NTT DATA Technology Foresight 2016

NTT DATA
Technology
Foresight

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NTT DATA Technology Foresight

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Contact NTT DATA Technology Foresight team if you are interested in knowing more about any of these trends.

NTT DATA
Global IT Innovator

Looking ahead :

Technology trends driving business innovation.

NTT DATA Technology Foresight is the "outlook and technology trends of the near future" that is derived by NTT DATA once a year. It finds the challenges our future society will face at an early stage, and it serves as a compass to promote the creation of new value.

We aim for the betterment of society by depicting a future vision and achieving it together with various customers through foreseeing the impacts future technology will have on societies and businesses.

At NTT DATA, we incorporate NTT DATA Technology Foresight into our management strategy, and we are committed to technology development and service creation that anticipates changes in the business environment.

NTT DATA
Technology
Foresight

Information Society Trend

We anticipate four key trends will have significant impacts on our clients' medium to long-term business.

- IST01 **Power of the Individual**
- IST02 **Decentralized Collaboration**
- IST03 **Hyperconnected Society**
- IST04 **Smarter Society**

IST01

Information Society Trend

We anticipate four key trends will have significant impacts on our clients' medium to long-term business.

Power of the Individual

The growing influence of individuals will transform existing societies and industries. Digitization will force providers to extend their existing business models to be more customer-centric, acknowledging the increasing power of the individual.

The rapid development of technology is transforming society. The almost universal use of smartphones is reducing information asymmetry, improving information distribution, and increasing the power of the individual. Decreases in the costs to access information and switch providers mean customers are reevaluating and selecting new providers at every opportunity. The diversification of taste as well as the increasing demand for more personalized products and services are leading to a Peer-to-Peer (P2P) based infrastructure—a network of individuals that does not rely on existing authorities—as the platform for the entire society.

Because of customers' demands for more convenient, speedy, and simplified services, the on-demand economy is growing rapidly. Digital technology has enabled online marketplaces to realize the potential that results from directly linking supply and demand. On-demand services have expanded from use in transportation and accommodations to the sharing of physical goods. They also are becoming more common in education, logistics, and healthcare. As a result, customers have been liberated from providers' constraints of regulated quantities and timing. The specifications of products and services have shifted from being determined unilaterally by providers to being personalized for customers' individual preferences. Pricing has moved from providers to customers, too, better reflecting not only the balance in supply and demand but also the lifetime value of customers. Empowered customers challenge providers to transform their business landscapes as well as the overall market structure.

Sophisticated customer needs and the diversity of requirements have led to the introduction of specialty high-visibility startups. Smaller enterprises also have become more competitive as digitization lowers the break-even point and shifts the source of competitive power from capital-intensive machines and equipment to intangible ideas and technologies. With lower transaction costs, a network of smaller organizations can be competitive, and community-style organizations are emerging. Sophisticated P2P tools support these smaller enterprises, making them better able to compete with larger enterprises. This is especially true in industries formerly protected by regulations, where transformation is spurred by startups not subject to these rules. Research indicates that within the next five years an average of four companies within each industry's top 10 will be replaced.[1]

Work itself also is changing. Flextime, discretionary work systems, and telecommuting have become common, shifting power from employers to employees. The increasing opportunities to make use of an individual's skills directly are leading to a business model that supplies high levels of expertise on demand rather than through permanent employees. New models of payment to independent contractors have emerged that change rates dynamically based on the balance between supply and demand. The increase in this new type of freelance worker indicates that the traditional concepts of "organization" and "employment" may no longer be applicable. On the other hand, preventing an increase of workers who are forced to freelance also is a challenge.

The amount of capital raised through crowdfunding—initiatives to which an unspecified number of individuals and organizations contribute—has rapidly increased, totaling $34.4 billion in 2015.[2] By 2020, that amount is expected to exceed the total of all investments from both venture capitalists and angel investors. Research indicates that the success rate of some crowdfunding services is greater than that of venture capitalists.[3] The trend of more individuals supporting startups is obvious.

The penetration of the Internet in the world as of 2015 has reached 43%.[4] However, more than four billion people, mainly in developing countries, still do not have Internet access. With the assistance of global technology firms and technically focused foundations, these countries are developing an Internet presence through drones, balloons, and satellites. When their people start using the Internet, different values and business models will emerge. As the digital economy continues to develop, long-established economic indicators appropriate to an industrial society (i.e., gross domestic product [GDP], productivity, unemployment rate, and inflation rate) may no longer reflect the actual condition of the economy. The development of new economic barometers will be required.

1 Global Center for Digital Business Transformation, "Digital Vortex: How Digital Disruption Is Redefining Industries," June 2015.

2 MASSolution, "2015CF – Crowdfunding Industry Report," April 2015.

3 Ethan Mollick, "Delivery Rates on Kickstarter," December 2015.

4 ITU, "ICT Facts & Figures," May 2015.

IST02

Information Society Trend

We anticipate four key trends will have significant impacts on our clients' medium to long-term business.

Decentralized Collaboration

Dynamic, digital ecosystems will emerge in which constituents will interact collaboratively over decentralized networks. This open exchange of information and resources will revolutionize both workplaces and societies.

The Internet has transformed the structure of information distribution from a centralized network to a decentralized one. Relationships between people and organizations have changed, too. Rather than a centralized structure based on authority and interpersonal ties, participants now support an open and distributed environment. Advancements in social structures are expected in the near future, too.

Although are still considered speculative in nature, cryptocurrencies are gradually being accepted as a bona fide means of payment. The core supporting technology is an algorithm to store information using a distributed open ledger, instead of a centralized closed one. As such, cryptocurrencies are expected to usher in a secure, global payment process that requires neither the brokers nor the clearing agencies currently necessary for payments between banks. Interestingly, major banks throughout the world have noted that such a process would be both prompt and inexpensive, leading to in-depth evaluations of its effectiveness. If a distributed payment mechanism is adopted globally, the result will be a major transformation of a system that has not changed materially in more than 150 years. In addition to finance-related uses (i.e., currency exchanges, stocks, and credit management, etc.), distributed processes may be valuable in a variety of other areas, including related rights (i.e., proprietary rights, intellectual property, etc.) and contract management. Experiments are already underway in medical records and the issuance of securities and grading records of jewels.

Most control systems, which are currently centralized, also are expected to become distributed. In manufacturing, for example, centralized management and control of the production process historically has been accepted as the most efficient method. However, if the production method called Industrie 4.0, or the Industrial Internet,[1] is widely adopted, data transmission speeds will become the limiting factor in handling the huge amounts of information generated from sensors. At the same time, collaboration with less controllable activities—such as a supplier's production process or distribution outside the factory—will become necessary. Production optimization will be realized through continuous adjustments among decentralized processes as they respond to other processes and relevant parties in real time. This is expected to drive control systems toward decentralization. Both evaluations and practical uses of such real-time control processes are already underway in areas such as railway operations, self-driving cars, and the operation of drones.

The organizational structure itself is being decentralized, as well. Distributed Autonomous Organizations (DAOs) are the ultimate example, because they have no centralized governing entity. A DAO can exist only on the Internet and, as a result, these organizations can be transnational. Because basic operations are determined automatically, based on pre-existing rules, DAOs can run unattended. With all activities recorded in the distributed database, many believe the highly transparent decision-making and financial conditions DOA provide will prevent fraud.

DAOs initially are expected to act as an infrastructure for a sharing economy (collaborative consumption of goods and services) that will automatically and directly connect both parties involved in a transaction; intermediaries will not be necessary. In the future, DAOs increasingly may be applied to not only businesses but also parts of operations within governmental agencies. Although it is difficult to imagine this transformation happening in the near future, DAOs will likely record information such as annual government revenues, expenditures, and election results. Another DAO application will be online public notary services for birth and marriage registrations. Some governments have adopted DAOs already. In Estonia, for example, the system provides certificates of marriage, birth, etc., to e-Residents who have government-issued digital identities regardless of their nationality.

Because a decentralized system does not need third-party intervention, it saves time and costs. As a result, these systems are likely to become popular quickly—if effectiveness can be assured. Decentralized system can be applied to anything that can be digitized, so the advancement of smart management of assets online may be possible. Research conducted by the World Economic Forum predicted that taxes will be collected via a distributed system for the first time in 2023 and that 10% of Gross Domestic Product (GDP) in the world will be managed using distributed systems by 2027.[2] It is possible that these highly transparent systems will influence the concepts of "government" and "laws." The first instances of decentralized systems are expected to be introduced in areas that will unmistakably demonstrate their effectiveness to the public.

1 It is said to be the fourth industrial revolution.

2 World Economic Forum, "Deep Shift Technology Tipping Points and Societal Impact," September 2015.

IST03 **Information Society Trend**

We anticipate four key trends will have significant impacts on our clients' medium to long-term business.

Hyperconnected Society

Big data analytics will fuel innovation. Even after they ship, products will become ever-evolving things through functionality and performance enhancements. This, in turn, will boost customer value and promote business model transformation.

The number of devices connected to the Internet has increased by 30%, from 3.8 billion devices in 2014 to 4.9 billion devices in 2015, and it is expected to reach 20.8 billion in 2020.[1] Some predict that number may exceed 50 billion by 2020.[2]

Because automobiles, machines, and consumer electronics, among other things, are connected to the Internet, processes common in the world of IT now will be used widely in the physical world. Familiar software updates and user upgrades for computers and other digital devices, for example, will be applied to product software. Currently, when a malfunction is found in products that have shipped, they are recalled. In the future, however, an update program will be distributed online if the product's defect can be fixed by a software update. If a product's location and the state of its use can be obtained via the Internet at all times, then—in some cases—its software may be updated and any malfunctions resolved before the user even notices. When information on how an individual uses a product is available, defects can be updated based on risk estimate priorities derived from usage data analysis, to prevent serious accidents.

Implementing product features is shifting closer to customers and away from manufacturers. As this happens, software updates and upgrades that enhance product performance or functionality may be provided online, similar to the way users add features to their smartphones by simply installing applications. Robots that can increase functionality by installing an application are in use already. A future watershed event will have an automobile that can be transformed into a self-driving car by upgrading software. Products commonly ship as completed goods, and their value depreciates with time. However, by improving performance and adding new functions through software updates and upgrades, it may become possible to create products whose value appreciates over time. In fact, the number of ever-evolving products is expected to increase. Continually increasing a product's value will challenge the concept of depreciation in accounting.

It is possible that making source codes public (open source)—a widely accepted practice in the IT world—also will happen in the world of product software. As a result, the boundary between manufacturing and the IT industry will become blurred. At the same time, it is expected that more innovative ideas and technologies from IT-related startups will be incorporated into traditional manufacturing processes. This is already taking place. For example, a vehicle's engine can now be started by a smartphone and a smartphone can act as a motorcycle's dashboard. It is likely that the fusion of applications across business categories will continue to increase.

The physical-to-digital shift of functions also may influence the physical structure itself. Increasing product value encourages manufacturers to create products that are more amenable to future changes and longer lifecycles. The result will be physical elements that are both simpler and more generic and that can add functionality and performance enhancements via software. Because it will be easier to accommodate customer needs, innovative changes in the design concept, adoption of Agile development methods, and business model transformation may accelerate. An increasing number of new entrants from different industries also may result in innovative changes in both the industrial structure and the basic principles of competition. It is possible that more flexible, amoeba-like organizations will be embraced.

Products are becoming more valuable, and the connected world is expanding their potential. Novel combinations of functions resulting from these connected things may generate remarkable values. On the other hand, the growing number of connected devices with security vulnerabilities will increase the risk of cyber attacks, potentially disrupting critical infrastructure by causing large-scale blackouts or transportation stoppages, among other problems. Complicated integration of physical and digital functions will make it more difficult to determine responsibilities, particularly when the approaches of hardware and software manufacturers differ. To extract the maximum benefit from innovation, business environments must adapt enhancements quickly to meet rapidly evolving changes in society.

1 Gartner Press Release, November 2015.

2 Cisco IBSG, April 2011.

IST04

Information Society Trend

We anticipate four key trends will have significant impacts on our clients' medium to long-term business.

Smarter Society

The physical-digital convergence will broaden in scope. More flexible and effective use of technology will create new value, address social issues, and lead to a smarter society.

The integration of "physical" and "digital" is not limited to particular situations or specific conditions; rather, it has become a daily event. In fact, this integration will advance to a point where differentiated use is unnecessary. IT infrastructure, for example, is widely accepted as a way to both enable essential services in society and solve social problems by integrating digital technologies into physical methods and techniques. Digital customers, meanwhile, do not care whether they shop in physical stores or online; they seek only consistent brand experiences and services. As opportunities to use smartphones at physical stores for promotions, price comparisons, and payments increase, so do advanced features in smartphones.

People now carry mobile devices equipped with various sensors and Artificial Intelligence (AI) in their pockets. Introducing positive cases of behavior analytics will encourage more people to use these devices, as well as wearable technologies, to record their actions and behaviors proactively. Applications that provide advice on behaviors and nutrition by understanding an individual's lifestyle (i.e., activities, meals, and sleep) and health conditions are emerging, as are applications that offer sports instruction by capturing body activity and movements. In fact, it may become common to receive instructions and advice from applications rather than humans.

Meanwhile, search algorithms that process natural language and even vague expressions, rather than words selected specifically for computers, are under development. Virtual assistants will answer questions, reserve tables at restaurants, and arrange meetings by comprehending the meaning of questions. These agents will deliver personalized services via a simple interface, rather than through applications based on activities such as ordering daily supplies, booking a trip, and searching restaurants. Inputting different passwords to verify identity or authorize transactions will become a thing of the past. Instead, the natural activities of touching or talking will be used to recognize fingerprints or voiceprints.

Natural interfaces are becoming common in products, too. Practical examples include thermostats and light bulbs that adjust to an individual's preferences and habits, cameras that automatically trail a subject, and shirts that measure vital data simply by being worn. Products that respond to a voice, a gesture, or an action (i.e., getting out of bed, leaving the house, etc.) without an interface, such as a touch panel or a button, also are becoming commonplace. Another possibility is products that operate by understanding the meaning of a gesture that differs from one individual to another.

The relationship between humans and machines is shifting from one where humans adapt to each machine to use it, to one where humans behave toward machines as they would with other humans. Self-driving cars may indicate a transformation from humans driving vehicles to vehicles operating for humans. Robots can now understand and judge human feelings without navigation commands, and even children, the elderly, and those who are non-native speakers are able to control them. In the past, digital literacy, irrespective of computer skills, was seen as a contributing factor in the digital divide. It will have much less of an impact in the future. In industry, use of cooperative robots is increasing. The workplace is building new relationships between humans and machines by creating an environment where robots and humans complement each other, rather than humans simply operating machines. Robots with AI are self-learning, do not require human instruction, and obtain new capabilities by sharing knowledge with other robots.

Augmented Reality (AR) and Virtual Reality (VR) also will be experienced more naturally. Although already in daily use, AI is now beginning to understand natural language. Some people say AI is helping to solve environmental issues, such as the food supply crisis and global warming. However, several ethical challenges must be considered. When interactions increase among humans and computers and AI, the knowledge and skills that humans must possess will change. A sustainable relationship will be created only by adapting education to technological change. Humans must continue to enhance their abilities so as not to be controlled by AI.

Information Society Trends
NTT DATA Case Studies

Power of the Individual

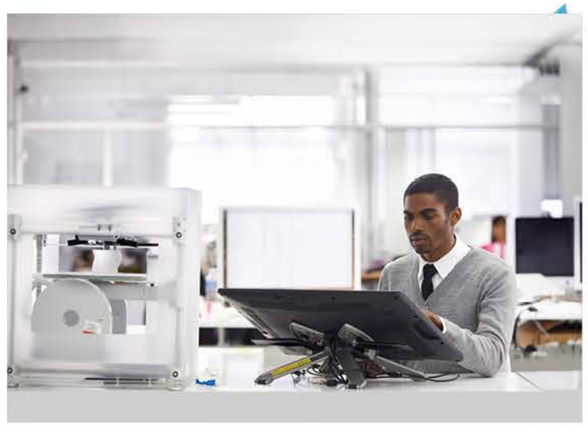
API Link Service for Internet Banking and Fintech Applications

Fintech services such as Personal Financial Management (PFM) and cloud accounting are spreading rapidly due to the significant convenience they provide users. These services are developed and provided primarily by small startup companies using cutting-edge IT technologies. NTT DATA has developed an API Link service within its "AnserParaSOL" Internet banking system as an interface between the system and a wide range of Fintech services, including a feature that enables customers to check their account activities, statements, and balances without using their Internet banking account ID and password. This API Link service enhances both customers' convenience and their safety when using Fintech services. NTT DATA plans to expand this service and to promote collaboration between Fintech services firms and financial institutions.

Hyperconnected Society

IoT Monitoring Services for the Manufacturing Industry

The globalization of the manufacturing industry has many companies facing a variety of challenges, including the transfer of skills from veteran workers to their younger colleagues and global remote monitoring. In addition, technology advancements such as 3D printing have been revolutionizing the production process. NTT DATA Group's Internet of Things (IoT) solutions for the manufacturing industry incorporate a wide range of technologies, including sensor infrastructure, networks, big data analytics, cloud computing, and system integration. In 2016, NTT DATA has plans to release a cloud monitoring system for 3D printers using its IoT technology that will be able to visualize the status of a printer and detect problems immediately. The system is expected to contribute to quality control efforts for printed products, improving maintenance efficiency and analyzing the cause of defects.



Decentralized Collaboration

Industrie 4.0 in Practice: Visualization and Automation of the Manufacturing Process

NTT DATA and intelligence, its German subsidiary, have been collaborating with RWTH Aachen University to realize the concept of Industrie 4.0 as part of the Excellence Initiative for the German Government. Specifically, NTT DATA has been working on the following development projects:

- A 3D-based assembly instruction system, where assembly operations are visualized in 3D to support novice workers.
- A real-time material flow tracking system, where the positioning data of the shop-floor-wagon is collected automatically through sensors connected to an SAP ERP system, and then used to visualize and control the entire assembly process.

The goal of these solutions is to visualize and automate the production processes within the factory.

Smarter Society

Analyzing Driver's Bio-Info during IndyCar Races with Smart Shirt

NTT DATA has been developing new technology to analyze a wearer's biological information using a smart shirt incorporating "hitoe", a functional material that acts as a sensor. As a specific experiment, a series of tests were conducted during IndyCar Series races, where cars reach speeds up to 235 mph (approx. 378 kph) and drivers are required to show advanced driving techniques under these severe circumstances. NTT DATA first gathered electrocardiogram (ECG), heart rate and electromyogram (EMG) data from the driver who was wearing the "hitoe" smart shirt. The company then analyzed this biological information, combined with other data from the vehicle, to successfully visualize the veteran driver's driving technique. This data will be analyzed further to enhance driving performance and improve training. NTT DATA also will continue to work on developing new services that leverage this technology in healthcare and other areas.

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Technology Trend

The following eight technology trends are expected to have the biggest influence in the coming years.

TT01 **Technology Trend**

The following eight technology trends are expected to have the biggest influence in the coming years.

Immersive Interaction

Devices and technology to enrich one's perception of reality is emerging. By enabling people to naturally perceive and utilize more information, new computer interaction can potentially transform human behavior and enhance the scope of their actions.

Technology that creates reality and lets users experience realistic sensations is generating significant buzz among the public. In November 2015, *The New York Times* provided more than 1 million subscribers with a documentary on refugee children, along with a Virtual Reality (VR) viewer. Unlike watching it on the screen, the documentary in VR gave viewers the actual experience of being with the refugees, including a sense of almost being able to reach out and touch these children. Although not yet perfect, VR has received a great response due to the power it adds to storytelling.

Many more advanced VR and Augmented Reality (AR) devices are scheduled to be released in 2016. As a result, related technologies also are expected to become increasingly available. VR that shows artificial virtual worlds and AR that enhances information in the real world are the most popular examples of these technologies, which most commonly use head-mounted displays and wearable eyewear devices. A determining factor in the creation of the most realistic simulation of senses and experience is the combination of technologies, which include a 360-degree camera and video composition; overlapping images with vision; realistic displays using high-definition and 3D graphics; interfaces to an artificial reality, such as operations using gestures; and technology that provides tangible feedback to make users actually feel the reality.

VR is now used for a variety of purposes, including political campaigns, live sports, and high-risk educational training in medical care, disaster prevention, military affairs, manufacturing, and construction. It also is used in colleges and at companies during the recruiting process to provide simulated campus or work environment experiences. These immersive experiences are having a positive impact. For example, in medical care, VR was used to plan an operation for a baby with a rare disease. Surgeons successfully simulated and evaluated the procedure based on a 3D VR image of the patient's heart. In another example, a conscious patient wore a VR device during brain surgery that enabled surgeons to test portions of the brain related to vision. VR enhanced the precision of the procedure and facilitated the removal of an otherwise inaccessible brain tumor. Three success factors for the continued expansion and development of this technology are: ease of creating the "reality"; reducing the cost to distribute and view it; and adequate quality for a particular use.

Mixed Reality (MR) is another technology that enhances real views with Computer Graphics (CG) so physical and digital objects can co-exist and interact in real time. In some ways, MR is a combination of VR and AR. One use of this technology had multiple people looking at the CG of a life-size automobile from a variety of angles to discuss and fine-tune its design. In another example, a person in a remote location can appear closer to the MR user. This is similar to a hologram that enables personal communication and makes it seem as if users are right next to each other. MR also is gaining substantial attention as a new computer interface. For example, instead of using files on a screen, MR users have direct access to ubiquitous "things" or computers in the environment. These items can be operated more intuitively and naturally through CG projected into the "reality," enhancing the reality in such a way that becomes more appropriate for the operation.

The core of reality is what users "think" they are experiencing subjectively through sensory perceptions. A prominent example of this is the Substitutional Reality (SR) system created by Riken. SR devices entirely cover the user's eyes and ears, and the technology shows images that are created by combining live scenes with scenes previously recorded at the same eye level. The result is combined images that feel real to the viewer. In a way, these technologies deceive the human brain and, as such, they are expected to be effective in treating certain illnesses and improving symptoms related to visual hallucinations, autism, phobias, and depression. As well as feeling real, technologies like VR have the added benefit of content that can be controlled, so user's who suffer from a phobia or autism, for example, can cope with the experience.

What will it mean to humans if technology can make reality combined with additional information look and feel natural? Biologist Jakob von Uexküll called the world created with an organism's specific type of sensory perceptions and behaviors "Umwelt." His assertion is that organisms create their own Umwelt by acting on things that are related and meaningful to selected individual sensory perceptions. Although these technologies do not create new senses, the new natural realities they do create will enable humans to obtain more information than was possible in the past. The questions are, will this help humans create better behaviors and will it shape the next broader Umwelt?

TT02

Technology Trend

The following eight technology trends are expected to have the biggest influence in the coming years.

Precision Life Science

DNA analysis has became readily available to all and obtaining continuous biological information will be easy through the use of sensors. Advancements made in analytical research utilizing large-volumes of shared data will enable a better understanding of people's daily lives leading to positive changes.

In 2003, 50 years after the discovery of the DNA double helix in 1953, the Human Genome Project (HGP) announced its completion. This scientific research initiative decoded the sequence of the entire human genome, which contains approximately 3 billion base pairs. HGP was the world's most collaborative gene mapping project among research institutions. The initial DNA sequencing of the human genome took 13 years and cost about $2.7 billion. Now, with further advances, a similar effort can be completed in under a day and for less than $1,000. In fact, a highly sophisticated "human's map" of all DNA information can be ordered and viewed online. It is literally at a user's fingertips. Along with the CRISPR/Cas9 DNA editing technology that has become well-known in the past few years, technologies that enable access to DNA are expected to accelerate advancements in the life sciences.

Efforts to decode DNA do not stop with the mapping of the human genome. The human body consists of approximately 30 trillion cells. Moreover, approximately 40 trillion microorganisms exist within the body and on its surface. Microorganism populations, called microbiome, have several million genes, which is more than 100 times the number human genes contain. This estimate is based on the 3.5 trillion base pairs sequenced in the Human Microbiome Project, a U.S. Institutes of Health initiative. Microbiome live in composites of hundreds of types in the stomach, intestines, nose, mouth, and skin and form a "microorganism profile" of each individual. Known to have an impact on an individual's life and health condition in terms of physiology, immunity, and nutritional intake, microbiomes may prove to be the key for resolving conditions previously thought to be genetic or psychological in nature. For example, a person is more likely to be obese if she/he has more microbes in the intestine that digest certain types of sugar. In recent studies, researchers found that severely malnourished children had immature stomach microbes. Further research might save millions of starving children. In another example, improvements in symptoms in children with autism were observed after regular use of an antimicrobial agent. Microbiome research is expected to continue to uncover unexpected links to additional diseases and conditions and to be applied to many other areas to improve health and wellbeing.

To obtain useful knowledge from highly detailed and complex information such as DNA, it is essential to have an enormous amount of data for comparison. The Precision Medicine Initiative (PMI) was announced in January 2015 by U.S. President Barak Obama during his annual State of the Union Address. Its objective is to pioneer prevention methods and treatments by taking into account a person's unique variables, such as genes, environment, and lifestyle. This individualized approach, called precision medicine, is the antithesis of traditional "one-size-fits-all" treatments designed for the average patient. The concept of tailor-made medical care and services has existed since early times. However, this PMI is attempting to create scientifically new treatments and preventive measures based on collaborative research among more than 1 million participating volunteers. In collaboration with its hundreds of members from 40 countries, the Global Alliance for Genomics and Health (GA4GH) Non-Profit Organization (NPO) is providing not only a mechanism to share databases owned by medical and research institutions but also a search engine for these databases. Meanwhile, 23andMe, a private company that provides a genetic information service for the public, announced that it reached 1 million users in 2015, 80% of whom have given consent for their data to be used for research purposes. This company's research department and its partner institutions are expected to continue to actively conduct important research.

Genetics is not the only factor in determining health. Environment and lifestyle are equally, if not more important. Progress is being made to gather vital information in these areas, as well, by leveraging technology. Smartphones, for example, can collect data from sensors and wearable devices with high levels of accuracy and at the most valuable time for each individual. Furthermore, daily information gathered from house sensors can uncover indications of diseases related to lifestyle, such as diabetes and gout. Chemical compositions of perspiration and a continuous stream of heart signals from wearables can provide a wealth of information that is far more precise than what is captured in an annual medical examination. By being better informed, individuals will be able to take preventive actions at the moment an illness is detected.

What will be the impact if highly accurate information for a specific individual is available at all times? Patients who are the most knowledgeable about their bodies and their environments will not be satisfied by a simple diagnosis from a doctor when they get sick. Instead, such individuals will select doctors with whom they can form an ongoing relationship. Their doctors will become health and wellbeing advisors/partners as they maintain the quality of their health and performance at home and at work. In this future, preventive measures will not only reduce the ever-increasing cost of healthcare but also enhance the productivity of individuals who will, in turn, contribute to economic prosperity.

TT03

Technology Trend

The following eight technology trends are expected to have the biggest influence in the coming years.

Symbiosis with Artificial Intelligence

Advanced machine learning algorithms will enable computers to understand time and be aware of context. Hence roles of computers will expand. The coexistence of humans and computers will advance through an evolution where people will take charge of work to realize overall optimization.

Artificial Intelligence (AI) received significant media exposure in 2015. This technology is developing rapidly. As a result, several AI-related research organizations have been founded and many companies have established special AI departments. Celebrated AI researchers are in great demand and actively recruited by major organizations. AI startups are being acquired at high valuations. In short, the competition to develop and market AI technologies is fierce.

Deep Learning Technology, which attempts to simulate the power of the human brain on a computer, also is progressing significantly—especially in the area of image recognition. In fact, the accuracy rate of image recognition has reached 95.2%, which exceeds the average accuracy rate of humans.[1] Many business are beginning to use high-performance image recognition technology. For example, autonomous driving support applications use it to recognize pedestrians and objects. Image recognition in the medical field detects malignant tumors within X-rays and CAT scan images. In marketing, the technology is being applied to tag images automatically and identify customer behavior patterns and attributes from images taken by store cameras. Image recognition technology is expected to be used in many areas in the future.

Among the many significant innovations in AI technology are major advancements in machine learning technology, which have enabled the recognition and prediction of future actions. In addition, natural conversation is being achieved by advanced AI with memory functions. Robots with the technology now are able to learn work routines without human programming. Importantly, a new approach to work in which humans and robots share tasks in accordance with their capabilities and competencies currently is being pioneered. Even in the game of Go (an ancient board game, similar to chess, that requires strategy and analytical skill) a watershed event has taken place. An AI computer won a game against a professional Go player. Being able to truly think and determine actions autonomously is an immense step forward for AI. From now on, the technology is expected to progress quickly into disciplines where intelligent decision-making and context-based behaviors are required.

In November 2015, Google open-sourced "TensorFlow," a software library for machine learning. With many researchers and developers using this system, it is believed that the technology will be adopted widely and that the supporting algorithms will be improved. Open-sourcing an AI engine signifies the importance of its data. Without large amounts of useful data, AI cannot perform meaningful work. Developing a learning system that continuously accumulates data for AI is the critical success factor.

Even though AI is advancing very rapidly, when it comes to conducting a simple task, the technology cannot accomplish it as accurately as a human. Therefore, it is important to determine where to apply AI as well as its most advantageous role in business. In some fields, AI can present ideas that humans may not consider. Computers should not be assumed incapable of creative works. As a result, businesses must reconsider the roles and responsibilities of both humans and computers, and then seek ways to take full advantage of the synergy between them. The roles played by humans and AI-enabled computers are predicted to change drastically as humans and AI collaborate in society.

Once AI is able to accomplish work previously done solely by humans, new challenges will emerge. Ethics is one of these challenges. For example, when an autonomous driving car encounters a situation where it cannot avoid a crash, what should it do? How should it factor in children, the elderly, pregnant women, and pets? Several other dilemmas must be considered, as well. How should cars respond to pedestrians crossing streets in accordance with laws versus those who violate traffic rules? With only human-driven cars, precise procedures for every situation are not required, because drivers are considered responsible enough to use proper judgment in specific circumstances. If humans and computers with AI are to coexist, complex ethical matters must be considered, as should the relative roles and responsibilities of both entities and any necessary modifications to the legal system.

1 Sergey Ioffe and Christian Szagedy, "Batch Normalization: Accelerating Deep Network Training by Reducing Internal Covariate Shift", March 2015.

TT04

Technology Trend

The following eight technology trends are expected to have the biggest influence in the coming years.

Autonomous Mobility

Next-generation mobility centered around connected cars will innovate the transportation of people and things.
Cities will develop as a fluid system through real-time, mutual sharing of information, including the transportation of people, the operator's condition, and the external situation.

With the advancement of the Internet of Things (IoT), cars that are connected to the Internet at all times have captured the public's attention. Driving assistance as well as transportation and safety controls are possible by collecting and distributing data such as location, speed, and road conditions from sensors attached to connected cars. Data from connected cars also is used in fleet management to develop optimal delivery plans and support fuel cost reduction initiatives. Telematics insurance services, which reduce insurance fees based on information about driving frequency and driving operations, have been introduced, as well. Such next-generation mobility efforts will not be a mere transportation method; instead, they will change the structure of society itself.

The number of connected cars is forecasted to reach 250 million by 2020, and one in five vehicles on the road worldwide will have some form of wireless network connection.[1] The rapid growth of this market is driven by not only advancement of the IoT but also regulatory actions to mandate embedded mobile technology in cars. For example, beginning in 2017 in Russia and 2018 in Europe, all new vehicles must be equipped with an emergency response system. Moreover, devices that can install add-on features in a connected car and the advancement of 5G mobile communications are expected to support the rapid growth of connected cars.

Mobility-sensing technology is already being used, and it has the potential to make a great contribution to society. For example, sensors in tires detect road conditions in real time and transfer this information to maintenance vehicles equipped with anti-freeze agents, enabling them to spray the proper amount of solution. In another case, detecting vehicle maintenance status and needed repairs beforehand via information from sensors is accelerating the supply chain and enabling quick parts replacement and vehicle repairs.

Driving assistance and communication technology with outside sensors are the basis for autonomous driving technology. Autonomous driving cars will contribute to society by alleviating traffic congestion, reducing energy consumption, reducing traffic accidents, and so forth. Additionally, these cars will influence both the insurance industry and city planning. In the future, cars will change from a means of transportation to a living space, a concept that is expected to bring about transformation in other industries. For example, while advertisements on the road will decrease, advertisements within a car or on a smartphone and based on location or user status will rise.

When discussing next-generation mobility, it is important to consider the advancement of energy-related technologies. One of the reasons electric cars are not popular is the low mileage per charge. However, recent advancements in rechargeable batteries have been remarkable. Additionally, a massive battery factory currently under construction is expected to contribute to lower battery costs. As such, experts predict that within a few years the mileage of electric cars per charge will double and be available at a lower cost. The U.K. government has announced the development of in-road wireless charging technology for electric vehicles. With such infrastructure improvements, electric cars will become increasingly popular. Alternatively, hydrogen fuel-cell cars have a material advantage in both driving range and charging time. However, technical difficulties and the high cost to develop hydrogen fueling stations are significant obstacles to future popularity. In an effort to jumpstart this market, Toyota recently announced that it would provide—for free—more than 5,000 patents related to fuel-cell batteries. This may accelerate the development of other companies' fuel-cell vehicles as well as the required infrastructure improvements.

Drone and autonomous robot technologies also are making remarkable progress. For instance, a security service by drone with a monitoring feature has been introduced. Additionally, drone and robot delivery services in 30 minutes are revolutionizing home delivery. Leveraging these technologies is expected to solve the "last-mile problem," a significant issue due to the disproportionate cost of the last mile of delivery to consumers.

What changes will the advancement of mobility technology bring? The transportation of people and things will become less of a factor, while various new services will be provided from the fusion of various industries. Conversely, security risks will increase as a consequence of constant Internet access. If the controls of autonomous cars, drones, or an entire city are hijacked, it could cause loss of human lives and social disorder. For people to enjoy the advantages and additional advancements of next-generation mobility, further security and legislative measures will be required.

1 Gartner Press Release, January 2015.

TT05

Technology Trend

The following eight technology trends are expected to have the biggest influence in the coming years.

Ambient Commerce

Service that is tailored to the preference, affiliation, and condition of individual customers will emerge.
The continuum of customer point of contact, from the discovery, purchase, payment and to receiving of products, will become seemless, thus enabling customers to have a stress-free purchasing experience.

With the proliferation of smartphones, e-commerce has become commonplace in people's lives. As of 2014, the world's e-commerce market had reached $1.3 trillion and it is expected to grow to $2.5 trillion by 2018.[1] The customer experience at every contact point has been digitized in e-commerce. Smooth and stress-free navigation in finding, decision-making, purchasing, and receiving products are key success factors for e-commerce market leaders.

Showing recommendations based on a customer's browsing and purchasing history is quite common in e-commerce. At present, however, users sometimes see recently purchased items displayed as recommendations. Irrelevant and incorrect recommendations result in not only lost sales opportunities but also a negative customer experience. In addition to following past behaviors, it is necessary to predict future behavioral changes to discover the items customers really need. To that end, a newly introduced service enables connected devices to order daily commodities when supplies are predicted to run out. Meanwhile, an analysis of customer behavioral patterns, attributes, and preferences is expected to be utilized further in marketing activities. For example, with the advancement of technologies that measure behaviors and attributes as well as analyze feelings from facial expressions or walking patterns via cameras and sensors, products can be better developed based on subconscious customer needs and product displays can be optimized at brick-and-mortar stores.

In recent years, websites have begun providing increasing amounts of search criteria, including keywords, product categories, sizes, and colors. However, it still takes customers a certain amount of time and effort to find wanted items. This is where fashion coordination applications based on Artificial Intelligence (AI) add value. These applications learn an individual's fashion preference using AI technology, and then recommend coordinated clothes and accessories. With the option to share preferences, others can find products similar to those chosen by a person whose fashion sense and style they admire. When combined with physical body measurements, this type of service enables users to find wanted products in the proper size more quickly and easily. With shoppers increasingly dependent on and influenced by AI for purchasing decisions, future advertisements may target the AI itself, rather than consumers.

Real-time marketing services to facilitate purchasing decisions also have been introduced. By analyzing mouse movements and webpage transitions in real time, this service detects a user who hesitates to buy a product and displays the proper coupons at the right time. Furthermore, personalized content streaming services have become widespread. By reducing the expectation gap of before and after purchase, a seamless and continuous relationship between suppliers and customers can be promoted.

The trend toward simplifying the purchasing process is accelerating, as well. Some Social Networking Services (SNS) and search engine websites now show "purchase" or "buy now" buttons on their sites, allowing users to complete both payment and purchase without visiting the original shop's website. With a series of seamless purchasing processes, users can buy products the moment they want them—a capability that is expected to reduce lost sales opportunities. The advancement of AI also enables users to order products through text message exchanges or tweets. In brick-and-mortar stores, biometrics authentication, such as fingerprint or vein and face recognition, is being introduced into payment systems so customers can buy products without hard currency.

With omni-channel technology, users can buy and receive products anytime and anywhere. In e-commerce, delivery in one hour or at a designated time and place, even outside of the home with Global Positioning System (GPS) information, has been realized. In addition, delivery by drone or robot and 3D printing technology to manufacture just-in-time products are expected to contribute to further logistics advancements.

Where is e-commerce headed? In the future, e-commerce will enable users to meet subconscious needs and feel satisfied when buying, even after the purchase. To make this a reality, in addition to analyzing purchase history, behaviors, and preferences, it will be necessary to design new user experiences within a series of purchasing processes.

1 eMarketer, "Retail Sales Worldwide Will Top $22 Trillion This Year", Dec 2014, http://www.emarketer.com/Article/Retail-Sales-Worldwide-Will-Top-22-Trillion-This-Year/1011765

TT06

Technology Trend

The following eight technology trends are expected to have the biggest influence in the coming years.

Distributed Mesh Computing

New distributed architecture has appeared to adapt to cloud-native applications and big data processing.
"Block chain," the peer-to-peer bitcoin platform, is expanding its application to diverse systems, not limiting its use to virtual currency.

Bitcoin, invented by the still unknown "Satoshi Nakamoto," began operation in 2009. It now can be used in more than 7,500 places around the world, especially in Europe and the United States. Whereas one Bitcoin was worth 6 cents in 2010, its value surged to more than $400 by the end of 2015. The number of daily Bitcoin transactions also has increased, totaling more than 200,000.[1] Surprisingly, the Bitcoin system has never been down in the seven years since its release.

The technology underpinning the Bitcoin system is called blockchain. Normally, financial systems adopt a centralized system architecture to process and record transactions consistently at a central location. Blockchain technology, on the other hand, is based on a distributed Peer-to-Peer (P2P) architecture in which all transactional data is shared and kept simultaneously among all participating systems of the P2P network. As such, the blockchain is called distributed ledger technology. Transactions recorded on the blockchain cannot be modified or deleted. Using blockchain technology, therefore, it may be feasible to build a highly reliable, irreversible system with high transparency and extraordinary availability at a low cost. In fact, many blockchain trial projects are being conducted, especially by financial institutions. As an example, in October 2015, NASDAQ launched the blockchain-based private securities platform called Linq.

Blockchain also has been gaining attention as a key technology through which the Internet of Value (IoV) can be realized. In the IoV, values are transmitted and transferred with the same ease as data flows around global networks. In fact, leveraging similar technology may redefine "value" itself. This revolution will begin with the traditional custodians of value, namely banks and financial institutions, and then become distributed as each individual throughout the world realizes the ability to buy and sell value.

Other signs indicate movement toward distributed systems, too. The proliferation of Internet of Things (IoT) devices generates enormous amounts of data. Companies are adopting Edge Computing, in which edge servers placed near IoT devices process a certain amount of data rather than having all data processed at a centralized node. For example, NTT DATA, Toyota, and Preferred Networks (PFN) have developed a demonstration of the "collision free automated driving cars" concept by conducting real-time analysis of the data from IoT devices placed in cars and on the roads on edge servers. Another sign of these trends is the now common use of distributed platforms to process huge amounts of data from devices. In fact, Airbnb, Uber, and other leading digital companies have adopted open-source, large-scale, distributed data processing infrastructures, such as Apache Hadoop and Apache Spark.

Then there is cloud computing. Worldwide spending on public cloud services is predicted to double from nearly $70 billion in 2015 to $141 billion in 2019.[2] This shift to the cloud also means a shift to "cloud native" applications, which are designed specifically for a cloud computing architecture and interconnect multiple services via Application Programming Interfaces (APIs).

Compatible with cloud native application, "microservices" is a software architecture style in which complex applications are composed of small and independent services within a container that can be changed easily. Because traditional monolithic architectures cannot accommodate requirements such as frequent and rapid changes and dynamic scalability, a trend has emerged to adopt microservices architectures. For example, Netflix built its system using microservices and it has successfully supported overall viewings that have grown by three orders of magnitude in the eight years since 2007.

Computer systems architectures have historically alternated between centralization and decentralization. Now, the blockchain, the IoT data explosion, and the trend toward cloud native applications are generating new distributed architectures. Hereafter, and beyond the simple dichotomy of centralization and decentralization, any discussion will need to include how to balance the use of these types of architectures according to the characteristics of the applications being used.

1 http://www.coindesk.com/price/

2 IDC, January 2016.

TT07

Technology Trend

The following eight technology trends are expected to have the biggest influence in the coming years.

Cyber-Physical Security

The advent of Internet of Things has extended the impact of cyber attacks to the physical world, requiring every device to have security measures. To cope with the growing scope of cyber attacks, joint defence, such as immediate sharing of threat information, is required.

Many serious security breaches resulting in the release of personal information throughout the world continued to happen in 2015. In June, for example, the U.S. Office of Personal Management (OPM) announced that it had been targeted by hackers and that personal information had been stolen. Further investigation in July revealed that the number of stolen records totaled more than 21.5 million. In Japan, the national pension system was hacked and the personal data of approximately 1.2 million people was leaked. Both the quantity and the severity of such security incidents are accelerating. In fact, the number of detected and reported incidents has increased by 66% annually since 2009.[1]

The security landscape has changed from attacks perpetrated by individuals as a challenge or for their amusement to attacks led by organizations with political or profit objectives. As a result, the tactics and methods used are rapidly becoming more sophisticated and diversified. Both targeted attacks and ransomware attacks have become more prevalent in recent years. A targeted attack is aimed at a specific individual, company, or organization. Because it "attacks" the target in a surreptitious and tenacious way, intrusion is quite difficult to avoid completely. In the case of Japan's national pension system, the security breach was the result of opening a virus-laced email attachment disguised as important work-related information. Ransomware, on the other hand, is a type of malware that restricts users from accessing their own computer or system by encrypting its data and demanding that users pay "ransom." New ransomware is detected every day, and damages from this type of cybercrime are predicted to continue increasing.

The Internet of Things (IoT) also is having a major impact on cybersecurity. "Things" such as smartphones, wearable devices, home electronic appliances, cars, houses, robots, and devices in factories or hospitals will be connected to a network, and soon. Some studies predict that more than 50 billion devices will be connected to the Internet by 2020.[2] Each of those connected devices will face increased cyber threats. In one shocking demonstration, a connected car was hacked and its brakes actually disabled using remote control. Meanwhile, major cybersecurity incidents already have occurred across the globe. A U.S. aircraft was hacked during its flight. The control system of a blast furnace at a steel mill in Germany was hijacked, resulting in massive damage to both the plant and its equipment. Because cyber attacks can now influence not only the cyber world but also the physical world, human lives are being threatened.

Most cyber threats are unknown, and new ones appear one after another, so it is impossible to prevent them completely. As a result, detection and recovery measures and technologies have become even more important than prevention or protection. By utilizing big data analytics and Artificial Intelligence (AI), new technology has been developed to detect and cope with unknown threats automatically. One new service incorporates AI technology in Security Information and Event Management (SIEM) to uncover unknown threats with a high detection rate. It isolates infected nodes from the network automatically and immediately, in cooperation with the Software-Defined Networking (SDN) enabled network devices.

Companies also are implementing Security Operation Centers (SOCs) or Computer Security Incident Response Teams (CSIRTs). Moreover, inter-organizational joint defense efforts are being explored as a way to share data about cyber attack trends and threats. Threat security platforms provide a snapshot of the current security situation by collecting, analyzing, and distributing real-time security threat data from a variety of global sources, including sensors, vendors, analytics, and humans. In addition, several open community-driven efforts are standardizing the specifications used to describe security threat information. Among these are the Trusted Automated Exchange of Indicator Information (TAXII), Cyber Observable Expression (CybOX), and Structured Threat Information Expression (STIX).

Although the IoT generates cyber threats in the physical world, it also can ensure security. For example, a new type of home security service places small sensors anywhere in the home to detect both expected and unusual activities, and then immediately notifies a registered smartphone. In the future, a new technology could prevent incidents before they occur by monitoring and predicting human actions and behaviors based on data collected by sensors and surveillance cameras.

1 PwC, "The global state of information security survey 2015", September 2014.

2 Cisco IBSG, April 2011.

TT08

Technology Trend

The following eight technology trends are expected to have the biggest influence in the coming years.

Engineering Innovation

The application of new technologies, such as virtual reality, sensors, 3D printers, and robots, to manufacturing will take place, thereby realizing sophisticated digital manufacturing. The application of design methods that make products evolve through the repetition of high-speed verification will expand.

Many countries are trying to enhance the competitiveness of their manufacturing industry with advanced digital technologies. Such efforts are called “Industrie 4.0” in Germany, “Industrial Internet Consortium” in the United States, and “Industrial Value-Chain Initiative” in Japan. New technologies, such as sensors, artificial intelligence, robotics, and virtual reality, enable visualization, real-time information sharing, automation, and restructuring of value chains. The goal of these changes is to boost productivity as well as generate new business models.

The Internet of Things (IoT) plays a key role in this movement. Conditions and status of factories or construction sites are visualized in real time by sensors attached to construction machines and machine tools that are connected to the Internet. Analyzing the enormous amount of data these sensors collect helps to not only identify challenges and improvements in the manufacturing process but also detect breakdowns in machines and suggest fixes for these problems automatically. Of course, the “Things” that the IoT will incorporate go far beyond machines in a factory. Everything related to the value chain, including manufactured products, delivery trucks, robots at delivery centers, and Point of Sale (POS) systems in stores, will be connected to the Internet and optimized autonomously. Human beings will be connected, too. In some experimental projects, for example, data on workers’ behaviors and their ongoing status is collected from wearable devices or sensors attached to special clothes, and then automatically analyzed. The results are used to ensure workers’ safety and improve productivity.

Digital fabrication technology as exemplified by 3D printing also is evolving. 3D printing costs are declining rapidly, and a variety of materials—such as metal, glass, plastic, resin, and even food—can be printed. Development continues on “3D bioprinters,” which can print living cells to create internal human organs, as well. Although 3D printing is still mainly used for prototypes and mockups, its evolution may enable the just-in-time manufacturing of items that meet individual needs and the creation of objects that have never before been manufactured.

Advancement of the IoT is accelerating the shift from “Things” to “Services.” It also indicates that the qualities and performance of products (“Things”) themselves cannot be a crucial competitive factor or differentiator. To earn high customer satisfaction, all customer contact points surrounding these “Things” must be highly developed and sophisticated. This can be achieved by designing new relationships between products and customers through repetitive improvements and trial and error. It means going through the processes of taking insights from observation, formulating a hypothesis, prototyping, and then validating results. Consequently, a methodology called “Design Thinking” has attracted a lot of attention. A number of design firms with strong design thinking capabilities have been acquired since 2012, indicating that it is considered a significant differentiator in product and service design. Design thinking also applies to software development. In fact, it is now required as a method to provide both valuable user experiences and business functions within software. The result is widespread, evolutionary, value acquisition development methods with iterative processes, including rapid prototyping and user evaluations. Methodologies include Agile development, DevOps, lean startup, and rapid automated software development.

Although such exciting changes will represent a significant evolution in manufacturing, the Fourth Industrial Revolution also will take us further toward a world where all “Things” will be provided as a form of “Service” and sophisticated user experiences will become the determining competitive factor. In short, it will signify a reinvention and digital transformation of the manufacturing industry itself.

Technology Trends
NTT DATA Case Studies

Immersive Interaction

Remote Work Support System With Smart Glasses

Remote field work, such as IT system maintenance, often requires multiple workers in different locations to ensure quality. The result is higher operating costs and lost productivity. To address these issues, NTT DATA has developed a remote work support system using smart glasses. With this system, remote workers can receive the information they need to complete a task—including instructions and manuals—through a smart glass display. By sharing the images, video, and sounds from these displays in real time with a supervisor in a different location, any problems that arise during the work can be addressed immediately. A feature to mark or add comments on shared images provides accurate additional instructions. This system enables on-site workers and those in a remote locations to interact as if they were in the same place.

Precision Life Science

New Predictive Analytics Solution for the ICU

Medical treatments in Intensive Care Units (ICUs) are for patients with life-threatening illnesses and injuries. These patients require constant monitoring with high-tech equipment and biomedical devices. Such devices generate a large amount of data, and doctors must dedicate considerable time to understanding this information and making decisions based on it. NTT DATA and everis, its subsidiary in Spain, have developed a new medical analytics solution called ehCOS SmartICU to improve patient care in ICUs. It comprehensively integrates all available patient information and data based on established medical protocols and provides healthcare professionals with advanced data analytics to predict outcomes and generate relevant alerts for each patient. By using NTT DATA big data analytics, this solution significantly improves both the efficiency and the accuracy of medical decision-making. A joint project among NTT DATA, everis, and a hospital and its doctors leverages ehCOS SmartICU to reduce patient morbidity and mortality as well as preventable adverse events.

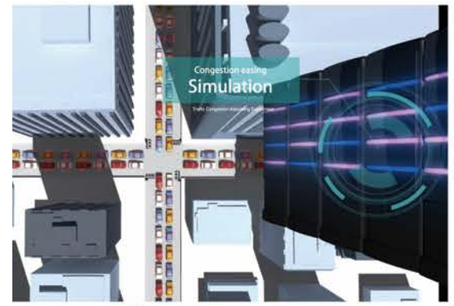
Symbiosis with Artificial Intelligence

New Cloud Robotics Solution

NTT DATA is developing new services using its cloud robotics technology, which combines robots, sensors, and the cloud to solve social challenges, such as the labor shortage escalated by a low birth rate, an aging population, and depopulation in rural areas. NTT DATA has been conducting field tests using cloud robotics technology in various environments. In special nursing homes, for example, an in-room communication robot monitors and interacts with elderly residents to ensure their status, including their safety or the proper intake of medication. A cloud robotics platform analyzes the data gathered from these robots and other sensors, and then sends the proper communication scenario back to each robot to ensure its communication and monitoring functions continue. In another example, a communication robot in the reception areas of a financial institution's retail stores recognizes customers and provides proper guidance to customers by communicating with the cloud. Through these and other experiments, NTT DATA continues to broaden its capabilities in leveraging cloud robotics technology.

Autonomous Mobility

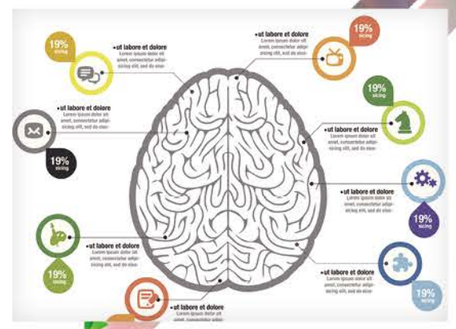
Alleviating Traffic Congestion Using Big Data Traffic Simulation Technology



The number of smart city initiatives has increased in recent years. Analyzing traffic patterns is among the new concepts, and NTT DATA has been developing big data-based traffic prediction and traffic signal simulation technology for that purpose. The technology has proven effective in a field study conducted in Jilin City, China, in alleviating traffic congestion and shortening travel times for public buses. Utilizing know-how acquired in that field test, NTT DATA has initiated a joint research effort with the Institute of Software, Chinese Academy of Sciences, located in Guiyang City, China, to develop traffic simulation technology based on the analysis of data collected by traffic control cameras. Furthermore, a joint project between NTT DATA and Imtech Traffic & Infra UK Ltd—in cooperation with Exeter City, Devon, United Kingdom—integrates Imtech's traffic light control system and NTT DATA's simulation technology to optimize traffic light settings in a wide area in real time to improve traffic congestion.

Ambient Commerce

Understanding Nonverbal Reactions/Feelings With Neural Decoding Technology



In the past, evaluating the quality and effectiveness of advertising campaigns depended on a subjective point of view and reactions captured in a questionnaire. To conduct a more objective and scientific evaluation, NTT DATA and the Center for Information and Neural Networks (NICT) have developed a "neural decoding technology" solution that visualizes subconscious information via brain activity. For example, when a person is watching TV commercials, feelings ("beautiful" or "scary"), movements ("eat" or "run"), and recognizable objects ("a female person" or "an animal") displayed at certain points in the content can be decoded by measuring brain activity patterns. Using this solution, companies can capture and analyze nonverbal information that is difficult to measure in a multi-dimensional way. This information, in turn, will enhance the communication between companies and consumers.

Distributed Mesh Computing

Blockchain-Based New Content Management Technology

NTT has been developing entirely new content license management technology through joint research with the Muroran Institute of Technology. Based on blockchain technology, it records the entire history related to licensed information shared among all network participants. By combining blockchain and cryptographic technologies such as electronic signatures created with a public-key encryption method, it enables highly reliable license management. This content management technology supports “Kirari!,” an immersive telepresence technology also being developing by NTT. “Kirari!” delivers a highly realistic experience as well as the sensation of being physically present at sporting or other events (including images, sounds, data, and the environment) to remote spaces in real time. It uses this blockchain-based content management technology to verify the authenticity and manage the license(s) of the content provided in a secure, reliable way.

Cyber-Physical Security

Immediate Network Isolation to Minimize the Damage of Targeted Attacks

The number of cyber attacks that target specific companies or organizations is increasing. These “targeted attacks” cannot be detected by existing signature-based anti-malware software. The only successful solution is to monitor communication logs, which is possible only after an intrusion occurs. In addition, it takes time to isolate infected devices from the network; both human judgment and actions, such as unplugging cables, are required. Therefore, when an intrusion is detected, in many cases its damage already has spread. To assist with these problems, NTT DATA has developed technology that immediately isolates infected devices by automatically controlling the network and its devices. Additionally, by monitoring the communication of suspicious devices, it is possible to more accurately detect and identify leaked information. NTT DATA supports not only the detection and initial handling of targeted attacks but also recovery efforts.

Engineering Innovation

Global Digital 3D Map Distribution Service

NTT DATA and the Remote Sensing Technology Center of Japan (RESTEC) have been operating a Global Digital 3D Map Distribution Service since 2014. This service uses satellite images and offers the highest precision 5-meter-resolution 3D maps in the world. The service has been employed in over 50 countries for a wide range of purposes, including infrastructure development, disaster recovery programs, and anti-epidemic initiatives. In May 2015, NTT DATA and RESTEC added two new features to the service: highly detailed 2-meter-resolution 3D maps, and a new data format for use with 3D printers. As of March 2016, maps of the entire world are available to clients as part of NTT DATA’s 3D map service. The result is that these maps now can be used in worldwide research or simulations of resources, environmental conservation, disaster prevention, and transportation, among other new purposes.

Looking ahead : Technology trends driving business innovation.

More than ever, the importance of applying innovative technologies for sustainable growth is accelerating.

NTT DATA Technology Foresight presents information society and technology trends.

By analyzing major issues within politics, the economy, society and technology, we hope to deliver business innovation for our clients and society.

Tsuyoshi Kitani

Executive Vice President
Technology and Innovation General Headquarters
System Engineering Headquarters