

NEC's Vision and Initiatives towards the Beyond 5G Era

NAGAI Ken

Abstract

In this paper, we examine the worldview and image of the future society in the Beyond 5G era, which is expected to begin around 2030. We also look at NEC's Beyond 5G vision, which considers changes in communications and the surrounding environment, expected role changes, and use cases. The direction of technological evolution that is considered necessary to achieve that vision, the key technology areas, and NEC's initiatives for open innovation and ecosystem formation are also described.

Keywords



Beyond 5G, 6G, 2030, probabilistic digital twin, co-creation activities, living lab, open innovation, ecosystem, social implementation

1. Introduction

By using digital technologies such as rapidly developing AI and IoT, digital transformation (DX) is accelerating to revolutionize society, economy, and industries. Communication technologies, including 5G (fifth-generation mobile communication system), are playing a crucial role in transforming business processes and business models by means of DX. The development of services and use cases leveraging the features of 5G has begun; such features include its ultra-high speed and large capacity, ultra-low latency, high reliability, and simultaneous multi-connections as well as the safety, stability, and flexibility of private 5G (dedicated 5G networks in Japan hosted by entities outside the communication service sector is referred to as private 5G in this paper). Various solutions for addressing corporate and regional issues are being investigated. We at NEC are utilizing 5G and private 5G to promote the creation of new business models that go beyond DX and to realize next-generation urban infrastructure while engaging in co-creation activities with communications service providers (CSPs) and our partners in a wide range of fields.

In this paper, we discuss the vision of the society

we are striving to achieve by broadly considering the developmental forms of the Beyond 5G era, which is expected to emerge around 2030. We explore how communications and the surrounding social environment will change in the future, what role communications will play, as well as use cases and supporting technologies. And we introduce NEC's vision and initiatives as examples of the commitment we are making in this area¹⁾²⁾³⁾.

2. Worldview and Social Vision in the Beyond 5G Era

In a world where digital technology has become an essential part of our daily lives, barriers created by gender, age, race, and disabilities will disappear. It will be commonplace to connect with others regardless of physical or temporal distance, to lead lifestyles that are optimized for each individual and that reflect each individual's values, and to have a diversity of workstyles. It is expected that we will witness the advent of an inclusive society that fosters shared wisdom and empathy through rich communication that transcends time, space, language, and generational barriers as well as fostering self-expression through work. Movements including Web3 and decentralized au-

Autonomous organizations (DAO) are beginning to emerge: Web3 is a movement that aims to decentralize and democratize the internet so that individuals can connect directly with each other, and DAO is a management structure that is transparent, fair, and accessible to everyone without being controlled by a central authority. When supported by the societal infrastructure enabled by Beyond 5G communication and its peripheral technologies, individuals will be able to exercise their innate creativity more easily.

When aiming for a sustainable world where everyone has the chance to reach their full potential, communication has the great power to change society. It can also be said that the Tele-X services to be implemented in society through Beyond 5G technologies will push the limits of our innate abilities and possibilities. When this is realized, we will be able to go beyond human, beyond space, and beyond time, and we believe that a new communication paradigm to achieve this is the goal of Beyond 5G (Fig. 1).

An example of a use case for going "Beyond Human" is the realization of an experience in which people can feel as if they are together in the same place even if they are in different locations by transmitting the sensations of their five senses, their emotions, and even the mood of their surroundings. We aim to achieve a world where people can appear to experience—through cyberspace—that they are standing in the same place, seeing the same things, breathing the same air, and feeling each other's warmth so that it is possible for them to even share their emotions.

Going "Beyond Space" by connecting all possible places in real time through a global network will enable people to instantly receive whatever information they need wherever they are — this in turn will provide support for them in everyday life and enable them to find more personal val-

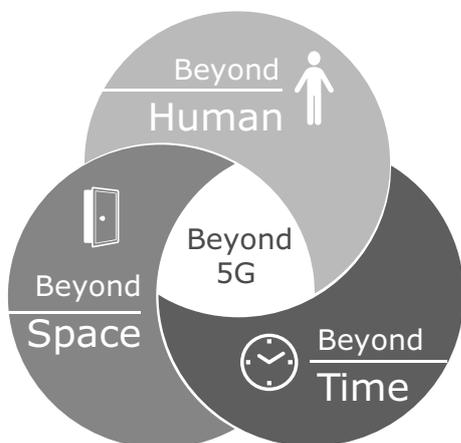


Fig. 1 A World Beyond Human, Beyond Space, and Beyond Time.

ues. In the future, not only will universal coverage expand but also needed information will be delivered to each user in accordance with their location and situation.

When it comes to going "Beyond Time," it will be possible to accurately predict the near future in the real world by utilizing probabilistic digital twins and other technological advances and thereby create new value by providing a safe and secure environment in which robots and humans coexist without any difficulties⁴⁾⁵⁾.

3. Beyond 5G Vision

To prepare for the future society after 2030, new forms of telecommunications are needed, and the technologies that support them must evolve (Fig. 2).

In addition to the evolution up to 4G and 5G, technology in the Beyond 5G era will literally go beyond human ability, beyond space, and beyond time and enable AI to analyze and understand everything—even people's appearances and feelings—in any possible space from one's personal surroundings to the entire planet. Then that knowledge will be instantly digitized and freely utilized as past data, real-time data, and future predicted data. Beyond 5G will become essential infrastructure that enriches people's lives and society.

Based on this, we at NEC consider the scope of Beyond 5G not only as the quantitative expansion of 5G but also as the integration of distributed data processing. In other words, we define Beyond 5G as a system that integrates networks and distributed data processing and that also organically utilizes globally distributed communication and computing resources to achieve real-time interaction with the real world.

As a new form of communication, Beyond 5G systems will achieve: (1) hyper-realistic communication between humans that transcends time and space as well as between humans and things; (2) the expansion of digital twins and cyber-physical systems; and (3) seamless

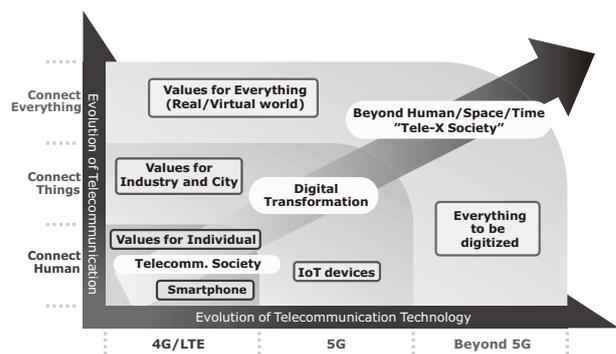


Fig. 2 Evolution of Telecommunications and Technologies.

connected coverage anywhere on the entire globe.

4. Direction of Technological Evolution and Key Technological Areas

At NEC, we do not only regard Beyond 5G as a progression of wireless communication technology but rather we consider it as an evolution of the social infrastructure where data processing platforms such as distributed computing and AI are integrated into the network. We view the technical scope of Beyond 5G from both the aspect of wireless communication technology such as ultra-high speed, broadband communications, and universal coverage and that of infrastructure technology for services and applications such as real-time recognition and control through AI (Fig. 3).

In wireless communication technology, we aim to realize an environment where humans and robots can coexist anywhere by realizing easy-to-use communications utilizing Millimeter waves (mmWaves) or Terahertz (THz) waves and by using network control technology to maximize the user's quality of experience (QoE)⁽⁶⁾⁽⁷⁾. In the coming age of Beyond 5G, AI technologies that collaborate with infrastructure — such as technologies for digitizing the whole world in real time to create its digital twin, for robot action planning, and for instant future prediction — will evolve together with networks. In this process, it is predicted that they will not evolve independently but rather complement

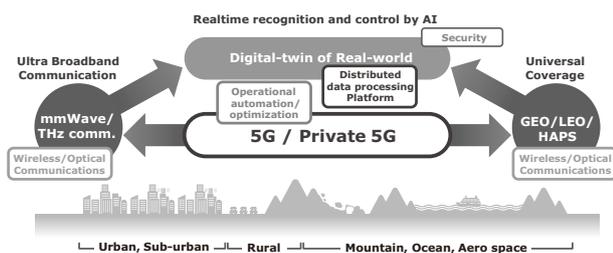


Fig. 3 Technology Scope of Beyond 5G.

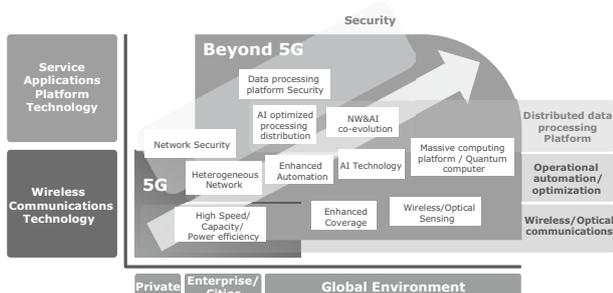


Fig. 4 Direction of Technological Evolution.

Wireless/Optical communications	<ul style="list-style-type: none"> High speed, large-capacity, coverage expansion Low power consumption, energy efficiency, carbon neutral Wireless/optical sensing
Operational automation/optimization	<ul style="list-style-type: none"> E2E network optimization for service and application Automated operation automation improvement AI technology
Distributed data processing Platform	<ul style="list-style-type: none"> Network and AI co-evolution Advance digital-twin, Probabilistic digital-twin Probabilistic Robotics
Security	<ul style="list-style-type: none"> Network security Data processing platform security

Fig. 5 Key Technology Areas for Beyond 5G.

each other in a relationship of co-evolution, so to speak.

Fig. 4 illustrates the direction of these technological advancements. The horizontal axis represents the evolution of telecommunications, and the vertical axis represents the expansion from wireless communication technology to service applications platform technology. At NEC, we have organized the technological components for this evolution into four key technology areas: (1) wireless and optical communication, (2) operational automation and optimizations, (3) distributed data processing platform, and (4) security. We are also conducting R&D while promoting cooperation between areas (Fig. 5).

5. Conclusion

Beyond 5G technology will spread in the form of the latest information and communication technology that supports every aspect of life and society. It will play a crucial role in supporting people and society as a DX platform, thereby contributing to the seamless interaction of people, things, and events in the real and virtual worlds. Upon the realization of this, people will utilize communication technology more than ever before to achieve a comfortable lifestyle and work style. In terms of network deployment, operation, and service provision, there will be a significantly wider range of choices and more freedom than currently available. Networks will be deployed in areas where services are needed, not only in urban and downtown areas but also in rural and depopulated areas. The construction, operation, and use of self-employed and closed-area networks by companies and organizations will become increasingly popular. It is also expected that the distributed data processing platform that is deployed and unevenly distributed in conjunction with these networks will be efficiently used.

To respond to the needs for providing increasingly complex services and solutions, in addition to the need to guarantee performance and requirements from a technical perspective, the network, applications and services must work together to optimize the entire sys-

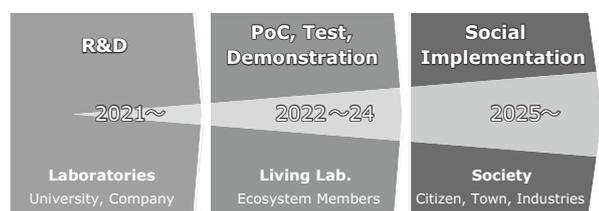


Fig. 6 Co-creation Activities Toward the Beyond 5G Era.

tem while developing and evolving it. NEC is one of the few companies that possess a well-balanced portfolio of world-class technologies in a wide range of areas, from network and IT to data and services. NEC will go beyond the conventional framework of information and telecommunications technology to take an integrated and unified approach to the quantitative expansion of 5G and distributed data processing — which are considered essential to the realization of Beyond 5G — from the research and development stage.

We will make maximum use of our expertise in system construction and operation as well as NEC's technological assets, so that we promote open R&D and business development in collaboration with our customers and partners (**Fig. 6**). For example, in industry-academia collaboration activities, we cover a wide range of activities including R&D on specific technology, vision formation with a view to social implementation, and the fostering of social consensus. By utilizing ongoing facilities in the real world and university campuses as living laboratories and also by demonstrating technological aspects as well as verifying governance and institutional aspects, we are promoting research and development with a high degree of social acceptability based on the premise of practical application and social implementation⁸⁾. By establishing and operating a living lab as a microcosm of future society, we will invite more companies, universities, and local governments to collaborate with us and advance open innovation and ecosystem formation as we move towards the 2030s.

At NEC, we are taking on the challenge of bringing amazing ideas to life, together in the Beyond 5G era. We are committed to continuing our efforts to seize the future together in collaboration with a wide range of stakeholders, implement cutting-edge technology in society, and letting everyone experience the value we have to offer.

* LTE is a registered trademark of the European Telecommunications Standards Institute (ETSI).

* All other company names and product names that appear in this paper are trademarks or registered trademarks of their respective companies.

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Author's Profile

NAGAI Ken

Senior Professional
Advanced Network Strategy Department

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NEC's Approach to Full Automation of Network Operations in OSS
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Toward Beyond 5G/6G

NEC's Vision and Initiatives towards the Beyond 5G Era

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Vol.17 No.1
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Special Issue TOP