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Devices Communication: Hindrances Toward 6G Network IoT

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Abstract - *Internet of Things (IoT) as a future tool that will be used for every line of life, socialization, and business in every corner of cities and villages, networks have been built to connect IoT communications, transportation, and human communication in the future. This is a very difficult challenge to implement. However, the rapid growth of devices, especially those with artificial intelligence, networks, heterogeneous, dynamic, and large-scale, making it difficult to meet requirements, especially the International Telecommunication Union (ITU), such as very low latency, high surveillance, high security, and generation the next massive connection (6G). Recently, 6G learning has emerged as a technique that will help all robust IoT communications make device and wireless connections highly efficient and adaptable. Naturally, the adoption of 6G into IoT communications and networks is a specialized topic and is being studied widely in academia and industry, paving the way for the future of IoT in 6G networks. In this research, the author gives a warm welcome h respect to different IoT methods connected to 6G network communication, 6G learning keys, and several opportunities to conduct research on IoT in general for the world.*

Keywords — *Internet of Things, 6G, Communication*

I. INTRODUCTION

Internet of Things (IoT) is a tool that often hears, both in offices, education, industry, etc. Using IoT technology has become a necessity now, which is always accompanied by advances in communication technology. Communication is needed in IoT, including measurement of delay, speed, reliability, etc. The first-generation offered is 1G, wherein there are still not many users this generation, but it is the fastest in its era. 10 years later, the second generation 2G was re-created, some of which could interact with the Internet only to the extent of ordinary data with the same type of cellphone. With the arrival of 3G 10 years later, there were already so many cell phone users because there were so many interactions with the Internet. Social media has begun to dominate the world of communication. Primary needs have shifted to secondary. The Indonesian state enjoyed 3G services in early 2008. The public was able to enjoy widespread internet services. At this time, the IoT was also introduced because communication was sufficient to move the wheels for the origin of the IoT, starting from the automatic door, etc.[1]–[3].

Meanwhile, rapid communication has made modern people compete to make tools that are integrated with the Internet. Plus, a few years later, a new communication emerged, namely 4G, where communication has made it possible based on video needs. Currently, there are many new YouTubers in Indonesia. The development of IoT is growing rapidly with the emergence of new startups. Some investors are burning money by storing materials in the form of hardware in supermarkets and malls in big cities, considering the many returns from big data, AI[4]–[9].

The 5G network itself has not been widely implemented in Indonesia, or maybe if you look at several other countries that have adopted this technology because communication is very fast with the needs already in video, such as video streaming and video calls. In this generation, the IoT is very sophisticated and can be applied in the medical or military fields with several special protocols as well[10]–[13].

It has been too long to use 5G technology. Now it is time to move to renewable technology, namely 6G, with technology above average and having very high speeds. It is a new challenge in Devices-to-Devices (D2D) communication, a renewable technology if IoT uses technology as a communication transfer. Not only for medicine, even for underwater and space technology, but IoT can also be used by utilizing this generation. The real challenge is signal waves, spectrum availability, and also the types of supporting devices[14]–[17]. The image below shows some of the evolution of the development of 1G-6G communication.

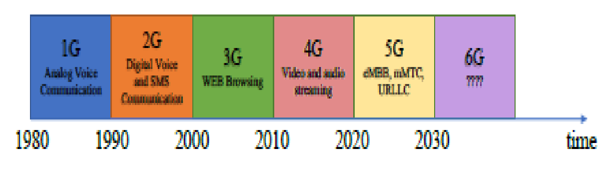

Figure 1. Development of cellular networks [3].

In previous studies, most researchers only wrote to look at research challenges, security, future challenges, and some about AI. At the same time, this paper discusses more communication in IoT after applying 6G technology in general in the world, mainly if it is used in Indonesia. It is hoped that the results will become a benchmark for IoT researchers in determining network protocols, research directions, and new challenges in the world of IoT.

II. KEY TECHNOLOGIES FOR IOT 6G NETWORKS

The definition of new technology is always coveted by everyone, where imagination is already at the highest level. Initially, humans will imagine that in 2030 or so can fly, or rapid technological advances such as VR, AR, automatic cars, etc.

The new advantages for 6G, which seem to go deeper, are usually about broad-based imaging, 3D-based detection and early detection of natural disasters, the reality of fully advanced IoT-based sensors, HTC (Holographic Type Communications).

6G must be green or clean and can be implemented properly, especially in Indonesia and IoT, with 6G generate a big amount of data [18]. Therefore, it is necessary to increase data transmission with an increase of up to 1 Tbps and low delay or jitter. 6G is applied to terahertz very high-frequency communications and uses spatial multiplexing, which provides a very large data capacity compared to its predecessor network. One of the ultimate goals of 6G is to achieve connectivity in all areas of concentration with the integration of all networks, especially satellite communications and underwater communications, without interference noise to provide a very large scope [19]. Taking energy from the antenna or harvesting and using renewable particles will improve the functioning of the system. Some of the services at 6G are already described at[5]: ultrahigh data density (uHDD),ultrahigh-speed-with low-latency communications (uHSLLC), and ubiquitous mobile ultra-broadband (uMUB).

Table I. The differentiator of 5G and 6G technology[19]

Characteristic	**4G**	**5G**	**6G**
AI integration	Partial	Partial	Fully
XR integration	Partial	Partial	Fully
Haptic Communication integration	-	Partial	Fully
Automation Integration	Partial	Partial	Fully
Operating frequency	>3	3 - 300	upto 1 THz
Uplink data rate	1Gbps	10 Gbps	1Tbps
Downlink data rate	2Gbps	20 Gbps	1Tbps
Spectral Efficiency	-	10 bps/Hz/m2	1000 bps/Hz/m2
Reliability	10^{-3}	10^{-5}	10^{-9}
Maximum mobility	100 km/h	500 km/h	1000 km/hr
U-plane latency	-	0.5 msec	0.1 msec
Processing delay	10ms	100 ns	10 ns
Technologies	• OFDM • MIMO • Turbo Code • Carrier Aggregation • Hetnet • ICIC • D2D Communications • Unlicensed Spectrum	• mm-wave • Communications • Massive MIMO • LDPC and Polar Codes • Flexible Frame Structure • Ultradense Networks • NOMA • Cloud/Fog/ Edge • Computing • SDN/NFV/ Network • Slicing	• THz Communications • SM-MIMO • LIS and HBF • OAM Multiplexing • Laser and VLC • Blockchain • Quantum Computing Communications • AI

A. TeraHertz Devices Communication

One of the particular challenges in achieving IoT at 6G is severe spectrum scarcity, which occurred at previous broadband penetration rates. Furthermore, there are new devices with strict bandwidth usage rules. Recently, 3GPP regulations made new features for the next 3GPPRel. The physical layer has generally increased through a new form of a frequency band outside of 52.6 GHz, up to 71 GHz. This rule could create new technologies that will come over or into the TerraHz band[7].

The THz wide band, starting from 0.1 THz to 10 THz, will play a very important role in determining which technology uses this frequency. Especially if the technology is to be applied in Indonesia with the following conditions: longer data capacity, best data speed, and transmission and recipients without packet loss. THz broadband can support the development of pico or microcells.

B. Cognitive Radio in IoT

Due to frequency limitations, new technology such as cognitive radio (CR) is needed. By using this technology, researchers, academics, and industry players need a frequency that can be used by all stakeholders in Indonesia, especially the frequency still used by analog TV.[20], Because of the large number of antennas as the assumption of IoT multiantenna[20], so need some frequency signal detection tools with simple but effective algorithms for efficient frequency use [21].

C. Topology

Topology in the next generation, 6G, will be fully regulated as dynamic as possible. It is a fact that each user, through their device, will form an IoT network, both single and multiantenna antennas will be dynamically connected to networks such as Software Defined Network (SDN). Which will support the best internet service and access ever, so it is if implemented, this will change people's view of the network. Autonomous Driving Vehicles, Unmanned Air Vehicles (UAVs), drones, satellite and radar communications, fast-moving network stations.

Hope to model noise and interference with each other better and increase. Therefore, network stations can agilely adapt to other parts of the network that provide the best service for sure, which will lead to needs with new mathematical models and new analyses [22].

D. Access Network

In some of the research and focus of the ITU organization which deals with technology for networks, by 2030 (FG NET-2030) is in dire need of a massive increase in growth and data flow that could make Backhaul's access network unable to cope with it, as well as with the requirements of other organizations. Some research [22] focuses on increasing research on higher available bands such as 60GHz or more on Tera will be realized directly, especially for the Indonesian region. What is more exciting, for example, optical communication and quantum communications such as satellites and terrestrial radio are very good for the 6G Backhaul based on meeting needs. Some focus in [23] The research takes the lead by using aircraft technology (drone) to determine the terrestrial network by providing connections for areas such as the Indonesian archipelago, which are still pristine. Drones and earth base stations need satellite and CubeSat to provide support. Aircraft technology (drone) can produce wireless, drone cells or UAV networks without cellular.

E. Undersea IoT Network

There are many differences between practitioners and researchers about whether the underwater network can be part of the IoT 6G network used in the future. IoT communications used in underwater wireless primarily involves effective RF, acoustic and optical communications. The complex underwater environment causes the spread of a complicated network due to the abundance of underwater animals and the water pressure that causes signal attenuation so that it can be drowned out by noise and fatal equipment damage [24], taking off a part of issues to be settled.

F. Optical Wireless Communications for IoT

The optical wireless communication system (OWC) is proclaimed as a technology that will become a new technology for assistants on 6G networks and beyond. There is an increasing need to use OWC with suburban rural and aerospace. This need is supported by advances in optical material manufacturing technology in Indonesia. Other specifications include high-frequency requirements, high-security layers, low latency and packet loss, high data rates, and resistance to noise and interference. The OWC system is located using a small frequency, allowing long-distance data transmission over high-speed wireless, which occurs in wireless backhaul networks [25].

G. Artificial Intelligence

Artificial Intelligence (AI) does not play an important role in 4G, which is being implemented in Indonesia or the previous generation. Some of it can already be supported by 5G., which makes a difference in the telecommunication world.

IoT networks open the door to extraordinary applications that are emerging, such as [26]. However, AI in IoT will be highly anticipated and completely backed in 6G to computerize all IoT-based products. This will involve dispatch, designation of networks, and deployment of performance-enhancing resources.

H. Holographic Beamforming (HBF)

Beamforming uses a beam that must be directed at a high source for transmission in transmission and reception using a multiantenna by concentrating power in a minimized antenna firing angle. This technology offers better emission and representation in sending signals against interference and noise. This basis can be used to know the user in using this technology. Holographic beamforming approaches beamforming at different levels using a Software-Defined Antenna (SDA). [27].

I. Quantum Computing and Communications

With very rapid developments in the integration of information communication, especially IoT and other quantum theories, quantum technology has developed rapidly in the past 20 years and slowly but surely has entered a practical stage. According to the theorem of the uncertainty principle and without quantum cloning, communication using quantum bases can be absolute in theory, tapping actions can be easily detected due to quantum state disturbances. This communication includes quantum cryptographic communication. So that this technology can help IoT, which will increase the network and communication capacity of IoT and produce a stronger and more efficient AI algorithm for 6G.[28].

III. CHALLENGES AND OPPORTUNITY

A. Privacy and Security

Collecting information that comes from sensors and is embedded in the body as is done by IoT. In particular, not much has been done in Indonesia. The difficulty of sensing resources and high energy consumption in it, the communication territories in the body, and the safe body are still areas of opportunity for rich research. The challenges that arise most often are: i) limited resources. Now that everyone is using nanotechnology, it leads to using key methods as needed, and it is very difficult to implement key methods; and ii) provider features to provide scalable networks across nanodomains[29].

B. Sub-Millimeter Wave and THz Frequencies

The transparent and apparent way to support massive increases in 6G or IoT communications is by increasing the bandwidth requirements. For Indonesia itself, because some things still use 4G, So that prioritizes speed on bandwidth. Previous studies have shown that large frequencies with a THz range or higher will be for 6G because there are many gaps in the band that are suitable to meet the requirements of future IoT technologies. A recent study shows the use of the 5G spectrum will probably not exceed the 140GHz band due to a number of obstacles such as a lack of knowledge of channel modeling, channels, propagation, antenna gain, etc. It is likely that 6G will use a spectrum beyond 140GHz with specific applications over a very short range[30]. On the other hand, the powerlessness of the THz band against clogging, sampling, and circuits to convert A / D & D / A and the communication range is one of the main barriers that should be increased in the future. Another obstacle is that the length of the antenna and the associated circuitry are hot topics of conversation at very high frequencies. It is challenging to build chips while ensuring the ability to follow up on interference between components.

C. Integrated Security Architecture IoT

The 6G deep underwater network will optimize underwater links (offshore, underwater, and island IoT equipment), land (cellular networks and other networks), air (all types of aircraft), and meet 6G necessities such as consistent scope and network all over.

The space-air-ground-underwater network is a coordinated, heterogeneous, productive, and clever network. It has very diverse characteristics, of course bringing a parcel of complexity to the system, particularly in choosing which privacy is used in security. It is basic to consider the capacities and highlights of distinctive sorts of systems and make IoT organizations against security to guarantee secure communication on a worldwide framework without borders.[31].

D. Transceiver and Receiver

every communication technology, especially in IoT, there are transceiver and receiver designs that support these aspects, as well as challenges in 5G to develop millimeter components. In Indonesia, antenna design is perfect, especially for the navy, because the country is an archipelago. However, the 6G IoT network will be more challenging and is also part of a research opportunity. 6G innovation underpins the high-frequency band in THz and bolsters range and asset sharing. The handset must be able to assist this innovation with an antenna outlined with the specified estimate; nanometer to micrometer components meet holographic beamforming necessities [32].

E. Network IoT Everywhere

With 6G, the Internet in IoT access will change from being available on only a few devices, especially devices and some electronic equipment, to being available anywhere at any time through most IoT devices or embedded technology. The interaction between the device and the cellular screen is no longer the only widespread interaction that connects humans and objects and items to objects. With the unused 6G innovation, the Web will vanish from users' lives, inserted in frameworks in ways that darken them. Another step towards this vision and mission is to spread all the receiving wires all over so that the separation to the client can be diminished to a number of meters and indeed conceivable to be less than 1 meter away. The shorter the connect length, the better the proliferation of the receiving wire, decreased obstructions, and the utilization of recurrence groups more successfully and productively, of course with the assistance of Cognitive Radio [33].

F. The effectiveness of using Cognitive Radio on IoT

Previously, it was explained that Smart Mirror technology or several technologies must use cognitive radio if you want to implement 6G technology that is effective and efficient in the use of frequency bands[34]. With this technology, the use of too many antennas and TeraHeartz technology will be reduced. The new challenge is whether researchers can maximize Cognitive technology by the vision of 6G technology.

Table II. Challanges In The 6G Era.

Challenge(type)	**Related research questions**
Interference management (regulation)	How to characterize feasible confirmation necessities between officeholder and participant frameworks
Interferencemanagement(technology)	How to arrange impedances between diverse remote frameworks with diverse levels of getting to rights
Long time spans for international spectrum decision making(regulation)	How might range sharing encourage the presentation of modern participants to range groups? How to secure the officeholder range clients from hurtful obstructions
Spectrum valuation and pricing	How to cost range for

(regulation)	localized organizations for different vertical utilize cases
Spectrum market(regulation &technology)	How to make a well-functioning moo exchange taken a toll range commercial center for diverse needs (e.g., local networks)
Divergence of spectrum management approaches(regulation)	What is the foremost suitable spectrum administration approaches in numerous recurrence groups (low, mid-, high, THz spectrum ranges)

G. Quantum Computing

Although large-scale quantum computing makes security schemes in logarithmic and discrete cryptography insecure or increasingly complex, not all conventional security is always vulnerable. Contemporary symmetric-key primitives, such as block ciphers, are still very safe to scale quantum computing models. This is proven only by security using the Grover algorithm [35]. The public key primitives are overridden in a quantum hold function. The ancient logarithmic-based network signature scheme needs to move with the quantum-resistant one based on the grid-based cryptography used in BLISS signatures. [36] or by another method using a supersingular elliptical curve [37].

Quantum computation can moreover illuminate more complex and challenging security issues. For example, Quantum Key Dissemination (QKD) employs two parties to share a mystery key with the security given. Another more sophisticated solution to avoid quantum risk is the creation of a [38]. The quantum blockchain comprises two layers, counting QKD and transmits messages to supplant conventional computerized marks and hashing capacities [39].

H. AI-Enabled Autonomous Networks

Virtualization, Softwarization, and cutting are still fundamental aspects of the systems that IoT employments independently; thus, the first to be undertaken to design a 5G network architecture is still a vital method established for developing 6G. Be that as it may, fake insights may be a key characteristic of the IoT systems that 6G employments. AI procedures can give insights for remote systems through learning and preparing by gathering big information; In this manner, AI will be the preeminent creative methodology for arranging free IoT frameworks on 6G. The combination of AI and SDN / NFV / NS can accomplish non-static and touchless energetic organize coordination, optimization, and administration, driving extreme changes in 5G to 6G systems. AI-enabled organize coordination can powerfully oversee network models and areas and combine numerous get to advances on its claim to attain a exchanged organize that meets requesting 6G prerequisites[40].

Network optimization that bolsters AI in IoT can screen network key execution pointers (KPIs) in genuine time and alter all parameters on the organization to give QoS ensures. AI-enabled organizes administration can screen organize status in real-time and keep AI steady. To bolster the fast advancement of AI for remote systems, ITU-T shaped a center gather on machine learning for future systems, counting 5G.

Multilevel application of AI to IoT will be utilized in specific to bolster insights within the future 6G network. Centralized Enormous Information / AI will be valuable on the center side of the network with bound together control, whereas the AI quickening agent can be implanted into hardware running at layers 1-3, such as switches. Substance suppliers will convey a centralized cloud / AI in further information centers. Moreover, centralized and dispersed cloud / AI will coexist and be given at the edge of radio get to organize (RAN). The centralized cloud / AI will handle multi-BS-related assignments, such as portability and obstructions administration (for illustration, utilized with cloud- RAN). With the gigantic improvement of IoT, AI will slowly move from information centers to network edges[41].

IV. CONCLUSIONS

The main drivers of IoT 6G communication, challenges and opportunities, and improvements result from new things and performance. These limitations are caused by 5G technology, and paradigm shifts are driven by technology and the evolution of wireless networks. Not all 5G communications are mainly for IoT devices. With this new potential, new sciences such as AI, TeraHeartz, Quantum, Radio wire, etc., will stand out as breakthroughs and troublesome innovations in the 6G drive. In any case, on the off chance that the IoT acknowledged in 6G is to succeed, 6G needs to be on a very basic level re-imagined. As in network architecture. 6G communication services also require communication code, sensing and computing, and Cognitive Radio based on Multi-Antenna, which is likely to become one of the leading IoT technologies in 6G. From here, it will be a matter of the ITU-R organization to create a consultative process that should start in 2023 and represent all international citizens by 2026. Until then, science will continue to innovate until the policy is put into effect.

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