

# CHALLENGES AND OBSTACLE TO IMPLEMENTING 5G IN INDONESIA

<sup>1</sup>AZANI CEMPAKA SARI, <sup>2</sup>JASON, <sup>3</sup>ENDRICO LANSKY, <sup>4</sup>MUHAMMAD ALIF FERDIANSYAH

Computer Science Department, School of Computer Science, Bina Nusantara University, Jl. K. H.

SyahdanNo. 9 Kemanggisan, Palmerah, Jakarta, 11480, Indonesia

E-mail: <sup>1</sup>acsari@binus.edu, <sup>2</sup>jason019@binus.ac.id, <sup>3</sup>endrico.lansky@binus.ac.id, <sup>4</sup>muhammad.ferdiansyah@binus.ac.id

## ABSTRACT

Over the last few years, the development of wireless communication has become something that is often to be seen. This development has been started from 1G to the latest, which is called the 5G Network. The 5G Network will greatly improve the quality of the internet network (QoS) and industry in Indonesia. However, to successfully implement 5G in Indonesia, there are several challenges that we must overcome to implement 5G in Indonesia. The challenges start from implementing the 5G Infrastructure. First we must know the exact frequency to implement 5G in Indonesia, other than that we also have to know the positive and negative effects if we succeed in Implementing 5G. If successfully implemented, it is certain that 5G will increase data transfer speeds with more stable bandwidth and much lower latency compared to its predecessor generation. This positive development will later improve internet performance in Indonesia to be able to compete with Countries that have already implemented 5G.

**Keywords:** *IOT Heterogen Networks, Massive MIMO, D2D Communication, Cloud Technology.NFV, SDN, EMB (Enhanced Mobile Broadband).*

## 1. INTRODUCTION

Evolution and progress of network communication these days has a very large impact on the life of every person in this world, especially in Indonesia. Every country surely wants to have an advanced and well developed network capacity for the sake of its people. For this reason, that's why the latest network technology is made, which is called 5G. The implementation of the 5G itself has been successfully applied in various developed and under-developed countries such as Saudi Arabia, South Korea, Australia, Taiwan, Hong Kong, England, China, Japan, and various other countries. It is hoped that the development and implementation of the new 5G network will have a huge impact on improving Indonesian economy and industry.

At this time, the government and operators are faced with various challenges and obstacles to implement 5G in Indonesia, which include regulation and infrastructure development. The main objective of 5G

technology is to fulfill mobile communication services and provide technology assistance and support in the economic and industrial sectors. Basically, 5G network system is constructed to fulfill the needs and network services for the future that are more capable of fulfilling any human needs in online communication. It should be noted that at this time, the internet connection in Indonesia is currently in a phase that is lacking in terms of the unstable network, low bandwidth, minimum speed, and high latency compared to any other Asian countries.

One of the solutions for implementing a more capable internet connection for Indonesia is to analyze the architecture of the 5G network and see its development so that it can be implemented in Indonesia. Common techniques that are usually used are Device to device communication (D2D) and also Massive MIMO. Function of Device to device communication (D2D) itself is to create a form of communication that allow User Equipment (UE) to communicate directly with or without supervision from eNB (Evolved Node B) and Massive MIMO to produce multiple

inputs as well as multiple outputs because it is necessary to know that the technology from the 5G network itself comes in various forms of IoT (Internet of Things). That's why, we need to synchronize between 5G and IoT using D2D Communications because it is necessary to know that IoT in Indonesia is currently still small (rare) and we need to do further study for this.

We choose this topic because we are interested in the D2D Communication method as a link between devices and to give us ideas to analyze the challenges and obstacles that exist for implementing 5G in Indonesia. We will use the existing literature as the main material for our research. We hope that our ideas will be useful for the progress and welfare of the people in Indonesia in the terms of telecommunications.

## 2. 5G NETWORK

5G is the new generation mobile network. It is a new global wireless standard after its predecessor 1G, 2G, 3G, and 4G Networks. This new generation network enables a new kind of network that was designed to connect everyone in virtual environments which include machines, objects, and also devices. 5G Wireless technology was intended to deliver higher multi-Gbps in peak data speeds, ultra low latency, more reliable, massive network capacity, increased availability, and the most important thing is to improve telecommunication between Users.

In order to develop 5G networks. There are a few challenges that we have to overcome. The First challenges are the system and architecture of 5G, Layer in 5G (5G Scenario) itself and the exact frequency for 5G Networks. In order to know the frequency, we should use EMBB (Enhanced Mobile Broadband), Massive MIMO (Multiple Input and Multiple Output), IoT, and Heterogen Networks, D2D Communication, Cloud Technology.

### 2.1 5G NETWORK REQUIREMENT

In order to implement 5G, there are several requirements needed, which is :

- 1) Enhanced Mobile Broadband (EMBB) : It's one of the three primary 5G New Radio (NR) use cases defined by the 3GPP as part of its SMARTER (Study on The New Services and Market Technology Enablers) Project. The objective of EMBB is to develop high

level use cases and identify what features and functionality needed to implement 5G. In EMBB, data- driven use cases require high data rates across a wide coverage area.

- 2) Massive Multiple Input Multiple Output (MIMO) : is an extension of MIMO (Multiple Input and Multiple Output), which essentially groups together antennas at the transmitter and receiver in order to provide better throughput and also provide better spectrum efficiency. This method's ability to multiply the capacity of the antenna links has made an essential element of wireless standards including the 802.11n (Wi-Fi), the 802.11ac (Wi-Fi), the HSPA+, WiMAX and LTE.
- 3) IoT (Internet of Things) : is a system of interrelated processes between computing devices, mechanical & digital machines, objects, animals, or people that are provided with UIDs (Unique Identifiers). The ability to transfer data over a network without requiring human to human or human to computer interaction. The thing in the Internet of Things can be anything such as a person with a heart monitor implant, a farm animal with a biochip transponder, or even an automobile that has built-in sensors. Variety of IoT is to improve decision making and increase the value of business.
- 4) Heterogen Networks: is a network connecting computers and other devices where the operating systems and protocols have significant differences. Heterogen Networks are used in wireless networks which use different technologies access. The architecture of Heterogen Networks itself can be viewed as encompassing conventional macro radio access network (RAN) functions, RAN (Radio Access Network) Transport Capability, small cells, and also the functionality of Wi-Fi.
- 5) D2D Communication : is one of the key solutions for implementing 5G Networks. D2D Communication in cellular networks allows direct communication between two mobile users without assistance from Transceiver Base Station (BS) or also from infrastructure based networks. Advantages by using the D2D Communications can improve many things, such as spectrum efficiency, communication delay, and also energy consumption.

- 6) Cloud Technology : is the on demand availability of computer system resources, especially in data storage (cloud storage) and computing power without direct management by user. 5G Technology will enable cloud service providers to reach

enterprise mobile customers easily and reliably. Lately, access to virtual machines will become common in the future because of these following aspects such as, larger computing and also machine-to-machine communication in 5G. Cloud computing will be a major help to allow remote workers access to cloud services.

2.2 5G NETWORK SYSTEM AND ARCHITECTURE

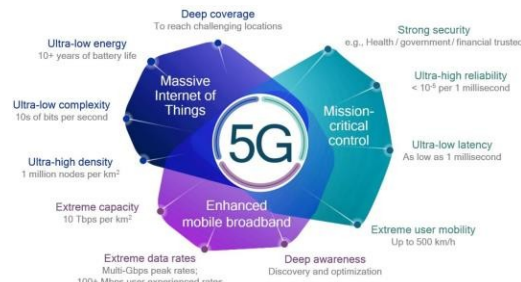
5G networks are built in order to increase the needs and quality of network systems all around the globe. International Telecommunication Union already determine the performance parameters for 5G technology through International Mobile Telecommunications-2020 (IMT-2020), the result is as follows:

- *Peak data rate:* Achievable data rate in normal condition is 20Gbps for downlink and 10Gbps for the uplink.
- *User experience data rate:* User experience data rate is the minimum data rate that is obtained by a user within the area. 100Mbps for downlink and 50Mbps for uplink.
- *Spectrum efficiency:* Defined as average data per spectrum allocated to a cell. For indoor conditions it's 9bps downlink and 6.75bps uplink. For urban areas it's 7.8bps downlink and 5.4bps uplink. And for the rural area it's 3.3bps downlink and 1.6bps uplink.
- *Mobility:* Users are still able to have normal data traffic while moving, as long as the speed is no more than 500Km/h.
- *Latency:* For *Enhanced Mobile Broadband (eMBB)* the latency for the services is 4ms, and 1ms for *Ultra Reliable and Low Latency Communications (URLLC)* services.
- *Connection density:* For *Massive Machine Type Communications (mMTC)*, the total number of devices that can connect to the network is up to one million devices/km<sup>2</sup>
- *Network energy efficiency:* The network

supports high sleep and long sleep schemes to save more energy for the devices.

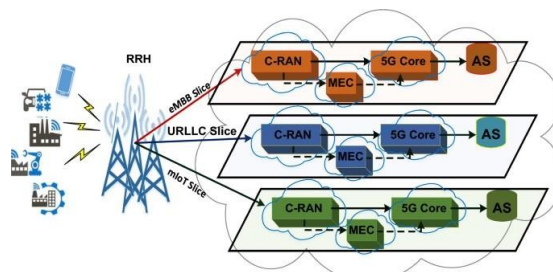
- *Area traffic capacity:* Is the total traffic that can be allocated within an area is 10Mbps/m<sup>2</sup> for indoor hotspot.

5G networks still improved until this day with aims to get much more flexible architecture, heterogeneous network access capability, and vertical integration of business lines by using Software Define Network and Network Functions Virtualization. Inside 5G network architecture there are networks access with high performance and a core network that has functions to control and forwarding to meet predetermined performance parameters.



Picture 1: 5G Network Capability According to Qualcomm White Paper

The evolution of 5G communication systems was a transition to a brand new network which required more advanced technology. For the 5G itself, the collection of technologies under the banners was known as 5G NR or people often called s 5G New Radio. This is an initial phase in order to successfully develop a 5G Network with various advantages such as Deep Coverage, Ultra Low Energy, Strong Security, Ultra High Reliability, Ultra Low Latency, Extreme User Mobility, Deep Awareness, Extreme Data Rates,and many more.



Picture 2: Multi-Stage Analysis of Network Slicing Architecture

In this Multi-Stage Analysis, network slicing architecture is intended to do multiplexing and virtualized processes and also independent logical networks on the same as the physical network architecture. The process begins with each network being sliced and isolated in order to fulfill requirements by an application. In this process, it will involve C-RAN, MEC, and also Cloud Data Center to create a model. In the end, the simulation

model will affect the quality of service targets of 5G Slices.

### 2.3 5G NETWORK SECURITY

In this section, there will be an explanation about the 5G Security requirement in order to implement 5G. This standard security architecture and procedures for the 5G system was developed through a partnership with the Internet Engineering Task Force (IETF). The security requirements are divided into two which are User Equipment Security Features and Network Security Features.

#### 1. User Equipment Security Features

In User Equipment Security Features, there requirement needed are :

- Authentication : In Authentication, the User equipment must authenticate the network identifier first by using key authentication.
- Confidentiality of User and Signaling Data : In Confidentiality of User and Signaling Data, User Equipment can support confidentiality of some data through cipher algorithms for encryption. In order to do that, User equipment must use the NEA0, 128-NEA1, and 128-NEA2 cipher algorithms.
- Integrity of User and Signaling Data : The cipher algorithms NIA0, 128-NIA1, and 128-NIA2 are the main thing used for integrity protection. User equipment must support integrity protection and replay protection of user data. This requirement was optional because using this will increase the processing load on both of the User Equipment and Network Node.
- Secure Storage and Processing of

Subscriptions Credentials : In this part, the requirements are credentials and a long term key success in order to implement 5G. This portion is the largest standard and also mandates to perform security evaluation on hardware components.

- Subscriber Privacy : The key success to meet 3GPP 5G Security standard, is by using Globally Unique Temporary UE Identity (GUTI). GUTI provides an unambiguous identification of the User equipment but does not reveal the UE of the User Identity. By using this, there will be a 5G Security Standard which is a home network that refers to the network of the User Subscribed.

#### 2. Network Security Features

In Network Security Features, the requirement needed are :

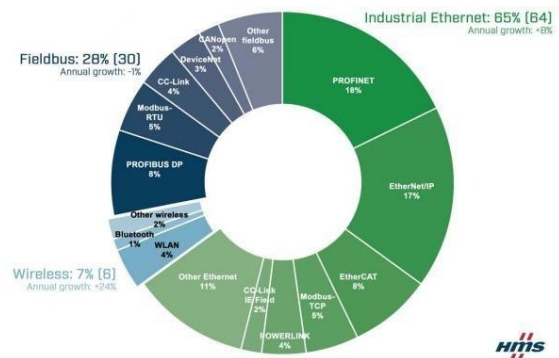
- Subscription Authentication : The network is required to authenticate the SUPI (Subscription Permanent Identifier) when authenticating and also performing key agreements with the user equipment.
- User Equipment Authorization : In this part, the serving network must firstly authorize the user equipment by using a subscription profile obtained from the home network. After that, the user authentication will depend on the Authenticated SUPI.
- Saving Network Authorization by the Home Network : This was the one of the largest 5G Security standards in which the User Equipment must connect to an authorized serving network by using the home network.
- Access Network Authorization : In This section, The serving networks must be authorized by the home networks and access networks must be authorized by serving networks in order to provide services for User.
- Confidentiality of User and Signaling Data : In this part, The 5G gNB must support the encryption of user data in transit and for RRC Signaling. Other than that, the gNB also has to activate the user data encryption based on the security policies.
- Integrity of User and Signaling Data : The nodes must support integrity

- protection and replay protection of User data between User Equipment and gNB. The algorithms that have been used are the same algorithm from integrity protection.
- Setup and Configuration Requirements : In the 5G Networks Security, the operation management and also system setup to configure gNB have to be authenticated and authorized by Registration Authority and a Certification Authority (RA/CA). Communication between the operation management and system setup has to be related between unauthorized entities.
- Requirements for Key Management Inside the gNB : In this section, there will be encryption keys provided by the 5G Network itself to gNBs. The attributes needed was subscription-specific session keying material, This attribute was used as a part of a gNB deployment storing or processing unencrypted keys.
- Handling User Plane and Control Plane Data Requirements : The requirements in order to do key management are similar for handling data in the gNB. Firstly, unencrypted data must be protected from physical attack and unencrypted data must be stored in a safe environment.
- Requirements for a Secure Environment : In this part, The secure environment that has unencrypted data will be running as a main requirement. The environment that has been created must be able to execute sensitive functions and protocols. The protocol is an authentication protocol.
- Requirement for F1 Interfaces : The F1 interface has to send signal traffic and user plane data between the distributed unit and central unit of the network. The F1 interfaces are intended to control planes with high confidentiality, integrity, and replay protection.
- Requirement for E1 Interfaces : The E1 interface works as an open interface between the central unit and control plane as well as the central unit and user plane. These requirements were also used in confidentiality, integrity, and replay protection.

### 3. SERVICE SCENARIO OF 5G NETWORK

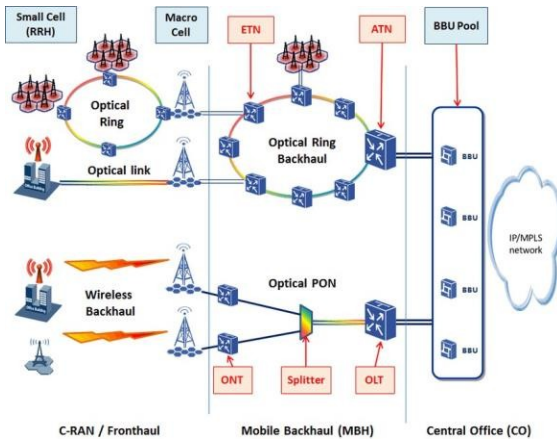
5G networks will be implemented soon or later, therefore scenarios for this will be needed to know the vision and requirements that will be needed to face the new era of networking. IoT and Mobile internet will become the major spear head in mobile communications technology in the future. In the future 5G will be able to support high data usage platforms perfectly, such as online games, augmented reality, virtual reality, high quality videos, etc. To fulfil 5G requirements there are several things that need to be upgraded, which is virtualization, millimeter wave, beamforming, small cells, low latency, massive MIMO, etc. But if we manage to cover all of the challenges, there are several preparations that need to be done in order to successfully implement 5G in Indonesia.

#### 3.1 INDUSTRIAL GROWTH



Picture 3: Industrial Automation Networking Market by HMS Networks

In this era of the 4.0 industrial revolution, networking has become the main source for industrial capacity. That's why having a better network quality will improve the industrial capacity with 5G, because 5G costs less and has a higher flexibility. In industrial capacity 5G will improve several technologies, such as artificial intelligence for better industrial automation and manufacturing, augmented reality, and IoT (Internet of Things).

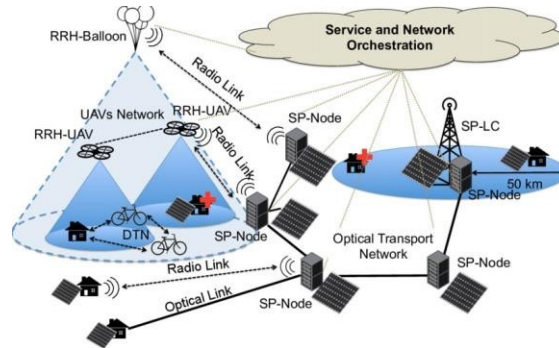


Picture 4: Crosshaul Network Architecture

Not only for industrial concern, 5G will be also used by civilians. After 5G has already been implemented, mobile operators such as Telkomsel, XL, etc must be prepared to operate 5G service, from building the infrastructure and facilities. Frequency band should be increased to 2.3 GHz with 30MHz bandwidth. Once the 5G network is already implemented in our country, there will be a lot of customers, therefore all of the mobile operators must be ready when it happens.

### 3.3 RURAL AREA COVERAGE

If the 5G Network is successfully implemented in the future, it will improve mobile broadband and support IoT (Internet of Things) in many situations. It may even be suitable for fixed broadband in urban areas and also has cost effectiveness to address the fixed broadband. In order to cover many areas with good connectivity, the broadband used by 5G Network must meet the demanding bandwidth. In order to do that, there are three methods to get more broadband which is increasing the transmit power or reducing noise, adding spectrum, and also reducing the number of users per cell.



Picture 5: Rural Area Coverage of 5G Networks

First is increasing transmit power or reducing noise. This method will increase the signal levels or reduce noise in the 5G Network that will enable better modulation techniques. In order to do this, there will be improvement in ratio of signal to the SINR. This improvement will provide higher efficiency modulations that can be used by only a few Users that are very close to the access point.

Table 1 : Radio Spectrum Frequency according to International Telecommunications Union (ITU)

Band Name	Symbols	Frequency range
Very low frequency	VLF	3 to 30 kHz
Low frequency	LF	30 to 300 kHz
Medium frequency	MF	300 to 3000 kHz
High frequency	HF	3 to 30 MHz
Very high frequency	VHF	30 to 300 MHz
Ultra high frequency	UHF	300 to 3000 MHz
Super high frequency	SHF	3 to 30 GHz
Extremely high frequency	EHF	30 to 300 GHz
Terahertz (ITU, 2015b)	THz	300 to 3000 GHz

Second is by adding spectrum frequency. In this method, there will be a tiny fraction in order to support the improvement requirement for the 5G Network itself. The Federal Communications Commission or often called as FCC will release repurpose mobile broadband in 18 GHz or millimeter wave with high frequency (6 GHz to 80 GHz). Within this frequency range, will make improvement in access point capacity and the transfer speed of data. Later in this future, all this improvement will be globally standardized and licensed in order to implement 5G.

Lastly, is by reducing the number of Users per cell. This improvement will bring an increase in capacity for an entire system. The process was started by placing the cells closer and

closer so the capacity can afford a large coverage of footprint at one cell using a radio channel that can be applied. In addition, user devices will have to cooperate with many brands and expand the MIMO (Multiple Input & Multiple Output) Capabilities in order to be successfully developed.

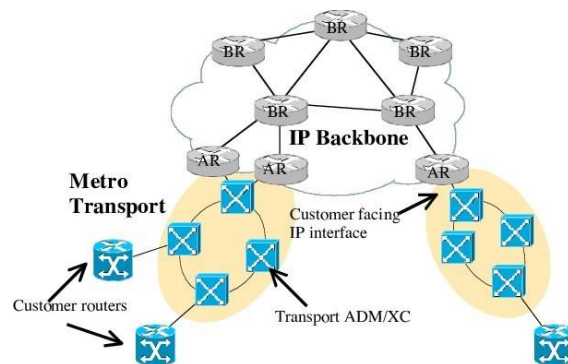
#### 4. MAIN CHALLENGES TO IMPLEMENT 5G NETWORK

Currently, a lot of countries today through telecommunication operators have rolled out 5G networks and conducted tests on their performance before they are officially launched in 2020. In this year (2021), 59 countries have already used 5G connection. While still watching the development from this new generation of connection. According to Kominfo, it will be launched in 2022. Operators will benefit from the formation of new types of services, as discussed earlier, thus providing opportunities for increased revenue. And from the side of society as a user can improve the economy through the use of internet technology. According to Grijpink's analysis, there will be a 60% increase in CAPEX in 2020-2025. To meet the performance parameters that have been determined in 5G Network technology, the development, and development of infrastructure is the thing that must be done by operators in Indonesia

##### 4.1 GEOGRAPHY DIFFICULTIES

There are a lot of mountains and forests that cover Indonesian soil. That is the reason why the development of 5G connection in Indonesia is slow. Developers of the connection must think about the mountain, forest and also the sea. This geography makes the connection hard to reach by someone. That is why even though the preparation of the 5G connection is ready, it has not yet been released.

##### 4.2 TECHNOLOGY FROM THE ISP



Picture 6: ISP Network Topology

There is a lot of technology that must be prepared by the ISP. The first thing that they have to prepare is how they reach the optimal frequency spectrum. This is the part for every RAN. The higher frequency spectrum makes the transfer rate of data higher too.

The second requirement that they have to prepare is RAN infrastructure. There are two schemes to develop this radio access, those are Standalone New Radio and Non-standalone NewRadio. A combination of New Radio is used for downlink and lower-band LTE as an uplink channel.

The last requirement is the Transmission, where RAN are affected by changes in the transport network. This will be reached with a good transmission, with this the maximum rate (20 Gbps Downlink) and (10 Gbps Uplink) will be reached.

#### 5. CONCLUSION

There are many challenges in developing the 5G Network in a country. Preparations are needed to successfully develop 5G which include frequency spectrum and government regulations. The need for network infrastructure which includes RAN and transmission lines using fiber optic cables must be carried out by operators in order to create 5G Network Architecture.

When we start the process of developing the 5G Network, there will be consequences such as radiation that will bring harm to humans, animals, and also plants. To solve this problem, we have to know the exact problem in order to

implement various methods. We can start by a project experiment using the D2D Communications method. In our opinion, this method is the best method to implement 5G Network System and Architecture.

D2D Communication features will allow communications between two User Equipment with or without the access point or Base Network (BS). The connected device can communicate by using a direct link. In this D2D Communication method, the network will automatically authorize the two devices connected to communicate directly with each other under its control. D2D communications methods offer various benefits such as ultra low latency, solved network capacity issues, extended coverage and also provide better services for the 5G Network.

One of the biggest challenges to overcome in the implementation of 5G Network itself is the 5G Network format which leads to its predecessor which is 4G. If 5G Successfully implemented, there will be limited range of use and people have to adapt with the changing environment. These changes will probably bring positive and negative effects to people but eventually, everyone will get used to it.

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