Beyond 5G Promotion Strategy Roundtable
Recommendations

June 2020

In Japan, frequencies were allocated for a 5th generation mobile communication system (5G) in April 2019, and 5G commercial services started relatively recently in March 2020. Based on the fact that wireless communications undergo a generational change in global standards every 10 years, services for Beyond 5G (i.e. 6G) are expected to be introduced around 2030.

Furthermore, digital innovation has brought about an advanced level of integration between physical space and cyberspace, and a rapidly progressing paradigm shift from a conventional capital-intensive society, to a knowledge-intensive society, where knowledge, information, and services that utilize the information, have value. Japan has been pushing ahead with initiatives to realize Society 5.0 under the precept of a sustainable society in which no one is left behind, where diversity and inclusiveness are respected, and in which everyone can forge secure and comfortable lives, and obtain new opportunities for growth, through the utilization of a range of real data in real time.

Beyond 5G is a core future infrastructure that will support the advanced distribution and utilization of data that is essential for the development of Society 5.0. It will also influence the international competitiveness of a future Japan in a knowledge-intensive society. Therefore, Japan needs to make full use of its strengths and be deeply involved in the development of technology and in international standard-setting processes.

To that end, it is necessary to consider what immediately should be done to promote Beyond 5G. The Beyond 5G Promotion Strategy Roundtable" (chaired by Makoto Gonokami, President of the University of Tokyo) has been meeting since January 2020 for discussions on Beyond 5G for the Minister for Internal Affairs and Communications. In these discussions they have studied measures that the government should take for the prompt and smooth introduction of Beyond 5G, and for the strengthening of Japan's international competitiveness.

On the other hand, at the same time that this roundtable started meeting, a worldwide pandemic of the infectious novel coronavirus disease (COVID-19) also began, and this has completely changed the preconditions for people's lives and economic activities. In the battle with COVID-19, teleworking using digital technology, remote conferences, and remote lectures at educational sites are spreading rapidly everywhere. The implementation of these smart technologies is part and parcel of the realization of Society 5.0. However, it has become clear from this rapid growth in the use of digital technology that the provision of ICT infrastructure that underpins the digitalization of society in Japan is not entirely sufficient, and that there is a need to further hasten upgrades of it, make it more resilient, and carry out an institutional review.

The Beyond 5G Promotion Strategy should not be limited to wireless technology strategies for what immediately follows 5G. They are comprehensive and thorough strategies for the systematic development of future ICT infrastructure which include an outlook that encompasses land, the sea, the sky and even outer space, while propelling the advancement and rollout of 5G communications and IoT, and beyond. Furthermore, this approach is a countermeasure against COVID-19, which remains an urgent and critical issue, and it is quite simply preparation for a post-COVID-19 era. In other words, it is necessary under the adversity of COVID-19 to utilize real data in real time, and harmoniously control the behavior of people and socio-economics, through

smartification based on digital transformation. This is in order to accelerate the development of medical treatments, transform the behavior of individuals and ensure the continuation of social and economic activities. For that purpose, it is essential that the concept of data free flow with trust (DFFT) is promoted, and that rules are developed for secure and high-performance data distribution infrastructure and its utilization and application. This is the approach that should be taken in Beyond 5G promotion strategies. As dealing with COVID-19 is an ongoing top priority it is essential to accelerate what can or should be done now. Above all, Japan has a global advantage in laying fiber-optic networks. The top priority should be on upgrades to make the best use of them. The number and density of base stations will be huge for 5G, and also Beyond 5G, and it is necessary to cover the whole country with a finer mesh fiber-optic network to order to connect them. For example, SINET is an academic network that connects universities and research institutions via a dedicated high-speed optical fiber mesh that covers all prefectures. Connecting local schools through SINET would have the significance of not only driving forward remote education, but also helping establish a high-speed digital network in an inclusive manner throughout Japanese society. At the same time, with consideration of the fact that Japan is an island nation surrounded on all sides by the sea, it is necessary to simultaneously develop and enhance technologies to connect not only land, but also the sea, the sky, and even outer space.

It is essential that the government, including the Ministry of Internal Affairs and Communications, fully recognizes the above points, and promptly and strategically implement a deployment strategy with the goal of achieving a Beyond-5G-ready environment, and through industry-academia-government collaboration accelerate the following initiatives: (1) an R&D strategy with the objective of achieving a world-beating R&D environment through intensive investment in advanced technology and bold radio wave liberalization; (2) an intellectual property standardization strategy with the objective of achieving real change by promoting strategic openness and de-facto development, and collaborating with international strategic partners, and; (3) the development of 5G and fiber-optic networks throughout society, and the promotion of industrial and public use through demonstrations of 5G solutions (including domestic rule improvements).

The epidemic spread of COVID-19 has clarified the strategies to be taken. The opportunities opened up by the pandemic have led to a movement around the world to aim for better living and economic growth in this new era, and intensifying international competition, in terms of developing a robust and secure ICT infrastructure that can support people's everyday lives under the new situation of living with COVID-19, and in addition after the end of the pandemic.

Japan should also see the COVID-19 pandemic as an opportunity to be seized to accelerate the creation of a Beyond-5G-ready environment and should hasten the digitalization of the entire society, including the development of robust and secure ICT infrastructure. It is essential for Japan to develop a sense of crisis in terms of not being able to lead discussions on Beyond 5G if Japan is left behind the rest of the world. There needs to be a strong determination to create many successful model cases for the creation of a Beyond-5G-ready environment within five years at the latest.

In the past, despite developing pioneering excellent technology, Japan has failed to capture the growing world market because it did not sufficiently implement global

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expansion. It is essential for Japan to present a vision for a better future society and to develop advanced technologies and systems required by the world market for that vision, and pursue a bilateral global strategy to actively attract world knowledge by making Japan an ideal place as a base for research, development and demonstrations. The results of the leading efforts should be presented to the world as a Beyond-5G-ready showcase by making use of the opportunity offered by the Expo 2025 Osaka, Kansai, Japan.

The Beyond 5G Promotion Strategy Roundtable has formulated national strategies for the promotion of Beyond 5G which take into account opinions received from a wide range of people in Japan and overseas through calls for public comments, and has also held discussions from expert and academic perspectives, of which the main strands are outlined above.

The Beyond 5G Promotion Strategy Roundtable recommends that the government, including the Ministry of Internal Affairs and Communications, actively promotes the attached *Beyond 5G Promotion Strategy—Roadmap towards 6G* under the cooperation of industry, academia, and government, and will continue monitoring the progress of the same.

Beyond 5G Promotion Strategy
Roadmap towards 6G

Introduction

The mobile communications system has generationally evolved from a communications infrastructure to one that forms a foundation for everyone's lives. The fifth-generation mobile communications system (5G), which is being introduced across the world, is expected to evolve into a social infrastructure that will go beyond one that is the foundation for lives. Moreover, Beyond 5G (otherwise known as 6G), which will be the next generation for communications systems, is expected to integrate cyberspace with the real world (physical space), and play a core function as the backbone of Society 5.0.

In the meantime, there has been an explosive spread of the novel coronavirus disease (COVID-19) across the world. People have found themselves forced to rely entirely on ICT due to restrictions on going out, which is typically exemplified by telework, regardless of whether they like it or not. Under such circumstances, it has become clear in Japan that there is a need to further enhance the sophistication and resilience of ICT infrastructure and review institutional systems to support the digitalization of society.

In terms of life under the pandemic, it is necessary to realize an environment in which ICT infrastructure such as 5G can be thoroughly used to smoothly maintain both lifestyles and economic activities. Furthermore, in order to handle the current situation that is being seen through the spread of COVID-19 infections, it is necessary to create a mechanism by which smart solutions can be found via smartification through a digital transformation and by promoting the concept of data free flow with trust (DFFT). Such a mechanism could be one that finds solutions by utilizing big data in real time, and thereby projecting what is happening in physical space to cyberspace. These solutions are also prescriptions for promoting Beyond 5G.

Therefore, a Beyond 5G promotion strategy will serve as an initiative to build a new social system called Society 5.0. Simultaneously, by back casting such a strategy from Society 5.0 it will also serve as an emergency measure against the current globalCOVID-19 crisis, and as measures for a growth strategy after the end of the pandemic.

What is essential here is that Japan should regard the crisis of the COVID-19 pandemic as an opportunity for accelerating the creation of a Beyond-5G-ready environment, and promote the immediate digitization of the entirety of society, including the development of a secure and resilient ICT infrastructure. For example, there is a need to quickly deliver 5G supported by advanced optical networks to approximately 1,700 municipalities nationwide so that secure communications can be utilized for medical treatment and education. Japan cannot lead discussions over Beyond 5G if it falls behind the rapid digitization of society which is happening as a whole on a global scale, and so it is necessary to urgently promote a Beyond 5G strategy.

With consideration of the above, Japan should divide its efforts to introduce Beyond 5G by 2030 into two phases, an "advanced implementation phase" and an

"acceleration phase." In particular, in the advanced implementation phase, intensive efforts should be stepped up within segmented phases, and many successful model cases for achieving a Beyond-5G-ready environment should be developed within 5 years at the latest. In doing so, these efforts should be based on an interactive global strategy so that they do not result in technology which can only be applied in Japan and can't capture the growing world market, and in addition so that the world's wisdom can be brought to Japan.

Japan should take advantage of the chance garnered by the holding of the Expo 2025 Osaka, Kansai, Japan, to reveal its world leading efforts through a "Beyond-5G-ready showcase" and ensure this contributes to the acceleration of global expansion in the acceleration phase.

1.　　Expectations for Society in the 2030s

It is expected that the exchange of data between physical space and cyberspace will increase dramatically in the future toward 2030. With the progress of the integration of cyberspace and physical space (cyber-physical systems (CPS)), physical interactions in physical space will be reproduced in the form of digital data in cyberspace. Utilizing AI to analyze such enormous digital data will make it possible to not only grasp the state of physical space at any one time, but also to make judgements on following actions in physical space based on that information.

If Japan shifts to a data-driven society that maximizes the use of CPS in socio-economic activities, then this will drive new forms of value creation through the use of big data and make it possible to render tacit knowledge concrete, to go from hindsight analysis to future forecasting, and to shift from partial to full optimization. From another perspective, it means that it will be possible to provide goods and services to the people who need them, when they need them, and according to the amount they need. This will represent the realization of Society 5.0, in which economic growth can be managed with the resolution of various social losses and challenges.

It is forecasted that CPS will further develop in line with the introduction of 5G, which has several features such as low latency and a massive number of simultaneous connections in addition to high speeds. In accordance with this, physical space will be reproduced faster and more precisely in cyberspace in the 2030s. Therefore, the functions of physical space will not only be enlarged by cyberspace, but this will create a society which is both vigorous and resilient, and where daily lives and economic activities are fully maintained within cyberspace even if there are unexpected crises in the physical world.

This is expected to enable not only a further improvement in the resolution of social challenges and generate economy growth in Japan, but also to greatly contribute to the realization of the principles outlined in the Sustainable Development Goals (SDGs), such as sustainable, diverse, and inclusive societies where no one is left behind and preserving the earth (environment), as the common foundation for humanity.

The following three elements can be considered as specific objectives for a vibrant and resilient society expected in the 2030s.

The first is **an inclusive society** where everyone can play an active role through the removal of differences, e.g., age and disabilities and also geographical barriers, such

as urban and rural areas and national borders.

The realization of such a society will need, for example, super telepresence technologies that will make it possible to enable people to feel as though they are physically present anywhere in the world through an avatar, or robot, etc., without having to leave their own home. In addition, this society will need super cybernetic technologies that expand physical and cognitive abilities by enabling real-time support for thoughts and actions from cyberspace through wearable devices.

The second is a sustainable society where society can achieve sustainable growth and be convenient, without any social loss, through optimization in cyberspace with real-world reproduction that can be fed back to the real world.

For example, it is conceivable that such a society can be realized with super mutual-control network technologies that make possible traffic systems without traffic jams or the need to wait for signals, by allowing things to exercise mutual control, and ultra real-time optimization technologies that, as an example, will reduce wastage of food products to zero by combining high-precision demand forecasting and real-time multi-location matching using AI.

The third is a dependable society, one which is a human-centered society where bonds of trust are unwavering and everyone will be able to work with peace of mind by autonomously ensuring the safety and stability of communications networks as a social infrastructure.

Such a society will be realized, for example, with super-autonomous security technologies that will ensure security and privacy, without users even being aware of them, through the utilization of AI technologies for automatic detection, automatic defense, and automatic repair, etc., and super fail-safe network technologies which will prevent communication interruptions even in times of disaster by flexibly and autonomously changing network configurations and power consumption and transmission methods.

(Fig. 1: Progress of Cyber Physical System and Society in the 2030s)
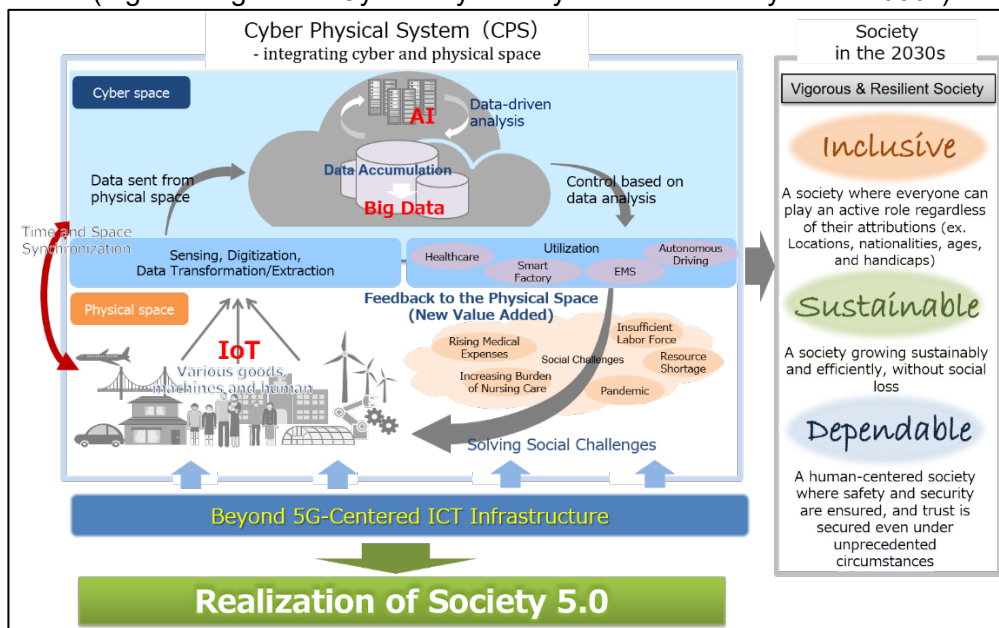
2.   What Beyond 5G Should Look Like

It is necessary to as far as is possible collect the latest data using a range of sensors for events occurring everywhere in physical space, including land, the sea, the sky, and outer space, in order to shift to a data-driven society that will support Society 5.0 and the realization of an **inclusive, sustainable, and dependable** society which is expected by the 2030s, where everyone will be able to play an active role, grow sustainably, and work with peace of mind. This collected data will be stored in cyberspace and analyzed along with past data and data obtained from other sensors. If the analyzed results can be reflected in physical space so as to select a more efficient and effective future, then it will be possible to feed this back to physical space, and convey it to entities such as people and things.

There will be a need for Beyond 5G as a communication infrastructure that is more advanced than 5G in order to safely and reliably realize extremely high-level data synchronization across both physical and cyber space everywhere. In doing so, it will also be necessary to develop advanced optical networks that can support Beyond 5G as a data neural network that encompasses the whole country.

On the other hand, it is expected that the flow of massive amounts of data through such communications infrastructure will cause energy consumption to increase. Consequently, from the viewpoint of promoting the secure flow of data while suppressing its impact on the global environment, it is necessary to adopt an approach of locally produced locally consumed data in Japan's desired Beyond 5G model. In addition, since the challenges to be solved vary from region to region, and additionally the services that are required are not fixed, it will also be necessary that the infrastructure that supports them be highly available, for example, by using software which is capable of flexibly changing functions and configurations according to the problem-solving aim. There is a need for a structural reform of conventional communications infrastructure since it is difficult for it to adequately meet these differing demands.

It is necessary to take into account expected technological trends when considering the ideal Beyond 5G vision. Since high-speed processing is required for devices that function as nodes in conventional communications infrastructure, in most cases this is realized through the utilization of dedicated hardware. However, recent improvements in the performance of microprocessors have made it possible to control general-purpose devices (white boxes) with software and perform processing equivalent to or better than that of conventional dedicated devices. This has made it possible to not only replace dedicated devices, but also to fix bugs and add new functions by updating software, and additionally it enables the speeding up of development and operational flexibility.

Mobile phone networks, including base station access network parts, will be almost wholly virtualized by around 2030, and together with the development of the slicing of services and applications, the surplus capacity of general-purpose devices will become ubiquitous on networks as a shared computing resource. The flexible and autonomous management and control of this kind of resource will become enabled by utilizing AI technologies. Furthermore, the utilization of distributed computing resources will make it possible to perform distributed processing in which data processing for a massive number of devices, and sensors, etc., can be rapidly performed via edge computing

close to users. In addition, this will enable cloud-native environments that can accommodate different telecommunication carriers, and it is predicted that this will lead to the development of functions of communications networks becoming externally opened through application programming interfaces (APIs). This will also permit users to configure communication conditions so that they are optimized for individual user cases.

(Fig. 2: Technology Trends related to Communications Networks)
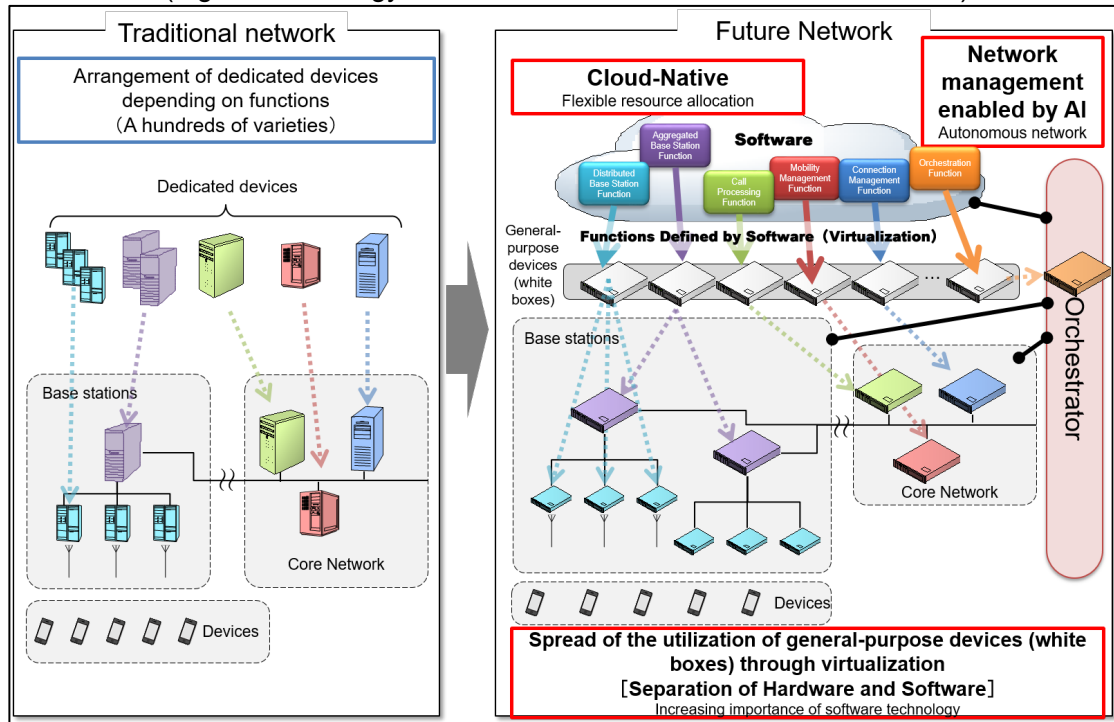
With consideration for the above, the desired Beyond 5G model will need to incorporate four new functions in addition to further enhancements of the specific features of 5G.

(1) Further enhancement of specific 5G features

First of all, enhancing 5G's specific features, and thereby providing additional features, such as **ultra-fast and large capacity**, **ultra-low latency**, and **ultra-**numerous connectivity, will make it possible to process massive amounts of data from any location instantly and accurately.

In light of the expected data processing volumes and the number of communications devices that are expected to be deployed in the 2030s, the target for access speed and the number of simultaneous connections should be 10 times higher than that of 5G. The throughput in Beyond 5G's core network should be 100 times higher than at present. In addition, in order to realize the completely synchronized CPS mentioned above, 1/10th of 5G's latency and a high level of synchronization of the network that supplements it will be required.

(2) New required features

In addition to these continuous evolutions from 5G, Beyond 5G should have the following new features.

- **Autonomy**: A feature that instantly builds optimal networks that meet the needs of users, regardless of whether the connection is wired or wireless, by utilizing AI technologies, and where all devices autonomously coordinate without the need for human intervention (zero-touch).

- **Scalability**: A feature that allows terminals and base stations to connect seamlessly with different communication systems such as satellites and High Altitude Platform Stations (HAPS), and also allows terminals, glass (such as windows), and other various interfaces to become base stations (ubiquitous base stations). This feature will allow communications to be used anywhere, including at sea, in the air, and in space, while enabling devices everywhere to work together.

- **Ultra-security and resiliency**: A feature that enables guarantee of security and privacy, without users even being aware of them, and services remain connected and instantly restore even when there is a disaster or failure.

- **Ultra-low power consumption**: It is calculated that without the development of low-power technologies the IT related power consumption in 2030 will have increased to 36 times as much as in 2016 (which would itself be 1.5 times the total of current energy consumption) [1]. In order to cope with this large increase in power consumption it will be necessary to reduce consumption to one per cent of what it is now.

(Fig. 3: Functions Required for Beyond 5G)

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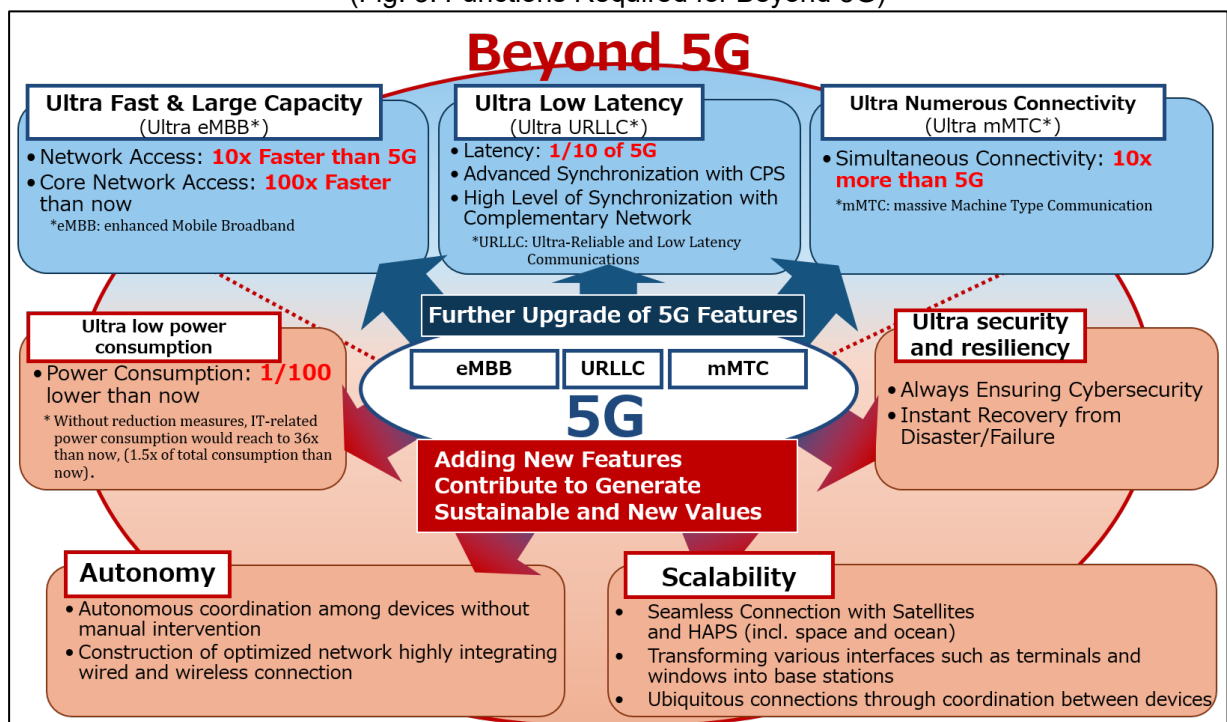
[1] IP traffic was estimated to be 4.7 ZB per year in 2016, and will reach 170 ZB per year (36 times as much) in 2030. There is a certain rationale to assuming that IT-related power consumption and data processing volume are proportional. Therefore, with this in mind, IT-related power consumption may increase by 36 times (41 TWh in 2016 and 1,480 TWh per year by 2030) if low-power technologies are not developed (equivalent to 1.5 times the current annual electricity consumption in Japan, i.e., approximately 980 TWh) (Source: The Japan Science and Technology Agency's Influence of Progress of Information Society on Energy Consumption (Vol. 1), March 2019)

3. Challenges to the Realization of Beyond 5G and the Necessity of Strategic Initiatives

In order to realize the Beyond 5G model that has been set out in the above sections, it is essential to continue to strengthen research and development in the cutting-edge technologies which will be at the core of its excellent features. There is a need to adopt radical concepts when designing a network which are different from conventional ones, for example, using light for signal processing inside integrated circuits or with the precondition of distributed data processing. In addition, as the development of CPS requires higher-precision synchronization between physical space and cyberspace, AIs that only derive optimum solutions cannot be said to be adequate for making appropriate judgments in physical space, and it will be essential to ensure AI accountability. Moreover, in modern times fake news (deep fake) has emerged which makes full use of realistic-looking video images using AI, and it is believed that new social problems, such as ensuring trust in information in cyberspace, will increasingly manifest themselves in the future.

It is necessary to mobilize private sector knowledge to tackle these new challenges. However, active support by the government is also indispensable in effectively accelerating such efforts by the private sector. Given that Beyond 5G will not only be utilized in all organizations and industrial sectors as a fundamental social infrastructure that supports daily lives and economic activities, but will also be deeply involved in national security as the nerve of the socio-economic system, it can be said that initiatives that go beyond the framework of ministries and agencies are critical for the early and smooth introduction of Beyond 5G.

Additionally, with consideration for the hurdles and costs that must be overcome in order to implement Beyond 5G, as well as trends in other countries that are taking an advanced approach to 5G, it can be said that it is impossible that only Japan will achieve Beyond 5G independently. Consequently, it will be necessary from an early stage to create international collaboration frameworks with strategic partners, such as foreign governments and companies that can be trusted and with whom productive synergies can be formed, and engage in international joint research and development and international standardization in innovative elemental technologies necessary for the realization of Beyond 5G.

This means that it is essential to unify efforts by the government and private sectors, and to undertake strategic efforts through international collaboration, to achieve Japan's Beyond 5G model.

4. Beyond 5G Promotion Strategy

4-1. Basic Principles

The purpose of this strategy is the quick and smooth introduction of Beyond 5G, which will form an essential foundation for realizing a vigorous and resilient society in the 2030s. Moreover, it is necessary to strengthen Japan's international competitiveness in the field of Beyond 5G so that this foundation can be trusted and used safely and stably in the future. Specifically, Japan should target the objectives of

having Japanese companies leverage their strengths together with partner companies to acquire about 30% market share in the global market for hardware and software that form the infrastructure for Beyond 5G, and maintain a continuous certain level of presence in the field of devices as well as solutions that utilize Beyond 5G as a platform.

It is critical that Japan becomes a cornerstone of the global open innovation ecosystem in the development and usage of Beyond 5G in order to achieve these two objectives. Based on this point, the three basic principles for the Beyond 5G promotion strategy are: (1) Global first, (2) Building ecosystems that drive innovation, and (3) Intensification of resources.

(1) Global First

In the various activities involved in Beyond 5G, such as R&D and the promotion of its use, it is necessary to recognize that cross-border movement will accelerate to exceed 5G. On top of that, it is essential to always to have a global perspective and pay attention to Japan's positioning, for example, by promoting international cooperation with strategic partners and becoming a bridge between developed and developing countries[2].

For this reason, there is a need to break away from conventional ideas, such as solidifying the domestic market and then expanding overseas, and from the beginning base all efforts on the assumption that the domestic market is a part of the global market, and that services and products, including software and hardware, will be used worldwide. At the same time, Japan should aim to realize bidirectionality in terms of becoming an attractive base for Beyond 5G R&D and field trials so that human resources and ideas gather from all over the world.

(2) Building Ecosystems that Drive Innovation

It is crucial to establish an ecosystem that enables rapid startups and generates innovation, while allowing for risks, in a field where the speed of technological innovation is extremely high. In addition, it is also essential for Japan to become an attractive base for Beyond 5G R&D and field trials, and attract human resources and ideas from across the world. For this reason, this basic principle is for a system design for Beyond 5G R&D, etc., that proactively encourages free and agile efforts by a range of players, for example by minimizing constraints as far as is feasible.

(3) Focused Allocation of Resources

Under the premise that in global collaboration each nation will bring their own strengths, Japan needs to make it so that Japanese players can participate effectively in those collaborations. From this perspective, the government should focus on policies that urgently need to be addressed from the perspective of driving forward Beyond 5G

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[2] The concept of Free and Open Indo-Pacific, which Japan announced at the Sixth Summit of the Tokyo International Conference on African Development (TICAD VI) in August 2016, is an example of a related foreign policy of Japan (The idea of promoting the peace, stability. and prosperity in the region by making the Indo-Pacific free and open internationally for public goods).

efforts, and inject focused resources for fixed periods of time.

With consideration of the above basic policies, the government should implement sub-strategies on R&D, intellectual property and standardization, and deployment, with a view to the early and smooth introduction of Beyond 5G and strengthening international competitiveness.

4-2. R&D Strategy

(1) Basic Concept

It will be essential to develop, advance and standardize wireless technologies, including emerging state-of-the-art technologies which will enable a discontinuous and dramatic evolution in terahertz waves and optics, quantum and Ai, etc., as well as the technologies of networks, low energy, and security, etc., and the underlying software technologies in them in order to realize new Beyond 5G features. Such features include autonomy and scalability, in addition to further upgrading of features specific to 5G such as ultra-fast, and large capacity. In addition, in developing these technologies, it is also necessary to pay attention to achieving price competitiveness.

However, from a global point of view, it is clear that research and development into these technologies are also making progress in the United States, Europe, China and elsewhere. For Japan to have strengths comparable to or superior to those of other countries in as many technological fields as possible, it must identify those fields where it is superior. Then Japan needs to further expand its R&D capabilities in these fields (i.e., to establish stronger technologies), and at the same time to raise the level of the nation's overall R&D capabilities in relation to a wide range of Beyond 5G connected technologies (i.e., to acquire essential technologies).

In other words, Japan has to focus on strengthening R&D capabilities in the technologies where there are pre-existing strengths, and ones that are essential for Japan, in order to secure future international competitiveness in Beyond 5G. Therefore, it is also important to implement focused support, through public expenditure, at the primary and foundational stages of R&D for emerging green shoots before a full-scale race for development starts between countries, however this must be limited to strategically important technologies[3]. In addition, in this regard it is essential to promote international joint R&D projects for innovative emerging technologies in collaboration with strategic partners.

In order to raise these green shoots in state-of-the-art technologies, and operationalize them as global pioneers, it is extremely important to proactively draw on diverse human resources, including from venture companies and other fields, as well as maintain an environment in which R&D can be freely pursued and where leaders are cultivated.

Further to this, it is necessary to learn from past examples where Japanese companies won technological races, but where this did not necessarily lead to victory in markets, and to take action under the global first principle with a view to commercializing developed emerging technologies by private companies, and competitively package them. For this reason, a system, plan and strategy for acquiring

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[3] The strategically essential technologies will be decided with consideration of a new ICT strategy (scheduled to be formulated in the summer of 2020) by the Information and Communications Council.

intellectual property, and dominating both domestic and overseas markets, must be set, in particular in regard to R&D by the government, and then followed through with.

Furthermore, R&D projects implemented by the government need to consider and reflect reforms for operations so that they have a more strategic and flexible implementation (by increasing their scale, making execution more flexible (flexible plan changes, and budget revisions, etc.), and strengthening support for initiatives associated with intellectual property, and international standardization strategies, etc.).

(2) Objectives

The world's best Beyond 5G R&D environment needs to be realized through intensive investment in needed and strategically important state-of-the-art technologies, and the relaxation of regulations related to the radio spectrum, in order to make Beyond 5G a reality. This would enable Japan to capture the world's knowledge and strengthen both R&D and manufacturing bases, and thusly lead to the establishment of emerging technologies in stages from 2025 and be reflected in international standards at the 3rd Generation Partnership Project (3GPP) and elsewhere. Through such efforts, we aim to competitively package developed technologies.

(3) Specific Measures

It is relevant to focus on essential core Beyond 5G technologies which are essential for realizing the following features that Beyond 5G should have: (1) Ultra-high-speed and large capacity, (2) Ultra-low latency, (3) Ultra-simultaneous Connectivity, (4) Autonomy, (5) Scalability, (6) Ultra-security and resiliency, and (7) Ultra-low power consumption.

The fields and technologies shown in Fig. 4 are examples which include areas where Japan has strengths or is actively engaged in R&D, and which require particularly focused R&D, regardless of industry-academia-government collaboration.

(Fig. 4: Examples of Technologies that Should be Prioritized for R&D)
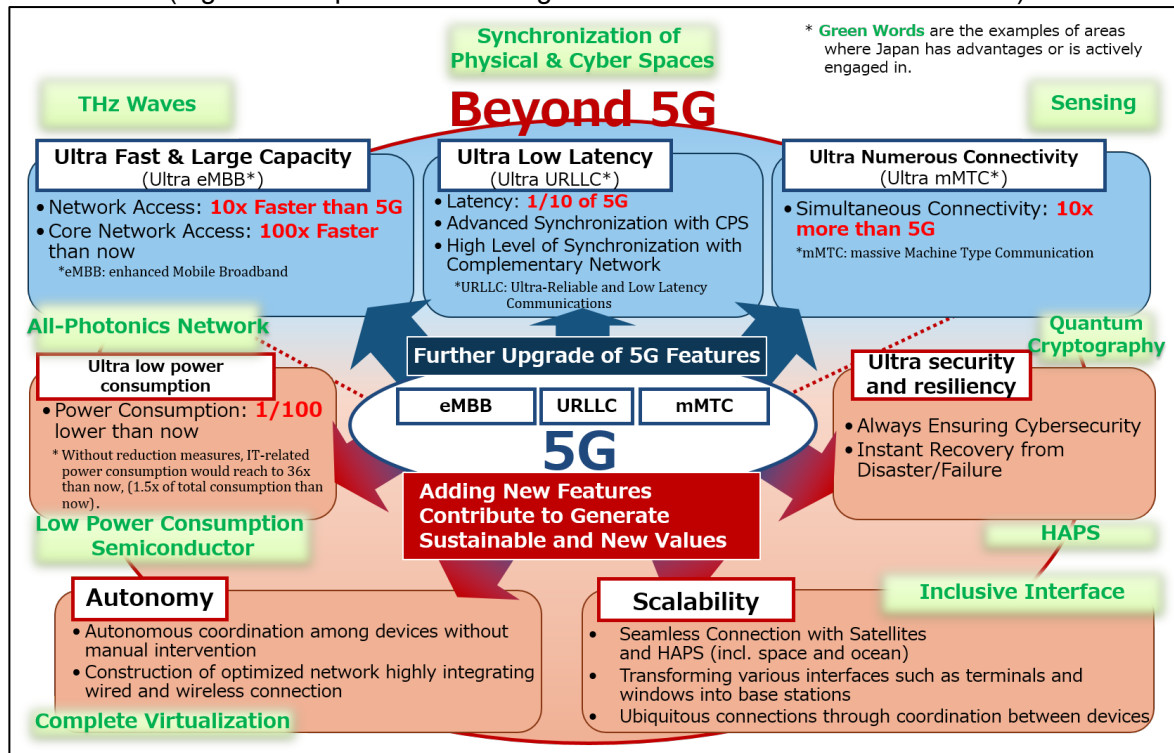
R&D for Cutting-edge Emerging Technology Utilizing R&D Platforms

Among the core Beyond 5G technologies listed in Fig. 4, it would be appropriate for relevant ministries and agencies to cooperate and intensively promote R&D for strategically essential emerging technologies which are national priorities for fixed periods of time. In this regard, there are several concrete measures which should be followed through in order to effectively promote R&D into cutting-edge emerging technologies. Namely, to collaborate with research units such as SINET[4] and the supercomputer Fugaku and funding programs[5] for young researchers, together with establishing, and a Beyond 5G R&D platform[6] at the National Institute of Information and Communications Technology (NICT) and elsewhere, and by providing a diverse range of domestic and overseas players with a sophisticated research environment, including testbeds for radio wave emulators, promote joint research, etc., that utilizes this environment (to be constructed and put into operation between FY2021 and FY2026).

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[4] An academic information network operated by the National Institute of Informatics (NII) and connected to more than 900 universities and research institutions throughout Japan.

[5] Implemented through the Strategic Creative Research Promotion Project of the Ministry of Education, Culture, Sports, Science and Technology and the Strategic Information and Communications Research and Development Promotion Project of the Ministry of Internal Affairs and Communications.

[6] The Fraunhofer-Gesellschaftof Germany developed an electric wave emulator for 5G for European urban areas. The US Defense Advanced Research Projects Agency (DARPA) also developed a radio emulator called the Colosseum, which can set various environments, such as cities and deserts. These emulators have been used to demonstrate new wireless systems.

(Fig. 5: Ideal Beyond 5G R&D Platform)
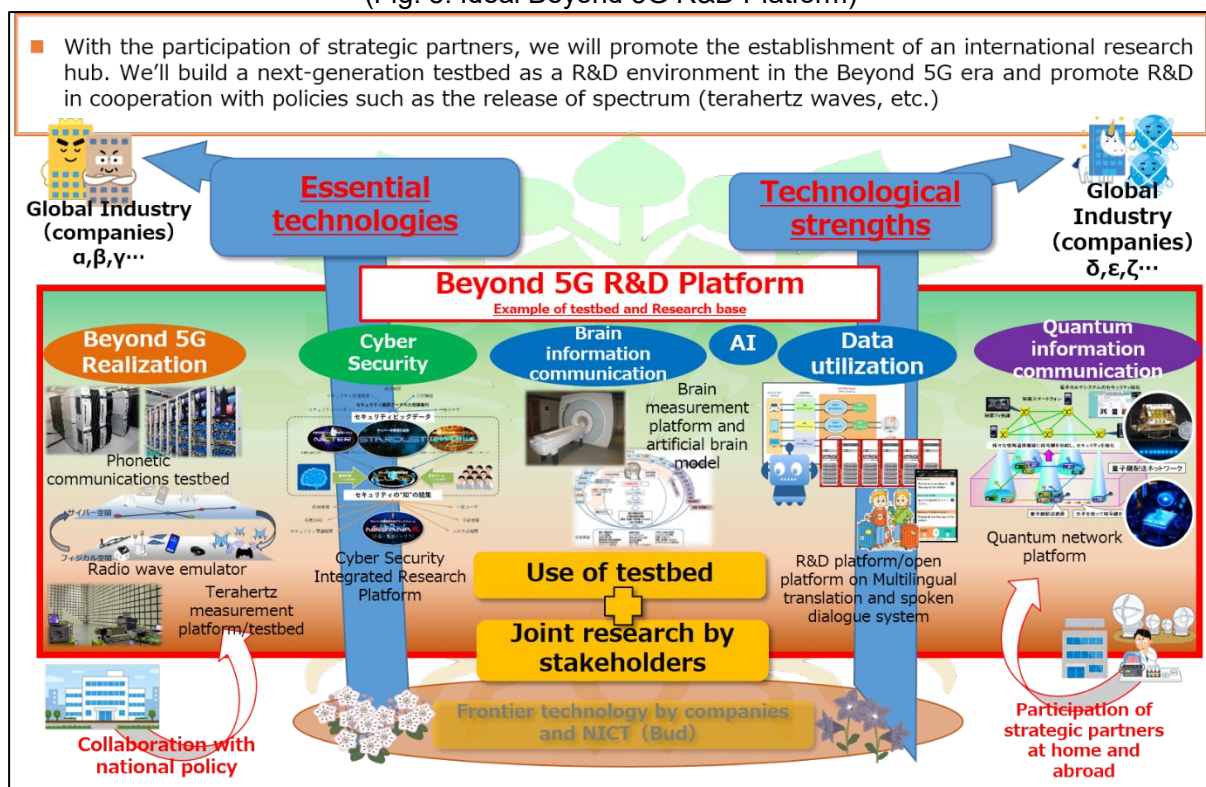
Strengthening Development and Manufacturing Bases

There is a need to maintain and strengthen development and manufacturing bases in Japan from the stage of 5G so as to have a national technological superiority in Beyond 5G, and to reduce supply chain risks in terms of equipment and devices.

To this end, this strengthening of development and manufacturing bases[7] is being tackled by developing core technologies for information communication systems that support the enhancement of 5G features (Implemented from FY2019).

In conjunction with this, the government will introduce a system[8] for appropriately certifying the development and supply of equipment and devices that meet the requirements of security, resiliency and openness in order to promote the stable supply of the same (under system development in FY 2020).

Support through R&D Tax System

In addition to support for R&D, whether public or private, whether digital related R&D is sufficiently supported under the R&D tax system will be verified, and necessary revisions made in order to actively support R&D by the private sector (to be implemented from FY2021).

Opening up of Radio Frequencies

Beyond 5G is expected to utilize frequency bands, such as terahertz waves (in

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[7] Typically implemented through the Post-5G Information and Communication System Enhancement R&D Project of the Ministry of Economy, Trade and Industry and the R&D for Further Advancement of 5th Generation Mobile Communications System of the Ministry of Internal Affairs and Communications.

[8] Act on Promotion of Developing/Supplying and Introducing Systems Making Use of Specified Advanced Information Communication Technologies (Act No. 37 of 2020)

frequency bands of approximately 100 GHz or higher), that are higher than the frequency bands currently allocated to 5G. Therefore, it is essential that the development of technology that utilizes these bands is strongly promoted. On the other hand, the current utilization of radio waves in these high-frequency bands has not seen any progress. Moreover, terahertz waves have strong rectilinear propagation and are subject to significant atmospheric attenuation with distance compared with low frequency bandwidth, therefore, it is believed that these waves are less likely to have a serious adverse impact on other radio stations. With these points in mind, a mechanism[9] is being developed by which, as a general rule, the high frequency bandwidth spectrum, such as terahertz waves, can be easily used for fixed periods using a simple procedure until the actual operation of Beyond 5G starts (system development to be completed by the end of 2022).

Furthermore, there is a need to enable licensees to flexibly establish and change radio stations for research and development and experiments within a range that does not cause significant interference with other radio stations, even in non-high frequency bandwidth, in order to promote technological developments for Beyond 5G.Consequently, the procedures for obtaining and changing an experimental radio station license will be significantly eased for experiments conducted under specific conditions. These conditions include the scale of the experiments, the output of the radio station, the installation location of the radio equipment, the frequency bands used, and the management system, etc. (to be promptly reviewed, and measures taken in order of availability).

Creating Disruptive Innovation and Developing Human Resources

There is an urgent need to discover and develop ideas and human resources that can cause disruptive innovation in anticipation of Beyond 5G, and thereafter, in order to gain an advantage in the development competition for the above mentioned technologies, as well as advanced technologies that will enable discontinuous and dramatic evolution. For this reason, a wide range of advanced research environments, such as radio wave emulators, should be opened up, and a Wireless Challenge (tentative name) should be issued as an open call for public solution-type research[10] with strong incentives to be won, such as prize money and research and development awards. Support must be given for the strengthening developing technologies, particularly those where Japan has strengths or which are considered essential to Japan, and for the creation of disruptive innovation that will effectively and promptly industrialize these technologies. This can be achieved by uncovering innovative technologies based on innovative ideas and by supporting efforts to commercialize and market them. In implementing these efforts, it will be necessary to make them topical and involve a large number of young wireless human resources at universities and technology colleges. By doing so, it will be possible to aim for an expansion in the base of R&D for Beyond 5G, support the future development of Beyond 5G, and develop and produce human resources who can play an active role in the world (to be implemented from FY2021).

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[9] In March 2019, the US Federal Communications Commission (FCC) created a new type of experimental station license to use 95 GHz to 3 THz for up to 10 years (some bands can be used without a license).

[10] In September 2019, DARPA in the United States held the Spectrum Collaboration Challenge (SC2), in which DARPA's Colosseum was used to compete for the development of efficient high-speed radio communication technology. Two million dollars was given to the winner.

4-3. Intellectual Property and Standardization Strategy

(1) Basic Concept

Efforts aimed at intellectual property and standardization, and then capturing domestic and overseas market share, are based on the self-help efforts of private companies which are the direct beneficiaries. However, given that Beyond 5G is a social infrastructure that supports people's lives and economic activities, and that intellectual property and standardization have far-reaching effects beyond those of private companies, the government needs to play an active role in cooperation with the private sector from the perspective of ensuring that the technical requirements necessary for realizing Japan's ideal Beyond 5G is adopted as an international standard, and is beneficial to Japan's security and industrial development.

The international standardization of intellectual property should attach importance to: 1) The realization of an all-photonics network, 2) The adoption of open architecture, 3) Maximum virtualization by software, 4) An expansion to areas beyond land, such as the sky and the ocean, and 5) The drastic reinforcement of security.
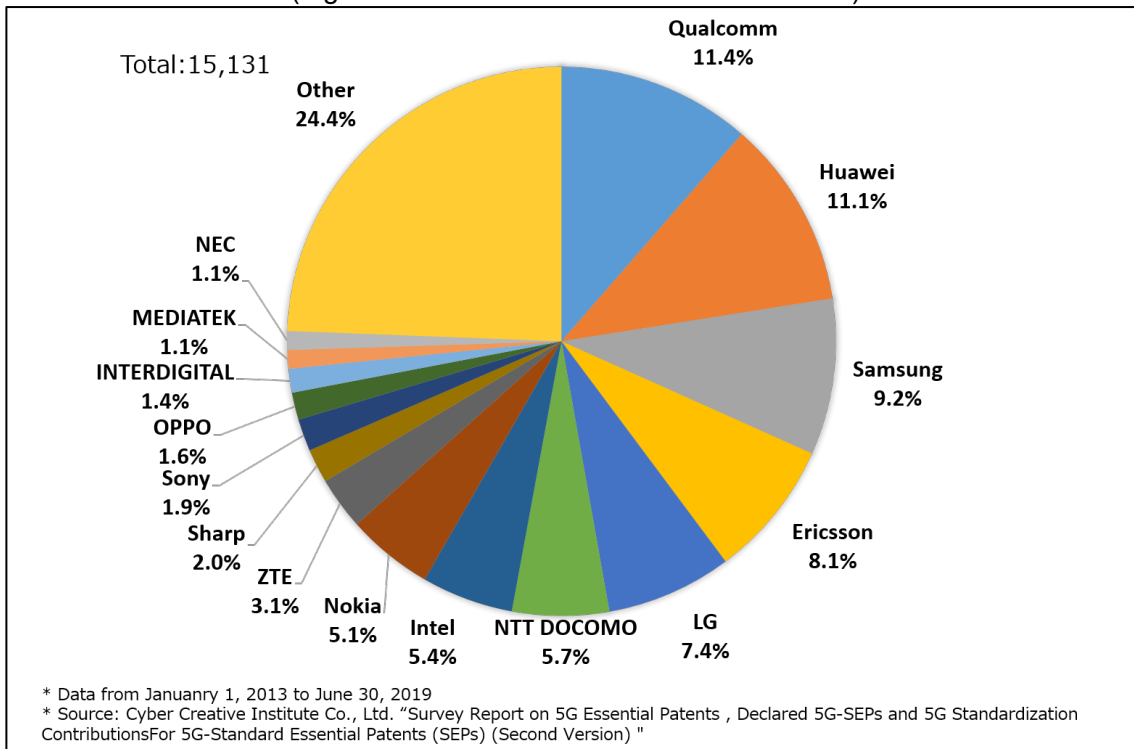
Efforts for the standardization and implementation of intellectual property should be carried out in close cooperation with strategic partners. In this regard, in order to secure Japan's influence, it is not enough to simply develop superior technology. It is also essential to expand the involvement of Japanese stakeholders in standardization activities and secure related intellectual property, and therefore, related ministries and agencies need to collaborate and drastically review existing intellectual property and standardization strategies.

(2) Objectives

For this purpose, technical requirements based on research and development results must be reflected in international standards at the 3GPP and the International Telecommunication Union (ITU) starting from around 2025, along with the objective of reducing supply chain risks and creating market entry opportunities in the Beyond 5G market. To this end, a framework for collaboration with strategic partners must be established as soon as possible, and an objective must be set out to obtain the top share of Beyond 5G essential patents in the world in 2030. The share would be at least 10%, around the same as that of foreign competitors in 5G essential patents,[11] so as to secure international competitiveness and bargaining power. In addition, the acquisition of related peripheral patents should be promoted.

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[11] The world's top shares of 5G essential patents (patents related to technology that must be used when offering products and services to meet international standards) are occupied by Qualcomm (US) (11.4%), followed by Huawei (China) (11.1%), and Samsung (South Korea) (9.2%). (Source: Cyber Creative Institute)

(Fig. 6: Number of 5G Essential Patents Held)

* Data from Januanry 1, 2013 to June 30, 2019
* Source: Cyber Creative Institute Co., Ltd. "Survey Report on 5G Essential Patents , Declared 5G-SEPs and 5G Standardization ContributionsFor 5G-Standard Essential Patents (SEPs) (Second Version) "

(3) Specific Measures

Strategic Identification of Intellectual Property and Standardization Areas, and Promotion of Open, and De-facto Standards

With regard to technologies for which Japan has strengths, there is a need to strategically assess the necessity for standardization and the acquisition of intellectual property, and take into account relevant product development and market trends, while paying attention to the perspective of open innovation, in which the bold opening and modularization of technologies accelerates new collaborations with other parties, and markets that can't be imagined by individuals can be created and acquired. For this reason, in national R&D projects, in particular, Japan should revise the evaluation tendencies that give importance to past standardization results, and consider setting more strategic goals (to be implemented in sequence from FY2021).

Furthermore, it is essential to promote standardization and implementation by reducing time and financial burdens required for device development for open, de-facto standardization in the Beyond 5G market. For this reason, the government should develop an interconnected/interoperable testbed between different vendor devices and an emulator that reproduces physical space in cyberspace, and make them accessible to private companies inside and outside of Japan[12] (to be built and operated from FY2021 through FY2026).

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[12] The facilities of Beyond 5G R&D Platform (tentative name) as described in 4-2.(3) should be also used.

Furthermore, the global expansion of the private sector (e.g., O-RAN Alliance[13], IOWN Global Forum [14], and HAPS Alliance [15]) should be supported through intergovernmental discussions and meetings of international organizations in order to promote the implementation and standardization of Beyond 5G open architecture, virtualization, and all-photonics networks (Implemented in sequence from FY2020).

Creation of Frameworks for Cooperation with Strategic Partners

International collaborative research should be expanded with companies in partner countries from the R&D stage in order to establish strong international collaboration toward international standardization. Bridging needs to be achieved, for example by encouraging emerging countries to participate in the standardization process, in order to expand results for the above and use cases in emerging countries, and contribute to problem-solving. (to be implemented in sequence from FY2021).

In addition, a cooperation framework needs to be strengthen between influential standardization and implementation organizations such as the European Telecommunications Standards Institute (ETSI), the National Institute of Standards and Technology (NIST), and the Institute of Electrical and Electronics Engineers (IEEE), etc., and Japanese private standardization organizations such as the Association of Radio Industries and Businesses (ARIB) and the Telecommunication Technology Committee (TTC), etc., in order to strengthen cooperation with the EU and the US in standardization (being implemented in sequence from FY2020). Also, under industrial-academic-government cooperation, collaborative work with related countries should be promoted to achieve an internationally harmonized allocation of frequencies at the World Radio Conference (WRC) and realize the establishment of ITU Radiocommunication Sector (ITU-R) recommendations (to be implemented in sequence from FY2021).

Use of Standardization Bases and Promotion of Activities for Strategic Intellectual Property Standardization

The Beyond 5G Intellectual Property and Standardization Strategy Center (tentative name) will be set up as a core organization where major players from industry, academia, and government sectors can participate and strategically engage on standardization, and promote the following efforts (Established in 2020, to be fully operational from FY2021).

- Provide a forum for discussions to fulfill the role of being a control tower function for standardization strategies, including IP strategies.

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[13] O-RAN Alliance (O-RAN stands for Open Radio Access Network): An organization established in February 2018 to promote the opening of mobile network equipment. As of April 2020, it includes 23 telecommunications carriers from around the world and 152 vendors, including NTT Docomo, KDDI, and SoftBank.

[14] IOWN Global Forum (IOWN stands for Innovative Optical and Wireless Network): An organization established in October 2019 with the aim of promoting the realization of a new communication platform consisting of all-photonics networks and distributed computing. The IOWN Global Forum was established by NTT, Intel, and Sony, and 10 telecommunications carriers and vendors are participating as of April 2020.

[15] HAPS Alliance (HAPS stands for High Altitude Platform Station): An organization established in February 2020 to promote the utilization of HAPS technology to provide communication networks from the stratosphere. As of April 2020, 12 telecommunications carriers and vendors are participating, including Softbank-affiliated HAPS Mobile and Google-affiliated Loon.

- Plan intellectual property and standardization strategies and monitor progress (including evaluation and improvement).

- Create and provide an effective intellectual property landscape (i.e., IP maps that incorporate market trends and R&D trends in all countries) to contribute to IP strategies for corporate management.

- Promote standardization activities by a team that includes domestic and foreign personnel with excellent diplomacy and coordination skills, including technical and business experts and those who have experience chairing meetings, and securing and maintaining personnel who can support standardization activities to help lead discussions in international standardization bodies.

- Study the effective use of experts who specialize in the fields of intellectual property, legal affairs, and business strategy planning and who are also specialists in the ICT field, and in addition medium- to long-term training measures for the same.

- Promote standardization activity participation by new players, such as companies and over-the-top (OTT) ventures who will become primary Beyond 5G users, the establishment of new forums, and the formation of international forums, etc.

- Promote the participation of private companies in the Beyond 5G R&D Platform.

In addition, when adopting research and development projects or allocating new radio frequencies to telecommunications carriers (e.g., for approving a plan to open a specific base station), the adoption of telecommunications equipment based on an open architecture standard as a condition should be considered. At the same time, other conditions should be set, such as contributing to international standardization and the strategic acquisition and utilization (e.g., efforts toward the formation of standard essential licensing and intellectual property portfolios) of intellectual property (to be implemented in sequence from FY2021).

4-4．Deployment Strategies

(1) Basic Concept

It is necessary to prepare a "Beyond-5G-ready" environment[16] in which 5G has permeated all fields and regions and is thoroughly utilized in order to achieve an early and smooth introduction of Beyond 5G.

As with 5G, Beyond 5G envisions a variety of network configurations, which include: (1) A nationwide commercial network of mobile phone operators, (2) Local networks flexibly constructed and operated by various entities, such as local companies and local governments, according to the individual needs of each region and industry, and (3) Medium-scale networks where various local networks are used in cooperation with each other.

In terms of solving various social challenges in the Beyond 5G era, it is necessary

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[16] An environment where everyone has the necessary literacy and can fully enjoy the benefits of Society 5.0.

to create use cases (utilization models) that take into account the diversity of these network configurations. It is important to integrally expand networks (on the supply side), and build and expand use cases related to industrial and public use (on the demand side) with a view to the future, including the rollout and expansion of 5G.

In this regard it is necessary to make maximum use of the capabilities of universities and companies, while keeping in mind from the beginning that global utilization and application will solve various challenges facing the world's nations and regions, and that Beyond 5G is based on security-by-design, privacy-by-design[17], and universal design[18].

(2) Objectives

The acceleration of the deployment of 5G and optical fiber networks throughout the nation, while simultaneously intensively implementing the needed environmental improvements to build and expand use cases that contribute to solving problems and establishing and disseminating impactful, user-oriented (based on the perspectives of the user) domestic and overseas use cases, are needed in order to realize a Beyond 5G-ready environment by 2030. Achieving this would create an additional value of 44 trillion yen in the economy in fiscal year 2030[19].

(3) Specific Measures

Development of 5G and Optical Fiber Networks throughout the Nation

Policy measures should be fully utilized, for example the institutional development of a 5G investment promotion tax system, 5G area development support system, and technical standards, etc., and early area development in all municipalities should be aimed for. The development of 5G networks that will support a Beyond-5G-ready environment should be actively promoted by developing more than approximately 210,000 5G base stations, which is three times the number set under the initial development plan (to be developed around the end of FY2023).

Specifically, the following efforts will accelerate the launch of 5G services nationwide:

- Support for the accelerated construction of 5G base stations in advance 5G investment promotion tax system (being implemented from FY2020).

- Financial support to promote the development of 5G in disadvantaged areas where voluntary development by mobile phone operators tends to be slow (being implemented from FY2020).

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[17] The idea is to create cybersecurity and privacy for information and communications systems from the planning and designing stage.

[18] The idea is to design facilities and products that are easy for anyone to use so as not to create new barriers. (Source: The Outline for the Promotion of Barrier-Free and Universal Design of the Cabinet Office (March 2008))

[19] It is estimated that GDP will increase by about 44 trillion yen (+7%) at the end of fiscal 2030 by activating efforts to improve productivity using wireless, assuming that the economy will stay at its current potential growth rate. (Source: Report of the Growth Strategy Roundtable Meeting on Effective Use of Radio Waves, the Ministry of Internal Affairs and Communications (August 2018))

- Financial support to promote the development of optical fibers that will support 5G in all areas that municipalities desire (implemented from FY2019).

- Securing new 5G frequencies that are indispensable for realizing various advanced services that utilize 5G (institutional development by the end of FY2021 at the latest).

- Realizing the broad coverage of 5G by making frequencies currently used in 4G available in 5G (Institutional development by the end of FY2020 and sequential base stations expansion).

Fig. 7: Overview of 5G Investment Promotion Tax System

To implement safe and reliable 5G facilities, investments in 5G facilities according to the Approved Introduction Plan which is based on the provisions of the Act on the Promotion of the Development, Supply, and Introduction of Specified Advanced Information and Communications Technology Utilization System, are eligible for tax deductions or special depreciation (temporary 2 year measure).

Supporting Scheme based on New Legal Framework

Specified Advanced Information and Telecommunications Technology Utilization System Introduction Plan (tentative name)

Competent Minister — Accreditation

Accreditation Criteria – Three Requirements
① Security/Trustworthiness
② Stability of Supply
③ Openness (International Alliance)
* Linked with information on the Approved Development and Supply Plan submitted by development and supply corporations (vendors)

Supporting Measures
· Special Provisions for Taxation
· Financial support such as the "two-step loan"

Competent Minister — Confirmation

Special Provisions for Taxation

Standards for Confirming Early Dissemination and Stability of Supply
· Base stations introduced ahead of installation schedule of nationwide 5G carriers
· Higher stability of supply
Important Equipment
· Advanced equipment for base stations in nationwide 5G
· Important equipment to build systems

Corporations — Plan

Details of Special Provisions for Taxation

● Investments in 5G facilities according to the Approved Introduction Plan would be able to be applied following measures.
① Corporate Tax, Income Tax

Target Entities	Facilities	Tax Deduction	Special Depreciation
Nationwide 5G Carriers	Machinery, etc.	15%	30%
Local 5G Licensees	Machinery, etc.	15%	30%

(Note) Tax Deduction is for at most 20% of corporate tax per fiscal year.
② Fixed Property tax (limited to Local 5G licensees)
Cut Tax Base by 1/2 for 3 years

Target Facilities
· Nationwide 5G (Advanced base stations introduced ahead of installation schedule of nationwide 5G carriers)
Transmitting and Receiving Equipment, and Antennas
· Local 5G
Transmitting and Receiving Equipment, Antennas, Communication Modules, Switching Facilities, and Optical Fibers
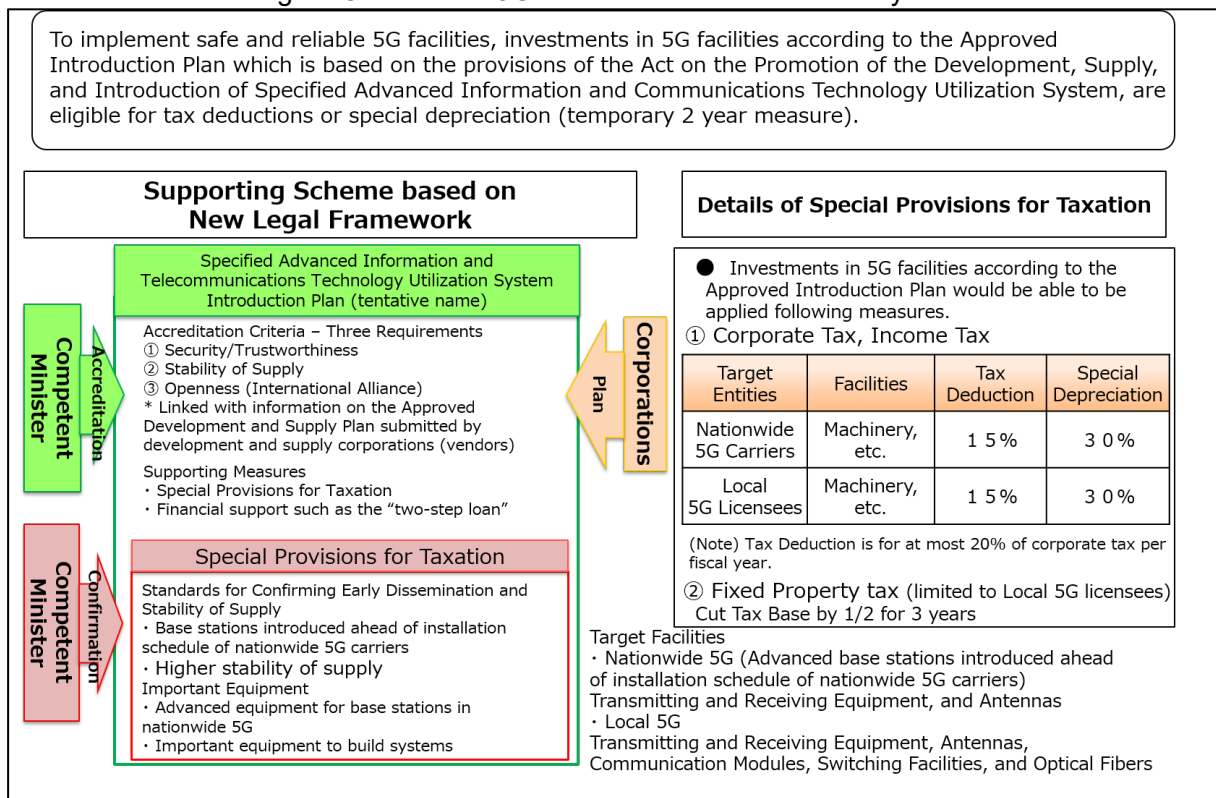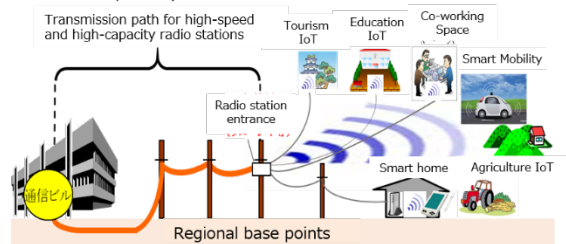
Fig. 8: Outline of Financial Support for Promoting 5G Development

Promotion of the ICT infrastructure through the support of a 5G and fiber optic nationwide network

① Partial subsidies for telecommunication carriers who install optical fibers, which is a prerequisite for high-speed/large-capacity wireless stations, in geographically unfavorable areas, in order to realize an advanced wireless environment such as 5G/IoT (Promotion of advanced wireless environment)

② Partial subsidies for local governments who install base station facilities to enable use of mobile phones, or for wireless communication operators who install advanced facilities such as 5G base stations, in areas where geographical conditions are unfavorable (area development for mobile phones)
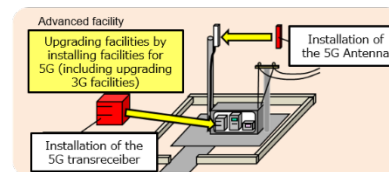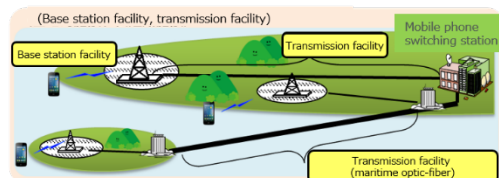
Also, the introduction of local 5G in various places and applications should be promoted through the following efforts.

- Local 5G maintenance support under a 5G investment promotion tax system (being implemented from FY2020).

- Expansion of frequency bands for local 5G (institutional development in FY2020).

- System development to enable flexible technical specifications and the operation of local 5G according to individual use cases (system development in sequence from FY2021).

Furthermore, there should be encouragement for infrastructure sharing, in which network facilities, such as base station equipment, are jointly developed by multiple network operators based on the Guidelines on Application Relationships of the Telecommunications Business Act and the Radio Act concerning Infrastructure Sharing in the Mobile Communications Field (published in December 2018), in order to propel the development of 5G areas, including rural areas, nationwide. Therefore, from FY2020, not only should R&D on technologies to share radio equipment at 5G base stations be put into practice, the installation of base stations on utility poles, including traffic light poles, at locations where there are physical limitations and the use of shielding countermeasures, such as tunnels, etc., by private sharing operators should be expanded.. Moreover, systems should be developed so that the devices of individuals, cars, smart poles, signs, and manholes, etc. can be used as base stations (being implemented in sequence from 2020).

At the same time, technology should be developed for the integrated operation of data centers dispersed in rural areas as a vast virtual cloud, while ensuring security, in order to facilitate the local production and use of growing data in rural areas and so as

to provide stable high-quality services[20] (being implemented from FY2020).

Realization of Constant Cybersecurity Functionality

With the development of CPS it will become necessary to consider cybersecurity in terms of taking a perspective that cyberspace and physical space as continuous and without boundaries. Furthermore, networks will be required to have functionality to maintain security continuously without boundaries, from the cloud to edge computing and devices. It is from these considerations that cybersecurity for 5G and Beyond 5G should be developed and maintained.

Guidelines should be established to ensure 5G and Beyond 5G cybersecurity, and to show the concepts for appropriate cybersecurity measures according to use cases and risks including breach of personal information. Further to this, when technical requirements related to communications networks are newly formulated there should be consideration for security-by-design and privacy-by-design, this is so that various communication services can be used safely, stably, and reliably (to be studied from FY2025 with consideration for the timing for the introduction of Beyond 5G).

While taking into account the advanced ICT implementation environment of the 2030s, and giving due consideration to the concepts of security-by-design and privacy-by-design, studies in cooperation with a wide range of stakeholders should be hastened on the ideal approach to an open, interoperable, reliable, and secure Internet which is based on the current Internet Protocol (TCP/IP), and on the architecture that realizes it. Bearing in mind that the results of these studies will be proposed to organizations such as the Internet Engineering Task Force (IETF), the way forward should incorporate cooperation with relevant parties to support human resources that can play an active role internationally and to push ahead with the implementation of related technologies and standards, etc (to be implemented as needed from 2020).

Furthermore, technologies for detecting tampering and vulnerabilities in real time, and using AI automatically detect, analyze, and prevent cyberattacks, should be developed since it is necessary to deal with cyberattacks that are becoming more sophisticated year by year. Moreover, intellectual infrastructure should be built under industry, academia and government collaboration to aggregate cybersecurity information on a large scale basis, and conduct cross-sectional analysis, in order to ensure safety and reliability (to be implemented as needed from 2020).

Moreover, robust post-quantum cryptography (PQC) for the age of quantum computing should be developed and tested, and together with the formulation of guidelines for PQC, etc., in line with a review of the CRYPTEC cipher list (e-government recommended cipher list), the social implementation of a quantum cryptographic system should be promoted through the rollout of quantum cryptographic devices (the guidelines for PQC are to be formulated by the end of FY2022, and the social implementation of quantum cryptography systems should be promoted from FY2025).

Furthermore, the implementation of needed technologies and standards in the communications field should be facilitated in order to ensure that communications

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[20] The Ministry of Economy, Trade and Industry subsidizes expenses of business related to the technology for integrated management of data centers distributed in rural areas and the R&D of parallel processing technology for highly efficient networks.

services can be continuously used even in the event of a cyberattack or a disaster, with an emphasis on services that require ultra-security and resiliency (to be studied with consideration for the timing of the introduction of Beyond 5G in or after 2025).

Building and Expanding Use Cases Contributing to Problem Solutions
Construction of Various Use Cases

We should build and expand use cases that truly contribute to solving social challenges in Japan. Therefore, problem-solving demonstration projects should be implemented that utilize 5G in a user-oriented form to ensure diversity and to build various use cases (including business models that are preconditions for spreading use cases), in order to realize a Beyond-5G-ready environment in which 5G has permeated all fields and regions and is thoroughly utilized(being implemented from FY2020).

the number of hurdles for small and medium-sized enterprises, and local governments, etc., to start using built use cases need to be significantly reduced in order to promote their horizontal deployment, and to digitize local industries (for digital transformation). For this reason, a mechanism called the 5G Solution Provision Center (tentative name) should be established with the function of being an innovation hub that enables the inexpensive and easy use of business models and use cases via a cloud-based (SaaS) common platform and edge computing. In conjunction with this, the modularization of each type of function in smart cities that utilize and apply data should be stepped up, and intercity cooperation and the nationwide expansion of smart cities should be promoted (being implemented from FY 2020).

(Fig. 9: Example for the 5G Solution Provision Center (Tentative Name))
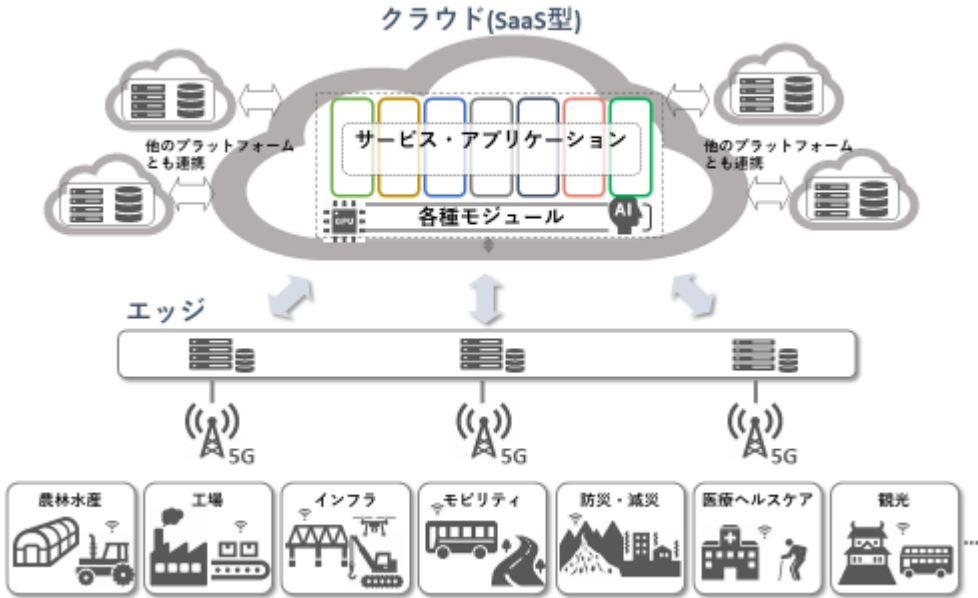
At the same time, environmental improvements, including technical requirements for promoting cloud utilization in local and small and medium-sized enterprises, and R&D on the security and stable operation of cloud services in times of disasters should be

promoted[21] (being implemented in sequence from FY2020).

Promotion of Utilization of Living Testbeds

There is a need to propel forward environmental improvements to enable the free and flexible implementation of bold demonstrations using data distribution and utilization for Beyond 5G, based on the principles of security-by-design and privacy-by-design, simultaneously, and in cooperation with companies and local governments, a framework for smart cities and super cities should be utilized as a living testbed[22] for whole cities and cooperation with ICT specialist universities should also be obtained. To this end the establishment of a system to solve social challenges under a community-based model, and in cooperation with local universities, local business circles, and administrative agencies, should be promoted. This system would enable regional projects for the realization of a data-driven society, which utilizes data collected and accumulated by 5G, etc., to be developed and deployed, and provide for the training of young and creative human resources to support the projects (to be implemented promptly from FY2021).

Global Deployment of 5G Infrastructure Solutions

From the perspective of both achieving economic growth and solving social issues, including emerging economies that are in the process of infrastructure development, it is believed that there is a great need around the world for solutions in IoT, agricultural ICT, and telemedicine, which have the potential to be provided with a high level of quality through 5G. Therefore, in conjunction with domestic development target countries and regions should be selected for immediate action based on the infrastructure development conditions that are the prerequisite for 5G, and the public and private efforts in the target countries and regions should be kept pace with. Moreover, in cooperation with finance support organizations[23] intensive research and demonstrations should be carried for solutions that can conceivably meet local needs in terms of both price and function (including support for infrastructure development when necessary) for about three years. Furthermore, successful cases, and those with potential for development, should be used as reference models to explore the possibility of their utilization in other countries (and regions), as well as Japan (started in FY2020).

The appropriate stepping up of cooperation with developing target countries in the deployment of infrastructure and solutions using 5G, and a future Beyond 5G, and the effective implementation of research and demonstration tests, along with the building of cooperative relationships, in target countries and regions are indispensable in terms of having human resources who are familiar with the situation in said targets, and that can propose infrastructure and solutions which match needs. Therefore, the participation of diverse relevant officials in the Digital Overseas Development Public-

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[21] Implemented through a number of programs, including the Project for the Development of Distributed Cloud Technology of the Ministry of Economy, Trade and Industry, the Operating Cost Grant of the Information-technology Promotion Agency (IPA).

[22] A testbed should be a place where residents actually live and social and economic activities are performed.

Unlike verification in a laboratory, verification as close as possible to actual services will be possible.

[23] Assumed to be a government-affiliated organization that supports overseas expansion in terms of finance, such as the Fund Corporation for the Overseas Development of Japan's ICT and Postal Services Inc. (JICT).

Private Council (tentative name), which is a consultative body which consists of public and private officials and which has the objective of promoting overseas expansion, should be encouraged, and efforts in securing and developing human resources should be made by by registering advisors who give advice on overseas operations (started in FY2020).

Furthermore, large ICT companies do not always provide reasonable infrastructure solutions. It is essential to discover and collaborate with small and medium-sized ICT companies, such as BOP businesses[24], for overseas and promising startups that create business innovation. To this end, a new mechanism to support the implementation and commercialization of ideas overseas through public appeals should be established, while referring to examples of innovations and competitive funds that have proven records in the R&D field(to start in FY2021).

Building a Society to Maintain People's Lives and Economic Activities even in Emergencies

It is necessary to achieve a society in which people's lives and economic activities can be smoothly maintained by ICT, including 5G or Beyond 5G, even in emergencies. For example, in 2020 people have been required to minimize their contact with other people in order to prevent the spread of COVID-19 infections. Regulations that were premised on in-person interaction in emergencies have been reviewed, for example with online medical diagnosis being reviewed, and telework, which enables work to be performed at home, has been progressing.

The digitalization of society as a whole needs to continue. Efforts should be made to ensure that people's lives and economic activities are smoothly maintained through cyberspace, even in the event of an unforeseen occurrence in physical space, in collaboration between relevant ministries and agencies. Such efforts should include security measures for remote conference systems, system load reduction, demonstrations of trust services as a mechanism to prevent spoofing and data tampering, prompt system development, support related to the establishment of systems for the introduction of telework by companies and local governments, and reviews into business rules and business practices (being implemented from FY2020).

Development of an Environment Whereby Anyone Can Use ICT Equipment and Services

People are forced to rely on ICT due to restrictions on going out as a result of the COVID-19 pandemic, this has enabled them to once more realize the need to build up both ICT, and an environment to facilitate the maximum use of ICT equipment and services. In order to realize Beyond 5G, there needs to be a profound shift in terms of having the entire population use ICT equipment and services, not only to handle emergency situations such as the COVID-19 pandemic, but also so that people can feel the benefits of Society 5.0.

Therefore, ICT equipment and services need to be easy to use. Developers and providers should be conscious of the need for further work to improve human interfaces, while at the same time, the development and provision of ICT equipment and services that contribute to barrier-free information should be supported to ensure universal

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[24] A sustainable business that develops companies while contributing to improvements in living standards in Japan by providing products and services that are beneficial to the Base of the Economic Pyramid, a low-income group whose annual income is less than 3,000 dollars on a purchasing power parity (PPP) basis.

design, and improvements in the web accessibility of public institutions should continue to be addressed.

In addition to the above, an environment should be created whereby people can learn about the use of ICT equipment and services, or find out more about them, and necessary institutional developments should be considered, in order to enable people to smoothly enter into a new society and lifestyle which utilizes ICT equipment and services,. Institutional development should also focus on the ability to carry out digital administrative procedures, which are expected to become even more widespread in the future, which should be centered on elderly people who often feel hurdles when using ICT equipment and services (being studied from FY2020 and implemented promptly).

5. Policies for Driving Strategy

The Beyond 5G Promotion Consortium (tentative name, hereinafter called the "Consortium") will be established as a body to strongly and actively promote the Beyond 5G Promotion Strategy through industry-academia-government collaboration. The Consortium will share specific efforts implemented under each sub-strategy with industry, academia, and the government, and support the launch of new demonstration projects by domestic and foreign companies and universities. In addition, the Consortium will annually hold a meeting called the Beyond 5G International Conference (tentative name) to accelerate industry-academia-government efforts and international collaboration to promote Beyond 5G. This meeting will be used as a mechanism to share the latest information on international trends related to R&D, and to disseminate Japan's Beyond 5G efforts to the international community.

A cross-departmental team called the Beyond 5G Promotion Task Force[25] (tentative name) will be established within the Ministry of Internal Affairs and Communications to support the activities of the Consortium. In addition to supporting the activities of the Consortium, the task force will oversee progress in the promotion roadmap for the Beyond 5G Promotion Strategy in cooperation with the Council for Science, Technology and Innovation, the IT Strategy Headquarters, and the Cybersecurity Strategic Headquarters. The task force will compile and publish a progress report every year. in addition, the strategy and sub-strategies should be revised as necessary based on an annual report.

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[25] International cooperation measures are implemented according to the MIC World Development Action Plan 2020 (released in May 2020).