsong Wu (Universidad de Chile, Chile); Arjuna Sathiaseelan (University of Cambridge, United Kingdom (Great Britain))

The Device-to-Device communication (D2D) is believed to be one of promising paradigm for 5G wireless communication networks. D2D networks are based on a distributed peer to peer (P2P) network architecture where the nodes are self-organized. Moreover, as the devices are controlled by humans, their behaviours become unpredictable. Trust and reputation management (TRM) emerges as a significant research problem to tackle the security issues in D2D networks. Recently, there is a rapid growth of literature related to TRM but mainly focus their attention on trust modelling and quantification, so as to effectively detect and avoid various malicious attacks or selfish behaviours. However, there are only very limited existing works on the impact of the underlying network structure on overlay dynamic trust behaviours. The network trust behaviour is not merely a function of trust modes, but also a network-wide activity. In this paper, we propose the concept of "Network-Trustworthiness-as-a-Service" (NTaaS) - a network trustworthiness evaluation framework for the trustworthiness of the networks from global point of view. We also evaluate the evaluation framework through a thorough simulation study comparing different network topologies. The study will validate the trustworthiness evaluation framework, and thus present a guideline to evaluate network trustworthiness and network structure optimisation.

pp. 474-479

16:20 *A Crowd Sourced Framework for Neighbour Assisted Medical Emergency System*

Akbar Hossain (Auckland University of Technology, New Zealand)

An emergency can possess an immediate risk to life and may require urgent intervention to prevent or mitigate the further causalities. However, the level of mitigation depends on the response to address an emergency. The current practice of emergency frameworks

includes different medical teams to improve the response time. In some cases, it is possible to achieve a reasonable performance with an additional cost. Hence it is necessary to develop a comprehensive response framework which can reduce both response time and operating cost of the emergency medical services. This study revealed that in today's connected society through different technologies, the power of crowd sourcing can be utilised to reduce the emergency response time as well as minimise the emergency medical operational cost. This study also discussed an escalation process based on the level of medical emergency. Integration of neighbours within the emergency response framework is the most novel framework studies in this field.

pp. 480-485

16:40 *User Behavior Analysis Based on User Interest by Web Log Mining*

Xipei Luo, Qi Qi, Jingyu Wang, Qiwei Shen and Jing Wang (Beijing University of Posts and Telecommunications, P.R. China)

With the rapid development of science and technology and the growing popularity of computer networks, the scale of network users is gradually expanding, and the behavior of network users is becoming more and more complicated. A large number of studies show that the user's actual interest is closely related to the browsing behavior on the web page. Through the user browsing behavior analysis can obtain the user interest information, and then build the user interest model, so that the search results closer to the user's expectations. This paper mainly introduces the method of web log mining, which can discover the mode of web pages by digging web log records. By analyzing and exploring the rules of web log records, we can identify the potential customers of the website and improve the quality of information services to users. In the stage of user behavior analysis, this paper explores the differences in user browsing behavior in different types of access events, and calculates the user's interest based on the M5 model tree to analyze the analytic events.

pp. 486-490

17:00 *ProFiOt: Abnormal Behavior Profiling (ABP) of IoT devices based on a Machine Learning Approach*

SooYeon Lee, Eunil Antonio Seo, Sarang Wi and Junkwon Jung (Sungkyunkwan University, Korea); TaiMyoung Chung (SungkyunKwang University, Korea)

In this paper, we aim to build Abnormal Behavior Profiling (ABP) of IoT devices while other works focus on abnormal behavior detection of IoT devices with high accuracy by a wide variety of machine learning algorithms. Abnormal Behavior Profiling (ABP) will integrate all type of abnormal behavior detection and play a key role for the IoT security purpose in the future. Our technical motivation is from IoT smart sensors, which are equipped with high computing power and communication capability; moreover, there is possible one sensed data can be modified instead of all sensed data (e.g., a sensor reporting temperature, humidity, light and voltage) for the malicious purpose. In this kind of threat, it affects the detect accuracy of abnormal behavior and we observed degradation of abnormal behavior detection from both machine learning algorithms such as K-means and Support Vector Machine (SVM). We used K-means and SVM to detect one sensed data modification out of 4 data from one sensor and we observe K-means (92%) has less affection than SVM (69.5%) in terms of detection accuracy. The Abnormal Behavior Profiling (ABP) is constructed and proposed on the basis of K-means with 9 cluster. In future work, we will research on how to improve the detection accuracy of abnormal behavior in IoT environment so that the improved Abnormal Behavior Profiling (ABP) will be proposed.

pp. 491-496

17:20 *Connecting the Unconnected 10% of New Zealanders by 2025: Is a MahiTahi Approach Possible?*

Maria Villapol, William Liu and Jairo A Gutierrez (Auckland University of Technology, New Zealand); Luca Chiaraviglio (University of Rome Tor Vergata, Italy); Arjuna Sathiaseelan (University of Cambridge, United Kingdom (Great Britain)); Jinsong Wu (Universidad de Chile, Chile); Antoine Bagula (University of the Western Cape, South Africa); Junaid Qadir (IT University, Pakistan); Jian Song (Tsinghua University, P.R. China); Wenjun Zhang (Auckland University of Technology, New Zealand); Mark A. Gregory (RMIT University, Australia); George Wu (Massey Univerity & N/A, New Zealand)

The New Zealand Government has set the goal of having 99% of Kiwis able to access broadband with peak speeds of at least 50 Megabits per second (Mbps) by 2025, and with the remaining 1% able to have access with rates of at least 10 Mbps. There is an interesting question to be raised: is it possible to achieve these goals earlier? Inspired by the United Nations' 17 Sustainable Development Goals (SDGs), we propose a bottom-up and top-down partnerships based on a sustainable research enlightened (MahiTahi) approach to pursue the goals. In Maori, MahiTahi means "collaboration" which best represents the key design and implementation principles embedded into our approach. It has addressed the three dimensional challenges of rural connectivity including the collaboration among various network access technologies to enhance geo-reachability; collaboration among different stakeholders to optimize social and economic reachability, as well as collaboration among national and international researchers from different disciplines to extend knowledge reachability. Rather than providing a final solution, this paper aims to use a MahiTahi approach to inspire and invite more discussions so as to finally seek out a holistic solution to achieve the government's goals as earlier as possible.

pp. 497-503

Friday, November 24, 17:40 - 17:45

CR: Closing Remarks

Room: Heritage room

Chair: Mark A. Gregory (RMIT University, Australia)