NTT DATA Technology Foresight 2018

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Looking ahead: Technology trends driving business innovation.

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Digitization has placed society at the beginning of the next social revolution. The constant innovation in technology will continue to drive social structures toward the future, transforming existing business models and bringing them to new levels.

To make optimal business decisions, it is critical for leaders to identify and understand future changes and to determine the best course for sustainability.

At NTT DATA, we continually investigate advanced technologies and social trends that we believe will impact businesses over the next three to ten years, and we publish these findings on an annual basis for the benefit of our clients.

NTT DATA
Technology
Foresight

NTT DATA Technology Foresight 2018

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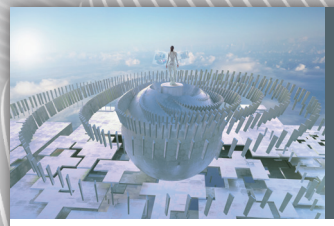

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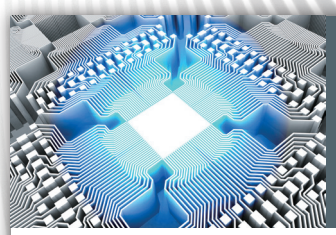

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Information Society Trends

Four key trends impacting social development in business

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IST
01
Information Society Trend

Power of the Individual

The growing influence of individuals and startup businesses are transforming established systems in societies and industries. Individuals with greater independence and unfettered actions, leveraging new ideas and modes of expression, will enjoy a more flexible society with limitless options.

Changes in Social Media

Born in the mid-2000s as merely a bidirectional communication tool for anyone, social media has transformed itself into something that empowers the public to spread and interact with information. For example, in the Middle East, social media helped to trigger a pro-democracy movement called the Arab Spring.

Businesses are using social media extensively as a communications channel with customers to create close relationships with them. Some companies also use social media for product research and development. Influencer marketing, which targets individuals with strong influence in social media, became popular when it was discovered to be effective in motivating product purchasing decisions. In 2017, for the first time, internet advertising exceeded TV advertising expenditures. Given its ability to reach the right targets in the most appropriate context, social media advertising is continuing to grow rapidly. The importance of social media is also increasing as a tool for customer support. In a sharing economy, where goods and services are shared, social media will become an important bridge between strangers, fostering trust and accountability.

A Platform That Interacts With Society

With added functions like news reporting, concierge service, shopping, games and payments, social networking services (SNS) enable individuals to interact with society. The first source of news for many people has become SNS, and an increasing number of politicians have been substituting SNS for traditional mass media to transmit messages directly to constituents. Some social activists also use SNS to reach the public about significant social causes such as the violation of human rights and the protection of wildlife and the environment. Alternatively, the great influence of SNS has resulted in suspicion of possible manipulation of public opinion through the transmission of fake news.

Other adverse effects of SNS include addiction and dependence with long-term use, and the reinforcement of current opinions while selectively reading information in which one is highly interested or agrees. Nevertheless, SNS will likely enhance its bidirectional communication characteristics and continue to serve as an important social infrastructure platform. Future society will likely reflect the opinions of the individual even more so than today.

Digital Transformation

Startup companies are appearing in many different fields using digital technology such as FinTech (financial), AgriTech (agriculture), GreenTech (environmental science) and HealthTech (healthcare) to solve problems and create value. These companies have expertise and technological capabilities in specific areas and collaborate as equal partners with multiple large companies. Also in progress is the unbundling of products and services, where users select and combine necessary and appropriate functions.

The digital economy has reduced transaction costs, and the provision of all functions by a single company has become less of a competitive advantage. As a result, more incumbent companies have been investing in or collaborating with startups to accelerate digital transformation. Partnerships with startups increase opportunities for incumbents to expand business boundaries and develop new business relationships by leveraging the core value of startups. Re-bundling based on clear concepts and customer needs may also increase. For example, in the financial field RegTech was born to harness technology to more easily comply with complex and rapidly changing regulations. In the future, similar services may be developed in fields other than financial.

01 Information Society Trend

Four key trends impacting social development in business

Expansion of On-Demand Economy

The on-demand economy, which provides products and services based on demand, is also expanding. With the pervasiveness of product information and the growth of mobile ecommerce, consumers are now empowered to get what they need when they need it. Some consumers pay a premium for personalized goods and services that are highly convenient. Several companies have adopted crowdsourcing, which uses consumers' opinions and innovative ideas as part of product development.

A changeover to a demand-driven business model requires the construction of an innovative supply chain. Development of digital technology, as well as small and flexible production systems such as 3D printers, has enabled manufacture at sites closer to the consumer. With such an innovative supply system, large companies and new businesses are on equal footing. Supporting this change, the gig economy, where independent workers provide skill, ability and time on demand, is continuing to expand.

Hyper-Personalization

A new business model being adopted mostly in the apparel and accessory areas is called direct-to-consumer (DTC), in which manufacturers and consumers are connected directly. This business model uses social media to acquire customers and sells products only on its own ecommerce site. Skipping a middleman enables the faster sale of higher-quality products at lower prices. The model is also characterized by a clear concept different from that of existing business operators, such as limited product options, transparency of materials, processes, costs and hyper-personalization based on customer data. One of the benefits of this model is that a company can collect all data about a customer and not just a purchase history. Highly accurate analysis based on continuous feedback enables commercialization and recommendations of products on the basis of a customers' preference and lifestyle. Some incumbent companies are trying to cooperate with DTC companies to strengthen their own customer channels.

Some DTC companies are opening physical stores that offer consumers different experiences, for example, advice from a personal stylist or personal counseling. Other instances include pop-up stores*1 and stores without inventory, where you try on clothes but purchase online; stores with restaurants and cafes where you can taste a company's drinks and food; and stores that focus on customer response and on the observation of customer behaviors. The benefits of physical stores have been redefined when combined with ecommerce sites. Additionally, a synergy develops when customers visit both the ecommerce site and the physical store. This clientele tends to buy more and has higher customer loyalty.

Meanwhile, another movement to deepen the understanding of customers and improve customer experience has begun, by clarifying the complete picture of customer behavior, including the hours outside the timeframe when customers are visiting the company, online or offline. In addition to purchasing histories and customer attributes, location information and social media posts are analyzed in real time to better predict customer values and expectations.

Society Driven by Individuals

The growing influence of the individual has already taken root in society, changing the power balance between provider and consumer, politician and citizen, and large company and startups, making society more difficult to lead. Because it has become easier for individual opinions to influence politics and business, more products and services that satisfy individual preferences are being supplied. At the same time, the opinions of people dissatisfied with society's fast changes have also become easier to influence, resulting in a global rise in populism. Concurrently, the international community has slipped into a state of reduced leadership. In an individually driven society, it is indispensable for each individual to act with a wide perspective for the growth and wellbeing of that society.

***1** Stores that open for a limited time at event sites and vacant spaces

Case Study

Real-Time Marketing Using Behavioral Data

An important recent marketing strategy is to use big data accumulated internally to select the optimal channel that reflects a customer's interests in real time, thereby maximizing its impact. However, in web marketing analysis using primarily internal data, customer behavior outside a company's own website cannot be collected and analyzed. This makes it difficult to launch a timely, targeted promotion using an optimal channel based on a broad understanding of the customer's interests.

To address this need, NTT DATA entered customers' behavioral data into an area marketing system using real-time processing technology to capture customer behavior at locations other than its own website. Audience data*1 and Beacon Bank*2 by unerry*3 was also used. This let us understand the targeted information and the locations of websites that the customer visited.

When combined these sources accurately portray customer behavior in the real world. Additionally, Treasure Data's Customer Data Platform (CDP)*4, a digital marketing data integration solution enabled the collection and analysis of large amounts of sales transactions, web viewing, and behavioral data such as applications and mobile terminal logs. This in turn allowed us to target a promotion to an individual customer, at a specific location, using the optimal channel. In addition, analysis of the customer's behavior allowed us to determine the most appropriate promotion timing.

Going forward, NTT DATA is integrating its real-time marketing analysis with behavioral data collected by social networking sites (SNS) further deepening our customer understanding. We will also be focusing on improving the accuracy and broadening the areas of application for our real-time marketing solution.

***1** Audience data uses attributes and behavioral data collected using cookies

***2** Beacon Bank is an off-line behavior platform for sharing and mutually using registered beacons in Japan

***3** unerry is a private marketing services company in Japan

***4** A customer data platform (CDP) is a system for collecting analyzing, and using large-capacity data, online and offline

IST
02
Information Society Trend

Decentralized Collaboration

The transition of various systems from a centralized and hierarchical structure to a decentralized and networked structure will drive new innovation. Dynamic, digital ecosystems will emerge in which constituents will interact collaboratively and autonomously.

A Peer-to-Peer Network Society

Most people are connected to the internet. Importantly, an open and decentralized internet is changing social systems from a vertical, hierarchical structure into a flat, network-type configuration. Devices are connected to the internet too, and the "internet of things" (IoT) directly exchanges information between devices. The type of currency that circulates on the internet is digital money. In particular, cryptocurrencies, which circulate freely and do not rely on national governments or central banks to validate transactions are suitable for value exchange in a digital world without national borders. In manufacturing, a network of smart factories using decentralized decision-making systems are called Industry 4.0. Building urban functions on the internet is called a smart city. The goal is for infrastructure, public services and social systems to be connected via the internet for autonomous, optimal control of assets and resources in order to increase benefits for citizens.

Expansion of the Internet of Things (IoT)

The global number of devices connected to the internet in 2017 is estimated to have increased to 8.4 billion*1, exceeding the world's population of 7.6 billion*2. Internet-connected devices for consumers are mainly automotive systems, smart TVs and digital set-top boxes. In the future, however, the number of smart homes and smart devices within them are expected to increase with connected smart speakers, lighting, appliances and locks. The IoT devices are expected to remotely control the operation of home appliances and vehicles, the adjustment of power consumption, and the ordering of foods and other necessities based on remaining quantities, even alerting users when food products expire. In addition, more natural, wearable devices will likely be developed to monitor exercise, diet and other health-related habits, while providing advice on when to see a physician or take medications. Another benefit of smart homes in an aging population will be looking after remote family members. The future will probably see consumer IoT devices that support a wide variety of appropriate actions based on the context.

For industrial purposes, isolated data use such as smart meters and security surveillance cameras will probably be combined within a wider inter-corporate, cross-industrial sharing of data. Analysis of onsite data, which has been underutilized is also expected to advance, leading to real-time solutions of onsite issues and value creation. Infrastructure for electric power, water, gas, and public transportation and emergency services, as well as street lights, bridges and parking lots are all likely to be connected to the internet. This will improve the safety, convenience and efficiency of smart cities.

In a society permeated by IoT, a constant internet connection is required. Delayed or disrupted communication may result in serious consequences. Compounding this issue, many IoT devices remain vulnerable in terms of security. Targeted for hacking, infected devices can spread the virus to entire ecosystems. Consequently, it will be necessary to limit the impact of hacking attacks in order to allow society to function without disruption.

Application of Blockchain Technology*3

Cryptocurrencies, also called the "internet of money," do not have centralized administrators. Devised as a core technology to support the virtual currency bitcoin, blockchain technology enables information exchange on open networks while guaranteeing reliability. Because each participant holds a ledger with the same content and updates it with everyone's consent, blockchain is also called distributed ledger technology. Because the technology is highly transparent and fraud-resistant, its application to a variety of business purposes is anticipated.

Blockchain technology can enable payments and remittances without going through third-party intermediaries. As one would expect, it is attracting a great deal of attention from financial institutions and other organizations. Although the technology in its present state has issues with slow transaction processing

speed, development is underway to augment blockchain technology to increase its speed of processing. In trade finance, where there are many involved parties and procedures are complex and time-consuming, distributed administration of common ledgers is expected to eliminate third-party intermediaries and speed the transmission of information.

The highly fraud-resistant characteristics of blockchain technology may be applicable for uses such as traceability of recorded food additives, storage conditions, and monitoring vibration and temperature changes of delicate drugs during transport. Although the data on blockchain is trusted only when the recorded data is not fraudulent, direct digital recording of measured values will improve reliability, and the technology can also be applied to the management of performance testing and quality control data in the manufacturing industry.

Smart contracts, which creates predetermined contracts when prearranged conditions are met on a blockchain, is a system that enforces execution without the intervention of a third-party organization. The predicted applications of such technology include automatic buying for when financial securities fall below a certain price, and delivery of smart keys in a sharing economy.

Although like the internet, blockchain technology has the potential to transform society, it is still at the proof-of-concept stage. It may prove to be a technology effective for an open, digital society. However, many challenges exist when applying such technology in a system fostered by a physically-oriented society. Recognition of redundancies within the existing system and acceleration of the aspiration for new technologies may help to change the current social system.

Alternative Funding

Funding methods for startups leading the migration to a digital society have become diverse. One method increasing in popularity is crowdfunding, in which investments, financing, loans, and subsidies from other companies, venture capitalists and financial institutions, receive funds from an unspecified number of entities through the internet. Crowdfunding does not incur any fees and is available to anyone. Financing through crowdfunding also functions as both market research and new customer acquisition, helping to mitigate barriers for startups. Some large companies also use it to finance new business ventures.

An initial coin offering (ICO), which offers investors crypto tokens in exchange for funds, is also attracting attention as another means for startups to raise capital. While this could make funding available to virtually anyone, there are many risks including contributions made for speculative purposes and potential loss of investment. Because much fraud has occurred, new regulations for ICOs are being considered and some countries have banned the practice. Whether or not this type of underwriting approach prospers as a new means of funding in the future deserves careful observation.

Moving Toward a Digital Society

An open system in which anyone participates may be most suitable for a digital society, while knowledge fostered in a closed and managed system may be appropriate for a traditional society. The current world in which we live is one with national borders and individual companies and organizations. Nations and organizations compete mainly with closed strategies and cooperate mostly with open strategies*4. These different approaches coexist. As we become a fully digital society, we will likely seek to harmonize both open and closed systems.

***1** https://www.gartner.com/newsroom/id/3598917

***2** World Population Prospects, the 2017 Revision by the United Nations (June 2017)

***3** Blockchain technology is so called because blocks containing multiple transaction records are chronologically chained together.

***4** An open strategy is inclusive and transparent allowing participation beyond organizational boundaries. A closed strategy enables the control and optimization of all the elements of any system for greater performance.

Case Study

Open Innovation Platforms for Financial Institutions

Fintech startups, mostly in western countries, continue to provide new, innovative services. To encourage such innovation in Japan, the government is actively promoting a systematic framework for the release of application programming interfaces (APIs)*1 for financial institutions. In addition, to ease regulatory obstacles The National Diet*2 is reviewing a bill to amend the current Banking Act.

To also help financial institutions and Fintech companies in Japan to cooperatively create new Fintech services, NTT DATA launched a high-reliability and high-security cloud service called OpenCanvas, which provides APIs and API management. OpenCanvas also includes a function to connect image, voice, video and language data with each company's AI in multiple ways.

OpenCanvas was also adopted as one of the demonstration environments for the blockchain-linked Japanese Bankers Association platform. The first of these demos explored the usability of blockchain technology for densai.net Co., Ltd. Moreover, by using Altemista Cloud AI connecter, NTT DATA makes it possible to connect AI or machine services provided by Amazon Web Services, GoogleIBM, Microsoft and other companies through APIs.

At NTT DATA we will continue to connect financial institutions and Fintech companies throughout the world by expanding our cloud services based on the OpenCanvas platform.

***1** Application Programming Interface: a set of subroutine definitions, protocols and tools for building application software.

***2** The National Diet is Japan's bicameral legislature.

IST
03
Information Society Trend

New Data-Driven Economy

Real-time and predictive data have become valuable resources driving growth and innovation. Exploiting the benefits of data through analysis and application will generate new value. This will transform the frameworks of industries and competition, prompting new business models.

The Arrival of a Data-Driven Economy

In today's social economy, digital data has become the source of value and competitive advantage as well as an important resource for creating innovations. Leading internet companies that monopolize customer information (data) to build a dominant competitive position are being rewarded with high market capitalizations. Some platforms recognized the value of data early and actively collected data based on the multi-sided platform model*[1]. Aggregation of customer information and continuous updates of algorithms improve both analytical accuracy and the speed in which customers can find information. This in turn increases customer satisfaction. The combined data can be used not only for customer analysis, but also for macro economy, stock market trends, election results, and the status and prediction of fashion. In addition, targeted advertising, which provides information to a specific group of customers at optimal locations and times, improves the conversion-to-sales rates. Because of the network effect, huge platforms will continue to accumulate customer information, quite possibly becoming even stronger in the future. Other companies are also starting to recognize the high value of data.

Using Healthcare Data

In the medical and healthcare field, information is now measured on a daily basis. Influenced by growth in the healthy living trend, more healthcare data is being generated outside of healthcare institutions from home healthcare equipment, wearable devices and smartphones as well as genetic tests for general consumers. Although some data may be low in accuracy, rapid diagnoses and changes in measurements cause a person to alter behavior or seek medical attention, leading to a shift from treatment to preventive medicine. Since patients spend an overwhelming amount of time away from healthcare institutions, information about their behaviors between medical visits is extremely useful to healthcare organizations. Detection of slight variations in health information could lead to a determination of the cause of pathogenesis as well as prevention of further disease development.

AI-based data analysis has started to be used in the development of new treatments, improvements in the drug discovery process and individualized treatments based on genetic information. Genetic information collected by biobanks is expected to accelerate the development of treatments for intractable diseases and many life-threatening illnesses. Clinical data is also being accumulated in studies of new treatments such as regenerative medicine using a patient's own stem cells, and integrated therapy including both regenerative medicine and gene therapy.

While successful results are expected from the use of information in the medical and healthcare fields, such data is highly sensitive. As a result, protection of personal information is a critical issue. One concept being considered is called a personal data store, in which all personal information, including medical and healthcare data, is managed and used based on the individual's intention. For example, one of the ideas under review is partial disclosure of personal information with consent to be used toward the solution of specific social issues. In this way, both privacy rights and the public interest can be balanced appropriately.

The Growth of Ride-Hailing Services

The automotive industry is facing a disruptive change where multiple technological and social renovations are developing in parallel. The boom of the sharing economy is proof that the source of product value resides in its function and not its ownership. For example, the popularization of ride-hailing services is evidence that the essential value of automobiles is as a means of transportation. As a result, some automobile manufacturers are entering the service industry by starting ride-hailing services or partnering with business operators to offer such a service. Effective matching

of transportation needs and means helps to shorten travel distances and improve operating rates, leading to better efficiency and protection of the environment. In the future, even more convenient transportation services will likely be offered as all vehicles such as cars, buses and taxis operate on a shared and on demand basis. If sharing extends to the logistics area, it would reduce costs and encourage the integration of transportation and logistics. Service demand is expected to be leveled through the application of dynamic pricing, in which fees fluctuate based on demand.

A Move Toward Autonomous Driving

In the field of autonomous driving, the vehicle collects and analyzes real-time location information and controls itself based on an autonomous assessment of the situation. Automobile manufacturers and IT companies are competing against each other to develop this technology. The accumulation of driving data is indispensable to further technology improvement. The year 2017 saw a significant increase in travel distance for unmanned vehicles and the start of public road trials under specific conditions. Technologically, a completely autonomous vehicle might appear over the next several years.

Autonomous cars may eliminate the need for public parking spaces in cities, which in turn might necessitate a review of urban planning. In addition, it will impact car insurance, transportation/logistics, travel and other related industries. Fast food restaurants will also undergo changes and delivery may become the most common business model for restaurants. Although a review of the current legal system to include autonomous vehicles has begun, it will take time for the issues of safety and the protection of collected information to be solved. Streets, where unmanned and manned cars might coexist, are particularly dangerous and the liability from accidents remain a major challenge. If these problems are resolved, autonomous driving on public roads will progress, beginning in the logistics and the ride-hailing fields. In addition, new services will be formed due to the abundance of commuter time during which no driving is required.

A Shift to Electric Vehicles

As European countries and China regulate the sale of gasoline and diesel-fuel vehicles, a shift to electric vehicles is in progress. Electric vehicles, which have simpler structures and fewer components, will also trigger a transformation in the pyramid structure of the automobile industry. The automobile industry faces an issue of creating superior customer value versus electric appliance manufacturers and venture companies that are already entering this market. Companies are working on efficient ways to provide electrical charges, which consider the type of EV, driving habit, travel distance, electric prices and weather conditions. In addition, vehicles must factor in contingencies for traffic jams and emergencies and the use of travel data for car insurance purposes. Creation of unique value with connected cars, which are capable of two-way internet communication, is also anticipated.

The Most Important Resource of the 21st Century

Data is considered to be the most important resource of the 21st century and a source of innovation and growth. However, accumulating data in itself does not create value. A study of 22 countries worldwide revealed that only 15% of the accumulated data has been indexed in a usable way; and 33% has been indexed but is unusable due to redundancy, triviality and obsolescence, and the remaining 52% is not in a format conducive to indexing*2. Progress in the recognition of the importance of data will likely encourage better processes for the accumulation of data, creating greater value.

As society fully understands the significance of data, some are concerned that a data monopoly by huge companies may undermine the interest of consumers. Others argue that the data itself belongs in the public domain. In the interim, the European Union established the General Data Protection Regulation (GDPR) to strengthen and establish the basic right of protecting personal information. In the future, when challenges related to data are resolved, it will enable the creation of new opportunities and provide solutions to difficult social issues.

***1** A business model that creates added value by connecting two independent customer groups

***2** Global Databerg Report by Veritas Technologies, March 2016: https://www.veritas.com/news-releases/2016-03-15-veritas-global-databerg-report-finds-85-percent-of-stored-data

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Case Study

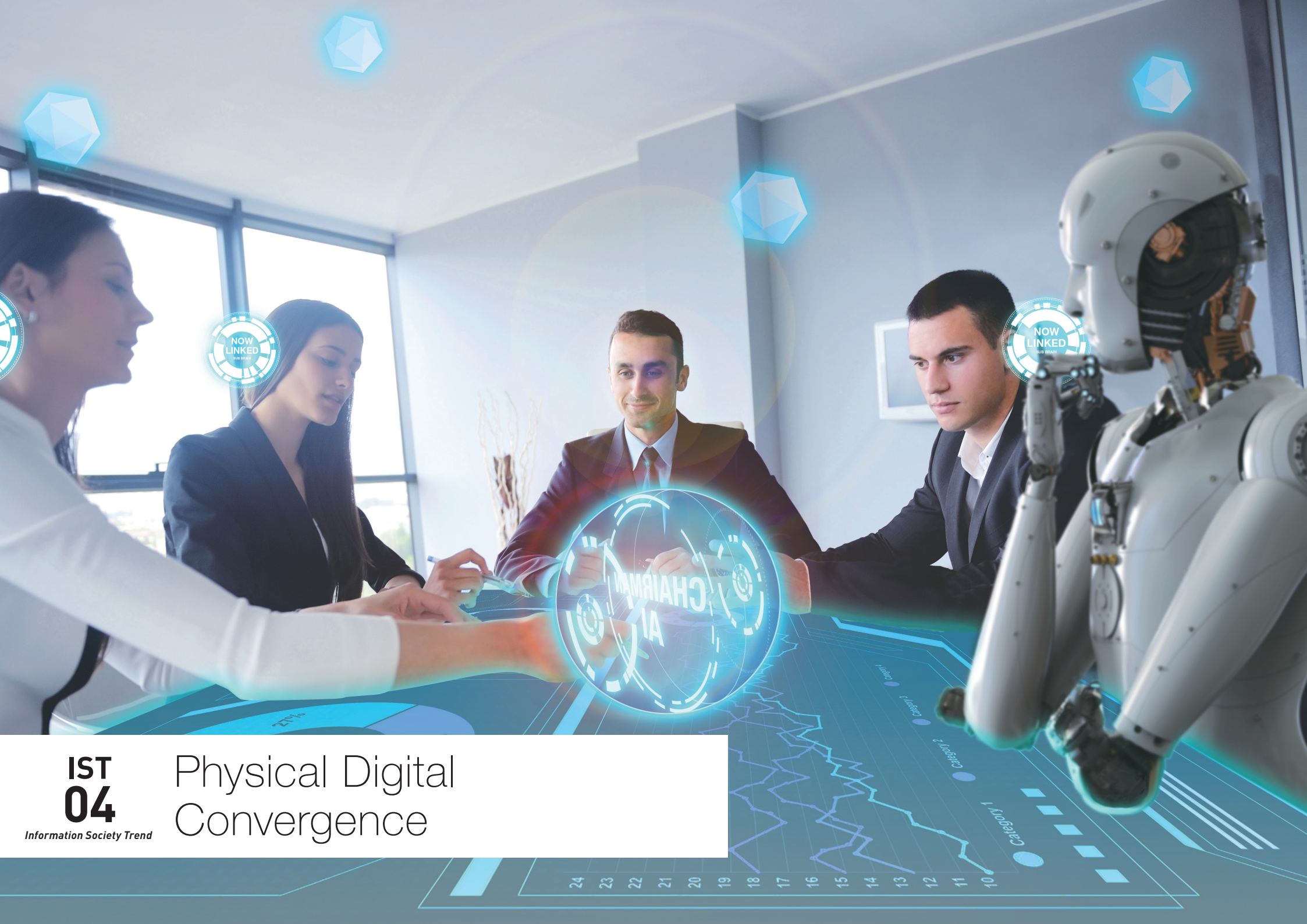
AI-Based Business Matching Service

The economic environment for small and medium-sized companies in Japan is becoming increasingly challenging with the maturation of Japan's domestic economy and due to factors such as a lack of successors and employment issues. As a result, the need for business matching services to enable companies to take advantage of global business opportunities is on the rise. Responding to this acute need, many public and regional financial institutions, and corporate enterprises, are promoting business matching service to help accelerate the growth of regional economies. However, to accurately understand corporate needs and select the best candidates for such a service requires significant experience and specialized expertise.

NTT DATA worked in cooperation with the Bank of Kyoto to conduct a demonstration using artificial intelligence (AI) to enhance business matching services without depending on personal experience and skill. The demonstration combined the bank's matching activity data and NTT Group's AI technology called corevo*1 to select optimal partnership candidates. Specifically, the AI analyzed words and sentences that described the company's needs and then ranked the matching candidates in order of best fit.

Based on the lessons learned from this successful demonstration, we at NTT DATA plan to further improve AI accuracy used in needs and success factor analyses. We believe this, in turn, will lead to the launch of a business matching support service. We will also be examining enhancements to business matching services, such as using the success factors analyzed by the AI to introduce optimal matching candidates to potential client companies without waiting for requests.

***1** corevo is a registered trademark that represents any effort that uses AI cultivated by the research and development of NTT laboratories. It is a consolidated brand of the NTT Group that accelerates collaboration between diverse partners.



IST 04
Information Society Trend

Physical Digital Convergence

The natural convergence of the physical and digital world is near. Ubiquitous artificial intelligence will impact people's thoughts, behaviors, relationships and more, prompting the reexamination of societal rules and norms.

Changes in the Retail Industry

Global ecommerce is expected to grow at the rate of about 19.4% per year (CAGR)*1 between 2016 and 2020. The ecommerce share of retail sales is estimated to have exceeded 10% in 2017.*2 While traditional retailers are joining ecommerce and closing brick and mortar (B&M) stores, a number of ecommerce companies have also built new physical store locations. Retailers are being responsive to the behavior of consumers, who go back and forth freely between digital and physical channels.

Meanwhile, physical stores have also changed. The growth of ecommerce has altered the role of B&M stores, which now not only sell goods but act as showrooms and distribution bases. Most importantly, stores have become a place to observe customer behavior. In contrast, some ecommerce companies use physical locations to deliver orders directly to customers' homes.

Physical stores are now integrated with digital technology and experimenting with advanced techniques. Some recent trials have included store guidance by robot, product promotion via interaction between the shelf and a customer's smartphone and behavior tracking using cameras and sensors. In some cases, AI is used to provide hyper-personalization service. Experiments with a cashier-less store have also begun. In short, B&M stores in the digital era provide vastly different value from that of traditional stores.

Moving Toward a Cashless Society

Cashless payments support retailers in a digital era. From 2014 to 2015, global cashless payments grew 11.2%. The average compound annual growth rate (CAGR) of cashless payments is expected to reach 10.9% between 2015 and 2020*3. Sweden, where cash payment has declined to as little as 1%, is considered to be the closest to a cashless society. Many stores there do not even accept cash. At the same time, cash payments at storefronts in the country have decreased to about 20% of sales. The cashless trend is even taking place in developing countries, where many people do not have bank accounts or credit cards. This is because mobile payments provided by cellular phone companies in locations such as Africa make this type of transaction possible. In addition, cashless payments provided by ecommerce companies and social media companies have also become available at physical stores.

Pervasive AI

AI is advancing the digitalization of face-to-face communication. Of particular interest to consumers is the smart speaker, equipped with a virtual assistant capable of answering simple questions by voice, managing schedules, playing music, operating home appliances and facilitating shopping. The penetration rate of smart speaker interfaces is expected to reach 16%*4 in the United States and is likely to grow more rapidly in the future. The results of a recent study concluded that the longer a user owned a smart speaker the more it was used, indicating that it influences behavior patterns. The virtual assistant function is now also widely equipped on smartphones, wearable devices, home appliances and automobiles. In the future, it might be possible for a smart speaker to buy things via another smart speaker with an artificial voice. With the smart speaker, AI has the potential of permeating our social life.

Coexistence With AI

AI is being accepted in many aspects of our lives. However, users' decisions are at risk of being influenced by options suggested by AI. In fact, in a life surrounded by AI, users could be manipulated by it. To make good use of AI while avoiding such biased decision making, it may become necessary to foster the human ability to think and make decisions. For children, it may be even more important to provide

them with emotional and ethical education as well as interpersonal communication skills. This is particularly true given that AI that has learned biased data may become a threat to humans. To enable AI to develop good judgment similar to that of humans, it must be allowed to learn social norms.

The relationship between humans and machines will change with AI-equipped machines acting autonomously. Some labor will be performed solely by machines, necessitating a review of laws and systems, which assume human operation and labor. Although it is important to protect human labor, it is also essential to prevent social restrictions from becoming a hindrance to innovations. If the substitution of human labor by machines becomes prevalent, common practices may have to be reexamined, including the eight-hour workday and the introduction of a basic income.

Changes in User Interfaces

Smartphones are shifting from type input to voice or image for search functions, and speech recognition technology already has an accuracy close to that of humans. In addition, smart speakers are now common in homes. In fact, voice might soon replace the keyboard as the most common form of data entry and smart speakers may displace household personal computers. Moreover, the virtual assistant function of smart speakers is changing computers from a tangible box to something intangible.

Further development of AI might even render instruction via voice or image unnecessary. For example, AI could proactively transmit information based on the user's expression, vital data measured by a wearable device and the user's pattern of behavior. AI might independently select and set the environmental conditions, or react to a user's responses by adjusting settings. In environments such as factories and hospital operating rooms, where users cannot readily use hands, smart glasses or aerial displays may be adopted as a more useful interface. Security numbers and passcodes for personal identification will likely be replaced by biometrics using face, fingerprints, iris and voiceprints. Biometrics can also be combined with user behavior patterns for natural authentication without the user's conscious participation. As a result, the digital divide stemming from the inability to use a keyboard will be eliminated.

A Human-Centric AI Society

Since AI will be used in households, hospitals, companies and public organizations, a review of societal systems and rules will be necessary for it to be integrated into society. For example, when AI with machine learning has an accident as a result of functions it has acquired on its own or from other AIs, who is legally liable? This and many other issues must be resolved. On the other hand, social norms and customs are difficult to control, and it takes time for changes to permeate humanity. If people harbor a negative concept that AI will rob them of jobs, resistance might elongate the time for changes to occur. Through continuing education as well a review of systems and rules, efforts must be made to prevent alienation and the creation of a new AI divide.

***1** https://www.researchandmarkets.com/research/96l536/global_ecommerce

***2** https://www.statista.com/statistics/534123/ecommerce-share-of-retail-sales-worldwide

***3** https://www.worldpaymentsreport.com/#non-cash-payments-content

***4** Regarding the innovator theory proposed by Everett M. Rogers, Geoffrey A. Moore argued that in high-tech products, there was a big chasm between the early adopters and the early majority (penetration rate of 16%).

Case Study

Enabling Sign Language Communication via RoBoHoN

According to the World Health Organization*1 about 360 million people worldwide have impaired hearing. In Japan, the number is several million and of those about 320,000*2 require the use of sign language. Without daily access to sign language interpreters, it is difficult for these hearing-impaired individuals to communicate with people with normal hearing. In addition, opportunities for people with normal hearing to learn sign language remains limited.

To help address this issue, NTT DATA worked in collaboration with Sharp and NTT DATA SBC to develop an application that interprets sign language and translates it into speech. This application operates on the "RoBoHoN"*3, a mobile robot telephone manufactured by Sharp.

RoBoHoN is also capable of expanding its scope of services by adding applications. For example, individual and corporate applications have recently been released that include support for office reception, product guides at stores and computer programming training for children. NTT DATA leveraged deep learning to develop this application for the RoBoHoN that recognizes and analyzes hand motions of a hearing-impaired person, then translates them into spoken Japanese. The application facilitates communication to a hearing-impaired person by recognizing speech and displaying it in sign language on a device, such as a smartphone. The idea to develop this application for the RoBoHoN was submitted as part of NTT DATA's internal competition for application development, which aims to foster an innovative organizational culture. The grand prize winning idea for this application prompted the three-company joint development of this helpful software.

This RoBoHoN application is currently in use when simple communication is needed in Japanese only. However, plans to further enhance its functionality through the addition of more sophisticated sign language vocabulary and support for multiple languages is in the works. This will allow the RoBoHoN to be used at government offices and global corporations. NTT DATA will continue to develop superior means for effortless sign-language interpretation for a variety of situations to improve the lives of the hearing-impaired.

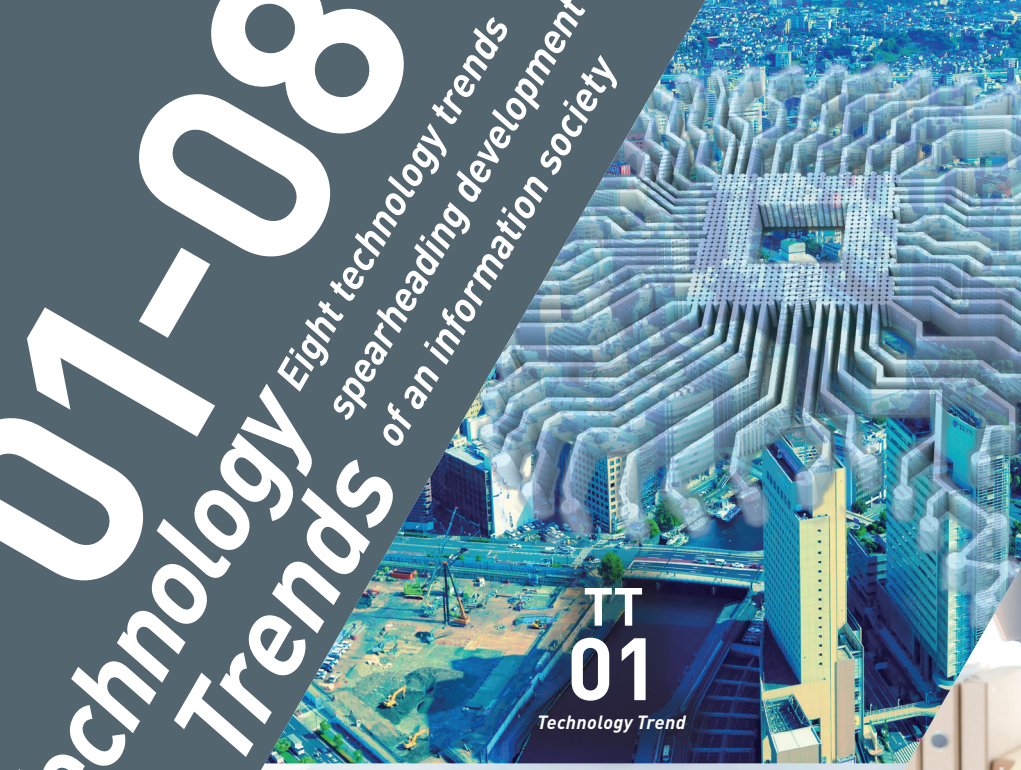
***1** Deafness and Hearing Loss by the World Health Organization

***2** A 2011 Survey on the Inconveniences of Living (A Study of the Status of In-Home Children and Adults with Disabilities) by the Japanese Ministry of Health, Labor, and Welfare.

***3** For more information about the RoBoHoN, please refer to the official website by Sharp Corporation at: https://robohon.com/

01-08 Technology Trends

Eight technology trends spearheading development of an information society



01-08

Technology Trends

Eight technology trends spearheading development of an information society

TT01 Pervasive Artificial Intelligence

TT02 Harmonious Automation

TT03 Intuitive UI

TT04 Data Sustainability

TT05 Hacking Life

TT06 Security Intelligence

TT07 Diverse IT Infrastructure

TT08 Perpetual Design

TT
01
Technology Trend

Pervasive Artificial Intelligence

The barriers to using AI are being overcome by its accelerating evolution. Companies without massive data or experts in machine learning can also have opportunities to use AI. Furthermore, the development of algorithms and hardware for mobile and IoT will bring about the pervasiveness of autonomous AI in every dimension of life.

Evolving AI

The burgeoning world of artificial intelligence (AI) is being championed not only by specialty journals but also by the general media. This is because AI is evolving rapidly with new technologies and services being released daily. For example, AlphaGo, the computer program well-known for having AI that beat a professional Go player, continues to evolve. Alpha Zero, introduced in December 2017, is the latest release of the program demonstrating world-class ability not only in Go but also in chess and shogi. What surprised the world is that Alpha Zero taught itself this expertise after learning only basic game rules. This indicates that AI can autonomously develop abilities by extrapolating rules for use in other applications. Since AI learns differently from humans, it has the potential to create groundbreaking techniques and approaches from which humans can learn.

In a reading comprehension test in January 2018 using a dataset called SQuAD*[1], AI exceeded human scores for the first time. AI has also outsmarted humans in image and voice recognition abilities. In the future, anyone will likely be able to comprehend complex information found in medical and court documents, for example, using AI to translate text into layman's terms.

Diminishing Barriers for AI Use

While AI continues to evolve, how much is it being used in business today? Deep learning, which is singlehandedly driving the advancement of AI, becomes more accurate as the amount of data increases. However, processing such data requires robust computing power. As a result, a gap may exist in the successful implementation and harnessing of AI for the development of products and services within large companies that possess huge amounts of data and rich computer resources, versus smaller companies that do not have such resources.

Recent developments in AI technology have begun to narrow this capability gap. For example, in deep reinforcement learning, AI repeats trial and error simulations to autonomously learn without prepared data. In transfer learning, AI can also adapt learning from one specific area to another. This enables learning with small amounts of initial data to produce highly accurate results. For instance, accessible data for medical images are limited due to privacy issues. Nevertheless, AI can learn from the huge amounts of data in common objects, transferring this knowledge to infer diagnoses with a high degree of accuracy.

Learning algorithms themselves have evolved. When recognizing an object using traditional deep learning, the positional relationships and directions of each part of the image are not considered. For this reason, learning data of different patterns is necessary. In a breakthrough technique called a capsule network, spatial attributes such as the positional relationships and angles of each part of an object are extracted for AI to learn. Using this technique, AI requires only small amounts of data to then recognize an object.

Recent developments encourage the use of AI at many companies. Robust computing power can now be used on cloud networks without an initial investment, and learning models can be designed via the neural network without programming. In addition, parameters can be optimized automatically. In the future, setting a task and preparing data is all that will be needed to easily create AIs specialized in individual applications.

Competitive Edge of Using AI

Given that any firm can now leverage AI, what are the factors that will differentiate one company from another? One is the ability to apply AI to business in the most appropriate way. In other words, the competency to leverage AI to solve business challenges. Since the AI evolution is accelerating, another differentiator is speed of application. Consequently, speedier development cycles with faster updates to the latest model will be important.

Another critical factor is building a system that can continuously accrue data. Although AI can now be used in fields with little accumulated data, the amount still differentiates one company from others using AI. For this reason, it will be important to compile feedback data from users through services and then continuously improve the quality of the services. An example of this process is a service offered by Google in which AI can recognize a picture drawn by a human. Using the one billion pieces of data accumulated through this service, Google has also introduced another service to convert a picture drawn by a person into an illustration. The concept of building an ecosystem where data accumulated through a service creates a different service will likely be necessary for continuous corporate development.

AI Transparency Is Needed

Because deep learning performs calculations based on intricate network structures, the derivation process is also complex. This makes it difficult to understand AI decisions. Discussions are underway on the ethical aspect of AI development and use, with some people desiring more transparency. The Asilomar AI Principles*2 and the AI Development Guideline for International Debate include principles*3 regarding AI transparency, which stipulate that AI's reasoning for a judgment should be verifiable in case it causes harm or negatively impacts humans.

To meet this need, efforts are ongoing to account for the reasoning behind AI decisions. For example, images taken by a camera mounted in autonomous vehicles have a strong impact on AI judgment. These cameras have enabled AI to incorporate visualization into its decision making. Development with transparency will probably increase the appeal of AI. However, such a requirement may also slow the pace of AI innovation. Although no legal restrictions currently exist for transparency in AI, it may become important for society to strategically invest in the development of such transparency in the future.

Edge Expansion with AI

The common method to process data acquired from edge devices such as mobile terminals and IoT devices, is to transmit the data to a cloud where it is processed and then to communicate the results back to the device. The problems with this method are that the location of data processing is limited to where a network connection is available, and data traveling back and forth may delay processing or cause information to leak. For this reason, data processing directly at the network edge is desirable. However, models learned via deep learning are complex and large in volume. The size of some highly accurate, object-recognition models may run from hundreds of megabytes to several gigabytes. This makes it very difficult in some situations for edge devices to provide proper services with currently available computational resources.

A technology that solves this problem has recently been attracting attention. This technology compresses learning models to make them significantly smaller, within an accuracy deterioration rate of a few percent. In some cases, the size is reduced to one 500ths of the original. In addition, the emergence of a framework for generating and processing small-size learning models and AI chips that enable high-speed processing, will also allow any device to process at high speeds wherever it may be. In the near future, advanced learning will almost certainly be available at edges, with individuals freely building and using AIs on their own devices. The advent of a world where individual AIs permeate all aspects of life and in which AIs cooperate with each other may dramatically transform the face of our lives and businesses.

***1** SQuAD is an abbreviation for Stanford Question Answering Dataset

***2** Future of Life Institute: https://connect.xfinity.com/appsuite/#!!&app=io.ox/mail&folder=default0//vcth/Umvt

***3** AI Network Social Promotion Conference: https://futureoflife.org/ai-principles/

Case Study

Vibration Control for Super High-Rise Buildings Using Deep Reinforcement Learning

The vibrations from long-period ground motion*1 from the Great East Japan Earthquake in 2011 damaged the exteriors, interiors and equipment of many super high-rise buildings. This alarmed many residents. Countermeasures to mitigate such ground motion is not progressing rapidly. Consequently, it is vital to develop and institute appropriate countermeasures prior to any predicted major earthquake.

To reduce damage to super high-rise buildings due to long-period ground motion and the anxiety of residents, NTT Facilities is harnessing artificial intelligence (AI) to create a new technology with a superior damping effect. In cooperation with NTT DATA and NTT DATA Mathematical Systems, NTT Facilities leveraged AI to create active damping*2 technology for super high-rise buildings. Based on the seismic vibration, the AI uses an electric actuator*3 to control the dampers*4 inside the building during an earthquake, determining the optimal damping through deep reinforcement learning, which combines reinforcement learning and deep learning.

Vibration tests using a large-scale model verified that this technology could reduce vibration in buildings by over 50%, when compared to traditional technologies. In addition, using this technology to mitigate long-period ground motion in existing super high-rise buildings achieves desired damping performance using significantly less dampers. This reduces the space required for vibration control seismic retrofitting, lowering construction costs and required time periods. Moreover, new value is added to buildings, because residents will feel more at ease by the improvements in vibration control.

To market this future technology, we are developing ways to efficiently implement it within real-world buildings. In particular, we are actively promoting the implementation of this technology as a means to mitigate the impact of long-period ground motion to super high-rise buildings during a predicted, future major earthquake.

***1** Long-period ground motion is caused by an earthquake that takes a long time period to make a full cycle.

***2** Active vibration control uses external energy to provide the force required for vibration control of the building.

***3** A damper is a device that controls the vibration in a building by absorbing seismic energy.

***4** An electric actuator is a mechanism that expands and contracts using electric energy generated by combining motor and mechanical components.

TT
02
Technology Trend

Harmonious Automation

Hardware-and software-based robotics have improved human productivity by automating routine tasks. These are being extended to non-routine tasks using AI. As full automation cannot be achieved in all areas in the near future, designing the interface between robots and humans and enabling each to share complementary assignments to create optimal interaction remains the challenge.

Automation by IT

IT supports automation. IT also supports robots lined up in a factory. For 24 hours/365 days a year, robots incessantly repeat the movements preassigned by the program, producing results at a consistent level of quality.

At huge ecommerce stores that sell billions of dollars in merchandise, the number of items processed exceeds 100 million. In a huge warehouse that supports their logistics, more than 1,000 product shelves are stored, each measuring more than 2 meters in height and 100 kilograms in weight. The workers, however, do not need to walk around this huge warehouse looking for a particular shelf that stores an individual product. The robot, whose installation began around 2010, lifts the entire shelf and delivers it to the workers. The workers wait at a designated location and follow the instructions on the screen to load or unload the needed product. After loading or unloading is complete, the next shelf is delivered immediately. The robot and human work efficiency is 4 to 5 times higher than that of a human alone.

It is clear that this type of robot-driven automation would not be possible without the support of IT. The IT system controls as many as 100 robots in an integrated manner including the movement to: relocate the appropriate shelf to the right location; select an efficient route of delivery; avoid collision between robots; and detect an obstacle on the floor and designate the surrounding area as unpassible. The robot also manages its own power charge. These automatic warehouses controlled by robots are already commonplace. Multiple vendors exist that sell robots for warehouses throughout the world, including China, which operates the world's largest ecommerce website.

Issues of Automation Expansion

IT cannot automate non-routine tasks that cannot be preprogrammed. An example of a non-routine task is "picking and stowing" products to and from shelves in an ecommerce warehouse. A human worker can look at a product to determine how to pick it up, depending on its shape, weight and hardness. The worker predicts what parts to grab with what degree of strength, and what strength is required when lifting the product. The worker can also adjust the pressure immediately if, after actually grabbing the product, the weight or hardness is different from the previous assumption.

From the human perspective, these movements are based on rules. To IT, those rules are too diverse, complex and ambiguous. Additionally, adjustments to situations that change every second cannot be preprogrammed. A human studies and establishes generalized rules, then adds flexible modifications to adjust to the situation before acting. As a result, non-routine tasks, which require sophisticated human actions, have been placed outside the scope of automation. Product handling, dangerous tasks at factories, serving food on plates at restaurants, operating/driving machines and many other non-routine tasks still depend on humans. What can be streamlined using robotic process automation (RPA) is limited to routine and repetitive tasks. The application of this method to non-routine tasks has not yet been successful and continues to be a longstanding challenge.

AI for Automation of Non-Routine Tasks

The use of AI and machine learning for automating non-routine tasks has long been studied. One of the most famous demonstrations used AI to recognize a variety of mixed and unorganized objects of different sizes and shapes in an image, determining a way to grab them and control the robot's arm to lift the packages. The AI program repeated the learning process until it could lift the objects with the robot's arm flawlessly.

Today, more practical trials and contests are currently being conducted. For example, in one contest for a large ecommerce company the AI looked at randomly placed and mixed, popular products in a bin, identified what they were and sorted them as it moved the robot arm. Some products were hidden from view by others within

the bin. Two kinds of products were identified, products for which enough data was provided in advance, and ones with a sample image provided immediately preceding the trial. The winners of these robot contests, where participants compete on work accuracy under conditions close to reality, are said to be able to extract all products and sort them. This is the result of combining multiple AI technologies, such as the use of an AI that has separately learned general object images well enough to identify an object by sight.

AI for Complex Automation

Autonomous driving is a more sophisticated, non-routine task that requires complex learning. In the real world, road conditions change constantly, and other vehicles and pedestrians enter in and out of the scene. As a driver, you must assess situations, identify risks and be prepared to take defensive action quickly. One theory is that driving data for travel over more than 10 billion kilometers is required to cover all such contingencies using AI technology.

Although AI remains key to providing a solution, reproduction of every scenario is impossible. For example, to replicate and exhaustively test the multitude of complex environments including a combination of weather changes, surrounding vehicles, pedestrians and road surfaces, is unrealistic. This requires use of a computer simulator to virtually reproduce the complex conditions randomly and perform repeated learning. It is thought that by using AI, particularly a generative adversarial network (GAN), images in the simulator and physical laws can be improved to a level equal to reality. In learning to mimic actual human driving, Generative Adversarial Imitation Learning (GAIL), a GAN learning method, can be used to achieve sophisticated mimicry based on a small data sample. Thus, the leading-edge technologies of AI are being introduced one after another to continue efforts to overcome the challenge of automating sophisticated non-routine tasks.

The Inevitability of Task Coordination

As we get closer to the time where robots will play an active role even in non-routine tasks, both the ways we sort tasks between humans and robots, and the establishment of a co-working relationship are now recognized as major issues. Automation of non-routine tasks may advance rapidly, but faultless automation with no human intervention is still far from a reality. Until then, continued adjustments in the scope of coordination is necessary, that is, how much to automate and how much should humans intervene. Over time, task details of robots that perform non-routine tasks will become closer to those of humans. The physical distance between robots and humans will also disappear. Once divided by a fence, robots and humans will stand next to each other in the future.

The difficulty of coordination becomes most apparent when considering self-driving, or autonomous, cars and humans. In the latest experiments with self-driving cars, the vehicle arrives at the destination by being told the location, with no human intervention. However, the vehicle can sometimes fail to respond properly to sudden actions, such as a signal from a traffic-control officer, a child who jumps out into the road or a vehicle that cuts in from an adjoining lane. Human drivers are required to keep their hands on the steering wheel at all times to prepare for these cases in which the self-driving car cannot respond appropriately. This experiment is built upon a presupposition that the driver, who is supposed to be relaxed, can perform a highly urgent and difficult task at a moment's notice. This is not optimal coordination between robot and human.

A new UI design is necessary so that autonomous vehicles will not drive automatically into an area where human intervention might be needed. In this situation, the self-driving car can retract its steering wheel, encouraging the human to rely completely on the car when it is running through an area where it can be operated safely. However, if the self-driving car determines that it cannot drive on its own, it can then extend the steering wheel to where the human's hands are, encouraging the human driver to take control. This switch in drivers is done overtly based on the judgment of the surroundings and with plenty of time to safely shift control of the vehicle. The human recognizes and coordinates the change. Although this is far from a perfect solution, it is one approach that shows possibility.

A deep understanding of the tasks to be automated is indispensable to the design of robot and human coordination. To analyze a task that humans have been performing casually and change it into a more efficient, interactive process between human and machine, involves more than just an understanding of the task. It also demands a deep grasp of behavior attributes inherent in humans.

Case Study

Operating Self-Driving Cars in the Commercial District of Sapporo

The population of municipal public transportation drivers is aging just as more people are voluntarily giving up driver's licenses to become dependent transportation users. New public transport services using self-driving technology is anticipated to be one of the solutions. To be successful, such technology must be both safe and convenient.

NTT DATA is working with Gunma University on the creation of self-driving car technology and related software. Gunma University established the Research Center for the Implementation of the Next Generation Mobility Society on its campus as a means for innovative collaboration between industry, academia, government and financial entities. As part of this effort, the university started an active social implementation of self-driving cars in cooperation with companies in related fields and municipalities, and staged a demonstration experiment on a public road in Kiryu City, Gunma.

In October 2017, Gunma University and NTT DATA held a self-driving car demonstration on the streets of Sapporo in an event called No Maps (Sapporo Creative Convention)*1. As part of this experiment, a self-driving car began a 3 km trip at the North Gate of the former Hokkaido Government Office, passing Sapporo City Hall and Odori Park, and then returning to the former Hokkaido Government Office. Running a self-driving car on central Sapporo's public roads, which hosts a sizable amount of traffic, was a substantial challenge for the early realization of self-driving technology. To ensure safety, the car used a sophisticated sensor installed on its roof and other devices to detect traffic signals and pedestrians while controlling its movements. It was thus able to drive safely amid human-driven vehicles at speeds of about 30 km per hour.

This event was held in cooperation with the Hokkaido Automobile Safety Technology Review Council and NTT, which partnered with the City of Sapporo. It demonstrated dramatically the potential of self-driving cars and was a significant first step toward the realization of a society that utilizes self-driving technology. NTT DATA will continue to experiment with and develop safe, convenient and worry-free public transportation services for a society with self-driving cars through our continuing work with Gunma University and our joint study with municipalities.

***1** A convention for local citizens with a modern frontier spirit who utilize advanced technologies and innovative ideas to create the next generation society in Sapporo and Hokkaido, a symbolic pioneering location.

TT
03
Technology Trend

Intuitive UI

Smart speakers and AR/VR headsets brought innovative experiences and enabled users to access computers intuitively. More devices will enable machines to discern human behavior and replicate human senses more precisely, minimizing human-IT frictions. The interaction will be naturally integrated with the surrounding environment providing intuitively augmented experiences to users.

Diffusion of Innovative Interfaces

A revolution is underway in interface technology. Typical examples include user interface (UI) devices collectively known as XR*[1] that connect humans to virtual reality and cloud-based voice UI services that permit voice-based interaction with IT devices.

The VR head-mount display (HMD), a UI device that offers a strong immersive experience in the virtual world, is one of the XR devices becoming popular particularly in entertainment. Partly because the specifications of some VR HMD devices have been standardized, personal computer companies are releasing new products at a rapid pace.

Augmented reality (AR) is also becoming popular with smartphones. Generally, the AR presented on smartphones is lower in accuracy between the virtual world and the real world. This is because a smartphone acquires the positional information required for AR based solely on information from the camera installed in the unit and the gyro-sensor. No special hardware is attached to the smartphone. However, the accuracy provided by this setup is enough for many applications. The hundreds of millions of smartphones sold each year represent a gigantic group of potential users and presents a major opportunity for application developers. Many new apps are being added to the market, expanding and creating a virtuous diffusion cycle.

Voice UI services have also been used in a wide variety of products, and are provided by large vendors as a cloud-based AI via the web. This service recognizes the human voice and returns a response in a natural-sounding voice. The voice UI service works in multiple languages and in cooperation with internet search engines and more than 10,000 other services soon to be available worldwide including ecommerce, travel and car sharing. As a result, voice UI services are establishing a global dominant position as a gateway to voice-related services.

Evolution and Expansion of Intelligent UI

The functions, weight and size of VR HMD have also evolved, with many high-end VR HMDs about to be launched. These new displays have vastly improved resolution quality, lower weight and enhanced adaptability. The traditional VR HMD, which is a heavy device that hangs over the head and uses a wide cable to connect to a computer, was a market barrier for its expansion to casual users. To address this, two new types of VR HMDs are expected to be introduced to the market for an improved user experience, including a standalone type that uses a VR HMD and requires no computer connection and a smaller, lightweight, thin model that aims at being close to eyeglasses in size.

Business applications for XR devices are also expanding. For example, the 3D-coordinated design system that uses VR HMDs designs and simulates industrial products in 3D instead of on flat design drawings. This system also enables cooperative work among multiple people in different locations. Although these ideas existed before, the evolution of highly accurate VR HMDs and powerful computers have brought the concept to a practical level. It is breakthrough technology that, for example, lets a user break down a vehicle made with a huge number of parts to the last screw, and expand, reduce and rotate images at will to view them in a 3D immersive space. These types of systems have the potential of innovating CAD-based, 3D design that requires experience and craftsmanship, leading to further efficiency.

The number of different types of products with a voice UI service is also increasing. At its onset, voice UI service became popular as a smart speaker associated with a music service. Currently, this service is installed in many household appliances as well. For cloud vendors that offer sophisticated voice recognition services, competition is heating up for technology development, market share and technical dominance. For instance, home appliance manufacturers have made multiple cloud AIs available for selecting product features, allowing users to make their own choices directly. It is probably safe to say that the focus of competition for home appliance manufacturers has

shifted to the attractiveness of the product itself and the effectiveness of its voice UI. In addition, such interfaces are being introduced to office machines, where competition will likely intensify.

Toward a Transparent UI

The ultimate challenge of UI development is the transparency of UI. If the interaction between humans and IT devices can be achieved using natural behavior and perception inherent in humans, humans should then be able to use the devices as if they were interacting with other humans. It would not be necessary to learn how to use the device, or for users to be fully aware that the other party is not human. UI innovation continues to evolve from punch cards first used to convey numerical values to the computer, to keyboard and a display and then a GUI and mouse. More recently, the touch interface appeared as a more natural interface for people. In either approach, interfaces are moving closer to a more natural interaction between people and computers. However, none of these are truly an organic form of interactivity since users remain aware that they are communicating with computers and must acquire proficiency in using these devices. The industry goal is a transparent interface that can be used without a learning curve.

The solution to make human-to-device communication transparent is within sight. For example, the ability to detect calls from human voice, gestures and communication with expression is being developed through high-accuracy sensors, AI-supported voice recognition and image recognition technologies. Further increases in accuracy is anticipated.

On the other hand, the development of techniques to make humans naturally detect stimulus from an IT device is underway. Humans receive stimuli from the external world in many ways such as the five senses of touch, taste, hearing, sight and smell. While UI devices designed for the senses of eyesight and hearing are well developed, the reproduction of technology for taste and smell, and particularly the sense of touch, which plays a major role in perception, are still immature. Even the latest research is far from reaching the level where the stimuli to the human hand can be reproduced.

This has led to an alternative approach for a transparent UI without the need of a device to reproduce stimuli to humans. Instead of directly reproducing the sense of touch or taste, this approach uses existing devices to simulate the sense of touch. An example of this approach is a study that uses VR HMD to elicit the sense of touch from the sense of eyesight. By holding a controller and moving one's hand, it makes the hand in the virtual space move. Picking up an object lets the user experience how the object changes. The user feels a simulated touch — even the object's weight. Information from the sense of eyesight can also change the taste of food. Even walking along a curved wall the user gets the feeling of walking straight forward based on the visual information available. Thus, a transparent UI might become available soon if studies accelerate the simulation of senses using existing interfaces.

The World of Super-Intelligent Interfaces

After the aggregation of completed transparent UIs, super-intelligent interfaces might enable a simpler and more serene world. When a person's natural communication method is detected and the response is sent back to a person in a similar way, users of transparent UIs will be able to leverage IT with an unprecedented level of productivity. In fact, people will behave naturally and may not even be aware that they are using IT.

Super-intelligence interfaces will result in an optimized user experience (UX) for each individual. In addition, it will be important for UI-based services in the future to use software-based human senses to offer personalized ease of use in performing tasks the best possible way. For example, when reproducing a relaxing environment in which the user can focus on a task, the reproduction of a particular realistic environment is not important. What is required is an optimal environment. As a result, the system might completely filter out unnecessary stimuli or distracting factors for the user. In a super-intelligence interface world, people would probably experience a relaxed feeling in their own space, while using the robust abilities of IT without being aware of it, thus achieving high productivity.

***1** XR is a collective term for virtual reality, augmented reality and merged reality.

Case Study

Digital 3D Maps and a New AR-Based Golf Spectating Experience

Popularization of virtual reality (VR) and augmented reality (AR) technologies began in 2016, and corporations have continued to focus significant investments in these technologies. In particular, VR/AR-based sports spectating and athletic training applications are gathering momentum even within the traditional sport of professional golfing.

NTT DATA, as an official patron of The Open Championship, the world's oldest major tournament in professional golf, installed an NTT DATA Wall at the event site, which provided attendees with an interactive display with continuously updated graphical information on scores, rankings, plays at each hole, details on each player, and related topics posted on social media.

NTT DATA has also taken the next step to create a more intuitive sports spectating experience for those not attending the event by using AR technology to superimpose game data displayed on the NTT DATA Wall onto NTT DATA's own Digital 3D Map (AW3D) of the golf course. When wearing the Microsoft HoloLens headset, users can enjoy a unique spectator experience from a perspective overlooking the entire golf course, which includes data that is difficult for viewers to capture on TV such as score changes and comparison of driver carry among the players. Such 3D visualization of data allows users to analyze the tournament from a multifaceted perspective, which in turn enables a more substantial sports viewing experience. In addition, empowering viewers to select the data they wish to watch also results in a more flexible and interactive experience.

Since AW3D is based on satellite images, which is superior in wide-spectrum applications, it can also be used to materially reduce the time and costs associated with 3D map rendering. We are planning to expand its use across different AR applications, resource development and infrastructure preparation to streamline business operations. NTT DATA has developed an enviable global track record in successfully applying VR/AR-based technology on behalf of our clients. Our plans are to leverage this expertise to contribute to future NTT DATA IoT service development.

TT
04
Technology Trend

Data Sustainability

As data volume continues to grow, AI has enabled the extraction of sustainable value from non-standardized data and allowed prompt action through high-level prediction. Concurrently, massive counterfeit data and technologies that deceive AI threaten the foundation relying on data. Securing the reliability of data and sustainability of AI is key to future data utilization.

Creation of Value From Data

What do you think when you hear the term big data? While some people might believe it describes reality in the business world, others think it is a buzzword for a concept that has fallen far short of expectations. Either way, the situation has changed dramatically from a few years ago. An increase in both the amounts and types of data generated, and the development of AI technologies, has enabled big data to fulfill its promise of creating new value.

The number of data files generated is expected to approximately double in two years. Moreover, the total amount of data to be generated in the world per year is anticipated to reach 163 zettabytes by 2025*[1]. For example, one of the causes of this dramatic increase is large amounts of video files produced and viewed as part of an upsurge in video marketing. Another reason is the expansion of personal assistants in mobile phones and home-based smart speakers, which gather large amounts of voice data. Internet of Things (IoT) devices, which are predicted to exceed 20 billion in 2020*[2], will continue to increase data amounts and types including large amounts of unstructured data.

In the past, human experts called data scientists were the only ones able to create knowledge by formulating hypotheses about cause-and-effect relationships between data, followed by validation. With the emergence of deep learning, however, AI has evolved to the point where it can generate knowledge from data and make decisions. At the same time, the amount of information used for analysis is dramatically increasing and includes objects and people's movements extracted from images, and emotions that can be estimated from voice data. For example, it is now possible to analyze fashion or travel trends from images on social media. In the future, many different types of unstructured data will be used to create more value.

Automatic Content Generation

The development of AI technologies has enabled the automatic generation of valuable content such as news articles, videos and financial statements. Although these services have already been commercialized, a new technology called GAN*[3] is significantly improving AI content generation. A GAN consists of a generator and a discriminator. The generator produces data that is extremely close to the learning data. The discriminator then identifies whether or not the data is fraudulent. This capability improves as each party competes with each other. For example, this process enables the production of video content that can replace actual participants with other individuals not present, creating an avatar in real time.

Such automatic content generation can streamline tasks and offers detailed and precise information not provided with manual content creation. In addition, extreme personalization could provide content with greater impact. For instance, imagine how personalized videos that feature your image could influence your decision making.

The Battle Between Fabrication and Control

Fake news is being used to shape public opinion and it has become a major social issue. As social networks penetrate society, false information transmitted by individuals can easily proliferate. Unfortunately, AI automatic content generation technology has the capacity to produce enormous amounts of fraudulent articles that appear real including images and voices that look and sound authentic. Some predict that by 2020, the amount of AI-driven fake content generated will exceed AI's ability to detect it. In addition, it is predicted that by 2022 a majority of people in advanced economies will consume more false than true information.*[4]

To solve this problem, technologies have been developed to detect fake news based on expressions in texts and patterns with which information spreads throughout the world. Companies that generate revenue from online advertising are particularly

susceptible to fraudulent content and are moving quickly to address this issue. For example, Google and Facebook, which account for more than 60% of the world's online advertising, are currently exploring a variety of defensive measures. These include using machine learning to infer fake news, cooperating with third-party organizations that perform fact checks, and leveraging user evaluation of articles as collective intelligence to assess reliability.

Problems of AI Data Dependence

Data quality has a great impact on AI since its decisions are dependent on the data entered. For example, if AI uses a biased statement made by a user, it might make a decision that is discriminatory or biased. AI recognizes objects and voices with an accuracy that exceeds that of humans. However, use of deceptions may fool AI to understand information incorrectly. Data sets that deceive AI are called adversarial examples, and such false information poses a grave threat to companies and people using AI. For example, if street signs are manipulated with a malicious intent, humans will likely consider it a nuisance and interpret the signs without difficulty. However, with a self-driving vehicle, AI may misinterpret road signs as false information, which in turn could become life threatening. In another example, a surveillance camera with AI could be fooled by a person wearing glasses with special printing, resulting in a person being misidentified.

One solution being tested to solve these problems uses a dataset of pseudo-adversarial examples to pinpoint vulnerabilities in advance. In addition to information accuracy, AI's robustness against malicious data will become increasingly important in the future.

A Sustainable Use of Data

Data holds the promise of generating limitless new value. However, the existence of fraudulent, biased and AI-deceiving data might jeopardize its use. So what is necessary to use data in a sustainable way? From the technological perspective, a technology that detects data falsities and bias plus the development of robust AI will be necessary. It is anticipated that technologies will continue to evolve in an endless fashion similar to the attack and defense cycles in cybersecurity. For this reason, systems must be built with the assumption that malicious data is present. Even with uncorrupted data, AI's misjudgment can be a problem. For example, in 2015, Google's image recognition system caused controversy when it recognized a human as a gorilla. (Google solved this problem by deleting tags related to primates). As long as AI is not 100% accurate, operation-level solutions will be necessary depending on the application.

There is a limit to the amount of data quality checks that one company can perform. Moreover, restricting data collected such as from IoT devices to a single company will greatly limit its value. Perhaps society needs a system in which everyone shares data and guarantees reliability. To accelerate this data revolution, it may be necessary to develop structures that distribute data, such as a data marketplace or information banks, as well as incentives for companies and individuals who offer data with guaranteed quality.

If the entire society works together to improve the reliability of both AI and data, the creation of value would be significantly improved. To do this, it may be necessary to enhance society's perception of the value of data.

***1** Data Age 2025 (IDC) https://www.seagate.com/files/www-content/our-story/trends/files/Seagate-WP-DataAge2025-March-2017.pdf

***2** Gartner 2017 https://www.gartner.com/newsroom/id/3598917

***3** Abbreviation for the generative adversarial network

***4** Gartner https://www.gartner.com/technology/research/predicts/

Case Study

Measuring & Analyzing Tourist Social Media Data

The number of visitors to Japan has steadily increased in recent years, reaching 28 million in 2017. However, to reach the government's goal of 40 million visitors by 2020, it will be necessary to uncover additional regional tourism opportunities. One untapped means to identify such spots is through visitor posts on social media. While tourist sites can be found all over Japan, ways to uniformly benchmark or measure posts related to such spots are not currently available. Although some GPS-based services do exist, little or no data is generated for places off the Golden Routes*1 that are less traveled by foreign visitors.

To gather such data for measurement and analysis and to reveal opportunities, NTT DATA has combined Twitter data, that we have access to as an official Twitter partner, with deep learning technology to provide a service that measures the value of more than 3 hundred thousand tourist spots throughout Japan based on social media. The service analyzes the volume and content of Twitter posts in all languages.

Comprehensive measurement and analysis of posted comments from both foreign and domestic visitors in Japan on a per-spot basis will enable identification of detailed attributes (nationality, age, gender, and preferences) of users who are discussing tourism. This, in turn, is expected to uncover hidden tourism resources throughout Japan that can then be promoted to help develop regional economies.

In conjunction with this service and related consulting, NTT DATA will be developing a holistic tourism dashboard based on client needs that collects data from multiple information sources to visualize and identify the status of businesses as well as the effectiveness of marketing, while integrating with customer relationship management (CRM) systems. In the future, we will be offering social media measurement and analysis services based on Twitter data for not only visitors within Japan, but also for Japanese visiting overseas.

*1 The "Golden Route" is a course that tourists use to sightsee the most popular tourist cities in Japan, such as Tokyo to Mt. Fuji/Hakone, Nagoya, Kyoto and Osaka.

TT
05
Technology Trend

Hacking Life

High-precision biological information, which can be obtained easily and continuously, can be analyzed with AI for the early discovery and prediction of future illnesses. The pursuit of a healthy lifestyle, coupled with technological advances in healthcare, will drive ongoing research into the current issues of an aging society and challenge the constraints of life itself to enhance physical abilities and improve human productivity.

Extension of Healthy Life Expectancy

Thanks to developments in medical technology and improvements in nutrition and the environment, the world's average life expectancy is expected to rise from 71 years old in 2015 to 78 years old in 2050*1. However, the aging population caused by this extension of life expectancy together with a declining birthrate has become a significant social issue. What is needed is the extension of a healthy life expectancy. Healthy life expectancy is defined as a period where a person can lead an independent life without depending on others or continuous medical treatment. If senior citizens can lead an independent life, many problems associated with aging could be mitigated. However, in Japan, although people are living far longer and healthy life expectancy has increased proportionally, the difference between the two has been virtually the same since 2001, when recording such statistical information began. In addition to treatment, advances in health, prevention and early detection of illnesses are essential to the extension of healthy life expectancy.

Changes Caused by Biometric Devices

Rapid advances continue to be made in a broad range of personal biometric devices. For example, with the cost of genetic analysis continuing to decrease, we are about to have human genome analysis available for $100. In addition, a portable sequencer has also been developed. As a result, it is likely that health management using genetic information will be of increasing importance in the future. The development of devices that can easily acquire biometric information and the popularization of smartphones have made health management part of daily life. Sensors for smartphones that can measure heart rate, blood pressure and blood oxygen level, as well as ultrasonic diagnostic imaging devices that connect to smartphones are in development. Smart watches have also allowed for the prediction of heart rate and sleep apnea syndrome. Additionally, a wristband has emerged that can measure electrocardiographic values. Having been approved by the FDA, this device can detect atrial fibrillation.

Another prototype that measures blood sugar level and looks like a contact lens is also in the pipeline. Because tears contain a variety of active substances, this device has the potential to detect multiple illnesses such as glaucoma, liver diseases and cancer. The emergence of these personal devices changes medical and healthcare from a service that is offered intermittently at limited locations, to something that is delivered continuously in the user's own environment. Physical monitoring on a regular basis is becoming the norm, rather than examinations after the onset of symptoms and annual medical visits. By detecting physical changes as early as possible, countermeasures can be initiated prior to the onset of an illness, dramatically improving prevention.

Expansion of Digital Healthcare

Depression is predicted to be the most prevalent disease that negatively impacts healthy life by the year 2030*2. This is an unavoidable issue associated with the extension of healthy life expectancy. In addition, the impact of dementia on society and people's daily life is horrific, as it is a factor for increasing the number of lost people, frauds and traffic accidents. Medical costs incurred from dementia in the world are predicted to increase from $818 billion dollars in 2015 to more than $2 trillion*3 in 2030, placing an added priority on this issue. Although the ultimate cure for dementia is not yet developed, the progression of symptoms can be delayed. That is why it is important to detect the illness early and start countermeasures as soon as possible.

To diagnose depression and other mental diseases including dementia early, it is important to identify changes in specific biometric information and in daily behavior. A continuous approach is required for effective treatment. To support this, IT-based diagnosis and treatments are being developed. Smartphone apps that infer depression and dementia based on voice are already on the market, reducing barriers to use and raising expectations for earlier detection. Besides

detection, chatbots that perform counseling and cognitive science-based games that can treat attention deficit hyperactivity disorder (ADHD) and depression are also in progress. Establishment of such technologies will allow people with potential mental illness to more easily go for treatment, with its effects exceeding those of traditional treatment. For dementia, a service is being developed that detects symptoms based on changes in walking speed as measured by a smartphone. A virtual reality (VR) technology is also being developed to detect mild cognitive impairment. In the application, a patient goes shopping in a virtual store where decision-making, calculation ability and many other cognitive functions are required. As applications of digital technology for prevention and treatment of illnesses continue, physicians may one day be prescribing an app or VR content for patients.

Data-Driven Acceleration of Life Science

The possibility is high that the development of the technologies summarized will enable early detection for a variety of illnesses and the monitoring of day-to-day treatment. However, depending on the illness, the earlier detection and its accuracy and treatment will probably not be sufficient. The missing factor is the lack of long-term data. For early detection, data for the normal condition is also required as well as data after the onset of symptoms. Because the normal range of biometric values and effective treatment differ from patient to patient, huge amounts of data are required to achieve a prevention and treatment plan that is optimal for an individual. For example, multiple components intermingle for the progression of diabetes, depression and other diseases in which lifestyle is a major factor. To detect a disease with high accuracy prior to the onset of symptoms, the factors need to be specified to improve the analysis ability of AI in addition to the accumulation of data. To achieve this, efforts are underway to track health conditions over long periods of time. For instance, Project Baseline*4 interactively and continuously accumulates a variety of information on 10,000 people, including healthy individuals. The information being gathered includes genetic information and blood test results; images from radiographic testing; heart rate, electrodermal activity, and other biometric information; hours of sleep, amount of exercise, diet and other life records. This project could elucidate the process of changes in health conditions, including what kinds of genes and factors lead to a disease, increasing the possibility for the achievement of precision medicine.

The Improvement of Physical Abilities

What lies beyond the achievement of the ultimate prevention and treatment of disease? When worries about illness disappear, the desire to enhance health and physical abilities will likely become paramount. Recent technological developments are making such enhancements a possibility. For example, contact lenses that shape and temporarily correct the cornea when worn at bedtime, and which permit the user to live without lenses the following day, have already been commercialized. Devices such as this, which improve physical functions without surgery, will likely be a major focus in the near future.

Also gaining popularity in recent years is brainwave training called neurofeedback. This training gives visual feedback directly to the brain when the targeted action has been achieved. The user only needs to consciously move toward the desired brainwave condition. Although this training has been used before for the treatment of autism, depression and other mental conditions, in recent years it is beginning to be used for the mental and physical training of athletes, as well as in the enhancement of other human abilities such as memory and language learning.

Many parts of the brain have yet to be explored. The Human Brain Project and other efforts to reveal the brain's functions will further enhance human abilities. In addition, with the application of brain information as the focal point in healthcare, we will likely challenge and overcome the inherent limitations of life. Technologies for the prevention of aging and rejuvenation previously thought of as only a pipe dream may yet come true. If people can work and live for long periods of time with higher abilities, the negative impact associated with an aging society will be a thing of the past.

***1** World Population Ageing 2017 http://www.un.org/en/development/desa/population/theme/ageing/WPA2017.shtml

***2** WHO http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/

***3** World Alzheimer Report 2015 http://www.worldalzreport2015.org/

***4** Project Baseline is the project to collect comprehensive health data and use it as way to disease prevention.

Case Study

Using Neuro Feedback to Support Language Acquisition

With globalization, English education has become a requirement in Japanese elementary schools. However, the inability to differentiate certain phonemes as part of listening comprehension has made the acquisition of English difficult for many students. For example, a study of Japanese college students revealed that only 42% of them could differentiate between the sounds of “L” and “R.” Differentiation of phonemes is deemed fundamental to listening ability.

One training method being explored to solve this issue is called neuro feedback*1, which trains the brain directly by providing immediate information back to the learner. The Japanese National Institute of Information and Communications Technology and Osaka University demonstrated an effective technique to use neuro feedback to enhance the brain activity in response to the “L” and “R” sounds. This experiment indicated that the use of neuro feedback would improve the ability to differentiate between these two sounds.

JSOL and the NTT DATA Institute of Management Consulting are applying neuro feedback technology to develop an English learning support service, in cooperation with the Japanese National Institute of Information and Communications Technology and Osaka University. This service uses a simplified electroencephalograph to capture brain waves, analyzes them in real time and quantifies the extent to which sound differentiation is achieved.

Performance results are visually represented to the learner using a green circle that scales with improvement. The user consciously tries to make the circle larger. With this approach, leaners can expect to achieve superior results when compared to traditional learning techniques.

We will be conducting multiple experiments offering English learning support services on a trial basis. Furthermore, we are also planning to integrate gamification into the feedback method to provide continuous motivation for learning. We believe that applying this cutting-edge brain wave communication technology will let learners of English master it in a fun and more efficient way.

***1** A technology that measures brain waves to provide feedback to the person about the status of his/her brain through visual media.

TT
06
Technology Trend

Security Intelligence

Cyberattacks will further intensify, causing leaks of highly valuable information and broadening accessible targets. The industrialization of cyberattacks has also progressed. Advanced technologies, including AI, to counter intensifying attacks are imperative, and ensuring the proper use of technology and the accumulation of information vital for cyber defense is required.

Expansion of Cyberattack Targets

Targets of cyberattacks are continuing to expand from individuals and organizations to critical infrastructure. Even essential infrastructure such as power grid and factory control systems are now connected to the internet for remote management and control of equipment and devices. This means that cyberattackers have access to these infrastructures. Major cyberattacks are occurring throughout the world. For example, the large-scale blackout in Ukraine, the failure of the railway operation system in Sweden, and other attacks have panicked citizens and inflicted heavy damage to the economic activity of organizations.

An increase in the number of IoT devices is also helping to expand the range of cyberattacks. In fact, many IoT devices still do not have adequate cybersecurity measures in place, presenting an easy point of entry. In particular, cars are now connected to more external networks than ever, such as for wireless updates of built-in firmware and automatic emergency notification systems. This might pose a risk to human lives. A technique was presented at a recent international conference that exploited the vulnerability of auto navigational systems to rewrite the built-in firmware and remotely control the vehicle.*1 To address issues such as these, in August 2017 Great Britain announced new guidelines*2 for cybersecurity of connected cars. Other countries are also forging ahead with their own cybersecurity plans and regulations.

Diversified Cyberattack Techniques

The year 2017 was the year of ransomware. Ransomware is also called ransom-demanding malware because it encrypts the data on an infected personal computer and demands a ransom in exchange for the recovery of the data. Armed with a cyber weapon that can infect another computer automatically, ransomware went on a rampage in May of last year infecting over 300,000 computers in more than 150 countries. Attacks targeting system vulnerability also show no sign of ending. In the United States in September 2017, personal information such as the social security numbers of more than 100 million people was made public, sending shock waves throughout the country.

Attackers are also threatening society in a variety of other ways. The damage from compromised business email, in which the sender pretends to be a business contact or management and falsely instructs the recipient to send money, reached approximately $5.3 billion dollars between October 2013 and December 2016. A more recent phenomenon is called cryptojacking, in which the attacker uses the computing ability of the device he/she has successfully hacked without authorization and mines virtual currencies.

One of the factors that has accelerated cyberattacks is the use of AI. For instance, one presentation at a 2017 international hacker conference*3 demonstrated malware that repeatedly learned how to avoid security software. AI can also be misused for many different applications including automatic generation of malware, the discovery of attack techniques and the exploration of targets and mass generation of spam mail with ingenious texts difficult to authenticate.

Cyberattacks are themselves becoming a booming industry. An ecosystem of evil has been formed in which individuals, organizations and services with specific expertise cooperate to plan and implement profitable attacks. These include companies that provide the service that performs the attacking, organizations that create malware and service companies that study vulnerability. Given such a successful hacker alliance their power is expected to continue to increase.

Since it is difficult to verify the effectiveness of cybersecurity measures, these have often been placed on the backburner in the past. However, once an attack hits the damage is often enormous including the labor incurred for recovery, compensation to

parties involved and the loss of brand and social equity. Organizations and companies must realize that it is time to seriously include cybersecurity as a management strategy.

Dynamic Protection Using Advanced Technologies

As the threat of cyberattacks multiplies, organizations and companies must fundamentally increase defensive readiness. These plans must include multiple security countermeasures and defense in depth. Part of this multilayered defense can include the use of AI at a variety of locations, such as endpoints (network boundaries, terminals, etc.) and the data managed in terminals. For example, AI can learn communication patterns and normal operating conditions. When suspicious behavior is confirmed, the AI will issue a security alert and begin a quarantine process by shutting off network connections to curtail a suspicious process. More powerful antivirus software has also emerged that can detect unknown malware by having AI learn its characteristic behaviors.

AI is also being used in determining system vulnerability to cyberattacks. Such tests can establish whether or not the code is susceptible to a wide variety of vulnerabilities previously overlooked. Of course, security countermeasures are advancing outside of the AI field as well. Two examples include security chips that verify if firmware has been manipulated before starting the OS, and remote forensics to identify the cause of infection and provide rapid recovery.

In addition to cybersecurity measures to protect products in operation, adding built-in defenses for future products has become an important trend. Security by design is a development process in which security requirements of products connected to the internet are clearly identified in the planning and design phases, and countermeasures to improve security further are examined. This method is a widely adopted concept in IT, and it will be an essential one for the development of IoT devices in the future.

Intelligence Being Sought

A group of experts called the Computer Security Incident Response Team (CSIRT) within many organizations is now responsible for the analysis and response to threat information. These efforts include responses when a vulnerability has been discovered, and management and decision-making after an incident occurs. However, the CSIRT receives countless alerts and threat information on a daily basis, which makes it difficult to prioritize and effectively respond. As a result, it is necessary to create an environment in which an AI-enabled machine handles certain kinds of threats while experts concentrate on the most dangerous ones.

In the past, much of the threat information was in natural language and interpretation by humans was required. However, AI is now able to analyze security-related reports, blog posts and attack notices and present its insights to experts. In addition, AI that make decisions like experts are being adopted in the field. These AI learn each behavior and decision made by experts including how they responded to past problems and acted against threat information once verified. This is enabling AI to build a 24/7 defensive environment.

As AI becomes integral to both cyberattacks and defense, battles in cyberspace will be transformed into AI versus AI combat. In such a world, the defense side must work together to collect the latest threat information and gather the means and approaches toward the development and growth of more robust AI. The sharing of intelligence beyond the boundaries of company and nation, and the establishment of a system that applies this acquired intelligence to defense are what is required for a cyber-safe future.

***1** The demonstration took place at a Black Hat global international security event

***2** Principles of cyber security for connected and automated vehicles

***3** DEF CON 25 Hacking Conference

Case Study

Security to Protect Mission Critical Global Infrastructure

The Internet of Things (IoT) has advanced supply chain management, enabled mass customization (high-mix, low-volume manufacturing), streamlined facility operation and management, and enhanced customer service. This in turn has driven innovative efforts toward the improvement of productivity and convenience in many industries. As a result, information technologies (IT) and operational technologies (OT) have been increasingly integrated, linking everything from networks, factories, plants, electricity and gas, to water, transportation, distribution, facility management and other industrial control systems.

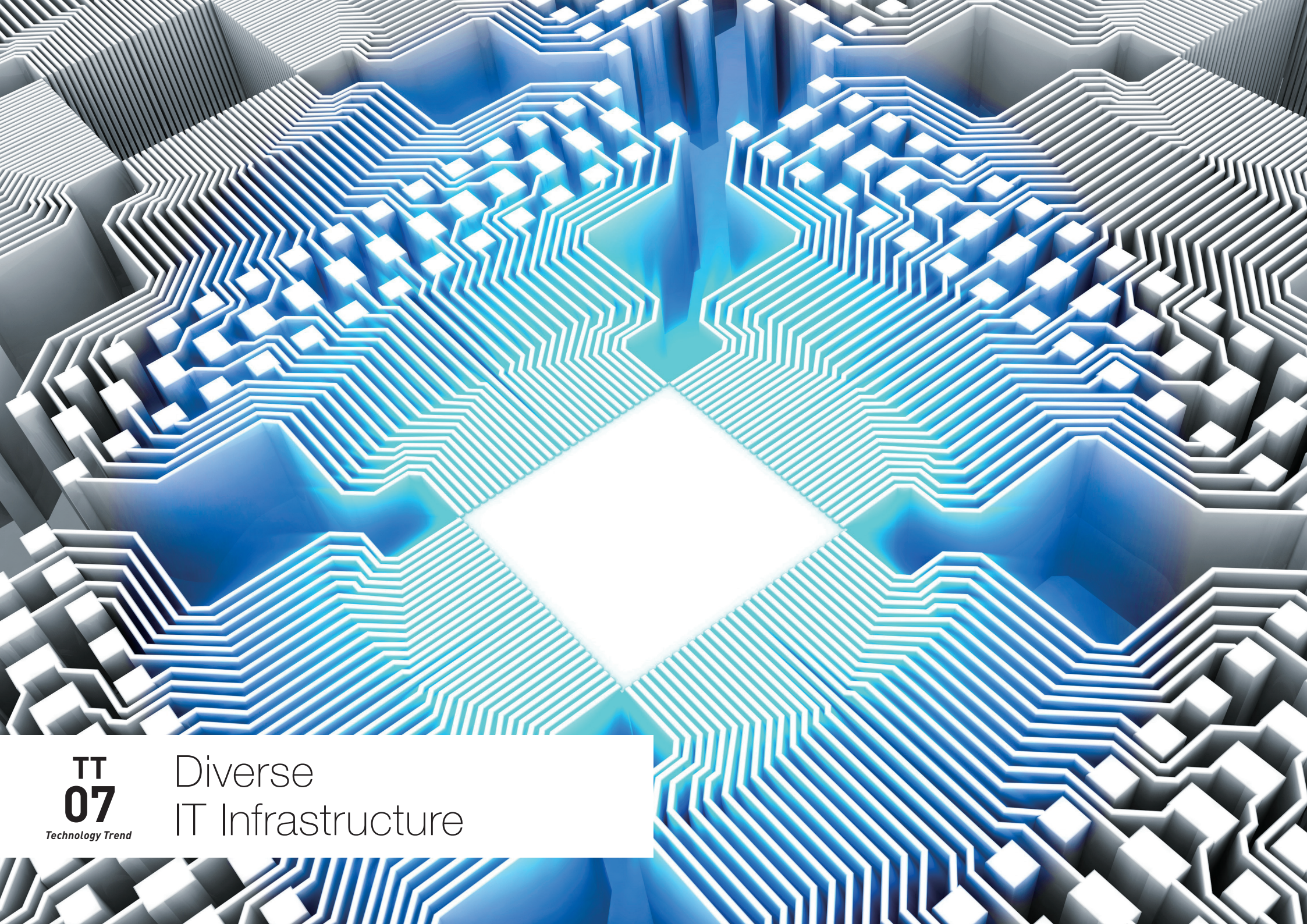
At the same time, damage to critical infrastructures from ransomware such as WannaCry and cyber weapons such as Stuxnet*1 and CrashOverride*2 have increased considerably. In an IoT world the damage from such attacks or an accident increases exponentially, significantly impacting society. Consequently, corporate risk management and OT security measures designed to ensure business continuity plans (BCPs) are increasing in importance, as well as traditional IT security measures to protect information.

NTT Security has deployed a robust worldwide security operation, accumulating cyber threat information on a global basis. Based on this data and advanced analytics technology for cyber threats, we offer IT/OT-integrated global security services. These integrated security services consist of: Consulting Services (CS) to assess risks and architect appropriate security solutions; Technical Consulting (TC) to engineer and build solutions for industrial control systems; and Managed Security Services (MSS) to operated, manage, and optimize systems and detect and stop cyberattacks.

NTT Security is investing in these comprehensive security services, while strengthening its advanced security analysis technology and global security threat information platform. We will continue to develop our IT/OT-integrated security services in tandem with NTT Laboratories and other partners. Additionally, we plan to create a series of industry focused security services through co-innovation with customers.

***1** Stuxnet is targeted attack malware discovered in Iran in 2010, which froze the control systems at a nuclear facility.

***2** CrashOverride is a targeted attack malware used in the attack on electrical transmission facilities in Ukraine in 2016, in which hundreds of thousands of residences suffered a power failure.



TT
07
Technology Trend

Diverse IT Infrastructure

In response to the continuing demands of evolving AI, diverse hardware and software solutions are being developed. To process staggering amounts of data and to enable IoT device networks, cloud-based distributed architectures are being implemented. IT infrastructure is also evolving in diverse ways to achieve ease of access and respond to user's changing needs.

Invisible IT Infrastructure

Similar to other social infrastructure, IT infrastructure supports a society through which IT has permeated without people realizing it. An IT infrastructure consists of hardware that makes up the base structure of an IT system and the software that operates it. Specifically, it refers to hardware such as a server and network, and middleware such as an operating system and database.

In recent years, advances in cloud computing have made it easier for IT engineers to focus more on application development and less on IT infrastructure. In a cloud-based environment, both processing ability and performance can be increased or decreased on demand. All that is required to get started with cloud computing is to designate a set of devices and to select a service function. Cloud providers perform frequent maintenance automatically and continually implement improvements, including simplifying and streamlining operations as well as adopting new technologies to improve performance, security, costs and to respond to new requests immediately. There are now few reasons to avoid placing all services, environments, platforms and applications in the cloud unless special requirements exist, such as the need to completely control a device to ensure stable operation, or for an unusual network configuration due to extremely high security requirements. Furthermore, there is little need to be aware of the latest IT infrastructure functioning behind these robust cloud environments.

The importance of understanding both the current and future state of IT infrastructure, however, increases when considering the needs of new businesses. This is because the evolution of infrastructure has enabled ideas that used to be considered impossible. An example is the emergence of deep learning. At its inception, deep learning's algorithm was expected to make AI evolve significantly, however, no IT infrastructure existed on which it could operate. The development of software that used a graphics processing unit (GPU), a super-parallel processor for multimedia applications, changed the situation. The emergence of this IT infrastructure enabled the deep learning algorithm to operate at a speed 100 times faster than traditional models, rapidly advancing research and development and proving the validity of the method. In fact, AI's achievements often exceeded human ability, such as in image identification and voice recognition, making AI a source of competitive advantage in business.

Diversified Processors

Any discussion of the IT infrastructure evolution centers around the central processing unit (CPU), located at the core of the computer brain to produce computing ability. Since its birth, the CPU continued to increase in speed until about the year 2000, when improvements diminished due mainly to physical limitations. After that, the processor became the focal point for improvements. The technologies at the center of the next advancement were the multicore processor and off-loading using a dedicated processor.

The multicore processor is based on a technology that installs multiple cores, which are the brain of the computing ability, in one processor. More cores result in accelerated speed. CPUs with 28 cores have appeared, and so have GPUs with more than 5,000 cores. However, if computing is performed only by a specific core, granularity of calculation differs from core to core; parallelism decreases and the full potential of the technology cannot be achieved. To optimize the use of multiple cores, dedicated middleware divides the calculation to be run by the processor based on the number of cores. It was not until this type of dedicated middleware was developed that multicore GPUs became the center of machine learning. For this reason, future mainstream multicore processors will probably require innovations in middleware.

The off-loading technology separates tasks from the CPU that cannot be expected to get any faster, and transfers some of these to an external dedicated processor for a particular type of calculation. For example, transferring tasks to a processor specialized

in AI learning enables speeds that are hundreds of times faster than processing by a single CPU. Off-loading is also used in the development of image processing for autonomous driving, AI processing, AI processing for smartphones and many other applications. Even for off-loading, middleware that appropriately delegates tasks to optimize the use of dedicated processors plays an important role. To make further advances, companies are disclosing their middleware and actively recruiting a larger pool of application developers.

Evolution of Architectures

Architectures have evolved that combine different IT infrastructure and offer them as a single service. This trend has particularly taken place with database technology for global distribution and integration and for blockchain technology.

It is revolutionary that the database technology that enabled global distribution and integration has reached the stage where it is offered on cloud platforms. In the past, geographically focused services offered in countries across the world would result in delayed responses and in discrepancies in recorded data due to physical distances. Thanks to the development of robust middleware, global distribution and integration is possible, where each data center provides positive user experiences in specific regions while using the same integrated set of data.

World-scale service platform developers used to build robust IT infrastructure on their own to offer social network services and emails exclusively for customers. Today, the time has come for all companies to migrate to the cloud for business. The promise of open-source development further raises expectations that IT vendors may emerge to offer architectures with an even greater degree of flexibility.

Blockchain, a technology that supports bitcoin, has solved a key issue related to distributed technologies, and is about to broaden its applications. A blockchain is distributed across the world instead of being centralized, and it ensures validity over a certain period of time, which slows processing speed. As a result, it is not considered appropriate for small payments and other accelerated transactions. To solve this problem, the development of off-chain technology is underway in which high-speed transactions are achieved by adding a high-speed peer-to-peer (P2P) network to the blockchain.

The development of cross-chain atomic swaps*1 is also happening. This technology enables transactions directly between chains, avoiding the need for the presence of a third-party clearinghouse to exchange value between blockchains. However, bitcoin, which has already circulated huge amounts of cryptocurrency is a barrier to entry. Coordination of interests between companies and technologies might also present an obstacle to the ongoing evolution of this technology.

IT Infrastructure of the Future

Competition to develop breakthrough IT infrastructure over the next 10 to 20 years has initiated significant capital investments from major global companies. The competition centers on quantum computing, which applies mechanics to achieve parallel processing. In the future as technologies advance, it is expected to achieve overwhelming computing power. Even today, the quantum computer's performance exceeds that of existing computers in processing combinatorial optimization problems. However, the reality of quantum computing is that it is more like an experimental device that uses today's computer to control a computation core called quantum chips. It is uncertain whether quantum computers will outperform today's computers in all types of computation. A more practical approach for the future might be for the computer to select a specific type of processing to off-load to the quantum computer.

If the ability of quantum computers, which are already 100 million times faster than today's, can be applied to AI, for example, the dominant position of quantum computing will be overwhelming. Understanding the evolution of IT infrastructure and its impact on the future should not be overlooked.

***1** Cross-chain atomic swaps allow the exchange of one cryptocurrency to another without the need of a third party service.

Case Study

Using Blockchain & APIs to Connect Trading Platforms

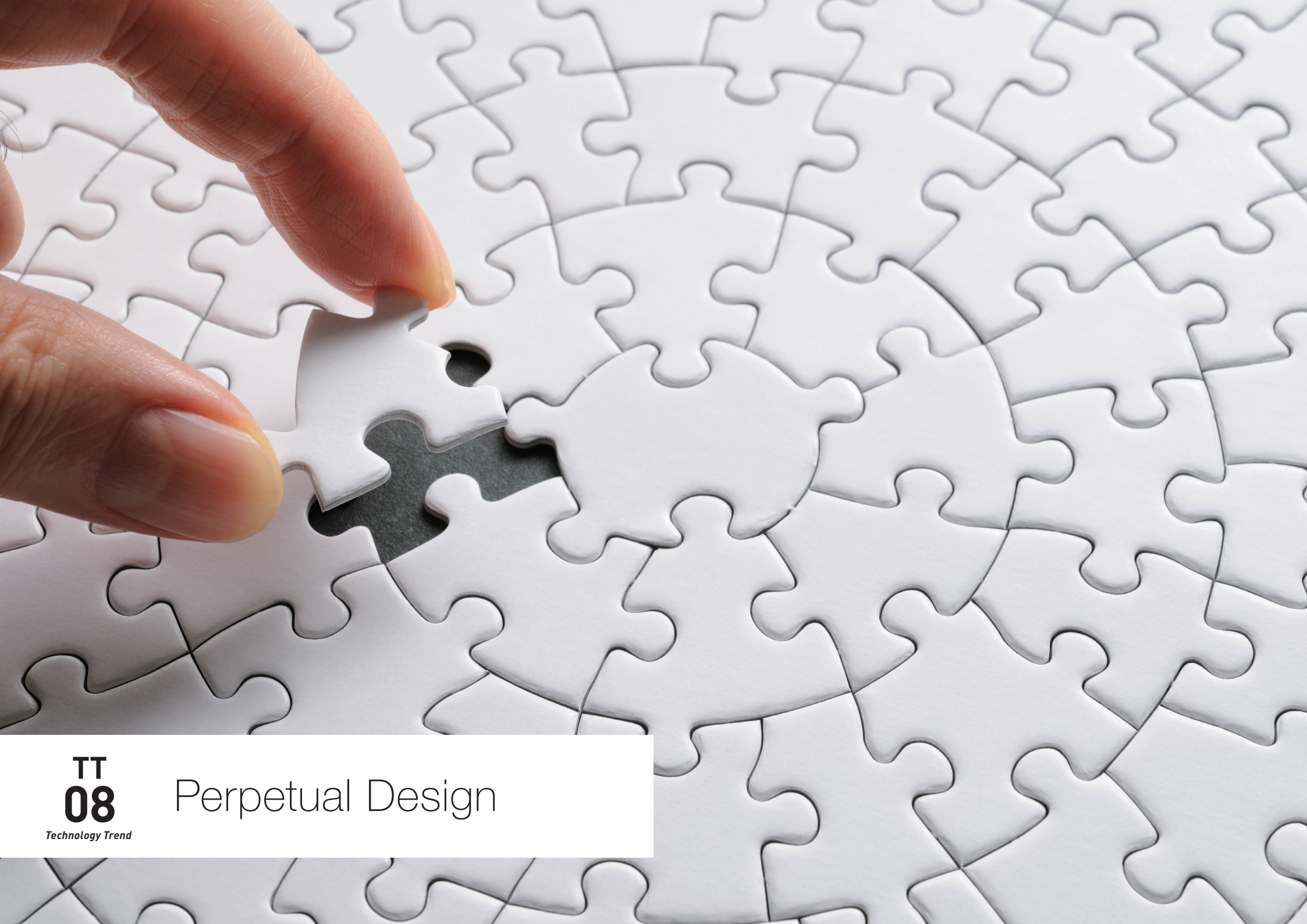
As a result of international and inter-regional business partnership agreements, hundreds of crucial documents are exchanged in the form of paper and emails among trading companies and financial institutions involved in cross-border merchandise transactions. In many cases, documents arrive after the merchandise itself. Consequently, those involved in merchandise transactions must further streamline and accelerate the trading document flow. Under these circumstances, the global financial center of Singapore has started an initiative to promote and harness a digital economy called Smart Nation. The goal of Smart Nation is to connect Singapore digitally with Hong Kong as well as with other countries and regions including Japan. To support these efforts and digital transformation, Singapore is building a trading platform called the National Grade Platform*1 (NTP).

As the leading company leveraging blockchain-based computerization of trading documents in Japan, NTT DATA is collaborating with 13 Japanese companies that represent different industry sectors involved with trading including banking, insurance, general logistics, shipping and freight forwarding, to launch a consortium to promote the realization of a coordinated base for trading information using blockchain technology. The Bank of Tokyo-Mitsubishi UFJ is also one of the consortium members participating in the working group for the NTP in Singapore, bridging the two platforms.

In cooperation with the NTP project, NTT DATA and the Bank of Tokyo-Mitsubishi UFJ started a proof of concept (PoC) demonstration, with the goal of connecting a prototype of NTT DATA's coordinated base for trading information using blockchain technology and the NTP via an API. In the PoC, we identify the challenges involved in improving safety, efficiency and transparency of cross-border transactions, and develop solutions. At the same time, we are examining the challenges involved in the building of a base that connects both trading and supply chains.

We believe this PoC demonstration, which verifies electronic exchange of cross-border trading documents between Japan and Singapore, is of high value for the entire Japanese trading industry. By working to solve the technical issues that arise by the sharing of trading documents, both NTT DATA and the Bank of Tokyo-Mitsubishi UFJ will continue to contribute to streamlining intranational and international trading in Asia and other areas.

*1 The National Trade Platform (NTP) in Singapore is a one-stop trading information ecosystem that enables the sharing and recycling of digital data regarding trading transactions between the private sector and the Singaporean government.



TT
08
Technology Trend

Perpetual Design

Business use of APIs and IoT platforms to accelerate products and services has become commonplace. Design, in combination with IT and business strategy, must now provide products and services personalized for one and applicable to millions to address the demands. Processes where IT strategies and design act as a whole to continuously improve business and produce added value will be sought to resolve this conundrum.

Innovation Created by IT

Businesses have produced many innovations through the IT conversion process, in which merchandise and services are modified to be controllable by IT. This conversion produces destructive creation that often alters the way businesses operate.

Innovation enabled by IT conversion results in the reduction of production and logistical costs. Electronic data is reproducible without any production facilities and it is faster and less costly than physical delivery. As an example, music and book business transactions are completed in seconds in the palm of the user's hand. This capability resulted in a transformation where existing stores and related logistics networks lost their reason for existence. Thus, a small number of platforms gained the business initiative.

With IT conversion, value transfers from hardware to software. Even if the hardware remains the same, updated software increases value. The public has learned this lesson from its experiences with smartphones.

If the protocol (a set of rules governing the transmission of data) is determined, IT-based businesses can easily interconnect and cooperate using application programming interfaces (API). Because of this characteristic, a system that combines an existing service and the internet to do business has become common. Consequently, starting a business is faster and the cost is lower. The following example is well known. While a ride-sharing service focused on its core competencies such as the development of smartphone apps for the driver and passenger and the construction of a business model, it depended on third parties for other elements such as payment and navigation, procuring them online.

The API economy will continue to develop in the future. Technological advances brought by IT and the reforms to leverage it will enable the continuous improvement of business.

Innovation Through Personalization

With IT, the personalization process, which has been previously done by segmentation or attribute group, can be focused entirely on an individual – a design for one. Regardless of the number of customers, a personalized service can be offered whenever a user needs it. For example, businesses with a subscription model are expanding and taking full advantage of this innovative personalization technology.

The subscription model, in which the customer agrees to pay a specified amount of money for a designated time period, is often used in the transmission of music, electronic books and videos. Providers offer services that are fully optimized for an individual, such as recommending items that the user wants with extremely high accuracy and offering special discounts or campaigns only for that individual. This results in improvement of user satisfaction and continuing trust and renewal of the contract. This is significant given that today's fluid customers can easily cancel an agreement online. Businesses use innovative IT technology to first let customers join with a low fee and then turn them into faithful, long-term clients with other incentives.

Innovation Enabled by Continuing Improvement

Another important trend is the application of continuous improvement flow, a development technique used in IT for business. In the IT world, development and operation are not separate phases but rather overlap in an iterative process to continuously improve the software. This method is called DevOps. In DevOps, a software developer uses the software in actual operation. After receiving feedback from users, the developer identifies points to be improved, enhances the software and then places it back into the operating environment.

This flow can also be used for the improvement of a variety of business designs. For example, sharing and other services with a short cycle, where users

pay for only what they request and use. Continuous improvement of the model is key to expansion in this business model. The same process can also be applied to the subscription model. In the subscription model, it is necessary to continually improve customer satisfaction through a series of messages to convince users that their judgment is correct, familiarize themselves with the service, expand use and decide to renew the contract. To remain successful, this process must be coupled with continuous improvement.

The technique in which the designing of the service and improvements based on a continuous feedback cycle can be called DesignOps. With the growing popularity of the subscription model, this will probably be an indispensable process for business designs in the future.

Innovation That Fosters Openness

It is easy for services integrated with IT to be more open, asking the world for its opinion. This open strategy is also useful as a means to enhance continuous improvement. For example, a large ecommerce company is known for using this approach to actively disclose to third parties the systems that they are developing for their own use. The reason for this is so that they can collect user feedback and competitor comparison information from a wider range of resources, integrating this information into the continuous improvement loop. As a result, the cloud and logistics services that this company disclosed have become the world's largest. These services are still repeating the improvement cycle and are likely to become even more competitive in the future.

The company is aware of user feedback and comparisons with competitors through the initial technical development phase. When a new development starts, this company writes a press release for reporters first, crafts expected questions and answers and then designs the user screens. Next, it creates a user manual, after which the company starts the required technical development. The company's process is intentionally the reverse of the most commonly used method. This is a shrewd, strategic technique because the technology to be developed, the services that use the technology and the businesses that use the services are explained to the users in advance – as are the benefits. As a result, the company may start continuous improvements based on user feedback on a service that does not yet exist.

Innovating Existing Industries via Business Design

A big wave of IT-based transformation is about to engulf the automobile industry. With the help of IT, the ride-sharing service has changed the role of a private car to that of a taxi or delivery vehicle paid in increments according to usage. In addition, the transition to autonomous vehicles, which separates the driver and completely automates its operation is underway. In the future, IT might obtain the core of the automobile industry from car manufacturers.

Under these circumstances, a large automobile manufacturer announced the future development of an autonomous driving platform. The company aims to develop its own proprietary, auto-driving technology while manufacturing cars with a competitive edge. In addition, the company plans to offer automated driving car systems to other companies. Other companies are using open API to offer services at will. It is significant news when an existing industry leader proposes an ambitious effort to fully adopt a new business model made by IT. This is a model of industry transformation that many different types of businesses may be facing in the future.

Case Study

Open Innovation: BeSTA FinTech Lab

Recent years have seen increased momentum in utilizing open innovation, where a company combines its own business with cutting-edge technologies and business models of IT vendors and startups to develop new businesses. NTT DATA has been working on linking itself with client companies and startups in a wide range of fields for rapid development of new businesses based on the concept of open innovation. In particular, NTT DATA established the BeSTA*1 FinTech Lab to accelerate open innovation efforts to develop new businesses in the financial sector.

The lab utilizes NTT DATA's own program for developing new businesses called DCAP*2, which incorporates design mindset, lean startup and other methodologies. DCAP expeditiously repeats a series of processes by trial and error, including idea development through design mindset based workshops, hypothesis verification through interviews and prototyping and demonstration experiments via test users. This results in a rapid release process, while mitigating risk factors. To develop novel financial services using IT, we at NTT DATA also use our own human resources and relationships to promote active cooperation with companies including startups, manufacturers and distributors that have unique ideas and/or cutting-edge technologies.

We at NTT DATA will continue to use our network with startups and other industries to promote our activities at the lab to develop novel financial services that combine startups with cutting-edge technologies and innovative ideas, with regional banks rooted in the community. We will also present to participating banks business ideas that have completed the business model construction and hypothesis verification phases, and regularly conduct experiments at consenting banks, aggressively deploying new services.

***1** Abbreviation for Banking application engine for Standard Architecture. NTT DATA's standard banking application with no specific vendor is an accounting system software package for the member banks of the Regional Bankers Association of Japan.

***2** Abbreviation for Digital Corporate Accelerate Program. It uses NTT Group's knowledge and open innovation know-how to assist new business development. From idea creation to hypothesis planning and launching a new business, it consistently assists in the entire process from both management and frontline perspectives, while meeting the company's needs.

Stories of Society and Life in the Future

http://www.nttdata.com/global/en/foresight/

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.

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