2021 31st International Telecommunication Networks and Applications Conference (ITNAC)

Sydney time	Tuesday, November 23	Wednesday, November 24	Thursday, November 25
8:00 - 8:30		R1: *Registration*	
8:30 - 10:00		S1: *Session 1:*	
10:00 - 10:30		S2: *Session 2:*	W1: *Workshop - DevOps enabling modern data network design*
10:30 - 12:00		S3: *Session 3:*	
12:00 - 12:30		S4: *Session 4:*	K3: *Keynote - 6G Fundamentals: Vision and Enabling Technologies*
12:30 - 13:00		L1: *Lunch*	
13:00 - 13:30		K1: *Keynote - Closing the Loop - Automation in Service Provider Networks*	L2: *Lunch - Presentation on ITNAC 2022*
13:30 - 14:00			
14:00 - 14:30		AT1: *Afternoon Tea*	S7: *Session 7:* S8: *Session 8:*
14:30 - 15:30			
15:30 - 16:00		S5: *Session 5:* S6: *Session 6:*	CR: *Closing Remarks and Prizes*
16:00 - 16:30	WR: *Welcome Reception*		
16:30 - 17:00		K2: *Keynote - For a Sustainable Future of Communications and Networking*	
17:00 - 17:30			

Tuesday, November 23

Tuesday, November 23 16:00 - 17:00

WR: Welcome Reception

Mark Gregory

Room 1

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

Welcome, an opportunity to meet and talk with other authors and attendees. Check Internet connectivity and applications are working ok.

Wednesday, November 24

Wednesday, November 24 8:00 - 8:30

R1: Registration

Room 1

Wednesday, November 24 8:30 - 10:30

S1: Session 1:

Room 1

Chair: Md Akbar Hossain (Manukau Institute of Technology, New Zealand)

8:30 *Data Acquisition from Cloud Network Storage*

Paula Lutui (Auckland University of Technology, New Zealand); Brian Cusack (AUT, New Zealand)

Forensic actions are taken to determine causes of system failure and to diagnose network security breaches. The challenge for network investigators is that many of the data repositories are now virtualized and Cloud distributed. The challenge is to devise effective and systematic methods for data acquisition that are robust in the new networking contexts and sufficiently comprehensive for fault determination. This paper reports the extraction of evidence from virtualized RAM in the Cloud context on a virtual machine. The contribution of this research is to promote awareness of the Cloud challenge and the extended data scope for network investigators. The Cloud is widely used as a transaction and data storage network and hence presents a new set of problems for investigators attempting to extract evidence from its many representations and occurrences.

pp. 1-6

9:00 *Performance Optimisation for Underwater Acoustic Chirp Communication*

Henrique Matzenbacher Duarte, Akram Al-Hourani and Richardt H Wilkinson (RMIT University, Australia)

The rapid expansion of the Internet of Things has been powered by the swift evolution of wireless communication technologies. In terrestrial networks, electromagnetic waves are the dominant transportation method. Comparatively, in underwater implementations, where the physical properties of the channel present severe obstacles to radio propagation, acoustic communication may be a viable alternative. This paper presents a framework for capturing the performance of chirp spread spectrum for underwater acoustic communication. The framework considers underwater acoustic transducer properties and channel attenuation, fading and noise characteristics. In addition, the paper presents an adaptive selection method of the carrier frequency and the spreading factor to maximise the communication range. Based on this adaptive scheme, results indicate that

communication in moderate underwater conditions can be effective for ranges of up to tens of kilometres using practical transmitter pressures.

pp. 7-12

9:30 *A Military Human Performance Management System Design using Machine Learning Algorithms*

James Jin Kang (Edith Cowan University, Australia)

The area of human performance improvement has become a greater focus in recent military contexts as evidenced by Australian Defence Force projects. The aim of the design proposed in this paper is to develop a Performance Management System using Machine Learning (PMSML) to enhance the physical human performance of individual warfighters in combat situations through 1) early recognition and self-management of acute health events in the field; 2) forecasting of warfighter failure; and 3) proactive selfmanagement of longer-term health outcomes during prolonged manoeuvres or combat situations. This paper proposes a highlevel design and approach using machine learning algorithms to assess the feasibility of improving metrics such as health data accuracy and efficiency when transmitting data from sensors to the cloud in military networks. The significance of this design is to predict health conditions of users on a personalised basis for an individual's physical and mental health performance without compromising performance metrics using machine learning algorithms. Results show that machine learning algorithms outperformed over other existing methods, which trade-off between metrics.

pp. 13-18

10:00 *Question Answering Model Based Conversational Chatbot using BERT Model and Google Dialogflow*

Nikita Kanodia, Khandakar E Ahmed and Yuan Miao (Victoria University, Australia)

Contemporary conversational chatbots are user-friendly and possess the capabilities to simulate human conversations. However, they cannot evaluate large comprehensive datasets to provide an answer to the user. In contrast, the state-of-the-art Question Answering Model (QAM) trained on a large dataset can answer questions in the given context, and sometimes without context. This research designed a QAM to improve the customer's experience while using a chatbot for reading comprehension tasks using the BERT model and Google Dialogflow. QAM analyses and provides an accurate response using a comprehensive dataset and simulates human-like conversation. BERT model is used to predict accurate answers using the reading comprehension Conversational Question Answering (CoQA) dataset and Google Dialogflow to simulate human-like interactions. QAM extends the conventional way of using Google Dialogflow. A user-friendly Question Answering Model (QAM) reaps the benefits of Google Dialogflow and BERT Model integration. The BERT model and the chatbot interacts with each other using webhook and API. When a user interacts with the Dialogflow chatbot, it matches intents and sends the request to the BERT model. Finally, the BERT model provides an answer to the chatbot and respond to the end-user. The QAM provides accurate responses to end-users for questions based on large datasets.

pp. 19-22

S2: Session 2:

Room 2

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

8:30 ***Interference Management for Indoor multicell Visible Light Communication Networks***

Liwei Yang, Xiangyuan Peng, Furong Zhu, Yuanhao Jiang and Xinlai Liu (China Agricultural University, China); Wenjie Zhang (Minnan Normal University, China)

Visible light communications (VLC) has emerged as a promising technology especially for short-range indoor applications. In indoor VLC systems, light-emitting diodes (LEDs) are used for data transmission, but indoor reflection will be produced at the same time. The multi-path effect will affect the signal quality and system performance. In this paper, a novel VLC system utilizing multiple input multiple output (MIMO) and orthogonal frequency-division multiplexing (OFDM) is investigated. The interference management processing of VLC system is discussed. The performances of the system are validated by simulations with zero forcing (ZF) and vertical bell laboratories layered space-time (V-BLAST) channel equalization algorithms.

pp. 23-29

9:00 ***A Framework for Real-time Sentiment Analysis of Big Data Generated by Social Media Platforms***

Kiran Fahd (Victoria University, Australia); Tony de Souza-Daw (Melbourne Polytechnic, Australia); Sazia Parvin (University of New South Wales, Canberra, Australia)

Sentiment and Opinion analysis have been of significant interest with the possibilities of creating more meaningful business analytics from using data sources such as social media creating a large-scale implementation using Big Data. There has been a range of implementation, typically focusing on one social media platform and user entered text as input. Recently, efforts have been made to make a real-time implementation of such a sentiment system using API and data streams from social media platforms. There exists a need to create a system that uses multiple input sources from social media in real-time. We present an architecture using existing Big Data technologies to implement a real-time multi-social media input source with a central sentiment extraction and analysis component. The proposal uses Apache Kafka for the ingestion layer, lexicon-based classifier and Spark for the analytical layer, YARN clusters for the tasks execution management, and MongoDB database for the storage layer. The performance of the proposed framework is measured based on different quality metrics.

pp. 30-33

9:30 ***Performance Enhancement of Intrusion Detection System Using Machine Learning Algorithms with Feature Selection***

Anuradha Samkham Raju, Md Mamunur Rashid and Fariza Sabrina (Central Queensland University, Australia)

Cybersecurity has emerged as a major concern for individuals and organisations due to digitalisation. As a result, data is growing exponentially making it susceptible to various cyberattacks. Intrusion detection systems are used to effectively detect cyberattacks to achieve cybersecurity. Traditionally, there are many existing IDS models developed using machine learning algorithms for anomaly detection. This study aims to explore the performance of the IDS using tree-based machine learning algorithms with feature selection. The experiment was conducted using three algorithms Decision Tree (DT), Random Forest (RF), and XGBooster (XGB). Each algorithm used five feature selection techniques Information Gain, Pearson Correlation, Chi-square, Principal Component Analysis, and Recursive Feature Elimination. The experiment is carried out with the NSL-KDD dataset. The performance of the models was evaluated using the performance metrics such as accuracy, recall, precision, F1-score, and false positive rate (FPR). Although each model effectively detects intrusion with different feature selection techniques, DT shows the highest performance with Pearson Correlation and achieved 82% accuracy and 0.02 FPR.

pp. 34-39

10:00 ***Deep Learning For Noisy Communication System***

Reem E. Mohamed (School of Engineering and Information Technology, University of New South Wales, Australia & Canberra ACT, Australia); Robert Hunjet (Defence Science and Technology Organisation, Australia); Saber Elsayed (University of New South Wales, Australia); Hussein Abbass (University of New South Wales at the Australian Defence Force Academy UNSW@ADFA, Australia)

In modern communication systems, channels vary with time due to the mobility of the transmitter (Tx) and the receiver (Rx). To achieve error-free communication in changing environments, Tx and Rx must effectively adapt to different noise levels. However, exiting frameworks face challenges during adaptation, leading to poor communication. In this paper, an independent pre-training collaborative learning framework is designed for tuning Tx and the Rx. The proposed framework incorporates more realistic challenges encountered in communication systems such as lack of feedback channels and the lack of updates at the Rx side. The experimental results show that the proposed approach can reduce noise up to 50% more than existing approaches and within a short training time.

pp. 40-47

Wednesday, November 24 10:30 - 12:30

S3: Session 3:

Room 1

Chair: Zhiyi Huang (University of Otago, New Zealand)

10:30 ***Linear and Non-linear Signal Reconstruction for Clipping Noise Mitigation in Optical OFDM***

Cuiwei He (Japan Advanced Institute of Science and Technology, Japan); Yuto Lim (Japan Advanced Institute of Science and Technology (JAIST) & School of Information Science, Japan)

In this paper, a new decision-directed signal reconstruction (DDSR) algorithm is proposed for clipping noise mitigation in optical orthogonal frequency division multiplexing (OFDM). OFDM is increasingly being considered as the modulation method for the next-generation intensity modulation/direct detection (IM/DD) based optical transmission systems. When optical OFDM is used, clipping noise remains one of the main challenges. In previous studies, a time-domain based DDSR algorithm has been used to effectively mitigate the clipping noise. In this algorithm, based on the preliminary data detection decisions, an unclipped version of the OFDM signal is reconstructed non-linearly which can be decoded with better performance compared with the conventional OFDM signal detection method. However, due to the influences of the avoidable noise at the receiver, many clipped signal samples can not be correctly processed which significantly limits the advantages of using this algorithm. In this paper, a new linear signal reconstruction method is proposed. Using this linear approach, all clipped signal samples can be successfully updated in the signal reconstruction process which consequently mitigates the clipping noise more effectively compared with the previous non-linear methods. Simulation results are presented to show that, when this new form of DDSR method is used, the bit error rate (BER) performance of the system is significantly improved compared with both the conventional receiver and the previous non-linear DDSR receiver.

pp. 48-53

11:00 ***NIDP: Low-Latency Networking without Application Customization in Virtual Machine***

Kei Fujimoto, Ko Natori, Masashi Kaneko and Akinori Shiraga (NTT Corporation, Japan)

More and more applications require high real-time performance, such as online games and autonomous vehicles, so low-latency networks are needed. However, forwarding packets to/from an application in a server increases latency because of the virtualization overhead. To remove the causes of packet-forwarding delays in a virtual machine (VM), we design and implement a non-interruptive data path (NIDP), which meets three requirements: (A) low latency in the order of microseconds and high throughput are achieved in a VM, (B) application customization is unnecessary, and (C) Linux kernel modification is unnecessary. NIDP meets these requirements by adopting an architecture of interworking between user-space networking and guest-kernel networking to prevent softIRQ competition, create a run-to-completion model, and reduce buffer copy. According to evaluation results, NIDP achieves low latency in the order of microseconds and reduces maximum latency by more than 98% and achieves about twice the throughput as existing NAPI, Open vSwitch with the Data Plane Development Kit (OvS-DPDK), and DPDK Kernel Network Interface Card Interface (KNI).

pp. 54-59

11:30 ***Evaluation of an Actor Model-based Consensus Algorithm on Neo Blockchain***

Widya Nita Suliyanti and Muhammad Salman (Universitas Indonesia, Indonesia); Riri Fitri Sari (University of Indonesia, Indonesia)

Neo Blockchain is a permissioned blockchain that adopts Practical Byzantine Fault Tolerance variant consensus algorithm called delegated Byzantine Fault Tolerance (dBFT). This algorithm is implemented using an Actor Model-based consensus algorithm, namely Akka.NET framework. In this paper, dBFT consensus algorithm among four nodes is simulated -- one primary and three backup nodes, that communicates using Akka.NET framework on a private chain on Neo Blockchain. The framework is used to evaluate the inner workings of the algorithm. The

simulation resulted in the Akka.NET framework supported multi-phases of dBFT consensus algorithm and parallel execution of tasks. In addition, it offers the asynchronous feature. Thus, it reduces the number of locks used and reduces deadlocks as measures to potentially improve blockchain performance and scalability.

pp. 60-64

12:00 *Path Planning Method using Deep Learning Model for Traffic Engineering in Small Networks*

Makoto Ito and Taiju Mikoshi (Nihon University, Japan)

Traffic engineering is a method for efficiently controlling traffic with large time fluctuations while maintaining the Quality of Service (QoS) level for the user. On the other hand, it is difficult to realize traffic engineering in a realistic network, and these technologies have problems such as difficulty in recalculating the link cost according to the network conditions and deterioration of scalability according to the network scale. In order to solve this problem, we try to solve it using machine learning. In particular, we propose a path planning method using a deep learning for traffic engineering. In the conventional path design method using machine learning, each router has a model in a distributed manner and designs the next hop. This is to maintain the path estimation accuracy at a high value. However, in traffic engineering, it is necessary to design the path considering the entire network, and it is difficult to learn the features with the conventional model. In this paper, we define a learning model and a teacher signal so that the entire path from source node to destination node can be designed. The experimental result shows that the entire path can be designed with extremely high accuracy, and that the proposed method is superior in terms of calculation time while achieving load balancing comparable to that of Dijkstra's algorithm.

pp. 65-70

S4: Session 4:

Room 2

Chair: Krassie Petrova (Auckland University of Technology, New Zealand)

10:30 *A Comparative Performance Analysis of MPTCP Path Management Algorithms: Fullmesh, PCDC, RBPM, SDC*

Huayi Xiong (Hainan University, China); Yantao Cai (University of Hainan, China); Min Chen and Xing Zhou (Hainan University, China)

Path management(PM) is an important part of multi-path transport control protocol (MPTCP). Through the PM algorithm, the subflows participating in concurrent transmission can be dynamically added or deleted. There are four default MPTCP PM algorithms in Linux, and the most commonly used is Fullmesh. Meanwhile, with the deepening of research, many new PM algorithms have emerged. This paper compares and analyzes the performance of Fullmesh, path characteristic and data characteristic based PM (PCDC), receive buffer based PM (RBPM) and select-delete-change (SDC) algorithm in terms of throughput, completion time of small data streams and algorithm complexity. Experimental tests are based on the real environment NorNet test bed. The experimental results show that for the real network environment, PCDC and RBPM have better performance on the whole. In particular, PCDC has incomparable advantages over the other three algorithms for small data stream transmission. Considering the complexity of SDC algorithm, its performance is barely satisfactory.

pp. 71-77

11:00 *D-OLIA: The Packet Loss Differentiation Based Opportunistic Linked-Increases Algorithm for MPTCP in Wireless Heterogeneous Network*

Yantao Cai (University of Hainan, China); Huayi Xiong, Shuai Yu, Min Chen and Xing Zhou (Hainan University, China)

Compared with wired network, there are random packet loss (RPL) and congestion packet loss (CPL) in wireless heterogeneous network where mobile terminal is located. In the current strategies of congestion control (CC) algorithms, however, they are all universally recognized as packet loss (PL), which is expressed by a sign of congestion. In this way, RPL may be mistaken for CPL. Meanwhile, there is no corresponding congestion window adjustment method for different PL. Blind reduction of congestion window for traffic control will only lead to the deterioration of multipath transmission control protocol (MPTCP) performance. Based on this reality, this paper proposes a PL Differentiation based Opportunistic Linked-Increases Algorithm, called D-OLIA. The D-OLIA can determine the type of PL by combining the eigenvalues of delay jitter and congestion window jitter, so as to make up for the shortage of judging only by delay or congestion window. We conduct simulation experiments in NS-3-DCE platform, the evaluation results show that the D-OLIA can effectively increase the PL differentiation accuracy and the throughput of mobile communication, as well as satisfy fairness and better balance congestion in the case of shared bottleneck based on MPTCP.

pp. 78-85

11:30 *Instantaneous Frequency Estimation for Frequency-Modulated Signals under Gaussian and Symmetric α-Stable Noise*

Huda Saleem (University of Kufa, Iraq); Zahir M. Hussain (University of Kufa & Edith Cowan University, Iraq)

Frequency estimation for frequency-modulated (FM) and single-tone sinusoidal signals is essential in various applications, such as wireless communications, sonar and radar measurements. In this paper, methods for estimating the instantaneous frequency (IF) under Additive White Gaussian Noise (AWGN) and Additive Symmetric α-alpha Stable Noise (SαSN)are investigated. Two MATLAB algorithms were considered: the spectrogram and pspectrum, both are based on the maximum likelihood for the Short Time Fourier Transform (STFT). SαS distributions commonly used to model impulsive noise disturbances, however, the SαS distribution lacks a closed-form Probability Density Function (PDF), except in specific cases. As the second-order statistic is infinite for alpha-stable noise, Geometric SNR (GSNR) is used to determine the amount of impulsiveness of the noise in a mixture of Gaussian and SαS noise processes. Results showed that SαS noise is much more harmful for

frequency estimation than Gaussian noise, even if it is small capacity, and it is less destructive when alpha is more than one.

pp. 86-93

12:00 *Optical SEFDM and NOMA in Visible Light Communications*

Cuiwei He (Japan Advanced Institute of Science and Technology, Japan); Yuto Lim (Japan Advanced Institute of Science and Technology (JAIST) & School of Information Science, Japan)

This paper describes a novel multi-user visible light communication (VLC) system which combines optical spectrally efficient frequency division multiplexing (SEFDM) with non-orthogonal multiple access (NOMA) to make the best use of the frequency resources which are normally very limited when light-emitting diodes (LEDs) are used as data transmitters. We show that, although both optical SEFDM and NOMA have their unique interference problems, it is still feasible to use these two advanced techniques jointly to achieve a highly spectral-efficient optical transmission system. More importantly, the simulation results suggest that the bit error rates (BERs) are below the forward error correction (FEC) limit when low-complexity linear equalizers are used.

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Wednesday, November 24 12:30 - 13:00

L1: Lunch

Room 1

Wednesday, November 24 13:00 - 14:00

K1: Keynote - Closing the Loop - Automation in Service Provider Networks

Dr James Kershaw, Juniper Networks

Room 1

Chair: Alexander A. Kist (University of Southern Queensland, Australia)

Telecommunications Network Service Providers are facing a major transformation as the capabilities of automation, machine learning and even AI are promising a path towards the "Self Driving (autonomous) Network". These technologies entice with the business objectives of increasing revenue through superior customer experience while simultaneously driving down primarily operational costs. Little surprise then, that significant industry effort is being applied to achieving those outcomes. Yet closing the loop in the general sense still seems a little beyond our reach. This presentation explores the motivations and current state of automation maturity in Service Provider networks, gives some examples of the results of successful automation and offers some immediate problems and next steps that can be taken by service providers on this journey.

Wednesday, November 24 14:00 - 14:30

AT1: Afternoon Tea

Discussion on simulation tools

Room 1

Wednesday, November 24 14:30 - 16:30

S5: Session 5:

Room 1

Chair: Alfandika Nyandoro (Abilene Christian University, USA)

14:30 *Enhanced Bat Algorithm for Resource Allocation in Wireless Heterogeneous Networks*

Liwei Yang, Furong Zhu and Xinlai Liu (China Agricultural University, China); Wencong Lai (Chinese Agriculture University, China); Wenyi Li (China Agricultural University, China); Shusheng Lyu (Chinese Academy of Agricultural Mechanization Sciences, China)

Wireless heterogeneous networks have gradually become the trend of future network development. In the traditional wireless communication technology, the system based on the macro cellular network can not satisfy the users' requirements for the high speed communication, so it is necessary to put forward a more scientific network resource allocation scheme to maximize the utilization of network resources. In this paper, the efficiency improvement of Macro/Femtocell heterogeneous network based on orthogonal frequency division multiple access (OFDMA) is proposed. The bat algorithm is used to improve the system energy efficiency. An inertial weighted bat algorithm based on exponential decline is proposed to solve the disadvantages of traditional algorithms. In order to maximize the energy efficiency of heterogeneous network and satisfy the quality of service (QoS) of users, the optimized bat algorithm is used to allocate spectrum resource carriers. The performance of the optimized bat algorithm is compared with the classical bat algorithm and genetic algorithm (GA). The simulation results show that compared with the traditional bat algorithm and genetic algorithm, the improved bat algorithm can improve the energy efficiency of the wireless heterogeneous network for carrier distribution.

pp. 98-103

15:00 *A battery-less RFID-based wireless vibration and physical-shock sensing system using edge processing for long-term measurements*

Zequn Song (University of Ibaraki, Japan); Ran Sun (Ibaraki University, Japan); Budi Rahmadya (Andalas University, Indonesia); Shigeki Takeda (Ibaraki University, Japan)

This paper presents an ultrahigh frequency (UHF) band radio frequency identification (RFID) tag and edge processing-based vibration frequency/physical shock sensing system. In this paper, shorter and longer radio wave irradiation times, which are called standby and active modes, respectively, are employed to achieve the energy-efficient operation of an RFID reader and an accurate sensing performance. The introduction of a standby mode is useful for lowering heat generation and CO2 emissions for the RFID reader during long-term measurements. This edge processing at the RFID reader also stores the data only in the active modes, reducing the amount of data uploaded to an Internet of Things (IoT) cloud. The proposed method was experimentally evaluated by monitoring the vibrations caused by a refrigerator.

pp. 104-106

15:30 *Multi-service Virtual Network Embedding in Wireless Network*

Letian Li (No. 38 Research Institute, China Electronics Technology Group Corporation, China); Wenlong Wei (Shanghai Institute of Satellite Engineering, China); Weilong Ren (CETC38 China Electronic Technology Group Corporation, China); Kaiwei Wang (No 38 Research Institute, China Electronics Technology Group Corporation, China); Shuo Wang (No. 38 Research Institute China Electronics Technology Group Corporation, China)

Network virtualization is a key technology that enables the coexistence of multiple heterogeneous networks on the same substrate network, where virtual network embedding is one of the most crucial problems to be solved. Most of previous works about virtual network embedding did not take the QoS requirements of different service types into consideration. Therefore, in this paper, we focus on solving the embedding problem for the virtual network requests with different QoS requirements in wireless network. Besides the bandwidth, we introduce the delay and reliability attributes to describe the QoS requirements of different services. Due to the complexity of

the problem, we propose a heuristic algorithm to solve it. In the algorithm, we design a new parameter called Mean Link Quality to show the mean quality of all outgoing links of a node and devise a hop-limit strategy to avoid selecting the paths with large hop count. Simulation results show that the proposed algorithm can achieve higher request acceptance ratio than other algorithms. Moreover, we analyze the effect of different parameter settings on the request acceptance ratio.

pp. 107-112

16:00 ***Differential Traffic QoS Scheduling for 5G/6G Fronthaul Networks***

Ogechi Akudo Nwogu (Université Sorbonne Paris Nord, France & Alex Ekwueme Federal University Ndufu Alike Ikwo, Nigeria); Gladys Diaz (Sorbonne Paris Nord University, France & L2TI, Institut Galilee, France); Marwen Abdennebi (L2TI Laboratory, University of Paris Nord, France)

The need to dynamically assign capacity to various network slices in virtualized C-RAN enabled 5G and beyond packet-switched networks require the added fronthaul network to be able to deliver standard bitrates. We therefore design a novel fronthaul network scheduling architecture and scheme based off the Burst Limiting Shaper (BLS) mechanism to provide Quality of Service (QoS) guarantees to service differential traffic which include ultra Reliable and Low Latency communication (URLLC) traffic and non-URLLC traffic In this work we compare our strategy to Weighted Round Robin (WRR) scheduling algorithm under bursty and low traffic conditions. Simulations are used to evaluate our schemes performance ad show how well it compares to WRR.

pp. 113-120

S6: Session 6:

Room 2

Chair: Vishal Sharma (Queen's University Belfast, United Kingdom (Great Britain))

14:30 ***A Review of DV-Hop localization algorithm***

Halima Ghribi (Tunisia Polytechnic School, Tunisia); Fakhreddine Khelifa (Research and Studies Telecommunications Center & CERT, Tunisia); Abderrazak Jemai (INSAT Institute, Tunisia & Researcher at SERCOM/EPT, Tunisia); M. Bassem Ben Salah (SERcom, Tunisia Polytechnic School, Carthage University, Tunisia)

In recent years, the wireless sensor network has become a fundamental area of research in the field of IT and communication. It is widely used in various applications such as environmental monitoring, smart farms, smart home, and smart irrigation. In smart farming applications, the sensors can be scattered randomly via an aircraft, or an airplane, to supervise a large crop field or to detect and collect a set of climatic and environmental parameters. The data collected by the sensor nodes don't matter if their locations are unknown. Therefore, it is necessary to determine the location of sensor nodes for correctly interpreting the detected information of communication between nodes. In this case, the location of the sensor nodes is carried out by the use of a set of localization systems such as GPS, GSM, and UWB. These last ones produce a major drawback in terms of huge energy consumption, high cost, and low accuracy in some zone. To resolve these problems, extensive research is being carried out to integrate the range-based or range-free localization algorithm into nodes sensors to improve the localization accuracy. In this paper, we present the performance evaluation of some improved versions of the DV-HOP localization algorithm existing in the literature. Thus, we study the impact of variation in the number of anchor nodes, the number of unknown nodes, and the communication range on the minimum mean square error(MMSE) of these algorithms. In order to make a comparison between the DV HOP algorithm and these versions, we extract a more practical, innovative version.

pp. 121-126

15:00 ***Machine Learning-based Service Function Chain over UAVs Resource Profiling and Framework***

TrungKien Nguyen (Hanoi University of Science and Technology, Vietnam); Hoang Anh Vu and Phong Dinh Vu (Ha Noi University of Science and Technology, Vietnam); Nguyen Ngoc Minh and Nguyen Huu Thanh (Hanoi University of Science and Technology, Vietnam)

Unmanned Aerial Vehicles (UAVs) are expected to align with Machine Learning (ML) to deliver smart Internet of Things (IoT) services on-board such as human detection or medicine delivery. In the context of massive IoT service deployment over UAVs, a platform such as Edge-Cloud model integrated synergistically with Network Function Virtualization (NFV) can be used for system management and control Quality of Service (QoS) via Service Function Chain (SFC) embedding strategy. However, implementing such framework should face many challenges due to limited energy and computing resources on UAVs. This issue is addressed in our article, which subsequently proposes a novel NFV-enabled Edge-Cloud architecture dedicating to implement ML-based services to UAVs. The system is implemented in our testbed that involves drone serving object detection service as a means to investigate the effects of resource, energy utilization of SFC embedding on smart service performance and drone flight duration. Results show that the proposed Edge-Cloud framework is able to deploy smart IoT services to limited resource devices such as UAVs and deliver QoS awareness via SFC embedding.

pp. 127-133

15:30 ***Reducing Network Operators' Expenses by Adjusting the MTTR***

Tobias Enderle and Andreas Kirstaedter (University of Stuttgart, Germany)

Network operators have to generate sustainable profits from the sale and provision of network connections. However, due to quickly growing bandwidth requirements and stagnating revenues, this becomes increasingly difficult to achieve. Lowering expenses is a proven remedy in such situations. The major part of a network operator's expenses is related to the provision of network connections and, in particular, their quality of service (QoS) in terms of availability. Here, an important aspect is the repair of network components to restore

connectivity in case of failures. Lowering expenses for network repair clearly results in a reduction of total enterprise expenses. However, it also results in an increase in compensation payments because availability guarantees will be violated more frequently. This paper explores the trade-off between the reduction in repair-related expenses and the corresponding increase in compensations. To this end, a general financial model is developed which considers the described trade-off. The model involves corporate key figures, a cost function that associates repair-related expenses with the mean time to repair (MTTR), and a probabilistic estimation of the expected compensations. Using exemplary model parameters, we show that the increase in compensations typically does not outweigh the reductions in repair-related expenses. Consequently, significant expense reductions are possible for network operators.

pp. 134-139

16:00 *Formal Verification of 5G EAP-AKA Protocol*

Megha Ajit (Amrita Viswa Vidyapeetham, India); Sriram Sankaran (Amrita University, India); Kurunandan Jain (Amrita Vishwa Vidyapeetham, India)

The advent of 5G, one of the most recent and promising technologies currently under deployment, fulfills the emerging needs of mobile subscribers by introducing several new technological advancements. However, this may lead to numerous attacks in the emerging 5G networks. Thus, to guarantee the secure transmission of user data, 5G Authentication protocols such as Extensible Authentication Protocol - Authenticated Key Agreement Protocol (EAP-AKA) were developed. These protocols play an important role in ensuring security to the users as well as their data. However, there exists no guarantees about the security of the protocols. Thus formal verification is necessary to ensure that the authentication protocols are devoid of vulnerabilities or security loopholes. Towards this goal, we formal verify the security of the 5G EAP-AKA protocol using an automated verification tool called ProVerif. ProVerif identifies traces of attacks and checks for security loopholes that can be accessed by the attackers. In addition, we model the complete architecture of the 5G EAP-AKA protocol using the language called typed pi-calculus and analyze the protocol architecture through symbolic model checking. Our analysis shows that some cryptographic parameters in the architecture can be accessed by the attackers which cause the corresponding security properties to be violated.

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Wednesday, November 24 16:30 - 17:30

K2: Keynote - For a Sustainable Future of Communications and Networking

Professor Michela Meo, Politecnico di Torino

Chair: Samaneh Madanian (Auckland University of Technology, New Zealand)

The emergency related to climate changes and unprecedented increase of inequalities is pushing sustainability in the agenda of international and national organizations. By shaping the future, research and innovation play a fundamental role in tackling these challenges, especially in those sectors, like Information and Communication Technologies (ICT), that are drivers of economic growth. In this talk, we first provide some data to understand sustainability issues in the ICT sector. We then discuss possible research directions and challenges. Finally, we present some solutions based on the integration of energy and resource management. As a case study, we investigate the effectiveness of mobile network operation solutions based on device sleep modes combined with machine learning approaches for traffic and energy prediction.

Thursday, November 25

Thursday, November 25 10:00 - 12:00

W1: Workshop - DevOps enabling modern data network design

Mr. Michael Purcell, Juniper Networks

Room 1

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

In addressing customer data networking requirements there are often different deployment options each with their own benefits and in some cases challenges; for example, do they move to or leverage 'the cloud', build it themselves or purchase off the shelf solutions - most likely it is a hybrid blend of all the above. The use of automation toolsets and open standard protocols, amongst many others, are important components to a successful solution. This workshop explores examples where networking meet CI/CD and Infrastructure as Code, and how these principles are being used to address modern networking requirements. In doing so, delivering a timely, scalable, and reliable service.

Thursday, November 25 12:00 - 13:00

K3: Keynote - 6G Fundamentals: Vision and Enabling Technologies

From 5G to 6G Trustworthy and Resilient Systems

Dr David Soldani, Rakuten Symphony

Room 1

Chair: Alexander A. Kist (University of Southern Queensland, Australia)

The keynote reviews the 6G global landscape and the most relevant private and public initiatives, with US$ billions of investments in next generation information and communication (ICT) systems and application services. Then, it presents the 3rd Generation Partnership Project (3GPP) technology roadmap towards 6G and 5G New Radio (NR) releases. This is followed by an introduction to the latest shift in paradigm "from Internet of Things (IoT) to Internet of Intelligence (IoI)", which paves the way towards 6G wireless. The new system is anticipated to provide pervasive connectivity to functions with the ability to represent knowledge,

process knowledge, and make decisions, with or without human intervention. Beyond that, the talk discusses the new carrier frequency bands above 110 GHz; and innovative fundamental enabling technologies, such as integrated semantic communication and sensing, low earth orbiting satellites, quantum key distribution, post quantum cryptography, and distributed ledger technology; and portrays a network vision for 6G wireless, looking to 2030 and beyond. Conclusions are drawn on 6G prospects, the needs of security by design for 6G; as well as the potential of 6G for securely connecting pervasive intelligence and preserving privacy; and new research directions to cater for new use categories and requirements.

Thursday, November 25 13:00 - 13:30

L2: Lunch - Presentation on ITNAC 2022

Wellington, New Zealand

Room 1

Chairs: Harith Al-Sahaf (Victoria University of Wellington, New Zealand), Ian Welch (Victoria University of Wellington, New Zealand)

Come along for a presentation on ITNAC 2022 to be held in Wellington, New Zealand. Let us celebrate the opportunity to come together in person again and to learn about the location of the next conference.

Thursday, November 25 13:30 - 15:30

S7: Session 7:

Room 1

Chair: Shuo Li (RMIT University, Australia)

13:30 ***A Study on RFID-based Arbitrary Point-to-Point Navigation and Path Recovery System for Mobile Robots***

Osaki Nakamatsu and Tomotaka Wada (Kansai University, Japan)

In recent years, due to the declining birthrate, there are more and more situations where elderly people need to be cared for. As a result, the burden per caregiver has been increasing . As a technology to solve this problem, indoor robot navigation systems that support indoor mobility of those who need care are attracting attention. A navigation system using a mobile robot has components such as position estimation and movement control. As a conventional technique for location estimation, there is a location estimation method using QR codes. In addition, there is a conventional method of mobile control using RSSI. In this paper, we propose a robot navigation system and a path recovery system for a mobile robot that deviates from its path during navigation, by taking advantage of the features of the QR code-based position estimation method, which uses a coordinate plane, and the RSSI-based mobile control method, which uses RSSI for mobile control. This is a path recovery system. In the performance evaluation of navigation between arbitrary points, the maximum error from the ideal trajectory was found to be 13 cm. We also found that the average error between the destination tag and the stop position was 20.4 cm, while the maximum error was 51 cm. In the performance evaluation of the path recovery system, the maximum error between the ideal path and the stop position was found to be 30 cm.

pp. 147-153

14:00 ***A social contract for cyberspace***

Dawood Sallem Hussian Sheniar (University of Southern Queensland & Thi-Qar University, Australia); Ron Addie, James Northway and James Talbot (University of Southern Queensland, Australia); David Millsom (San Andreas Technology, USA); Yan Li (University of Southern Queensland, Thailand)

The current standards for the Internet and its services and devices are set and developed by multiple standards organizations, and national governments. In this paper, we argue that a social contract is needed between these organizations and the entities (individual users, organizations, devices, and service providers) which use the Internet to communicate. Criteria which a social contract should meet are proposed; fifteen major current cybersecurity or ethical issues are then discussed; the necessity and feasibility of a social contract are considered. A draft social contract is then proposed and solutions or strategies to address the fifteen issues identified previously, on the basis of this draft social contract, are presented.

pp. 154-161

14:30 *Digital-twin-assisted Software-defined PON: A Cognition-driven Framework for Energy Conservation*

Siti Damit (Universiti Teknologi Brunei, Brunei Darussalam); S H Shah Newaz (Universiti Teknologi Brunei (UTB), Brunei Darussalam); Fatin Rahman (Laksamana College of Business, Brunei Darussalam); Au Thien Wan (Universiti Teknologi Brunei, Brunei Darussalam); Nazmus Shaker Nafi (Boeing Defence Australia, Australia); Ravi Kumar Patchmuthu (Universiti Teknologi Brunei, Brunei Darussalam); Fawaz AL-Hazemi (University of Jeddah, Saudi Arabia)

The energy consumption footprint of Passive Optical Network (PON) is high due to its widespread deployment. Therefore, a large and growing body of literature has investigated how energy consumption in PON can be minimized. Existing research impart that sleep mode is an effective means for reducing energy consumption in PON. There is also a growing number of contributions demonstrate the importance of integrating PON with Software-defined Networking (SDN). Such integration facilitates a programmable PON, which can dynamically adjust its operation on-the-fly based on the decision made by a SDN controller. The most important limitations in the previous energy-efficient PON research lies in the fact that they failed to address how the energy saving and traffic performance can be fed in real-time into the network operation decision process. Digital Twin (DT) is an emerging field of research in the communication networking area. DT can bridge between real and virtual world making a significant contribution in defining optimal operation of the network. Therefore, in this paper, we propose a Digital-twin-assisted Software-defined PON framework in order to feed the network performance data in real-time to the network operation decision support system, which aims at maximizing energy conservation while meeting quality of service, and control PON infrastructure on-the-fly. Our DT based solution also integrates a supervised learning Autoregressive Integrated Moving Average (ARIMA) method for making traffic arrival forecast based on time series traffic traces. The initial findings of our research based on a C++ discrete event simulator show that the proposed solution successfully reduces energy consumption while meeting traffic delay requirement in a PON.

pp. 162-167

15:00 *Enhancement of Healthcare Data Performance Metrics using Neural Network Machine Learning Algorithms*

Qi AN, Patryk Szewczyk, Michael N Johnstone and James Jin Kang (Edith Cowan University, Australia)

Health patients are encouraged or required to use various medical sensor devices (healthcare wearables or personal health devices) for their health condition monitoring. Medical sensor devices have a significant advantage over conventional medical technology as they are non-invasive leveraging wireless technology. Whether the health data is generated and stored locally or forwarded to the cloud, it is imperative to transmit the patient's data accurately and efficiently. However, the pervasive use of such sensors means that data volume increases significantly. The need to reduce the battery consumption of sensor devices, coupled with the voluminous nature of the data suggests that machine learning can be used to analyse complex health data metrics such as accuracy and efficiency of data transmission. This study uses time series nonlinear autoregressive neural network algorithms to enhance both metrics by taking fewer samples. The three algorithms examined were Levenberg-Marquardt, Bayesian Regularization, and Scaled Conjugate Gradient, which were tested with a standard heart rate data set to compare their accuracy and efficiency. The result showed that the Levenberg-Marquardt algorithm was the best performer with an efficiency of 3.33 and accuracy of 78.37%, while Bayesian Regularization achieved 77.23% accuracy and 2.5 of efficiency, followed by Scaled Conjugate Gradient with

72.08% accuracy and efficiency of 2 respectively. Hence, machine learning proved to improve specific healthcare data metrics simultaneously compared to the existing methods with high efficiency.

pp. 168-175

S8: Session 8:

Room 2

Chair: Leith H. Campbell (RMIT University, Australia)

13:30 *A High-efficiency Collaborative Spectrum Sensing with Gated Recurrent Unit for Multi-UAV Network*

Zhiyong Luo (Sun Yat-sen University, China); Xiti Wang (Sun Yat-Sen University, China)

Unmanned aerial vehicles (UAV) have been widely used in military and civil fields, and the reliability and working efficiency of the system can be well improved by combining several small UAVs into a collaborative multi-UAV network. Cognitive radio (CR) is considered as a feasible way to solve the problem that there is no authorized frequency band for UAV communication. However, the sensing performance of traditional algorithm based on single artificial design feature is poor in complex electromagnetic environment including low SNR, high noise-uncertainty etc., which can not meet the communication needs of cognitive multi-UAV network. Spectrum sensing algorithms based on machine can obtain better performance and higher spectral efficiency (SE) by learn the potential feature and rule, and long short-term memory (LSTM) is naturally suitable for processing time series because of its structural characteristics, so it has achieved relatively good performance in spectrum sensing. Nevertheless, the complexity of the algorithm based on LSTM is high due to its redundant structure, which is unsuitable for UAV as the energy of UAV is always limited. For the above reasons, we propose a spectrum sensing algorithm based on gated recurrent unit (GRU), a variant of LSTM. And we prove by theoretical derivation and simulation experiments separately that it can not only consume about 1/4 less energy for computation and save 1/4 of parameter storage, but also achieve slightly better sensing performance compare to LSTM-based algorithm, which is meaningful. We also use a double-threshold decision method, which the threshold can be adjusted as needed to achieve the appropriate sensing accuracy. Besides, cooperative spectrum sensing (CSS) can obtain better performance and is very suitable for multi-UAV scenarios, and our experiments prove this. We combine the proposed algorithm with an energy-saving alternate centralized collaborative model which can improve system stability and reach a longer working time than traditional collaboration model. In general, we propose a high-efficiency CSS scheme based on GRU for multi-UAV network, which has higher sensing performance, less implementation complexity, and we verify it by theory or simulation.

pp. 176-183

13:52 *A Distributed Control Plane Architecture for Handover Management in MEC-enabled Vehicular Networks*

Syed Danial Ali Shah, Mark A. Gregory and Shuo Li (RMIT University, Australia)

Enhanced vehicular communication is considered to be one of the emerging beyond 5G services with Ultra-reliable and Low-Latency Communications (URLLC) requirements. Multi-access Edge Computing (MEC) is a promising paradigm that brings computational resources, storage and services closer to vehicles, providing low latency and high reliability. MEC servers have limited resources, and therefore given the vehicles' highly dynamic and mobile nature, developing effective MEC handover schemes, and mobility management is a challenge. Software-Defined Networking (SDN) is an emerging network paradigm that provides intelligent centralized and programmatic network control for effective handover management in MEC-enabled vehicular networks. The varying wireless network conditions and MEC server resource availability means that the network state information must be frequently transmitted to the centralized SDN controller to optimize the vehicle's mobility and network performance. This poses a significant load on the centralized controller, resulting in delayed response to extensive service mobility requests from large-scale vehicular networks. Therefore, this paper explores various SDN control plane architectural approaches for handover management in MEC-enabled vehicular networks. We also provided preliminary results of the distributed control plane architecture, where multiple SDN controllers collaborate to perform effective MEC handovers in a vehicular network.

pp. 184-187

14:14 *Uplifting Healthcare Cyber Resilience with a Multi-access Edge Computing Zero-Trust Security Model*

Belal Ali (RMIT, Australia); Mark A. Gregory and Shuo Li (RMIT University, Australia)

Telemedicine over the Internet of Things has the potential to generate a massive amount of data. To process the data an increase in transmission, computing, storage and analysis capability is required. Utilising cloud computing to handle the increase in data could introduce high latency and increase storage costs. Multi-access Edge Computing (MEC) has become an essential component of the next generation 5G networks that provide improved reliability and low latency. This paper proposes a model that will enable MEC operators to collect information from the environment that can be analysed before making trust decisions. Trust is achieved by continuously applying authentication and authorisation while maintaining robust management practices to drive the trust decision process. The proposed model trusts the User Equipment (UE) only after verifying user credentials, which are converted into ciphertexts. The integration of different technologies such as computers, medical devices, and telecommunications will significantly improve the efficiency of patient treatment, reduce the cost of health care and improve privacy and security. Trust decisions are based on the trust posture criteria, existing and potential trust relationships, and the MEC environment trust state. The research outcomes show that this approach provides a positive improvement whilst establishing trust.

pp. 188-193

14:36 *Joint Game Theory and Greedy Optimization Scheme of Computation Offloading for UAV-Aided Network*

Zhiyong Luo (Sun Yat-sen University, China); Ao Huang (Sun Yat-Sen University, China)

The UAV-aided network has great potential in emergency response scenarios, which is a necessary complement to the conventional terrestrial cellular network. With the increase of data to be processed, users' expectations for low latency and low energy consumption are also improved. Traditional networks are unable to meet the rapidly growing actual needs gradually. To solve this problem, as an important role of edge computing, computing offloading technology makes edge nodes have processing ability and reduce time delay, which further improves the practicability of UAV-aided network. However, the computing resources deployed on the edge nodes are limited. In order to solve the competition of non-cooperative game scenario and ensure the algorithm complexity is as low as possible, we adopt a heuristic algorithm based on game theory, consider the weighted sum of delay and energy consumption as the objective function and decision basis, and propose to introduce the greedy strategy to optimize the MEC server selection policy in the algorithm. The simulation results show that the joint algorithm can significantly reduce the overall user loss compared with the two traditional schemes. Compared with the game theory algorithm itself, the greedy optimization strategy can also bring about 12% gain when the parameters meet certain conditions. Meanwhile, the selection strategy with O(n) time complexity introduced does not affect the highest term, and the total complexity is still O(mn) at each time slot.

pp. 194-199

14:58 *Performance Analysis of WDM-PON Radio over Fiber network system using Multi-Pump Raman Amplifier*

Muhammad Towfiqur Rahman (University of Asia Pacific, Bangladesh & Computer Science and Engineering, Bangladesh); Nur-A Alam (Synesis IT Ltd, Bangladesh); Roni Ahmed, Kamal Hossain and Asadul Haque (Northern University of Bangladesh, Bangladesh)

Long-reach passive optical network (PON) architecture is proposed in this article, with different Raman configurations being used to compensate for fiber loss in the long-reach PON connection. The effect of different Raman amplifier setups for wavelength division multiplexing (WDM) on the overall channel data capability was investigated. The efficiency of the WDM system with forward and backward pumping was measured using Raman fiber amplifiers (RFAs) in this paper. Due to its gain efficiency and different pumping techniques with WDM technology, the power levels, RFA position, fiber length vs BER and Data rate vs BER have been evaluated up to 10 Gb/s data rate in a 100 GHz (0.8 nm) channel interval. We have measured bit error rate (BER), signal to noise ratio (SNR) level and related eye diagram of the system from 10 km up to 100 km fiber length. At 70 km BER was recorded the best one related to the distance and system noise level which was -60dBm and after 80 km. 1 Gb/s up to 10 Gb/s data was transmitted and BER 10-9 and OSNR -6.35 dBm was recorded at data rate 9 Gb/s and RFA has boosted up around 1.5 dB for commercial C band (1530nm-1565nm).

Thursday, November 25 15:30 - 16:00

CR: Closing Remarks and Prizes

ITNAC 2021 is in Sydney, Australia

Mark Gregory

Room 1

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