2019 29th International Telecommunication Networks and Applications Conference (ITNAC)

	Tuesday, November 26	Wednesday, November 27	Thursday, November 28	Friday, November 29
8:00 - 8:40		R1: *Registration*		
8:40 - 9:00		S3: *Session 3: IoT* S1: *Session 1: Satellite and Wireless*	S13: *Session 13: Cloud and Applications* S12: *Session 12: Mobile Cellular*	
9:00 - 9:40		S2: *Session 2: SDN*		S14: *Session 14: Security* S15: *Session 15: Workshop track*
9:40 - 10:00		C1: *Conference Opening*		
10:00 - 10:40		K1: *Keynote*	K3: *Keynote*	
10:40 - 11:00		MT1: *Morning Tea*	MT2: *Morning Tea*	MT3: *Morning Tea*
11:00 - 11:30		K2: *Keynote*	K4: *Keynote*	K5: *Keynote*
11:30 - 11:40				K6: *Keynote*
11:40 - 12:00		SP1: *Juniper Welcome*	SP2: *Huawei Welcome*	
12:00 - 12:10		L1: *Lunch*		L3: *Lunch*
12:10 - 13:00			L2: *Lunch*	
13:00 - 13:10		S6: *Session 6: Security* S4: *Session 4: IoT* S5: *Session 5: SDN*		S17: *Session 17: Wireless and Applications* S16: *Session 16: Workshop track*
13:10 - 13:30				
13:30 - 14:00			C1: *Conference Tour*	
14:00 - 15:20		S8: *Session 8: Mobile Cellular and IoT* S9: *Session 9: Security* S7: *Session 7: Transmission*		S19: *Session 19: Algorithms* S18: *Session18: SDN and Applications*
15:20 - 15:40		AT1: *Afternoon Tea*		
15:40 - 16:00		S11: *Session 11: Applications* S10: *Session 10: Wireless*		AT3: *Afternoon Tea*
16:00 - 16:05				CR: *Closing Remarks*
16:05 - 17:00				
17:00 - 17:30	WR: *Welcome Reception*			
17:30 - 18:00				
18:00 - 20:00			D1: *ITNAC 2019 Dinner*	
20:00 - 22:00				

Tuesday, November 26

Tuesday, November 26 17:00 - 20:00

WR: Welcome Reception

Nurul Sarkar

Room: WG128 Foyer

Chair: Nurul I Sarkar (Auckland University of Technology, New Zealand)

Wednesday, November 27

Wednesday, November 27 8:00 - 8:40

R1: Registration

Room: WG128 Foyer

Wednesday, November 27 8:40 - 9:40

S3: Session 3: IoT

Room: WG126

Chair: James Jin Kang (Edith Cowan University, Australia)

8:40 *Adaptive Control of Nonstatistical Sensor Data Aggregation to Minimize Latency in IoT Gateway*

Hideaki Yoshino, Kenko Ota and Takefumi Hiraguri (Nippon Institute of Technology, Japan)

In order to realize latency-critical Internet of Things (IoT) applications, such as factory automation and smart grids, it is important to suppress the latency in an IoT gateway that aggregates a large amount of small-sized data from massive sensor devices. In previous studies, we derived the Laplace--Stieltjes transforms of the latency distributions for statistical and nonstatistical data aggregation schemes for the IoT gateway, and derived simple and accurate estimation formulae for the optimal aggregation parameters under steady-state conditions with a Poisson arrival. Moreover, we proposed an adaptive control scheme of statistical aggregation that minimizes the latency when time variation exists in the arrival rate. In this study, we extend the adaptive control scheme to the nonstatistical aggregation and propose three kinds of estimation formulae for the optimal aggregation number. Applying the estimation formulae for the nonstatistical aggregation model to time-variant inputs, we realized adaptive control of the aggregation number according to the arrival rate. The transient and average characteristics of the estimation formulae were compared by simulation. The results indicated that the proposed control with each estimation formula achieved stable and nearly theoretically optimal latency.

pp. 1-6

9:00 *Outdoor Signal Performance of LoRaWAN Technology for Campus-Scale IoT Connectivity*

Husna Zainol Abidin, Fadhlan Hafizhelmi Kamaru Zaman and Syahrul Afzal Che Abdullah (Universiti Teknologi MARA, Malaysia)

Long range with low-power consumption wireless platform known as LoRa, is an increasingly popular technology. It is specifically tailored for Low Power Area Network (LPWANs). It offers long distance, efficient energy management, and low data rates for wireless communication. This technology has the potential to realize the application of the Internet of Things (IoT). A lot of studies have been carried out to evaluate the performance of LoRa technology. In this paper, the outdoor signal performance of Long Range Wide Area Network (LoRaWAN) technology is studied. The study is done to evaluate the outdoor signal performance of LoRaWAN and to study the relations between the signal parameters. The test was conducted at Universiti Teknologi Mara (UiTM) campus in Shah Alam, Selangor. The performance was studied in terms of Received Signal Strength Indicator (RSSI), Signal to Noise Ratio (SNR), and Time on Air (ToA) for different Spreading Factor (SF). The results show that LoRaWAN technology is highly adaptable to be used in campus scale as well as urban IoT connectivity.

pp. 7-12

9:20 *Demystifying LoRaWAN Security and Capacity*

Michael Santamaria and Alan Marchiori (Bucknell University, USA)

LoRa and LoRaWAN are developing technologies that are meant as a way to implement a Low Power Wide Area Network which allows devices to communicate. This technology is being used to develop Internet of Things solutions for cutting edge applications such as smart farming, metering, and cities. Since this technology promises to be widespread and greatly used in the future it is very important that the security and capacity of the system is ensured. To this end, a large amount of research has been done looking into potential security threats to LoRa solutions, and how to protect against these vulnerabilities. Additionally, LoRa networks are meant to handle a high capacity of devices to provide coverage for urban areas. In such environments, it is important to know the practical capacity of the network. The goal of our paper is to collect this information and present it in a way that helps developers assess and optimize LoRaWAN deployments.

pp. 13-19

S1: Session 1: Satellite and Wireless

Room: WG608

Chair: Nazmus Shaker Nafi (MIT, Australia)

8:40 *Download Traffic Scheduling for CubeSats Swarms with Inter-Satellite Links*

Yawen Zheng and Kwan-Wu Chin (University of Wollongong, Australia); Luyao Wang (Beijing University of Technology, China)

Cube satellites are becoming popular for space research, and are also poised to become a critical communication backbone that links future Internet of Things (IoTs) and vehicular networks over wide geographical areas. A key problem is maximizing the total data downloaded from an orbiting CubeSat swarm to ground stations subject to constraints related to energy, available data, and link capacity. A key challenge is that CubeSats have varying contact times and duration with ground stations. We present a Mixed Integer Linear Program (MILP) and also a heuristic to solve the aforementioned problem. Unlike prior works, we consider Inter-Satellite Links (ISLs). Our results show that CubeSats swarms that employ ISLs help increase the total downloaded data, and our heuristic has near optimal performance, especially with increasing ground stations.

pp. 20-25

9:00 *Hierarchical Architecture for Computational Offloading in Autonomous Vehicle Environment*

Arslan Rasheed (Auckland of University of Technology, New Zealand); Asim Anwar (UoL, Pakistan); Arun Kumar (NIT Rourkela, India); Peter Han Joo Chong and Xue Jun Li (Auckland University of Technology, New Zealand)

Mobile Edge Computing (MEC) is a key enabler technology for fifth generation (5G) networks and has numerous use cases including, Device to Device (D2D) communication and computation offloading. In future, the Internet of Vehicles (IoV) applications will require high data rate as well as extensive computational capacity. In connected vehicles, MEC has emerged as a strong candidate due to its proximity with the users, high throughput, better traffic monitoring & management, large coverage area, and context-awareness. For this purpose, a vehicular architecture is needed to handle the computation under the stringent latency conditions and to meet the high computational requirement. This paper proposes a hierarchical architecture for computation offloading in the futuristic vehicular network. The proposed architecture divides the computation offloading into multiple levels, resulting in efficient and cost-effective architecture. This work proposes the assigning of weights to each task based on speed, computational requirement and latency. Also, a controller needs to be installed within the MEC server to handle the computation handover efficiently without introducing complexity into the network.

pp. 339-344

S2: Session 2: SDN

Room: WG609

Chair: Lincy Elizebeth Jim (Melbourne Institute of Technology, Australia)

8:40 *Green Multi-Stage Upgrade for Bundled-Link SDNs with Budget Constraint*

Lely Hiryanto (Curtin University, Australia & Tarumanagara University, Indonesia); Sieteng Soh (Curtin University, Australia); Kwan-Wu Chin (University of Wollongong, Australia); Mihai M Lazarescu (Curtin University, Australia)

Upgrading a legacy network into a Software Defined Network (SDN) in stages, and minimizing the energy consumption of a network are now of great interests to operators. To this end, this paper addresses a novel problem: minimize the energy consumption of a network by upgrading switches over multiple stages subject to the available monetary budget at each stage. Our problem considers (i) bundled links that can be powered-off individually only if they are adjacent to a SDN switch, and (ii) decreasing upgrade cost and increasing traffic demands over multiple stages. We formulate the problem as an Integer Linear Program (ILP) and propose a greedy heuristic called Green Multi-stage Switch Upgrade (GMSU). Experiment results show that increasing budget as well as number of stages affect the total energy saved and number of upgraded switches. GMSU produces results that are up to 5.8\% off the optimal result. Moreover, on large networks, in which ILP becomes computationally intractable, GMSU uses less than 0.1 second to compute a solution.

pp. 32-38

9:00 *Load-balancing In Software-Defined Networking: An Investigation On Influential System Parameters*

Amirhossein Moravejosharieh and Francisco Claudio Palmeira (Auckland Institute of Studies, New Zealand)

Software-Defined Networking (SDN) is a recently-developed networking paradigm that achieves flexible network management through separation of control plane and data plane. In an SDN-enabled network, the deployment of a multi-controller architecture as a centralised control plane along with the implementation of a load-balancing strategy to share the load among controllers in the control plane achieve higher degree of availability and scalability. To efficiently balance the load between SDN-controllers, two tasks seem to be of utmost importance, namely: identifying the system parameters whose values' variations initiate the load-balancing operation, and the amount of time taken to complete the load-balancing operation between controllers. In this paper, an SDN-enabled network topology has been emulated to identify a subset of influential system parameters that trigger load-balancing operation between SDN-controllers. Additionally, this paper determines the impact of all possible combinations of such system parameters on the amount of time taken to complete the load-balancing operation in a cluster of OpenDayLight controllers.

pp. 39-44

9:20 *Realization of congestion-aware energy-aware virtual link embedding*

Minh Pham and Doan B Hoang (University of Technology Sydney, Australia); Zenon D Chaczko (University of Technology, Sydney & SEDE, Australia)

Network virtualization is an inherent component of future internets. Network resources are virtualized and provisioned to users on demand. The virtual network embedding entails two processes: node mapping and link mapping. However, efficient and practical solutions to the link mapping problem in software-defined networks (SDN) and data centers are still lacking. This paper proposes a solution to the link mapping process that can dynamically interact with the routing protocols of the substrate network to allocate virtual link requests to the underlying substrate links and satisfies optimizing cost, minimizing energy consumption, and avoiding congestion (CEVNE LiM) concurrently. CEVNE LiM is realized as a composite application on top of the SDN controller running the Segment Routing (SR) application. The performance of the CEVNE LiM algorithm is compared with the k-shortest path (link mapping) algorithm and shows its superior performance in terms of the overall runtime, the average path length, the average node stress, the average link stress and the overall energy consumption.

pp. 45-50

Wednesday, November 27 9:40 - 10:00

C1: Conference Opening

Professor Guy Littlefair, Pro Vice Chancellor and Dean of the Faculty of Design and Creative Technologies

Room: WG126

Chair: Nurul I Sarkar (Auckland University of Technology, New Zealand)

Wednesday, November 27 10:00 - 10:40

K1: Keynote

What can we learn about 5G performance from clustered ray-based channel models?

Professor Peter Smith

Room: WG126

Chair: Nurul I Sarkar (Auckland University of Technology, New Zealand)

Wednesday, November 27 10:40 - 11:00

MT1: Morning Tea

Room: WG128 Foyer

Wednesday, November 27 11:00 - 11:40

K2: Keynote

Murphy Loves Constructive Interference

Associate Professor Venkatesha Prasad

Room: WG126

Chair: Nurul I Sarkar (Auckland University of Technology, New Zealand)

The power of the Constructive Interference (CI) phenomenon was exploited for the first time by Ferrari et al. through their glossy paper in 2011. Instead of avoiding interference by neighbouring nodes, the Glossy protocol deliberately orchestrates simultaneous transmissions to achieve fast and efficient network-wide flooding. That insight of "embracing interference" prompted many researchers to go back to the drawing board. However, from the previous studies, there appears to be an inconsistent and often contradicting picture about the working of CI. In this keynote, I will sketch the main developments around Constructive Interference over the last 5 years. Further, I will present not only the understanding of CI with theory and rigorous experimentation but also question its actual existence. This talk covers advanced sensor networks issues.

Wednesday, November 27 11:40 - 12:00

SP1: Juniper Welcome

Room: WG126

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

Wednesday, November 27 12:00 - 13:00

L1: Lunch

Room: WG128 Foyer

Wednesday, November 27 13:00 - 14:00

S6: Session 6: Security

Room: WG126

Chair: Ron Addie (University of Southern Queensland, Australia)

13:00 *An Encryption Algorithm to Prevent Domain Name System Cache Poisoning Attacks*

Xue Jun Li (Auckland University of Technology, New Zealand); Maode Ma and Narayanan Arjun (Nanyang Technological University, Singapore)

One of the major security threats in domain name system (DNS) is Cache Poisoning (CP) attack, where an attacker can change the IP address in the response packet or the database in DNS. To address CP attacks, many security protocols have been proposed. This paper proposes character-wise encryption (CWE) method to provide better security against CP attacks (the probability of successful attack is low as 10-33) as compared to the shift-key based method. In addition, the proposed method

results in shorter encryption time. For example, with a domain name length of 30, CWE can reduce the encryption time by 10.7% as compared to the shift-key based method.

pp. 51-56

13:20 *Mitigating Time-Constrained Stolen-Credentials Content Poisoning in an NDN Setting*

Jerzy Konorski (Gdansk University of Technology, Poland)

NDN is a content-centric networking architecture using globally addressable information objects, created by publishers and cached by network nodes to be later accessed by subscribers. Content poisoning attacks consist in the substitution by an intruder publisher of bogus objects for genuine ones created by an honest publisher. With valid credentials stolen from an honest publisher, such attacks seem unstoppable unless object recipients can afford costly content verification. We argue that limited-time validity of stolen credentials gives rise to a mitigation scheme that does without content verification; instead, propagation of trust in an object is carefully designed. We formulate NDN, trust, and intruder models, and specify the mitigation scheme as a Markovian infection process on a graph, whose desirable properties we establish. We validate through simulations that bogus and genuine objects can be distinguished in a probabilistic sense, and evaluate several introduced measures of interest.

pp. 57-63

13:40 *A Novel Entitlement-based Blockchain-enabled Security Architecture for IoT*

Fariza Sabrina (Central Queensland University, Australia)

There has been a massive growth of Internet of Things (IoT) applications recently for both personal and organization use cases. An IoT network can connect to a very large number of devices with diverse storage and computational capabilities but its vulnerable to many privacy and security concerns. While some researchers have tried to define different access control models for IoT and tried to use blockchain in some cases, the solutions presented to date lacks a flexible and robust access control model that can be used for complex organization and cross-organization resource access scenarios and lacks the scalability and performance needed for IoT. This paper introduces a novel entitlement-based access control model that provides an efficient and secure way to delegate resource access rights to any entity. The solution uses service-oriented approach and a combination of public blockchain (with smart contracts) and local off-chain data for entitlements management and control. To analyze the proposed architecture, a large-scale cross-organization IoT scenario is taken into consideration and some qualitative evaluations are presented while implementation with Ethereum blockchain and smart contracts are currently in progress.

pp. 64-70

S4: Session 4: IoT

Room: WG608

Chair: James Jin Kang (Edith Cowan University, Australia)

13:00 *UAV-aided Data Collection in Self Organized IoT Network for Social Augmented Reality*

Zhenjie Tan, Hua Qu and Jihong Zhao (Xi'an Jiaotong University, China); Shiyu Zhou (Southwestern University of Finance and Economics, China); Wenjie Wang (Xi'an Jiaotong University, China)

To realize a seamlessly connected living in smart city is an attractive topic nowadays. With the help of massive machine type communication (mMTC) technology and drone-based networking strategy, we can create ubiquitous computing framework which is both agile and green. In this paper, we propose a cooperative data collecting mechanism in unmanned aerial vehicle (UAV) covered internet of things (IoT) community, aiming at delay-sensitive context information update and system energy efficiency (EE) optimization. To better collect small and fragmentized IoT data scattering around, we first propose a self-organizing algorithm to compress them into a hotspot area and derive the theoretical collecting efficiency (CE) therein. Then, a system EE maximizing power control algorithm is proposed, exploiting cooperative communication theory. When dealing with this highly non-convex programming problem, we look carefully into its Hessian matrix and prove that under two physically meaningful conditions, the modified problem can be turned into a strictly concave one and tractably solved. Finally, a social augmented reality (AR) use case is proposed and tested with our mechanism. Simulation results validate our analysis and demonstrate a clear improvement in EE performance comparing with benchmark solutions.

pp. 71-77

13:20 *Relay Selection Scheme for Energy Harvesting IoT Networks with Direct Link*

Chenchen Liu (CETC, China); Yuyang Zheng (CETC 38, China); Zhengyu Zhang (CETC, China); Weilong Ren (CETC38 China Electronic Technology Group Corporation, China)

In this paper, we propose a relay selection scheme in an energy-harvesting relay Internet of things network, which contains a source node, a multi-relay node and a destination node. The direct link between the source node and the destination node is used for signal transmission. In the proposed scheme, the relay selection is based on the instantaneous channel status information of the wireless link, which can decrease the outage probability. In addition, the relay node employs the technique of simultaneous wireless information and power transfer to harvest energy, and each relay node is equipped with a power splitter to split the received signal into signal processing part and energy harvesting part. A closed-form and simple asymptotic expression for the outage probability of the proposed relay selection scheme is provided. Computer simulations confirm that the optimal power splitting factor of each relay node is able to minimize the outage probability. The effectiveness of the proposed scheme is also verified.

pp. 78-81

13:40 *Ambient Intelligence for Smart Home using The Internet of Things*

Hakilo Sabit, Peter Han Joo Chong and Jeff Kilby (Auckland University of Technology, New Zealand)

This article presents an ambient intelligence application for smart home systems for efficient use of electricity, enhance comfort zone, independence of living and security. The smart home system integrates smart home occupants' identification, sensors/actuators deployment, a gateway, machine learning, and cloud computing components to realize the objectives of smart living. A Mobile phone MAC address based occupant identification and machine learning algorithms are proposed to address the multiple smart home occupant problems and an instant user control versus rule-based control conflicts. Results show that machine learning algorithm could learn the ambience preferences of multiple occupants well when trained on a large enough datasets. The results suggest that the proposed system is capable of implementing ambient intelligence applications in smart home

pp. 82-84

S5: Session 5: SDN

Room: WG609

Chair: Alan Marchiori (Bucknell University, USA)

13:00 *Unsplittable flow Edge Load factor Balancing in SDN using P4 Runtime*

Eiichiro Kawaguchi (Graduate School of Engineering, Soka University, Japan); Norihiko Shinomiya (Soka University, Japan); Hikaru Kasuga (Graduate School of Engineering, Soka University, Japan)

The spread of services and applications using cloud computing has led to an increase in the amount of network traffic. Therefore, traffic control methods using an SDN architecture for flexibly managing a network have been studied. Previous studies have proposed a traffic load balancing method by a single SDN controller. However, implementation with multiple SDN controllers has been considered to cope with scalability and redundancy. This paper models the distributed network as a flow network and defines the ratio of flow to capacity in an edge as a load factor. Besides, this study proposes a traffic load balancing method considering Unsplittable flow Edge Load factor Balancing problem and implements it to confirm its feasibility in a real network.

pp. 85-90

13:20 *SDN-based Wireless Access Networks utilising BBR TCP Congestion Control*

Hoang Minh Do, Mark A. Gregory and Shuo Li (RMIT University, Australia)

The Open Systems Interconnection (OSI) Reference Model indicates that TCP is a transport layer protocol and in that role it provides congestion and flow control. The TCP congestion control function is a key for the efficient operation of transport networking. Bottleneck Bandwidth and Round-trip propagation time (BBR) is a novel TCP congestion control algorithm developed for transport networking. This paper analyses Software Defined Networking (SDN) based wireless access networks that leverage the BBR TCP congestion control algorithm. A comparison of TCP performance over wireless access networks that utilise either conventional CUBIC TCP congestion control or BBR is provided. A SDN-based jitter minimization method for wireless links is proposed to achieve higher data throughput.

pp. 91-98

13:40 *A method for comparing OpenFlow and P4*

Paul Zanna (RMIT University & Northbound Networks, Australia); Pj Radcliffe and Karina Mabell Gomez (RMIT University, Australia)

OpenFlow has had a significant impact on computer networking and ushered in the age of Software Defined Networking (SDN). Now the P4 programming language promises to drive this innovation even further by allowing the unparalleled customisability of network devices. Even though they have different capabilities and goals, there is still an overlap in functionality between OpenFlow and P4. This overlap, predominately in the way packets are processed, has not been compared and therefore remains a question that could impact operators considering these two implementations. The primary reason for the lack of comparison data lies in the physical deployment model of these technologies. The inability to isolate pipeline processing and perform a comparison based on identical functionality, without the external influence from auxiliary functions, has made this type of measurement difficult. In this paper, we present such a comparison using the Zodiac FX a hybrid hardware/software Ethernet switch with a dedicated open-source firmware capable of running both implementations equally. By developing a P4 compiler backend capable of generating an equivalent packet processing pipeline for the Zodiac FX, we have been able to perform a direct like-for-like comparison of the performance and efficiency of these two approaches. This comparison highlights the similarity in performance of the two approaches when implementing the equivalent functionality on the same hardware.

pp. 99-101

Wednesday, November 27 14:00 - 15:20

S8: Session 8: Mobile Cellular and IoT

Room: WG126

Chair: Hakilo Sabit (Auckland University of Technology, New Zealand)

14:00 *Decoding Latency of LDPC Codes in 5G NR*

Hao Wu and Huayong Wang (ZTE Corporation, China)

Fifth generation (5G) new radio (NR) is the next generation of mobile network beyond the fourth generation (4G) long term evolution (LTE). In order to meet high throughput and low latency requirements, low-density parity-check (LDPC) codes are adopted by the 5G NR standard for data channels. In 5G NR, the decoder provided to implement the peak throughput requirement may not be able to decode transport blocks over the same radio resources in the same time duration. In this paper, we analyze the decoding latency of LDPC codes in a typical scenario from a system point of view. The analysis can be used to guide the design of the decoder.

pp. 102-106

14:20 *Analysis of Staircase Power Distributions for Reduced Number of Power Levels for 5G Planar Array Antenna Analog Beamforming*

Muhsiul Hassan (Monash University, Australia); Nazmus Shaker Nafi (MIT, Australia); Nguyen Vo and Rahul Thakkar (Victoria Institute of Technology, Australia); Mark A. Gregory (RMIT University, Australia)

High frequency analog beamforming, especially over 20GHz array antenna, is a challenge as the width of the feed line is reduced. In this paper different beamforming techniques have been analysed using theory and simulation to compare Beam Efficiency (BE), 3 dB beamwidth and Minimum Side-lobe Level (MSLL). Techniques such as Gaussian, Taylor, and Chebyshev give more power levels that are complicated to implement in a very thin substrate system. Staircase power distribution is an exciting recent technique, and that can be tailored to reduce the number of power levels with the same features as in BE, 3 dB beamwidth and MSLL, which is a significant achievement. The analysis can be used to design power distribution feed lines for high frequency array antenna.

pp. 107-110

14:40 *A Weight Based Channel Scheduling for LTE-A Femtocells*

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

In LTE-A, uplink channel allocation is mandated by the contiguity paradigm, which requires computational complexity and intricacy. With the massive deployment of small cells, e.g. femtocells, user experience in the uplink is as vital as in the downlink. PAPR is the critical factor in the SCFDMA network that allows low power consumption and contiguous resource allocation. In SC-FDMA, a contiguous resource block is required to take advantage of the PARP. An uplink channel scheduling algorithm for uplink operation can reduce the PAPR in transmission. An efficient and optimised uplink channel scheduling algorithm will allow the system to maximise resource occupation and uplink channel allocation. A weight-based resource allocation algorithm is proposed to improve the network performance in the LTE-A uplink femtocell network. Simulation results show that the proposed algorithm performs better for uplink and eliminates the gap of the current channel scheduling algorithms for the LTE-A femtocell.

pp. 111-115

15:00 *Device to Device Collaboration Architecture for Real-Time Identification of User and Abnormal Activities in Home*

Seong Su Keum, Cheol Hwan Lee and Soon Ju Kang (Kyungpook National University, Korea)

Activities of Daily Living (ADL) are indicators for evaluating individual health, ability of independence and daily living, and degenerative brain disease of old people. Therefore, many researches are actively underway to measure user's ADL data by constructing Internet of Things (IoT) based smart home. However, general smart home solutions for measuring user's ADL only focus on collecting user's activity data, appliance usage and home environment data. Such simple ADL data cannot be used as an indicator for early recognition of the above-mentioned symptoms of the elderly people. Intuitively speaking, the ADL data we want to collect should be to know who the user is, and whether the device has been successfully used or misused. In this paper, we propose device-to-device collaboration architecture to identify the user, device to use, and success or failure of the device usage in real-time. By designing and implementing the proposed architecture, we can record the ADL data on the user's wearable device without any user intervention. In addition, as another advantage of the proposed concept, it is possible to easily check and record the physical moving ability of the user between two fixed spaces. The collected ADL and abnormal behavior may help a user or guardian to determine the user's dementia symptoms, activeness and daily living skills.

pp. 116-118

S9: Session 9: Security

Room: WG608

Chair: Xue Jun Li (Auckland University of Technology, New Zealand)

14:00 *Dynamic RNN-CNN based Malware Classifier for deep learning algorithm*

Youngbok Cho (dept. Information Security Daejeon University, Korea)

This study proposes a malware classification model that can handle arbitrary length input data using the Microsoft Malware Classification Challenge dataset. We are based on imaging existing data from malware. The proposed model generates a lot of images when malware data is large, and generates a small image of small data. The generated image is learned as time series data by Dynamic RNN. The output value of the RNN is classified into malware by using only the highest weighted output by applying the Attention technique, and learning the RNN output value by Residual CNN again. Experiments on the proposed model showed a Micro-average F1 score of 92% in the validation data set. Experimental results show that the performance of a model capable of learning and classifying arbitrary length data can be verified without special feature extraction and dimension reduction.

pp. 119-124

14:20 *The inference Graph of Cybersecurity Rules*

Dawood Sallem Hussian Sheniar (University of Southern Queensland & Thi-Qar University, Australia); Nabeel Hadaad (Southern Queensland, Australia); Ron Addie (University of Southern Queensland, Australia)

Cybersecurity is essentially the enforcing of the rules required by the stakeholders of the system under consideration. The process of enforcing rules is analogous to a network of theorems and their proofs in mathematics. Expecting cybersecurity professionals to study and apply pure mathematics is unrealistic and unnecessary. Instead, we can observe that the inferences which connect cybersecurity rules can be represented as a graph. These graphs can be used to document and develop cybersecurity rules in a natural manner, as required for ICT professionals to complete the work of securing the systems which they manage. The inference graph of cybersecurity rules is defined, illustrated by several examples, and its use for development of cybersecurity is explained.

pp. 125-130

14:40 *Steganalysis of Storage-based Covert Channels Using Entropy*

Jun O Seo (University of Auckland, New Zealand); Sathiamoorthy Manoharan (The University of Auckland, New Zealand); Ulrich Speidel (University of Auckland, New Zealand)

A covert channel is a means of transmitting information that is not normally allowed in a network protocol. For instance, unused or insignificant bits of a network protocol could be used to transmit secret messages. This paper presents a novel technique to uncover the existence of covert channels in network data transfers. The technique uses entropy estimates, and is able to not only find the existence of secret messages, but also estimate the size of the messages. A covert network channel or a network steganography creates a secret channel by exploiting a network protocol. There exist two generic methods how a ...

pp. 131-136

15:00 *Improvised MANET Selfish Node Detection using Artificial Immune System based Decision Tree*

Lincy Elizebeth Jim (Melbourne Institute of Technology, Australia); Mark A. Gregory (RMIT University, Australia)

Mobile Ad hoc network (MANET) are networks that lack a flexible infrastructure and are networks created on the fly. They are highly dynamic in nature. For an efficient packet delivery it is vital that nodes in MANET cooperate in forwarding packets. However, this is not the case always as MANETs encounter packet delays and dropping of packets due to the presence of nodes with malicious intention. Any node that deviates from normal behaviour of forwarding packets is termed as a Selfish node. A selfish node is responsible for dropping packets which in turn harms the process of routing and forwarding packets. Hence it is crucial to detect the presence of these selfish nodes and avoid them which will result in improved performance of the entire network. Here an improved scheme based on Artificial Immune System incorporating Decision Tree is used to identify Selfish Nodes. This strategy guarantees improvement in performance of MANET in terms of Packet Delivery Ratio.

pp. 137-142

S7: Session 7: Transmission

Room: WG609

Chair: Peter Han Joo Chong (Auckland University of Technology, New Zealand)

14:00 *Frame Synchronization Performance of Optical-Wireless Hybrid BPPM-OOK System*

Tomohiro Kiguchi (Graduate School of Science and Engineering, Ibaraki University & Major in Computer and Information Sciences, Japan); Hiromasa Habuchi, Ran Sun and Yusuke Kozawa (Ibaraki University, Japan)

Turbo code is attractive error correction code in optical wireless communications. There are a binary pulse position modulation (BPPM) and an on-off keying (OOK) for modulating optical-wireless signals. A turbo code scheme using a hybrid BPPM-OOK frame that combines the advantages of BPPM and OOK has been proposed. We proposed a frame synchronization method for a turbo code system of the hybrid BPPM-OOK frame. However, we must evaluate the retention time and the recovery time to set the optimal number of stages of racing counters in the proposed frame synchronization method. In this paper, we derive the retention time and the recovery time on the frame synchronization method. As results, we determine the best number of stages of racing counters in terms of the retention time and the recovery time.

pp. 143-148

14:20 *Compact Multiband Frequency Reconfigurable Antenna for 5G Communications*

Adnan Ghaffar, Xue Jun Li and Boon-Chong Seet (Auckland University of Technology, New Zealand); Wahaj Abbas Awan (COMSATS, Sahiwal, Pakistan); Niamat Hussain (Chungbuk National University, Korea)

This paper presents a frequency reconfigurable antenna with compact size to cover sub 6 GHz. First, a wideband triangle shape antenna is designed to cover from 2.31 GHz to 4.4 GHz. Two slots are included in the design to get multiband response. To make the antenna frequency reconfigurable, two pin diodes are added to get dual-band and tri-band mode. By changing the states of pin diode, resonance in the sub 6GHz band (2.5GHz, 3.5 GHz, and 3.7-4.2GHz) is achieved. When both diodes are on, it resonate at 2.18-2.36GHz, 2.68-3.32GHz, and 3.75-4.50 GHz. In dual-band case, when both diodes are off, the resonance frequency is 2.25-2.58GHz, and 3.5-4.46GHz.

pp. 149-151

14:40 *Blockchain Enabled Opportunistic Fog-based Radio Access Network: A Position Paper*

Jofina Jijin, Boon-Chong Seet and Peter Han Joo Chong (Auckland University of Technology, New Zealand)

Fog-based radio access network (F-RAN) have the potential to meet the stringent latency and bandwidth requirements of next-generation mobile networks. However, the current F-RAN is implemented mainly by utilizing dedicated hardware and does not leverage on the available large number of distributed edge devices. This motivated us to recently propose the idea of an opportunistic fog RAN (OF-RAN) which introduces the concept of a virtual fog access points (v-FAP) formed by two or more local edge devices (referred as service nodes), and monitored by physical FAPs (referred to as seed nodes). Some of the challenges arising from having many devices opportunistically deployed to serve client nodes are accessing, forming and managing them. In this paper, we propose to harness blockchain technology for assigning roles and permissions to service nodes and seed nodes in our OF-RAN, and supporting the formation and management of v-FAPs. For this blockchain architecture, the distributed formation and management algorithm (DFMA) is implemented as a script in the smart contract. The blockchain then executes the logic of the smart contract while considering the resources from all service nodes participating in the system. By integrating OF-RAN with blockchain systems and smart contracts, it is possible to provide verifiable automation of physical processes involving different nodes.

pp. 152-154

Wednesday, November 27 15:20 - 15:40

AT1: Afternoon Tea

Room: WG128 Foyer

Wednesday, November 27 15:40 - 17:00

S11: Session 11: Applications

Room: WG126

Chair: Edmund Lai (Auckland University of Technology, New Zealand)

15:40 *Early Warning System with Real Time Tilt Monitoring*

Baden Parr, Daniel Konings, Mathew Legg and Fakhrul Alam (Massey University, New Zealand)

Remote sensing is becoming popular for real time monitoring of a wide variety of objects and phenomena like assets, structural health, ambient air quality. This paper reports the real-world implementation of a remote sensor system that was employed to monitor the stability of a seawall during repair work using cost effective tilt sensors. The system consisted of custom made remote sensing nodes, providing measurements in real time to a robust backend server that presented the data in the form of an interactive web application. An accelerometer paired with a Wi-Fi chip was sealed in a weatherproof casing to construct the tilt sensors and the data was transmitted back to the server over 4G cellular network for processing. To ensure a quick response should sudden movement be detected, SMS text messages could be dispatched to all parties involved. Four pairs of remote sensors were deployed, each capable of real time monitoring of the wall's angle of inclination to an accuracy of ±0.05°.

pp. 155-157

16:00 *Leveraging CNN and Transfer Learning for Vision-based Human Activity Recognition*

Samundra Deep (Macquarie University, Australia); Xi Zheng (Macquarie University & School of Engineering, Australia)

With the advent of the Internet of Things (IoT), there have been significant advancements in the area of human activity recognition (HAR) in recent years. HAR is applicable to wider application such as elderly care, anomalous behaviour detection and surveillance system. Several machine learning algorithms have been employed to predict the activities performed by the human in an environment. However, traditional machine learning approaches have been outperformed by feature engineering methods which can select an optimal set of features. On the contrary, it is known that deep learning models such as Convolutional Neural Networks (CNN) can extract features and reduce the computational cost automatically. In this paper, we use CNN model to predict human activities from Wiezmann Dataset. Specifically, we employ transfer learning to get deep image features and trained machine learning classifiers. Our experimental results showed the accuracy of 96.95 % using VGG-16. Our experimental results also confirmed the high performance of VGG-16 as compared to rest of the applied CNN models.

pp. 158-161

16:20 *An Orientation Aware Learning MAC for Multi-UAVs Networks*

Saadullah Kalwar and Kwan-Wu Chin (University of Wollongong, Australia); Luyao Wang (Beijing University of Technology, China)

In this paper, we consider channel access in Unmanned Aerial Vehicles (UAVs) networks where a ground station is equipped with Successive Interference Cancellation (SIC) capability. The problem at hand is to derive a transmission schedule for UAVs to communicate with a ground station frequently, and with minimal collisions. We first formulate a stochastic optimization problem before introducing a novel distributed Learning Medium Access Control (MAC), aka L-MAC, protocol. A key novelty of L-MAC is that it allows UAVs to learn the best orientation that results in the highest decoding success. Our simulation results show that L-MAC achieves a throughput that is 68\% higher than the well-known Aloha protocol without SIC, and 28\% higher than Aloha with SIC.

pp. 162-165

16:40 *Development of a Supply Chain Product Monitoring Network*

Darryn Wells and Fakhrul Alam (Massey University, New Zealand); Yi Chen, Robert Abbel and Kate Parker (Scion, New Zealand)

With world exports of agricultural products increasing by an average of 5% per annum, there is a critical need for systems capable of actively monitoring such perishables during exportation. Existing systems to monitor the condition of products typically do not actively track over the entire supply chain. This paper describes the development and the experimental trialing of an active monitoring system that is able to monitor any damage or extreme conditions imposed on products during their journey by measuring various parameters including temperature, humidity and mechanical shock. The system integrates GPS, ZigBee and cellular technologies in order to send the sensor and positional data from a pallet in transit to a front-end user interface. The design is flexible enough to incorporate more energy efficient alternatives like Narrowband Internet of Things (NB-IoT) to the utilized cellular technology.

pp. 166-169

S10: Session 10: Wireless

Room: WG608

Chair: David Osemeojie Airehrour (Auckland University of Technology, New Zealand)

15:40 *Two-Tier Spectrum Trading Strategy for Heterogeneous Cognitive Radio Networks*

Xiaowen Huang (Minnan Mormal University, China); Wenjie Zhang (Minnan Normal University, China); Liwei Yang (China Agricultural University, China); Chai Kiat Yeo (Nanyang Technological University, Singapore); Shengyu Chen (Indiana University, USA)

The heterogeneous network structure is a promising paradigm to improve the quality of service across the entire network. Nevertheless, such structure is challenging due to the presence of multiple-tier secondary users (SUs). In this paper, we investigate the effect of spectrum allocation in a heterogeneous cognitive radio network with a primary network and two-tier secondary networks, and propose a two-tier spectrum trading strategy which includes two trading processes. In Process One, we model the spectrum trading as a monopoly market, where the primary spectrum owner (PO) acts as the monopolist and the first-tier secondary users (FSUs) act as the buyers. We design an optimal quality-price contract with the objective of maximizing the utility of PO, and the FSUs will choose the spectrum with appropriate quality and price in order to enhance their satisfaction. In Process Two, the spectrum trading is modeled as a multi-seller, multi-buyer market. The dynamic behavior of second-tier secondary users (SSUs) is studied using the theory of evolution game, while the competition among FSUs is analyzed via a noncooperative game where the Nash equilibrium is considered as the solution. The existence of the optimal contract and Nash equilibrium is demonstrated in the performance evaluation.

pp. 170-175

16:00 *Theoretical Analysis of Equal-Weight (2, 2) VSS on VN-CSK Illumination Light Communication*

Keisuke Manaka (Ibaraki University, Japan); Liyuan Chen (Ibaraki Unversity, Japan); Hiromasa Habuchi and Yusuke Kozawa (Ibaraki University, Japan)

In illumination light communication, the variable N-parallel code-shift-keying (VN-CSK) system having function of dimming control and an adjacent illumination light interference cancelation while satisfying an illumination function is proposed. In addition, the VN-CSK system not only cancel co-channel interference, but also allows transmitting information using co-channel interference by using high affinity with the visual secret sharing (VSS) scheme that handles binary images. The performance evaluation of the VN-CSK system using VSS was only when the receiver was fixed at an equidistant position from each LED. In this paper, the bit error rate (BER) performance was compared when the receiver position was moved in VN-CSK illumination light communication using VSS in indoor communication channel.

pp. 176-181

16:20 *Design and Implementation of Wi-Fi Based Attendance System Using Raspberry Pi*

Archana Banepali (Melbourne Institute of Technology (MIT), Australia); Rajan Kadel (Melbourne Institute of Technology, Australia); Deepani B. Guruge and Sharly J. Halder (Melbourne Institute of Technology (MIT), Australia)

The proposed system uses cutting-edge technologies such as smart phone and Wireless Access Point (WAP) to automate student attendance system in classroom setting. The system is implemented in four steps: Wireless Local Area Network (WLAN) formation using Raspberry Pi and smart phones; Received Signal Strength (RSS) threshold determination for each setting; database and web interface implementation using Apache server, MySQL and PHP; and updating attendance using threshold, Media Access Control (MAC) address, association status of mobile device and RSS value. The system was tested in several classroom settings including laboratory room, lecture hall and tutorial room and obtained more than 94% of accuracy in attendance marking for all settings.

pp. 182-187

16:40 *Dynamic Resource Allocation for Visible Light Communications (VLC)-WiFi Heterogeneous Systems*

Liwei Yang (China Agricultural University, China); Wenjie Zhang (Minnan Normal University, China); Lining Deng (China Agricultural University, China); Junning Zhang (Chinese Academy of Agricultural Mechanization Sciences, China)

Visible Light Communication (VLC) systems are becoming an effective means of wireless communication with the potential to provide dense and fast connectivity at low cost. In this paper, we consider a VLC-WiFi heterogeneous system and investigate dynamic resource allocation for a multi-user environment to maximize the downlink capacity. This work addresses the joint allocation problem of assigning users to Access points (APs) and scheduling them to resource blocks (RBs). An improved Proportional Fairness (PF) algorithm is proposed that takes into account the fairness of the hybrid heterogeneous VLC-WiFi network. Simulation results demonstrate that the proposed algorithm outperforms the traditional PF scheme, while the simulations have also illustrated the effectiveness of the proposed method.

pp. 188-193

Thursday, November 28

Thursday, November 28 8:40 - 10:00

S13: Session 13: Cloud and Applications

Room: WG126

Chair: Leith Campbell (University of Melbourne, Australia)

8:40 *BL-Hybrid: Graph-Theoretic Approach to Improving Data Center Performance*

Walaa M. AlShammari and Mohammed J.F. Alenazi (King Saud University, Saudi Arabia)

Modern data centers can process a massive amount of transferred data in a short time and with minimal errors. Data center networks use equal-cost, multi-path topologies to deliver split flows across alternative paths between the core layer and hosted servers, which could lead to significant overload if the path scheduling is inefficient. Thus, distributing incoming requests among these paths is crucial to provide higher throughput and protection against link or switch failures. Several approaches have been proposed for path selection, mainly relying on round- robin and least-congested schemes. In this paper, we introduce a path selection method, called BL-Hybrid to improve the overall performance of a data center in terms of throughput, delay, and energy consumption. For evaluation, we compare our method with baseline methods with different data center topologies; Fat-tree, DCell, and BCube. The results show that BL-Hybrid outperforms the round-robin and least-congested schemes in terms of throughput, while minimizing the delay and energy consumption in several data center network topologies.

pp. 194-199

9:00 *Feature Selection: Multi-source and Multi-view Data Limitations, Capabilities and Potentials*

David Osemeojie Airehrour (Auckland University of Technology, New Zealand); Marianne Cherrington (University of Huddersfield, United Kingdom (Great Britain)); Qiang Xu (University of Huddersfield, New Zealand); Joan Lu (Huddersfield University, United Kingdom (Great Britain)); Fadi Thabtah (Principal Lecturer, New Zealand); Samaneh Madanian (Auckland University of Technology, New Zealand)

Feature Selection (FS) is a crucial step in high-dimensional and big data analytics. It thwarts the 'curse of dimensionality' to get rid of redundant and irrelevant features. Most FS algorithms use a single source of data and struggle with heterogeneous data, yet multi-source (MS) and multi-view (MV) data are rich and valuable knowledge sources. In this paper is a review of current FS techniques suitable for these data, a now vital topic. The major contribution of this paper is to underscore uses and limitations of these methods to inform capabilities and potentials for key future areas of research and application.

pp. 200-205

9:20 *Supercomputer Networks in the Datacenter: Benchmarking the Evolution of Communication Granularity from Macroscale down to Nanoscale*

Sayan Kumar Ray (Manukau Institute of Technology, New Zealand); Firas Al-Ali (Senior Lecturer, Manukau Institute of Technology, New Zealand); Thilina Gamage and Hewa Nanayakkara (Student, Manukau Institute of Technology, New Zealand); Farhad Mehdipour (Otago Polytechnic - Auckland International Campus, New Zealand)

In the Datacenter, a supercomputer network refers to the interconnections between the clustered processing nodes within a single supercomputer. In this paper, we primarily aim to describe how in supercomputers, as they evolve, the granularity of this inter-node communication continues to scale down, as a direct result of the processing nodes scaling down from full-sized clustered computers (and servers) to interconnected processor cores and even smaller reconfigurable logic cells. Hence, we start by first describing our exploration of the four generations of supercomputing and how they have evolved over the years from macroscale packet switched coarse-grained cluster computing and grid computing, to conventional supercomputing, and then to fine-grained supercomputer Networks-on-Chip (NoC), and finally, to emerging fine-grained nanoscale NoC FPGA (Field Programmable Gate Arrays) supercomputer-on-chip as we see today. Apart from this, in this work, we also aim to demonstrate and analyze the results of benchmarking the Mandelbrot Set performance on a 3rd generation supercomputer, which is the Adapteva's 16-core Epiphany supercomputer NoC. On the basis of our study we can come to an inference that the next generation supercomputing-on-chip will more likely depend on the fine-tuning between multi-core NoCs and high-end FPGA co-processors built into these NoCs.

pp. 206-211

9:40 *A Cloud-Based Traffic Flow Framework for Tactile Internet using SDN and Fog Computing*

Vaibhav Fanibhare, Nurul I Sarkar and Adnan Al-Anbuky (Auckland University of Technology, New Zealand)

Tactile Internet (TI) is an emerging area of research which is still in its infancy, and facing many issues and challenges. One of the main challenges in TI is to achieve a round trip time (RTT) or latency of 1ms or less. This RTT consists of transmission time, processing time (operator's end), and acknowledgement time (controlled environment end). In this paper, we first present a system framework of the multilevel structure of cloud units incorporating Software-Defined Networking (SDN) and Fog Computing (FC) for TI. We then propose an efficient traffic flow framework that can avoid unnecessary processing and waiting times at each cloud units. The SDN and FC approaches are used to control the traffic flow in the system. As FC-empowered edge nodes, fog nodes (FNs) are placed close to the end-user devices, consequently, the communication paths are reduced and minimised RTT is achieved. The system performance is evaluated by iFogSim simulation. Results demonstrate the superiority of the proposed traffic flow framework than edge, cloud, and cellular networks. The findings reported in this paper provide some insights into Tactile Internet that can help network researchers and engineers to contribute further towards developing the next-generation Internet.

pp. 212-217

S12: Session 12: Mobile Cellular

Room: WG608

Chair: Yong Jin (Tokyo Institute of Technology, Japan)

8:40 *Performance Analysis of Defused VLC Channel for Mobile Environment*

Shakir Ullah, Saeed Ur Rehman and Peter Han Joo Chong (Auckland University of Technology, New Zealand)

Visible light communication (VLC) is proposed to complement the RF spectrum. In the VLC system, the existing LED lighting infrastructure is utilized for data communication. The visible light cannot penetrate walls and other objects, and mainly relies on the line-of-sight (LOS) communication. The critics have reservations on the application of VLC in high mobile scenarios either due to device orientation or mobility. In practical scenarios, it is observed that visible light experiences reflections from the diffused surfaces such as walls, ceilings, and floor, and thus creates defused/non-line of sight (NLOS) channels. These defused reflections contribute to optical gain, which can be helpful to provide data communication to highly mobile users. Most of the previous research work is based on the LOS channel. However, this research work evaluates the NLOS channels and study their effect on mobile users. In this paper, the analytical model is evaluated for two simulation scenarios: a) LOS only, b) LOS and NLOS. Results show that NLOS contributes to optical gain and maintains communication in high mobility scenarios.

pp. 218-223

9:00 *Cooperative Location Acquisition of Mobile Nodes without Direct Distance Measurement and Node Identification*

Hiroaki Higaki and Masaaki Namekata (Tokyo Denki University, Japan)

In wireless networks composed of numbers of mobile wireless nodes, their location information is required to be achieved for fundamental network services such as routing of data messages and determination of server nodes providing various services such as name services and for supporting network applications based on locations of the mobile wireless nodes, for instance, sensor network applications and ITS applications. Until now, various methods for achieving distances between two mobile wireless nodes have been proposed; however, some of them requires too expensive devices and others achieves too lower solution results. Most of the methods using RSSI of transmitted wireless signals between two mobile wireless nodes cannot provide enough high resolution due to large deviation of transmission delay and the multi-pass problem. This paper proposes a novel method for achieving distances between mobile wireless nodes by cooperation of 3 mobile wireless nodes with cameras and a device for measuring its own migration length. The cameras are only used for measuring angles with high accuracy between 2 mobile wireless nodes which are independent of their shapes, sizes and distances. In addition, our proposed method does not require to make matching between images of each mobile wireless nodes and their IDs by using video images gained by the cameras. Finally, the proposed method is implemented in an experimental mobile network. The results show that it is expected for our method to provide precise distance mesurement between two nodes.

9:20 *Improving Prediction Accuracy for Power Consumption in Virtual Environments*

Humaira Abdul Salam (University of Genoa, Italy & TUHH, Germany); Franco R. Davoli (University of Genoa & National Inter-University Consortium for Telecommunications (CNIT), Italy); Andreas Timm-Giel (Hamburg University of Technology, Germany)

Modern processors with multi-cores and several power states make power modeling of servers challenging. This issue becomes more complex in virtualized environments, owing to the presence of hypervisors. Requests and instructions as processed at the guest level cannot be straightforwardly related to instructions processed at the host, and this relation varies with changing virtual environment configuration. However, observing performance at both levels, host and guest, might be helpful in developing realistic performance models. Also, the scale of virtual systems in modern computing environments such as data centers and clouds is very large, and these systems have massive data to manage, in terms of their allocation, scheduling, migration, etc. For such heterogeneous systems and large scale data, machine learning (ML) methodologies can play a vital role. Developing power and performance models using effective performance counters at host and guest level can provide significant features for training data. In the research work described in the present paper correlated performance counters for the running applications are monitored and trained for different linear and non-linear models. This novel approach of monitoring performance counters at both levels provides in-depth performance information about individual VMs and servers. Results show that estimating power using these models reduces the prediction error, and hence can help in providing more effective power-aware decisions.

pp. 224-229

Thursday, November 28 10:00 - 10:40

K3: Keynote

MCS2.0: A Development Direction of Urban Sensing

Professor Huadong Ma

Room: WG126

Chair: Adnan Al-Anbuky (Auckland University of Technology, New Zealand)

Mobile Crowd Sensing (MCS), combining crowd intelligence with mobile sensing technology, provides the excellent way of large scale and complex IoT sensing services for smart cities. However, MCS systems are with many weaknesses such as poor intelligence of individual sensing, less guide of group behavior objective, weak readjustment of crowd intelligence procedure. The development of Artificial Intelligence (AI) brings many opportunities to MCS. In this talk, we first analyze the challenges of current crowd sensing systems, then we discuss some explorations of mobile crowd sensing system with more intelligent (called MCS 2.0). Finally, we outline the prospects of IoT sensing in AI era.

Thursday, November 28 10:40 - 11:00

MT2: Morning Tea

Room: WG128 Foyer

Thursday, November 28 11:00 - 11:40

K4: Keynote

Mobile Edge Computing in the 5G Era - Bridging Applications and Networking Environments

Professor Franco Davoli

Room: WG126

Chair: Adnan Al-Anbuky (Auckland University of Technology, New Zealand)

Telecommunication networks are undergoing a profound evolution, which is bringing their structure ever closer to computing systems. With the advent of Software Defined Networking (SDN) and Network Functions Virtualization (NFV), Network Service Providers (NSPs) have started considering an increasing level of "softwarization" of the functionalities to be performed, especially as regards the access segment. This trend has been further strengthened by Mobile Edge Computing (MEC), and by the consolidation of the fifth generation of mobile networks (5G), providing a much stronger integration between the wireless mobile access and the fixed transport network and enhancing configuration flexibility through the concept of network slicing.

In this scenario, more and more often resource allocation and network control problems are encountered that present analogies with similar settings in computing systems and datacenters. Typically, given a set of general-purpose computing machinery, deployed by an Infrastructure Provider (InP), they will host multiple tenants that act as NSPs for their (fixed or mobile) customers; through their User Equipment (UE), the latter consume and feed application-related data that may need custom computing resources/processes that are partly local (at the mobile edge - to cope with possible latency constraints that may require resource reallocations to follow users on the move) and partly residing in a remote datacentre. Bridging the world of Cloud Computing and 5G to transform cloud-native applications to 5G-ready ones is becoming of crucial relevance.

This talk will highlight the architectural and optimization problems behind this effort, touching in particular topics related to the interaction between the 5G Vertical Applications Orchestrator (VAO), Mobile Edge Orchestrator (MEO) and NFV Orchestrator (NFVO) and to the ensuing network management and resource allocation tasks to be performed in order to meet Key Performance Indicators covering a vast range of aspects, including users' Quality of Experience (QoE), network performance and energy efficiency.

Thursday, November 28 11:40 - 12:10

SP2: Huawei Welcome

Dr David Soldani

Room: WG126

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

Thursday, November 28 12:10 - 13:10

L2: Lunch

Room: WG128 Foyer

Thursday, November 28 13:30 - 17:30

C1: Conference Tour

Conference Tour

Room: Auckland Tour

Chair: Adnan Al-Anbuky (Auckland University of Technology, New Zealand)

Conference tour leaving the AUT conference venue for a walk through Albert park and the Domain, with afternoon tea at 3.30 at the Winter garden café before a walk back to AUT conference venue for the Conference Dinner. To see the route, look at the Conference Program page on the ITNAC website.

Thursday, November 28 18:00 - 22:00

D1: ITNAC 2019 Dinner

Annual Dinner

Room: WG201

Chair: Adnan Al-Anbuky (Auckland University of Technology, New Zealand)

The conference dinner commences at 6pm at the AUT conference venue room WG201.

Friday, November 29

Friday, November 29 9:00 - 10:40

S14: Session 14: Security

Room: WG126

Chair: Sayan Kumar Ray (Manukau Institute of Technology, New Zealand)

9:00 *Detecting IRC-based Botnets by Network Traffic Analysis Through Machine Learning*

Xue Jun Li (Auckland University of Technology, New Zealand); Maode Ma and Yi Lin Yen (Nanyang Technological University, Singapore)

Cybersecurity becomes increasingly important as information and communications technology (ICT) is adopted throughout the world. Cyber attacks can happen both externally and internally. With majority of cyber attacks being executed by insiders, it is important to detect insider attacks and even prevent them. This paper studies how to apply machine learning in analyzing network traffic to detect insider attacks, particularly in the area of botnet detection. Different from existing work considered two types of Hyper Text Transfer Protocol (HTTP)-based botnets, we consider two types of popular Internet Relay Chat (IRC)-based botnets. With selected flow characteristics, experimental results show that the proposed detection model can achieve a true positive rate of over 96%, with a false positive rate of less than 5%.

pp. 230-235

9:20 *Hybrid Routing for Man-in-the-Middle (MITM) Attack Detection in IoT Networks*

James Jin Kang (Edith Cowan University, Australia); Kiran Fahd and Sitalakshmi Venkatraman (Melbourne Polytechnic, Australia); Rolando Trujillo (Deakin University, Australia); Paul Haskell-Dowland (Edith Cowan University, Australia)

The deployment of affordable and expandable low power networks such as 5G and Low Power Wide Area Networks (LPWAN) in the public and private network areas have improved network bandwidth capacities and processing performance. Internet of Things (IoT) technologies are increasing in popularity with numerous applications and devices being developed for smart environments and health-related applications. This consequently raises privacy concerns for security in these networks, as many IoT devices handle confidential personal information or private information such as IP/MAC addresses which could be used to identify a user's location. This presents a potential vulnerability to data tampering by man-in-the-middle (MITM) attacks, which feature two observable characteristics: (1) there is a measurable delay in the session and (2) has unusual travel times compared to previous normal transactions. To improve the detection of these attacks, this paper proposes a novel scheme using a hybrid routing mechanism. This method involves appointing dedicated nodes for enforcing routing between IoT devices and users with minimal intervention and workload to the network and its systems. The function of dedicated devices with more computational and battery power can provide three advantages: (1) determine secured paths within the network by avoiding suspicious nodes and networks, (2) provide stable travel times (less fluctuations) for a trusted time server (TTS) to improve the accuracy of estimated travel times, and (3) provide packet inspection for security checks. This proposed solution contributes towards increasing the security of IoT networks by enabling the real-time detection of intruders.

pp. 236-243

9:40 *A Secure End-to-End Key Exchange Mechanism by Cooperation of Multiple Devices Using QR Codes*

Yong Jin and Masahiko Tomoishi (Tokyo Institute of Technology, Japan)

End-to-end key exchange for the subsequent secret sharing and secure communication between two remote parties has been an important issue due to the threats of eavesdropping and Man-In-The-Middle (MITM) attacks. In this paper, we propose a secure end-to-end key exchange mechanism between two remote parties by cooperation of multiple devices at each party using QR (Quick Response) codes. In the key exchange process, the data transmission will be conducted by two different applications via two different infrastructure networks, SMS (Short Message Service) via cellular network (e.g. LTE, 4G, etc) and Email via Ethernet respectively, between the two remote parties using two different devices at each party in order to mitigate security risks. Public-key cryptography will be adopted for the data transmission during the key exchange and the corresponding asymmetric key pair will be used only once. The data transmission within the multiple devices at each party only uses QR codes (scan and display) without involving any network based communication. The main contribution of this paper is that a novel secure end-to-end key exchange approach has been proposed in which unless both the devices using cellular network and Ethernet have been compromised or MITM attacked by the same attacker the key will not be leaked during the exchange process. We verified the main features of the proposed mechanism and confirmed the effectiveness of the design.

pp. 244-250

10:00 *Detecting Compromised Switches And Middlebox-Bypass Attacks In Service Function Chaining*

Nguyen Canh Thang and Minho Park (Soongsil University, Korea)

Service Function Chaining (SFC) provides a special capability that defines an ordered list of network services as a virtual chain and makes a network more flexible and manageable. However, SFC is vulnerable to various attacks caused by compromised switches, especially the middlebox-bypass attack. In this paper, we propose a system that can detect not only middlebox-bypass attacks but also other incorrect forwarding actions by compromised switches. The existing solutions to protect SFC against compromised switches and middlebox-bypass attacks can only solve individual problems. The proposed system uses both probe-based and statistics-based methods to check the probe packets with random pre-assigned keys and collect statistics from middleboxes for detecting any abnormal actions in SFC. It is shown that the proposed system takes only 0.08 ms for the packet processing while it prevents SFC from the middlebox-bypass attacks and compromised switches, which is the negligible delay.

pp. 251-256

S15: Session 15: Workshop track

Room: WG608

Chair: Mohammad Rashid (Massey University New Zealand, New Zealand)

9:00 *Energy Efficiency Optimization in Energy Harvesting Two-Hop Half-duplex Relay Systems*

Jing Zhao and Chenchen Liu (CETC, China); Ming Zhao (University of Science and Technology of China, China); Zhengyu Zhang (CETC, China); Zhang Shi Bin (CHINA, China)

To achieve energy conservation and quality of service (QoS) improvement, it may need deploy some energy harvesting (EH) powered relay nodes in the future green cellular systems, while base stations (BS) are still powered by the conventional power grid to ensure basic coverage requirements. In this paper, we investigate how to maximize the energy efficiency (EE) of the non-EH source with the cooperation of an EH decode-and-forward (DF) half-duplex relay with an average throughput constraint within a given time. To deal with the randomness of energy arrivals and non-ideal circuit power, we formulate the EE optimization problem of the relay system by combining power allocation and sleep mode in both the source and the relay. We first solve this problem in a special case where the given time is a single timeslot, and then solve it in a multi-timeslot scenario by the dynamic programming (DP) approach. Due to the high complexity of the DP algorithm, we propose a heuristic algorithm to achieve the suboptimal solution. We compare the performance of the two algorithms and a baseline scheme by computer simulations. The results show that the heuristic algorithm provides close EE with the DP algorithm, and a significant EE gain over the baseline scheme.

pp. 257-262

9:20 *Decentralized Interference Mitigation Technique for D2D Networks Using Game Theory Optimization*

Saad Aslam, Fakhrul Alam and Syed Faraz Hasan (Massey University, New Zealand); Mohammad Rashid (Massey University New Zealand, New Zealand)

Device-to-Device (D2D) Communication has proven to bring various advantages for the conventional cellular networks such as high spectral efficiency, lower delay and high data rate. D2D enables new applications like content-sharing and disaster management. These benefits come at the expense of interlayer and intralayer interference. To fully exploit the inherent benefits of D2D communication, interference mitigation techniques must be developed. This article proposes a decentralized approach to handling interlayer and intralayer interferences. We use the pricing concept, which is introduced by the Base Station (BS) to control the inter-layer interference. On the other hand, game theory is exploited to handle intralayer interference. D2D pairs compete for the resources based on their power profiles and the price broadcasted by the BS. These users and the BS formulate a Stackelberg Game which continues until an optimal state is achieved known as Nash Equilibrium is achieved. The most important aspect of the proposed scheme is that it jointly addresses the interference mitigation and power allocation problem.

pp. 263-269

9:40 *A Disaster Response Framework Based on IoT and D2D Communication under 5G Network Technology*

Shakil Ahmed (Massey University, New Zealand); Mohammad Rashid (Massey University New Zealand, New Zealand); Bapon Fakhruddin (Tonkin and Taylor Ltd, New Zealand); Fakhrul Alam (Massey University, New Zealand)

This paper provides a conceptual framework for designing a disaster response system based on Internet of Things (IoT) and Device to Device (D2D) under the new generation 5G mobile networks. The next generation of mobile network and technologies such as Fifth Generation cellular network (5G), Device to Device (D2D) communication, Internet of Things (IoT) and big data technology can play a significant role to overcome the drawbacks of the current disaster management system.A conceptual model is simulated to study the performance of the system. Preliminary results show the possible improvements in terms of enhancing responsiveness, increasing resilience and reliability, improving scalability.

pp. 270-275

10:00 *Performance Analysis of Random Backoff based D2D Discovery in Cellular Networks*

Zhongyang Yu and Boon-Chong Seet (Auckland University of Technology, New Zealand)

Device to Device (D2D) communication is one of the key features of future 5th generation (5G) cellular networks. Most D2D researchers have focused on the data communication phase, assuming the device discovery has already been done. However, there are still many challenges in the discovery phase, with the transmission collision as one of the critical problems to be resolved. Collisions occur when the number of beacon-transmitting D2D user equipment (UEs) exceeds the limited amount of discovery resources, resulting in two or more UEs selecting the same resource to transmit their beacons simultaneously. One promising way of avoiding continuous collisions is to undertake a random backoff upon the occurrence of the first collision. In this paper, the performance of a random backoff based D2D discovery (RDD) scheme with beta-distributed UE arrivals is analyzed in terms of the discovery rate and discovery latency. The impact of different parameters such as the maximum number of transmission attempts and backoff window length on the performance of the RDD scheme are also investigated.

pp. 276-281

Friday, November 29 10:40 - 11:00

MT3: Morning Tea

Room: WG128 Foyer

Friday, November 29 11:00 - 11:30

K5: Keynote

When AI meets high-speed networking - Making AI Computing and Services Anywhere Anytime

Professor Yonghong Tian

Room: WG126

Chair: Nurul I Sarkar (Auckland University of Technology, New Zealand)

Artificial intelligence (AI) and high-speed network (e.g., high-speed Internet, 5G) are two major information technology fields that have a significant impact on our lives and the world. The intersection and deep fusion of these two fields will incubate many new applications, as well as present some new technological challenges. Networking itself can benefit from these promising AI technologies, for example, by bringing machine learning algorithms into the network domain to leverage the powerful abilities for higher network performance. Meanwhile, the distributed computing system built on high-speed networking is also the key infrastructure to provide efficient computational resources for AI. By utilizing the ultra-highspeed networking technology, it is highly promising to connect many hardware and devices distributed geographically to provide a unified computing platform in which some large-scale AI tasks can be run, in particular jointly training a very deep model on a large dataset, or performing inference jointly on hierarchically distributed computing system consisting of the cloud, the edge and devices. In this talk, I will briefly report the related research and development that are conducted on the Pengcheng Laboratory, Shenzhen, China. Basically, how to combine AI and future networking infrastructure is the core topic in two major ongoing projects in this lab.

Friday, November 29 11:30 - 12:00

K6: Keynote

5G for Rural and Remote communities Communications?

Professor Richard Harris

Room: WG126

Chair: Nurul I Sarkar (Auckland University of Technology, New Zealand)

The rural areas in NZ (and elsewhere) require wireless connectivity but without excessive investment in network infrastructure. Topics such as autonomous D2D communication and distributed discovery can serve this purpose very well. The invited talk proposed in this workshop will set the stage for discussing rural connectivity issues. It is expected that the discussion after the workshop will give participants an opportunity to comment not only on the presented research papers, but also on the relevance of D2D communication and associated areas to New Zealand.

Friday, November 29 12:00 - 13:00

L3: Lunch

Room: WG128 Foyer

Friday, November 29 13:00 - 14:00

S17: Session 17: Wireless and Applications

Room: WG126

Chair: David Osemeojie Airehrour (Auckland University of Technology, New Zealand)

13:00 *A Context-Aware and Technology-Assisted Informal Caregiver Selection Method to support Medical Emergency*

Sayan Kumar Ray (Manukau Institute of Technology, New Zealand); Akbar Hossain (Auckland University of Technology, New Zealand); Seyed Reza Shahamiri (Manuka Institute of Technology, New Zealand)

Communities globally are experiencing an increasing number of patients with medical conditions and elderly people, living alone, who need immediate attention and support in case of medical emergency incidents. At times, even calling an ambulance becomes difficult for them and even then ambulance may turn up late causing to their sufferings. On the other hand, ambulances may turn up only to find a situation a non-emergency one not requiring an ambulance but that costs them money and wastes their time. In context to such situations, informal caregivers, in forms of friends, families and neighbours, can initially attend the patients and elderly people before the arrival of ambulance. Selection of appropriate informal caregivers is critical for a patient or a particular medical emergency situation and in this paper we propose a context-aware recommendation system (CARS) to recommend appropriate informal caregivers based on a list of pre-identified context information of informal caregivers, patients and elderly people. CARS operates as part of the technology-assisted medical emergency framework introduced by us. This work discusses the different phases of CARS, namely, context dimension, context acquisition and processing and context recommendation, and explains the entire informal caregiver recommendation procedure of CARS. Preliminary simulation results have shown that our proposed CARS perform better than other such existing systems.

pp. 282-287

13:20 *Link Scheduling for Data Collection in SIC-Capable UAV Networks*

Yawen Zheng and Kwan-Wu Chin (University of Wollongong, Australia)

Unmanned Aerial Vehicles (UAVs) are ideal for use as aerial base stations, mobile relays or data collectors. In this paper, we consider a UAV with a Successive Interference Cancellation (SIC) radio that visits M collection points to download data from ground devices or sensors. The problem at hand is to determine the links to be scheduled at each data collection point. We formulate an Integer Linear Program (ILP) to compute the optimal transmission schedule. We also propose a Cross-Entropy (CE) approach to select links when there are a large number of ground devices. Our results show SIC helps double the average throughput of the UAV. We also find that the average throughput is affected by the number of ground devices and the number of data collection points. Lastly, our CE approach is capable of producing a schedule that is near optimal.

pp. 288-293

13:40 *Digital Forensic Readiness In Wireless Medical Systems*

Paula Lutui (Auckland University of Technology, New Zealand)

individuals and businesses has become very much dependent on digital devices these days. These devices are now used in the healthcare systems including hospitals Wireless Medical Networks (WMedSys). Security incidents in the WMedSys has been increased over the past few years. This paper reports research into digital forensic readiness in wireless medical systems by inserting forensic readiness states into the network system and preparing mitigation for security failure. A design is built and tested, and then validated by expert feedback. The contribution of this research is to present a novel conceptual design for a digital forensic readiness framework for WMedSys, which can be easily implemented and integrated into existing wireless networks in the healthcare sector.

pp. 294-299

S16: Session 16: Workshop track

Room: WG608

Chair: Mohammad Rashid (Massey University New Zealand, New Zealand)

13:00 *Performance Analysis of Clustering Algorithms for Content-Sharing Based D2D Enabled 5G Networks*

Saad Aslam, Fakhrul Alam and Syed Faraz Hasan (Massey University, New Zealand); Mohammad Rashid (Massey University New Zealand, New Zealand)

5G networks are expected to be content-centric which present various research challenges. Content-Sharing via Device-to-Device (D2D) clustered networks has emerged as a popular approach of alleviating the burden on the 5G network. A novel channel-based clustering algorithm, for grouping the D2D User Equipment (DUEs) sharing a common interest, is proposed in this paper. Performance parameters such as energy consumption of devices and area spectral efficiencies (ASE) are considered for evaluating the performance of the D2D clustered network in a simulation study. The proposed algorithm exhibits better node energy consumptions as compared to several existing clustering algorithms. It also yields better ASE compared to the existing algorithms for various node densities. Effect of the number of clusters on the performance parameters is also discussed.

pp. 300-306

13:20 *A Novel Relaying Mechanism for Multi-Cast Transmission with Ground-Aerial NOMA*

Syeda Kanwal Zaidi, Syed Faraz Hasan and Xiang Gui (Massey University, New Zealand)

Unmanned aerial vehicles (UAVs) are gaining recognition as aerial base station and as relays to provide coverage in fifth-generation and beyond networks. With a multitude of devices present in future wireless networks, a ground or an aerial device,bothcanactasarelayforcoverageextension.Wepropose to utilise either ground or aerial device as a relay based on the channel characteristics of the device with transmit source. Nonorthogonal multiple access is enforced to pair the ground and aerial device. In our scheme, a device which establishes strong communication link with transmit source is selected as a relay. The relay communication is further fuelled by harvesting energy from the radio signals of transmit source using power-splitting mechanism. It is shown that the channel fading characteristics and path-loss environment of a ground and aerial user which are different in nature, contribute towards the relay selection. The results indicate that the proposed scheme achieves improved signal reception at the end user with the use of this dynamic relaying scheme.

pp. 307-312

13:40 *Non-Centralised and Non-GPS Navigation Mechanism using IoT sensors: challenges and trade-offs*

Debraj Basu (University of California, Davis, USA); Xiang Gui (Massey University, New Zealand); Yi Zhang (Trinity College Dublin, Ireland); Avishek Nag (University College Dublin, Ireland)

In this paper, we propose a non-centralised navigation setup framework using the ubiquitous IoT sensor nodes as landmarks for non-GPS navigation where GPS or cellular coverage is poor or non-existent. Navigation will not require central control like legacy cellular networks but the IoT nodes can communicate among themselves. Such scenarios may arise in dense urban landscape and forest regions where device to device communication can enable navigation. These IoT sensors for navigation purposes will be referred to as navigation anchor points (NAP). When a navigation request arrives, these NAPs send distance information to the hand-held device of the requester. This hand-held device runs a computationally inexpensive shortest path algorithm to find out the NAPs between the source and the destination. The NAPs estimate the distances between themselves by using the received signal strength when they exchange beacon packets. The distance estimation between these NAPs can be plagued by measurement noise due to the multi-path effect. Measurement noise can be reduced by increasing the number of beacon packets used to measure the signal strength. In this paper, we conducted simulations with a variable number of beacon packets and measurement noise levels to include all types of wireless channel conditions. We argued that radio clutter can change without any notice due to objects, humans and change in vegetation. Therefore it is necessary to run navigation setup every time a request arrives and not rely on a fixed set of NAPs for a source-destination pair. These NAPs are mostly battery operated and therefore, energy conservation for an extended period of operation is necessary. Hence we can see a trade-off between the accuracy of the number of NAPs used in navigation to the energy used in setting up the navigation path. This paper has explored the possibility of using the non-GPS non-centralised navigation scheme in scenarios where there is inadequate satellite coverage, and the NAPs are power-constrained, and the navigable device cannot support energy-expensive GPS based navigation. The simulation results with different network densities and uncertainties in distance measurement show that there can be an upper limit to the number of beacon packets that can be used to reach the optimal number of NAPs. In some instances, when the uncertainty is very high because of poor channel conditions, the optimal NAP value may not be reached even when the beacon packet number is extended indefinitely. This framework is an excellent example of use-case for 5G device-to-device (D2D) communication.

pp. 313-318

Friday, November 29 14:00 - 15:40

S19: Session 19: Algorithms

Room: WG126

Chair: Shuo Li (RMIT University, Australia)

14:00 *Rate Matching Pattern Estimation*

Byoungjo Choi (Incheon National University, Korea); Stevan Mirko Berber (University of Auckland, New Zealand)

Rate matching in 3GPP standard is a process of getting the right amount of bits out of full-rate channel encoded bits, either by repetition or by puncturing, at the transmitter. The rate matching parameters may not be available at the receiver in various non-cooperative communication contexts, and the estimation of the rate matching pattern is required before any channel decoding attempt. A rate matching pattern estimation scheme for 3GPP is proposed for repetitive rate matching and its performance is explored by simulations. We found that there are two distinct bit-repetition patterns regardless of rate matching parameters, one at the first part of the stream and the other at the end, because of the turbo encoding scheme employed in 3GPP standards. It was demonstrated that the proposed scheme is successfully applicable over the binary symmetric channel when the bit error rate is up to 10%.

pp. 319-321

14:20 *A proposal of information diffusion model using information vitality*

Yuya Ota and Norihiko Shinomiya (Soka University, Japan)

In the case of existing information diffusion models, probability of information diffusion only follows parameters of neighbor nodes sending and receiving information. But the momentum of diffusion gains in an exponential fashion whenever the information passes through influential nodes in a real network. For example, when information diffuses through SNS, the speed of diffusion increases whenever information passes nodes that is influential users. This paper quantifies the degree of influence as information vitality that was defined by information engine theory, and proposes the model using it. In addition, the paper considers relationship between diffusion speed and information vitality in simulation of the model.

pp. 322-324

14:40 *Max-cut and min-flow theorem for coal-transportation networks based on fault-tolerant routing*

Da-Ren Chen, Hao-Yen Chang and Ye-Zheng Chen (National Taichung University of Science and Technology, Taiwan)

A transportation network for the coal-fired power plant is very complicated and custom-designed. It requires special transportation equipment such as coal sieving, crusher machines connecting transportation belts with different capability of input/output and speeds to different directions. In this paper, we analyze the max-cut and min-flow properties of the coal transportation network in a thermal power plant in Taiwan. Firstly, we analyze the current daily operational coal transportation and model several transportation modes based on minimum spanning tree from a dedicate ship uploaders to each coal-fired generators. Secondly, based on the derived modes, we propose fault-tolerant routing for one-to-one, one-to-many and many-to-many transportation in different operation cases. The routing algorithms are implemented with a web-based user friendly software using JAVA. Finally, the transportation performance is evaluated by using a max-cut min-flow theorem and we conclude this paper.

pp. 325-330

15:00 *Evaluating TCP Connection Healthiness*

Nils Rodday (Bundeswehr University Munich, Germany & University of Twente, The Netherlands); Raphael Labaca-Castro and Klement Streit (Bundeswehr University Munich, Germany); Gabi Dreo Rodosek (Universität der Bundeswehr München, Germany)

TCP/IP has been around for decades and even though it is a connection-oriented protocol, an important number of connections get interrupted or lost compromising the information been transferred. We propose an approach to measure the quality of the connection by using finite-state machines (FSM) based on the protocol definition. Our method can parse any traffic-dump file and report a success ratio for both client and server by comparing the packets sent and received with transitions defined on the protocol FSM. This implementation can have multiple applications across different domains from quality assurance to Moving Target Defense. By understanding how good the performance of TCP/IP is for a given approach, we can create defense mechanisms that better protect the network without compromising its performance.

pp. 331-334

15:20 *Data Security Frameworks for Mobile Cloud Computing: A Comprehensive Review of the Literature*

Noah Oghenefego Ogwara, Krassie Petrova and Mee Loong Yang (Auckland University of Technology, New Zealand)

The emerging computational framework of mobile cloud computing (MCC) sits at the interconnection of cloud computing, mobile computing, and wireless networks. It aims to provide powerful computational resources to mobile device users, cloud services providers, and mobile network operators by overcoming weaknesses such as the low storage capabilities and the high energy consumption of mobile devices, and inadequate network connectivity. At the same time, MCC needs to preserve the integrity of the resources of the different clouds it interconnects. Traditional defensive mechanisms such as host-based firewalls may not be efficient in protecting customer data in MCC environments. Based on a literature review of MCC data security frameworks and data protection methods, intrusion detection systems (IDS) were identified as an approach that leads to more comprehensive MCC data protection solutions. The challenges that need to be addressed in further research include: (i) the need to develop highly comprehensive and efficient MCC data security frameworks that also provide efficient protection of the mobile device, with optimized computing overhead; (ii) the need to develop energy- and resource-effective anomaly-based detection methods for host-based or network-based IDS applying machine learning techniques; (iii) the need to develop strong security frameworks that address the security issues in the MCC communication channel; (iv) the need to develop efficient intrusion detection and prevention systems whose prevention module is autonomous; (v) the need to develop intrusion detection and prevention systems in both the mobile and cloud environment using an efficient machine learning feature selection model which removes features that are not important for attack classification, in order to reduce the amount of time needed for training and to improve the accuracy of the detection.

pp. 335-338

S18: Session18: SDN and Applications

Room: WG608

Chair: Lincy Elizebeth Jim (Melbourne Institute of Technology, Australia)

14:00 *On Robust Controllers Association in Software Defined Networks*

Changlin Yang (Zhongyuan University of Technology, China); Kwan-Wu Chin (University of Wollongong, Australia)

Controllers play a key role in Software Defined Networks (SDNs). They are responsible for reacting to network events and managing switches/routers quickly. However, existing switch-to-controller association solutions do not consider varying traffic characteristics that may cause controllers to overload. Henceforth, we propose an Integer Linear Program (ILP) based robust optimization approach and a fast heuristic to associate switches to controllers such that the maximum load experienced by controllers is minimized whilst being robust to peak demands from their associated switches. Numerical results show our approaches yield robust solutions to varying loads from switches, and the running time of the proposed heuristic is orders of magnitude faster than the ILP.

pp. 345-348

14:20 *Music Response Based on Real-time Facial Expression Recognition*

DaiLun Chiang, JihHsiang Yang, ZiYuan Huang and Feipei Lai (National Taiwan University, Taiwan)

This research employs information and communication technology (ICT) to develop an App that plays music lists based on emotion. Music can regenerate brain cells and ease emotions, and when users are in a negative mood, the App will automatically play the appropriate music list. Emotions are the results of users' facial expression recorded by camera and judged by a deep learning model. The accuracy of each expression is as follows: Happiness, 79%; surprise, 80%; anger, 54%; sadness, 54%; and neutral, 56%. The dataset is the public data set fer2013 of the competition held by Kaggle in 2013, and some data in many real scenes are downloaded from the Internet, such as family members who mourned after the earthquake in Nepal, families of victims of terrorist attacks, and weddings. Deep learning has been popular in the field of computer vision in recent years, as it can facilitate the home care environment in recognizing users' emotions. Coupled with Internet of Things (IoT) technology, this study allows users to ease their emotions through music when they are depressed, so as to avoid any improper transfer of physical or mental suffering.

pp. 349-351

14:40 *Analog Least Mean Square Loop for Self-Interference Cancellation: Implementation and Measurements*

Anh Tuyen Le (University of Technology Sydney, Australia); Le Chung Tran (University of Wollongong, Australia); Xiaojing Huang and Y. Jay Guo (University of Technology Sydney, Australia)

Analog least mean square (ALMS) loop is a simple and efficient adaptive filter to cancel self-interference (SI) in in-band full-duplex (IBFD) radios. This paper proposes a practical structure and presents an implementation of the ALMS loop. By employing off-the-shelf components, a prototype of the ALMS loop including two taps is implemented. The prototype is evaluated in IBFD systems which have 20 MHz and 50 MHz bandwidths, respectively, with the carrier frequency of 2.4 GHz. The performance of the prototype with different roll-off factors of the transmit pulse shaping filter is also examined. Experimental results show that the ALMS loop can provide 39 dB and 33 dB of SI cancellation for the two systems, respectively. Furthermore, when the roll-off factor of the pulse shaping filter changes, different levels of cancellation given by the prototype are also demonstrated accordingly. These experimental results validate the theoretical analyses presented in our previous publications on the ALMS loop behaviors.

pp. 352-357

15:00 *Utilising SDN to Counter BGP Convergence Delays*

Hamad Alotaibi (University of RMIT & RMIT, Australia); Shuo Li and Mark A. Gregory (RMIT University, Australia)

Software Defined Networking (SDN) is a new paradigm for the control and management of computer networks and it is now a focus for research and industrial development. The SDN revolutionizes the network operation, design, and management through network centralised control, abstractions and programmability. In Multi-domain SDN, Governments, organisations and service providers use the Border Gateway Protocol (BGP) as the only protocol for exchanging the information among different domains or different autonomous systems. BGP has a lot of arguments due to security issues like the third party between domains or performance and efficiency issues like the high BGP convergence time while exchanging the information between domains. In this paper, we investigate the implications of the SDN controllers to improve multi-domain SDN traffic control/management mechanism. In addition to that, an investigation about SDN-based multi-domain gateway to utilise a new multi-state BGP engine to reduce the high BGP convergence time in multi-domain SDN which will contribute to benefits for customers, service providers, and government is presented in this paper.

pp. 358-363

15:20 *Mininet Topology: Mirror of the Optical Switch Fabric*

Sadia Qureshi (University of Technology Sydney, Australia); Robin Michael Braun (University of Technology, Sydney, Australia)

Software Defined Networks (SDN) is a new approach to change the conventional networking and is being researched in the various networking domains. To test and prototype SDN based concepts, a lightweight and closer to reality option is Mininet emulator. Mininet emulates SDN behavior by creating a virtual network of elements using Network Namespaces on a single Linux kernel machine. In this work, we have developed a Mininet topology that emulates the structure of a WDM Switch. The topology mirrors the paths that can be used by the wavelengths in a WDM switch fabric. The SDN controller can find a path for communication between hosts through this network. We simulated our Mininet topology, which mirrors an architecture for three wavelengths. The Ping command results show that only a set of hosts can be reached out by a particular host; which is the requirement of a WDM switch, and this verifies that Mininet topology is mapping a WDM switch.

pp. 26-31

Friday, November 29 15:40 - 16:00

AT3: Afternoon Tea

Room: WG128 Foyer

Friday, November 29 16:00 - 16:05

CR: Closing Remarks

ITNAC 2020 is in Melbourne, Australia

Nurul Sarkar, Adnan Al-Anbuky, Mark Gregory

Room: WG128 Foyer

Chair: Nurul I Sarkar (Auckland University of Technology, New Zealand)