

ITU KALEIDOSCOPE

ONLINE 2021

6-10 December 2021

WRAP-UP
SESSION



Wrap-up Session Chair

Mostafa Hashem SHERIF

Kaleidoscope Steering Committee Member and
TPC Chair



Session Chair

Christoph DOSCH

ITU-R Study Group 6 Vice-Chairman; ARD,
Germany



Session 1: Enabling future wireless communication systems

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S1.1 Proposal for a user-centric RAN architecture towards beyond 5G
Kosuke Yamazaki, KDDI Research, Inc., Japan

*S1.2 Toward a robust new radio compatible with XR**
Yuzhou Hu and Jiajun Xu, State Key Laboratory of Mobile Network
and Mobile Multimedia Technology, ZTE Corporation, China

S1.3 A design of NB-IoT random access preamble receiver for large frequency offset
Chenchen Zhang, State Key Laboratory of Mobile Network and Mobile
Multimedia Technology, ZTE Corporation, China

*S1.4 Optimal pilot sequence design for machine learning based channel estimation
in FDD massive MIMO systems**
Hayder AL-Salihi, Iraqi Communications & Media Commission, Iraq

Highlights from Paper 1

Proposal for a user-centric RAN architecture towards beyond 5G

- The authors identify two gaps in the design of actual 5G networks:
 - Cell fringe: reduced reception quality at the edge of a mobile cell
 - Limited uplink capacity: small form factor of handsets, reduced transmission quality.
- To improve access quality, the authors describe methods for user management and cell-free massive MIMO.
- In near-field, peripheral devices are connected at 300 GHz (user-centric RAN and virtualization of the terminal).

Highlights from Paper 2

*Towards a robust new radio compatible with XR**

- The authors first describe the background of eXtended Reality (XR).
- Subsequently, traffic models for XR are depicted for:
 - Single-stream model
 - Multi-stream model.
- To improve the throughput, priority-based adaptive preemptive schedulers are proposed and positively compared to 3GPP Rel-16 NR (New Radio).
- The preemptive mechanism improves latency, e.g., for multiparty gaming and immersive services.
- Further work is announced to enhance QoS for different services and to balance UE-pairing with the preemption in the scheduler (capacity, power, coverage, mobility) including intra-stream preemption.
- Further studies should also include CBG (code block group) retransmission in order to provide higher data-rates per transport block.

Highlights from Paper 3

A design of NB-IoT random access preamble receiver for large frequency offset

- Narrow-band IoT via satellite transmissions suffer from time offsets, i.e., Doppler effect, leading to spill-over into adjacent sub-carrier channel(s).
- A compensation technique was developed to cope with this leakage (by rotation of the phase and weighted summary of the signals).
- The proposed method makes use of the leaked power, and hence improves the transmission performance.

Highlights from Paper 4

*Optimal pilot sequence design for machine learning based channel estimation in FDD massive MIMO systems**

- Theoretical study based on massive MIMO (in the simulations up to 1000 beams).
- The authors start by explaining MIMO configurations.
- Feedback from UE leads to good channel estimation.
- The challenge is to construct a channel estimation scheme with a limited number of pilots to address the pilot overhead problem:
 - As signal is sparse, compressed sensing is possible (better than Nyquist)
 - Bayesian estimation (posterior probability) can be applied
 - Optimal pilot design is based on minimum mean square error (MSE) under the total transmit power constraints.
- Further studies are required before standardization could be envisaged.

Conclusions/Recommendations

- The four papers of Session 3 discuss key issues with respect to the introduction of future wireless communication systems (5G/6G).
- Much effort is given to realize and optimize the architecture and operation of future wireless terrestrial networks including satellited feeds for narrow-band IoT.
- One of the main challenges is the improvement of the radio-access networks (RAN), three of the four papers deal with RAN.
- Further research is certainly needed to consolidate the achieved results and, importantly, to introduce them to the ongoing standardization activities of 3GPP and ITU.

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Thank you!



Session Chair

Eva IBARROLA

University of the Basque Country, Spain



Session 2:

**Networking requirements and solutions
for IoT and industrial applications**

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S2.1 Optimizing packet transmission for ledger-based points transfer system in LPWAN: Solutions, evaluation and standardization

Xin Qi, Waseda University, Japan

S2.2 Enhancing the system model for home interior design using augmented reality

Dhananjay Kumar, Anna University, India

S2.3 Future industrial networks: Requirements, challenges, research and standardization needs

Marco Carugi, Huawei Technologies European Research Center, France

Highlights from Paper 1

Optimizing packet transmission for ledger-based points transfer system in LPWAN: Solutions, evaluation and standardization

- Distributed ledger-based points transfer systems have many advantages in LPWANs. This paper **discusses some of the problems of existing distributed ledger technologies in LPWAN in IoT scenarios**.
- To **address these issues**, the authors **propose an optimized packet transmission mechanism** for a ledger-based points transfer system in LPWAN. This is done by selecting some nodes as ledger nodes through a K-means clustering method.
- The proposed mechanism **reduces the packet transmission in the whole system** and improves the success rate of transactions.
- Finally, the authors **summarize the standardization work going on in** ITU-T, ISO, and IEEE on distributed ledgers.

Highlights from Paper 2

Enhancing the system model for home interior design using augmented reality

- The goal of the system is to improve the process of home interior design by allowing users to try out various settings in the shop before purchasing using augmented reality.
- **Providing real-time experience** to users based on an **augmented reality platform** faces challenges due to the limited computational capacity of mobile devices which increase latency.
- The authors propose a **system model** for enhancing **the home interior design using augmented reality** using:
 - 3D object models from vendor data
 - 3D projections of the home interior
 - Anchors and feature points to determine the object
- After further refinement, the **proposed system model** can be **proposed for standardization in ITU-T Study Group 16**.

Highlights from Paper 3

Future industrial networks: Requirements, challenges, research and standardization needs

- Given the on-going **digital transformation** that is affecting most industries, the paper presents **a review of the critical network challenges to be addressed** to satisfy the requirements of future industrial network applications in the following areas:
 - Stringent and quantifiable latency objectives
 - Semantic and flexible addressing and sector-specific routing (such as specific routing)
 - Intrinsic security and privacy protection including packet authentication and integrity protection
- The authors analyze these **challenges in specific scenarios**:
 - IoT-enabled industrial and robotic applications
 - Haptic Communication-enabled applications
 - Integrated satellite-terrestrial network-enabled applications
- An **overview of relevant standards highlight their limitation in these scenarios** and the authors believe that important **standardization efforts for the development of future industrial networks must be undertaken**.

Conclusions/Recommendations

- The three papers of Session 2 **discuss key issues** related to the increase of IoT devices, **virtual and augmented reality techniques** and emerging applications **for future industrial networks**.
- **Much effort is needed** to optimize and **enhance the networks, models and protocols** for the emerging environment.
- **Further research** is certainly also needed **before the achieved results can be consolidated and introduced to the ongoing standardization activities** of ITU.

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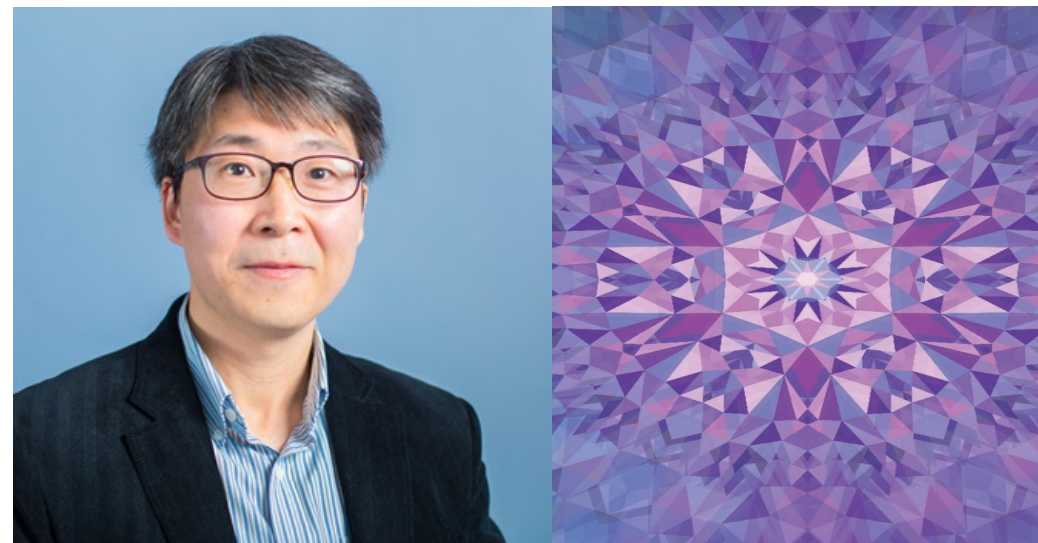
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Session Chair

Gyu Myoung LEE

Liverpool John Moores University,
United Kingdom



Session 3:

Contributions to security

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S3.1 *Strengthen the security of cyberspace with device-independent quantum randomness*

Ming-Han Li, CAS Quantum Network Co., Ltd & Jinan Institute of Quantum Technology, China

S3.2 *Abnormal activity recognition using deep learning in streaming video for indoor application*

Dhananjay Kumar, Anna University, India

S3.3 *Research on security and privacy for IoT-domotics*

Jinxue Cheng, China Mobile (Hang Zhou) Information Technology Co. Ltd, China

Highlights from Paper 1

Strengthen the security of cyberspace with device-independent quantum randomness

- Aim
 - To introduce the concept of Device-Independent Quantum Random Number Generator (DIQRNG)
 - To propose the principle and architectural framework of a randomness beacon based on DIQRNG
 - To present contract signing and confidential disclosure as an example in detail.
- Key results
 - Detailed protocol design for device-independent QRNG and randomness beacon
 - Used for the future cybersecurity facing more powerful computing capabilities.
- Q&A
 - Relation with the published Recommendation (X.1702) in ITU-T SG17: Related application cases are currently being studied in the ITU-T FG-QIT4N, ITU-T X.1702 is related to an architectural work.

Highlights from Paper 2

Abnormal activity recognition using deep learning in streaming video for indoor application

- Aim
 - Abnormal activity recognition in a streaming video – address the presence of the large spatio-temporal data along with the constraints of communication networks affecting the quality of received data for analysis.
- Contributions
 - propose a deep learning-based system to identify abnormal human activities
 - combination of Skeleton Activity Forecasting (SAF) and a Bi-Long Short-Term Memory neural network
 - Skeleton activity forecasting for predicting the future pose.
- Key results
 - Performance analysis – demonstrate results on training and test accuracies.
- Q&A
 - Performance issues – trade off relation between precision (accuracy) and complexity of deep learning algorithms in particular a real-time processing perspective .

Highlights from Paper 3

Research on security and privacy for IoT-domotics

- Aim
 - Comprehensive control of security and privacy risks to support the long-term development of IoT-domotics.
- Key results
 - Propose an IoT-domotics reference model
 - Analyzes the security and privacy risks of the IoT-domotics for different IoT-domotics entities.
 - Propose the security control principles of the IoT-domotics
 - Give the corresponding security and privacy controls
 - Compare the supporting control schemes implemented by some researchers.
- Future work
 - The continuous integration of IoT-domotics with blockchain, edge computing, 5G and other technologies.

Conclusions/Recommendations

- Security, privacy and safety issues
 - Security and privacy - essential components in a broad range of applications areas
 - Safety needs to be significantly considered along with security and privacy issues (Abnormal activity recognition)
 - Various approaches for performance improvement with AI/ML techniques and combination of them.
- Relevant standardization efforts on the papers presented in this session
 - ITU-T FG-QIT4N, SG17 on QRNG
 - ITU-T SG16, H.627 (“Signalling and protocols for a video surveillance system”)
 - ISO/IEC 29100:2011 Information technology- Security techniques - Privacy framework. ISO,2011.
- Bridging gaps between global standards/recommendations and real implementations
 - To best utilize available standards and enhance them for developing practical solutions with emerging technologies our daily life environments.

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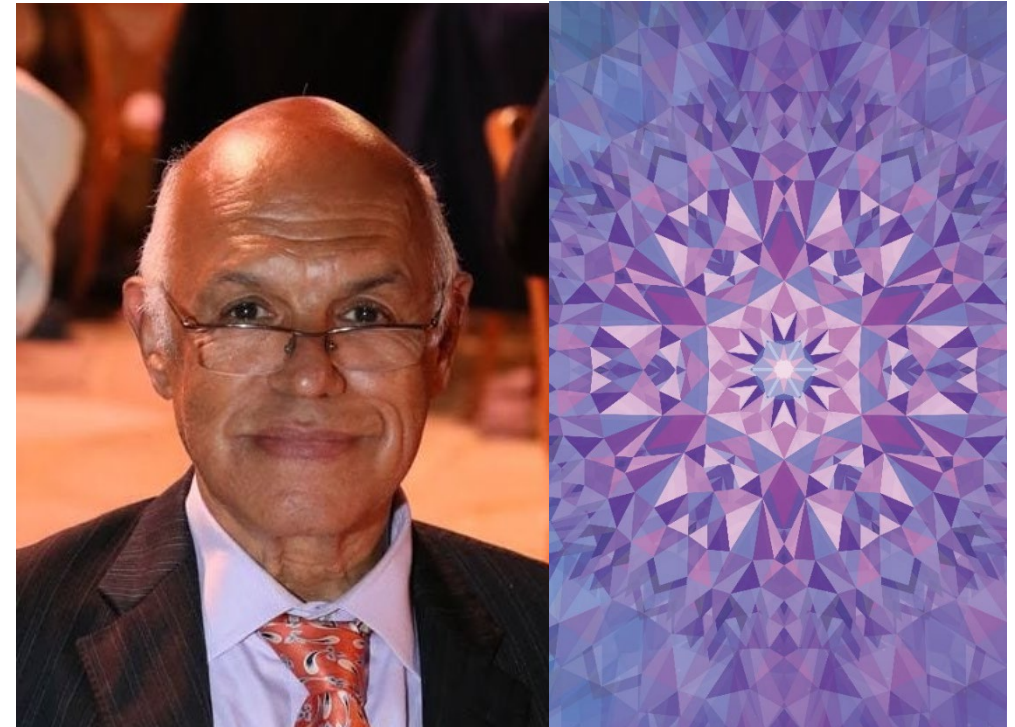
Thank you!



Session Chair

Mostafa Hashem SHERIF

Kaleidoscope Steering Committee Member and
TPC Chair



Session 4: Policies and ontology for security management

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*S4.1 Collaborative 5G multiaccess computing security: Threats, protection requirements and scenarios**
Hongyang Zhang, China Mobile, China

*S4.2 Security vulnerability expressions: A technology for empowering novice practitioners around the world with security maturity capabilities**
Jacques Francoeur, Security Inclusion Now, USA

Highlights from Paper 1

*Collaborative 5G multiaccess computing security: threats, protection requirements and scenarios**

- In 5G Mobile Edge Computing (MEC) the functionalities of the core network are moved to the edge. This adds new security requirements
- The paper presents a comprehensive review of the various threats and the protection policies
- The target audience consists of network operators as well large industrial campuses
- Two examples are discussed:
 - The security of the smart grid (WAN application)
 - The security of a smart factory (LAN application)
- The framework has been already implemented in 100 applications

Highlights from Paper 2

*Security vulnerability expressions: A technology for empowering novice practitioners around the world with security maturity capabilities**

- There are many security frameworks floating around:
 - They describe similar threats but with different terminologies
 - More than one framework may be needed to address a given application
 - Each framework is represented in a spreadsheet
 - Navigating between the spreadsheets is not easy
- ITU-T SG 17 has published a non-normative reference architecture called the Unified Security Model (USM) that can be used to represent the textual data in a form that can be processed by machines
- An open source software tool has been developed based on USM
- The architecture and the tool make the body of knowledge accessible to novice users (2/3 of the world) and to experts
- Help is welcome to go to the next step

Conclusions/Recommendations

- A systematic way to address the threats that arise when 5G mobile edge computing (MEC) was introduced
- There is a way to make the vast body of knowledge on security easily accessible

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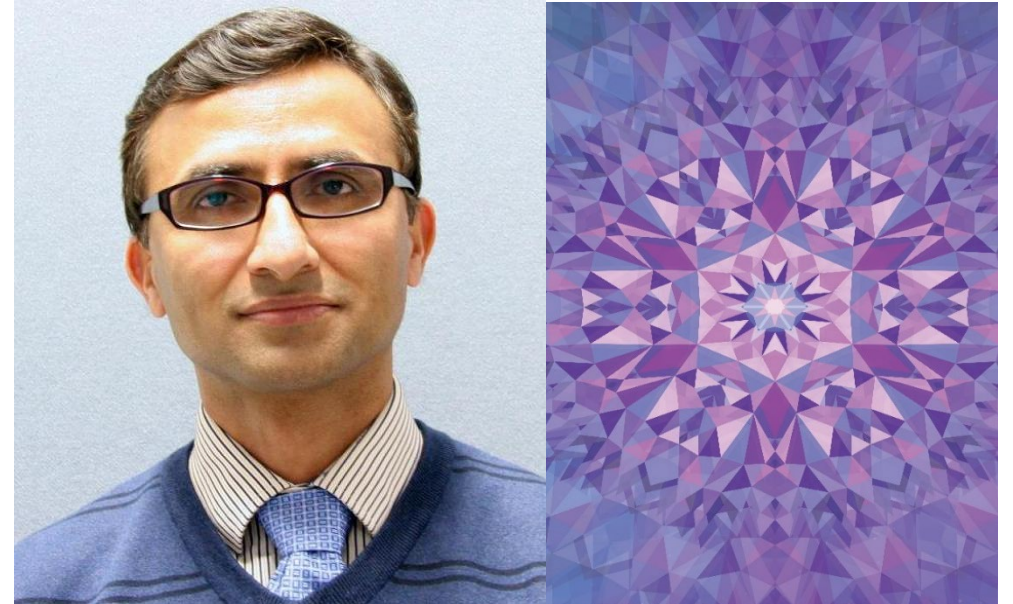
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Session Chair

Ved P. KAFLE

National Institute of Information and
Communications Technology, Japan



Session 5:

**Augmented reality and machine learning
for future spatial applications and services**

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*S5.1 Building a distributed XR immersive environment for data visualization**

Fernando Beltrán and Jing Geng, University of Auckland, New Zealand

S5.2 Assessment of spatial intervention of public spaces by locative augmented reality games players

Mohd Faredzuan Mohd Noor, International Islamic University Malaysia, Malaysia

S5.3 Identification of deadliest mosquitoes using wing-beats sound classification on tiny embedded system using machine learning and edge impulse platform

Kirankumar Trivedi, Vishwakarma Government Engineering College, Ahmedabad, India

Highlights from Paper 1

*Building a distributed XR immersive environment for data visualization**

- Using mixed-reality immersive technology to support more effective and higher quality decision-making in a business context that uses the richer structure of network datasets.
- Built Aroaro, a mixed-reality, multi-user platform with Unity, MS Mixed-Reality Toolkit:
 - Providing total spatial immersion to business decision makers
 - Supporting a **virtualized environment** with **visualization of network datasets**.
 - Providing a **collaborative virtual environment**.
 - Supporting both synchronous and asynchronous collaboration.
- **Conducted lab experiments** to investigate the performance w.r.t. traditional 2D data visualization approach.
- Results show higher quality of decisions.
- The standardization aspects are not discussed.

Highlights from Paper 2

Assessment of spatial intervention of public spaces by locative augmented reality games players

- Assesses public perceptions of spatial intervention of public spaces by locative AR games players
 - Using both the qualitative (data analysis) and quantitative approaches (using survey questionnaires).
- Research finding
 - 53.8% mention uncomfortable as locative AR players cause disturbance and distraction to people movement
 - 46% expressed fun to see players
 - 30.4% said it is not suitable to play locative AR games in public places.
- The standardization aspects are not discussed.

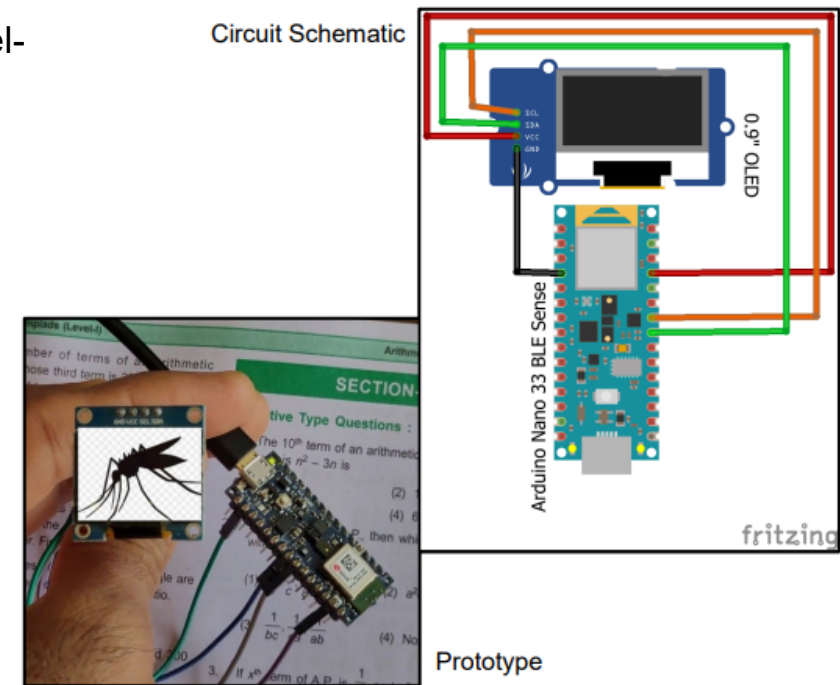


Figure 8 – Locative AR players gathering under the shaded area to play the game in public park.

Highlights from Paper 3

Identification of deadliest mosquitoes using wing-beats sound classification on tiny embedded system using machine learning and edge impulse platform

- Designed and developed a **prototype system for mosquitoes identification**
 - Hardware: Arduino Nano 33, BLE Sense, 0.9" OLED display
 - Software: Edge Impulse (containing ML) for database acquisition, impulse design, Mel-Filterbank Energy (MFE), Neural Network (NN) classifier, model training, testing, and deployment
- Database acquisition
 - Database acquired from HumBug re-sampled to 16 kHz
- Impulse design and model training
 - Takes raw data, uses signal processing to extract features
- Model testing
- Model deployment
 - Model works without requiring an Internet connection, with little latency and battery consumption
- The standardization aspects are not discussed.



Conclusions/Recommendations

- These papers highlight the application of AR, machine learning and data visualization technologies for addressing the social issues (e.g. high quality decision making in business context, policy formulation for facilitating outdoor locative AR game payers, detection of deadly mosquitos).
- Although these studies are at preliminary stage, when they are advanced, they have potential to address social challenges.
- It would be better if the standardization and policy formulation aspects were also discussed.

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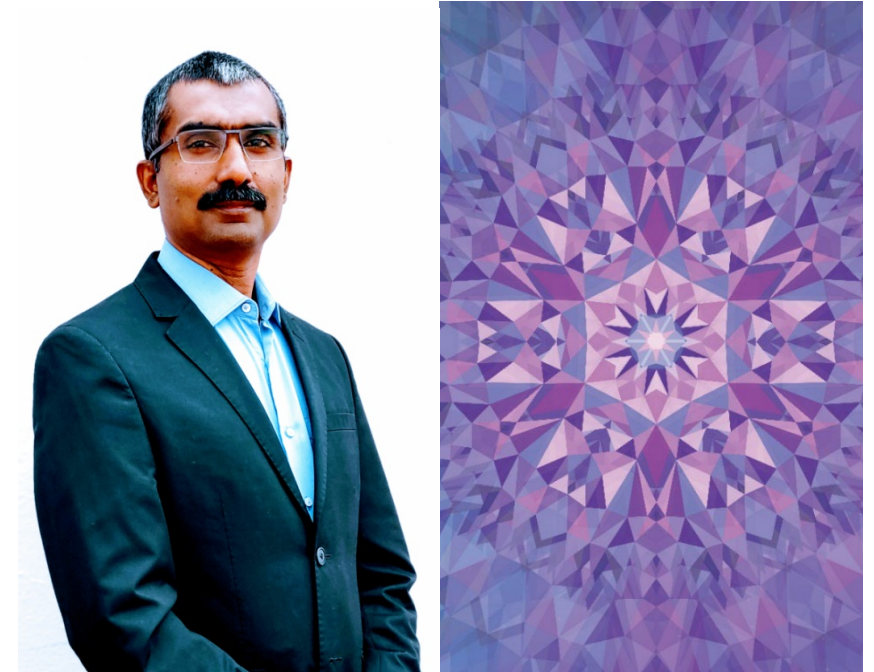
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Session Chair

Vishnu Ram OV

Independent expert and co-organizer of the
ITU AI/ML in 5G Challenge



Session 6:

**Machine learning for next generation
wireless network**

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S6.1 Wireless channel scenario recognition based on neural networks

Xiaojing Xu, State Key Laboratory of Mobile Network and Mobile Multimedia Technology, ZTE Corporation, China; and
Wei Cao, ZTE Corporation, China

*S6.2 A review of network slicing in 5G and beyond: Intelligent approaches and challenges**

Ghazal Rahmanian, Iran University of Science and Technology, Iran

*S6.3 Reinforcement learning for scheduling and MIMO beam selection using CAVIAR simulations**

João Paulo Tavares Borges, Universidade Federal do Pará, Brazil

Highlights from Paper 1

Wireless Channel Scenario Recognition Based on Neural Networks

- The paper proposes a wireless channel scenario recognition framework based on neural networks.
- Certain parameters of the wireless propagation environment are analysed in the paper, and the frequency domain fading factor, multipath power delay distribution, time domain energy peak response ratio and time correlation characteristics.
- Applications of this research include:
 - the receiver performance improvement
 - Signalling optimization
 - MIMO scenarios.
- The paper compared traditional threshold comprehensive decision on the extracted channel characteristics for channel scenario recognition, and the combination of wireless channel characteristic sets and neural networks for channel scenario recognition.
- The proposed method has a greater improvement in the recognition accuracy than the traditional threshold algorithm.

Key learnings:

- Collection and Use of datasets needs to be further studied, with an aim to simulate and generate more data and using open datasets.
- Discussion points centered around training and inference latencies that need further study.

Highlights from Paper 2

*A review of network slicing in 5G and beyond: Intelligent approaches and challenges**

- An excellent survey paper on network slicing, especially including design, deployment, monitoring and management of slices, with a comprehensive study of AI-based network slicing functions algorithms is comprehensive.
- In addition, it addresses an important the need for automation of network operations in network slices.
- From a security perspective, 5G network slicing allows slices to be isolated.
- Thus, the key words are - Isolation, customization, flexibility, automation, programmability.
- Discussion centered around Resource allocation and fault management especially in the area of automation and autonomy can be studied further and we invite contributions. Also, the availability of open datasets were discussed.

Key learnings:

- Further study on security was identified.
- Also, we called for greater collaboration in the area of autonomous operation of networks.
- Applicability of various ML techniques was clarified.

Highlights from Paper 3

*Reinforcement learning for scheduling and MIMO beam selection using CAVIAR simulations**

- Describes a framework for research on Reinforcement Learning (RL) applied to scheduling and MIMO beam selection.
- Asking the RL agent to schedule a user and then choose the index of a beamforming codebook to serve it.
- Simulation of the communication system and the artificial intelligence engine is based on a virtual world created with AirSim and the Unreal Engine.
- CAVIAR methodology : which leads to highly realistic 3D scenarios is described.
- Describes the communication and RL modelling adopted in the framework and also presents statistics concerning the implemented RL environment, such as data traffic, as well as results for three baseline systems.
- The CAVIAR simulation integrates three subsystems: the communication system, the AI and ML models, and finally the virtual world components.

Key learnings:

- Importance of creating test data and validation data was discussed.
- Importance of creating accurate simulations as a service was emphasised.

Conclusions/Recommendations

1. While the integration of AI/ML techniques are critical to future networks, Collection and Use of datasets needs to be further studied, with an aim to simulate and generate more data and using open datasets (as in the ITU AI/ML 5G Challenge).
 1. **Recommendation: Promote the use of open data for AI/ML model trainings and validation.**
2. Training and inference latencies need further study
3. Further study on security – especially the use of AI to solve such issues as well as the vulnerabilities introduced by AI/ML needs to be studied.
 2. **Recommendation: Study the overlap of security and AI/ML.**
4. Opportunities exist in the area of collaboration in the area of autonomous operation of networks.
 3. **Recommendation: Involve academia in the work of FG AN.**
5. Applicability of various ML techniques has to be clarified and captured along with the use cases – so that it is clear to understand the choices.
 4. **Recommendation: Highlight such guidelines and bring them to standards.**
6. Quality and choice/use of validation data is important.
7. Accurate simulations-as-a-service can boost the use of AI/ML in future networks.
 5. **Recommendation: Host such services in cloud.**

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