Social Value Creation Report

\Orchestrating a brighter world NEC

Communication

The acceleration of Digital Transformation

Brighter societies and industries connected by 5G

As digital technology including AI (Artificial Intelligence) and IoT (Internet of Things) rapidly evolves, related costs have reduced, and its range of applications has expanded significantly. On this backdrop, digital transformation is accelerating throughout the world, generating new processes and business models by fully utilizing digitalization. In many countries, actions for promoting innovation have begun under national strategies that aim for industrial and social transformation through digital technology. To this end, each country has been preparing 5G (5th generation mobile communication systems) as a strategic infrastructure. Enhanced mobile broadband (ultra-high speed and high capacity), massive machine type communications (massive Internet of Things), and ultra-reliable and low latency communications (mission critical services) are among the requirements crucial to the information and communications infrastructure that support digital transformation. 5G fulfills these requirements, forming a base for business process re-engineering through digitalization, as well as for providing customers with high quality added values and forming new business models. This report discuss NEC's new social value creation and ideal vision for the 5G era, realized with three initiatives in "NEC Smart Connectivity," the technologies supporting them, and co-creation by working across industrial boundaries with customers and partners.

The structural redesign in society and industry that digital technology will drive

The accelerating wave of digital transformation in industry

Digital transformation is changing social, economic, and industrial structures at an accelerated rate through the use of digital technologies such as the rapidly progressing AI and IoT. Digitalized companies are taking the lead in disrupting old business models. They are promoting transformation to new models and rapidly expanding business, a result of attracting a large number of users.

Two typical examples of such digitalized companies in the "sharing economy" of shared goods and services might be Uber, which offers a car dispatch app, and Airbnb, which is used to rent out rooms for lodging. These companies have expanded their services around the world in just a few years, greatly transforming business.

Even non-digital native companies are starting actions that aim for business transformation through the use of digital technology. For example, some companies in the manufacturing industry are embedding IoT into their products. In doing so, they are making a shift from selling goods to selling services, such as usage-based billing models. Furthermore, "cyber-physical systems," which aim to improve efficiency and provide new values by collecting real world data through IoT and analyzing it in cyberspace, are being used to advance transformation in a range of industries.

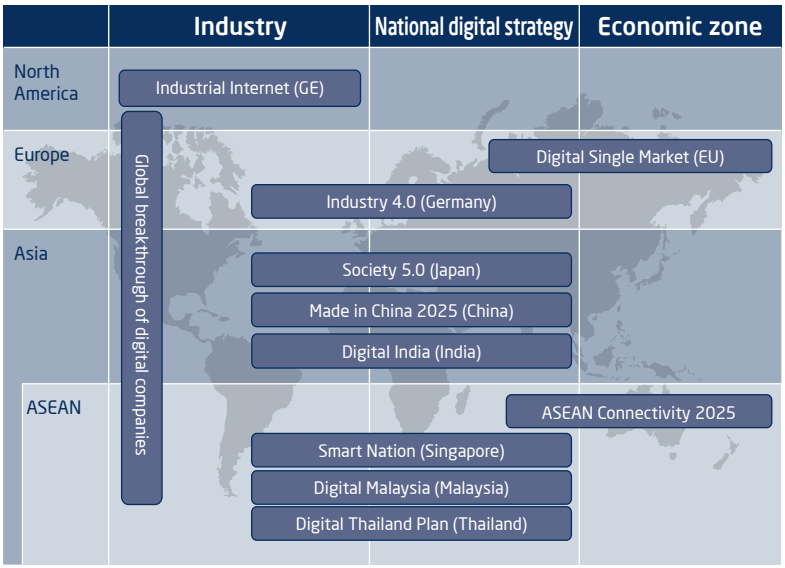
In this way, digital transformation has changed the rules of business and society through the acceleration of actions around the world. Unless companies engage in digitalization at an early stage and develop their businesses under new rules, the gap with advanced companies may widen more and more.

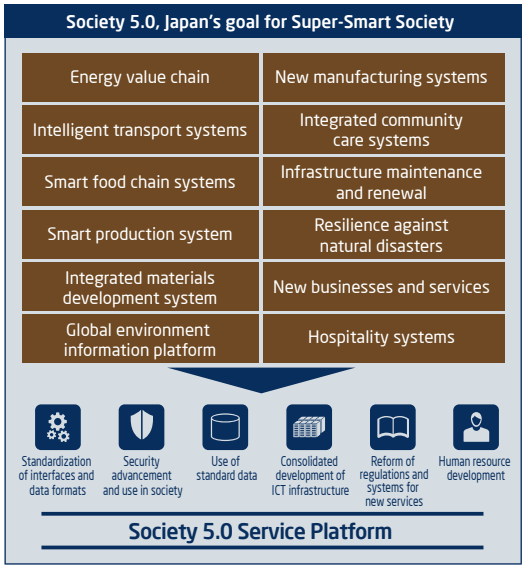
National governments look toward social and industrial transformation in the digital age

Throughout the world, government-led movements to advance digital strategies are heating up, with the goal of maintaining or increasing national power. These include Germany's Industry 4.0 strategy for digitalization in the manufacturing industry, and Singapore's Smart Nation program to achieve a smart nation driven by ICT. The Japanese government is also making use of digital technology to realize Society 5.0, a Super-Smart Society that will balance economic development with the resolution of social issues such as a declining birthrate, and local depopulation. The government has formulated the Basic Act on the Advancement of Utilizing Public and Private Sector Data to strengthen collaboration among industry, academia, and government, and is accelerating actions in areas including the construction of a cross-industry data distribution platform.

Digital transformation will extend beyond the borders of industries and nations to create new values that connect people, things, and events. Viewing this technology-driven paradigm shift as an opportunity and undertaking digitalization at an early stage will lead to the expansion of business opportunities and the early resolution of social issues.

Advancing through collaboration among industries, governments, and economic zones: digital transformation around the world





Source: Based on an overview of the 5th Science and Technology Basic Plan of the Cabinet Office

5G supporting the achievement of digital transformation

5G is indispensable to the advancement of services in the digital age

New processes and the transformation of business models through digital transformation require the advancement of mobile networks. 5G (5th generation mobile communication systems) forms the communication infrastructure that supports this transformation of society and industry in the digital age. The United States and South Korea launched commercial services in April 2019, and Japan started a pre-service in September of the same year.

The characteristic features of 5G can be broadly stated as (1) Ultra-high speed and high capacity that meet the need for delivery of high-definition, high-capacity video, including virtual reality (VR) and augmented reality (AR); (2) Massive machine type communications that link multiple devices and sensors with high precision; and (3) Ultra-reliable and low latency communications that meet requirements for self driving cars and remote medicine. These characteristics are critical for achieving transformation that makes maximum use of digital technology.

The domains in which 5G is utilized have gone beyond smartphones, expanding to encompass all manner of things and events, including home appliances used in everyday life, automobiles, and sensors used in factories and facilities. Through this, digitized information will increase to a degree never seen before, and its shared use will accelerate collaboration that crosses the boundaries of society and industry.

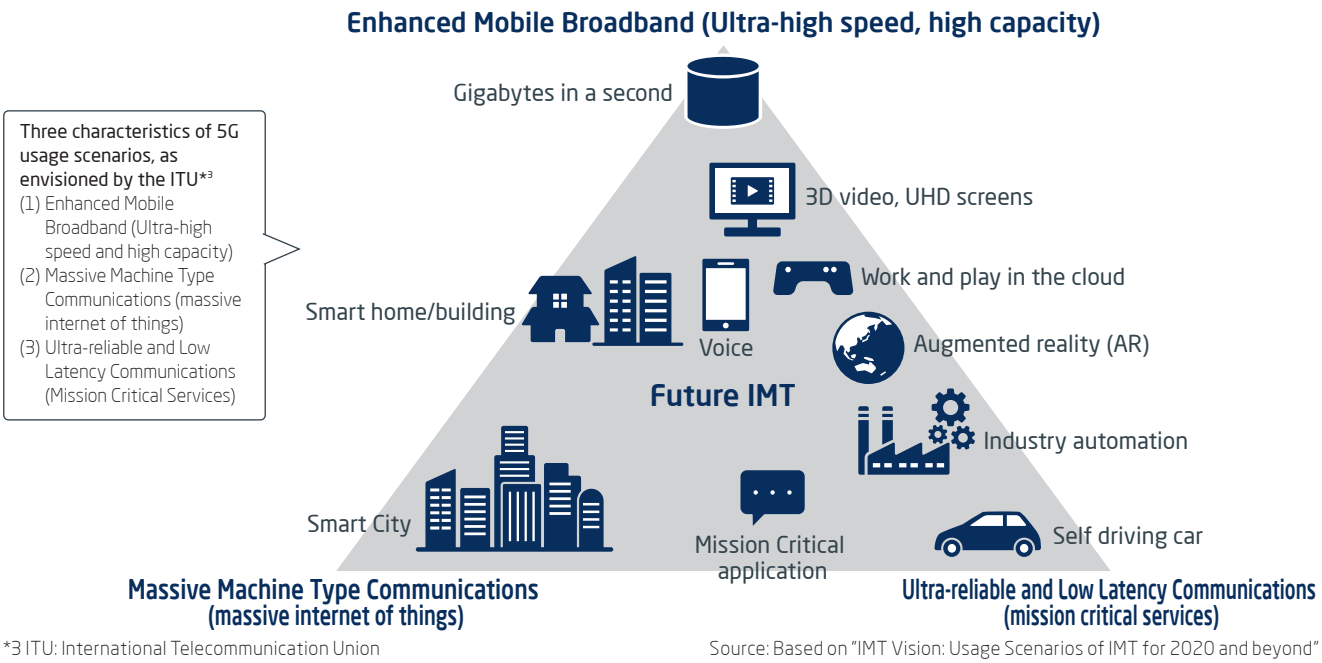
Value creation through utilization of 5G: the driving force for companies' growth

Societal implementation of 5G has been strategically advanced around the world to form the information and communications infrastructure that supports the digital strategies of nations. An example of this is Europe's 5G-PPP[*1], which identified five fields of industry that make use of 5G, and is collaborating with industries and developing new markets. In Japan, the Ministry of Internal Affairs and Communications conducted the "5G System Integrated Verification Trial," in cooperation with 5GMF[*2]. New 5G services were realized for international sporting events held in Tokyo in 2020. There are also a variety of projects being advanced to expand and accelerate the utilization of 5G, leveraging the achievements and know-how gained from the developed services.

Through all this, 5G services from communications providers have started in Japan and abroad, establishing infrastructure for value creation. Making maximum use of 5G and digital technologies such as AI and IoT will continue to provide the momentum behind companies' growth.

*1 5G-PPP: 5G Public-Private Partnership, a public and private sector partnership for the construction of 5G infrastructure
*2 5GMF: The Fifth Generation Mobile Communications Promotion Forum

Usage scenarios of IMT for 2020 and beyond



Three characteristics of 5G usage scenarios, as envisioned by the ITU*3
(1) Enhanced Mobile Broadband (Ultra-high speed and high capacity)
(2) Massive Machine Type Communications (massive internet of things)
(3) Ultra-reliable and Low Latency Communications (Mission Critical Services)

*3 ITU: International Telecommunication Union

Source: Based on "IMT Vision: Usage Scenarios of IMT for 2020 and beyond"

The New Markets and Major Economic Impacts Arising from 5G

Efforts toward 5G: the key to international competitiveness

The development of new markets that utilize 5G will have a major impact on the international competitiveness of industries. The 5G-PPP project by the EC has begun a variety of activities under five priority areas: (1) automotive; (2) factories and manufacturing; (3) energy; (4) medicine and health; and (5) media and entertainment.

In Japan, the Ministry of Internal Affairs and Communications' Round-table Conference on Radio Policies 2020 has identified nine key fields based on the industrial characteristics and industrial structure of Japan. These include the five areas identified by the EC and other areas that are key to Japan. As an example, "Agriculture, forestry, and fisheries" and the construction industry, included in "Smart cities/smart areas," are struggling with the major issue of preserving human resources amid a significantly declining working population. For this industry, the use of 5G will enable transformation to a more efficient industrial structure.

"Smart houses/life (daily necessities, communications, etc.)," "Retail (finance, settlement)," and "Sports" in view of international sporting events held in Tokyo in 2020, are also key areas of Japan not included in the EC's five areas.

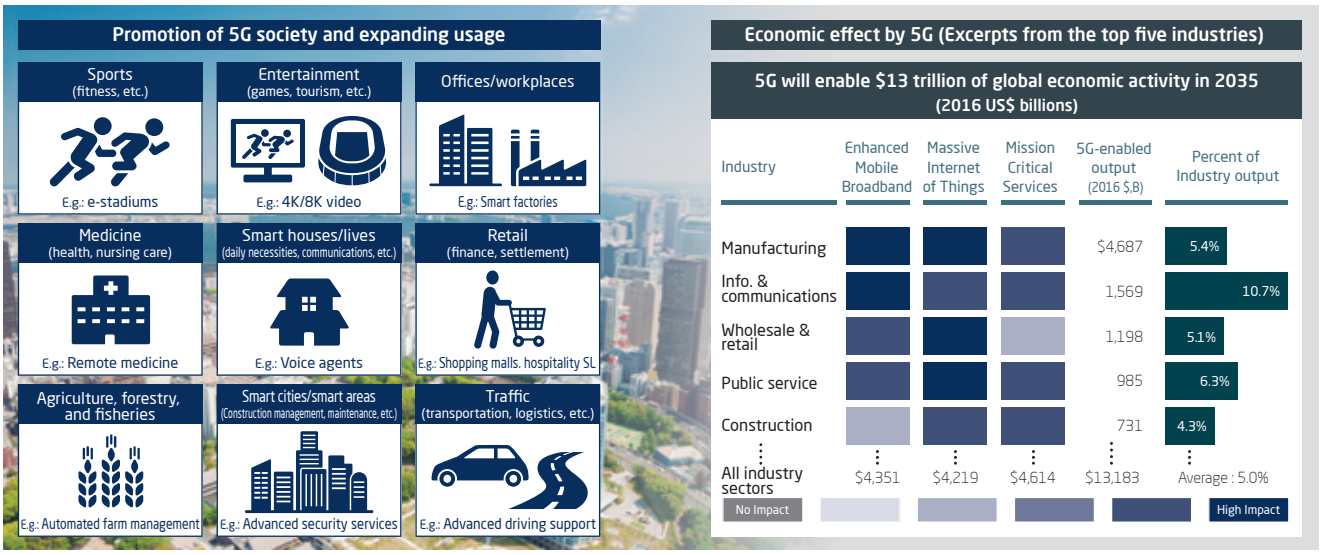
5G-enabled output will exceed US$13 trillion worldwide

In a joint survey commissioned by Qualcomm Technologies, IHS Markit has estimated that the potential global sales activity enabled by 5G will reach US$13.2 trillion in 2035 as the result of greater efficiency, engagement with customers, and launching new business models. This estimate represents 5.0% of global real output in 2035.

Broken down by the industrial sector, it is calculated as US$4.7 trillion in the manufacturing sector and $1.6 trillion in the information and telecommunications sector, both of which will receive direct economic benefits from the manufacture of 5G-related equipment and the provision of telecommunication services, as well as $1.2 trillion in the wholesaling and distribution sector, $1.0 trillion in the public services (government) sector, and $0.7 trillion in the construction sector. The economic effect is expected to spread throughout society and industries as a whole. This report also predicts that this incredible flexibility is different from the generations that came before, which includes the shared spectrum and operating on private networks, and will promote adoption by industry. In terms of technology, applications making use of Enhanced Mobile Broadband (Ultra-high speed and high capacity) will proceed, and for the medium- and long-term point of view, applications exploiting Massive Internet of Things and Mission Critical Services (Ultra-reliable and low latency communications) will proliferate.

Offering new characteristics in addition to higher speeds and larger capacities in communications, 5G will become a key part of the next generation's infrastructure, bringing the rapid transformation of all society and industry. As markets change at amazing speed, forming new business models and services in view of the evolution and future development of technologies such as 5G, will become the key to success in corporate competition.

New markets and economic value arising from 5G



Source: Based on ad-hoc group report by the Ministry of Internal Affairs and Communications' Round-table Conference on Radio Policies 2020

Source: Created based on "The 5G Economy—How 5G will contribute to the global economy," November 2019, an IHS Markit technology research solutions survey (now a part of Informa Tech) commissioned by Qualcomm Technologies.

* Information is not an endorsement of NEC. Any reliance on these results is at the third party's own risk.

Realizing brighter societies: "NEC Smart Connectivity"

Aiming for new value creation through networks

In societies advanced through 5G, the number of devices that connect with networks is increasing. Also, networks are growing in complexity due to device types and communication methods becoming more diverse to realize services optimized to each usage. In addition, data transmitted over networks increases exponentially in accordance with the increase in number of connected devices.

In response to this, NEC is promoting "NEC Smart Connectivity" to realize new value through networks that can be used without consciousness of their complexity, and can utilize large amounts of data at will. NEC will provide new social value through "NEC Smart Connectivity" by seamlessly connecting physical and cyber spaces based on the technology and know-how of IT services and networks that we have provided thus far. These efforts are aimed toward the realization of brighter societies by optimally connecting people, things, and events smartly.

Three initiatives promoted by "NEC Smart Connectivity"

NEC will promote "NEC Smart Connectivity" through the following three key initiatives for realizing brighter societies, and create social value for the 5G era through collaboration with companies, organizations, communications providers, and other customers.

(1) Network innovation

In 5G-implemented societies, NEC aims to provide ICT (Information Communication Technology) infrastructure for safe and comfortable connectivity anytime and anywhere. This is an initiative for innovating networks that can flexibly handle a wide range of services in the 5G era through stress-free realization of advanced services that make full use of the characteristics of 5G.

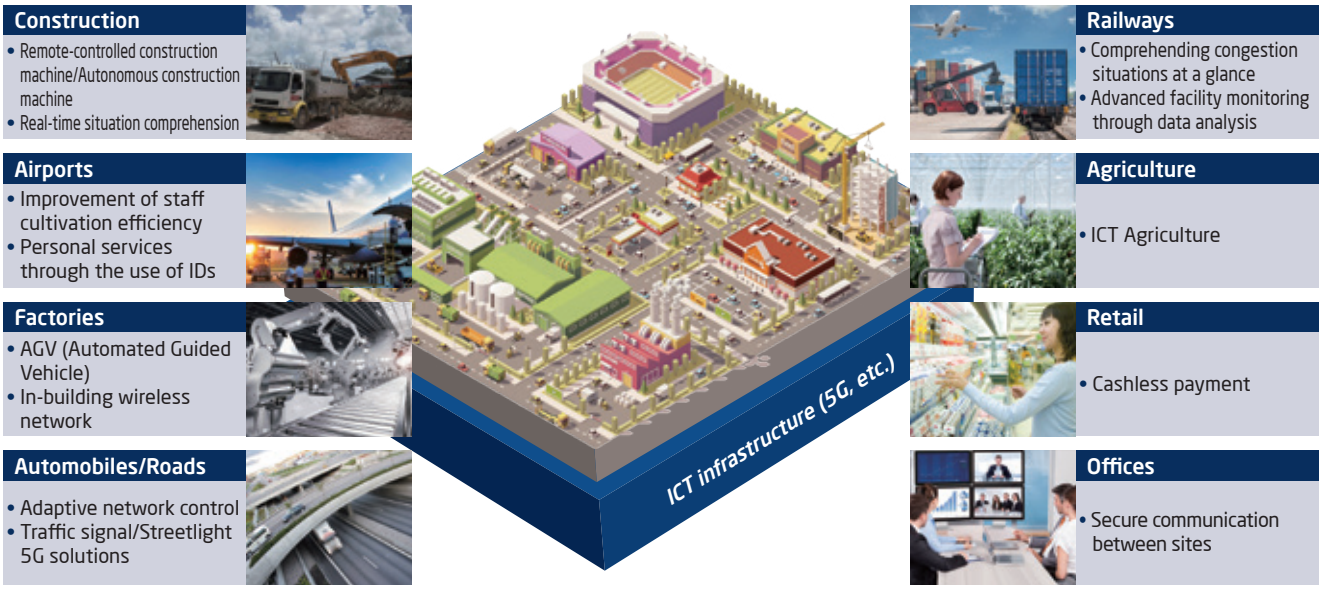
(2) Operational innovation of ICT infrastructure

NEC aims to make operating ICT infrastructure flexible and efficient, even as it increases in complexity. This is an initiative for innovating operations for realization of optimized services in the 5G era.

(3) Digital innovation of industries through advanced ICT infrastructure

NEC aims to solve issues specific to each industry and transform business through the promotion of digitalization which conforms to each industry by combining network technology with AI, authentication, and a variety of other leading-edge technologies. This is an initiative for developing cross-industry data sharing mechanism through co-creation with industrial partners, as well as providing advanced ICT infrastructure and network services optimized to users.

Realizing brighter societies: NEC Smart Connectivity



Using reliable technology to develop ICT infrastructure of the 5G era

Innova tion of networks that support implementation of 5G in social practice

NEC is promoting a variety of activities to transform ICT, an important social infrastructure, into networks optimized for the 5G era. There are several challenges to realizing societies that enable the stress-free use of advanced services which utilize the characteristics of 5G by anyone, at anytime, and anywhere.

For example, in order for everyone to enjoy the benefits of 5G, a large number of 5G systems will require installation. NEC supports the efficient and effective deployment of 5G by making installation easier and decreasing the burden of maintenance by reducing size, weight, and power consumption, which is realized using NEC's wireless technologies and know-how. Furthermore, the realization of services which utilize low latency communications, one of the characteristics of 5G, requires the high-speed processing of large amounts of data. In response to this issue, NEC is working on MEC*4 for processing data in close proximity to terminals, and making efforts to realize low latency communications through the development of real-time control technology.

In addition, in the 5G era, requirements such as interface openness and network utilization flexibility are rising in response to more active sharing economy and ecosystem formation. NEC is working on standardization and virtualization through correspondence on O-RAN*5/Open vRAN*6, while also providing a cloud-based 5G core network.

NEC is already offering a 5G network that incorporates a number of network technologies to communications providers and industries, which also support 5G implementation in social practice. We will continue to promote network innovation for important ICT infrastructure.

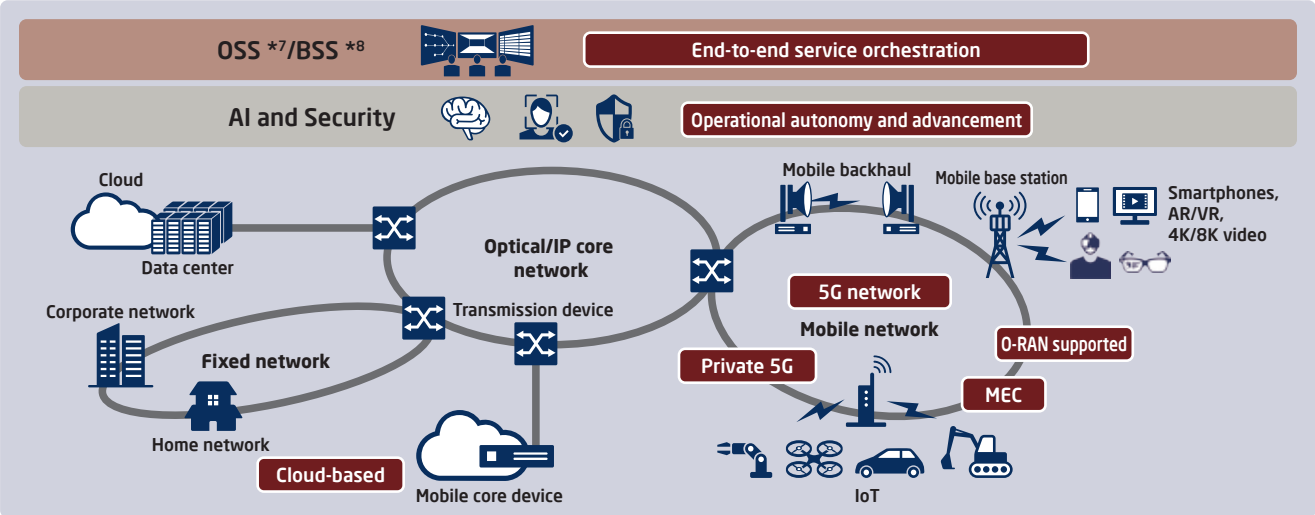
Operational innovation of increasingly complex ICT infrastructure

NEC is working on more advanced and autonomous operations in response to the increasing complexity of ICT infrastructure and the diversification of 5G services. For advanced operations, network slicing which virtually divides networks according to the required quality and functions will be realized. This enables the provision of networks optimized to diversified services. And for autonomous operations, NEC is providing end-to-end service orchestration which dynamically optimizes and integrates management of everything from networks to services through the use of AI.

This helps reduce the operational management load of complex networks and IT systems, while also realizing innovative operations that can rapidly and flexibly handle services in the 5G era.

*4 MEC: Multi-access edge computing
*5 O-RAN: Open radio access network
*6 vRAN: Virtualized radio access network

ICT infrastructure of the 5G era



*7 OSS (Operation Support System): A system for network operation and management
*8 BSS (Business Support System): A system for managing contractors, billing information, etc.

Realizing brighter societies where people, things, and events are all connected

Realizing industrial digital innovation through the use of advanced ICT infrastructure

NEC is promoting co-creation activities with its partners in the industrial sector to create new social value. One such activity is "5G Co-Creation Working," a working group started in Japan that crosses borders of business, and was established in collaboration with communications providers, as well as with companies and organizations involved in a variety of industries, to work on solutions to social issues through open innovation.

For example, in the construction industry, NEC is working to realize remote control and autonomous operation of construction machinery using 5G as a way to solve issues such as labor shortages and ensuring safety. And in the manufacturing industry, NEC is combating labor shortages and strengthening quality control by deploying private 5G*[9] in factories, working to migrate to smart factories through the automation and visualization of production lines, and the advancement of machining tools and robotics. To accomplish this, in addition to the utilization of 5G, AI is being used to predict communication delays in a unique combination of technologies, working with industries to create such values as labor-saving, improved operational efficiency, optimized supply chain, and increased productivity.

In addition, NEC is also working to create new value through data usage optimization. Through cross-industry trading of large amounts of data distributed among various companies and businesses, NEC is driving a data-matching structure, extracting necessary information and significant data after confirming their reliability.

This initiative is intended to enable the actualization of industrial digital innovation, the development of completely new customer experiences and services, and the realization of brighter societies.

Aiming to realize an end-to-end secure and safe society

The most important thing for realizing brighter societies in the 5G era is to protect important social and industrial services and information from threats such as cyber attacks, which are becoming more advanced day by day. To accomplish this, NEC is developing security technologies such as IoT device tamper detection and the world's fastest*[10] blockchain. NEC is also working to provide one-stop secure solutions that take into account the entire supply chain, including procurement, manufacturing, and logistics, through processes that prevent vulnerabilities and product development that eliminates intentional threats.

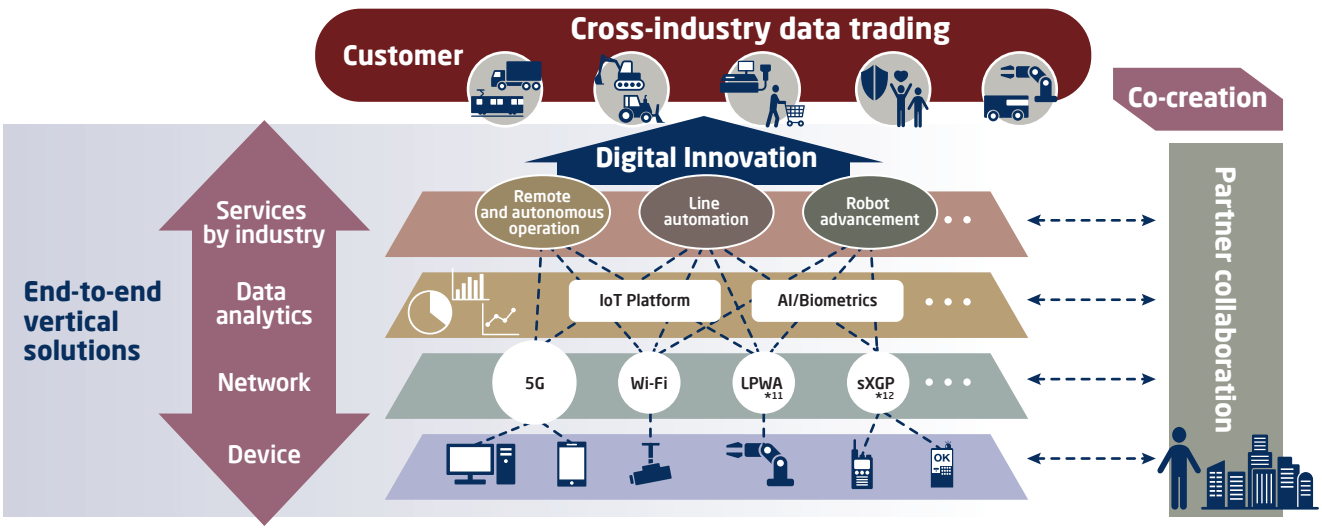
NEC is aiming to realize secure and safe advanced ICT infrastructure through these initiatives.
We will also provide this ICT infrastructure for the digital transformation of industry and realize brighter societies.

NEC hopes to design new social value that leverages ICT together with customers and to work toward the realization of a "Brighter World," while placing importance on the pursuit of intrinsic value for society and for customers. We welcome your comments and questions concerning the content of this report and initiatives by NEC.

*9 Private 5G: 5G wireless networks independently managed at specified sites

*10 According to NEC surveys, as of December 2017

Realizing industrial digital innovation and data utilization



*11 LPWA (Low Power Wide Area): A generic term for wireless communication systems that can communicate over distances in units of kilometers with low power consumption

*12 sXGP (shared eXtended Global Platform): LTE standard for independently managed communications that can communicate over distances of between several tens to several hundreds of meters

NEC Group is focusing its efforts on providing "Solutions for Society" by upgrading the social infrastructure with ICT. NEC defined six megatrends based on a structural observation of the global economy and social trends. Based on the six megatrends, NEC formulated seven themes for social value creation as its mission.

 Sustainable Earth	Establish a sustainable lifestyle base by utilizing limited resources effectively and taking measures to prevent damage to the global environment in order to live in harmony with the Earth.
 Safer Cities & Public Services	Help emerging countries build safe and secure cities, and help developed countries mature their societies. Establish a "global" administrative service platform through joint initiatives between the public and private sectors.
 Lifeline Infrastructure	Establish ICT systems that resolve disparities of area and delivery time, and build safe and efficient lines for travel, utilities, etc. that can support around-the-clock activities in society.
 Communication	Build a platform for information and communications to support the distribution of information and knowledge, which becomes more important as society advances.
 Industry Eco-System	Innovate a new industrial ecosystem including connection of industrial machinery with the Internet, 3D printers, crowdsourcing and reverse innovation.
 Work Style	Create new work style and relationship with society in which people work together with communities and robots regardless of gender and generation.
 Quality of Life	Build a diversified and equal society to support people's enriched and active lives through contributions to education, healthcare and medicine.

This Social Value Creation Report is issued for each of the seven themes listed above and summarizes NEC's concepts, efforts, and proposals, in addition to social issues and global trends. NEC hopes that this report can be the first step in establishing cooperative creative partnerships with customers.

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