5G's Role in the Data Communication Revolution

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Abstract-*The 5G technology is an important milestone in the evolution of data communications by offering higher transmission speeds, lower latency, and greater network capacity. The implementation of 5G contributes to the improvement of data communication efficiency in various sectors, including industry, health, and transportation. This research aims to analyze the impact of 5G technology on data communication speed and reliability as well as the challenges in its implementation. The method used in this research is a literature study that refers to various academic sources related to the development of 5G and its application in data communication. The results show that 5G technology has great potential in improving network performance, although it still faces challenges in terms of infrastructure and security. Therefore, a proper strategy is needed in the implementation of 5G to maximize its benefits in data communication.*

Keywords: 5G, Data Communication, Speed, Reliability, Infrastructure, Security

I. INTRODUCTION

The development of network technology continues to progress rapidly, especially with the arrival of the fifth generation or 5G. This technology offers various advantages over previous generations, such as increased data rates of up to gigabits per second, very low latency, and the ability to handle more devices connected in one network. These advantages open up great opportunities for various sectors to adopt more efficient and reliable data communications.

However, behind these advantages, there are various challenges that need to be overcome in the implementation of 5G, including limited network infrastructure, compatibility with previous technologies, and increasingly complex data security issues. Therefore, this research aims to explore the role of 5G in revolutionizing data communications by reviewing its impact on network speed and reliability, as well as the challenges faced in its implementation. 5G technology is the fifth generation technology that will bring many positive impacts in the field of telecommunications, this capability is needed by telecommunications operators to meet the needs of users both personal, corporate, organizational, and also others. This 5G technology brings broadband, low latency, IoT (Internet of Things), and others.[1]

In Indonesia, 4G technology has developed and upgrading to 5G technology must be done because the development of the times is accelerating this 5G technology will be indispensable later. This 5G technology is a challenge for Indonesia itself because this technology requires Indonesia to build infrastructure and also various considerations, ready or not Indonesia must experience the development to this 5G technology.

Not only that, the development of 5G also led to the latest development of antennas in packages for 5G waves. these waves can bring the latest paradigm for communication. In recent years this wave also has a lot of enthusiasts. This happens because the frequency used by the bandwidth to receive data in the mmW spectrum is very wide.[2]

Data communication is an important part of an information system because it supports the provision of infrastructure that allows computers to communicate with each other. Data communication can run well if it refers to the rules or standards recommended by the main international bodies that regulate it. [3]

Komunikasi Data communication is an important element because it provides the infrastructure that enables communication between devices. The data in question are electromagnetic signals generated by the data source which are then received and sent to the receiving device

II. METHODS

Penelitian This research uses a literature study method by collecting and analyzing various academic sources, scientific journals, books, and publications related to the development of 5G technology and its impact on data communication. This literature study aims to understand the benefits, challenges, and solutions that can be applied in optimizing the use of 5G technology.

The research steps taken include:

1. Identification of topics and scope of research related to 5G technology in data communication.
2. Collection of references from trusted academic sources regarding the impact of 5G on the speed and reliability of data communication.
3. Analysis and synthesis of information from various literatures.
4. Evaluation of the challenges faced in the implementation of 5G technology.
5. Drawing conclusions based on the results of the analysis.

With this method, this research is expected to provide a deeper insight into the role of 5G technology in data communication as well as strategies that can be applied to improve its effectiveness and reliability.

III. RESULT

1. Communication Technology

Communication technology is a process by which systems are established, maintained, and also changed with the aim that signals to be sent and received are carried out in accordance with the rules. In other words,

communication technology is a major factor in societal change. Developments will occur very quickly in the field of communication making experts call it a communication revolution. This rapid change is driven by various inventions in the field of technology so that communication activities that used to have many obstacles are no longer. Nowadays, a person can communicate with other people or groups very easily and is not limited by the factors of time, distance, capacity, and speed.[4]

The development of technology is growing day by day, this is evidenced by the emergence of many work and daily devices that are equipped with high technology devices. The development of this technology is not wasted by telecommunications manufacturers, cellphones, to add the latest technologies in it. Deflur & Ball-Rokeach (1989) state that humans in the nineteenth century had to develop the ability to read newspapers, but now, people must become computer literate in the face of the emergence and success of computer-based mass media.

Meanwhile, the development of the education system is concerned with how to teach people to read, but now the education system for the community is important to develop proficiency in computers. According to Bungin, the development of information technology has undergone an evolution, starting from the era of computerization, the era of information technology, the era of information systems and the era of information globalization (Bungin, 2009). It can be briefly presented in Table 1 below.

Table 1. Era of Computerization Development

Number	Period	Years	Direction of Utilization
1	Computerization Era	1960s	The use of computers to increase efficiency
2	Information Technology Era	1970s	The use of computers is not only to increase efficiency, but also to support more effective work processes
3	Information Systems Era	1980s	Computer as a medium of information
4	Information Globalization Era	1980/ 1990s	Change management

The flow of development of communication technology is widespread and also penetrates into all walks of life simultaneously. Experts are cautiously accepting this revolution in communication technology because it also has a negative impact. From historical records we can see and learn that every technological advance will have a significant impact on the development of society. Technological developments also have an influence on the political, economic and military fields. Therefore, the development of technology, especially communication

technology, needs to be sought and studied in order to find the right way out for human life.

McLuhan saw media as the main thing that determines or influences other things. In general, this theory seeks to explain how technology, especially media, determines how individuals in society think, feel and act. [5]

His premise is that changes in the way humans communicate shape our existence and as a culturalist he argues that culture is formed based on how we communicate. To understand the above statement, this theory has three sequential frameworks of thought, namely:

(1) New discoveries in the field of communication technology cause cultural changes.

(2) Changes in human communication shape the existence of human life.

(3) "We shape our tools, and they in turn shape us",

McLuhan stated that media is the core of human civilization. The dominance of media in a society determines the basis of human social organization and collective life. To explain his idea, McLuhan examines the history of human development as a society by identifying media technologies that have an important role and dominate human life at any given time and dividing them into four different media periods, namely:

Table 2. Periods of Communication Media by Time

Number	Period	Characteristic
1	Tribal	Speech or oral (pre-literate) culture dominated human communication behavior at that time. Word of mouth made the humans who used it a cohesive community. The sense of hearing played an important role in this communication process.
2	Literary	The invention of the phonetic alphabet was used by humans as symbols to communicate in writing without face-to-face interaction. Through the culture of reading, writing, it is easier for humans to get information and vision is an important sense in this communication process. The nature of communication is linear.
3	Printing	Mass writing of texts, although still linear, cannot be done in the literature period. Along with the invention of printing machine technology by Johann Gutenberg, humans entered the printing period. Books and printed materials can be used by everyone, so this mass production of writing forms homogeneity in society because it sends the same message to all people. In terms of the process

		of 'message consumption', in this period people did not need to be physically close to share messages, but people seemed to be isolated and society became fragmented.	
4	Electronic	The invention of telegraphic communication technology was the beginning of the period when the fragmentation of society was eliminated. The distance to communicate is not felt in this period, so humans with other humans feel very close. The broadcast of the outside world on television made it seem as if television viewers were on the other side of the world and witnessed firsthand the reality of what was happening there.	

2. Data communication

Data communication is an important part of an information system because it supports the provision of infrastructure that allows computers to communicate with each other (Suryadi, 2003). Data communication can run well if it refers to the rules or standards that have been recommended by the main international bodies that regulate it. [6]

Picture 1. Communication System Components

Source ——————————→ Recipient
                    Media

Data communication is a fairly important element because data communication provides an infrastructure that allows communication between devices or tools. The data in question is electromagnetic signals generated by the data source which are then received and sent to the receiving device. In order for data to be communicated properly, the communication model must be fulfilled. The communication model consists of the following things:

- Source, which generates data to be transmitted.
- Transmitter which functions to convert data into signals that can be transmitted.
- Transmission System which is in charge of carrying data.
- Receiver which functions to convert the received signal into data.
- Destination is the final data destination or data retrieval.

There are 3 types of data communication models based on the type of transmission channel, namely one-way transmission type (Simplex or one way transmission), alternating two-way transmission (Half Duplex or either

way transmission), or simultaneous two-way transmission (Full Duplex or both way transmission).

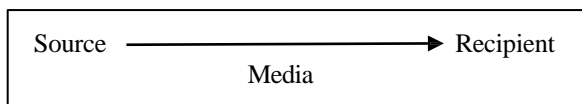Duplex or either way transmission), or simultaneous two-way transmission (Full Duplex or both way transmission). [7]

Table 3. Data Communication Type

Number	Type	Explanation
1	Simplex or One Way Transmission	This type of transmission channel can only carry data information in one direction only, not back and forth. For example, radio or television broadcasts.
2	Half Duplex or Either Way Transmission	Data information can be sent and received but not simultaneously (alternately). This means that if one sends then the other receives and vice versa such as Walkeitalkie.
3	Full Duplex or Both Way Transmission	Transmission channel where data information can flow in two directions simultaneously or can send and receive data at the same time.

Based on the application of communication data can be either Off-Line or On-Line

1. Off-Line Communication System

Off-line communication system is a system of sending data through telecommunication facilities from one location to the data processing center, but data sent is not directly processed by the CPU (Central Processing Unit).

Picture 2. Off Line Communication System

Terminal — Modem — Modem — Terminal
                                    │
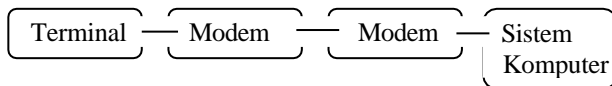   Sistem Komputer
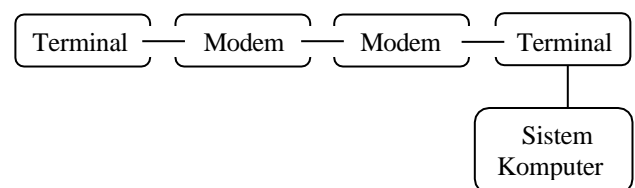
2. On-Line Communication System

Unlike the offline communication system offline communication system, in the on-line communication

system this data sent through the terminal can be directly processed by the computer center, in this case the CPU.

Picture 3. On Line Communication System

Terminal — Modem — Modem — Sistem Komputer

3. 5G Technology

The arrival of 5G network speed access opens up quite a lot of opportunities for information producers such as mass media to multiply the types of information and their forms. Today, high-resolution video technologies such as HD and 4K are great. In the future, there will be new types of technology that may surpass these resolutions. The same goes for network technology, which is constantly evolving[8]

The study of 5G technology developed from the range of 2013 to 2017 quoted from the article 5G Technology Research Mapping. It can be interpreted that research studies for the development of 5G networks have been carried out in recent years with a relatively long time. 5G is the 5th generation in network development from the previous 1G, 2G, 3G, 4G or 4th generation.

The first generation (1G) of mobile telecommunications networks has actually supported the existence of mobile voice calls but with limited coverage and capacity. Furthermore, the second generation (2G) began to appear by developing it as a solution to the limitations of 1G by utilizing digital systems to offer higher quality communication services. (Eluwole, 2018) Then, the third generation (3G) was launched in 2000 with a focus on developing better data transmission speeds and message reception.

Then, the Fourth Generation (4G) was present as a prima donna in the development of cellular telecommunications networks. Where, this 4G technology focuses on emphasizing digital elements in every industrial sector such as information technology and mobile communication. Therefore, it can be illustrated that the development of mobile telecommunications networks in each generation offers an increase in speed, greater capacity and the latest features in its services.

5G (fifth generation) is a term used to refer to the fifth generation as the next phase of mobile telecommunications standards. 5G technology is planned to be officially released in 2020[9]

5G technology is a new technology that will provide all desired applications using only one universal device and interconnect with existing telecommunications infrastructure. The 5G mobile network will focus on the development of customer terminals where customer terminals will have access to different mobile technologies at the same time and will consolidate the different ways of using various technologies. In addition, terminals will make choices between different mobile network providers for the services provided.

5G technology is the latest technology in the development phase of mobile telecommunications networks. Referring to a statement issued by the 5G Public Private Partnership (5G PPP), 5G technology will even be the key to the digital world. This is because the improvements offered in this technology are able to jump far compared to previous technologies.

A little review of the development of cellular telecommunications networks in each generation. It can be started with the first cell phone that was invented in the 1980s. Since then, telecommunications providers have begun to develop innovations and investments in cellular networks in order to have a wide range, increasing services and implications for the proliferation of users. [10]

Picture 4. Telecommunication Network Development
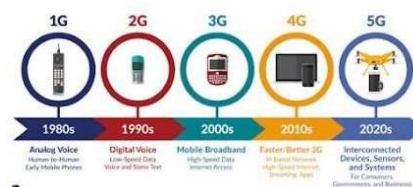
Society 5.0 or Industrial Revolution 5.0 is a concept that illustrates that technology will coexist with humans to support the quality of life. The concept of the Society 5.0 era was actually first adopted by Japan through the 5th Science and Technology Basic Plan in the 2016 Basic Policy on Economic and Fiscal Management and Reform which aims to build a human-centric society where everyone can enjoy a quality life. Therefore, the key to realizing this goal is through integrating cyberspace and the real world to create data, information and a higher quality of life.

In this era, everyday human problems can always be solved with various technologies, such as the presence of Artificial Intelligence (AI) which can be used to do work through digital technology-driven processes based on big data and sophisticated internet. (Tasya Safiranita, 2020) Society 5.0 era technology will also create value that can erase gaps by providing services that will be designed according to the needs of society at large.

Looking at the capabilities possessed by 5G technology, as one of the supporting technologies in the era of society 5.0. This technology is able to develop potential by giving humans the presence of various other latest technologies and very easy access to various applications through only one universal device that is interconnected with other telecommunications infrastructure. Meanwhile, this technology will try to bring remote interaction in real time or the same time. So that the quality of communication between humans will be better created.

5G Technology Utilization
Machine to Machine (M2M) Communication
Machine to Machine (M2M) communication is a technology that allows electronic equipment to communicate with each other electronic equipment to communicate with each other. Connectivity of devices such as cell phones, cars, refrigerators refrigerator, to washing machine becomes easier. Users will be able to control air conditioners and refrigerators from cell phones or

equipment that works automatically because it is triggered by other equipment. For example, a home air conditioner immediately turns on when it detects a car entering the garage. There are many fields that can already be supported with M2M technology are also many, including security, logistics, transportation, health, and finance. [8]

M2M refers to technology that allows systems, both wireless and wired, to communicate with other devices. with other devices. M2M can use devices (such as sensors) to capture an event (such as temperature, movement, and finance). event (such as temperature, movement, etc.), which is relayed over a network (wireless, wired, or a combination) to a central server. combination) to a central server.

Green Communication

With the number of devices that will be connected to the network expected to increase 100 times and the volume of data is expected to increase by more than 1000 times in the next decade, one of the challenges in challenge in future communications in meeting the requirements is in an affordable and sustainable way and sustainable. Currently, operators are already facing the reality that electricity bills are a high of operating expenditure.

Lowering energy consumption and moving towards alternative green communications is not only important from an environmental perspective, but also significant from an economic perspective. economic perspective. Another approach to achieving such green communication networks is to use renewable energy resources such as solar power, wind power, vibration in base stations, and using them to reduce wasteful electricity consumption as is the case today.

Radio Access Techniques

The demand for high speeds in 5G networks has motivated research into radio access that must be able to support higher data rates. Since spectrum is a limited resource, spectrum efficiency is a major factor that is considered in the radio access techniques that will be developed in 5G technology. Some 5G network applications will require very low latency (1 ms).This is a constraint on the latency perspective of the development of radio access techniques. Some innovations in the development of radio access techniques in future communication systems,include the development of modulation systems, full duplex communication systems, multiple access techniques SCMA(Sparse Code Multiple Access), Filtered-OFDM technology (Filtered- Orthogonal Frequency Division Multiplexing), massive MIMO, and channel coding (polar coding).

The presence of 5G network speed access opens up many opportunities for information producers (mass media) to further multiply the types of information and their forms. High-definition video-based content(4K and HD) and interactive infographic visuals will be the future as 5G network speeds are adequate network speed. In implementing 5G technology, this research utilizes several indicators that are analyzed, namely infrastructure, frequency spectrum, demand, and revenue/ARPU.

The network infrastructure of 5G technology consists of standalone and non-standalone. networks

A standalone network is a 5G network configuration that consists of itself, without being supported by a 4G network. In contrast, for non-standalone networks, 5G networks are supported by 4G networks (International Telecommunication Union, 2019).

Fiber Coverage

5G infrastructure development is inseparable from fiber optic networks used as a transport system or backhaul due to their high capacity.transport system or backhaul due to its high capacity. With this high capacity, the data rate received by customers will also be high.

Spectrum

Ownership of radio frequency spectrum licenses is very supportive of the successful development of 5G technology network. 5G frequency allocation consists of low band (less than 1 GHz), mid band (1-6 GHz), and high band in the millimeter wave band frequency range (ETSI 3GPP 5G, 2018). The radio frequency spectrum licensed by cellular operators in Indonesia is currently in the low band and middle band frequencies, which are used for 2G, 3G, 4G and technology-neutral technologies.

Revenue and ARPU

5G infrastructure development is costly. Mobile operator revenue revenue greatly affects the ability to invest in 5G technology. The greater the revenue, the greater the possibility to invest in 5G technology. In addition to revenue, ARPU also plays a role in the sustainability of the mobile operator's business, which then determines the readiness to implement 5G technology.

IV. CONCLUSION

5G technology has brought significant changes in data communications by offering high speeds, low latency, and greater network capacity. This enables increased efficiency in a variety of sectors, including industry, healthcare, and transportation. With 5G, data communication becomes faster and more reliable, supporting the growth of technologies such as IoT, artificial intelligence, and smart cities.

However, 5G implementation still faces challenges in terms of infrastructure and data security that need to be addressed. Therefore, more efficient infrastructure development strategies and more sophisticated security systems are urgently needed. With the right measures in place, 5G technology can become a key foundation in the future evolution of data communications, creating broader and smarter connectivity for the global community. Therefore, further research and cooperation of various parties are needed to optimize the application of this technology.

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