ICOTEN

THE INTERNATIONAL CONGRESS OF ADVANCED TECHNOLOGY AND ENGINEERING

The International Congress of Advanced Technology and Engineering (ICOTEN 2021)

Congress Themes:

- Toward Intelligent Solutions for Societies' Development
- Toward Smart and Sustainable Engineering and Environment
- Enhancing Management and Education Polices and Technologies in Crises Time

- ICOICS 2021
- ICOEEE 2021
- ICOBBE 2021
- ICOSEE 2021
- ICOAPS 2021
- ICOMET 2021

(Virtual Conference) July 4-5, 2021

Organized by:

YSRG

International Collaborators:

UNIVERSITY OF THE WEST of SCOTLAND UWS

CHARLES DARWIN UNIVERSITY

UTM UNIVERSITI TEKNOLOGI MALAYSIA

ENSET

UTHM

isamm

The International Congress of Advanced Technology and Engineering (ICOTEN 2021)

July 4-5, 2021

(Virtual Conference)

"*Toward Intelligent Solutions for Societies' Development.*

Toward Smart and Sustainable Engineering and Environment.

Enhancing Management and Education Polices and Technologies in Crises Time."

Editors:

Faisal Saeed
Fathey Mohammed
Fuad A. Ghaleb

Organizing Committee

Congress Parton

Prof. Dr. Khalid Alwesabi, Minister of Higher Education, Scientific Research and Technical Education, Yemen

Congress Honorary Chair

Mohammed Saeed Khanbsh, President, Hadhramout University, Yemen

Congress General Chair

Faisal Saeed,Yemeni Scientists Research Group (YSRG)

Conferences Chairs

Faisal Saeed, Chair of the International Conference of Intelligent Computing and Informatics (ICOICS 2021)
Zaid Shamsan, Chair of the International Conference of Advances in Electrical and Electronic Engineering (ICOEEE 2021)
Wahdi Ali, Chair of the International Conference of Advances in Bioscience and Biomedical Environment Engineering (ICOBBE 2021)
Adeeb Qaid, Chair of the International Conference of Advances in Sustainable Environmental Engineering (ICOSEE 2021)
Muneer Aziz, Chair of the International Conference of Advances in Applied Sciences (ICOAPS 2021)
Nabil Hussein Alfahim, Chair of the International Conference of Advances in Management and Education Technology (ICOMET)

IEEE-Yemen Subsection Technical Sponsors

Ammar Zahari, Chair of IEEE-Yemen Subsection
Mazen Bahashwan, Vice-Chair of IEEE-Yemen Subsection
Muneer Al-Mekhlafi, Secretary IEEE-Yemen Sub-Section
Abdelqader Muhsen, Treasurer, IEEE-Yemen Sub-Section Treasurer

Program Co-Chairs

Mohammed Alshargabi, Najran University, Saudi Arabia
Tawfik Al-Hadhrami, Nottingham Trent University, United Kingdom
Ammar Al-Zahari, Chair of IEEE Yemen SubSection
Imed Riadh Farah, University of Manouba, Tunisia
Mamoun Alazab, Charles Darwin University, Australia

Publication Committee

Fathey Mohammed (Chair), Universiti Utara Malaysia, Malaysia and Taiz University, Yemen
Fuad A. Ghaleb, Universiti Teknologi Malaysia, Malaysia and Sanaá Community College, Yemen
Maged Nasser, Universiti Teknologi Malaysia, Malaysia

General Secretary

Nadhmi Gazem, Yemeni Scientists Research Group (YSRG)

IT Committee

Sameer Hasan Albakri (Chair), Sana'a University, Yemen
Amer Alsaket, Sitecore, Malaysia
Mohammed Al-Sarem, Yemeni Scientists Research Group (YSRG)

Registration and Finance Chair

Abdullah Aysh Dahawi, Universiti Teknologi Malaysia, Malaysia

Publicity Committee Co-Chairs

Abdullah Faisal Abdulaziz Al-shalif, UTHM, Malaysia
Wadii Boulila, University of Manouba, Tunisia

Publicity Committee Members

Ali Salem, UTHM, Malaysia

Organizing Committee

Bassam Alhammadi, UTeM, Malaysia
Esmat Wahdain, USM-Malaysia
Majed Nasser, UTM, Malaysia
Nabil Mohammed, Macquarie University, Australia
Redhwan Algabri, Sungkyunkwan University, South Korea
Abdulmajeed Al-hokabi, UMP, Malaysia

Note: All times in Yemen/Mecca Time (GMT Time + 3)

Day 1:	Sunday: July 4, 2021					
Zoom Meeting ID: **861 7028 9022** Zoom Passcode: **ICOTEN2021** **Meeting Link:** https://us02web.zoom.us/j/86170289022?pwd=MGJUU2xxUUU1eUxWZlpmS0hsTWxtZz09						
8:10 am – 9:00	**Main Room** **Session 1: Opening Ceremony**					
8:10 am - 8:20 am	Doa'a Recitation					
8:20 am - 8:30 am	Welcoming speech by ***Dr. Faisal Saeed***, ICOTEN 2021 General Chair					
8:30 am - 8:40 am	Welcoming speech by ***Prof. Dr. Mohammed Saeed Khanbsh***, ICOTEN 2021 Honorary Chair, President, Hadhramout University, Yemen					
8:40 am – 8:50 am	Welcoming speech by ***His Excellency Dr. Adel BaHamid, Ambassador of Yemen in Malaysia***					
8:50 am – 9:00 am	Welcoming and Officiating speech by ***His Excellency, Prof. Dr. Khalid Alwesabi,*** ICOTEN 2021 Parton, Minister of Higher Education, Scientific Research and Technical Education, Yemen					
9:00 am - 9:10 am	Break					
9:10am – 12:00 pm	**Session 2: Parallel Keynote Speeches**					
9:10am – 10:30 am	**Room 1 (ICOICS)**	**Room 2 (ICOEEE)**	**Room 3 (ICOSEE)**	**Room 4 (ICOBBE)**	**Room 5 (ICOAPS)**	**Room 6 (ICOMET)**
	Parallel Keynote Speeches 1 & 2					
10:30 am – 10:40 am	Break					
10:40 am – 12:00 pm	**Room 1 (ICOICS)**	**Room 2 (ICOEEE)**	**Room 3 (ICOSEE)**	**Room 4 (ICOBBE)**	**Room 5 (ICOAPS)**	**Room 6 (ICOMET)**
	Keynote Speeches 3 & 4	Keynote Speech 3	-	Keynote Speech 3	Keynote Speech 3	Keynote Speech 3
12:00 pm – 1:00 pm	Break					
1:00 pm – 5:30 pm	**Session 3: Parallel Paper Presentations**					
1:00 pm – 3:00pm	**Room 1 (ICOICS)**	**Room 2 (ICOEEE)**	**Room 3 (ICOSEE)**	**Room 4 (ICOBBE)**	**Room 5 (ICOAPS)**	**Room 6 (ICOMET)**
	8 papers	8 papers	8 papers	5 papers	7 papers	8 papers
3:00 pm – 3:30 pm	Break					
3:30 pm - 5:30 pm	8 papers	8 papers	-	-	-	2 papers

Note: **All times in Yemen/Mecca Time (GMT Time + 3)**

Day 2:	**Monday: July 5, 2021**			
Zoom Meeting ID: **899 3851 1298** Zoom Passcode: **ICOTEN2021** **Meeting Link:** https://us02web.zoom.us/j/89938511298?pwd=T0xyWk8xTHdqVWFidC8yUnRUaDdidz09				
8:00 am – 8:40 am	Main Room: Keynote Speech 4 (**ICOEEE**)			
8:40 am - 9:00 am	Break			
9:00 am – 12:00 pm	**Session 1: Parallel Paper Presentations**			
9:00 am – 10:15 am	**Room 1 (ICOICS)**	**Room 2 (ICOEEE)**	**Room 3 (ICOICS)**	**Room 4 (ICOICS)**
	5 papers	5 papers	5 papers	5 papers
10:15 am - 10:30 am	Break			
10:30am – 12:00pm	6 papers	6 papers	6 papers	6 papers
12:00 pm – 1:00 pm	Break			
1:00 pm – 3:45 pm	**Session 2: Parallel Paper Presentations**			
	Room 1 (ICOICS)	**Room 2 (ICOEEE)**	**Room 3 (ICOICS)**	**Room 4 (ICOICS)**
	11 papers	3 papers	10 papers	11 papers
3:45 pm – 4:00 pm	Break			
4:00 pm - 4:15 pm	Closing ceremony			

ICOICS Presentation Schedule

Day 1: Sunday: July 4, 2021	
Time :	**9:10am – 12:00 pm (Yemen/Mecca Time (GMT time + 3))**
Zoom link :	https://us02web.zoom.us/j/86170289022?pwd=MGJUU2xxUUU1eUxWZlpmS0hsTWxtZz09
Meeting ID :	861 7028 9022
Passcode :	ICOTEN2021
8:10am – 9:00am	**Session I: Opening Ceremony**
9:00am-9:10am	**Break**
Session II: Keynote Speeches	
Room 1	
9:10am – 9:50 am	Keynote Speaker I: **Prof. Dr. Amin Al-Habaibeh** *Professor of Intelligent Engineering, Nottingham Trent University, United Kingdom* Keynote title: *The ASPS Approach- a Self-Learning Artificial Intelligence Method for Sensor Fusion and the Rapid Design of Condition Monitoring Systems*
9:50am – 10:30 am	Keynote Speaker II: **Assoc. Prof. Dr. Nabeel Alsohybe** *Sana'a University, Yemen* Keynote title: *Smart Governance for Smart City: Current Issues, Challenges and Trends*
10:30 am – 10:40 am	Break
10: 40 am – 11:20 am	Keynote Speaker III: **Dr. Korhan Cengiz** *Trakya University, Edirne, Turkey* Keynote title: *Novel Wireless Sensor Network Protocols*

ICOICS Presentation Schedule

Day 1: Sunday: July 4, 2021	
11: 20 am – 12:00 pm	Keynote Speaker IV: **Dr. Afnizanfaizal Abdullah** *Universiti Teknologi Malaysia, Malaysia* Keynote title*: Machine Learning-as-a-Service (MLaaS): Putting the Intelligence into a cloud*
12:00 pm – 1:00 pm	Break
Session III: Paper Presentations	
Room 1: Artificial Intelligence	
1:00 pm – 1:15 pm	*Refka Hanachi, Akrem Sellami, Imed Riadh Farah and Mauro Dalla Mura.* Semi-supervised Classification of Hyperspectral Image through Deep Encoder-Decoder and Graph Neural Networks
1:15 pm – 1:30 pm	*Amira Ayadi, Mongi Boulehmi and Imed Riadh Farah.* Proposed Architecture for Hyperspectral Image Parallel Processing Methods Based on GPU
1:30 pm - 1:45 pm	*Hela Yahyaoui, Fethi Ghazouani and Imed Riadh Farah.* Deep learning guided by an ontology for medical images classification using a multimodal fusion
1:45 pm - 2:00 pm	*Umar Anjum, Ahmed Hussain, Babar Ali Channa, Umer Afzal, Israr Hussain, Abdulfattah Noorwali and Syed Aziz Shah.* JPEG Image Compression Using Multiple Core Strategy in FPGA achieving High Peak Signal to Noise Ratios
2:00 pm - 2:15 pm	*Ardan Hüseyin Eşlik, Emre Akarslan and Fatih Onur Hocaoğlu.* Cloud Motion Estimation with ANN for Solar Radiation Forecasting

ICOICS Presentation Schedule

Day 1: Sunday: July 4, 2021	
2:15 pm – 2:30 pm	*Jarray Noureddine, Ali Ben Abbes, Manel Rhif, Farah Chouikhi and Imed Riadh Farah.* An open source platform to estimate Soil Moisture using Machine Learning Methods based on Eo-learn library
2:30 pm - 2:45 pm	*Salim Klibi, Makram Mestiri and Imed Riadh Farah.* Emotional behavior analysis based on EEG signal processing using Machine Learning: A case study
2:45 pm - 3:00 pm	*Najla Hamandi and Jawad Alkhateeb.* Sentiment Analysis of Arabic Tweets Related to C0VID-19 Using Deep Neural Network
3:00 pm – 3:30 pm	Break
Room 1: Data Science	
3:30 pm – 3:45 pm	*Kawser Ahmed Pinto, Nasuha Lee Abdullah and Pantea Keikhosrokiani.* Diet & Exercise Classification using Machine Learning to Predict Obese Patient's Weight Loss
3:45 pm – 4:00 pm	*Abdulfattah Ba Alawi and Ali Al-Roainy.* Deep Residual Networks Model for Star-Galaxy Classification
4:00 pm – 4:15 pm	*Soufiane Hamida, Bouchaib Cherradi, Oussama El Gannour, Oumaima Terrada, Abdelhadi Raihani and Hassan Ouajji.* New Database of French Computer Science Words Handwritten Vocabulary

ICOICS Presentation Schedule

Day 1: Sunday: July 4, 2021	
4:15 pm – 4:30 pm	*Manel Rhif, Ali Ben Abbes, Farah Chouikhi, Noureddine Jarray and Imed Riadh Farah.* Towards a Tunisian earth observation data cube for environmental applications
4:30 pm – 4:45 pm	*Abubakar Ado, Noor Azah Samsudin and Mustafa Mat Deris.* A New Feature Hashing Approach Based on Term Weight for Dimensional Reduction
4:45 pm – 5:00 pm	*Nouf Alharbi, Arwa Althagafi, Shrooq Alhazmi, Omamah Alshomrani and Ahad Almotiry.* A Blockchain Based Secure IoT Solution for Water Quality Management
5:00 pm – 5:15 pm	*Manel Chehibi, Ahlem Ferchichi, Imed Riadh Farah and Allel Hadjali.* Management of Uncertain Spatial Information
5:15 pm – 5:30 pm	*Hanen Balti, Ali Ben Abbes, Nedra Mellouli, Yanfang Sang, Imed Riadh Farah, Myriam Lamolle and Yanxin Zhu.* Big data based architecture for drought forecasting using LSTM, ARIMA, and Prophet: Case study of the Jiangsu Province, China

ICOEEE Presentation Schedule

Day 1: Sunday, 4th July, 2021	
Time :	**9:10am – 12:00 pm (Yemen/Mecca Time (GMT time + 3))**
Zoom link :	https://us02web.zoom.us/j/86170289022?pwd=MGJUU2xxUUU1eUxWZlpmS0hsTWxtZz09
Meeting ID :	861 7028 9022
Passcode :	ICOTEN2021
Session 2: Keynote Speeches	
Room 2	
9:10am – 9:50 am	Keynote Speaker I: **Prof. Dr. Haitham Abu-Rub** IEEE Fellow, Texas A&M University, Qatar Keynote title: *Renewable Energy Dominated Grid – Opportunities and Challenges*
9:50am – 10:30 am	Keynote Speaker II: **Prof. Dr. Marwan Dhamrin** Specially Appointed Professor at Osaka University and Senior Specialist Executive at Toyo Aluminium K.K, Japan Keynote title: *Photovoltaics and World Energy Transition Outlook: Research and Development Opportunities*
10:30 am – 10:40 am	Break
10: 40 am – 11:20 am	Keynote Speaker III: Assoc. Prof. Dr. Muhammad Ramlee Kamarudin Universiti Tun Hussein Onn Malaysia (UTHM), Malaysia Keynote title: *Overview on 6G*
12:00 pm – 1:00 pm	Break

ICOEEE Presentation Schedule

Day 1: Sunday, 4th July, 2021	
Session 3: Paper Presentations	
Room 2	
1:00 pm – 1:15 pm	*Anas Binshitwan, Seraj Keskeso, Abdulmunem Alquzayzi and Ahmed Elbarsha* 38GHz Rectangular Microstrip Antenna with DGS for 5G Applications.
1:15 pm – 1:30 pm	*Mamunur Rashid, Nasir Algeelani, Samir A. Al-Gailani and Nohaidda Binti Sariff* Indoor Electrical Installation Design Layout Using IOT
1:30 pm - 1:45 pm	*Alhusayn Yousuf, Seraj Elshwehdi and Ahmed Elbarsha* Analysis and Design Rectangular Microstrip Patch Antenna for LTE Terminals at 2.6 GHz
1:45 pm - 2:00 pm	*Hamid Mohammed Qasem Rasheda and Qazwan Abdullah Tarbosh* Design of UWB Antenna for Microwave Imaging using Modified Fractal Structure
2:00 pm - 2:15 pm	*Muniru Okelola, Sunday Salimon, Oluwole Adegbola, Emmanuel Ogunwole, Samson Ayanlade and Baruwa Aderemi* Optimal Siting and Sizing of D-STATCOM in Distribution System using New Voltage Stability Index and Bat Algorithm
2:15 pm – 2:30 pm	*Abdulrahman Th. Mohammad, Zuhair S. Al-Sagar, Ali Nasser Hussain and Majid Khudair Abbas Al-Tamimi* Performance Analysis of 4.68 kWh Proposed Grid-Connected PV System in Iraq

ICOEEE Presentation Schedule

Day 1: Sunday, 4th July, 2021	
2:30 pm - 2:45 pm	*Meryem Benakcha, Abdelhamid Benakcha, Salah Eddine Zouzou and Abdelkarim Ammar* Experimental study of a real-time control by backstepping technique of an induction motor drive
2:45 pm - 3:00 pm	*Abdulrahman Baboraik, Sameh Kassem, Abdulla Ebrahim and Alexandar Usachev* NEW ALGORITHM FOR ELIMINATION OF INDUCTION EFFECT ON THE MAGNITUDE OF PARTIAL DISCHARGE CURRENT PULSE
3:00 pm – 3:30 pm	Break
3:30 pm – 3:45 pm	*Abdulrahman Baboraik, Abdulla Ebrahim, Sameh Kassem and Alexandar Usachev* INVESTIGATION THE IMPACT OF PARTIAL DISCHARGES POLARITY ON RELIABILITY ASSESSMENT OF INSULATION CONDITION IN HIGH VOLTAGE EQUIPMENT
3:45 pm – 4:00 pm	*Hamid Rasheda and Qazwan Abdullah Tarbosh* An Optimization of Fractal Microstrip Patch Antenna with Partial Ground using Genetic Algorithm Method
4:00 pm – 4:15 pm	*Mohamed Lotfi Cherrad, Hocine Bendjama and Tarek Fortaki* Vibration analysis for defective bearings by blind source separation
4:15 pm – 4:30 pm	*Aymen Mohammed Khodayer Al-Dulaimi, Mohammed Khodayer Hassan Al-Dulaimi and Omer Mohammed Khodayer Al-Dulaimi* Construction and Analysis of Dynamic Distribution for Resource Blocks of Real-Time and Data Elastic Traffic in IMS/LTE Networks
4:30 pm – 4:45 pm	Break

ICOEEE Presentation Schedule

Day 1: Sunday, 4th July, 2021	
4:45 pm – 5:00 pm	*Yaser Awadh, Shakir Saat and Izadora Mustaffa* State Feedback Controller Design for Capacitive Power Transfer System
5:00 pm – 5:15 pm	*Evizal Abdul Kadir, Raed Shubair, Sharul Kamal Abdul Rahim, Mohamed Himdi and Muhammad Ramlee Kamarudin* B5G and 6G: Next Generation Wireless Communications Technologies Demand and Challenges
5:15 pm – 5:30 pm	*Nawfan Al-Fakih, Salem Bagaber and Salman Al Abd* IMPROVEMENT OF WIND TURBINE LIGHTNING RECEPTOR

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

The International Conference of Intelligent Computing and Informatics

(ICOICS 2021)

Smart Sensor System for Detection and Forecasting Forest Fire Hotspot in Riau Province Indonesia

Evizal Abdul Kadir[1], Mahmod Othman[2] and Sri Listia Rosa[1]

[1]Department of Informatics Engineering, Universitas Islam Riau, Pekanbaru, 28284 Indonesia
[2]Fundamental Applied Science Dept., Universiti Teknologi Petronas, Seri Iskandar, Perak, 32610 Malaysia

evizal@eng.uir.ac.id, mahmod.othman@utp.edu.my, srilistiarosa@eng.uir.ac.id

Abstract. Indonesian is one of the countries in a tropical region, in the summer season normally high temperature and hot environmental then forest and forest fire happened. This is because most of the land in Indonesia is peatland and forestry area, especially in Sumatera and Kalimantan island. Worst when it has a huge impact on the local economy, environment, flora, fauna and human health. As reported, millions of people have suffered from respiratory problems, which some have died and in serious health conditions. This research aims to prevent more casualties, providing detection and forecasting as well as warning on fires as alert to the community and representative institution. Furthermore, the research discusses on developing a smart sensing system for the ground level to do monitoring and forecasting. Several types of sensor used based on fire basic parameters such as temperature, humidity, gasses and carbon sensor to measure value in the open environment. Arduino microcontroller and algorithm introduce to the system to achieve smart monitoring system and filtering noise data from the sensors. Mathematical model and analysis applied in this system to do forecasting for the future and estimate number of hotspots in the area of forest in Riau Province. The information based on sensing and analysis as well as forecast data forward to the respective institution or government agency for further action.

Keywords: Smart Sensing, Forest Fire, Detection, Forecasting, Riau Indonesia

The International Conference of Advances in Electrical and Electronic Engineering

(ICOEEE 2021)

B5G and 6G: Next Generation Wireless Communications Technologies, Demand and Challenges

Evizal Abdul Kadir[1], Raed Shubair[2], Sharul Kamal Abdul Rahim[3], Mohamed Himdi[4], Muhammad Ramlee Kamarudin[5], and Sri Listia Rosa[1]

[1]Department of Informatics Engineering Universitas Islam Riau, Pekanbaru, 28284 Indonesia
[2]Research Laboratory of Electronics Massachusetts Institute of Technology Cambridge, MA, 02139 USA
[3]Wireless Communication Centre Universiti Teknologi Malaysia, Skudai, Johor Bahru, Johor, 81310 Malaysia
[4]Institute of Electronics and Telecommunications of Rennes, University of Rennes 1, 35000 France
[5]Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, Johor, 86400 Malaysia

evizal@eng.uir.ac.id, rshubair@mit.edu, sharulkamal@fke.utm.my, mohamed.himdi@univ-rennes1.fr, mramlee@uthm.edu.my, srilistiarosa@eng.uir.ac.id

Abstract. The Fifth Generation (5G) is now have been implemented in some countries and will be progressing according to its plan to be commercialized worldwide soon. Nevertheless, many research institutions around the world have now started to look Beyond 5G (B5G) and Sixth-Generation (6G) where these could be the next generation of wireless communications technologies. The demand for wireless connectivity has grown exponentially over the last few decades, to meet the demands of future connectivity a significant improvement needs to be made in communications technologies. A new paradigm of wireless communication, the 6G system, with the full support of massive multiple inputs multiple-output (MIMO) system and millimeter-Wave (mmWave), is expected to be implemented between 2027 and 2030. B5G, some fundamental issues that need to be addressed are higher system capacity, higher data rate, lower latency, higher security, and improved quality of service (QoS) compared to the 5G system. This paper focusses on the discussion of the potential of 6G wireless communication and its network demands and challenges including mmWave, terahertz communications and massive MIMO systems.

Keywords: Wireless Communication, Terahertz, MIMO System, B5G, 6G.


ICOTEN
THE INTERNATIONAL CONGRESS OF ADVANCED
TECHNOLOGY AND ENGINEERING


Organized by:
VSRG
International Collaborators:
UWS
UTM
ENSET
UTHM

B5G and 6G: Next Generation Wireless Communications Technologies, Demand and Challenges

Evizal Abdul Kadir
Department of Informatics Engineering
Universitas Islam Riau
Pekanbaru, 28284 Indonesia
evizal@eng.uir.ac.id

Raed Shubair
Research Laboratory of Electronics
Massachusetts Institute of Technology
Cambridge, MA, 02139 USA
rshubair@mit.edu

Sharul Kamal Abdul Rahim
Wireless Communication Centre
Universiti Teknologi Malaysia, Skudai
Johor Bahru, Johor, 81310 Malaysia
sharulkamal@fke.utm.my

Mohamed Himdi.
Institute of Electronics and
Telecommunications of Rennes,
University of Rennes 1, 35000 France
mohamed.himdi@univ-rennes1.fr

Muhammad Ramlee Kamarudin
Faculty of Electrical and Electronic
Engineering, Universiti Tun Hussein
Onn Malaysia, Johor, 86400 Malaysia
mramlee@uthm.edu.my

Sri Listia Rosa
Department of Informatics Engineering
Universitas Islam Riau
Pekanbaru, 28284 Indonesia
srilistiarosa@eng.uir.ac.id

***Abstract* — The Fifth Generation (5G) is now have been implemented in some countries and will be progressing according to its plan to be commercialized worldwide soon. Nevertheless, many research institutions around the world have now started to look Beyond 5G (B5G) and Sixth-Generation (6G) where these could be the next generation of wireless communications technologies. The demand for wireless connectivity has grown exponentially over the last few decades, to meet the demands of future connectivity a significant improvement needs to be made in communications technologies. A new paradigm of wireless communication, the 6G system, with the full support of massive multiple inputs multiple-output (MIMO) system and millimeter-Wave (mmWave), is expected to be implemented between 2027 and 2030. B5G, some fundamental issues that need to be addressed are higher system capacity, higher data rate, lower latency, higher security, and improved quality of service (QoS) compared to the 5G system. This paper focusses on the discussion of the potential of 6G wireless communication and its network demands and challenges including mmWave, terahertz communications and massive MIMO systems.**

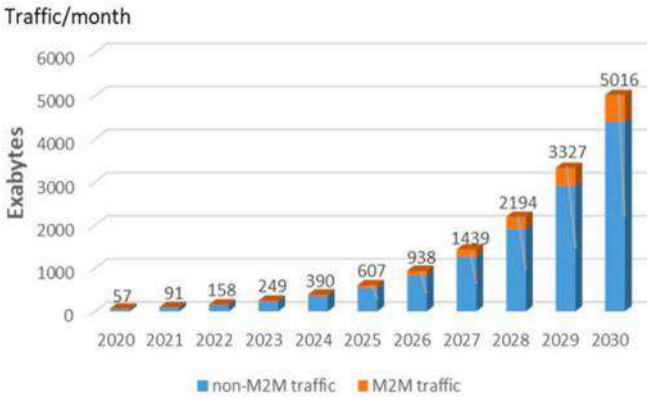
***Keywords*—Wireless Communication, Terahertz, MIMO System, B5G, 6G**

I. INTRODUCTION

The evolution of wireless communication technology started a few decades ago by introduced First Generation (1G) in the year 1980's for voice communication only with an analog system. Second Generation (2G) in the year 1990's used digital modulation technologies such as Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) as well as support for Short Message Service (SMS). Third Generation (3G) wireless communication which available in the year the 2000s has a major transformation with a high data rate that available for video communication (video call). In the year 2010's a Fourth Generation (4G) wireless technology introduced with the capability of high-speed data communication, not only video calling but be able to do a video conference with many peoples up to a few hundred of peoples [1][2]. Fifth Generation (5G) and Beyond 5G (B5G) are technologies that are currently being commercialized since the year 2020 some countries introduced 5G technology with the capability of transfer data up to Gigabits communication. Sixth Generation (6G) is a technology for the future with the target of data communication up to Terabits per second expected available in the year 2030. Refer to the evolution of wireless technology started from 1G to 6G mostly the sequence and transform to the new technology in every ten years [3][4].

Fig. 1. Prediction of growth global data traffic in year 2020 to 2030.

The increasing number of devices connected to the internet very significant every year, the use of the internet is



not only for communication but for other purposes such as data sharing, sensors, automation systems, etc. Furthermore, the introduction of Internet of Things (IoT) technology which used the internet as a medium for data collection, controlling, and automation systems is required high data rate and bandwidth. Fig. 1 shows a prediction of global mobile data traffic in the year 2020 to 2030 by the International Telecommunication Union (ITU) [5]. Exponential of increasing data divided by two categories which are non-Machine to Machine (non-M2M) and Machine to Machine (M2M) communication. M2M support for automation system which implemented by many companies and industries to reduce human interference for example industrial robots, self-driving vehicles, answer machine, etc.

978-1-6654-1224-7/21/$31.00 ©2021 IEEE

II. Demand of High-Speed Communications

The demand for high-speed internet access for communications is mandatory to handle the significantly increasing number of users and devices connected to the internet. Everyday new subscriber keeps going on and required high data communication, the internet access is not only for voice and data communication but for industrial application, for example, intelligent robot to control industrial process, automatic answer machine, self-driving vehicle, and many more application that required high data rate and low latency. Since the users of the internet as a communication system in a variety of devices and purpose as well as in any kind of applications, thus the number of subscriptions become huge of numbers. Sensing and controlling technology is one of the applications that required a high data rate because they required real-time communication, furthermore including surveillance cameras with audiovisual communication need high bandwidth to send the information. Table 1 shows detailed types of subscriptions in the year 2010 and 2020 and predicted to the year 2030 [6]. According to the prediction in the year 2030, the high of mobile subscription up to 17 billion devices with traffic volume up to 5016 Exabyte per month. The huge of data traffic for communication have to take attention and concrete solution before the date else the communication become down and jam that effected in many applications used [7].

TABLE I. Prediction of number subscriber in 2030

Issue	2010	2020	2030 (Predicted)	Unit
Mobile Subscriptions	5.32	10.7	17.1	Billion
Smartphone Subscriptions	0.645	1.3	5.0	Billion
M2M Subscriptions	0.213	7.0	97	Billion
Traffic Volume	7.462	62	5016	EB/month
M2M Traffic Volume	0.256	5.0	622	EB/month
Traffic per Subscriber	1.35	10.3	257.1	GB/month

Besides mobile communication, Machine to Machine (M2M) communication may take attention as well, because the subscription up to 97 billion devices with data traffic up to 622 exabyte may be affected to total traffic that required action and proper action plan, else the M2M used by industrial may get a problem and the use of technology in M2M automation get effected. Online teaching and learning is one of the systems required high data rate, as the current situation in pandemic Covid-19, most of the school and University implementing remote teaching from home using online media such as Zoom, Google meeting, Cisco Webex, etc. High data rate consumes by online teaching because of the number of students attending in the class, in normal class number of students up to 40 peoples, in some case might be more up to 100 peoples. Thus, good system and broadband data communication keep increase with low latency, to fulfill the requirement of the applications.

Another future that consumes high data rate communication and data retrieving is the application in medical and healthcare services. Equipment and remote monitoring of patients become common in healthcare centers to monitor patients due to safety issues for medical staff especially doctors and nurses. By using a remote system to minimize direct contact between patients to medical staff, thus the use of wireless communication and bandwidth is high to get real-time and live to monitor of patients. The most hospital used digital equipment's to monitoring patients then all the record and history of data can be recorded for analysis and future purpose as well as for faster analyze.

III. Millimeter-Wave and Terahertz Communications

Currently, most of the spectrum used for communication is below 6 GHz for example cellular communication, wireless fidelity (Wi-Fi), Bluetooth communication, etc. The lower band of the spectrum gives good communication service and less complicated in terms of hardware design and suitable for voice and data communication. Besides the front services spectrum, there is a backhaul communication system such as for point to point for base station and most of them used spectrum below 60 GHz, the high spectrum for backhaul because is not direct communication to use and required high data rate to support all the clients. Fig. 2 shows all the spectrum available and use by many applications, telecommunication system applicable up to 3 THz band [8].

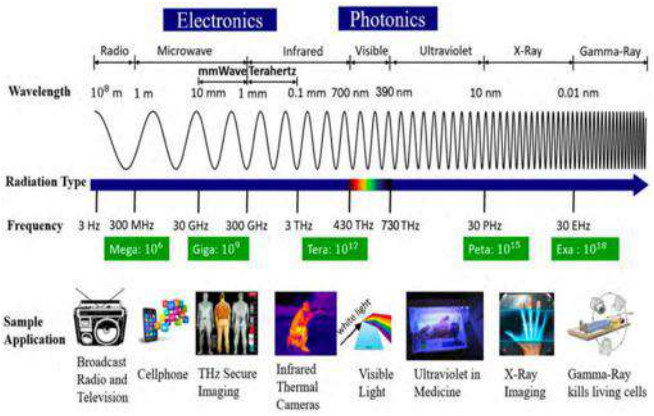


Fig. 2. All the spectrum bands available by many applications.

The use of high spectrum bands is required to handle crowded bands in lower spectrum, by the time increasing number of users and devices connected to the internet as well as spectrum requirements makes the system have to look for higher bands. Terahertz bands are one of the potential and possible spectrums for communication but there are some challenges use in these bands.

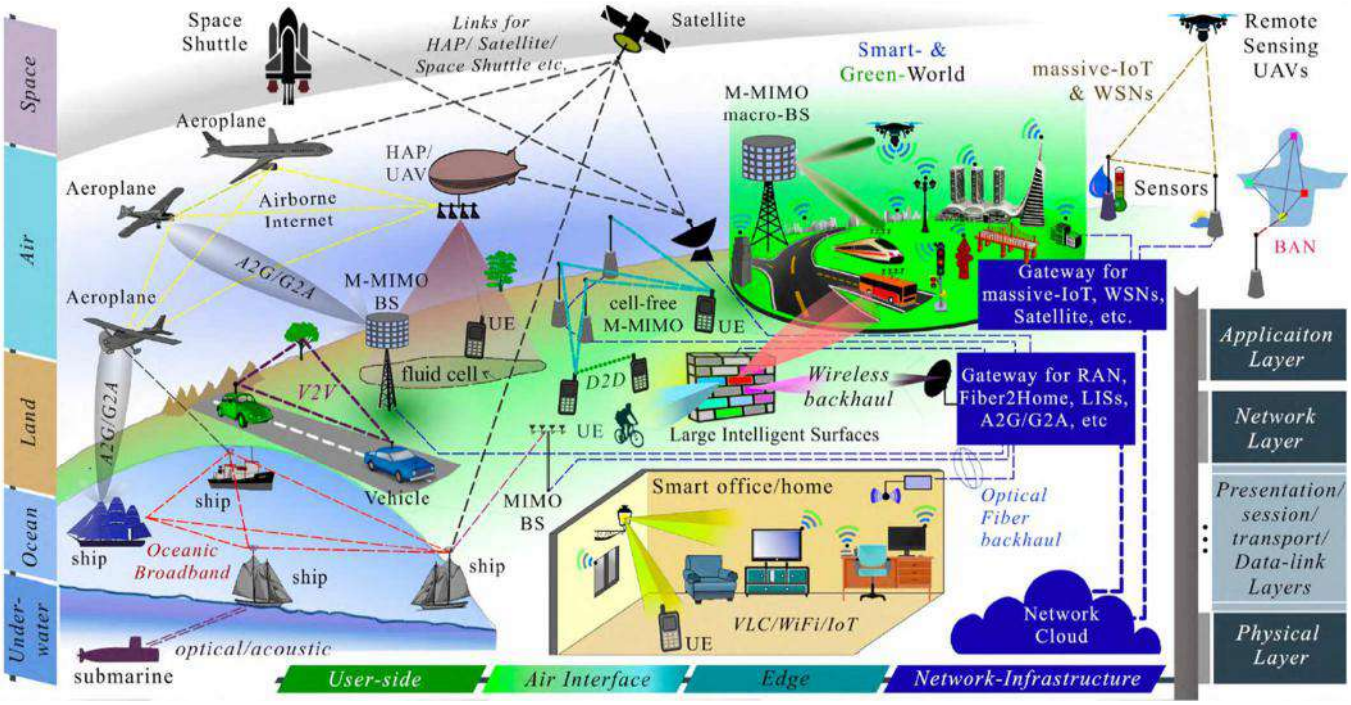


Fig. 3. Example of complex architecture of 6G wireless communications.

Today, communication systems only coverage for land and ocean to handle communications with most of them for voice and data used. The future communication system may very complex scenarios, everything's become connect to the internet and communicate each other's. Fig. 3 shows a complex scenario of wireless communication estimate in 6G technology [10]. Additional coverage areas such as underwater, air, and space are required since many devices have to connect to the internet for communication, sharing data, and other purposes. Thus, a wideband spectrum has to allocate in the future wireless communication system to facilitate the needed, as well as to cover all the number of devices. Furthermore, high-speed data communication has to prepare as well to tackle the huge number of devices connected with sharing data, and some of the devices required real-time communication with minimum latency for example autonomous vehicle communication. Fig. 4 shows terahertz bands with Millimeter Wave and hundreds of GHz slots [9].

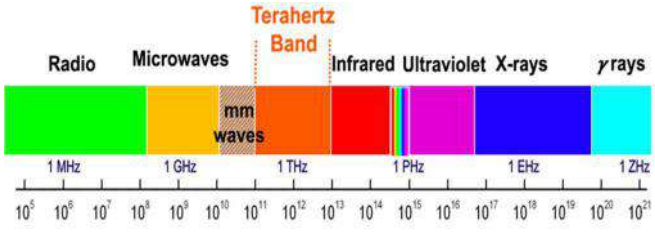


Fig. 4. THz band available with hundreds of GHz spectrum slots

Terahertz spectrum bands are one of the visible solutions to increase data rate and cover the huge number of devices, but there is a weakness of using a very high spectrum in the communication system, one of the limitations is the distance. The millimeter-wave (mmWave) bad into buildings penetration since in the urban area the buildings may in complex and blocked the signal. Reflected and attenuation of signal as well as inference to other devices may happen in a complex scenario in urban with a high number of populations. Path loss is another issue has to address to overcome bad in communication system but there is some solution for this issue such as increasing antenna gain and optimize the efficiency. Fig. 5 shows a graph of how the distance affected the path loss in frequency band microwave and mmWave from 0.1 to 0.35 THz [11][12]. The use of high spectrum bands with mmWave then penetration to obstacles during transmission is very susceptible to objects including raindrop when raining then the combination of the use of spectrum bands in a communication system is a possible solution to overcome the issue.

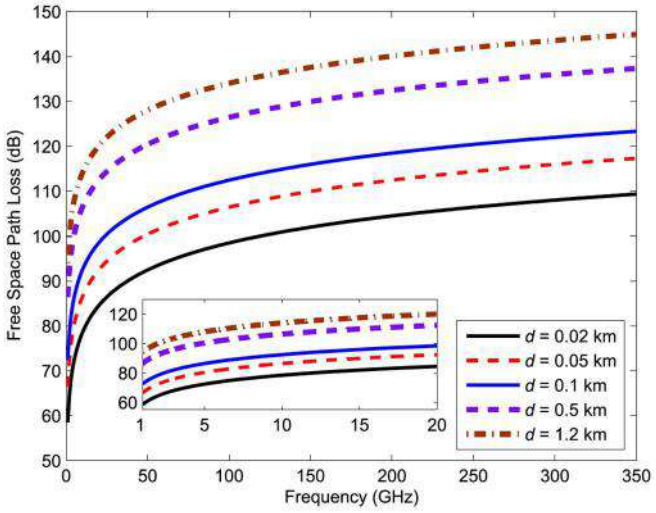


Fig. 5. Free space path loss in microwave and mmWave spectrum bands over different distances.

IV. Massive MIMO Communications

In the era of B5G and 6G communication system, a multi-input multi-output (MIMO) antenna system is a solution to increase the data rate, the requirement is very high up to Tbps then difficult to achieve by the current technology. The spectrum of radio in the lower band from 300 MHz to 6 GHz is already congested and not possible to get more channels for wireless communication then MIMO system is one of the solutions to increase the data rate. Classic massive MIMO has the capability to support in increasing data rate up to Gbps, while cell-free massive MIMO system expected to implement in 6G cellular communication to achieve Terabits data rate. Fig. 6 shows a massive MIMO comparison between classic and cell-free massive MIMO technology [9][13]. 6G of cellular communication expected to achieve a tremendous data rate in Terabits, thus cell-free technique has to apply by every device connected to contribute as a cell in the communication system. The use of higher spectrum bands assists in increasing data rate in the communication system but in some case very complex scenarios and environments make the system may not applicable [14][15].

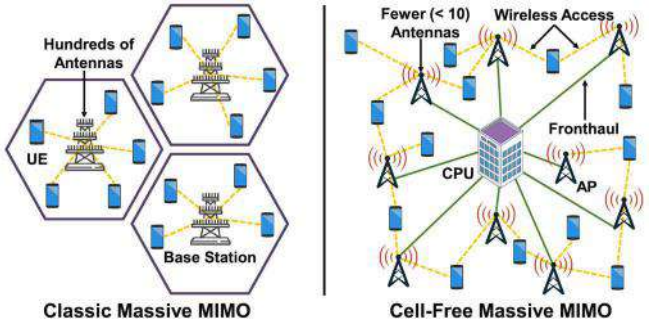


Fig. 6. Comparison of the classic and cell-free massive MIMO in cellular communication system.

To fulfill massive wireless communication then have to increase the performance of the system in term of Quality of Service (QoS), there are several solutions proposed and expected to overcome the low latency and high throughput as well as packet loss in QoS for next-generation B5G and 6G communication services. Explore and analyze the spectrum with low congestion frequency bands is another potential solution to increase the capacity that can find besides other proposed solutions. Fig. 7 shows a key enable for the next generation communication system which 6G and beyond to cover the requirements in the wireless communication system, cell-free massive MIMO, and Terahertz Band are the solution offered in this system.

Cell-free massive MIMO has a significant contribution to increasing the data rate and capacity because of the large number of individual antennas controlled by each device connected to the system. Distributed in wide of the area in simultaneous service in almost all the time which contribute by equipment's (UEs). This proposed method is a promising solution for the next-generation technology in wireless communication because of the ability to gives similar QoS to all UEs [16][17].

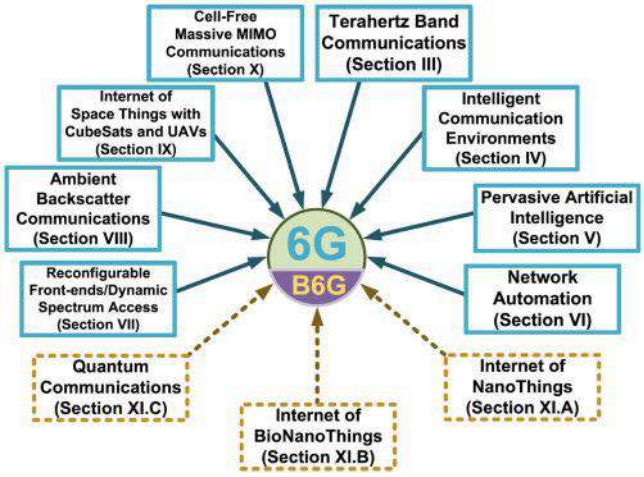


Fig.7. The envisioned key enabling technologies for 6G and beyond wireless communications systems [9].

In comparison to the traditional cellular system used a massive MIMO network to the proposed cell-free massive MIMO is the scheme gives high macro-diversity and has the capability to suppress the interference in multi-user. The actual deployment with a high probability that UEs is in large number to service as well as become access points then have to provide good channel condition. Table 2 shows in the detail of specific advantages and disadvantages of the massive MIMO system between, centralized, network, and cell-free [14][18].

TABLE II. Comparison Between Centralized Massive MIMO, Network MIMO, and CF Massive MIMO.

Architecture	Centralized	Network	Cell-Free
Number of antennas	large	moderate	large
Deployment cost	high	high	low
Macro diversity	small	moderate	large
Channel hardening	strong	weak	moderate
Favorable propagation	strong	weak	moderate
Uniform coverage	bad	moderate	good
Energy efficiency	large	small	very large
Channel estimation	global	global	local
Fronthaul resource	small	large	moderate

Furthermore, compared to the traditional massive MIMO system, cell-free massive MIMO networks expected can give significant features and outstanding performance compared to current massive MIMO technology which are: [14][19].

- Large energy efficiency.
- Flexible and cost-efficient deployment.
- The channel hardening and the favorable propagation conditions.
- Appealingly uniform quality of service.

V. B5G AND 6G KEY TECHNOLOGIES CHALLENGING

The deployment and commercialization of 5G technology in some countries started the last year 2020 shows that the evolution of wireless communication going forward, anyhow the performance and 5G system may no longer due to rapid increasing of user and high-speed data rate requirement. Thus, B5G and 6G technology have to do in advance before the commercialize date of 6G technology is coming. Although the current technology approach has indicated that 5G vision and performance in the right direction to achieve expected data rate and the high number of users. Many types of research are doing by the academician and research institutions worldwide to do similar objective and target in mobile or cellular communication. The objectives to achieve 1000 times faster and improvement compared to the current technology have to wait several years before the actual technology deploy and can be used. Table 3 shows a comparison of cellular technology in few years before which are fourth-generation (4G), fifth-generation (5G), and 6G technologies [9]. The 6G system implement in most of the issues with expect to achieve a super-fast data rate in Terabits per second. Support by artificial intelligence and extended reality technologies makes 6G technology promising in the future.

TABLE III. COMPARISON OF 4G, 5G, AND 6G KEY PERFORMANCE

Issue	4G	5G	6G
Per device peak data rate	1 Gbps	10 Gbps	1 Tbps
End to end (E2E) latency	100 ms	10 ms	1 ms
Maximum sprectral efficiency	15 bps/Hz	30 bps/Hz	100 bps/Hz
Mobility support	Up to 350 km/hr	Up to 500 km/hr	Up to 1000 km/hr
Satellite integration	No	No	Fully
Artificial Intelligence (AI)	No	Partial	Fully
Autonomous vehicle	No	Partial	Fully
Extended Reality (XR)	No	Partial	Fully
Haptic Communication	No	Partial	Fully
THz Communication	No	Very limited	Widely
Service level	Video	VR, AR	Tactile
Architecture	MIMO	Massive MIMO	Intelligent surface
Maximum Frequency	6 GHz	90 GHz	10 THz

The technology challenges to achieve a super high data rate up to Terabits as the target in B5G and 6G technologies are the complexity of the user scenario and have to manage and provide super high-speed data rate because of the increasingly huge number of new users (subscriber) to the internet system. Besides that the new user is not only for mobile devices but for machine and automation equipment's in industrial [20]. All these constraints and challenges have some potential solutions proposed by the researcher based on experiment have been done. The two solutions give high attention is introducing cell-free massive MIMO system and looking for higher frequency bands for communications system such as Terahertz band. Fig. 8 shows an example of a model cell-free massive MIMO system with several number user devices as front services then some number of devices as backhaul link to backend system [21].

The future wireless technologies are not only for communication, data sharing, automaton system, etc. but have the objective to address social issues by the next decade in the year 2030 as 6G technology expected to deploy and commercialize. Besides that, sensing system for the automation and data collection is another significant required bandwidth as well as demand for high data rate for transferring data in real-time. A large number of sensors connected to the internet and predicted by 2030 the number of sensors connected to the internet increasing to 700% compare by the year 2020 is 50 billion sensors [22]. The huge number of sensors supported by the IoT technology makes everything connected to the internet. Total data sharing from all the devices connected to the internet is predicted by 2020 up to 5016 Exabytes including machine to machine communication. Thus, the huge data have to handle by a super-fast communication system to avoid traffic congestion and delay.

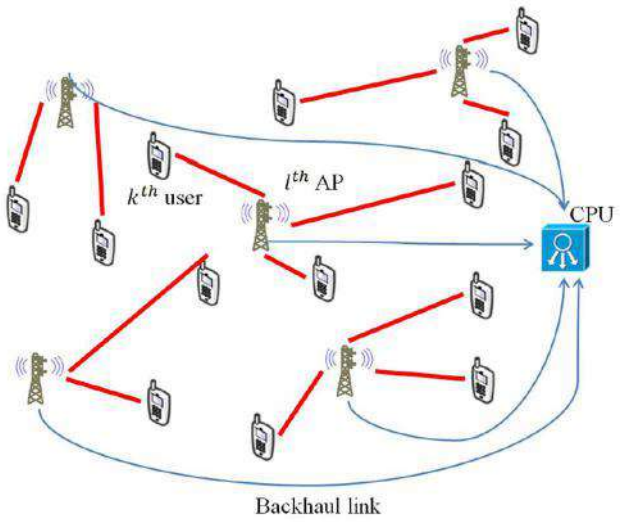


Fig.8. Example of model a cell-free massive MIMO system [19].

There are several trends to the upcoming decade in the use of data for communication and automation system, such as:

- Significant increasing wireless connectivity and use of mobile data.
- The use of mobile data for many applications including teaching and learning as well as automation in the industrial.
- The 6G communication system is one of the possible ways of technology.
- 6G technology service requirements for communication.
- Emerging 6G to other potential technology to fulfill the high data rate requirement.
- Expected 6G applications with the requirements of the QoS system.
- Possible solutions in challenges and research directions to reach the 6G goal.

VI. Conclusion

This paper evaluates the potential solution for future wireless communication especially for the B5G and 6G technology. These technologies are promising to support the requirement and demand of super high data rate and fulfill QoS wireless communication system. The significant increasing number of users and the need for a high data rate makes the system have to explore new spectrum in higher bands that never use before to avoid spectrum congestion and interference. The use of higher spectrum bands especially in the Terahertz band may have challenges in a hardware design that need to do carefully to avoid caused to human or other systems. Cell-free massive MIMO system is one of the technology potentials to support communications system working at the physical layer. The challenges for the next-generation wireless system are to serve the huge number of devices and users connected to the internet with all the equipment's contribute the data and have to do in real-time with minimum delay or latency, especially in the automation system. Additional support for the next-generation system is introducing of artificial intelligence system in the wireless connection that makes the system smarter and more effective in determining the decision.

Acknowledgement

We would like to express our gratitude to Ministry of Education, Culture, Research and Technology of Indonesia and American Indonesia Exchange Foundation (AMINEF) or Fulbright for funding this visiting research scholar and research project.

References

[1] T. Huang, W. Yang, J. Wu, J. Ma, X. Zhang, and D. Zhang, "A Survey on Green 6G Network: Architecture and Technologies," *IEEE Access*, vol. 7, pp. 175758–175768, 2019, doi: 10.1109/ACCESS.2019.2957648.

[2] S. D. Amit, Kumar, Yunfei, Liu; Jyotsna, "Evolution of Mobile Wireless Communication Networks: 1G to 4G," *Int. J. Electron. Commun. Technol.*, vol. 1, no. 1, pp. 1–5, 2010.

[3] V. Raghavan and J. Li, "Evolution of Physical-Layer Communications Research in the Post-5G Era," *IEEE Access*, vol. 7, pp. 10392–10401, 2019, doi: 10.1109/ACCESS.2019.2891218.

[4] U. G. Anju, "An Overview on Evolution of Mobile Wireless Communication Networks: 1G-6G," *Int. J. Recent Innov. Trends Comput. Commun.*, vol. 3, no. 5, pp. 3130–3133, 2015.

[5] S. Elmeadawy and R. M. Shubair, "6G Wireless Communications: Future Technologies and Research Challenges," in *2019 International Conference on Electrical and Computing Technologies and Applications (ICECTA)*, 2019, pp. 1–5, doi: 10.1109/ICECTA48151.2019.8959607.

[6] M. Z. Chowdhury, M. Shahjalal, S. Ahmed, and Y. M. Jang, "6G Wireless Communication Systems: Applications, Requirements, Technologies, Challenges, and Research Directions," *IEEE Open J. Commun. Soc.*, vol. 1, pp. 957–975, 2020, doi: 10.1109/OJCOMS.2020.3010270.

[7] H. Viswanathan and P. E. Mogensen, "Communications in the 6G Era," *IEEE Access*, vol. 8, pp. 57063–57074, 2020, doi: 10.1109/ACCESS.2020.2981745.

[8] T. S. Rappaport *et al.*, "Wireless Communications and Applications Above 100 GHz: Opportunities and Challenges for 6G and Beyond," *IEEE Access*, vol. 7, pp. 78729–78757, 2019, doi: 10.1109/ACCESS.2019.2921522.

[9] I. F. Akyildiz, A. Kak, and S. Nie, "6G and Beyond: The Future of Wireless Communications Systems," *IEEE Access*, vol. 8, pp. 133995–134030, 2020, doi: 10.1109/ACCESS.2020.3010896.

[10] S. J. Nawaz, S. K. Sharma, S. Wyne, M. N. Patwary, and M. Asaduzzaman, "Quantum Machine Learning for 6G Communication Networks: State-of-the-Art and Vision for the Future," *IEEE Access*, vol. 7, pp. 46317–46350, 2019, doi: 10.1109/ACCESS.2019.2909490.

[11] L. Zhang *et al.*, "A Survey on 5G Millimeter Wave Communications for UAV-Assisted Wireless Networks," *IEEE Access*, vol. 7, pp. 117460–117504, 2019, doi: 10.1109/ACCESS.2019.2929241.

[12] H. Elayan, O. Amin, B. Shihada, R. M. Shubair, and M. Alouini, "Terahertz Band: The Last Piece of RF Spectrum Puzzle for Communication Systems," *IEEE Open J. Commun. Soc.*, vol. 1, pp. 1–32, 2020, doi: 10.1109/OJCOMS.2019.2953633.

[13] G. Femenias and F. Riera-Palou, "Cell-Free Millimeter-Wave Massive MIMO Systems With Limited Fronthaul Capacity," *IEEE Access*, vol. 7, pp. 44596–44612, 2019, doi: 10.1109/ACCESS.2019.2908688.

[14] J. Zhang, S. Chen, Y. Lin, J. Zheng, B. Ai, and L. Hanzo, "Cell-Free Massive MIMO: A New Next-Generation Paradigm," *IEEE Access*, vol. 7, pp. 99878–99888, 2019, doi: 10.1109/ACCESS.2019.2930208.

[15] J. Zhang, Y. Wei, E. Björnson, Y. Han, and S. Jin, "Performance Analysis and Power Control of Cell-Free Massive MIMO Systems With Hardware Impairments," *IEEE Access*, vol. 6, pp. 55302–55314, 2018, doi: 10.1109/ACCESS.2018.2872715.

[16] J. García-Morales, G. Femenias, and F. Riera-Palou, "Energy-Efficient Access-Point Sleep-Mode Techniques for Cell-Free mmWave Massive MIMO Networks With Non-Uniform Spatial Traffic Density," *IEEE Access*, vol. 8, pp. 137587–137605, 2020, doi: 10.1109/ACCESS.2020.3012199.

[17] E. Abdul Kadir, "A reconfigurable MIMO antenna system for wireless communications," in *International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, 2017, doi: 10.1109/EECSI.2017.8239191.

[18] E. A. Kadir, H. Irie, S. K. A. Rahim, Y. Arta, and S. L. Rosa, "Reconfigurable MIMO Antenna for Wireless Communication Based on Arduino Microcontroller," in *RFM 2018 - 2018 IEEE International RF and Microwave Conference, Proceedings*, 2018, doi: 10.1109/RFM.2018.8846549.

[19] H. T. Dao and S. Kim, "Effective Channel Gain-Based Access Point Selection in Cell-Free Massive MIMO Systems," *IEEE Access*, vol. 8, pp. 108127–108132, 2020, doi: 10.1109/ACCESS.2020.3001270.

[20] A. Dogra, R. K. Jha, and S. Jain, "A Survey on beyond 5G network with the advent of 6G: Architecture and Emerging Technologies," *IEEE Access*, p. 1, 2020, doi: 10.1109/ACCESS.2020.3031234.

[21] P. Yang, Y. Xiao, M. Xiao, and S. Li, "6G Wireless Communications: Vision and Potential Techniques," *IEEE Netw.*, vol. 33, no. 4, pp. 70–75, 2019, doi: 10.1109/MNET.2019.1800418.

[22] M. Swan, "Sensor Mania! The Internet of Things, Wearable Computing, Objective Metrics, and the Quantified Self 2.0," *Journal of Sensor and Actuator Networks* , vol. 1, no. 3. 2012, doi: 10.3390/jsan1030217.

ICOTEN
THE INTERNATIONAL CONGRESS OF ADVANCED TECHNOLOGY AND ENGINEERING

The International Congress of Advanced Technology and Engineering (ICOTEN 2021)

CERTIFICATE OF ATTENDANCE

This is to certify that the paper:

B5G and 6G: Next Generation Wireless Communications Technologies, Demand and Challenges

Authors

Evizal Abdul Kadir, Raed Shubair, Sharul Kamal Abdul Rahim, Mohamed Himdi, Muhammad Ramlee Kamarudin and Sri Listia Rosa

at

The International Conference of Advances in Electrical and Electronic Engineering (ICOEEE 2021)

that was organized in conjunction with ICOTEN 2021 and held online on July 4-5,2021.

DR. FAISAL SAEED,
ICOTEN 2021 GENERAL CHAIR

YSRG YEMENI SCIENTISTS RESEARCH GROUP

HADHRAMOUT UNIVERSITY

IEEE Yemen Subsection

UNIVERSITY OF THE WEST of SCOTLAND UWS

CHARLES DARWIN UNIVERSITY

UTM UNIVERSITI TEKNOLOGI MALAYSIA

ENSET

isamm

UTHM Universiti Tun Hussein Onn Malaysia

FACULTY OF SCIENCE AND TECHNOLOGY UIN SUSKA RIAU