

Innovation Management

NEC has adopted "Relentless Pursuit of Innovation" as one of its Principles. The word "Innovation" here denotes more than technological innovation; it refers to the creation of social value through contributing to solutions for social issues. Innovation management refers to managing innovation across the entire value chain. As a major part of this, we focus on explaining our initiatives to strengthen our technological capabilities and to commercialize them as the keys for continued provision of value to society.

Policy

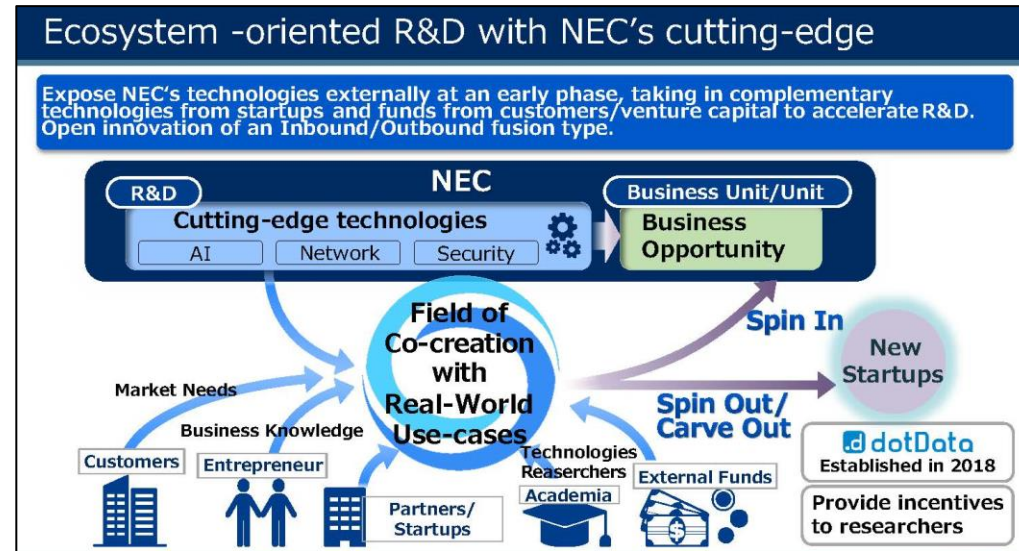
With regard to strengthening our technologies, under the direction of our Chief Technology Officer (CTO), we have formulated a technology strategy for the next stage of growth in social value innovation. We will continuously allocate approximately 4% of our revenue to R&D and make concentrated investments in NEC's proprietary No.1/Only 1 core technologies.

We are promoting "ecosystem-oriented R&D" that encourages a fusion of inbound and outbound types of open innovation. We try to attract customers, startups, and venture capital companies by exposing our technologies at an early phase to incorporate complementary technologies and funds from them so as to accelerate our R&D activities.

In addition, we will actively promote packaging of common technologies based on R&D results, commercialization of technologies across our conventional business framework, and global open innovation, working to accelerate monetization of competitive technologies.

Strategy

We will engage in the following strategies for NEC's initiatives in technology development and business development, including intellectual property.

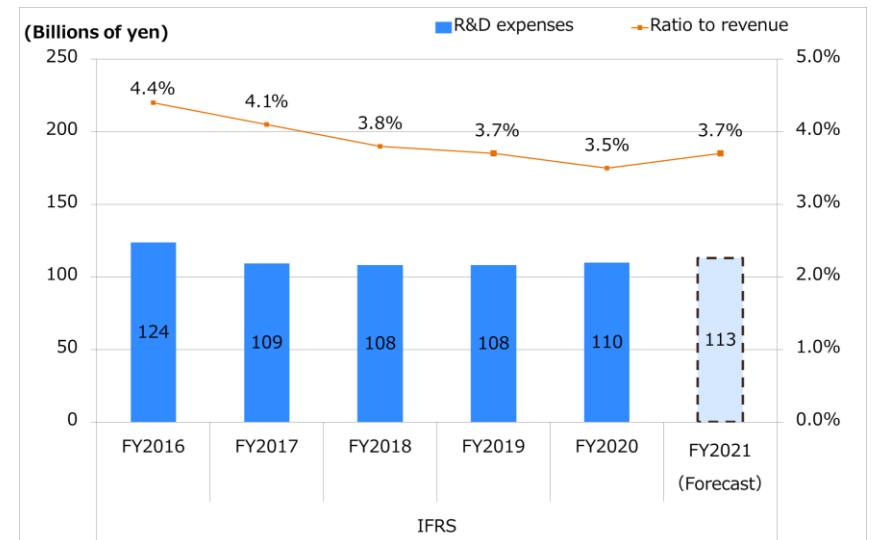


Technology Development Strategy

At NEC Corporation, the CTO is responsible for overall technology development, companywide optimization of development investment, optimizing development investment companywide, drawing up an open innovation strategy and formulating open innovation strategies and process design.

R&D is a source of technological development. NEC's basic approach to R&D is to deliver value to society as quickly as possible by identifying the best solutions we should create for social issues presented in SDGs and other guidelines, then efficiently and rapidly aligning the necessary technology assets to realize them. These technology assets include NEC's No.1/Only 1 core technologies that have been refined to a high level based on technology trends, as well as technologies produced through open innovation.

We have set our investment in R&D at around 4% of revenues. To ensure that these investments are used effectively and efficiently, we are investing also in collaborations with external research organizations, in addition to concentrated investments in the key business areas. In fiscal 2020, R&D expenses were 3.5% of revenue.



Sustainable Management	Environment	Governance	Social	5-7	Sustainable Management	13	Sustainable Management Needed in the Post-Pandemic World	23	Dialogue and Co-creation with Our Diverse Stakeholders
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Concentrated Investment in Strong Technology Areas

We are concentrating investment in two areas of technology: data science and ICT platforms. NEC Corporation has many unique and competitive technology assets in these two areas, and we believe that continuously building strength in these areas will improve our competitive edge in delivering solutions for society.

In the area of data science, we are developing AI technologies that contribute to the creation of new values by carrying out visualization, analysis, and prescription for the real world. In the area of ICT platforms, we are developing computing and network technologies that can adapt dynamically and in real-time to changes in the real world, and security technologies that allow social systems to operate securely and stably.

Moreover, as part of our concentrated investment in strong technology areas, we will continue to strengthen “[NEC the WISE](#)” as a cutting-edge AI technology brand, along with our [Bio-IDiom](#) brand for biometric authentication products.

“NEC the WISE” expresses our determination to address prominent and complex social issues by combining the many AI technologies of which NEC is proud.

“Bio-IDiom” is our comprehensive brand for biometric authentication products and services using six biometric authentication technologies for face, iris, fingerprint and palmprint, finger vein, voice, and ear acoustic. One of NEC’s strengths is in multimodal authentication, which combines multiple biometric authentication technologies to achieve higher accuracy.

We take pride in our ability to provide completely new social value and user experiences by combining these AI, video analytic and biometric authentication technologies. NEC will continue to invest intensively in world-leading biometric authentication and AI technologies.

Standardization Strategy

We are carrying out strategic standardization activities, such as building business ecosystems, expanding business opportunities, and utilizing standardization-related patents needed for strengthening business.

Intellectual Property Strategy

At NEC Corporation, because intellectual property is regarded as an essential business resource supporting our Group’s competitiveness and stability, as well as for contributing to co-creation with our customers, we strive to strengthen and protect not only our patents and knowhow but also the designs and trademarks that support our global brand.

To create and develop social value, we are not only building IP-based barriers to entry and securing competitive advantage, but also building and using our IP portfolio to strengthen and protect collaborations with customers and partners.

NEC owns some 47,000 patents worldwide (including approximately 21,000 Japanese patents) as of March 2020.

Business Development Strategy

We are promoting a transition into new business models that transcend existing business frameworks and the development of business from NEC’s core technologies.

Inspired by social issues and our core technologies, we will formulate hypotheses about issues, undertaking “business exploration” to promote development of business models through practical field testing and “business development” to implement new business models and realize high social value and sustainable growth.

Among these activities, we not only establish business within NEC, but also promote business development activities through various schemes that include spin-outs and carve-outs.

Business Exploration

We collaborate with stakeholders in and outside the Company to promote a “Generate” phase of formulating business visions and strategies and an “Ideate” phase of customer development and business model verification.

We are using exploration of social issues and technologies from our Central Research Laboratories to create business models that will underpin the Company’s next growth stage.

Business Development

We will drive a business development approach that is not bound by conventional in-house norms, and rapidly create businesses that provide high social value and will become future core businesses.

New businesses are established through a “Develop” phase involving product development and business plan verification and a “Launch” phase preparing for the market launch.

In May 2019, we announced our full-scale entry into the drug development business. NEC will engage in drug development itself, seeking to provide pharmaceuticals to patients.

Furthermore, the 181st Ordinary General Meeting of Shareholders, held in June 2019, approved an amendment to the Articles of Incorporation, establishing a new objective: “To manufacture, sell or otherwise dispose of, medicines, quasi-medicines, reagents, and other chemical products, and to provide medical support services and medical testing services” (Article 2 (5)). The Company will expand the social solution business by further promoting the medical system business and the drug development business using cutting-edge technologies in the growing healthcare business field.

▶ [NEC initiates AI-driven drug discovery business targeting a business valuation of ¥300 billion by 2025](#)

Social Value Design® from the Perspective of Individuals and Society

To create new social value, we need to illustrate what society should be in the future, for example, by creating a city vision from the corporate, government, and community points of view. To address these needs, it is imperative to find ways to increase the value of systems and services from a societal perspective in addition to individual points of view. NEC has embedded this way of thinking based on “Social Value Design” into the planning and development of new products and services and is thereby creating innovation.

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Promotion Framework

NEC has created a CTO position to establish a Companywide perspective in our effort to optimize development investment companywide, and link our corporate strategy with the planning of collaboration strategies with others. The CTO has overseen the establishment of a technology development promotion framework for examining and promoting technology development strategies in cooperation with business units and the Central Research Laboratories.

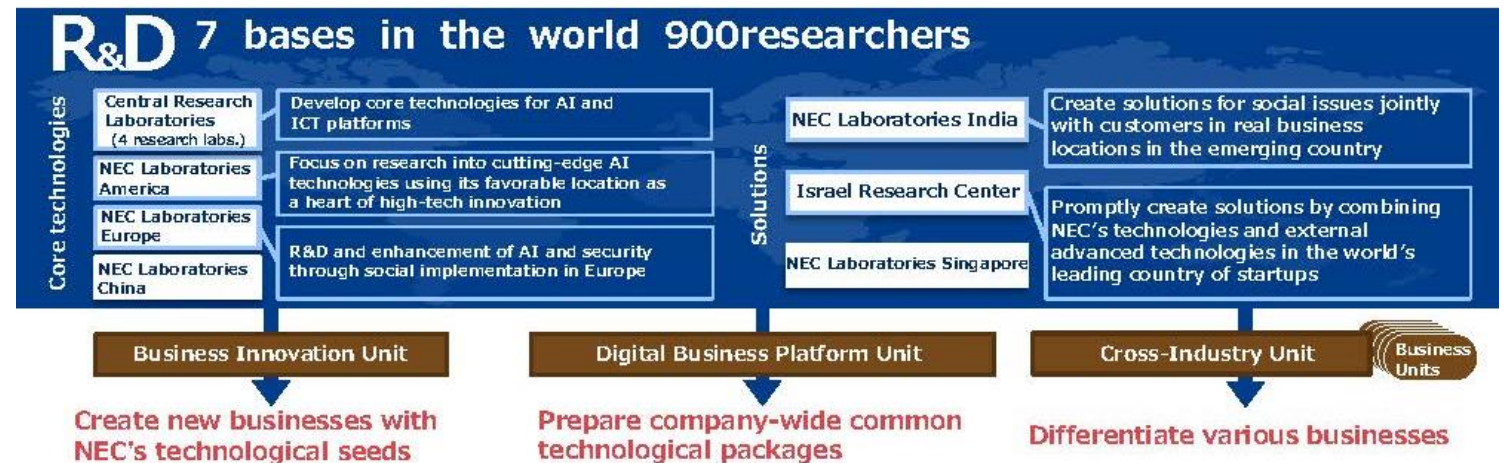
In April 2020, the Central Research Laboratories were integrated with the technology strategy/intellectual property division to establish the Research and Development Unit with added solution development capabilities. The new Unit will take the lead in maintaining and expanding the Company's core technologies, creating business models that maximize technological value through co-creation across the boundaries of industries, and promoting the sharing of infrastructure technology owned by each business unit, with an aim to accelerate the commercialization of technologies as an outcome of R&D.

In addition, the Research and Development Unit works to accelerate commercialization of core technologies towards the creation of social value in cooperation with the Business Innovation Unit, which tackles innovation from a business development perspective, and other units.

Research and Development Unit Aiming to Create Global Social Value

NEC aims to create No.1/Only 1 core technologies using its global advantage and to create social solutions for markets in both advanced and emerging countries. We are promoting R&D at two different types of laboratories: one for creating core technologies, such as Central Research Laboratories, and the other for verifying values of solutions, such as NEC Laboratories Singapore.

In April 2020, we established the Technology Value Creation Division and the Technology Synergy Creation Division, which will act as a bridge between technologies produced by R&D and business. Through co-creation activities with our customers, we will promote commercialization with core technologies in and outside the Company and companywide sharing of the technologies. This system will enable us to realize a completely integrated process for commercialization of technologies from research to business.



Research Laboratory Aimed at Creating Global Social Value

NEC's research laboratory system includes R&D bases established in Japan, North America, Europe, China, India, Israel and Singapore, as shown in the figure above. The system aims to create No.1/Only 1 core technologies using its global advantage and to create social solutions for markets in both advanced and emerging countries.

Corporate Technology Strategy Division: Promoting Companywide Technology Development and Research Strategy

The Corporate Technology Strategy Division provides strong leadership in the innovation of technologies to promote efficient R&D and commercialization strategies. It also creates a companywide technology portfolio to promote growth across the different Business Units. In April 2020, the Corporate Technology Strategy Division, which was directly under corporate management, was integrated with the strategy department in the Research Planning Division of the Central Research Laboratories to strengthen companywide strategy functions. The Corporate Technology Strategy Division will work together with the CTO to formulate implementation plans, including strategies for R&D, open innovation, standardization, and regulation in collaboration with the officers in charge of technology in each Business Unit and the general managers of Central Research Laboratories and the Intellectual Property Management Division.

Intellectual Property Management Division: Strengthening NEC's Intellectual Property Capability

In anticipation of future global business expansion, we are focusing on the construction of an IP portfolio that is on par with global leaders. We have established intellectual property centers in North America, Europe, and China to carry out global intellectual property activities. Moreover, for our social solution business, we are implementing strategic patent projects across the entire NEC Group to acquire strong patents and patents that can be leveraged to our advantage, while promoting the establishment of a comprehensive IP portfolio centered on those patents to encompass all our businesses. In terms of strengthening and protecting our global brand, we are ensuring the proper communication of our corporate brand statement and the protection of rights.

Business Innovation Unit: Creating Business Models and Core Businesses to Underpin the Next Growth Stage

The mission of the Business Innovation Unit is to explore social issues and create business models that will underpin the next growth stage using the technologies of the Central Research Laboratories. It also works to drive new business development approaches to rapidly create NEC's future core businesses, and accelerate of NEC's value maximization. Unit also strengthens the market intelligence and design functions to drive social value creation activities over the medium to long term.

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Digital Business Platform Unit: Aiming to Provide Value for a Digitally Inclusive Society

The Digital Business Platform Unit promotes increased customer value and process reformations and enhancements by linking R&D outcomes to social issues and needs, packaging common technologies, incorporating them into DX platforms, and delivering them to the market as DX offerings.

Cross-Industry Unit: Promoting Differentiation of Diverse Businesses

The Cross-Industry Unit promotes new business development flexibly and swiftly across the entire company by forming links with academia and government, and between different industries to realize Society 5.0.

Human Resources Development and Training

In promoting innovation management, we consider human resources to be the source of innovation.

NEC is working to attract leading researchers by providing ample opportunities for active roles and remuneration. In 2015, we introduced the post of research fellow, which has no upper limit on compensation. In 2019, we introduced the Selective Compensation Program for Professional Researchers, with no upper limit on compensation for non-managerial employees, in our effort to acquire and develop top level R&D talent.

In addition, as our focus shifts from manufacturing to the creation of intangible value, we are actively working to develop personnel who can use NEC Corporation's core technologies to create new businesses.

In April 2020, certain personnel with high levels of expert knowledge and ability in certain fields outside of technology and research, and who contribute to the company's business by demonstrating the ability to make an impact in and outside the company, were appointed to a new officer class professional position called "corporate executive."

Developing Human Resources Who Can Use Core Technologies to Create Social Value

To create social solutions businesses, we need to cultivate and strengthen researchers who not only have specific core technology expertise, but also possess broad and diverse domain knowledge as well as a business mindset. To broaden our scope on the creation of new value, we are working on strengthening the development of global human resources, bolstering efforts to hire domain specialists, and developing leaders who are equipped with the business acumen to drive business forward. Aiming to strengthen our human resources tasked with tackling advanced global issues, we are implementing measures to raise the percentage of researchers with global business experience to 70%.

In the creation of social solutions businesses, it is also necessary to have not only specialist knowledge of specific technologies, but also wide-ranging knowledge of the social issue domains where these technologies will provide value to society. We are therefore also strengthening and accelerating our mid-career recruitment programs.

We are also endeavoring to accelerate the realization of social solutions businesses by strengthening the ability of our in-house human resources to promote business development through the exchange of personnel between our business and research divisions. In particular, in AI technologies and security technologies we conduct training of human resources by top engineers and nurture project leaders and technology architects through personnel exchange in order to strengthen business development capabilities. From fiscal 2021, the Research and Development Unit has adopted an organizational structure that enables smoother and swifter business incubation from a technology perspective.

At the same time, NEC is working to develop human resources who will lead the commercialization of core technologies. In fiscal 2018, we established the role of "business designer" to create new businesses and support their acceleration. We also established the Business Designer HRM (Human Resource Management) Promotion Committee made up of general managers of divisions responsible for business development of the Business Innovation Unit and each business unit. The Committee defines the skillset of a business designer and establishes training systems, as well as formulating measures for rotation and expert specialist qualifications. By implementing and improving these measures, NEC Corporation will develop human resources who will bolster its business development capabilities.

Open Innovation

To expand the scope of value for social value creation, we are actively promoting open innovation with research institutions around the world, as well as commercialization partners, start-ups, and others. By promoting collaboration with external partners and specialist institutions, we envisage the development of the technologies needed for new businesses that are difficult for NEC Corporation to develop alone, and our vision for the future, then back-cast from there to study the key business areas in the next generation.

Collaboration with World-Leading Research Organizations and Universities

Realizing Highly Confidential and Available Transmission and Storage of Biometric Data Using Quantum Cryptography

The National Institute of Information and Communications Technology (NICT, President: Hideyuki Tokuda) and NEC have teamed up to develop and successfully demonstrate a system that achieves high confidentiality and availability during authentication by using quantum cryptography and secret sharing for transmission of feature data in a facial recognition system and storage of authentication reference data.

Industrial Internet Consortium Approves Testbed of Negotiation Automation Platform for Coordinating Interests among AI Systems

NEC Corporation, Fraunhofer IOSB, Kabuku Inc., the Korea Electronics Technology Institute, Oki Electric Industry Co., Ltd., and Toyota Tsusho Corporation received approval from the Industrial Internet Consortium for their proposal of an inter-AI Negotiation Automation Platform Testbed in cooperation with Japan's National Institute of Advanced Industrial Science and Technology, designed for validating the utility of new technologies, applications, products, services and processes for industrial networks.

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NEC and Osaka University Demonstrate Possibility of Analyzing Genome Information from Multiple Institutions with Reduced Risk of Privacy Infringement

NEC Corporation and Osaka University conducted trials to apply secure computation, which enables the analysis of data in its encrypted state, to a genome analysis system. They demonstrated the practicality of a tool that allows analysts to use their own analysis methods in secure computation and showed that computation processing can be carried out at a practical speed, making it possible to perform genome analysis with minimized risk of privacy infringement, thereby contributing to the progress of research on personalized medicine.

- ▶ [NEC and Osaka University Demonstrate Possibility of Analyzing Genome Information from Multiple Institutions with Reduced Risk of Privacy Infringement Using Secure Compilation of Encrypted Data.](#)

Main Results for Fiscal 2020

Major Research Achievements for No. 1/Only 1 Core Technologies

NEC Face Recognition Technology Ranks First in NIST Accuracy Testing

NEC Corporation's face recognition technology achieved the highest matching accuracy in the Face Recognition Vendor Test (FRVT) 2018 performed by the U.S. National Institute of Standards and Technology (NIST), with an outstanding low error rate of 0.5% when registering static images of 12 million people. NEC's technology ranked No. 1 in NIST testing for the fifth time, following its top placement in the face recognition testing for video in 2017.

- ▶ [NEC Face Recognition Technology Ranks First in NIST Accuracy Testing](#)

NEC Develops Iris Recognition Technology That Works Even with Walking Subjects

NEC Corporation developed iris recognition technology capable of highly accurate identity verification of people as they walk past. This makes it possible to implement "walkthrough" ticket gates and security gates serving large numbers of people with improved convenience. Until now, iris authentication has required that the user remain still at a prescribed location in front of a camera, which is then adjusted to the position of the user's eyes. This is a

troublesome process, and there have been calls for a more convenient solution. Now, by combining iris recognition technology with our newly developed imaging technology, we have made it possible to perform walkthrough identity verification instead of requiring people to stand still.

- ▶ [NEC Develops Iris Recognition Technology that Works Even with Walking Subjects](#)

NEC Develops AI Technology That Learns the Intentions of Experts to Reproduce Advanced Decision-Making

NEC developed AI technology that learns the intentions of experts as a model based on their excellent cognition and judgement from their behavior history data, thereby significantly improving the efficiency of operations that require a high degree of skill. By extending the inverse reinforcement learning* framework with NEC's proprietary algorithm, the technology automates the building of decision-making models, which was previously carried out by engineers. By creating a decision-making model from experts' behavior history data for decision-making problems that are difficult to formulate manually, the technology can quickly and autonomously derive a judgement comparable to that of an expert. By applying this technology to decision-making processes depending on experts, the work burden can be greatly reduced, leading to a dramatic increase in work speed.

* Inverse reinforcement learning: Whereas reinforcement learning derives an optimal behavior based on a reward, inverse reinforcement learning estimates the reward from an optimal behavior.

Full-Scale Entry into the Quantum Computing Field

To help create solutions for increasingly complex social issues, NEC launched a co-creation service during the first quarter of fiscal 2021. The service solves optimization problems, including use of annealing machines that utilize NEC's vector engine supercomputer SX-Aurora TSUBASA. Furthermore, to accelerate our activities in the field of quantum computing, we will promote application development and technology development through joint verification with customers.

Results of Activities in the Field of Medicine

Government of Bihar and NEC Partner to Provide Preventive Health Check Services

The Government of Bihar (Republic of India), NEC Corporation, and NEC Technologies India Private Limited

(headquarters: New Delhi, Republic of India) concluded a memorandum of understanding (MOU) on collaboration in the area of preventive healthcare services.

This collaboration is aimed at promoting the health and wellness of citizens in the state of Bihar, India. The three parties will collaborate to offer a periodic, home-visit health check, and encourage citizens to change their lifestyle habits to mitigate the risk of chronic diseases such as diabetes.

- ▶ [Government of Bihar and NEC Partner to Provide Preventive Health Check Services](#)

Transgene and NEC Start Two Clinical Trials with TG4050, an AI-Powered Cancer Vaccine for Ovarian and Head & Neck Cancers

Transgene, a biotech company that designs and develops virus-based immunotherapies for the treatment of cancer, and NEC Corporation enrolled the first patients in the first in-human trials evaluating TG4050, an individualized therapeutic vaccine, based on Transgene's viral vector technology and powered by NEC's cutting-edge AI capabilities.

- ▶ [Transgene and NEC Start Two Clinical Trials with TG4050, an AI-Powered Cancer Vaccine for Ovarian and Head & Neck Cancers](#)

Results of Intellectual Property Activities

NEC participates in various patent pools and is building a system to provide its patents to industries in a form that is easier to use.

For details of the results of NEC's intellectual property activities, please refer to the following.

- ▶ [NEC Receives the Top 100 Global Innovator Award for a Ninth Consecutive Year from Clarivate Analytics \(Formerly Thomson Reuters\) \(Clarivate Analytics website\)](#)
- ▶ [Successful Outcome for NEC Corporation in United States ITC Investigation Brought by Xtera, Inc. \(ITC Investigation No.337-TA-1098\)](#)