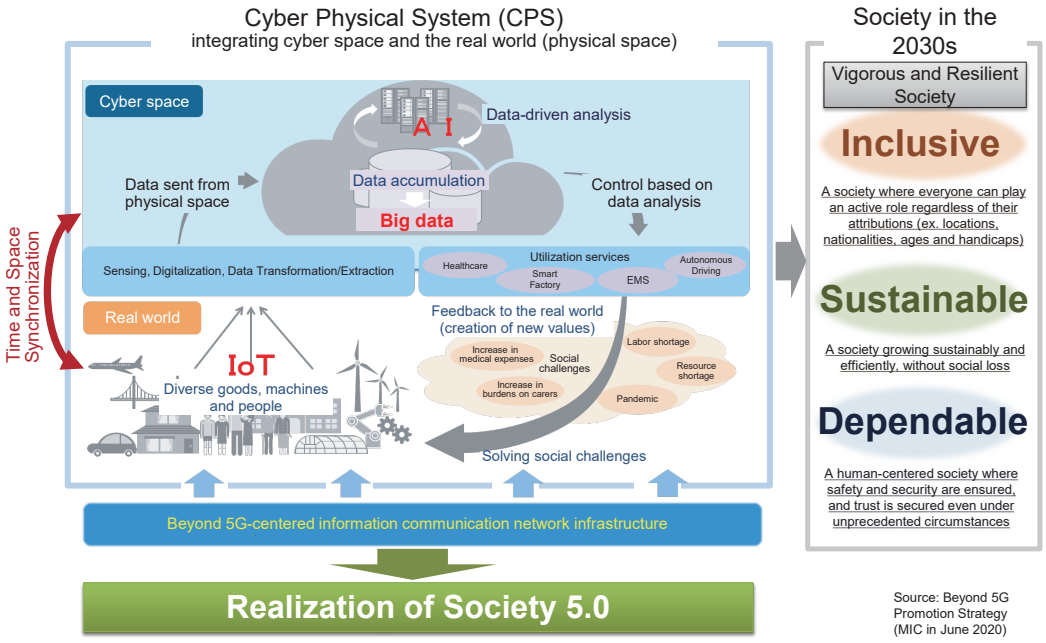
Section 7 ICT Technology Policies

1. Summary

(1) Initiatives so far

The "Beyond 5G Promotion Strategy" formulated by MIC in June 2020 aims to realize a "vigorous and resilient society" where people's lives and economic activities are smoothly maintained through a Cyber Physical System integrating cyber and physical spaces as a society in the 2030s when realization of Beyond 5G is expected (**Figure 4-7-1-1**). While pursuing Beyond 5G R&D strategies and IP/international standardization based on the strategy, MIC has promoted R&D and international standardization of cutting-edge technologies in the ICT field based on the Growth Strategy, the Science, Technology and Innovation Basic Plan, the Integrated Innovation Strategy (AI Strategy and Quantum Technology Innovation Strategy), the Intellectual Property Strategic Program, and the Basic Plan on Space Policy, etc. of the entire government.

Figure 4-7-1-1 Society expected in the 2030s



Source: Beyond 5G Promotion Strategy (MIC in June 2020)

Related data
Science, Technology, and Innovation Basic Plan (Cabinet Decision in March 2021) for the entire government
Source: Prepared by MIC from materials of the Cabinet Office
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2022/data_collection.pdf#4-7-2 (Data Collection)

(2) Future challenges and direction

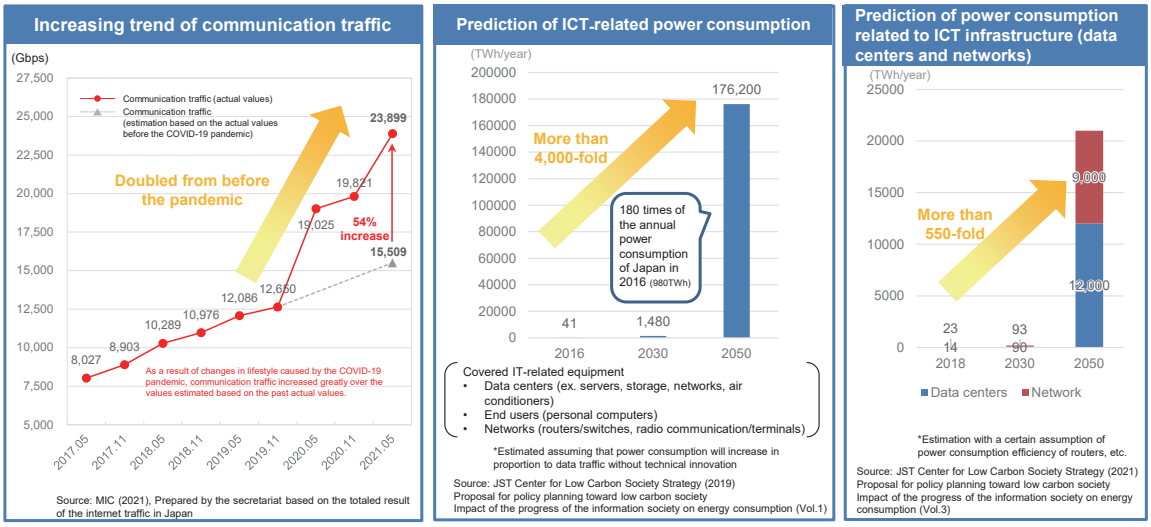
As global R&D competition toward Beyond 5G has been intensifying every year, beyond 5G studies and activities are progressing at home and abroad. In this context, it is necessary to realize the social implementation of development results and market gain, strengthen Japan's international competitiveness and ensure its economic security by further crystallizing the existing strategies of R&D, IP and international standardization in close industry-academia -government coordination and promoting such crystallized strategies. Considering the role of Beyond 5G connected to the infrastructure of all industries and social activities, this process should be based on the government-wide policies including post-coronavirus society, Vision of Digital Garden City Nation, environment/energy, disaster prevention/mitigation and security policies. To this end, the Act on Promotion of Ensuring of Security by Taking Economic Measures in an Integrated Manner (Act No.43 of 2022) was enacted in 2022.

In addition, after tackling the challenge of economic growth and the solution of social issues after the COVID-19 pandemic, and with consideration of future technology trends in the ICT sector and the innovation policy of the entire government, it is necessary to strategically promote development of cutting-edge technologies, IP and international standardization, while at the same time advancing the study/formulation of ICT technology strategies toward a resilient and vigorous society in the 2030s.

Furthermore, communication traffic in Japan has increased exceeding the past estimation due to changes in lifestyle caused by the COVID-19 pandemic and other factors, and power consumption of the ICT sector is increasing as a result. In addition, there is concern over significant increase in power consumption in the ICT

sector as a result of the future development of technologies and services (**Figure 4-7-1-2**). In this context, Japan declared that it aims to achieve carbon neutrality by 2050 as an international commitment. As the realization of green digital society and carbon neutrality of the ICT industry by 2040 are positioned in the policies of the entire government, MIC needs to promote initiatives toward greening and digitalization in the ICT sector.

Figure 4-7-1-2 Trends of communication traffic and energy consumption in the ICT sector



(Source) MIC, the Department of Information and Communications Technology of the Information and Communications Council, materials of the 27th technology strategy committee

2. Beyond 5G

(1) International trends surrounding Beyond 5G

Other countries have started to consider or implement Beyond 5G-related R&D investments by governments for the purpose of securing international competitiveness and economic security. For example, the United States in the Japan-US joint declaration announced investments in the next generation mobile communication network, etc., while Next G Alliance formulated "6G Roadmap." In Europe, there is progress in various initiatives including decision on investments in 6G R&D by Horizon Europe and the launch of Hexa-X that is a 6G R&D project. It is expected that the countries will continue to actively promote Beyond 5G R&D in the future (**Figure 4-7-2-1**).

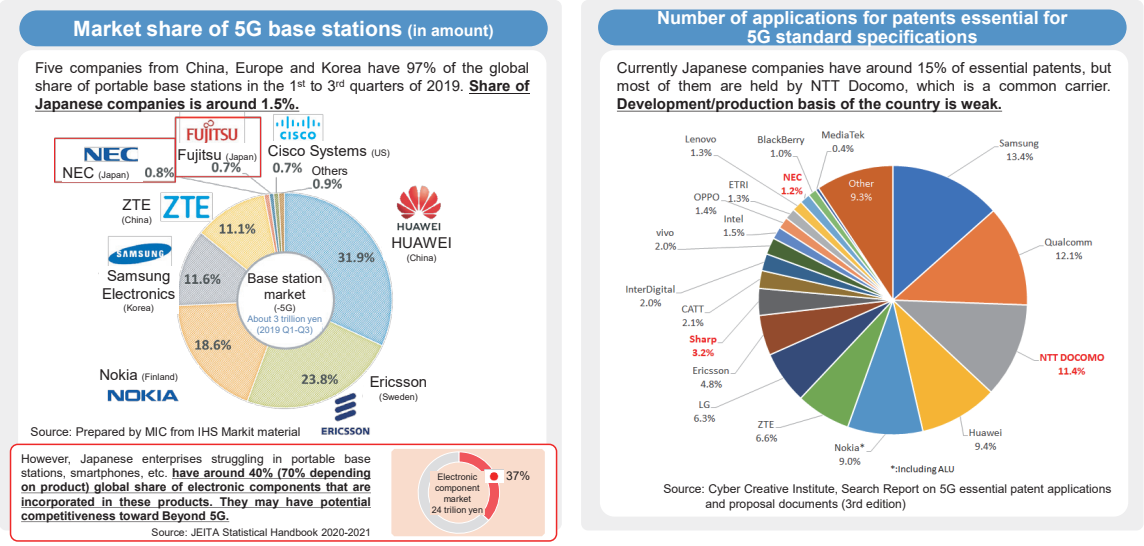
Figure 4-7-2-1 Beyond 5G R&D by the governments of other countries

The United States	● **Next G Alliance that is an industry group to promote 6G set up a Roadmap WG and a Green G WG** and started studies to clarify the elements necessary for promotion of 6G and other new technologies and realization of a sustainable ecosystem through new technologies. (March 2021) ● The government expressed **2.5 billion dollar** (4.5 billion dollar in total from Japan and the U.S.) **investment** in the next generation mobile communication network, etc. in the **U.S.-Japan Joint Leaders' Statement** (April 2021) ● **Next G Alliance formulated 6G Roadmap** and recommended government support in three areas: "consistent policy framework for success of 6G", "support for 6G research and development" and "policies to incentivize private investment in 6G" (February 2022) ● Federal Communications Commission (FCC) reorganized the Technological Advisory Commission (TAC) with 6G as a new focus (February 2022). ● National Science Foundation (NSF) announced projects adopted for RINGS that is 6G R&D support partnership (April 2022)
Europe	**EU, Germany and Finland governments invest 1.85 billion Euro (about 240 billion yen) in total in 6G R&D** (as of March 2022)
EU	● 6G R&D project Hexa-X started, funded by Horizon 2020 (from January 2021 to June 2023) ● EU decided **900 million Euro investment in 6G R&D** in the next R&D program **Horizon Europe (2021-2027)** (March 2021) Combined with 1.1 billion Euro from the private sector, SNS JU secured 2 billion Euro (260 billion yen) in total (March 2022) and already made 240 million Euro (31 billion yen) contributions to Work Program (2021 to 2022) (December 2021)
Germany	● Decided to **invest 700 million Euro** in total in 6G technology R&D (2021 to 2025) (April 2021). 250 million Euro (about 33 billion yen) of the amount is invested in construction of 6G R&D hub (June 2021)
Finland	● Started **6Genesis Flagship Program** and budgeted **250 million Euro (about 33 billion yen) in eight years from 2019 to 2026** (May 2018) ● Held the 1st **6G Wireless Summit** (March 2019)
China	● Established a 6G promotion organization 2IMT-2030(6G)" and started 6G R&D (June 2019) ● Released a digital economy plan to enhance 6G R&D as part of the 14th five-year plan (January 2022) ● Tsinghua University announced a success of 1TB/sec transmission experiment at a Beijing Olympic venue (February 2022)
Korea	● Ministry of Science and ICT (MSIT) announced a 6G R&D action plan, including **220 billion won (about 21 billion yen) investment by 2025** (June 2021). ● Started to formulate "the Next-Generation Network Development Strategy" that includes 6G (January 2022) ● Discussed cooperation in ICT including 6G with the United States, Finland and Indonesia (March 2022)

(2) Potential competitiveness toward Beyond 5G

Major overseas enterprises have a high share in the global communication infrastructure market (portable base station), hold many related patents and are expected to maintain high competitiveness also in the future. Japanese enterprises are less competitive and could be left in the dust in the field of 5G if the situation remains the same. Whereas Japanese enterprises are struggling in portable base stations and smartphones, they have a certain global share in the electronic components incorporated in these products. For this reason, they may have potential competitiveness in Beyond 5G (**Figure 4-7-2-2**).

Figure 4-7-2-2 International competitiveness of Japan in the communication infrastructure market



(Source) MIC, the Department of Information and Communications Technology of the Information and Communications Council, materials of the 34th technology strategy committee

(3) Policy trends

i Formulation of Beyond 5G strategy

Toward realization of "Beyond 5G," which is the next-generation information and communication infrastructure in the 2030s, Japan has accelerated industry-academia-government activities by formulating the "Beyond 5G Promotion Strategy," and setting up "Beyond 5G Promotion Consortium" and "Beyond 5G New Business Strategy Center." Specifically, focusing on the seven functionalities to be upgraded and expanded from 5G (ultra-fast & large capacity, ultra-low latency, ultra-numerous connectivity, autonomy, scalability, ultra-security and resiliency and ultra-low power consumption), industry, academia and the government cooperate to study visions and technical challenges. MIC has started R&D on core technologies.

In September 2021, MIC sent an inquiry to the Information and Communications Council on "information and communications technology strategy for beyond 5G." The council gave shape to technology strategy toward Beyond 5G, including priority R&D tasks and measures to promote them, and compiled an interim report on June 30, 2022.

Related data
Functions required for Beyond 5G
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2022/data_collection.pdf#4-7-6 (Data Collection)

ii Promoting R&D on Beyond 5G

In order to support R&D on cutting-edge elemental technologies necessary for Beyond 5G, MIC established a Funding Program for World-Leading Innovative R&D on information and communication technologies at NICT by using the 3rd supplementary budget of fiscal 2020, while at the same time developing test beds and other common facilities/equipment to promote Beyond 5G R&D by gathering knowledge of the public and private sectors. In the "Beyond 5G R&D Promotion Project," MIC implements core technology R&D based on open application with focus on the seven functionalities required from Beyond 5G (ultra-fast & large capacity, ultra-low latency, ultra-numerous connectivity, ultra-low power consumption, ultra-security and resiliency, autonomy and scalability) under the following programs:

① Beyond 5G Function Realization Program
R&D of core technologies to realize the functionalities required from Beyond 5G

② Beyond 5G International Joint R&D Program
R&D on cutting-edge technologies in international collaboration with strategic partners

③ Beyond 5G Seeds Creation Program
R&D projects to generate innovation by creating seeds for technology

Related data
Schema of the Beyond 5G R&D Promotion Project (Fund)
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2022/data_collection.pdf#4-7-7 (Data Collection)

"Beyond 5G R&D Promotion Project" in fiscal 2022 and after plans to promote Beyond 5G R&D reflecting the technology strategy mentioned in (i) and aims to implement the development results in society gradually starting from EXPO 2025 Osaka, Kansai.

iii Promoting acquisition of IP and international standardization for Beyond 5G

With the aim of strategically accelerating acquisition of Intellectual Property and global standardization under industry-academia-government cooperation, MIC established the "Beyond 5G New Business Strategy Center" in December 2020. The center disseminates information through New Business Strategy Seminars and promotes human resource development through workshops for candidate-executives of enterprises and Hackathon events for university and technical college students. Furthermore, MIC is working on development of information infrastructure for study on future standardization, which includes construction of IP landscape to analyze IP acquisition status.

In order to promote international standardization activities from the initial stage of R&D, MIC conducts international joint research that promises synergy effects with research institutes of countries/regions that are reliable strategic partners. Specifically, MIC in collaboration with the European Commission has implemented Japan-EU joint research that provides R&D funds to joint proposals from universities, private enterprises and other research institutes in Japan and the EU. In fiscal 2022, research on eHealth adopted through the 5th public invitation is underway. Since fiscal 2016, MIC has implemented joint research with the U.S. research institutes, started research on 5G upgrading adopted through the new public invitation in fiscal 2021 and plans public invitation for new Japan-U.S joint research and Japan-Germany joint research in fiscal 2022.

3. Quantum technology

(1) Trends of the quantum security network policy

Quantum technology is an innovative technology that will dramatically and discontinuously develop future society and economy. It is also crucially important for economic security. Other countries, especially the United States, European countries and China are significantly increasing R&D investments in this technology and making strategic efforts including development of R&D sites and human resources.

Based on the "Quantum Technology Innovation Strategy" (decision made by the Integrated Innovation Strategy Promotion Council in January 2020) and "Vision for the Quantum Future Society – a vision for future society to create using quantum technology and strategies toward its realization" (decision made by the Integrated Innovation Strategy Promotion Council in April 2022), the Government of Japan supports enhancement of R&D and activities for commercialization in each technology field (quantum computers, quantum software, quantum security networks, quantum metrology/sensing and quantum materials). In addition, the government plans to promote formation of sites for comprehensive initiatives from basic research to technology demonstration and human resource development in industry-academia-government partnership, and other infrastructural initiatives to generate innovations.

(2) R&D on quantum cryptographic communication technologies

In the age of quantum computing where there is a concern of security failure of the current cryptography, we need quantum cryptography, decryption of which is impossible by any computer in principle. MIC in collaboration with NICT is promoting R&D on quantum cryptographic communication (quantum key distribution) technologies, while at the same time establishing a "Quantum Security Hub" for the field of quantum security network technologies at NICT based on the Quantum Technology Innovation Strategy in fiscal 2021 and tackling a broad range of activities including social implementation through construction and use of test beds and human resource development.

i R&D on distance extension and networking of quantum encryption communication

For social implementation of quantum encryption communication, extension of its communication distance is one of the big challenges. With the aim of tackling the challenge of distance extension and realizing a global quantum encryption communication, MIC has been working on R&D of long distance linking and relaying of terrestrial quantum encryption communication since fiscal 2020. In addition, toward safe satellite communication networks, MIC has been working on R&D to use quantum encryption communication for microsatellites since fiscal 2018 and started R&D to construct a global quantum encryption communication network integrating terrestrial and satellite networks in fiscal 2021.

ii Developing testbeds for quantum encryption communication and promoting its social implementation

In Japan, NICT has been working on R&D of elemental technologies of quantum encryption communication from an early stage. NICT constructed the "Tokyo QKD Network" that is a testbed for quantum encryption communication in 2010 with the aim of verifying principles of quantum encryption communication, and has operated it for a long period of time. The basic specifications of quantum encryption communication equipment devel-

oped based on the long-term operation of Tokyo QKD Network were adopted as international standard (ITU-T Y.3800 series) in 2020, which shows its high international competitiveness.

Because quantum encryption communication is expected to be used in financial, medical and other commercial services in addition to use in public institutions handling confidential information, there are strong demands for its early practical application. In response, with the aim of accelerating social implementation through verification of use in actual environments, since fiscal 2021 MIC has been working to develop broad-area testbeds for quantum encryption communication, which are capable of demonstration of network architectures including routing control with architecture connecting multiple sites.

Related data
Image of global quantum cryptography network
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2022/data_collection.pdf#4-7-8 (Data Collection)

4. AI technologies

In recent years AI has been evolving at an accelerated pace as represented by machine learning based on deep learning. Its application is progressing around the world with significant impacts on a wide range of industries and social infrastructure, making AI an essential technology to maintain fundamental functions of society.

Based on the "AI Strategy 2022" (decision made by the Integrated Innovation Strategy Promotion Council in April 2022), MIC, in collaboration with NICT that has AI-related core centers, is working on a wide range of R&D and social implementation of natural language processing, multi-lingual translation/speech processing and brain cognitive model construction.

For example, MIC together with NICT is working on R&D of multi-lingual translation to eliminate language barriers in the world to realize global and free exchange. Multilingual translation technology developed by NICT achieved a practical level accuracy for 12 languages assuming response to foreigners visiting or staying in Japan. MIC and NICT are also promoting social implementation of multilingual translation technology. NICT provides VoiceTra as a research application targeting independent travelers. More than 30 private-sector services are developed[49] through technology transfer and used in a variety of fields including disaster management, transportation and medical care in addition to government offices.

Related data
Multilingual translation technology
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2022/data_collection.pdf#4-7-9 (Data Collection)

With a view to EXPO Osaka, Kansai in 2025, MIC formulated "Global Communication Plan 2025" in March 2020, in order to further advance the multilingual translation technology of NICT. Based on the plan, MIC creates a computer environment for the world's cutting-edge and top-level AI R&D at NICT, while at the same time implementing R&D to upgrade the technology of serial translation of short sentences to "simultaneous interpretation" that can handle discussions at business and international conferences since fiscal 2020.

Related data
Efforts to further advance the multilingual translation technology
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2022/data_collection.pdf#4-7-10 (Data Collection)

Furthermore, MIC plans to add eight languages with foreigners visiting/living in Japan and diplomacy in mind, while conducting R&D on multilingual simultaneous interpretation.

5. Remote sensing technologies

With the aim of contributing to early detection of sudden atmospheric phenomena represented by "guerrilla rainstorms" and tornadoes, and elucidation of their development mechanism, NICT implements R&D of remote sensing technologies to observe precipitation, vapor, wind, etc. with high time/space resolution.

Regarding Dual Polarization Multi-Parameter Phased Array Weather Radar (MP-PAWR) capable of high-speed and high-accuracy 3D observation of rain clouds, for example, NICT implements large-scale events using the metropolitan area heavy rain forecasting system in collaboration with other institutions, and demonstration experiments together with local governments. NICT is also promoting R&D on: technology to estimate water vapor content in the atmosphere by using propagation delay of terrestrial digital broadcast waves; wind profiler

[49] Global Communication Development Promotion Council, examples of products/services of private enterprises using the multilingual translation technology of the National Institute of Information and Communications Technology (NICT): https://gcp.nict.go.jp/news/products_and_services_GCP.pdf

technology to measure wind speed up in the air; on-ground water vapor/wind lidar using eye-safe infrared pulse lasers capable of simultaneous observation of water vapor and wind up in the air, for example.

Related data
Improvement of resolution and technology demonstration of synthetic-aperture radar for observation of the ground surface from aircraft
URL: https://www.nict.go.jp/press/2022/01/25-1.html

6. Space ICT

According to the Basic Space Plan based on the Basic Space Act (Act No. 43 of 2008) and its schedule, MIC is promoting the following R&D for space development and use:

① R&D of radio-optical hybrid communication technology toward small satellites constellation in order to realize ultrawide-band satellite optical communication system through effective use of frequency resources
② R&D to establish core technologies of quantum cryptography in satellite communication and realize a global network of quantum encryption communications through satellite networks, etc.
③ R&D of technology to explore water energy resources on the lunar surface to contribute to the international space exploration (Artemis Program) proposed by the United States
④ R&D of satellite communication systems for the engineering test satellite No.9 and optical communication technology that will enable ground-satellite optical data transmission at 10Gbps level
⑤ R&D of space environment monitoring sensors that will observe and analyze ionosphere, magnetosphere and solar activities, to be used for space weather forecast under 24-hour, 365-day human-crewed operation and to be mounted on the successor of the geostationary meteorological satellite Himawari.

Importance of space weather forecasting is increasing among enterprises responsible for the stable operation of social infrastructure, especially electric power, communications, broadcasting and aviation. Considering the forecast that solar activities will increase in the future, MIC, by holding a "Study Group on the Advancement of Space Weather Forecasting" encourages the industry, academia and the public sector to take their respective measures, while at the same time ensuring space weather forecasting (a report was compiled in June 2022).

Related data
Influence of solar flares on the earth
Source: MIC, Material of the Study Group on the Advancement of Space Weather Forecasting (the 1st session)
URL: https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2022/data_collection.pdf#4-7-11 (Data Collection)