

A systematic literature review of 6G applications and use cases

Alina-Elena ANCU¹

*National University of Science and Technology POLITEHNICA Bucharest,
Doctoral School of Entrepreneurship, Business Engineering and Management*

ORCID: <https://orcid.org/0009-0009-0025-5226>

ancualina@gmail.com

Cristina-Elena UNGUREANU¹

*National University of Science and Technology POLITEHNICA Bucharest,
Doctoral School of Entrepreneurship, Business Engineering and Management*

ORCID: <https://orcid.org/0009-0006-2887-1838>

cristina.elena.u@gmail.com

Gheorghe MILITARU¹

National University of Science and Technology POLITEHNICA Bucharest

ORCID: <https://orcid.org/0000-0003-4243-6630>

gheorghe.militaru@upb.ro

Abstract.

High demand for better quality of services, increased capacity, better coverage, service efficiency, security and privacy prevention techniques is driving a rapid evolution, at every 10 years of the next generation of mobile communication. This paper provides a picture of the main aspects of the sixth generation of mobile communication with a focus on the development from the current generation, the expected use cases from different industries and domains that will improve the user experience, but also will increase the risks in different applications available to the customers upon the deployment of 6G. Based on the methodology research, there were identified and presented the key aspects of top 14 applications or use cases that are expected to be available or to be improved with the support of 6G and Artificial Intelligence, that has been mentioned in multiple papers.

Keywords: 6G, mobile communication, 6G use cases, 6G development, 6G applications

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Introduction

Mobile wireless communication networks have evolved in the last 20 years, with each cellular generation marked with “G” that reflects a change in the operational characteristics as frequency, technology, speed, making a distinction from the previous one, as new standards, capabilities and features were introduced. [1]. The need for collaboration is crucial in achieving the 6G vision, improving life and transforming industries, while academia or researchers, government and private industry should work together [1].

Each new generation from 1G to 5G, has introduced higher frequencies, larger bandwidth and faster data rates, while from the architecture point of view, each mobile system has evolved, incorporating more antennas, multiple access technologies have been used and offer every time higher number of services [2].

This paper aims to provide the reader with a systematic literature review on 6G technologies, applications and use cases. The papers in scope for this study were selected based on the settled criteria. For this purpose, over twenty two papers have been selected and analysed.

While the method of conducting a systematic literature review can be perceived to be a foundational activity as part of the academic research process and make use of existing practices, this paper’s novelty brings to the attention of researchers in the fields of mobile communication. Through a systematic literature review, this paper will synthesize and analyze relevant academic research to explore the functions, the capabilities and the relationship between 6G applications and use cases.

Literature review

Actual generation meets the current industrial demands, but society's needs are increasing day by day, and new capabilities will be required and cannot be provided by the actual generation, Even though 5G is considered a major improvement from a capabilities perspective, compared to 4G. [1]. Progressing from 5G to 6G, there must be significant differences on the following indicators like speed and capacity, latency, Spectrum Utilization, Energy Efficiency, Artificial Intelligence (AI) Integration that will be seen in the capabilities like faster data speeds, enabling new applications and experiences that require massive data throughput, ultra-responsive applications, including remote surgery, autonomous vehicles, improvement of energy efficiency, ensuring that advanced technologies can be sustained without significantly increasing power consumption and enabling advanced capabilities like intelligent network management, adaptive resource allocation, and enhanced security [2].

5G is considered the foundation of a truly digital society, where there were delivered high performance, better energy efficiency, robust support for mobile features, Quality of Service, and a higher number of devices. The research of the next generation is considered in the early stages, where experts from academia and industry are examining the vision, trends, and goals for this future technology, which is expected to be deployed around 2030 [3] and should serve as a platform which will introduce a wider extend of use cases, optimized and evolved [4]. In recent years, several organizations have established strategies for developing 6G, where Finland has invested in a program to develop a complete 6G ecosystem. British and German governments, USA and China have started to explore the technologies of 6G [3, 5].

Authors like (Singh et al, 2023; Wang et al, 2023; Quy et al 2023; Trichias et al, 2024; Porambage et al, 2021; Mourad et al, 2020; Danuti & Otesteanu, 2024; De Alw et al, 2021; Arshad et al, 2023; Na et al, 2024; Shah, 2022; Siriwardhana et al, 202) in [1, 2, 3, 5, 6, 8, 9, 10, 11, 12, 15, 18] have started to investigate the trends in 6G focusing on architecture, applications, technologies and challenges as well.

Methodology

To achieve the aims of this paper, it was carried out a systematic literature review that has a few phases presented in Figure 1. Firstly, it was designed the plan for this scientific research by setting the research objectives. The criteria were settled. There were selected papers from one of the databases that is known by the academia as a trusted resource for the telecommunication subject, as IEEE/IET Electronic Library (IEL), the range of the publications must be between 2020-2025, and the keywords used include 6G, 6G application scenarios, 6G network achitecture, Mobile Networks, Wireless Communication, 6G key technologies. Twenty two papers were selected and can be found in the References section.



Figure 1. Research methodology
Source: Authors' own contribution

Results and further discussions

Although 5G offers improvements compared to the fourth generation, some limitations cannot meet the performance demand of the future applications that will be available with the next generation. Researchers concluded that some of the actual applications and services require better communication performance that exceeds the capabilities of 5G [2]. The use cases of 6G presented in Figure 2. were classified into four classes as follows: enhanced human communication refers to immersive experience, telepresence and multimodal interaction, enhanced machine communication refers to robotic communication an interaction, enabling services refer to positioning, mapping, automatic protection, smart health and manufacturing, while the last class as network evolution refers to native artificial intelligence exposed as a service, energy efficiency and coverage [13].

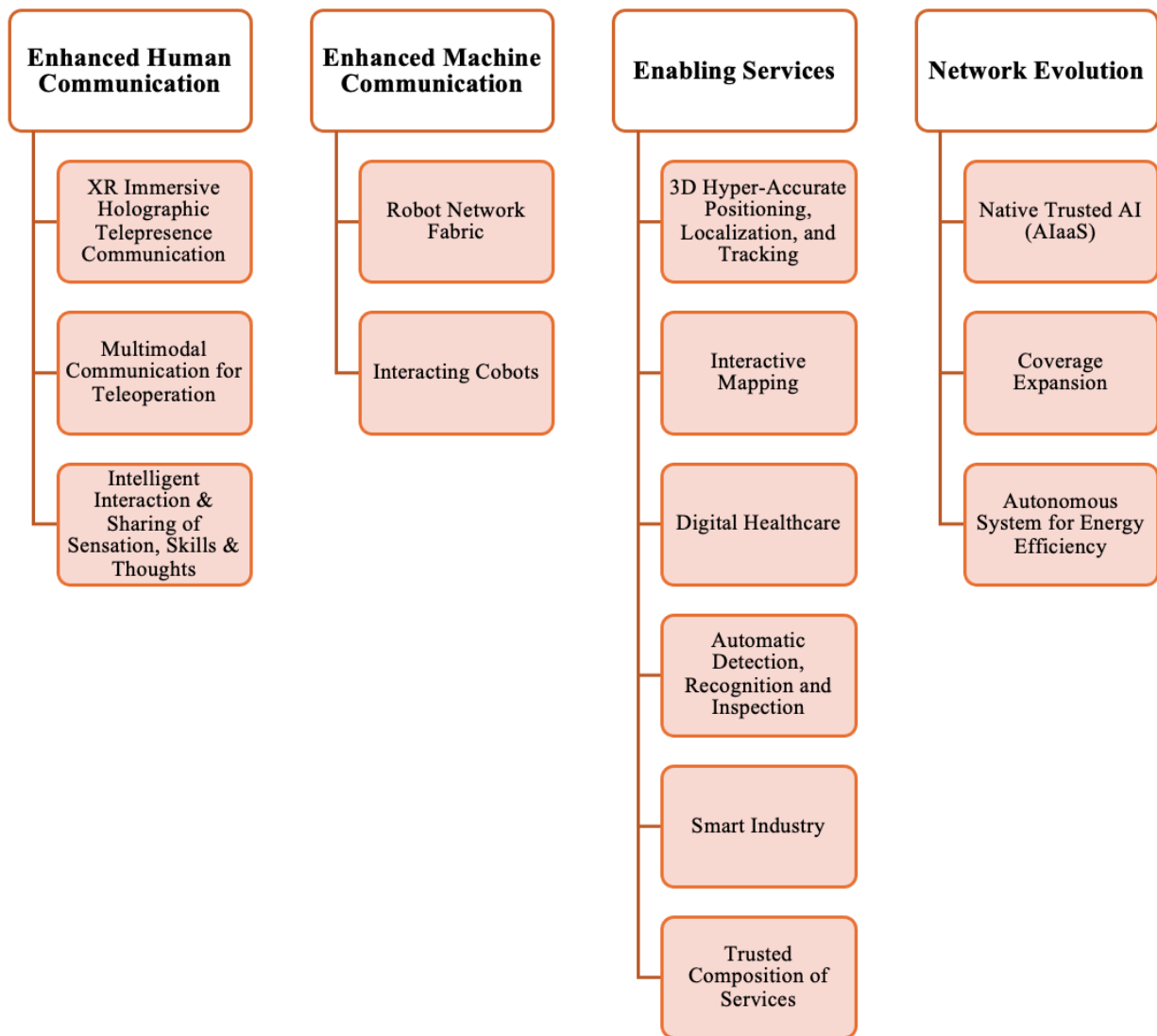


Figure 2. 6G Use cases and analysis

Source: NGMN Alliance, 6G Use Cases and Analysis, NGMN Alliance, 2022; available: <https://www.ngmn.org/publications/6g-use-cases-and-analysis.html>

As mentioned in the Methodology section, based on the literature review of the selected twenty two papers, it was built Table 2, which contains the top of the 6G application scenarios or expected use cases.

Table 2. 6G application scenarios or expected use cases

6G application scenarios or use cases	Sources	Numbers of mentions
Industry 5.0	[1, 6, 10, 11,18]	5
Unmanned Aerial Vehicles (UAV) based mobility	[6, 10, 11]	3
Connected Autonomous Vehicles (CAV)	[6, 8, 10, 11, 12,18]	6
Smart Grid 2.0	[1, 6, 10, 11, 18]	5
Holographic Telepresence	[1, 6, 10, 15]	4
Collaborative Robots	[1, 5, 6, 10, 12, 18]	6
Hyper-Intelligent healthcare	[5, 6, 9, 10, 11, 18]	6
Digital Twin Applications	[2, 3, 5, 6, 12]	5
Extended Reality	[1, 2, 5, 6, 8, 9, 10, 12, 15, 18]	10
Wireless Data Center	[2]	1
Tactile Internet	[2]	1

Wireless Brain-Machine Interface Applications	[2]	1
Holographic Communication	[2, 5, 9, 12]	4
Emergency Rescue Communication	[2]	1
Internet of Everything (IoE)	[1, 10, 11]	3
Tactile/Haptic Communications	[5, 8]	2
Imaging and Sensing	[5, 8]	2
Transportation Vertical (automotive, logistics, aerial, marine)	[5]	1
Space-Terrestrial integrated network	[5]	1
Intelligent Operation Network	[5, 18]	2
Critical Infra, Government/National Security	[5]	1
First Responder/Emergency Services	[5]	1
Hyper-Intelligence IoT	[10, 15]	2
Personalized body area network (BAN)	[2, 6, 10]	3
Connected industries and automation	[5, 8, 9, 10, 15, 18]	6
Aerial and satellite networks and platforms	[8, 12]	2
Volumetric media streaming	[8]	1
Urban air mobility (UAM)	[12]	1
Metaverse	[3]	1

Source: Authors' own contribution

Extended Reality (XR) has been mentioned in ten papers and is known as an umbrella terms covers all environments combining real and virtual elements, including Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), while 6G is an enabler and key driver supporting the advancement of XR that will support XR to be in multiple use cases as virtual tourism, online gaming, entertainment, online teaching, healthcare and robot control [6].

Connected Autonomous Vehicles (CAV) have been mentioned in six papers. Automotive and tech companies made investments in autonomous vehicle technology, while the progress of making driverless cars is going beyond, not only autonomous, but also reliable, safe, and commercially viable. The development of Connected Autonomous Vehicles (CAVs) will be visible in creating completely new services which include driver-less taxis and public transportation [6].

Hyper-Intelligent Healthcare has been mentioned in six papers. Digital healthcare or e-healthcare services based on evolving technology will become AI-driven intelligent healthcare and will be built based on various new concepts as Quality of Life (QoL), Intelligent Wearable Devices (IWD), Intelligent Internet of Medical Things (IIoMT), Hospital-to-Home (H2H) services, and novel business models. The growth of elder population can increase the importance of those services than was before. The integration between intelligent health systems and Body Area Networks (BANs) that provide the capabilities of collecting health information from multiple sensors, dynamically exchange the collected information with the environment and interact with networking services including social networks. 6G is expected to be the main communication platform to interconnect the intelligent healthcare services [6]. Personalized body area network (BAN) has been mentioned in three papers as [2, 6,10].

Digital Twin Applications has been mentioned in five papers. While the connection between the physical real world and the digital world is explored by academia and industry, this technology creates a precise digital duplicate of the physical world and with this interconnection, mapping and influencing each other and simultaneously developing. Artificial Intelligence is considered a key component that facilitates the running of operations and predictions in the digital world (the "twin"), being an opportunity and a refences for making good decision in the physical world. Digital twins are expected to be used in different fields as: interconnected digital twins of urban infrastructure, transportation networks, urban ecological environment, power systems, and other systems, providing a series of functions, such as the environmental monitoring, emergency warning, and risk prediction. Collaboration with body area network (BAN) will facilitate the simulation of a "virtual human body", this one can be used for 24/7 health tracking, predicting diseases in advance, and simulating surgeries or the effects of medication, and speed up drug development, improve quality of life, and help manage epidemics [2].

Collaborative Robots has been mentioned in six papers, or in a short way cobots collaborate and work side-by-side with humans, mainaining their health and safety and automate the production lines, while they can take tedious, repetitive and risky tasks and in Industry 5.0 they can offer set of benefits. As a challenge is mentioned the functioning in a safety and effectively manner as they should process a big amount of data and make real-time decisions, which is also difficult or impossible since they have a limited storage, computing, and communication capabilities. Another challenge is their demand of a revolutionary levels of reliability, safety, and trust [10].

Industry 5.0 has been mentioned in five papers and is defined as a collaboratiob between people and smart machines as robots, that can add a "personal human touch" in the automation and the efficiency goals of the Industry 4.0, while is expected to have the the key enabling technologies as cloud/edge computing, big data, Artificial

Intelligence, 6G, and IoE (Internet of Everything). Industry 5.0 is expected to connect a huge number of things using wired or wireless technologies, which will facilitate the provision of various applications and services that are enabled by a complete integration of cloud/edge computing, big data, and AI. 6G is considered key to solve the challenges of Industry 5.0 that refer to advanced connectivity, that is needed for critical applications like telesurgery and autonomous manufacturing, intelligent robots, thanks to the combination of 6G and Artificial Intelligence are expected to become more intelligent by processing huge amounts of data and by learning in real-time. Sustainability is considered a challenge, as one of 6G technologies like wireless power transfer and energy harvesting are expected to provide sustainable energy solutions for the many low-power sensors and robots in Industry 5.0 [10].

Holographic Telepresence has been mentioned in four papers and is known as a technology that projects realistic, full-motion 3D images of distant people and objects. This technology can be used applications like 3D video conferencing, because it works by capturing, compressing, and transmitting 3D footage, which is then decompressed and projected at the receiving end. HT has extreme network requirements as ncompressed hologram can require data rates with a high value, while to be fully immersive and interactive, it will require an ultra-low latency, but the actual generation cannot meet these requirements [10].

Connected industries and automation have been mentioned in six papers and the concept refers and includes smart cities, smart buildings, agriculture or smart farming and also hyper intelligent Internet of Things, which is presented below.

Smart Grid 2.0 has been mentioned in five papers. Smart Grid 2.0 defined as an advanced system that integrates intelligent decision systems with smart meters to accurately monitor consumption, detect outages and manage energy demand, while the main challenge has been represented by communication, because a big number of devices need to be connected as transformers and towers for secure and high-quality remote control. The actual technology can permit the connection of a limited number of devices, and it is not enough for the future, as 6G is expected and required to handle the massive scale, diversification, and new challenges like climate change, like integrating CO2 sensors with Artificial Intelligence for load balancing [10].

Holographic Communication has been mentioned in four papers. Real-time holographic communication is expected to be available with 6G, which is a concept that has been used in science fiction, a reality and it facilitates the interaction of people with high-precision 3D virtual images of others, like they were face-to-face. There are two key aspects of this technology as Extreme Network Requirements, because it's needed a large bandwidth, low latency, and high-precision resolution that can permit the transmission of complex 3D data (like color, angle, and position) and connecting with past and future, because holographic communication is expected to avoid limitation of real-time interaction. Is expected to provide the following capabilities to users, as they will be able to preserve, construct, and communicate with holographic images from the past (like people who left this world) or concepts from the future, creating entirely new experiences [2].

Internet of Everything (IoE) has been mentioned in three papers and is defined as the advance version of the actual IoT (Internet of Thing), that will facilitate the integration of data, people, processes, not only "things". 6G is considered a key enabler of IoE, that is dependent of the next generation, because IoE requires new capabilities as: Massive Connectivity which is the capacity to connect a scalable number of intelligent devices, potentially reaching billions and high Performance, because those high data rates and low latency needed to support this massive network of devices [10].

Personalized body area network (BAN) has been mentioned in three papers. The integration of Body Area Networks (BANs) and mHealth systems is driving the evolution for advanced, personalized health monitoring and management, while these networks use multiple sensors to collect and share health information for a variety of applications that cover medical domains like replacing wired setups in sleep disorder diagnoses and also non-medical domains like emotion detection, entertainment, and secure authentication [10].

Hyper-Intelligent IoT has been mentioned in two papers. The next generation of Internet of Things is expected to be "Hyper Intelligent", where the applications will use Artificial Intelligence to optimize data processing and will integrate devices as robots, UAVs (Unmanned Aerial Vehicles) and digital assistants to provide smarter services. Involving a massive number of connected devices, is predicted to create a huge amount of data and the actual generation cannot support this future demand and expectation [10].

Unmanned Aerial Vehicles (UAV) based mobility has been mentioned in three papers. In actual generation, Unmanned Aerial Vehicles have become popular and used in different application domain. Based on the support of 6G and Artificial Intelligence based services, those technologies will enable advanced new applications like such as passenger taxis, automated logistics, and military operations. Beside the benefits, there are also introduced a set of challenges like resource constraints as they have a limited processing power and batteries, requiring lightweight, low-latency security mechanisms, artificial intelligence vulnerabilities as become targets for AI-related attacks, where the protection of integrity of their control data is crucial, physical vulnerabilities and weaponization as they can be used by adversaries to launch organized cyber-attacks or even physical terrorist attacks [6].

Wireless Brain-Machine Interface Applications, Wireless Data Center, Tactile Internet, Emergency Rescue Communication have been mentioned in [2]. In [5,8] are mentioned Tactile/Haptic Communications and Imaging and Sensing. In [5] are mentioned the followings: Transportation Vertical (automotive, logistics, aerial, marine, etc.), Space-Terrestrial integrated network, Critical Infra, Government/National Security, First Responder/Emergency Services.

Aerial and satellite networks and platforms are mentioned in [8, 12], while Volumetric media streaming is mentioned [8], Urban air mobility (UAM) is mentioned in [12], Metaverse is mentioned in [3].

Conclusion

6G networks clearly represent a revolutionary step in wireless communication, promising to transform industries, improve lives, and enable innovations once thought impossible. However, the journey to 6G is just beginning. Turning these ambitious concepts into reality will demand a unified, collaborative effort from researchers, policymakers, and industry leaders [1].

Based on the analysis of the 6G applications and capabilities, can be summarised the correlation between those ones as follows: Extended Reality has been mentioned in ten papers, which represents the top expected application in the next generation. The next applications mentioned in six papers refers to Connected Autonomous Vehicles (CAV), Hyper-Intelligent healthcare, Collaborative Robots, Connected industries and automation, while the next ones were mentioned in five papers: Smart Grid 2.0, Industry 5.0, Digital Twin Applications.

Artificial Intelligence has been considered a key component in Digital Twin Applications, Industry 5.0, Unmanned Aerial Vehicles (UAV) based mobility, Smart Grid and Hyper Intelligent IoT. Intrnet of Everything is considered the advanced „Intrnet of Things” where will integrate things, data, people and processes, expending the capabilities of IoT. Collaborative Robots are strictly correlated with Industry 5.0, where the collaboration between people and smart machine is actually the definition of this concept. Internet of Everything, artificial intelligence are considered as key enable technologies in Industry 5.0.

Body area network (BAN) is correlated with hyper-intelligent Healthcare and based on this integration, is predicted to provide different capabilities and is also correlated with Digital Twin Applications and will facilitate simulation of a “virtual human body”, this one can be used for 24/7 health tracking, predicting diseases in advance, and simulating surgeries or the effects of medication, and also speed up drug development, improve quality of life, and help manage epidemics [10].

The anticipated contributions from these applications or use cases include enhancing environmental, social, and governance effects and facilitates the creation of cycle of development and advancement within the broader industrial ecosystem and driving innovation in the lifestyles of individuals and society as a whole [12].

This his study considered IEEE resources only, as this is only experimental technology and IEEE was identified as the most relevant source for such a study.

References

- [1]. Singh, J., Singh, G., & Vashisht, N: Evaluating 6g network technology principles and applications: A review. In *2023 3rd International Conference on Smart Generation Computing, Communication and Networking (SMART GENCON)* (pp. 1-5). IEEE, (2023)
- [2]. Wang, C. X et al. On the road to 6G: Visions, requirements, key technologies, and testbeds. *IEEE Communications Surveys & Tutorials*, 25(2), 905-974, (2023)
- [3]. Quy, V. K et al.: Innovative trends in the 6G era: A comprehensive survey of architecture, applications, technologies, and challenges. *IEEE Access*, 11, 39824-39844, (2023)
- [4]. Uzunidis, D. G., & Patrikakis, C. Z. The 6G Era: What It Takes to Add Another G. *IT Professional*, 26(4), 4-8, (2024)
- [5]. Trichias, K., Kaloxylos, A., & Willcock: 6G global landscape: A comparative analysis of 6G targets and technological trends. In *2024 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)* (pp. 1-6). IEEE, (2024)
- [6]. Porambage, P., Gür, G., Osorio, D. P. M., Liyanage, M., Gurtov, A., & Ylianttila, M. The roadmap to 6G security and privacy. *IEEE Open Journal of the Communications Society*, 2, 1094-1122, (2021)
- [7]. Baek, S., Lee, J., & Lee, M.: Standardization trends of 6G mobile communications in ITU-R. In *2024 15th International Conference on Information and Communication Technology Convergence (ICTC)* (pp. 1424-1425). IEEE., (2024)
- [8]. Mourad, A., Yang, R., Lehne, P. H., & De La Oliva, A. Towards 6G: Evolution of key performance indicators and technology trends. In *2020 2nd 6G wireless summit (6G SUMMIT)* (pp. 1-5). IEEE, (2020)
- [9]. Danuti, F., & Ottesteanu, M.: 6G: An Overview of Key Technologies and Challenges. In *2024 International Symposium on Electronics and Telecommunications (ISETC)* (pp. 1-5). IEEE, (2024)
- [10]. De Alwis, C., Kalla, A., Pham, Q. V., Kumar, P., Dev, K., Hwang, W. J., & Liyanage, M. Survey on 6G frontiers: Trends, applications, requirements, technologies and future research. *IEEE Open Journal of the Communications Society*, 2, 836-886, (2021)
- [11]. Arshad, R., & Muzzammel, R. Realizing intelligence in 6g communications: A review. In *2023 2nd International Conference on Emerging Trends in Electrical, Control, and Telecommunication Engineering (ETEECTE)* (pp. 1-5). IEEE, (2023)
- [12]. Na, M., Lee et al. Operator's perspective on 6G: 6G services, vision, and spectrum. *IEEE Communications Magazine*, 62(8), 178-184, (2024)

- [13]. Ran, Y., & Zhang, D.:The Overall Development Trend of 6G. In *2023 5th International Academic Exchange Conference on Science and Technology Innovation (IAECST)* (pp. 398-403). IEEE, (2023)
- [14]. NGMN Alliance, 6G Use Cases and Analysis, NGMN Alliance, Available from : <https://www.ngmn.org/publications/6g-use-cases-and-analysis.html> , (2022)
- [15]. Shah, A. S. :A survey from 1G to 5G including the advent of 6G: Architectures, multiple access techniques, and emerging technologies. In *2022 IEEE 12th annual computing and communication workshop and conference (CCWC)* (pp. 1117-1123). IEEE, (2022)
- [16]. Zhao, L., Zhao, Y., Zhou, S., Yu, P., Dong, Q., Wang, L., & Li, J.:Discuss the key development direction of 6G key technology based on 5G technology. In *2023 2nd International Conference on Artificial Intelligence and Computer Information Technology (AICIT)* (pp. 1-3). IEEE, (2023)
- [17]. Akgul, O. U., Ericson, M., Burguera, P. G., Arar, B., Khorsandi, B. M., Querio, R., ... & Fitzek, F. H.: Discussion on 6G architecture evolution: Challenges and emerging technology trends. In *2024 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)* (pp. 664-669). IEEE, (2024)
- [18]. Siriwardhana, Y., Porambage, P., Liyanage, M., & Ylianttila, M. :AI and 6G security: Opportunities and challenges. In *2021 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)* (pp. 616-621). IEEE, (2021)
- [19]. Norp, T., Sachdeva, P., Anton, C., Trichias, K., & Mohnani, P.: 6G Research & Innovation Activities in Europe: An Overview of EU & Nationally funded Programmes. In *2024 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)* (pp. 1109-1114). IEEE, (2024)
- [20]. Xia, X.: 6g satellite communication: Key technologies, challenges and trends. *2024 International Wireless Communications and Mobile Computing (IWCMC)*, 703-705, (2024)
- [21]. Xing, Y., Zhou, J., Li, P., & Yu, M. (2024, May). Research on Key Technologies of 6G Network Architecture. In *2024 International Wireless Communications and Mobile Computing (IWCMC)* (pp. 451-455). IEEE, (2024)
- [22]. R. Liu, H. Lin, H. Lee, F. Chaves, H. Lim and J. Sköld, "Beginning of the Journey Toward 6G: Vision and Framework," in *IEEE Communications Magazine*, vol. 61, no. 10, pp. 8-9, October 2023, doi: 10.1109/MCOM.2023.10298069, (2023)