28th International Telecommunication Networks and Applications Conference (ITNAC)

	Tuesday, November 20	Wednesday, November 21		Thursday, November 22	Friday, November 23	
8:40 - 9:00		S1: *Session 1: Energy efficiency* S3: *Session 3: IoT*		S11: *Session 11: Wireless* S13: *Session 13: General* S12: *Session 12: Wireless*		
9:00 - 10:00			S2: *Session 2: SDN*		S16: *Session 16: Quality and Performance* S15: *Session 15: Security* S14: *Session 14: Transport*	WK3: *Workshop 3: SDN and NFV with open-source and white-boxes*
10:00 - 10:40		K1: *Keynote*		K3: *Keynote*		
10:40 - 10:50				MT2: *Morning Tea*	MT3: *Morning Tea*	
10:50 - 11:00		MT1: *Morning Tea*				
11:00 - 11:10				K4: *Keynote*		
11:10 - 11:40		K2: *Keynote*			K5: *Keynote*	
11:40 - 12:00				WK2: *Workshop 2: Juniper Contrail SDN Deep Dive*		
12:00 - 12:30		L1: *Lunch*			L3: *Lunch*	
12:30 - 13:00				L2: *Lunch*		
13:00 - 13:30		S4: *Session 4: IoT* S5: *Session 5: IoT + SDN* S6: *Session 6: Security*	WK1: *Workshop: Huawei*		S17: *Session 17: Traffic Management* S19: *Session 19: Security* S18: *Session 18: Video and Virtual Reality*	
13:30 - 14:00				C1: *Conference Tour*		
14:00 - 15:00		S8: *Session 8: MANET and VANET* S7: *Session 7: Transmission*			S22: *Session 22: SDN and General* S21: *Session 21: General* S20: *Session 20: Wireless*	
15:00 - 15:20						

15:20 - 15:40		AT1: *Afternoon Tea*			AT3: *Afternoon Tea*	
15:40 - 16:00		S10: *Session 10: Wireless*	S9: *Session 9: IoT*			
16:00 - 16:05					CR: *Closing Remarks*	
16:05 - 17:00						
17:00 - 17:20	WR: *Welcome Reception*					
17:20 - 17:30						
17:30 - 18:00						
18:00 - 20:00				D1: *ITNAC 2018 Dinner*		
20:00 - 23:00						

Tuesday, November 20

Tuesday, November 20 17:00 - 20:00

WR: Welcome Reception

Room: Foyer

Chair: Vijay Sivaraman (University of New South Wales, Australia)

Wednesday, November 21

Wednesday, November 21 8:40 - 10:00

S1: Session 1: Energy efficiency

Room: M10

Chair: Shuo Li (RMIT University, Australia)

8:40 *New Framework for analysis Of Energy Efficiency in massive MIMO With Hardware Impairments*

Talha Younas (COMSATS University Islamabad, Sahiwal Campus)

Enormous improvements in bandwidth and energy efficiency have been achieved in wireless communication systems by the employment of large number of antennas at BS due to significant array gain and efficient spatial resolution. Recent studies proved that large number of antennas provide extremely narrow beam thus decorrelating user channels efficiently. Apart from the benefits of large scale antenna systems, some issues also come along such as effects of hardware impairments on the antennas of base station (BS). These hardware impairments include mutual coupling, amplifier distortion etc. In this paper we prove graphically that these impairments have significant effect on over all performance of system by creating an error floor resulting negative effects on both energy and bandwidth efficiency. We derive a new framework and modified form of MMSE estimator including the effects of hardware impairments to analyse the effect of hardware impairments on energy efficiency of the system.

pp. 1-3

9:00 *Energy-Aware Adaptive Trickle Timer Algorithm for RPL-based Routing in the Internet of Things*

Arslan Musaddiq, Yousaf Bin Zikria and Sung Won Kim (Yeungnam University, Korea)

The Routing Protocol for Low Power and Lossy Network (RPL) is IPv6 protocol for Low Power and Lossy Networks (LLNs) devices. RPL uses the hope count and Expected Transmission Count (ETX) as two routing Objective Functions (OF). Along with these two OFs, RPL uses a Trickle timer algorithm to control the frequency of control messages. However, the RPL standard in its current form does not consider the node energy while routing the traffic. Due to unevenly traffic distribution, some parent nodes results in energy hotspots. Similarly, the Trickle timer affects the battery and overall convergence time. This paper includes an efficient Energy-Aware Adaptive Trickle (EAAT) timer mechanism for scaling the DIO transmission based on the Future Energy (FE) and the Residual Energy (RE) information. The simulation evaluation shows that by utilizing the FE based OF and by scaling Trickle related parameters prolongs the network lifetime and improves the routing performance

pp. 4-9

9:20 *Enabling Energy Efficient Data Ferrying*

Robert Hunjet (DST Group, Australia); Hong Jun Yu and Cheng-Chew Lim (University of Adelaide, Australia)

This paper investigates data ferrying among stations using UAVs with limited communication ranges. The aim is to drive UAVs to pass data among stations along optimal path in minimal traveling distance. One mobile UAV is chosen to receive data from and send data to stations at static waypoints, and the rest of the UAVs are required to reach static relay points of different stations to extend their communication ranges to reach the waypoints. The waypoints and relay points are searched from initial positions. Simulation examples are given to demonstrate the capacity of the proposed algorithm.

pp. 10-15

9:40 *Performance Analysis of Energy Harvesting based Two-way Multi-Relay Wireless Network*

Supreet Singh (Baba Banda Singh Bahadur Engineering College, Fatehgarh Sahib Punjab India)

In this paper, wireless powered two-way multi-relay cooperative network is analyzed. The selected Amplify-and-Forward (AF) relay node harvests the RF energy using time-switching relaying (TSR) from source and destination nodes using harvest-and-use approach without storing it. We investigate the performance parameters of the network such as outage probability, throughput and ergodic sum-rate considering two cases of relay selection scenarios. Simulation results demonstrate that with the proper selection of relay along with the optimum time-switching parameter better throughput and outage performance can be achieved. Results show that there is an improvement of about 8% in the throughput at optimum value of TSR parameter.

pp. 16-21

S3: Session 3: IoT

Room: M11

Chair: Sarbjeet Singh (Panjab University, Chandigarh, India)

8:40 *Comparision of pathfinding algorithms for visually impaired people in IoT based smart buildings*

Payal Tusharkumar Mahida, Seyed Shahrestani and Hon Cheung (Western Sydney University, Australia)

Indoor navigation is highly challenging for visually impaired, particularly when visiting an unknown environment with complex design. Also, a person at the entrance of the building might not be aware of distant changes/disruption in the path to the destination. Internet of Things devices can become the foundation infrastructure for scanning the dynamic changes in such an environment. With the sensory data of the scanned nodes, a dynamic pathfinding algorithm can provide guided route considering the changes to the destination. There are various pathfinding algorithms proposed for indoor environment including A*, Dijkstra's, probabilistic roadmap, recursive tree and orthogonal jump point search. However, there is no study done to find if these algorithms are suited to the special requirements of low vision people. We have carried out simulations in MATLAB to evaluate the performance of these algorithms based on parameters such as distance and nodes travelled execution time and safety. The results provide strong conclusion to implement most suitable orthogonal jump point search to achieve optimal and safe path for low vision people in complex buildings.

pp. 22-24

9:00 *Prediction of Personalised Life Expectancy using Personal Health Devices in mHealth Networks*

James Kang (Melbourne Polytechnic, Australia)

The ability to predict life expectancy (LE) for an individual or a group of people has been in demand for long, however the accuracy and validity of results are difficult to enhance due to the numerous variables required for consideration. The main causes of issues are that human behaviour and activities can be so different and unpredictable that it is almost impossible to measure, classify, define and predict against generic statistic values, which themselves are too numerous in variables to determine. However, with the emergence of technologies such as computer and data science technologies, health related data are increasing in availability and many applications such as smartphone apps and wearable devices that provide wellness and fitness tracking are entering the market to aid the demands. Some apps provide health related data such as sleep monitoring, heart rate measuring, and calorie expenditure collected and processed by the devices and servers in the cloud. These requirements can be extended to provide a personalized life expectancy (PLE) for the purpose of wellbeing and encouraging lifestyle improvement. No existing works provide this PLE information that is developed and customized for the individual. This article is based on the concurrent models and methodologies to calculate and predict LE and proposes a novel idea of using multi-phased approaches to the solution. The major contribution of this paper is that the solution encourages people to change their lifestyle by monitoring and observing to extend LE which results in improving the quality of their life.

pp. 25-29

9:20 *Collaborative Neighbor Discovery with Slow Scan for Directional Sensor Networks*

Nipun Sood (BITS Pilani KK Birla Goa Campus, India); Shamanth Nagaraju (BITS PILANI K. K. BIRLA GOA CAMPUS, India); Sreejith V (BITS-Pilani, KK Birla Goa Campus, India); Lucy Gudino (BITS Pilani, India)

Neighbor discovery forms a vital part of Medium Access Control (MAC) or routing protocol in Directional Sensor Networks (DSN). Discovering neighbors in DSN is a challenging task due to limited coverage of directional antennas. The COllaborative Neighbor Discovery (COND) protocol suggests a time-efficient mechanism to discover neighbors but fails to discover all the neighbors. In this paper, we propose an improvement over COND protocol which aims to discover all the nodes in the network. We call this model COllaborative Neighbor Discovery with Slow Scan (COND-SS). The simulation results reveal that the COND-SS protocol has lower latency and it improves the neighbor discovery ratio considerably up to 100% by employing Slow-Scan mode, inspired from the Scan-Based Asynchronous Neighbor Discovery (SBAN) protocol.

pp. 30-32

9:40 *Dynamic Vehicular Traffic Load Quantification by Considering Intermittent Unused Road Space*

Gerald Ostermayer, Christian Backfrieder and Manuel Lindorfer (FH Upper Austria, Austria)

With the goal of dynamic traffic scheduling, road planning, intelligent route optimization or traffic control, it is important to quantify the traffic load of a particular area of a road network as a vital factor of influence. An ever increasing number of vehicles which are capable of wireless communication enables new possibilities to measure this traffic load. In this paper, we introduce a methodology which quantifies the amount of traffic over time by the help of a cloud calculation service and vehicular communication. Furthermore, the approach is applicable also in vehicular traffic simulations, which are widely used to demonstrate the effects of proposed solutions to traffic problems in research. As unused road segments strongly influence the overall traffic load (i.e. used vs. full road capacity), we propose a methodology which dynamically calculates the load over time, and considers whether specific parts of the road network are used. We introduce two possibilities to filter out distortion of the created statistics due to variation in usage over time. Our novel approach is both simple but widely configurable to fit the individual needs. The approach is proven by simulations and application of the load calculation in combination with a intelligent route optimization approach by putting the optimization gain in contrast to the calculated traffic load.

pp. 33-40

Wednesday, November 21 9:00 - 10:00

S2: Session 2: SDN

Room: M18

Chair: Marco Prandini (University of Bologna, Italy)

9:00 *Towards SDN Fault Tolerance using Petri-Nets*

Wael Hosny Fouad Aly (University of Quebec in Montreal, Canada)

Software defined networking (SDN) is an emerging paradigm that has become very popular recently. SDN depends on separating control and data planes. Vendors seek flexible and ease-for-use networks. SDN has introduced two main functions; centralized control and programmability which have become the pillars of SDN. In this paper we use SDN as a centralized architecture which is composed of a master-controller connected to a set of slave-controllers. Switches connect to slave-controllers forming clusters. In this paper, we introduce a new petri-net based mathematical framework for SDN fault tolerance. The proposed model is called Fault Tolerance using Petri-nets for SDN networks (FTPNSDN). Simulation results show a significant improvement in the availability of the network when compared to a reference model. The model shows stability after controller failures. Petri net capability functions are used to sort the backup controllers to take over in case of failure in descending order. This helps the switch to be aware of the next controller to take over next and avoid interruption of service. Results show an improvement of above 10% improvement in terms of transition time before another controller takes over which leads to an improved fault tolerance of the network. Packet delays are reduced by 12% when compared to Hyperflow reference model.

pp. 41-43

9:20 *Towards an Active Probing Extension for the ONOS SDN Controller*

Christopher Metter (University of Würzburg, Germany); Valentin Burger (University of Wuerzburg, Germany); Hu Zheng and Ke Pei (Huawei, P.R. China); Florian Wamser (University of Wuerzburg, Germany)

Network monitoring is a complex task and is always a trade-off between granularity of information and the performance impact of the monitoring itself on the network. SDN controllers, such as the ONOS SDN controller make this challenge easier as they can supply centralized information over the whole network. In our previous work, we analyzed the built-in detection mechanism of ONOS and revealed a lack of detection performance and the vulnerability of this process to jitter. These results have also been verified by measurements. In this paper, we present an active probing extension for the ONOS SDN controller that overcomes these shortcomings by emitting probing packets that are transmitted through the network. Packet loss is detected by calculating statistics of a list which contains data from previous packets. The evaluation by the means of measurements proves the benefits in terms of detection performance and controller load of this application. Furthermore, our extension is able to detect jitter in the data plane and to automatically adapt the probing process to these conditions.

pp. 44-51

9:40 *A Multi-agent Controller to enable Cognition in Software Defined Networks*

Vijaya Durga Chemalamarri (University of Technology Sydney, Australia); Robin Michael Braun (University of Technology, Sydney, Australia); Mehran Abolhasan (University of Technology Sydney, Australia); Justin Lipman (University of Technology, Sydney (UTS), Australia)

Current SDN controllers are not cognitive. We propose a new architecture for an SDN controller to enable intelligence. The proposed new architecture is based on Multi- agent systems. As a prototype, we have built a MAS-SDN controller using the GOAL agent programming language. We highlight the motivation behind the new architecture, describe the architecture and provide some initial results.

pp. 52-56

Wednesday, November 21 10:00 - 10:50

K1: Keynote

Security

Dr Malcolm Shore

Room: M18

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

Wednesday, November 21 10:50 - 11:10

MT1: Morning Tea

Room: Foyer

Wednesday, November 21 11:10 - 12:00

K2: Keynote

Cybersecurity of critical systems, 2020 and beyond

Professor Matthew Roughan

Room: M18

Chair: Vijay Sivaraman (University of New South Wales, Australia)

We've been doing large-scale cybersecurity now for 20 years (at least). But the landscape is demonstrably worse now than ever. We have a wealth of research on the topic, but the scale and pace of the problems are only increasing. Vulnerabilities are being discovered at an increasing rate; exploits are being developed more quickly by increasingly well resourced professional hackers; and the Internet of Things creates an almost perfect storm of new problems. And the economic incentives to fix problems are not always strong enough to force businesses into action. Where does this end -- should we just give up? No! There are some good tools and ideas out there. In this talk I will go through a (somewhat lopsided) view of network-level cybersecurity, with the aim of talking about what we need to do to build better, more secure networks in the future.

Wednesday, November 21 12:00 - 13:00

L1: Lunch

Room: Foyer

Wednesday, November 21 13:00 - 15:00

WK1: Workshop: Huawei

Network Slicing as a Service (NSaaS)

Dr David Soldani

Bld F8 Room G17

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

This workshop will cover:

1. Network slicing for 5G systems
2. Network Slicing as a Service
3. Demonstrations o Huawei core network slicing o 5G network slicing enabled gaming industry
4. Future applications
5. Q&A

Wednesday, November 21 13:00 - 14:00

S4: Session 4: IoT

Room: M10

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

13:00 *A Deep Learning Approach for Intrusion Detection in Internet of Things using Bi-Directional Long Short-Term Memory Recurrent Neural Network*

Bipraneel Roy and Hon Cheung (Western Sydney University, Australia)

Internet of Things (IoT) is one of the most rapidly evolving technology nowadays. It has its impact in various industrial sectors including logistics tracking, medical fields, automobiles and smart cities. With its immense potentiality, IoT comes with crucial security concerns that need to be addressed. In this paper, we present a novel deep learning technique for detecting attacks within the IoT network using Bi-directional Long Short-Term Memory Recurrent Neural Network (BLSTM RNN). A multi-layer Deep Learning Neural Network is trained using a novel benchmark dataset: UNSW-NB15. This paper focuses on the binary classification of normal and attack patterns on the IoT network. The experimental outcomes show the efficiency of our proposed model with regard to precision, recall, f-1 score and FAR. Our proposed BLSTM model achieves over 95% accuracy in attack detection. The experimental outcome shows that BLSTM RNN is highly efficient for building high accuracy intrusion detection model and offers a novel research methodology.

pp. 57-62

13:20 *Implementation and Performance Analysis of Power and Cost-Reduced OPC UA Gateway for Industrial IoT Platforms*

Han Jun Cho and Jongpil Jeong (Sungkyunkwan University, Korea)

OPC UA is an international standard for smart factories that defines communication technologies and data processing methods. Therefore, OPC UA supports high interoperability among various protocols and plays an important role in building Smart Factory. However, changing a factory using a variety of existing devices and protocols to a device using a single protocol is, in reality, a barrier to entry due to the enormous cost and lack of experimentation. Therefore, this paper proposes OPC UA gateway that can accommodate OPC UA specification in industrial device platform based on ARM processor. Evaluate performance based on indicators such as publication interval, sampling interval, subscription limit, encryption, and security guidelines. Our experimental results show that operating costs are reduced by about 66% compared to x86 processors. It also provides a way to reduce costs over older systems by connecting Microsoft's Azure IoT cloud.

pp. 63-65

13:40 *Comparative study of classification techniques for indoor localization of mobile devices*

Hifsa Iram (National University of Computer and Emerging Sciences, Pakistan); Kamran Zia (National University of Sciences and Technology, Pakistan); Muhammad Aziz Ul haq (COMSATS University Islamabad, Pakistan); Aasim Zia (Comsats Institute of Information and Technology, Pakistan)

GPS and GLONASS are used worldwide to locate the devices using satellites but it cannot locate objects under the roof. Therefore different sensors are required to be deployed inside for indoor localization of the devices. Indoor location estimation has been a prime area of research by many engineers and a lot of work has been done to improve to accuracy of location estimation. Different techniques have been developed including angle of arrival technique, triangulation, trilateration, Artificial Neural Networks, KNN Classification techniques and Bayesian classification techniques. One of the most popular technique known as Naïve Bayes Technique is mostly used for indoor localization of the objects and devices. Naïve Bayes classifier assumes conditional independence between the attributes but in real world this is not the case. The attributes or input data is dependent on each other and this assumption reduces the accuracy of the estimation results. Moreover, if the training dataset for Naïve Bayes classification technique is not complete then problem of zero probability comes up and further reduces the accuracy. In order to address this issue, different variants of Naïve Bayes technique have been developed. In this paper we have done a comparative study of different Naïve Bayes theorem based classification techniques and some other classification techniques for location estimation of device in indoor environment are done. The accuracy and efficiency of different techniques including SVM, SMO, Random Forest, Random Trees, Augmented Naïve Bayes, Hidden Naïve Bayes, Fine Grained Naïve Bayes and Multinomial Naïve Bayes technique are compared to find the best location estimation algorithm.

pp. 66-70

S5: Session 5: IoT + SDN

Room: M11

Chair: James Kang (Melbourne Polytechnic, Australia)

13:00 *On the Error Rate Analysis of Distributed Transmit Beamforming*

Ishtiaq Ahmad and Gottfried Lechner (University of South Australia, Australia); Ismail Shakeel (Defence Science and Technology Group, Department of Defence, Australia)

This paper analyses the error rate performance of distributed transmit beamforming (DTB). We derive new simple asymptotic (in the number of transmit nodes N) closed-form average bit error rate (BER) expressions for M-ary quadrature amplitude modulation (M-QAM) and M-ary phase shift keying (M-PSK) modulation schemes. Our results provide many useful insights, e.g. for fixed total transmit power: (i) the average BER of both M-QAM and M-PSK modulation schemes decreases exponentially with increasing number of nodes N, (ii) M-PSK requires more transmit nodes than M-QAM to achieve the same average BER. Moreover, Monte Carlo simulations are used to validate the accuracy of our analysis.

pp. 71-74

13:20 *Four Single-Sideband M-QAM Modulation using Soft Input Soft Output Equalizer over OFDM*

Mohammed Alhasani and Quang Ngoc Nguyen (Waseda University, Japan); Gen-Ichhiro Ohta (Yokosuka Telecom Research Park, Japan); Takuro Sato (Waseda University, Japan)

The Single Sideband (SSB) modulation through Hilbert Transformation has successfully transmitted data using only half bandwidth for the same amount of contained information. Towards this line, the Four Single SideBand (4-SSB) using QPSK modulation over OFDM was proposed as a new applicable modulation for the next generation communication system, such as 5G. This approach can improve the network efficiency, however, the InterSymbol Interference (ISI) is substantially introduced in 4-SSB based modulation due to the wireless channel characteristics, especially when we are increasing the order of modulation. Particularly, the Widely Linear Minimum Mean Squared Error (MMSE) equalizer is impractical in high order modulation because of its high performance degradation. In this paper, we propose a 4-SSB M-QAM over OFDM approach to improve the modulation feasibility and data rate, compared to the previous 4-SSB using QPSK over OFDM. The proposal uses the Infinite Length MMSE Soft Input Soft Output (SISO) equalizer to deal with ISI induced by the Finite Impulse Response (FIR) of the Hilbert Transform Filter. The evaluation results show that the proposed 4-SSB-based modulation technique using MMSE SISO equalizer can considerably reduce the effect of ISI in non-ideal environments, including the Additive White Gaussian Noise (AWGN) and fading channel.

pp. 75-80

13:40 *Multi-domain Software Defined Network Provisioning*

Franciscus Xaverius Ari Wibowo and Mark A. Gregory (RMIT University, Australia)

Multi-domain provisioning can be a time consuming and complex process, especially when the provisioning occurs between different administrative domains. The Software Defined Networking (SDN) paradigm provides a flexible programmatic solution that can be used to improve network management and control. SDN can be used to implement automated flexible provisioning in multi-domain networks, and provides an opportunity to implement improved processes for automated provisioning between different administrative domains. In this paper, a SDN-based framework is proposed for multi-domain provisioning. The BGP UPDATE message is used to pass provisioning related information between the SDN domains. An application prototype was developed to test the framework with a Bandwidth on Demand use case. The evaluation shows that the framework behaved as expected and the application prototype successfully carried out multi-domain provisioning between different administrative domains.

pp. 81-87

S6: Session 6: Security

Room: M18

Chair: Sarbjeet Singh (Panjab University, Chandigarh, India)

13:00 *Blockchain-Based Implementation for Financial Product Management*

Bihuan Chen (GF Securities, P.R. China); Zhixiong Tan (South China University of Technology, P.R. China); Wei Fang (GF Securities, P.R. China)

In order to decrease the delay of financial product information update among multi institutions, manage multi-dimensional and diversified financial product information, enhance the properties traceback ability, we propose a blockchain-based financial product management platform. It constructs a distributed network architecture for financial product information management which possess a tamper-resistant, information transparency and secure information sharing environment. The management platform in our paper, using Hyperledger Fabric as underlying architecture, realized the fundamental financial product manage operations. Such as routine maintenance of financial product, multi-function data inquiry and traceability of financial product. As last, considering the characteristics of financial product management, we put forward a follow-up prospect for improving the weaknesses of Hyperledger Fabric to perfect our management platform.

pp. 88-90

13:20 *Power Allocation and Outage Analysis for Cognitive Radio with Jamming Signal under Primary Secrecy Outage Constraint*

Dae-Kyo Jeong and Dongwoo Kim (Hanyang University, Korea)

In this paper, an optimal power allocation between information and jamming signals at a secondary user (SU) in cognitive radio is investigated. The power allocation is achieved to minimize SU's outage probability while keeping a secrecy requirement at a primary user (PU). By sending jamming signals, SU contributes to improving PU's secrecy outage, which in turn enables SU to find a vacant room of radio spectrum for transmitting its own information signal. The jamming signal is assumed to be known to PU in advance. But we investigate either of two cases regarding whether SU's receiver knows the jamming signal or not. SU's outage probability is derived as a function of the power allocation for the respective cases and is optimized with the primary secrecy constraint. Numerical results are provided to verify the analysis and to give insights on the outage performance for the proposed method.

pp. 91-96

13:40 *Security network policy enforcement through a SDN framework*

Davide Berardi (Università di Bologna, Italy); Franco Callegati (Universita` di Bologna, Italy); Andrea Melis and Marco Prandini (University of Bologna, Italy)

In this work we present an exploitation of the Software Defined Networking paradigm to implement an architecture allowing a system network administrator to implement and verify in a formal way security policies. The main result is a framework that support the network administrator in the security management process providing services during all this phase, from automated traffic analysis during the prevention phase to tools for the exclusion of malicious traffic from the main flow in the reaction phase. In order to validate the proposed architecture we will showcase an industrial network applied scenario, simulating attacks and countermeasures techniques.

pp. 97-100

Wednesday, November 21 14:00 - 15:20

S8: Session 8: MANET and VANET

Room: M10

Chair: Robert Hunjet (DST Group, Australia)

14:00 *Evaluating the Performance of QoI Algorithms in Realistic MANETs*

Ameer Arsalaan (The University of Adelaide, Australia); Hung Xuan Nguyen and Andrew Coyle (University of Adelaide, Australia)

Quality of Information (QoI) based solutions for multi-criteria decision-making problems have recently gained attention in tactical networks. These schemes combine application and network layer information to select the best source among multiple available options to meet the specific quality needs of the task. A large part of this research evaluates their performance using simple models of the underlying network. In this paper, we study the performance of a QoI scheme in a more realistic network environment. For this purpose, we create a MANET environment with realistic radio propagation, MAC and routing protocols to study the performance of a state-of-the-art QoI scheme for source selection procedure. We cross compare this solution with a simple Quality of Service (QoS) algorithm that selects highest available bandwidth. We evaluate the performance of both schemes in a network of 100 nodes. In situations where a single network metric is of significance to the task, the simple traffic engineering solution is a better choice with minimal overhead. In contrast, the QoI scheme provides an efficient solution when multiple network criteria contribute equally to the decision making, at the cost of increased network overheads and long convergence time.

pp. 101-106

14:20 *PEGADyn: A Cluster-Based Energy Efficient Routing Protocol for Ad Hoc Networks*

David Osemeojie Airehrour and Emmanuel Ndashimye (Auckland University of Technology, New Zealand); Vinojitha Raghavan (Nelson Marlborough Institute of Technology, New Zealand); Abdullahi Baffa Bichi (Bayero University Kano, Nigeria)

Mobile Ad hoc Network (MANET) is a group of networked mobile devices working in a cooperative manner, which are deployed in situations like fire disaster and earthquake rescue. Due to usage these devices quickly run out of battery power in critical situations thus, fail in packet transmission in an ad hoc network. The energy or lifetime of ad hoc networks has been a topical research issue, and many proposals have been put forward to address this. Power-Efficient Gathering in Sensor Information Systems (PEGASIS) and Dynamic State algorithm are two research works with unique energy efficiency concepts that if harmonized and refined, will deliver a better optimized energy efficient routing protocol for MANETs. This study therefore, proposes PEGADyn, a hybrid version of PEGASIS and Dynamic State algorithm into a new energy-efficient routing protocol for ad hoc networks. PEGADyn creates a virtual grid classification of nodes based on the current location of nodes, and this is followed by a cluster formation of nodes in each virtual grid created. In each cluster and virtual grid formed, cluster heads (CHs) and designated cluster heads (dCH) are selected based on their energy levels. CHs and dCHs are used for communication between clusters and virtual grids. The use of CHs and dCHs limits communication overheads among nodes hence, reducing the energy expended and thus, increasing the network lifetime. A simulation comparison of PEGADyn with PEGASIS and Dynamic State shows PEGADyn to be more optimal in extending network lifetime and maintaining network throughput.

pp. 107-112

14:40 *A Scalable and Efficient PKI Based Authentication Protocol for VANETs*

Miraj Asghar, Robin Doss and Lei Pan (Deakin University, Australia)

Intelligent Transportation System (ITS) deploy- ment in the near future will reduce road accident and traffic congestion problems by providing the users with real-time information. Such information should be highly specific, frequently updated and trustworthy. In this setup, the vehicles communicate with other peer vehicles as well as with the road side infrastructure via the self-organizing vehicular ad hoc networks (VANETs). VANETs is a core part of ITS to dissemi- nate data between ITS entities. Because the data often contain private information of VANETs users such as exact location, authentication of users is mandatory. The authentication helps prevent any malicious user or attacker from accessing sensitive information. For VANETsm, most authentication protocols is based on the Public Key Infrastructure (PKI). However, many PKI-based protocols suffer poor performance in terms of transmission delays due to the fast growing size of the Certificate Revocation List (CRL). The CRL increases with the number of revoked vehicle which is inevitable during the use of VANETs. In order to mitigate the growing CRL issue, in this paper, we propose a protocol which makes CRL size linear. The shortended CRL helps improve the authentication efficiency. Our simulation results confirm the reduced authentication delay for a wide range of authentication requests. Our protocol can be used to improve the efficiency and scalability of VANETs.

pp. 113-115

15:00 *Context-Aware Mobile Edge Computing in Vehicular Ad-Hoc Networks*

Zachary W Lamb and Dharma P Agrawal (University of Cincinnati, USA)

Vehicular Ad-Hoc Networks (VANETs) are an integral part of Intelligent Transportation Systems (ITS) and provide a means for vehicles to communicate with one another as well as to the Cloud and Internet. The recent push toward 5G networking has laid the foundation for a VANET architecture that can accommodate the high bandwidth, high speed, and high availability expected by consumers. Next-Generation technologies will support future autonomous vehicle applications and define the infrastructure necessary to facilitate ubiquitous communications. With future networking technologies set to support much higher bandwidth and high numbers of users, our focus shifts to management of the compute resources that will support the back-end computations required for autonomous vehicle applications. The numerous on-board sensors expected to be available on autonomous vehicles, makes each vehicle an invaluable source of data. Gathering large amounts of data in real-time will incur a significant cost on networking infrastructure as well as the compute resources which process the data. In this paper, we introduce an architecture which seeks to execute computational tasks on the most logical and feasible resource. In our proposed technique, resource allocation takes into account the context of the job and the real-time availability of resources.

pp. 116-122

S7: Session 7: Transmission

Room: M18

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

14:00 *Analysis of the effects of multiple reflection paths on high speed VLC system performance*

Muhammad Towfiqur Rahman (Monash University Malaysia); Masuduzzaman Bakaul (Senior Lecturer, Malaysia)

In the recent past, research in visible light communication (VLC) has gained a lot momentum due to its distinct characteristics in supporting high-speed optical wireless communication and illumination simultaneously. To implement a reliable VLC system, few parameters have to be considered for communication channels such as the distance between transmitter and receiver, data rate, line of sight (LOS) and non-line of sight (NLOS) communication paths, signal power and delay of the channel. In this paper, we designed and simulated a LOS and NLOS multipath VLC model using single and multiple LEDs. Basic on-off keying (OOK) modulation scheme and available conventional LED configuration have been considered to analyze the effects of field of view (FOV) and the reflection of the light signal on received power level. Moreover, BER and quality of transmission were measured for single and multipath transmissions considering distance, incident and irradiance angles.

pp. 123-128

14:20 *Outage Capacity Analysis for Ambient Backscatter Communication Systems*

Siwen Xing and Zihuai Lin (University of Sydney, Australia); Ming Ding (Data 61, Australia)

Ambient backscatter communication (AmBC) has become a promising technology to the Internet of Things (IoT) due to its low cost and high energy-efficiency. Since the AmBC shares the same frequency band with the conventional system, they can be considered as a spectrum sharing system. In this paper, we first focus on the minimization of the secondary (i.e., AmBC) system's outage probability by optimizing the power allocation strategy with perfect channel state information (CSI). Then, a more practical scenario where the CSI is imperfect is considered. A new power allocation strategy is proposed by introducing a channel power protection gap to improve the robustness of the secondary system. Finally, extensive numerical results show that as such protection gap increases, the decrease of the additional outage probability slows down. Therefore, with a certain tolerance of the additional outage probability, the primary transmitter can save its transmit power by using a proper channel power protection gap.

pp. 129-134

14:40 *A Study on Fiber-Optic Relaying Scheme using Spatial Modulation for MIMO transmissions*

Ikuya Kitamura, Hong Zhou and Kazuo Kumamoto (Osaka Institute of Technology, Japan); FengPing Yan (Beijing Jiaotong University, P.R. China)

In order to decrease system implementation costs of fiber-optic relaying system for MIMO mobile transmissions, we have proposed a novel relaying schemes using SM technology. In this paper, we have study the performance of the proposed scheme with multiple RoF links. Computer simulations have confirmed that the proposed scheme can achieve much better transmission performance than the conventional relaying scheme thanks to strong transmission diversity effectiveness. Computer simulations also show that the optimum number of RoF links of the proposed scheme for 4×4 MIMO transmissions is around 2 and 3, while the optimum number of RoF links for 8×8 MIMO transmissions is around 3 and 4.

pp. 135-138

15:00 *Optimization of LED Layout to Improve Uniformity of Illumination and SNR for Indoor Visible Light Communication*

Quanrun Chen, Tao Zhang and Weibo Zheng (Chinese Academy of Sciences, P.R. China)

Compared with the traditional LED array layout, our paper consider the reflection of the wall and study layout schemes of different LED topology. By adjusting the topological distribution, we proposed square array combined with circular ring layout model. This model reduces the power consumption of system and ISI. With satisfying indoor lighting, it provides dynamic range compression of illumination and SNR by power distribution. Simulation results show that the number of light sources used in our layout is reduced by 48 compared with the traditional layout, and improve illuminance distribution, received power distribution, SNR distribution and bit error rate.

pp. 139-141

Wednesday, November 21 15:20 - 15:40

AT1: Afternoon Tea

Room: Foyer

Wednesday, November 21 15:40 - 17:00

S10: Session 10: Wireless

Room: M10

Chair: Shuo Li (RMIT University, Australia)

15:40 *Channel-based Rate Selection for Commodity RFID Networks*

Jiajia Guo (University of Science and Technology of China, P.R. China); Caidong Gu (Suzhou Vocational University, P.R. China); Si Chen (Simon Fraser University, Canada); Hongwei Du and Xiaoxiao Wang (University of Science and Technology of China, P.R. China); Jihong Yu (Beijing Institute of Technology/ Simon Fraser University, P.R. China); Wei Gong (University of Science and Technology of China, P.R. China)

Backscatter communication has been an emerging research field in power-constrained and short-range wireless sensor networks. In RFID networks, sensors need to transfer masses of sensing data via backscatter communication. In order to meet this need, we propose a novel Channel-based Rate Selection framework (CRS). Specifically, we design a novel channel selection algorithm that covers each backscatter node at first and benefits as many nodes as possible meanwhile. Then, considering the difference among the rate requirements of different backscatter nodes, we choose different data rates for different nodes on a selected channel. We implement all experiments via traces captured by a commercial reader. Experiment results show that CRS achieves up to 21.4% throughput gain compared with state-of-the-art rate adaptation algorithm.

pp. 142-147

16:00 *An Enhanced K-means Clustering Algorithm with Non-Orthogonal Multiple Access (NOMA) for MMC Networks*

Emerson Cabrera and Rein Vesilo (Macquarie University, Australia)

In this paper, we address the need for motivating applications, such as sensor nodes, to operate under the Massive Machine to Machine Communication (MMC) mode in the future 5G cellular wireless network, while under constraints such as energy efficiency, etc. It has been shown that the Random Access CHannel (RACH) in LTE-A cannot handle the possible simultaneous access of network resources by the billions of devices expected within an MMC Network. Thus, an enhanced K-means clustering algorithm accompanied by Non-Orthogonal Multiple Access (NOMA) is proposed, where each strong channel gain device is allocated to the appropriate cluster as a cluster head (CH) to enhance the network sum throughput. A performance analysis is conducted, where our proposed scheme was shown to have a higher network sum throughput than the traditional K-means, with a minimum rate requirement of 100-1000 kbps.

pp. 148-155

16:20 *Analysis of Interference Mitigation in Heterogeneous Cellular Networks using Soft Frequency Reuse and Load Balancing*

Muhammad Sajid Haroon and Ziaul Haq Abbas (GIK Institute of Engineering Sciences and Technology, Pakistan); Ghulam Abbas (GIK Institute of Engineering Sciences & Technology, Pakistan); Fazal Muhammad (City University of Science and Information Technology, Peshawar, Pakistan)

One of the promising solutions to meet the demands for ubiquitous coverage and high capacity in heterogeneous cellular networks (HCNets) is the co-deployment of small base stations (sBSs) inside the coverage region of a macro base station (mBS). Due to its high transmit power, most of the users get associated with mBS. This results in imbalanced load distribution across the HCNets. To balance the load, users from mBS are offloaded to low power sBSs to decrease the mBS load and increase network capacity. However, mBS now acts as a strong interferer for offloaded users. Therefore, a proactive interference mitigation technique together with load balancing is required to mitigate the interference and balance the network load. In this paper, we use the soft frequency reuse (SFR) scheme to abate such interference. Furthermore, we use cell range expansion (CRE) based cell association where coverage regions of sBSs are increased by using cell association bias to include more users. Moreover, we derive coverage probability expressions for the proposed model. Numerical results demonstrate that the SFR scheme together with association bias

pp. 156-161

16:40 *Energy-Detection performance for SIMO Cognitive Radio Systems with Selection Combining over \kappa_\mu Shadowed Fading Channels*

Mohammed Aloqlah (Dubai Women's College, UAE); Reem Alzubaidi (Yarmouk University, Jordan)

In this paper, we are interested in analyzing and evaluating the performance of energy detection (ED) - based - spectrum sensing (SS) systems that operate over the \kappa-\mu shadowed fading channels with selection combining (SC) diversity. In particular, novel, unified, and accurate analytical expressions for the average detection probability (\bar{P}_d) and the average area under the receiver operating characteristic curve (average AUC) are derived. Note that, the derived theoretical solutions are presented for the particular case when both fading parameters, namely \mu and m are integer values. To that end, the derived expressions are then used to address the implication of the fading channel conditions and the number of receive antenna branches on the detection performance. Finally, the validity of the correctness of theoretical derivation is tested against extensive Monte-Carlo simulation results, considering a wide range of average signal-to-noise ratio (SNR) and the choice of different values of the fading parameters while employing different number of branches.

pp. 162-167

Wednesday, November 21 15:40 - 17:20

S9: Session 9: IoT

Room: M18

Chair: Hassan Habibi Gharakheili (University of New South Wales, Sydney, Australia)

15:40 *RF Energy Harvesting and Information Transmission in IoT Relay Systems based on Time Switching and NOMA*

Ashish Rauniyar (University of Oslo, Norway); Paal E. Engelstad (Oslo and Akershus University College, University of Oslo/UNIK and FFI, Norway); Olav Norvald Østerbø (Telenor Corporate Development, Norway)

A huge expansion of billions of Internet of Things (IoT) sensor and devices is expected over the next few years which will consume more power. Therefore, energy efficiency is a major concern for the development of fifth generation (5G) wireless systems. In wireless communication systems, energy harvesting (EH) is an emerging paradigm that allows the sensor nodes to recharge themselves through radio frequency (RF) signals directed to them from the source node and then relaying or transmitting the information. Although a myriad of works have been carried out in the literature for EH, the absolute vast majority of those works only consider RF EH at relay node and transmission of source node data successfully to its destination node. Those approaches do not consider the data transmission of the relay node that may be an IoT node which needs to transmit its data along with the source node data to their respective destinations. Thus, such approaches are clearly ineffective for energy efficient IoT relay systems. In this paper, we rather focus on RF EH and information transmission based on time switching (TS) relaying and non-orthogonal multiple access (NOMA) for IoT relay systems. A source node information data is relayed through power constrained IoT relay node that first harvests the energy from source node RF signal using TS protocol and then transmits source node information along with its information using NOMA protocol. We have mathematically derived analytical expressions for outage probability, throughput, and sum-throughput for our proposed system. We have also formulated an algorithm to find out optimal TS factor that maximizes the sum-throughput for our proposed system. Our proposed system analytical results are validated by the simulation results.

pp. 168-174

16:00 *Multiple Intermittent Controllers for IoT Home Automation*

Tyler Steane and Pj Radcliffe (RMIT University, Australia)

The central controller in home automation systems is problematic but eliminating it requires the functionality to be redistributed. This paper considers the problem of maintaining up-to-date status information for devices with multiple intermittent controllers such as smartphones. In order to suggest a robust protocol to handle this functionality, key insights from existing protocols, MQTT and CoAP are identified. This work then informs the proposal for four novel protocols which are then implemented and tested for comparison of their packet efficiency. It is demonstrated that the combination of devices registration and packet broadcasting makes for the most efficient protocol and should form the basis for further work going forward.

pp. 175-180

16:20 *CamThings: IoT Camera with Energy-Efficient Communication by Edge Computing based on Deep Learning*

Jaebong Lim, Juhee Seo and Yunju Baek (Pusan National University, Korea)

In recent years, the demand for IoT camera is increasing due to the increasing demand for image data on the IoT. However, the image sensor is not suitable as an energy-constrained edge device of IoT because of high power consumption. Therefore, the periodic on-off scheduling for IoT camera is a promising approach since continuous video recording with image sensor has large power consumption. Due to the constrained computing performance of edge devices, IoT is still based on cloud computing with energy leaks. When an image is transmitted from an edge device to a cloud server, there is a problem that power consumption is large due to wireless communication with a large size of image data. In this paper, we proposed energy-efficient communication by edge computing based deep learning, which reduces power consumption by transmitting only interest images classified with edge computing. We also designed and implemented CamThings that an energy-efficient IoT camera with periodic on-off scheduling and energy-efficient communication that we proposed. To analyze and evaluate the efficiency of the proposed energy-efficient communication, we proposed a power consumption model of CamThings. In an environment with low ratio of interest images, the proposed method that CamThings is superior to baseline method with only periodic on-off scheduling in terms of power consumption and lifetime. When scheduling period T is 5s and interest ratio is 0.1, The proposed method shows 41% less power consumption than the baseline method. As a result, CamThings has lifetime about more than one month.

pp. 181-186

16:40 *S-MANAGE Protocol For Software-Defined IoT*

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

The Internet of Things (IoT) has started to make a real impact with many IoT-based services in agriculture, smart farming, smart cities, personal health, and critical infrastructures. Sensor/IoT devices form one of the indispensable elements in these IoT systems and services. An effective IoT system requires the interoperability among its heterogeneous physical devices, but this presents a significant challenge regarding various communication protocols, networking management policies, as well as data processing approaches. Software-defined paradigm is considered essential for managing and provisioning IoT services on demand. An emerging solution is the application of software-defined networking (SDN) and Network Function Virtualization (NFV) in programming WSN/IoT systems. However, these technologies cannot be directly deployed due to the differences in the functionality of SDN network devices and sensor/IoT devices as well as the limitation of resources in IoT devices. We proposed the software-defined IoT(SD-IoT) model in our earlier work. This paper focuses on the S-MANAGE protocol that enables an SD-IoT controller to control and manage sensor/IoT devices via their virtual representation, called software-defined virtual sensors (SDVS). The paper presents in detail the design and the implementation of the S-MANAGE southbound protocol.

pp. 187-192

17:00 *Situational and Adaptive Context-Aware Routing for Opportunistic IoT Networks*

Jaime Galán-Jiménez, Javier Berrocal Olmeda and José García-Alonso (University of Extremadura, Spain); Carlos Canal (University of Málaga, Spain); Juan Manuel Murillo Rodriguez (University of Extremadura, Spain)

The increased capabilities of embedded devices have made them smarter and able to adapt themselves to their users' needs and preferences. Nevertheless, this adaptation has been limited to a single device or to a small number of them. Moreover, the Internet of Things (IoT) paradigm requires

to coordinate a huge number of devices and to adapt them to their users' context, which will lead to an increase in the traffic exchanged between these devices and the cloud. In this paper, the definition of Opportunistic Context-Virtual Networks (OCVNs), and a novel routing algorithm, namely Situational and Adaptive Context-Aware Routing (SACAR), are proposed to dynamically adapt the users context to the opportunistic IoT network environment they belong to at a given time. By taking advantage of the computing capacities of the nodes, and under simulations over a realistic reference scenario, SACAR outperforms other well-known opportunistic routing algorithms in terms of packet delivery ratio, reducing both average latency and network overhead.

pp. 193-198

Thursday, November 22

Thursday, November 22 8:40 - 10:00

S11: Session 11: Wireless

Room: M10

Chair: Frank den Hartog (University of New South Wales & DoVes Research, Australia)

8:40 *Radio-Frequency Emitter Localisation Using a Swarm of Search Agents*

Bradley R Fraser (Defence Science and Technology Group & The University of Adelaide, Australia)

Gradient-based methods of radio-frequency localisation can be used to track and locate an unknown radio-frequency (RF) emitter. However, due to the nature of wireless propagation, the signal gradient is not smooth. To overcome this issue, this paper considers the use of a swarm of mobile sensors that exploits its geographic distribution and network topology to effectively locate a source emitter in a distributed fashion. Through simulation, trade-offs in the swarm configuration are explored and the efficacy of the approach is confirmed.

pp. 199-204

9:00 *Wi-Fi Based Device-free Microwave Ghost Imaging Indoor Surveillance System*

Ruichen Luo (University of Sydney, Australia); Ziqian Zhang (the University of Sydney, Australia); Xiaopeng Wang and Zihuai Lin (University of Sydney, Australia)

In this paper, we propose an Wi-Fi based device-free microwave ghost imaging (GI) indoor surveillance system. Wireless-Fidelity (Wi-Fi) signals originally designed for communication purposes are employed as the incoherent illumination source in the framework of microwave GI. The object reconstruction procedure of microwave GI is modified to fit indoor scenarios where both stationary and moving objects are presented. Numerical simulation validates that the proposed Wi-Fi based microwave GI scheme can effectively isolate indoor targets reflections with different velocities and obtain focused images respectively. Since the proposed system takes the advantage of existing Wi-Fi access points (APs) as its transceivers, it can be regarded as a device-free system and its complexity and operational cost have been significantly reduced.

pp. 205-210

9:20 *A Reinforcement Learning Based User Association Algorithm for UAV Networks*

Qingzhi Li (University of Sydney, Australia); Ming Ding (Data 61, Australia); Chuan Ma, Chang Liu and Zihuai Lin (University of Sydney, Australia); Ying-Chang Liang (University of Electronic Science and Technology of China, P.R. China)

There have been increasing interests in employing unmanned aerial vehicles (UAVs) such as drones for telecommunication purpose. In such networks, UAVs act as base stations and provide downloading service to users. Compared with conventional terrestrial base stations, such UAV-BSs can dynamically adjust their locations to improve network performance. However, there exist two important issues in UAV networks, handoff overhead, and UAV deployment. The handoff overhead issue is particularly important for UAVs because UAV BSs are connected to cellular BSs via wireless backhaul links, which are costly in terms of spectrum usage and energy consumption. Hence, it is highly desirable to eliminate any unnecessary handoff to minimize the waste of wireless backhaul. The UAV deployment, on the other hand, introduces a new tool for radio resource management, since BS positions are open for network optimization. In this paper, a smart user association algorithm, named reinforcement learning handoff (RLH), is devised to reduce redundant handoffs in UAV networks and two methods of UAV mobility control are designed to co-operate with the proposed RLH algorithm to optimize the system throughput. In the RLH algorithm, users perform handoffs according to the reward of a reinforcement learning process. In UAV deployment two UAV mobility control methods are proposed respectively base on the SNR estimation and based on the K-Means approach. According to our simulation results, the RLH algorithm can reduce the number of handoffs by 75%.

pp. 211-216

9:40 *NC-MapCast: Network Coding based Multi-Attribute Profile-Cast in Mobile Opportunistic Networks*

Di Zhang, Huadong Ma, Dong Zhao and Lei Kuang (Beijing University of Posts and Telecommunications, P.R. China)

Profile-cast is a novel data dissemination paradigm in mobile opportunistic networks, which allows messages to be disseminated to nodes defined by their profiles rather than network identities. Profile-cast has attracted increasing attention, but most of existing algorithms cannot account for some scenarios where multiple attributes need to be considered simultaneously in a profile. By contrast, we focus on the Multi-Attribute Profile-Cast (MapCast), where the concept of group profile is defined, and a new high-efficient algorithm, Group-profile based MapCast (G-MapCast), is proposed to limit the scope of message forwarding or delivering to the nodes whose profile or group profile are similar to the target profile. To further reduce the network overhead, we propose another Network Coding based MapCast (NC-MapCast) algorithm on the basis of G-MapCast, which can meanwhile reduce the message decoding time. Real human contact dataset driven simulations are conducted to verify the effectiveness of our algorithms.

pp. 217-222

S13: Session 13: General

Room: M11

Chair: Nazmus Shaker Nafi (VIT, Australia)

8:40 *Joint Design of Relay-User Selection in Direct-link Energy Harvesting Relay Networks*

Chenchen Liu, Jing Zhao, Jiaxi Zhou and Zhengyu Zhang (CETC, P.R. China); Weilong Ren (CETC38 China Electronic Technology Group Corporation, P.R. China)

In this paper, we investigate the outage performance of the proposed relay-user selection (RUS) scheme for amplifyand- forward full-duplex multi-relay multi-user network, where the direct link between the source node and the user node is used to convey information. Meanwhile, each relay node is energy-constrained and the simultaneous wireless information and power transfer technology is employed to harvest energy. A power splitter is equipped in each relay node to split the received signal into energy harvesting part and signal processing part. The closed-form and a simple asymptotic expression for outage probability is provided. Moreover, the optimal power splitting factor of each relay node is calculated to minimize the outage performance of the system. Finally, the numerical simulations are provided to validate the analysis.

pp. 223-226

9:00 *Bit Rate and Task Scheduling in Cloud Computing for Multimedia Big Data*

Chae Y. Lee and Byeongok Choi (KAIST, Korea)

As video traffic increases with plentiful multimedia services and the proliferation of mobile devices such as smartphones, stream mining to extract valuable information out of multimedia big data is garnering attention. By applying cloud computing to stream mining, resource-scarce mobile devices can offload the workloads of heavy applications to a remote cloud. However, resource provisioning for task scheduling is an inherent challenge of stream mining in cloud computing. In this paper we consider problem of resource provisioning and bit rate scaling for multimedia big data processing. We aim to minimize the virtual machine (VM) leasing cost and the classification error cost while satisfying the deadline constraints of workloads which is formulated as a mixed integer nonlinear programming. Deadline based task scheduling and bit rate scaling are developed to find near optimal solution of the NP-hard problem. The upper and lower bounds of the required number of VMs are obtained for infeasible and feasible schedules respectively. Scaling down the highest bit rate first in the bit rate set of a workload is suggested to guarantee the minimum increase of error cost. Our simulation results show the efficiency of bit rate scaling in task scheduling. 5-10% cost reduction is achieved by bit rate scaling in a cloud computing environment.

pp. 227-231

9:20 *Comparison of learning techniques for prediction of customer churn in telecommunication*

Sarbjeet Singh (Panjab University, Chandigarh, India); Manpreet Singh and Nadesh Seen (UIET, Panjab University, Chandiagarh, India); Sakshi Kaushal and Harish Kumar (Panjab University, India)

Customer Churn is a challenging issue that can affect many businesses and is one of the most demanding issues in the telecom sector. The primary motivation of businesses at present is just not only to acquire new customers, but to retain existing customers as well. In fact, customer retention is more important because of the associated high costs. The present work has been carried out in a churn prediction modeling context and benchmarks four machine learning techniques against a publicly available telecommunication dataset. The results provide two important conclusions: i) Random Forest technique outperforms other basic classification models and ii) Feature Engineering plays critical role in the performance of the model.

pp. 232-236

9:40 *Performance Analysis of Polling Mechanism in WBAN*

Khalid Hasan (Griffith University, Australia); Khandakar E Ahmed (Victoria University, Australia); Kamanashis Biswas (Griffith University, Australia)

Medium Access Control (MAC) design is one of the essential pre-requisites for successful implementation of a wireless network, particularly in the application of health monitoring in other words Wireless Body Area Network (WBAN). IEEE 802.15.6 defines different access mechanisms for WBAN including contention based, scheduled/unscheduled and polling mechanisms. In this paper, we focus on the analysis of polling mechanism and the impact on WBAN. We derive an analytical model from examining the mean waiting time, delay and throughput, and present the analytical result for varying transmission rate, nodes and payload size. This elemental analysis provides significant insight into implementing polling mechanism that corresponds to realistic physiological data. Our study also provides an explanation that could be taken into consideration while realizing WBAN.

pp. 237-240

S12: Session 12: Wireless

Room: M18

Chair: Hassan Habibi Gharakheili (University of New South Wales, Sydney, Australia)

8:40 *Context-Aware and Energy-Efficient Protocol for the Distributed Wireless Sensor Networks*

Da-Ren Chen (National Taichung University of Science and Technology, Taiwan); Ming-Yang Hsu (National Taichung University of Science and Technology, Taichung, Taiwan)

Wireless sensor network (WSNs) are composed of a large number of battery-powered wireless sensors, which acquire and monitor physical data from their surroundings through self-organization. Sensors are deployed randomly in a target area where maintenance and battery replacement are difficult or even impossible. To effectively save energy and prolong network lifetimes, networks typically adopt clustering protocols with hierarchical inter-cluster topologies for network management and data acquisition in WSNs. However, such solutions require cluster re-configuration due to early death of cluster heads (CHs) and energy inefficiency. This paper proposes a coverage- and energy-aware protocol with intra- and inter-cluster methods called CEMST based on newly defined parameters for sensor overlapping and node density functions. In addition, to adapt network dynamics while improving energy efficiency, a self-stabilizing algorithm is proposed with the Borůvka algorithm to respectively construct minimum spanning trees (MST) for intra- and inter-cluster routes. Simulation results indicate that CEMST yields more balanced clustering structures than previous efficient protocols, and provides longer network lifetime than those methods.

pp. 241-246

9:00 *Detection of Primary User Emulation Attack in Sensor Networks*

Md Rana (University of Engineering and Technology, Bangladesh); Mazed Rayhan Shuvo (ECE, Bangladesh)

In sensor nodes, localization is very important characteristic in wireless sensor network. By using localisation technique, it can find out the position of any sensor node in the network. Technically, unlicensed users in this network share the spectrum of primary users using a spectrum sensing process while do not cause significate interference to the primary users. Unfortunately, the spectrum sensing process is hampered by security problem called primary user emulation attack. In this paper, the aforementioned problem is solved using the localization defense model with proposed weighted least square algorithm. In this scheme, sensor nodes or secondary users cooperate together to detect and localize the attacker by comparing its location with the position of the primary user. Afterwards, the nonlinear output equations of localisation is linearised using the Taylor series. Finally, the weighted least square algorithm is proposed. The proposed method can be effectively computed the optimal writhing factor to minimise the estimation error. Numerical simulation results are compared with the existing approaches such as linear least square, subspace, nonlinear least square, and maximum likelihood. It shows that the proposed optimization algorithm provides significate performance improved compared with the aforementioned algorithms.

pp. 247-252

9:20 *Beam Detection Analysis for 5G mmWave Initial Acquisition*

Mahbuba Ullah (University of Texas, USA)

In conventional initial acquisition (IA) process, a base-station (BS) periodically transmits synchronization signals called pilot signals on downlink (DL) channels to assist a user-equipment (UE) to connect to the cellular system. This paper introduces a new approach where the IA is done on an uplink (UL) channel where pilot beams are detected by multiples base station's receivers. A primary contribution of the paper is the development of an analysis technique that can compare various mmWave IA schemes including detection of directional pilot beams transmitted by multiple transmitters (as in conventional downlink IA process) and the newly proposed UL scheme. The analysis deduces a metric called the non-centrality parameter that quantifies the detection performance with respect to the pilot signal's duration and bandwidth, the number of sweeping beams, total transmitted power per beam, and the antenna size at the receiver(s). The above selection of design parameters for IA processes allows us to investigate the overall impact of the various IA schemes on power consumption, latency, or hardware implementation complexity. The analysis and simulation results show that the proposed UL scheme does not compromise on the detection performance compared to the conventional DL schemes. Furthermore, we show via simulation that pilot signal's bandwidth and sweeping beam's directional offset can attribute to large variations in detection performances. From these results we conclude that an UL scheme can provide a low latency and a flexible cell search process catered to each mmWave transmission channel between a BS and an UE.

pp. 253-260

9:40 *Proximity Coordinated Random Access (PCRA) for M2M Applications in LTE-A*

Jason Brown (University of Southern Queensland, Australia); Jamil Y Khan (The University of Newcastle, Australia)

A significant amount of research has been conducted on adapting 3GPP Long Term Evolution (LTE) and LTE-Advanced (LTE-A) random access to be more efficient for machine-to-machine (M2M) devices because of the huge number of such devices that may reside in each LTE/LTE-A cell. However, there are other attributes of M2M applications that can be used as the basis of independent efficiency improvements. One characteristic which has been overlooked thus far is the spatial and temporal correlations that often exist in the activity of neighboring M2M devices belonging to the same M2M application. In this paper, we illustrate how these correlations can be exploited by coordinating the preambles to be used by neighboring M2M devices to reduce the number of collisions during LTE-A random access, particularly in wireless sensor network (WSN) type applications. The technique is referred to as proximity coordinated random access (PCRA). Through simulation of an example local preamble coordination algorithm that can be executed autonomously by randomly deployed devices of the same M2M application, we demonstrate an increase in the efficiency of the random access process.

pp. 261-263

Thursday, November 22 10:00 - 10:40

K3: Keynote

IoT+AI: Opportunities and Explorations

Professor Huadong Ma

Room: M18

Chair: Shui Yu (University of Technology Sydney, Australia)

The Internet of Things (IoT) can enable the interconnection and integration of the physical world and the cyber space, and has been widely considered as the kernel technology for sensing the urban environments and providing smart services further. At the same time, the rapid development of Artificial Intelligence (AI) brings many opportunities to IoT. In this talk, we first introduce the challenges of intelligent sensing networks for smart urban. Combing AI theory, we discuss some explorations and recent research progresses on sensing, networking and computing, and service in the IoT environment. Finally, we outline the prospects of IoT development.

Thursday, November 22 10:40 - 11:00

MT2: Morning Tea

Room: Foyer

Thursday, November 22 11:00 - 11:40

K4: Keynote

Towards a Secure Automated Multicloud

Diogo Montagner

Room: M18

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

Networks are designed to connect things. Over the years, the context defined by 'things' has changed dramatically. From simple mail transfer applications to advanced artificial intelligence bots that can control your entire house, the architecture of software applications have evolved from standalone applications running on LANs to distributed applications running over the WAN. Next, they evolved from running within the private DCs to the public clouds, and more recently, they evolved to a multicloud environment. The architecture of these applications became far more complex than what they used to be. The same happened with the networks used to connect these applications. In order to enable this evolution, the networks have evolved considerably over the last few years.

In this presentation we will look how Software Defined Networks are enabling this transformation by abstracting away the complexity of dealing with hybrid network environments and delivering networks that are scalable, automated and secure.

Bio: Diogo has worked in the networking industry for over 18 years. He is a passionate fullstack network engineer and occasional technical author and book reviewer. Diogo currently works as automation and software expert for Juniper Networks in APAC where he helps customers to design and deploy automation and software solutions.

Thursday, November 22 11:40 - 12:30

WK2: Workshop 2: Juniper Contrail SDN Deep Dive

Room: M18

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

Thursday, November 22 12:30 - 13:30

L2: Lunch

Room: Foyer

Thursday, November 22 13:30 - 17:30

C1: Conference Tour

Conference Tour

Room: Coogee Beach

Chair: Ayyoob Hamza (University of New South Wales, Australia)

Conference tour leaving Coogee Beach near the bus stop at 1.30pm and walking to Bondi Beach along the coast. Walk or bus back to the Crowne Plaza Coogee Beach Hotel for the Conference Dinner.

Thursday, November 22 18:00 - 23:00

D1: ITNAC 2018 Dinner

Annual Dinner

Room: Crowne Plaza Coogee Beach Hotel

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

The conference dinner commences at 6pm at the Crowne Plaza Coogee Beach Hotel.

Friday, November 23

Friday, November 23 9:00 - 11:00

WK3: Workshop 3: SDN and NFV with open-source and white-boxes

Bld G17 Room 436

Chair: Vijay Sivaraman (University of New South Wales, Australia)

Sponsored by Canopus Networks Pty Ltd (https://canopusnet.com)

Location: UNSW Electrical Engineering Building (G17 on map) Room 436 (SDN lab) Agenda: This workshop will cover:

1. Use-cases of SDN and NFV
2. Eco-system of white-box hardware and open-source software for SDN/NFV
3. Hands-on experience with OpenFlow match-action rules and Ryu controller applications
4. Walk-through of NFV applications
5. Future trends in programmable networks

Participants are encouraged to bring their own laptops with the Chrome browser and the "postman" plug-in.

Friday, November 23 9:00 - 10:40

S16: Session 16: Quality and Performance

Room: M10

Chair: Markus Fiedler (Blekinge Institute of Technology, Sweden)

9:00 *Cloud Applications Consolidation through Context Information and Heuristic Optimization*

Alessandro Carrega and Matteo Repetto (CNIT, Italy)

Resource consolidation has been proposed as an effective mechanism to save energy in data centers. Several algorithms have been developed for this purpose, which use the minimal number of servers and network switches, and power off unused equipment. Consolidation algorithms usually take into account static service constraints (CPU, RAM, disk, bandwidth), but do not consider dynamic context information, as CPU utilization and the specific role of each Virtual Machines in the running application (e.g., core component, backup replica, member of a pool of workers for load balancing). In this paper, we describe and evaluate a novel heuristic-based consolidation strategy that explicitly considers context information. Our approach avoids running idle VMs that are pre-provisioned for availability and redundancy purposes, hence pursuing a better linear relationship between power consumption and actual computation than other existing algorithms. We demonstrate through simulations, by comparing different heuristics, the optimal trade-off between service level and energy efficiency achieved by our approach.

pp. 264-271

9:20 *Towards information modeling for a QoS-aware support in the lifecycle of virtual networks*

Gladys Diaz (University of Paris 13 & L2TI, Institut Galilee, France); Michelle Sibilla (University of Toulouse 3 - Paul Sabatier & Institut de Recherche en Informatique de Toulouse, France); Noëmie Simoni (Telecom-Paristech, France)

Information network modeling is a hot area of research in the last years. In special the introduction of virtualization technologies changes the life cycle of systems. Virtualization enables to consider separate levels for applications, networks, and computing resources and services. The design of new virtual networks must consider the requirements of all these levels. Quality of Service (QoS) is the key aspects to be integrated. We focus in this paper the virtualized environments where we define a generic concept, named the VirtualElement. In special, we are interested in the representation of information enabling the automation of deployment, monitoring and management tasks for virtual networks. For this purpose we characterized the VirtualElement by constrains representing its functional and not- functional behavior. We apply our model at different phases of lifecycle of virtual networks by defining the service profiling. We propose a translation of the virtual network into an OVF++ file.

pp. 272-277

9:40 *Are Internet Tunnels Worthwhile?*

Habiba Akter and Chris Phillips (Queen Mary University of London, United Kingdom (Great Britain))

Despite a significant increase in capacity of the Internet regional congestion remains an issue at certain times of day. Dimensioning the system to provide minimal delay under these transient conditions would be uneconomical, particularly as various forms of application data are more or less sensitive to these delays, as are different end-users. We therefore investigate a scheme that allows end-users to selectively exploit a sequence of mini tunnels along a path from their origin to a chosen destination. We assume the availability of such tunnels is advertised centrally through a broker, with the cooperation of the Autonomous System (AS) domain operators, allowing end-users to use them if so desired. The closest analogy this scheme is that of a driver choosing to use one or more toll roads along a route to avoid potential congestion or less desirable geographic locations. It thus takes the form of a type of loose source routing. Furthermore, the approach avoids the need for inter-operator cooperation, although such cooperation provides a means of extending tunnels across AS peers. In this paper we ascertain the benefit in terms of delay for a given degree of tunnel presence within a portion of the Internet. The expectation is that a relatively small number of tunnels may be sufficient to provide worthwhile improvements in performance for some users at least.

pp. 278-283

10:00 *Sleep-based Resource Allocation Algorithm for Inter-Femto Interference Mitigation*

Weilong Ren (CETC38 China Electronic Technology Group Corporation, P.R. China); Letian Li (University of Science and Technology of China, P.R. China); Chenchen Liu (CETC, P.R. China); Yao Yanjun (University of Science and Technology of China, P.R. China); Shuo Wang (No. 38 Research Institute China Electronics Technology Group Corporation, P.R. China)

With the increasing tendency of dense femtocell deployment, the inter-femtocell interference has become one of the most critical issues that need to be concerned in future cellular networks. In this paper, we propose a novel dynamic base station sleep based resource allocation algorithm to mitigate the interference among femtocells. First, we build an interference map to indicate whether a user is interfered by any femtocell base station (FBS). Then, to reduce the inter-femtocell interference, we design a set of sleep criterions based on the interference map to let certain FBSs to be deactivated, which is proved to be more effective than the existing base station sleep methods. On the basis of the sleep control, we propose a heuristic resource allocation algorithm to get the optimal allocation of subchannel and power, which achieves a remarkable overall performance and outperforms other methods, such as the random assignment method and the self-organizing method. Moreover, the proposed algorithm is especially suitable for the scenario with dense femtocell deployment.

pp. 284-289

10:20 *Performance Comparison of WhatsApp versus Skype on Smart Phones*

Nayankumar Patel, Swapnil Patel and Wee Lum Tan (Griffith University, Australia)

This paper presents the findings of our study into the performance of two popular instant messaging applications: WhatsApp and Skype. We have evaluated the performance of WhatsApp and Skype in terms of their data consumption/usage when sending text messages and making VoIP calls, as well as the quality of the VoIP calls made with these applications. Our results show that WhatsApp uses less data compared to Skype when sending text messages and making VoIP calls. We also find that both applications have similar VoIP call quality (mean opinion scores) when network conditions are good. However under poor network conditions, WhatsApp VoIP call quality is better than that of Skype. Our results will be useful to smart phone users who have mobile plans with limited data allowance, and provides guidance to them in terms of their selection of which instant messaging app is more suitable for them.

pp. 290-292

S15: Session 15: Security

Room: M11

Chair: Sakshi Kaushal (Panjab University, India)

9:00 *LSTM for Anomaly-Based Network Intrusion Detection*

Kaushik Roy and Sara Althubiti (North Carolina A&T State University, USA)

Due to the massive amount of the network traffic, attackers have a great chance to cause a huge damage to the network system or its users. Intrusion detection plays an important role in ensuring security for the system by detecting the attacks and the malicious activities. In this paper, we utilize CIDDS dataset and apply a deep learning approach, Long-Short-Term Memory (LSTM), to implement intrusion detection system. This research achieves a reasonable accuracy of 0.85.

pp. 293-295

9:20 *Blockchain in IoT Security: A survey*

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

Blockchain shows a huge prospective in the coming future as it is currently in its initial state. It is a technology that provides the possibility of generating and sharing transaction ledgers that are tamper proof. Use cases of Blockchain are enlarging in numbers and width in multiple areas like, Internet of Things (IoT), finance and security. Even though many public and private sectors are introducing this technology nowadays, it remains a fear to others due to their lack of familiarity and the point of it not taking any big role in any major security enterprises till now. In this paper we will explain what is a blockchain and define its characteristics, benefits, types, and the differences between them and how to choose the suitable type that accommodates your needs. Then we will discuss blockchain security (For public and private blockchains) and compare it with a standard cyber security environment and discuss both of them in different cyber-attack scenarios.

pp. 296-299

9:40 *Feature-Selection based PMU Placement for Detection of Faults in Power Grids*

Rana Alhalaseh, Halil Alper Tokel, Subhodeep Chakraborty, Gholamreza Alirezaei and Rudolf Mathar (RWTH Aachen University, Germany)

The monitoring of power distribution networks and identification of system faults become more and more important as the overall power grid undergoes structural changes. Such changes are due to the increasing integration of distributed and volatile renewable generation units. This work focuses on strategies for the placement of phasor measurement units (PMU) in a power distribution system, such that the detection and classification of line outages can be facilitated accurately. The determination of sensor locations is based on a feature selection approach, where the measurement locations, which provide the most informative input to the supervised learning techniques, are successively selected until the required classification accuracy is obtained. Hence, the number of required PMUs is minimized without jeopardizing the detection accuracy. The proposed methodology is applied to benchmark distribution systems, where simulated data is used for training deep neural networks (DNN), decision trees (DT), and random forests (RF) for fault detection and classification.

pp. 300-305

10:00 *Security threat probability computation using Markov Chain and Common Vulnerability Scoring System*

Ngoc LE and Doan B Hoang (University of Technology Sydney, Australia)

Security metrics have become essential for assessing the security risks and making effective decisions concerning system security. Many security metrics rely on mathematical models, but are mainly based on empirical data, qualitative method, or compliance checking and this renders the outcome far from accurate. This paper proposes a novel approach to compute the probability distribution of cloud security threats based on Markov chain and Common Vulnerability Scoring System (CVSS). The paper gives an application on cloud systems to demonstrate the use of the proposed approach.

pp. 306-311

10:20 *AIS Reputation Mechanism in MANET*

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

In Mobile Ad hoc Networks (MANET) nodes act as a host as well as a router thereby forming a self-organizing network that does not rely upon fixed infrastructure, other than gateways to other networks. MANET has several features that can be leveraged when it is necessary to put in place a flexible network that supports node mobility, has a dynamic topology and is quick to deploy network that is not reliant on fixed infrastructure. MANET nodes transmit, relay and receive traffic from neighbor nodes as the network topology changes. Security is important for MANET and trust computation is an approach that is instrumental to improving collaboration amongst the nodes. MANET trust frameworks depend on the trust computation. If the trust computation is not resilient against attack, the trust values computed will be insignificant. This paper proposes an Artificial Immune System based approach to compute trust and thereby provide a resilient reputation mechanism.

pp. 312-317

S14: Session 14: Transport

Room: M18

Chair: Nazmus Shaker Nafi (VIT, Australia)

9:00 *Towards an Unified Multi-service Ethernet Transport Network(ETN)*

Qichang Chen (Huawei Technologies Corp., P.R. China); Rixin Li (Huawei Technologies Co., LTD, P.R. China); Hongbiao Zhang and Shuai Xiao (Huawei Technologies Corp., P.R. China); Qiwen Zhong (Huawei Technologies, P.R. China); Desheng Sun, Lehong Niu and Li Ding (Huawei Technologies Corp., P.R. China); Sen Zhang (Huawei, P.R. China)

With IP/Ethernet traffic becoming the predominant traffic in the data center and mobile backhaul, we propose an unified multi-service capable Ethernet Transport Network(ETN) architecture targeting for carrying future data-center interconnect, metro and 5G mobile traffic. In addition to Ethernet's best effort delivery, the envisioned ETN provides the reliable delivery, deterministic low latency, and transport network slicing capability, rich Ethernet-friendly in-path OAM and multiplexing capabilities for the short-haul and long-haul transmission. We have designed and implemented ETN prototype 1RU-sized switch boxes using FPGA and the experimental evaluation of the ETN prototype switches over the multi-service access and long-haul test cases demonstrates that ETN can provide hard traffic isolation for multiple types of service traffic, low forwarding latency with very low packet delay variation, and utilize the commercially available coherent transceivers to achieve the long distance transmission.

pp. 318-323

9:20 *HIDTN: Hybrid DTN and Infrastructure Networks for Reliable and Efficient Data Dissemination*

Yasser Mawad (Universität zu Lübeck, Germany); Stefan Fischer (University of Lübeck, Germany)

The development of future network architectures and of wireless devices needs to take the challenges in developing region into account. The unexpectedly intermittent connections due to sparse deployment, dynamic topology, or node mobility create a new challenge environment that has not been tackled before in both wired and wireless networks. Many developing regions' network infrastructures have a lack of a reliable connectivity, such as frequent packet losses and bit errors due to low-quality hardware, and frequent network disconnections. Delay Tolerant Networks were developed to be used as an advanced step towards building a future reliable interplanetary Internet. It has shown significant potential for building systems to deliver public services to remote parts of developing countries. Most of the current work has focused on the problem of message delivery within a single region with the same network infrastructure and namespace. However, many deployments in developing countries will probably involve routing between multiple regions, based on technologies such as WiMAX, Satellites or Ad-hoc networks with short-range radio devices, as in the case of mobile phones with Bluetooth interface. In this paper, we consider the design and implementation of an infrastructure based solutions that effectively handle the intermittent connection in DTNs, for a scenario with hybrid DTN and infrastructure networks (HIDTN) which employs the global handover technologies to manage the performance of developing regions' network infrastructures.

pp. 324-331

9:40 *Virtualized oneM2M System Architecture in Smartfactory Environments*

Changyong Um, Jaehyeong Lee and Jongpil Jeong (Sungkyunkwan University, Korea)

As Internet of Things(IoT) is actively researched and used, it is also emphasizing the need for IoT standards. IoT is an essential element to establish Cyber Physical System(CPS) of Smart Factory. Therefore, the IoT system of smart factory should be established so that the IoT system complies with the IoT standard. Container is a virtualization concept that benefits from rapid deployment, flexibility, stability and manageability. This paper proposes an architecture that utilizes container concepts in smart factory environments that comply with IoT standards.

pp. 332-337

10:00 *Integrating Routing Schemes and Platform Autonomy Algorithms for UAV Ad-hoc & Infrastructure based networks*

Ogbonnaya Anicho, Philip B Charlesworth, Gurvinder Baicher and Atulya K Nagar (Liverpool Hope University, United Kingdom (Great Britain))

This paper highlights the considerations for implementing unmanned autonomous or self-organising UAVs for communications area coverage with particular emphasis on the impact of aerial vehicle autonomy algorithms on routing techniques for such networks. UAV networks can be deployed either as ad-hoc or infrastructure based solutions. However, the challenges of topology changes due to mobility of the UAVs and impact on routing techniques may be a relevant research theme. This work examines the implications of autonomous coordination of multiple UAVs on routing techniques and network architecture stability. The paper proposes a solution where routing techniques and UAV autonomy algorithms are integrated for improved global network efficiency for both ad-hoc and infrastructure-based scenarios. Integrating UAV autonomy algorithms with routing schemes may be an efficient method to mitigate link/topology stability issues and improve inter-UAV communication and network throughput, a key requirement for UAV networks. The implementation of inter-UAV links using optical, microwave or mmWave transmission was examined as a critical element in the context of this work. The proposed integration may be crucial for communications coverage, where UAVs provide communications area coverage to community of mobile or fixed users in either ad-hoc or infrastructure based modes.

pp. 338-342

10:20 *Iterative Decision-Directed Receiver for the Mitigation of Side-Effect Modulation in indoor VLC applications*

Mohammed Mansoor Ahmed Mohammed, Cuiwei He and Jean Armstrong (Monash University, Australia)

Side effect modulation (SEM) has been shown to be an important impairment in visible light communication (VLC) systems. SEM is the unintended modulation of the light caused by the switched mode power supplies which are often used in light emitting diode (LED) luminaires. These power supplies may result in fluctuations in the driving current. In this paper, we investigate the performance of VLC in two different configurations. In both configurations, simulation results show that even low levels of SEM can substantially degrade the performance for most receiver positions. An iterative decision-directed receiver is described which mitigates the effect of SEM. In this receiver, the fundamental frequency component of SEM is estimated and removed from the received signal. The iterative processing is used to improve the estimation accuracy and thus improve performance. The iterative receiver is compared to the previously described decision-directed and pilot-assisted receivers. It is shown that, with only two iterations, the iterative decision-directed receiver effectively mitigates the impact of SEM.

pp. 343-348

Friday, November 23 10:40 - 11:10

MT3: Morning Tea

Room: Foyer

Friday, November 23 11:10 - 12:00

K5: Keynote

Advances in microwave photonic signal processing for 5G and IoT

Professor Robert Minasian

Room: M18

Chair: Vijay Sivaraman (University of New South Wales, Australia)

Next generation global telecommunication platforms and emerging applications in radar and communications will require entirely new technologies to address the current limitations of electronics for massive capacity and connectivity. Microwave photonics, which merges the worlds of RF and photonics, shows strong potential as a key enabling technology to enable new paradigms in the processing of high speed signals and in sensing that can overcome inherent electronic limitations. Photonic signal processors are intrinsically compatible with optical-wireless systems, and can provide connectivity with in-built signal conditioning, while also providing important advantages of EMI immunity. Moreover, photonic integration on semiconductor material platforms that co-exist with CMOS electronics enables boosting the performance of future systems performing sensing and communications with the potential for implementing high bandwidth, fast and complex functionalities. This integration technology is driven by high bandwidth optical communications and massive deployment of low-cost optical interconnects for datacom. Recent microwave photonic research advances will be presented in the context of 5G and the Internet of Things (IoT). This includes versatile beamforming for phased array antennas, widely tunable passband and interference rejection filters, high-speed frequency converters, dispersion-free microwave-optical links, and a range of high-resolution sensors.

11:10 ***Advances in microwave photonic signal processing for 5G and IoT***

Robert Minasian (University of Sydney, Australia)

Advances in microwave photonic signal processing for 5G and IoT are presented. Photonic signal processing offers a new powerful paradigm for processing high speed signals, due to its inherent advantages of wide bandwidth and immunity to electromagnetic interference. Recent trends are focused on realising photonic integrated circuits using silicon photonics that are compatible with CMOS electronics. Microwave photonic advances including versatile beamforming for phased array antennas, dispersion-free microwave-optical links, frequency conversion and filtering, and integrated high-resolution photonic sensors, are presented.

pp. 349-352

Friday, November 23 12:00 - 13:00

L3: Lunch

Room: Foyer

Friday, November 23 13:00 - 14:00

S17: Session 17: Traffic Management

Room: M10

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

13:00 *On Emptying Small Satellite Networks with In-Network Data Aggregation*

Luyao Wang (Beijing University of Technology, P.R. China); Kwan-Wu Chin (University of Wollongong, Australia)

Recently, small satellites such as pico, nano (cube) and micro class satellites have attracted much attention in both academia and industry thanks to their small size, low weight and cost. These satellites can form a swarm via Inter-Satellite Links (ISLs) and help each other download data to one or more Ground Stations (GSs). A key challenge is that each satellite only has a short contact period with different GSs over time. Henceforth, this paper considers the following objective: downloading a given amount of data from each satellite to ground stations within the shortest time. The main challenging issues are that satellites have different energy, and buffer constraints. We model the problem as a Mixed Integer Linear Programming (MILP). Its objective is to minimize the total number of slots taken to download a fixed amount of data from each satellite. Its key decision variables relate to (i) routing, (ii) link scheduling, and (iii) data aggregation rate in each time slot. Our results show that in-network data aggregation is able to significantly reduce the total download time by from 52% to 84% when the data aggregation rate is between 10% to 50%.

pp. 353-360

13:20 *Data Ferry Flocking for Bulk Information Transfer Under Ferry Buffer Constraints*

Bradley R Fraser (Defence Science and Technology Group & The University of Adelaide, Australia)

This paper considers the use of multiple ferries moving in a communications-connected formation, for the transfer of data around a disconnected network in a delay-tolerant fashion. A formation is generated by the flocking emergent behavior which, when considered as a single node, has a larger collective buffer size and footprint than an individual. It is shown through extensive analysis and simulation that ferrying data in this fashion yields shorter data latency under certain buffer size and geographic conditions than in current approaches where ferries act individually.

pp. 361-366

13:40 *Redundancy Management for Safety-Critical Applications with Time Sensitive Networking*

Maryam Pahlevan and Roman Obermaisser (University of Siegen, Germany)

In modern cyber physical systems like industrial automation systems and Advance Driver Assistance Systems (ADAS), safety is considered as the main concern. Failures in safety-time critical systems may lead to high economic losses as well as dangers for humans and the environment. Therefore, the Time Sensitive Networking (TSN) task group not only introduced real-time properties to Standard Ethernet, but also developed a novel fault-tolerance mechanism called Frame Replication and Elimination for Reliability (FRER). FRER offers highly reliable communication for Time-Triggered (TT) traffic. Simulation tools are seen as a cost and time efficient approach to evaluate and verify network protocols during the development phase and before the actual implementation. As no simulation model in the state-of-the-art implements the time-based features (e.g. time aware shaping and policing) and non-time-based properties (e.g. FRER) of TSN at the same time. Hence, in this paper we present a simulation model for temporal properties and redundancy management in TSN networks using the Riverbed simulation framework. In addition, we introduce the fault injection mechanisms to evaluate the reliability (e.g. violation of end-to-end deadline and packet loss) of TT communication based on FRER and different faults. We demonstrate the applicability of the framework using the realistic network use cases and traffic profiles.

pp. 367-373

S19: Session 19: Security

Room: M11

Chair: Leith Campbell (University of Melbourne, Australia)

13:00 *Performance Evaluation of Machine Learning Algorithms in Apache Spark for Intrusion Detection*

Kaushik Roy (North Carolina A&T State University, USA)

As the Internet continues to get stronger, so does the potential risk of malicious users trying to harm others. An intrusion detection system (IDS) can be used to alert the appropriate entities when potentially dangerous operations are happening within a host of set of hosts. Nowadays, we need a system that can accurately process large amount of network data quickly. Most of the current work sees an IDS using traditional machine learning algorithms to classify whether a packet is a part of an attack. However, these algorithms typically aren't implemented with a big data platform. Here, we will use Apache Spark, a big data processing tool known for handling tasks at fast speeds, to process network packet data. In this paper, we utilize the Spark libraries to implement Random Forest, SVMs, Logistic Regression, Naïve Bayes, and Gradient Boosted Trees. We will also use a Deep Multilayer Perceptron, which is a Spark implementation of a deep learning algorithm. We compare the results of the traditional machine learning algorithms to the deep learning method. The results show that the deep learning algorithm produces favorable accuracy, precision, and recall, but takes far longer to process the data than classical machine learning algorithms.

pp. 374-379

13:20 *A Hierarchical Intrusion Detection System using Support Vector Machine for SDN Network in Cloud Data Center*

Kashinath Basu and Muhammad Younas (Oxford Brookes University, United Kingdom (Great Britain))

Software-Defined Networks (SDN) has emerged as a dominant programmable network architecture for cloud-based data centers. Its centralised programmable control plane decoupled from the data plane with a global view of the network state provides new opportunities to implement innovate security mechanisms. This research leverages this features of SDN and presents the architecture of a hierarchical and lightweight Intrusion Detection System (IDS) for software enabled networks by exploiting the concept of SDN flows. It combines advantages of a flow-based IDS and a packet-based IDS in order to provide a high detection rate without degrading network performances. The flow-based IDS uses an anomaly detection algorithm based on Support Vector Machines (SVM) trained with DARPA Intrusion Detection Dataset . This first line of defence detects any intrusions on the network. When an attack is detected, the malicious flow is mirrored to a packet-based IDS, for further examination and actions. The results show that this scheme provides good detection rates and performances with minimal extra overhead.

pp. 380-385

13:40 *Experiments and Proofs in Web-service Security*

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

Many web services have a subsystem for allowing users to register, authenticate, reset their password, and change personal details. It is important that such subsystems cannot be abused by attackers to gain access to the accounts of other users. We study a system which was initially prone to such attacks. Specific attacks are demonstrated and the system is then modified to prevent such attacks in future. The design achieved in this way is then analysed to show that it can't be broken in future unless users allow their email to be intercepted. This is achieved by formulating the requirement as a statement of the user's expectations of the system and then analysing the source code of the system to prove that it meets these requirements. The process or attack, correction, formulation of security rules, and proof that rules hold, is proposed as a methodical security design philosophy.

pp. 386-391

S18: Session 18: Video and Virtual Reality

Room: M18

Chair: Md Rana (University of Engineering and Technology, Bangladesh)

13:00 *Coefficient of Throughput Variation as Indication of Playback Freezes in Streamed Omnidirectional Videos*

Viktor Kelkkanen and Markus Fiedler (Blekinge Institute of Technology, Sweden)

A large portion of today's network traffic consists of streamed video of large variety, such as films, television shows, live-streamed games and recently omnidirectional videos. A common way of delivering video is by using Dynamic Adaptive Streaming over HTTP (DASH), or recently with encrypted HTTPS. Encrypted video streams disable the use of Quality of Service (QoS) systems that rely on knowledge of application-dependent data, such as video resolution and bit-rate. This could make it difficult for a party providing bandwidth to efficiently allocate resources and estimate customer satisfaction. An application-independent way of measuring video stream quality could be of interest for such a party. In this paper, we investigate encrypted streaming of omnidirectional video via YouTube to a smartphone in a Google Cardboard VR-headset. We monitored such sessions, delivered via both WiFi and mobile networks, at different times of day, implying different levels of congestion, and characterised the network traffic by using the Coefficient of Throughput Variation (CoTV) as statistic. We observe that this statistic shows to be able to indicate whether a stream is stable or unstable, in terms of potential video playback freezes, when the DASH delivery strategy is used.

pp. 392-397

13:20 *Enabling Efficient and High Quality Zooming for Online Video Streaming using Edge Computing*

Ayub Bokani and Jahan Hassan (Central Queensland University, Australia); Salil S Kanhere (UNSW Sydney, Australia)

High quality zooming function for online video streaming using cloud content servers remains a challenge due to the intertwined relationships among video chunk lengths, viewer's fast changing Region of Interest (RoI), and network latency. It is possible to utilize tiled Video technique and store picture tiles in separate files with their unique URLs on the media server with smaller chunk sizes, however it introduces a significant burden on the network core due to increased total video length contributed by combined non-video bits from too many smaller chunks. To overcome this, in this paper we propose the use of edge computing to achieve high quality zooming function for video steaming. Our proposal includes the system architecture using Tiled-DASH (T-DASH) video encoding on edge servers, and a novel ROI prediction method combining three different prediction models: online, offline and object-level prediction models on the client side. Our evaluations show that a high level of ROI prediction accuracy is achieved by our approach, fulfilling a core condition for making the zooming function a reality.

pp. 398-403

13:40 *A Test-bed for Studies of Temporal Data Delivery Issues in a TPCAST Wireless Virtual Reality Set-up*

Viktor Kelkkanen and Markus Fiedler (Blekinge Institute of Technology, Sweden)

Virtual Reality (VR) is becoming increasingly popular, and wireless cable replacements unleash the user of VR Head Mounted Displays (HMD) from the rendering desktop computer. However, the price to pay for additional freedom of movement is a higher sensitivity of the wireless solution to temporal disturbances of both video frame and control traffic delivery, as compared to its wired counterpart. This paper reports on the development of a test-bed to be used for studying temporal delivery issues of both video frames and input input traffic in a wireless VR environment, here TPCAST for HTC Vive. We provide a solution for monitoring and recording of traces of (1) video frame freezes as observed on the wireless VR headset, and (2) input traffic from the headset and hand controls to the rendering computer. So far, the test-bed illustrates the resilience of the underlying WirelessHD technology and TCP connections that carry the input traffic, and will be used in future studies of Quality of Experience (QoE) in wireless desktop VR.

pp. 404-406

Friday, November 23 14:00 - 15:20

S22: Session 22: SDN and General

Room: M10

Chair: Graeme K Woodward (University of Canterbury, New Zealand)

14:00 *Enhancing Quality of Experience of VoIP Traffic in SDN based End-hosts*

Anees Al-Najjar (University of Queensland, Australia); Siamak Layeghy (The University of Queensland, Australia); Marius Portmann (University of Queensland, Australia); Jadwiga Indulska (The University of Queensland, Australia)

In this paper, we present a new SDN-based interface selection approach, which allows selecting the optimal network interface when new VoIP calls are originated on multi-homed end hosts, such as smartphones. We demonstrate that our model-based approach can significantly improve the Quality of Experience of VoIP calls.

pp. 407-414

14:20 *Towards a viable business model for collaborative use of unlicensed frequency bands in densely populated areas*

Frank den Hartog (University of New South Wales & DoVes Research, Australia); Koen Dittrich (Erasmus University Rotterdam, The Netherlands); Jan de Nijs (TNO, The Netherlands)

The overwhelming commercial success of connected things and personal mobile devices is driving the dense and uncontrolled deployment of wireless networks using unlicensed frequency bands. This results in heavy congestion and interference, leading to considerable loss of network performance. The only sustainable solution is some form of collaboration between users. Not only does this require new technology to facilitate such collaboration, it also demands for new business models that accommodate new, collaboration facilitating roles. In this paper we propose a generic business model for sustainable spectrum sharing in unlicensed frequency band. It includes two new actors, the Spectrum Broker and the Wi-5 System Operator. The business model is tested against five popular use cases, in dialogue with various European network operators. The results indicate that the model is applicable and viable.

pp. 415-420

14:40 *Clustering-based Handover and Resource Allocation Schemes for Cognitive Radio Heterogeneous Networks*

Mahyar Shirvanimoghaddam (University of Sydney, Australia); Shahriar Shirvani Moghaddam (Shahid Rajaee Teacher Training University (SRTTU), Iran); Ameneh Habibzadeh (Shahid Rajaee Teacher Training University, Tehran, Iran)

We propose a resource allocation and clustering strategy for the handover of both primary and secondary users in a Femtocell-based cognitive radio heterogeneous network (CR-HetNet). We consider two resource allocation and clustering schemes, where the first approach, referred to as resource allocation-clustering (RC), first allocates the resources to the Femtocells and then performs the clustering. In the second approach, namely joint clustering-resource allocation (JCR), clustering and resource allocation will be performed simultaneously. Numerical results suggest that although the utility function of primary and secondary users increases with the number of clusters, the number of horizontal handovers within the cluster reduces and the horizontal handovers between the clusters increases. It also reduces the energy efficiency and the maximum achievable throughput in each cluster. There is a tradeoff between the utility function and the maximum throughput of secondary users that can be well maintained by choosing a proper number of clusters and appropriate resource allocation. Finally, simulation results and numerical analyses show that one can reduce the handover execution time by 25% compared to the conventional approach that no clustering is performed in a network consisting of 10 Femtocells.

pp. 421-426

15:00 *Comparison of Two Sharing Modes for a Proposed Optical Enterprise-Access SDN Architecture*

Xiaoyu Wang (University of Virginia, USA); Xiao Lin (Fuzhou University, P. R. China); Weiqiang Sun (Shanghai Jiaotong University, P.R. China); Malathi Veeraraghavan (University of Virginia, USA)

A proposed two-wavelength design for high-speed access links has been shown to be a cost-effective means for large enterprises to improve the performance of large dataset transfers. In the original design, requests to dynamically connect a second wavelength to one of the shared high-speed provider IP- router ports for large dataset transfers are handled in Immediate- Request (IR) mode. In this paper, we consider an alternative solution for sharing high-speed provider ports, i.e., Advance- Reservation (AR) mode, which requires provider-side storage. Simulation results show that the AR-mode solution can achieve performance improvement over the IR-mode solution in terms of blocking probability and average response times across all requests. We also provide a differential cost-and-power comparison of the AR-with-storage mode and the IR mode to quantify the extra cost and power consumption introduced by the in-network storage in the AR mode.

pp. 427-434

S21: Session 21: General

Room: M11

Chair: Leith Campbell (University of Melbourne, Australia)

14:00 *Joint Mode Selection and Resource Allocation for Relay-Assisted Device-to-Device Networks*

Narayut Putjaika (King Mongkut's University of Technology Thonburi, Thailand); Phond Phunchongharn (King Mongkut's University of Technology Thonburi, Thailand); Khajonpong Akkarajitsakul and Unchalisa Taetragool (King Mongkut's University of Technology Thonburi, Thailand)

Device-to-device (D2D) communication considerably advances proficiency in a wireless network system. However, the emerging of D2D can cause crucial interference problem in Advanced Long-Term Evolution (LTE) network and the quality of service (QoS) problem. It is, therefore, necessary to develop an effective algorithm to control and manage the resources of the system to avoid harmful interference in the system. Consequently, we focus on the joint transmission mode, channel and power allocation of communication links in a D2D communication network. A D2D link can transmit in one of the different transmission modes (i.e., direct, indirect, relay, and dedicated mode). To solve the problem, we propose a coalitional game model for finding an optimal combination of communication links along with a channel and power allocation which can simultaneous share the same channel. Each D2D link firstly selects a transmission mode. All links in the same transmission mode form as a coalition. With a cooperative game approach, each D2D link within the same coalition cooperatively selects the channel to achieve the minimum total transmission powers while satisfying the data rate requirement of each link. To solve the joint power allocation and channel selection, we also develop a greedy algorithm with low complexity. Each D2D link can change its coalition (i.e. transmission mode) to a better coalition that provides the lower cost (i.e. a function of the transmission power and the channel occupancy cost depending on the D2D link's communications mode) as long as there is no other D2D link getting the worst-off cost. Our proposed framework can improve the average energy efficiency by 39% and reduce the computation time by 96% compared with the existing work.

pp. 435-440

14:20 *Towards Prediction of Power Consumption of Virtual Machines for Varying Loads*

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

Power management and load balancing in data centers are becoming critical with the growing size of the infrastructure. In front of an increasing number of cloud networks, virtual machines (VMs) and containers, smart management and control decisions are required, in order to instantiate or mobilize these virtual components. As regards reducing power consumption, it is also essential to consolidate virtual resources on the minimum possible number of servers compatible with performance requirements. In such a dynamic scenario, estimating the power that can be ascribed to a specific virtual component and its relation with the offered workload could be beneficial for optimized resource scheduling. Predicting the power consumption caused by a specific virtual component is however challenging. In this paper, two power models that relate a VM workload with the fraction of power consumed attributable to the VM are developed based on power profiling of a server. Precision and accuracy of these models are discussed further in the paper.

pp. 441-446

14:40 *R2Lab Testbed Evaluation for Wireless Mesh Network Experiments*

Farzaneh Pakzad (The University of Queensland, Australia); Marius Portmann (University of Queensland, Australia); Thierry Turletti (INRIA & Université Côte d'Azur, France); Thierry Parmentelat (Inria, France); Mohamed Naoufal Mahfoudi (Université Cote d'Azur Inria Sophia Antipolis, France); Walid Dabbous (INRIA, France)

We have provided critical evaluations of new potential testbeds for the evaluation of SDN-based WMNs. We evaluated the R2Lab wireless testbed platform at INRIA Sophia Antipolis, France. This testbed has 37 customisable wireless devices in an anechoic chamber for reproducible research in wireless WiFi and 4G/5G networks. Our work presents the first initial evaluation of the testbed for wireless multi-hop experiments, using traditional WMN routing protocols. Our results demonstrate the potential for SDN experiments. We believe this is an important contribution in its own right, since experimental validation is a key research methodology in this context, and trust in the validity of experimental results is absolutely critical.

pp. 447-452

15:00 *Experimental Evaluation of LoRaWAN in ns-3*

Furqan Hameed Khan (The University of Queensland, Australia); Marius Portmann (University of Queensland, Australia)

Long Range Wide Area Networks (LoRaWAN) is a proprietary network technology devised for the long range connectivity of massive number of low power network devices. This work gives an over-look of the key aspects of LoRaWAN technology and shows some interesting results that we achieved via extensive evaluation of class A LoRaWAN devices in different network settings using the state-of-the-art network simulator (ns-3). At first, we focus on a single end device and its mobility. Later, we did evaluation in an extended network scenario with changing network load (e.g. number of users) and traffic intensity. In summary, we evaluate the uplink (UL) throughput, packet delivery ratio, channel utilization, and UL frame loss for the confirmed and unconfirmed UL transmissions in different environments. Our results gives new insights for the future research efforts to optimize the LoRaWAN performance for different Internet of Things (IoT) applications with large scale low power end devices.

pp. 453-460

S20: Session 20: Wireless

Room: M18

Chair: Jahan Hassan (Central Queensland University, Australia)

14:00 *Rescue Mission Enhancement through Ambulance-to-Vehicle Communications*

Chakkaphong Suthaputchakun (Bangkok University, Thailand); Yue Cao (Northumbria University, United Kingdom (Great Britain))

Rescue missions are very crucial for live saving. The standard implementation of siren signal, such as siren light and sound, could be used to raise awareness of other non-emergency vehicles nearby during the rescue missions. However, there are several limitations of the siren signal. For example, it requires a line of sight to spot any approaching ambulances. However, the eyesight in driving environment is very limited. Siren sound in addition could confuse other non-emergency vehicles, because there is no information in the siren sound. The other vehicles may not be able to know where the ambulances actually are. To enhance the rescue missions, this paper proposes an implementation of vehicular communications to allow communications between ambulances and other non-emergency vehicles called Ambulance-to-Vehicle communications (A2V). A2V contributes in sharing emergency information between ambulances and other vehicles nearby in far advance. Therefore, the other vehicles can know in advance about where exactly the ambulances are, and which route or which lane these ambulances will go through. This information allows other vehicles to clear the emergency route very efficiently even before spotting and hearing the siren light and sound. Our comprehensive performance simulation results and analysis show that A2V remarkably achieves more than 40% speed improvement to ambulance, while rarely reduces speed of the other non-emergency vehicles by less than 6%.

pp. 461-466

14:20 *A New Result on Rearrangeable 3-Stage Clos Networks*

Satoru Ohta (Toyama Prefectural University, Japan)

Rearrangeable 3-stage Clos networks have long been studied for their theoretical interest and rich potential applicability. Although the existing connections of a rearrangeable Clos network may block a newly requested connection, this problem can be resolved by adequately rearranging some of the existing connections. The number of rearrangements needed to unblock the system poses an interesting question. In past studies, the number of rearrangements has been found only in limited cases and has not been determined for generic parameter values. This paper discovers a new bound on the number of rearrangements for a certain parameter range, which has not been considered in past studies. The underlying analysis is performed by a rearrangement algorithm that unblocks the system with the minimum number of rearrangements. The algorithm is based on the connection chain concept, which clearly and efficiently represents a sequence of connections to be rearranged.

pp. 467-472

14:40 *An Integrated mHealth and Vehicular Sensor Based Alarm System*

James Kang and Sitalakshmi Venkatraman (Melbourne Polytechnic, Australia)

Long distance driving is highly prone to road accidents and incidents due to various factors, in particular the health conditions of the driver. Professional long-distance drivers such as truck drivers having high health risks could benefit from the recent developments of mobile health (mHealth) technologies that can monitor various health parameters through wearable devices used in the vehicle. This paper proposes a novel method of combining mHealth data of the driver along with vehicular data for improving the vehicle safety system. The key objective is to minimise road accidents by integrating the emerging mHealth technologies with vehicular applications through the use of wireless body area network sensors and devices. The prime contribution of this paper is that the integrated system provides advance and real-time alarming notification for current and predicted emergency situations to drivers as well as their related parties such as health service providers and the company headquarter and forcing the ability to even safely immobilise a vehicle, if needed. In addition, the information gathered by the integrated system could also be used by other parties such as health service providers to address the driver's root causes of potential health deteriorations or other circumstances that are contributing factors to road accidents.

pp. 473-478

15:00 *Cloud Enabled Solution for Privacy Concerns in Internet of Medical Things*

Nazmus Shaker Nafi (VIT, Australia); R. Rathnayake (Sabaragauwa University of Sri Lanka, Australia); Sajeewani Maddumage (Victoria Institute of Technology, Australia); Mark A. Gregory (RMIT University, Australia)

The Internet of Medical Things (IoMT) refers to the worldwide network of interconnected medical devices based on a standard communication protocol. IoMT is about interconnected medical devices that are accessible over the internet. With the rapid pace of technology advancement, the healthcare field has been affected by challenges such as security, privacy, data integrity, amplified storage and processing power needs. This study investigates the IoMT related technologies and key challenges and proposes an adaptive model to address the identified challenges. The main contribution of this study is an entrusted framework for IoMTs which satisfies the major security, privacy and sensor data integrity challenges. The proposed cloud-based health management system increases data availability, storage needs and processing power. In the cloud-mobile architecture, security is entrusted to three encryption techniques: Advanced Data Encryption, Attribute-Based Encryption and Proven Data Possession. The proposed model shows how the three encryption techniques, along with cloud technologies, address the identified medical application challenges: Security, Privacy, Data Integrity, Processing Power and Storage.

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Friday, November 23 15:20 - 16:00

AT3: Afternoon Tea

Room: Foyer

Friday, November 23 16:00 - 16:05

CR: Closing Remarks

ITNAC 2019 is in Auckland

Room: M18

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