

Orchestrating a brighter world

NEC

NEC Research Activities
- English -



Digitalization is impacting society and industry with unprecedented speed.

Meanwhile, NEC is working to solve social issues using cutting-edge AI and ICT platform technologies. We will bring the benefits of digitalization to people everywhere with these technologies as the core of the ecosystem-oriented R&D that transcends organizational boundaries and consolidates knowledge from around the globe.

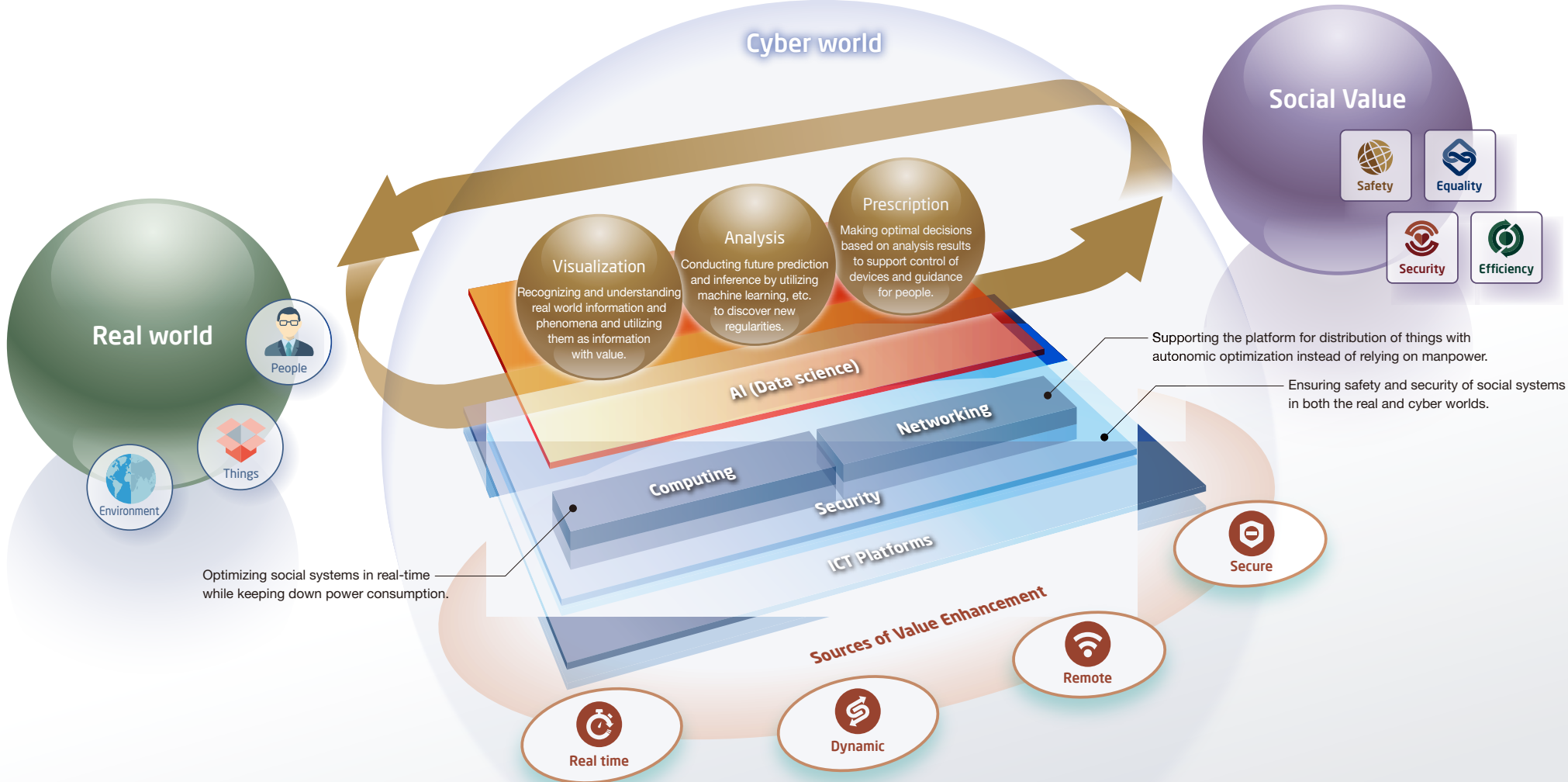
Motoo Nishihara

Executive Vice President,
CTO and Member of the Board
NEC Corporation



Technology areas we are focusing on and our process of creating social value for the future

NEC utilizes AI to carry out the processes of “visualization” to obtain a wealth of real-world information, “analysis” to create new knowledge from the vast volumes of data generated through visualization, and “prescription” to return the knowledge back to the real world and actualize value. New value is created by connecting the real world and the cyber world using these three AI-based processes, which are supported by an “ICT platform” with highly secure computing and network at its core. We are engaged in the research and development of core technologies that are essential for the realization of a sustainable society.



Global R&D Formation

NEC has R&D bases in 7 locations across the world. The research laboratories closely collaborate with each other while maintaining the regional strengths including local ecosystems.

NEC Laboratories America

Based in Princeton on the academically-oriented east coast, and in San Jose in Silicon Valley on the innovation-minded west coast, NEC Laboratories America contributes to society through technological innovations that drive the development and commercialization of core technologies, such as cutting-edge data analysis and platform technologies.

NEC Laboratories Europe

NEC Laboratories Europe is based in Heidelberg, home to the oldest university in Germany, where we collaborate with nearby universities, research institutes, enterprises, hospitals, and local governments. We anticipate trends in Europe and the world, and work on advanced research in AI and IoT with a focus on finance, medical care, and transportation as our primary targets.

NEC Laboratories China

In the Chinese market that leads the world in the field of AI, NEC Laboratories China focuses on R&D of data science and wireless communication networks. We aim to develop platform technologies that can be applied to the global market through standardization as the key to resolving social issues.

NEC Laboratories Singapore

Collaborating with government agencies, enterprises, and research institutes in Singapore and other developed countries, NEC Laboratories Singapore combines leading technologies from all NEC research laboratories to co-create and demonstrate solutions for social issues in public safety, public transportation, and medical care.

Israel Research Center

Israel Research Center implements expedited R&D through technological integration with local universities and startups by leveraging Israel's unique ecosystems of technological innovations that promote the creation of a diversity of new businesses with aggressiveness and flexibility.

NEC Laboratories India

Collaborating with the Government of India, and companies and research institutes in India, NEC Laboratories India works on issues in the fields of transportation, logistics, safety, payment, and authentication. Through the co-creation and demonstration of solutions utilizing advanced technologies of all NEC research laboratories, we accelerate commercialization of these solutions for emerging countries.



Heidelberg, Germany

NEC Laboratories Europe



Beijing, China

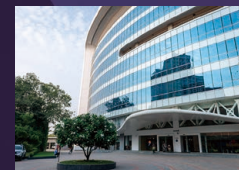
NEC Laboratories China

Israel Research Center



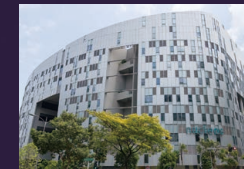
Herzliya, Israel

NEC Laboratories India



Mumbai, India

NEC Laboratories Singapore



Singapore

Organizational structure

NEC's research laboratories are responsible for strengthening the technology competencies of the NEC Group. We are pursuing R&D to pioneer the future with co-creating social values in joint efforts of our globally located research laboratories.

Japan

Data Science Research Laboratories

Biometrics Research Laboratories

Security Research Laboratories

System Platform Research Laboratories

Value Co-creation Center

Overseas

NEC Laboratories America

NEC Laboratories Europe

NEC Laboratories China

NEC Laboratories Singapore

Israel Research Center

NEC Laboratories India



San Jose, U.S.A



Princeton, U.S.A

NEC Laboratories
America

Central
Research
Laboratories



Tamagawa,
Kanagawa



Tsukuba, Ibaraki



Data Science Research Laboratories

General Manager Toshihiko Hiroaki

Promptly Develop AI technologies valuable for the society

Data Science Research Laboratories is primarily engaged in research and development of AI. In our view, AI is comprised of the three processes of “visualization,” “analysis,” and “prescription.” By continuously conducting these processes and accumulating data, we aim to achieve ICT systems and system platforms that continuously create new social value. Our researchers visit the customers’ sites and work with data and problems in the real world of society and business, while engaging in cutting-edge technology development at a level that gains recognition at top conferences.

For example, we have recently achieved research results in areas such as “high-speed-camera object recognition technology” and “fiber optic sensors” that provide precise wide-area measurements of vibrations and temperature, which are unique and have garnered high expectations from the business perspective. Also, in “small data analytics,” which is attracting attention as the next paradigm and is one of NEC’s world-leading technologies, we are conducting collaborative research with Dr. Sugiyama of RIKEN, one of the global authorities in this research area. When our small data analytics technology is applied to image recognition, for example, we are able to maintain the same level of performance as conventional machine learning, with only about 1/10 the volume of training data.

In the future, we plan to further enhance our research in the areas of wellness and robotics. Our hope is to make a huge contribution to realizing a brighter future society through cutting-edge research and development.

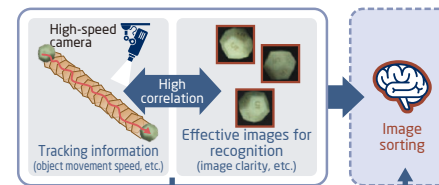


High-speed-camera object recognition technology

High-speed-camera object recognition technology is used to perform real-time recognition of the detailed appearance features of moving objects without having to stop them. High accuracy is achieved by using high-speed, lightweight image recognition technology to process a large volume of images captured by high-speed cameras. One of the potential application areas of this technology is appearance inspections in the manufacturing industry. Unlike conventional automated appearance inspection processes, which require target objects to stop in front of the camera one at a time, our high-speed-camera object recognition technology makes it possible to perform inspection continuously without stopping the flow of products. An innovative aspect of this technology is that it makes it possible to completely omit operations and processes that were considered necessary for conventional image recognition. Since this technology has a wide range of possible applications outside the manufacturing industry, we are presently pursuing research in many areas.



Data Science Research Laboratories
Keiko Yokoyama Shigeaki Namiki



Judgment of whether images are effective for recognition, based on information obtained when tracking

Conceptual diagram of image sorting

Aiming to achieve “human understanding” through biometric research

NEC has an extensive track record as a leading pioneer in biometrics, with a long history that spans over 40 years. Our fingerprint recognition, face recognition, and iris authentication technologies have been ranked the world No. 1 in accuracy by third-party organizations. For example, our fingerprint recognition technology was ranked No. 1 eight times in a period of 13 years since 2004, in a benchmark competition organized by a U.S. government agency.*1 In addition, NEC’s face recognition technology ranked No. 1 three consecutive times in still image face recognition tests organized by the U.S. National Institute of Standards and Technology (NIST). In 2017, NEC’s video face recognition technology also ranked No. 1 in a contest that measures the matching accuracy of faces in video.*2

The solutions that we develop are not limited to the field of security. For example, we recently developed technology that uses wristband-type wearable sensors for long-term monitoring of stress levels. Because biometrics technology digitalizes the external and internal information that people possess, it is a technology that ultimately leads to greater “human understanding.” Moving forward, we will continue conducting research in various directions in pursuit of the wide-ranging possibilities in applications such as promoting health, improving work efficiency, and conducting marketing.

*1: FpVTE 2003 (Fingerprint Vendor Technology Evaluation), Slap Fingerprint Segmentation Evaluation 2004
ELFT 2007 (Evaluation of Latent Fingerprint Technologies), PFT 2009 (NIST Proprietary Fingerprint Template Testing)
FpVTE 2012, PFT II 2013, MINEX 2016 (Minutiae Interoperability EXchange Test), MINEX III 2016

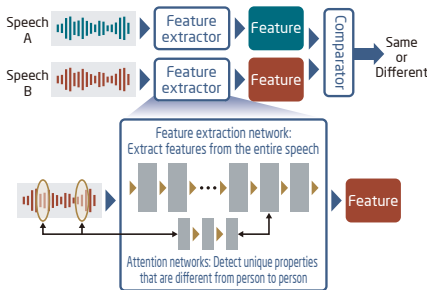
*2: MBGC 2009 (Multiple Biometric Grand Challenge), MBE 2010 (Multiple Biometrics Evaluation)
FRVT 2013 (Face Recognition Vendor Test), FIVE 2017 (Face In Video Evaluation)



Voice recognition technology

Voice recognition is one of a number of the world’s leading biometric authentication technologies that NEC possesses. In benchmark tests conducted in 2018 by a third-party evaluator in the U.S., the National Institute of Standards and Technology (NIST), our voice recognition was able to demonstrate a high accuracy rate of approximately 95% even under extremely difficult environments, such as when speech was contaminated by loud noise. By incorporating our unique data augmentation technique and a neural network that extracts unique individual features, we have achieved a system highly robust against environmental changes.

Voice recognition is the only biometric authentication technology that enables authentication to be performed remotely by telephone. As such, it is expected to be used in a wide range of applications in society, such as in authentication for e-commerce or Internet banking, or in call center operations.



Overview of Voice recognition technology



Biometrics Research Laboratories
Takafumi Koshinaka



Biometrics Research Laboratories

Masayuki Mizuno General Manager



Security Research Laboratories

General Manager Mikiya Tani

Implementing a reliable security framework to support OT and IoT

Security Research Laboratories conducts research in both data and cyber security to ensure the safety and security of society. We possess world No. 1 technologies for secure computation and blockchain, which are our particular areas of strength. In secure computation, we have achieved world-class speed by using proprietary multi-party computation technology to process data dispersed across different servers. Our blockchain technology is also one of the world's most outstanding in terms of processing speed, with a processing performance level that is 100 times* better than previous technology. Recently, the evolution of AI and IoT technology has resulted in the development of new areas of research. For example, new attacks have appeared that intentionally cause image recognition AI used in automatic driving etc. to be recognized incorrectly. One of the themes that we are actively working on is to prevent that kinds of new attacks for AI. We are also focused on pursuing research aimed at using AI technologies to detect anomalies, perform machine learning based on the expertise of security analysts, and carry out cyber attack simulations to automatically derive attack-defense combinations. The ultimate purpose of security research is the pursuit of safety and security. Going forward, we would like to continue our efforts in research aimed at creating a society in which each individual can naturally enjoy safety and security.

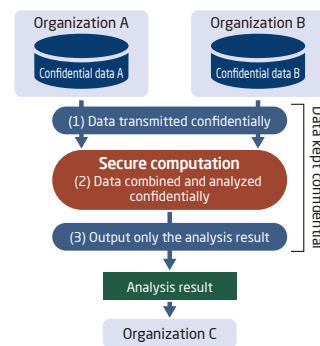
* Based on a comparison as of February 2018



Secure Computation

Secure computation using secure sharing is a field of research in which NEC is a world leader. The fast processing speed (amount of work per unit of time) of this technology as well as its security and ease of development is highly rated by top international conferences that have been accepting our recent research papers.

Secure computation technology promotes combined data analysis of highly confidential information that are separately managed by multiple organizations or departments. During our collaborative research with Osaka University, we were able to demonstrate the effectiveness of the combined data analysis of genome information possessed by various medical institutions. We are currently researching its application in various fields including the medical and healthcare fields as well as its use in information banks. It is expected to become a technology that greatly assists acquisition of new insights that can solve social problems.



Overview of secure computation



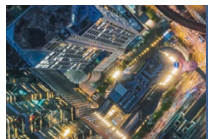
Security Research Laboratories
Toshinori Araki

Hardware research integrating the real world and cyber world

System Platform Research Laboratories engages in research focused on processing platforms ranging from cloud systems to edge systems and devices. Computing and communication technologies are at the core of our research, and our research themes are focused mainly on hardware that connects the digital world to the real world.

With a long-standing focus on the development of communication and computing technologies, we at NEC have accumulated a wealth of hardware knowledge over our extensive history, which is one of our greatest strengths. When attempting to fully implement AI and IoT in the real world, there are some aspects that cannot be addressed simply with cyber knowledge and insight. For example, it is necessary to have real-world knowledge and expertise pertaining to how radio waves are transmitted, in order to ensure the stable operation of communication systems. In such areas, we at the System Platform Research Laboratories draw greatly on NEC's experience cultivated over years of research, and on our researchers' deep knowledge and expertise in basic fields of physics and chemistry.

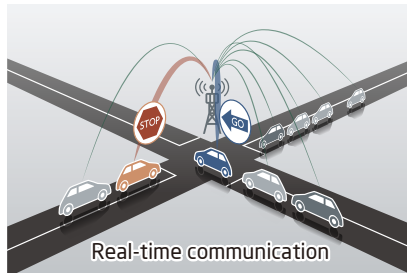
We are also actively pursuing cutting-edge research in technologies such as quantum computing, spin-current thermoelectric conversion, and quantum sensors. In these areas, we aim to engage in research that can bring about unprecedented and disruptive innovation to society.



Adaptive network control technology

Adaptive network control technology recognizes the types and statuses of devices that are connected to the same wireless network, determines the level of priority for each device, and then performs real-time distribution and control of the network's wireless bandwidth. This technology is expected to become increasingly important as AI and IoT become widely adopted in the future.

For example, as autonomous driving vehicles become more prevalent in society, bandwidth congestion will occur at intersections where large numbers of vehicles gather. In this situation, if there is a significant communication delay with even a single vehicle, there is a risk that the vehicle may collide with another vehicle. Adaptive network control technology is capable of meeting communication delay deadlines under these types of conditions, by appropriately allocating the bandwidth based on the level of priority for each vehicle and device.



Adaptive network control technology of image sorting



System Platform Research Laboratories
Takanori Iwai



System Platform Research Laboratories

Soichi Tsumura General Manager





Value Co-creation Center

General Manager Kazuo Fujita

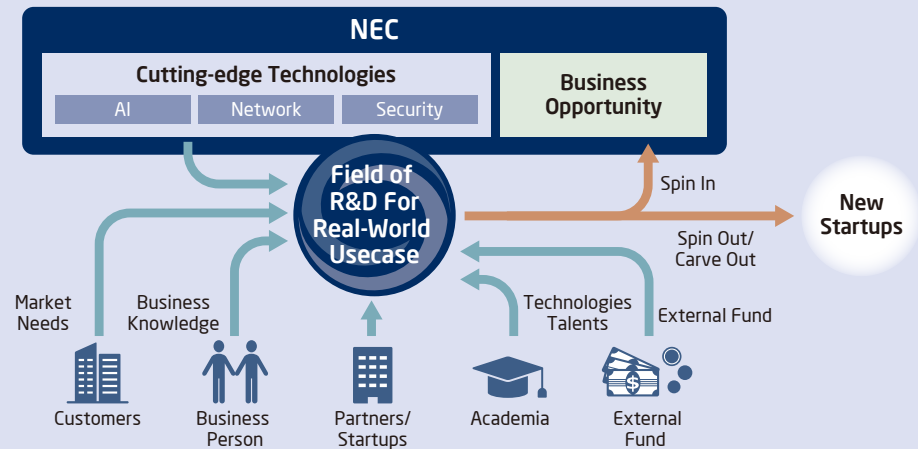
Promote commercialization of Labs' cutting-edge technologies

The Value Co-creation Center was founded in 2016 as an organization that takes charge of the business side of research and handles incubation and acceleration of business. We take on the role of promoting new business development, which is a difficult task for researchers to accomplish alone.

Our vision is very clear: maximizing business value—that is, our market capitalization in the stock market. As long as we are able to announce promising world-class research technologies and services, we are sure to significantly increase the value of NEC's businesses. In addition, if we can ultimately create new companies out of the laboratories and launch IPOs, this will earn major profits for NEC. These kinds of carve-outs should also provide appealing career paths for researchers.

The level of NEC's technologies is just as high as that of other companies and services that have revolutionized the world in recent years. In fact, I think we can consider them to be at a high level globally as well. However, the only remaining issue is the creativity to come up with services that have an impact on users around the world. We must pay attention to society and our users and continue to respond flexibly to the market environment and users' needs while pursuing our research. I think this stance is what is required of laboratories nowadays. To achieve this, it is important for laboratories to enter the market themselves and rapidly generate new businesses and services. We will strive to lend these efforts our full support going forward.

Ecosystem-oriented R&D with NEC's Cutting-edge Technologies as a Core





Technology Vision

NEC established a technology vision as guidance for our research and development to create new value. How can we evolve the future technology?

What kind of innovation do we bring to society?

NEC addresses the realization of a brighter future, let us explore our outlook on future technology.

Data science

Recognition AI

Realizes a deep understanding of humans and things by combining a wide variety of sensors

Today, sensor technology is growing; therefore, it is possible to bring together a space that humans cannot recognize directly with information that far exceeds the five senses or human cognitive abilities into the cyber world. By applying advanced AI to this massive volume of information, NEC makes it possible to capture deep information such as the internal states of people or the inside of objects which cannot be perceived by humans. NEC's face recognition technology is capable of reconciling a picture taken ten years ago with a current image for authentication that is independent of race and age, as well as identifying individuals hidden by makeup or a malicious disguise. This technology has been evaluated as the best performance in the world by the National Institute of Standards and Technology (NIST) in the United States. In the future, we will further develop recognition AI technology to recognize more in-depth information, such as a person's psychological state. This will help to prevent crimes instead of just finding a suspect after an incident.

Analytics AI

Being up-to-date with changes: Realizing advanced insightful analysis from fragmented information

Solving social problems that we face requires the ability to react to the environmental changes in the real world. NEC continues to develop prediction and optimization technologies that predict changes from system-generated data and determines the optimal response. This enables dynamic reactions to constantly changing conditions, such as product demand forecasting.

On the other hand, solving unknown complex problems in society at large requires final decisions by humans with the assistance of AI. NEC will continue to develop ways to use information by direct learning while preserving the correlation of information as well as reasoning AI that builds logically valid hypotheses and quickly verifies them. This can present appropriate suggestions along with reasoning even where there is only fragmented knowledge and information, such as in the case of unprecedented cyber attacks, and helps solve complex problems.

ICT Platforms

AI platform

Streamlines the learning process while managing hardware

AI processing is broken down into two phases: learning and inference (execution), and in many cases, the computational load of learning is enormous. For example, image recognition requires learning about 10 million images in a week in advance; actual recognition processing takes approximately 0.1 seconds to complete. NEC will accelerate the learning process in AI using a variety of appropriate hardware, including a GPU that is suitable for high-speed deep learning, a vector processor with wide memory bandwidth suitable for machine learning other than deep learning, and a FPGA with a performance per unit power consumption that is about 100 times better than a CPU. This improves the processing capacity by two digits and allows the learning processes to take place on a single server that previously required dozens of servers.

Communications

Meeting to diverse needs by integrating AI with communications expertise

Future communications must satisfy the need for ultra fast speeds and large capacity to deliver high definition video and the need for extremely high reliability and low latency to perform real time control of autonomous vehicles. NEC will meet such diverse needs by integrating AI which learns from massive volumes of data obtained in the field with modeling and other communications expertise based on physics, engineering, and informatics. NEC is one of the world's top vendors of undersea optical cable systems and has implemented communications related technologies such as the commercialization of the world's first networking equipment to support SDN (Software-Defined Networking) which can be flexibly defined by software. Using such advanced communications technologies as a foundation, the integration of AI will produce far more advanced communications technologies.

Cyber Security

AI and the digital twin ensure the safety and security of life

Cyberattacks are becoming more sophisticated, and the attacks extend to the physical systems, such as commercial facilities, in addition to public services that provide electricity, gas, water, and sewerage. The attacks are diversified and often use internal crime. In order to protect a system that must not have its supply terminated against a variety of attacks, it is important to take advantage of the digital twin, including the physical system and people, to enhance security measures by continuously implementing a huge number of simulated attacks as predicted by AI and simulated defenses as created by AI. In addition, it is critical to encrypt the communication and authenticate the IoT device to prevent the invasion of a virus. NEC will take advantage of AI and the digital twin with authentication encryption technology that passed the second screening in an international competition. As a result, perfect security measures are being implemented that would be impossible to implement manually in a system.

Data distribution platform

Shares a wide variety of data to make the entire society more efficient

The sharing of data to promote the use of public data will become increasingly more important as the driver in transforming society in the future. However, most private data cannot be easily shared because of privacy protection or conflicts of interest. NEC has achieved computation technology that can conceal the original data, which is more than ten times faster than any other company's method. The combination of this computation technology and a system to ensure the safety of programs makes it possible to leverage private data without worrying about data leaks. Providing this system as a data linkage service enables the streamlining of society as a whole through the development of new medicines, efficient traffic solutions, and loss reduction in manufacturing and distribution.

For further information





Data Science Research Laboratories
Shinji Ito



I am presently researching decision-making assistance algorithms in uncertain environments. In academic terms, this area is related to mathematical optimization. The major theme is the application of optimization methods even in environments where it is not known how various factors change in correlation to certain actions. For example, I have recently been working on an investment optimization problem known as portfolio optimization.

In my view, a good point about NEC is that there is an environment that provides solid support for researchers to do what they want. For example, I enrolled in a doctoral program at university in April 2018, and am now conducting research at university while working at the company. I became inspired to enroll in the doctoral program when, after entering the company and starting research, I gained a newfound appreciation for the academic side of things. Of course, it is extremely challenging to conduct both company research and academic research at the same time, but I am grateful that the environment at NEC allows me to pursue both lines of research.

In addition, NEC is actively engaged in collaborative research with external organizations, and the company even encourages researchers to become involved in this type of research. Actually, I began conducting collaborative research soon after entering NEC. By virtue of this approach, in 2018 we had research papers accepted by NIPS, ICML, and AISTATS, which are considered the top international conferences in the field of machine learning. In my view, it is a great blessing to work in a research environment that is not confined to the boundaries of the company. I believe the company has a long-standing mindset that places importance on raising the international presence of individual researchers and helping them establish their careers.

Security Research Laboratories

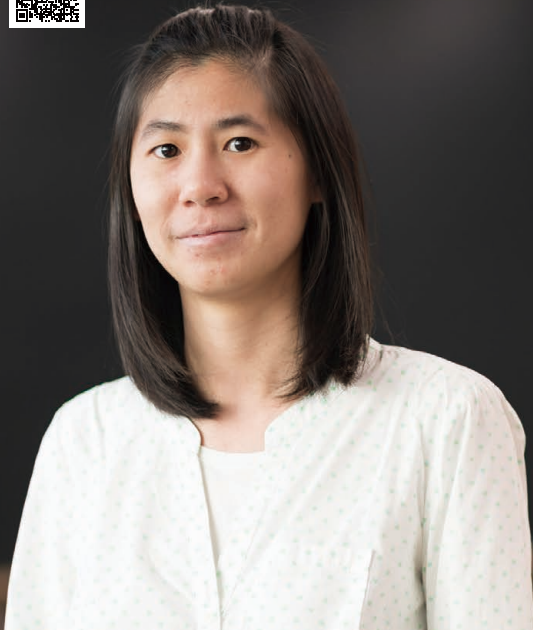
NEC has long been involved in security and has a particularly strong presence in encryption technology, even on a global scale. In addition, NEC takes part in a wide array of businesses ranging from undersea cables to satellites, and is engaged in applications for national defense systems. The company has abundant experience in business domains that require high levels of accuracy and confidentiality, which serves as a great strength to our security technology. Recently, I developed NEC's "Automatic Cyber Attack Risk Assessment" technology. When this technology is implemented in an existing system, it automatically assesses the risks by acquiring data from the system, constructing a virtual environment, and conducting attack simulations. Unlike conventional technologies that simply manage the vulnerabilities, our technology is unique in its ability to visualize a variety of intrusion and attack scenarios even in areas where vulnerabilities do not exist. This technology also makes it possible to assess OT (operational/control technology) systems, which were not considered as targets of attacks in the past. As a result, the technology is also able to handle attacks on control systems such as power plants and industrial plants, which have been on the rise in recent years.

As for the application of the technology to OT systems, I found a university in Singapore that owns a water treatment control system, and collaborate with. I became a visiting researcher at the university for about six months, during which time I conducted research while traveling back and forth from Japan. In my case, I actively jumped to the appropriate location to conduct the research. A good point about NEC is the environment that supports this sort of approach to research.



Security Research Laboratories
Hirofumi Ueda





Data Science Research Laboratories
Salita Sombatsiri

I am now working on the research and development of hardware at the Data Science Research Laboratories. My main research theme is acceleration technology for convolutional neural networks (CNN). We presented our paper, entitled "Parallelism-Flexible Convolution Core for Sparse Convolutional Neural Networks," at the 2018 Workshop on Synthesis and System Integration of Mixed Information Technologies (SASIMI) international conference, where it won the Outstanding Paper Award. We have taken one technological step forward, but in the future, I hope that we can continue to make progress in our research toward achieving further acceleration and practical applications.

Also, I am currently attending university while working at the company. Actually, when I entered NEC, I quit my doctoral studies before completion. However, everyone in the company was concerned about this, and they encouraged me to follow through and finish the degree. I heeded their advice, and recently I have been going to Osaka University about once every two months. I am working on the research and exams that are required until I graduate. I am extremely grateful to my superiors and the company for providing this support.

NEC employs researchers from overseas, like me. I went to university in Japan, so the Japanese language was not a disability for me. But even for people who cannot speak Japanese, there is no trouble with communication. The Japanese researchers can speak English, so I usually switch between English and Japanese as appropriate when communicating. Private Japanese language lessons are also available to anyone who is interested, which can also help with daily communication in Japan.

Biometrics Research Laboratories

Before entering NEC in 2018, I conducted research in astrophysics for about 10 years, including my time at graduate school and the Max-Planck Institute, a research institute in Germany. When my research entered a period of stability, I decided to take the opportunity to enter NEC. At the time, I thought that I would like to pursue machine learning and artificial intelligence as new research themes.

The transition from astrophysics to biometric authentication was a pretty significant change. Although I am still getting accustomed to conducting research in a new field, I would like to make use of my research expertise to create new technology.

Deep learning, which is at the core of the present machine learning field, has been experiencing remarkable technological evolution. The question now is what to do with this technology, or how to come up with an approach that nobody has considered, from all the countless possibilities. In machine learning and artificial intelligence research, this is key. I believe that, as somebody with experience in astrophysics research, my way of thinking and knowledge can lead to the pioneering of new possibilities in machine learning and biometric authentication technology.

Also, NEC is a large company, so a variety of benefits and systems are available. For example, one good point is that employees can take childcare leave, regardless of their gender. It is very helpful to be able to work in a good work environment that even provides support for raising children.



Biometrics Research Laboratories
Makoto Takamoto





System Platform Research Laboratories
Masaaki Tanio

Since entering NEC, I have been engaged in the research of hardware for wireless devices. My research theme is signal processing technology that can achieve low power consumption in wireless devices. The distortion compensation technology that I developed in 2015 makes it possible to counteract the distortion that occurs even when power amplifiers are operated at a high efficiency, leading to a great improvement in power consumption. The technology is now used in actual products in at least 10 countries around the world. In 2018, the patent for this technology also won the Kanto Region Invention Encouragement Award (presented by the Japan Institute of Invention and Innovation).

In the field of 5G, which is expected to be the communication system of the future, I developed 1-bit digital transmission technology that can completely eliminate the digital-analog conversion process. This technology successfully cuts in half the amount of power consumed by analog wireless circuits other than the power amplifier circuit. The technology has received high praise in academic circles, leading to its acceptance at seven international conferences, including the International Microwave Symposium (IMS), which is the top conference in the field of microwave technology, as well as five invitations for me to speak as a guest lecturer.

Also, NEC has a system to support employees for a year of study overseas. I made use of this system and went to study at university in the United States. With an approach that includes this overseas study support system, NEC carefully thinks about the career of each individual researcher. I am extremely grateful that the company considers the viewpoint of cultivating researchers when managing projects.

System Platform Research Laboratories

I am presently working on the R&D of elements used in quantum computers at the System Platform Research Laboratories in Tsukuba. There are two types of quantum computers. One type uses the quantum gate method, which has been thoroughly researched for a long time, and the other type uses the quantum annealing method, which has been attracting attention lately. Our team is currently focused on computers that use the quantum annealing method. I am performing activities such as the design, theoretical calculation, measurement, and analysis of circuits that use superconductors, which are used in these quantum annealing machines. NEC is currently aiming to develop practical applications for these quantum annealing machines by the year 2023, and is now expanding the organization to achieve this aim.

In the quantum annealing machines that use NEC's unique superconducting circuits, one characteristic is that the quantum effects (coherent states) have a long duration. The ability to sustain the quantum state for a longer time is a promising sign in terms of being able to appropriately use the quantum effects required for computation.

Another characteristic of our machines is that they can be scalably designed. By adopting the idea of making physical quantum bits redundant and establishing connections between all logical quantum bits, the problem of wiring between physical quantum bits was also eliminated, making it possible to apply the technology on a large scale.

Together as a team, we are making a concerted effort to establish our quantum computer as the new standard. I find great motivation in working toward the completion of an innovative machine that can change the world.



System Platform Research Laboratories
Tomohiro Yamaji



Established

1899



Consolidated Revenue

\$26.2 billion
* 110.99yen=U.S.\$1

Employees

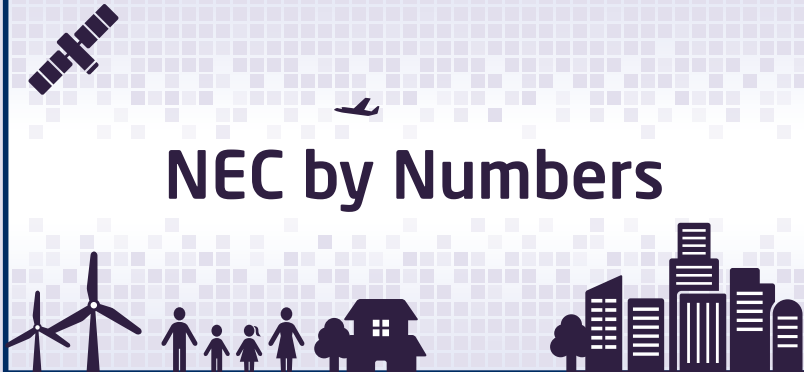


110,595

Group Companies



327





NEC by Numbers

Global Networks


327 group companies are doing business in **169** countries and territories.

NEC Biometrics Authentication Technologies




used in **700+** systems in **70+** countries and regions

AI




NEC AI technology portfolio consists of four world's **No.1** technologies

Satellite Systems



Developed **73** satellites since 1970.

Submarine Cable Systems



Circle the globe **6** times over **250,000** km.

As of March 31, 2019

<https://www.nec.com/en/global/rd/>

