

Orchestrating a brighter world

NEC

NEC Celebrates 120 Years 120 Years, and the Road Ahead

1999-2019: A 20-Year Journey
to a Brighter Tomorrow

NEC Corporation

Preface

On July 17, 2019, NEC celebrated its 120th year in business. Our longevity is undoubtedly a result of the unwavering patronage of all our customers, business partners, and shareholders, as well as the tireless efforts of every NEC Group employee, from the most senior manager to the newest of recruits. I cannot thank everyone enough for their kind support.

To mark this wonderful milestone, we decided to take up where we left off with the NEC Corporation 100th Anniversary Book, published in our 100th year of operation, and revisit some of the events of the last 20 years to provide an updated record of our corporate history. During this period, the environment in which companies operated changed dramatically on the back of advances in infocommunication technologies and increasingly globalized economies. The years between 1999 and 2019 were a time of challenge for NEC as we struggled to redefine our core competencies for growth and aimed to steadily improve our profit structure by pushing forward with measures to selectively focus on certain businesses on an unprecedented scale.

In recognition of these challenges, this historical record focuses on the concept of working “towards social value creation”—value exploration and co-creation—and was compiled with a strong sense of how best to learn from and pass on the lessons of the past 20 years so that NEC may continue to create new value into the future.

“120 Years, and the Road Ahead” is an easy-reading account that matches specific events with the important initiatives of the last 20 years given NEC’s origins and history. It depicts NEC’s ongoing efforts to become a contributor to the realization of a sustainable society through the stories of our progress: our resolve to strengthen compliance in light of the Defense Agency Central Procurement Office Breach of Trust incident that sent shockwaves through senior management, the wide-scale structural business reform measures we adopted, including withdrawing from traditional core businesses, and our restart as a company driven to create social value through the use of ICT.

This frank and retrospective chronicle of the troubles NEC has faced, the debates it has endured and the goals it has pursued in this period of immense change aims to link those engaged in value creation efforts in the NEC Group going forward with the sentiment that we can “continue to succeed under the One NEC initiative while always adapting to meet the future from a global perspective.” And I sincerely hope that this record of the past 20 years also speaks somewhat to our support of the economic community and will give our customers, as well as our business partners, shareholders and other domestic and international stakeholders, a deeper understanding of NEC as they partner with us to promote co-creation activities into the future.

Takashi Niino

President and CEO (Representative Director)

NEC Corporation

March 2020

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Chairman of the Board of Directors





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Becoming a global company with of high-value proposals for human

NEC's future as a Social Value Innovator



an active culture society

Lessons to pass on to future generations on this 120-year milestone

The Nippon Electric Company came into being right at end of the 19th century in 1899 as Japan was traveling the road to modern nationhood. Time has moved on and Japan's industrial structure has undergone a spectacular transformation in the little over a century since the founding of our company. Our predecessors' personal and enduring commitment to the motto of "Better Products, Better Service," a market approach advocated by NEC founder Kunihiko Iwadare as a way to take on rapidly changing business environments, while adopting flexible mindsets and behaviors has grown our business immensely.

On the occasion of our 100th anniversary in 1999, NEC published the "NEC Corporation 1899–1999: A Century of Better Products Better Services" to detail NEC's first century of history. However, fast forward 20 years to 2019, and I feel that this recent 20-year period marks a separate milestone in NEC's history.

This is particularly true of the progress made by ICT and its related businesses (value creation fields), which have undergone enor-

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mous change when compared with previous eras. ICT advances in the last 20 years have dramatically increased data gathering and processing capabilities, and as a result, human society is moving from being an “information society” to a “data society.” That is to say that the value source in solutions is shifting from information to data, and depending on the data volumes that can be processed, it is now possible to obtain even higher value for human society by moving from “partial optimal solutions,” created deductively and based on information formed from data subsets in the information society, to “overall optimal solutions” constructed inductively directly from big data.

To ensure that NEC maintains on-going capacity to reliably create value amid this sort of change, I think we need to reflect back on the last 20 years so that we can identify areas of our culture that require strengthening.

Around 4,000 BC, some 6,000 years ago, the Jomon era in Japan emerged as the Neolithic age ended. If each generation is said to contribute to society for an average of 20 years, then we are now on our 300th generational change. Each generation, despite many twists and turns,

has not let a fear of failure stop them from creating better lives and better communities. What would have been the outcome if generational change only happened every 1,000 years? This recent 6,000-year period would have only consisted of six generations. Surely the rate of human progress would have been far slower over this period. People living such long lives most likely would not think too much about the importance of passing on knowledge and experience to their children. But life is short. That’s why we feel we should treasure every moment. And I believe that we consciously want to pass on knowledge and culture that may be of value to our descendants in the next generation. None of us will be alive in a 100 years’ time, but worthwhile knowledge and culture will most likely be passed down through each generation and form the basis of efforts to create better value. How did NEC face up to changes in the business environment in the last 20 years? What opportunities and difficulties did we encounter and what decisions did we make? Not all were spectacular successes; we also experienced failure and made a number of painful decisions. And therefore, we wanted to be honest when passing on our



experiences to the next generation. I hope those that carry NEC into the future will use these lessons to build a culture intent on further strengthening NEC's on-going value creation capabilities.

Sense of alert about a passive culture and expectations for the NEC School for Social Value Creation

The 20-year period from 2000 was a time of upheaval. The dot-com bubble appeared on the scene and then burst. There was the evolution of mobile internet and the impact of the iPhone. In 2008, the world economy was hit by the collapse of Lehmann Brothers. The effects of AI became

apparent as we entered the 2010s and today it is becoming an indispensable part of many businesses. AI, as well as technologies like big data, IoT and robotics, are all rapidly evolving into value creation tools.

The speed at which change equals progress is getting faster each year and this progress gives rise to new discoveries and technologies that have the potential to create new value and provide enhanced value to human society. If we limit ourselves to the existing sense of value and ignore how our environment is changing in these ways, we would not expend the energy to take on self-improvement.

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The comfort of a warm bath is difficult to leave, but if we do not find the motivation to get out when the water is warm, the water will cool, and we will have already lost the body heat needed to take action at the right time. We need to make every effort to retain a constant sense of alertness to the prevailing conditions and enhance our abilities to proactively and continually create value.

Dedication to creating future value above remaining complacent with the status quo. One such initiative is the NEC School for Social Value Creation, started about 5 years ago. This one-year training course, conducted in both Japanese and English, welcomes employees from all over the world.

This course differs from conventional training programs. Trainees may, for example, travel to South-East Asian and African countries and find themselves in environments quite unlike Japan where they discuss such intrinsic human values as desire and happiness with the local people living their daily lives. Inspired by this experience, graduates from the NEC School for Social Value Creation have embarked on efforts to understand the intrinsic nature of human society and create value by giving consideration to

what values sustain this society.

The NEC School for Social Value Creation was started because we felt we needed to change NEC's seemingly introverted and somewhat passive culture. We want trainees to be inspired from different directions and experience the process of taking the initiative to actively create value. The key concepts here are "from passive to active," "global," and "gravitate to the fundamental values of human society." There is a limit to what one can achieve in one year, but even so, students seem to react positively to the course. We look forward to these graduates becoming leaders who will guide NEC into the next era.

How commoditization impacted Japan's No. 1 businesses

In the last 20 years, NEC has stepped forward and separated or withdrawn from a number of businesses. The major of these, including semiconductors, BIGLOBE, personal computers and mobile terminals, were all businesses that had carried NEC in the past. These were painful decisions. And for sure many of us harbored concerns that these businesses may still be able to generate some value. But in order to turn NEC into a Social Value Innovator, this

process was something we could not avoid.

Our personal computer and mobile terminal businesses shared common features. Both were businesses that achieved No. 1 market share in Japan; both experienced a failed foray into the global market; and both were unable to keep up with international standards and the trend toward platform technologies.

During the peak of the personal computer business, NEC products contained NEC's own chips. These chips were what gave NEC products value and increased their competitiveness. The tide turned and conditions fundamentally changed with the spread of PC/AT compatible computers and Microsoft's Windows. A global platform was born, and it may seem extreme to say, but it soon became possible for just about anyone to produce a personal computer using these products, which in turn narrowed the margins in which technology could add value.

Our mobile terminal business enjoyed its golden age in the 2G era of the 2000s. Japan had adopted its own telecommunications standard called PDC, and NEC had loaded its mobile devices with proprietary chip sets. These compact and high-quality chip sets offered

reliable connectivity and delivered significant added value by supporting basic product functions. But even these mobile terminals faced a growing new trend. As 3G became the new global communications standard, Qualcomm, Inc. promptly released a new compliant chip that took the market by storm. Again, we saw a new global platform appear and NEC technology being used in less and less fields.

Global commoditization turned NEC and other personal computer and mobile terminal manufacturers into assemblers and, whether we liked it or not, dragged us into competition with each other on both scale and price. No doubt there are ways to seek value as an assembler, but it requires the scale to overwhelm your competitors.

From a domestic business servicing 100 million people to a global market of 7.7 billion

Purchasing power greatly affects the market competitiveness of commoditized products. Take for example products that have internationally standardized parts supporting their essential core functions. Companies with a 1% share of the world market and those with a 30% share are quoted significantly different prices

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Contributing greatly to human society by gaining a global understanding of society and taking the initiative to actively create value will smooth the path for NEC in the next generation.

by parts manufacturers. And this is directly connected to price competitiveness. NEC took two of its businesses—personal computers and mobile terminals—global so that we could expand the scale of our operations to increase purchasing power and battle it out on price in a tough international market.

In the 1970s when the decision was taken to embark on this overseas expansion, NEC held the biggest share of the domestic market for both businesses. So, we naturally thought we should build on this momentum and launch overseas. You could say that we were rolling out the Japanese model for success across the globe. At the time, this thinking had a certain persuasiveness to it. The prevailing discourse within NEC went something like this, “Japanese consumers are discerning, and any products perfected in the tough Japanese market would be winners on the world stage.”

Of course, there are fields in which this type of strategy is effective.

But looking back now, we realize that NEC’s personal computer and mobile terminal businesses needed a different approach. NEC’s failure to apply a global perspective to the successful experiences in Japan would later affect these businesses greatly.

When expanding globally, it is important that business operations and commoditized products established in a single market look at customer value from a global perspective and reflect this in product value. The scale of Japanese market is on a downward trend. We should not be satisfied with just doing business with a domestic market of 100 million people when it is critical that we work to adopt a global viewpoint on business development to enrich the communities and lifestyles of the world’s 7.7 billion people. That is to say, we must gravitate to the fundamental values of human society. We should rethink the excessively sophisticated business style used in Japan and create one more

compatible with the global market. This will require a change in mindset on the part of all NEC employees as it will be critical for us to reorganize the value creation process.

Business platforms considered from a global perspective

Although I have spoken about the difficulty of adopting a global perspective, some of NEC's businesses have enjoyed success with this approach. One of these is the ultra-compact microwave communication system PASOLINK.

To create the device specifications for PASOLINK, we did the rounds of the international customers we visited every year and consolidated their requirements in an NEC strategy to devise product specifications. Some of the major suggestions for our initial specifications came from in-depth discussion conducted with the technical team at the British communications operator BT Group plc.

During the first half of the 2000s, we rapidly increased the number of PASOLINK units we shipped from 50,000 to 300,000 in response to the increased need for mobile phone infrastructure. It was a profitable business and we captured the top share of the global market. The major reason we were successful

was because we conducted business with a global perspective.

On-site, we poured ingenuity and effort into meeting the requirements of our foreign customers. One example was cost reductions. Every year, customers requested a 10% or more reduction in our cost price. At the time, we had to cut prices by roughly half over three years or we would not get the business. We were able to take the top spot in the global market simply because we could endure this price cutting exercise. One has to have a strong awareness of the demands of the global market from the very start and get as close to these demands as possible. This approach will become even more important in the future.

And some of our businesses are already deploying this approach. Biometric authentication technologies like face and fingerprint recognition are prime examples. In 2013, NEC's biometric-related business division set up NEC Laboratories Singapore as a development hub in Singapore. It's not easy to get a handle on the demands of international customers while situated in Japan. It is important that teams have overseas bases from which to reach out directly to customers. In the six years since its opening, NEC Laboratories

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Singapore has laid down a system for delivering value globally.

The team at NEC Laboratories Singapore come from a variety of nationalities and backgrounds, and their perspective is global. An awareness of creating “world-focused solutions” has taken root and we are, little by little, starting to see results. The attitude change occurring in Singapore is likely to serve as a model case for employees here in our Japanese offices. We now have research facilities in India as well which are expanding business possibilities in that country, and even our American face recognition business is going global.

In the ten or so years from the year 2000, I think NEC’s focus on the domestic market was way too strong. NEC’s business platforms were probably too aligned to domestic Japanese business. We delivered high-quality solutions to domestic customers, but I feel we did not keep enough of a watchful eye on overseas markets during that period.

So, we had to move from a domestic orientation to a global view. Shifting business platforms is not easy. It takes time to replace platforms that have been so successful in Japan.

One example of this is payment



systems. Countries all over the world are moving ahead with cashless systems while the pace of this development has been much slower in Japan. Japan is a comparatively safe society with a comprehensive system of very exquisitely printed bank notes, so it is difficult to incentivize people to shift to a new platform. Maybe if Japan was a society

with a counterfeit currency problem, we would have moved to cashless payments long ago.

It is often pointed out that Japanese society and Japanese companies lag behind other countries in digitalization. It is certainly a major issue, but an advanced platform has already been constructed throughout the country, and given Japan is not that large, we must consider the time and costs associated with switching over to a new platform when promoting digitalization in Japan.

I emphasize a global perspective because of a sense of crisis for a Japanese society that has come to normalize low growth. We are being told that the present global population of 7.7 billion people will reach 9.7 billion in 2050. While there are concerns over insufficient food and energy supplies, Japan will need to demonstrate a stronger presence overseas than ever before if it is to maintain a healthy society.

It is here that companies will come to play a bigger role. It is vital that Japanese companies are active on a global scale if we are to leave behind a society in which the next generation can live safely. NEC feels strongly about doing its part as we engage in our day-to-day activities.

From One-to-One to One-to-Many Creating our own specifications to become a value proposition company

One of NEC's biggest strengths is our system integration capabilities. Drawing on advanced technical strengths, we have been able to meet the expectations of our mainly domestic customers over many years. Our many successes have been underpinned by the commitment of our engineers and other project-related staff. More than a few of these have been colossal projects that have called for long hours grappling with high-level requirements and overcoming adversity. The optimum information system is delivered to each individual customer. System integration is a "One-to-One," customer-specific solution.

NEC's depth of outstanding talent makes this a viable business model in Japan, but it is very difficult to service a global market of 7.7 billion people in the same way. It is for this very same reason that NEC has turned the implementation of platforms such as SAP systems at Japanese companies into a business. Developing a business globally requires a "One-to-Many" business model, or in other words,

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the development of “one” high-value platform that can be used by “many” overseas customers.

The essential process of the One-to-Many business model is: (1) gain a deep understanding of the needs of most customers, (2) designate the largest areas in which NEC can contribute, (3) define functions of the greatest common divisor to allow for the largest contribution possible, and (4) decide on and develop platform specifications. The most important thing is to know the “many,” namely by gaining a personal understanding of human society from a global perspective. Platforms that offer value to large numbers of people throughout the world come about from a deep understanding of intrinsic human needs. We must continue to improve our powers of comprehension and insight into human nature.

Social value creation responds to intrinsic human desires

Intrinsic human desire may sound complicated, but in most cases the concept of intrinsic is extremely simple. There are, for example, three intrinsic desires for a communications network. They are “anytime,” “anywhere” and “with anyone.” Companies dealing in communications,

whether fixed line or mobile, have come to pursue these three elements.

Fixed line telephones fulfilled the desire for “anytime” and “with anyone,” and we managed to achieve the “anywhere” with mobile networks. This did not mean that we gave up on the idea of fixed line technology providing the “anywhere.” In the pre-mobile phone era, communications carriers sought to realize the “anywhere” element by installing telephone boxes all over the country. Telephone boxes were the solution to closing the gap on demands for “anywhere” access in the fixed line era.

I presume some people associate the term intrinsic desires with Maslow’s 5 levels of hierarchy of needs. Maslow proposed 5 levels of human needs that are basically categorized (from the bottom upwards) as physiological, safety, love and belonging, esteem, and self-actualization. We must give some serious consideration to what sort of value we can provide in which of these levels.

Safety occupies the second-to-the-bottom position of the hierarchy pyramid. Safety is one of the important elements NEC pursues in the creation of social value, and even encompasses the biometric

To grow in the global marketplace, NEC must establish a business model that proposes solutions rather than conventional system integration, and one that moves from “passive to active” engagement.

authentication technologies that I touched on before. Regions that lack safety and security cannot attract investors or tourists. The vibrant economic activity necessary to support human society just does not happen in these places. Without safety and security, there is no hope for prosperity. Through One Platform, NEC is looking to deliver a platform that meets the intrinsic desire of human society for safety and security. In going from One-to-One to One-to-Many we are expanding the provision of value from just one customer to many customers, which requires us to shift from understanding just one customer to understanding many. This means we must understand human society, and we must do so by gaining our own understanding of the intrinsic nature and desires of people and human society. There are pointers to intrinsic human desires in the solutions referred to as “needs” in the market. Although we can monitor needs with market research, these

needs that exist in the market essentially derive from intrinsic human desire. Therefore, we should be able to assume people’s intrinsic desires from solutions of multiple needs.

This process is the very key to the One-to-Many strategy, and when we can provide solutions that are better at connecting with intrinsic human desires than solutions to current needs, this results in innovation.

I hope that we can pivot away from a passive business model that waits for specification suggestions from customers, to a more active model that sees us gain our own understanding of the intrinsic desires of people and human society. We can then formulate our own specifications for even better solutions and expand our business activities across the globe.

Leveraging our strengths and NEC’s unique position in the world

Computing power has increased more than two million times since the mid mid-1990s. Processes that

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at the time took one year can now be achieved in about 15 seconds. This unprecedented and extraordinary progress has made big data possible and heightened the effectiveness of AI technologies.

These advances in ICT are starting to shift the source of value from information to data. NEC is a rarity across the world in that it has capabilities in all three elements of ICT: computing development, network development and software/solution development. The important functions created by ICT are (1) real-time performance that adds significant value to solutions by eliminating time constraints, (2) dynamic performance that creates a high-level value very different from data, and (3) remote performance that releases people from location restraints. Making use of these functions maximizes the value of solutions, but these functions would be nothing without the three elements of ICT. NEC has the potential to create significant value.

Corporate activities and human society are two sides of the same coin. Completely understanding human society and delivering value and contributing to the sustainability of this society ensures the continuity so critical to business.



“Orchestrating a brighter world” carries the hope that, through dialog with the market and human society, we can build a brighter future using NEC’s intelligent solutions. The slanting rod on the left of the brand message is a conductor’s baton for all to carry. The baton is tilted at the angle of the earth’s axis, 23.4 degrees, and is an expression of our desire for all members of NEC to take up this baton and through large orchestrations create social value and contribute on a global scale. Now is the time for all of us to contribute more and deliver greater value to global customers.

Part. 2

HISTORY

NEC's 100 Years of Progress 1899-1999



NEC's 100 Years of Progress

1899-1999

100 years of ongoing contributions to the development of infocommunications

The history of Nippon Electric Company, Limited opened in 1899 when it became Japan's first joint venture company established with foreign capital. Initially involved in the trading of telephone-related imports, the company steadily moved its focus to the research and development of its own technologies, and by the late 1920s had gained a considerable reputation as a manufacturer of communications equipment. After the Second World War, the company grew in step with the rapid economic growth of Japan and emerged as a diversified manufacturer of electronic products. With the development of computer technology and advances in digital communications from the late 1970s, the company unveiled its ground-breaking vision of "C&C" (Computers and Communications) and placed this concept at the center of business operations as it advanced towards becoming a global IT company.

NEC's history opens as Japan's first foreign-capital company 1899-1945

The founding of Nippon Electric Company, Limited was triggered by a meeting between Kunihiko Iwadare, the company's first managing director and highest ranking employee, and the US-based Western Electric Company (WE), which would become the company's original parent company.

Iwadare was born in 1857 in what is now Fukuoka Prefecture. After graduating from the Imperial College of Engineering (the predecessor to the Faculty of Engineering of the University of Tokyo) Iwadare moved to the United States to work at pioneering legend Thomas Edison's company, Edison Machine Works.

After returning to Japan, Iwadare started his own business in Osaka, dealing in imported products. During the same period, WE had become a world leader in the production of telephone-related devices, and when the then Japanese Ministry of Communications issued its First Telephone Expansion Plan in 1896, the American company recognized the great potential of the Japanese telephone market. WE persuaded Iwadare to take on an intermediary role in the company's search for a partner to develop its business in Japan.



Founder Kunihiko Iwadare

Despite repeated negotiations with numerous companies, however, WE was unable to find a partner. Iwadare came to the conclusion that, "if no other suitable company can be found then I will just have to do it." A joint venture with WE also held considerable appeal for Iwadare.

Together with his business partner, engineer Takeshiro Maeda, Iwadare established the Nippon Electric Limited Partnership on September 1, 1898. On the same day that the revised Treaty with Western Powers came into effect allowing direct investment with foreign capital on July 17, 1899, Nippon Electric Company, Limited came into being. WE formally acquired shares and the company became Japan's first joint venture with a foreign enterprise.

Despite other contenders for the company name, it was decided that Nippon Electric Company, Limited reflected the pride of being a Japanese electric company. In December 1903, the company also registered the trademark "NEC" in a diamond-shaped logo for its own-brand products.

Initially, the company mainly traded in telephones, switching systems, and cables, with around 93% of sales in 1900 coming from imports. Approximately 76% of these imports were WE products.

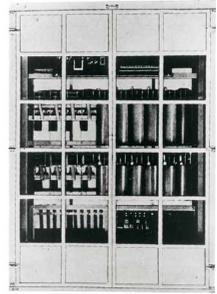
Development of domestic production using original technologies and business expansion spurred by the Great Kanto Earthquake

As electricity spread to ordinary households in urban areas at the start of the 1910s, NEC increased its focus on importing and selling home electrical appliances from WE and its affiliates. In addition to telephone-related items, the major products imported during this period included electric cooking pots, toasters, heating and cooling appliances, irons, vacuum cleaners, washing

machines, and fans. When importation of foreign products was all but stopped during the First World War, the company moved ahead with domestic production to fill some of the gaps. NEC's domestic production of paper insulated lead sheath cables proved particularly successful and secured the company's position as a leading cable manufacturer.

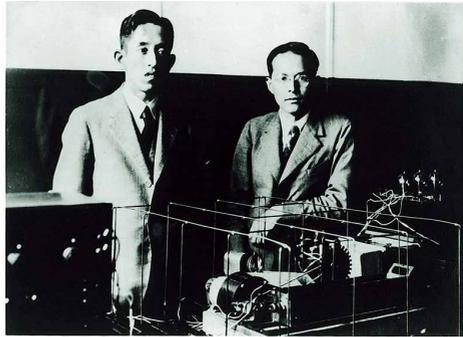
The Great Kanto Earthquake struck on September 1, 1923, and turned large swaths of the Keihin (Tokyo-Yokohama) region into a disaster zone. As a result, the Ministry of Communications proposed the start of radio broadcasting businesses to deliver disaster-resistant wireless communications, as well as moved ahead with automating telephone exchanges. In July 1927, NEC developed Japan's first automatic switching system. In May 1928, NEC became the designated contractor for large-volume automated switching systems for the Ministry of Communications and steadily strengthened the company's position as a domestic manufacturer of automated switches. Matsunosuke Matsushiro, the so-called "father of wireless telegraphy in Japan," held the posts of Director and General Sales Manager at the time, and while sales of radio broadcasting equipment remained focused on imported products, a decision was made to commence research on wireless technologies with the aim of initiating domestic production. With this decision, NEC made its move from manufacturer of telephones and switching systems and took its first steps towards becoming a fixed-line and wireless communications device manufacturer.

Despite NEC's commitment to selling only WE technology, there were growing aspirations among younger engineers to develop their own technologies. One such engineer, Yasujiro Niwa, suggested that the company needed to develop its own original technology, and together with Masatsugu Kobayashi and others, pushed forward initiatives for proprietary technologies. The NE-type phototelegraphic system was an outcome of these initiatives. The system offered outstanding speed and photo clarity when compared with Western products, and after its successful use in covering the Showa Emperor's Enthronement Ceremony in Kyoto in November 1928, the system was adopted by newspaper publishers and the Ministry of Communications.



First Japanese-made automatic switching system

Despite Japan being hit with the Showa Financial Crisis in 1927 and plunging into serious recession, the insightfulness of Niwa, now General Manager, meant that the Engineering Division continued to secure exceptionally talented engineers in preparation for the future. Future President and “reviver of NEC’s fortunes,” Koji Kobayashi, was just one of the high-caliber recruits that joined the company during this period.



Yasujiro Niwa (left) and Masatsugu Kobayashi (right) with the NE-type phototelegraphic system

NEC becomes a Sumitomo affiliate under an advancing war-time economy

The outbreak of the Manchurian Incident in September 1931 would have a significant impact on the telegraph and telephone business. With the declaration of the state of Manchukuo in March 1932, private companies actively expanded into the new territory, with NEC going on to set up a Manchukuo corporation in December 1936.

At the time, NEC’s non-loaded cable carrier equipment technology, developed jointly with the Ministry of Communications, was attracting attention all over the world. This equipment resolved the shortcomings of existing systems by using vacuum tube amplifiers to restore decaying signals. In 1939, a 3,000-kilometer non-loaded cable line, the world’s longest at the time, was completed between Japan (Tokyo) and Manchuria (Mukden) through the Tsushima Channel.

In June 1932, the International Standard Electric Corporation (ISE), which had inherited WE’s interests in NEC, concluded an agreement that entrusted the management of NEC to Sumitomo Limited Partnership Corporation and transferred NEC managements rights.

Later, as tensions in US-Japan relations intensified, ISE was unable to underwrite an increase in capital approved in August 1941, resulting in Sumitomo Honsha, Ltd (formerly Sumitomo Limited Partnership Corporation)

shouldering this increase and becoming the largest shareholder in NEC. NEC was designated an affiliated company of Sumitomo Honsha in January 1943 and renamed Sumitomo Communication Industries Company, Ltd. at the general shareholders' meeting the following month.

After the start of the War in the Pacific in December 1941, NEC's operations became war-time businesses. Demand centered on radio equipment including wireless communications devices, radars, locator devices equipped with radar and anti-aircraft components, direction finders, and passive and active sonars.

During the final stages of the war, facilities all over Japan, including factories, dormitories, warehouses, and car parks, were severely damaged by air raids. Production systems were in tatters as a result of the forced distribution of factories into regional areas, and by the end of the war, production capacity had decreased dramatically.

NEC becomes a comprehensive electronics manufacturer as Japan experiences high post-war growth 1945-1977

The end of the war for Japan came on August 15, 1945. Sumitomo Honsha was dismantled under the Zaibatsu dissolution orders issued by the General Headquarters of the Allied Powers (GHQ), and on November 30 of the same year, the Sumitomo Communication Industries name was dropped in favour of reinstating the Nippon Electric Company, Limited title.

Post-war NEC quickly got its business operations back on track by focusing on superior communications technologies. In this high-growth era, the greatest advances were made on the back of developments in radio, television transmission and broadcasting systems, and television sets. NEC continued to grow from a communications device manufacturer into a comprehensive electronics manufacturer by also directing resources to computer development based on semiconductor technology cultivated over the years.

Full-scale post-war recovery aids rapid development of the communications business

Post-war demand in the private sector centered on the telephone business. At the end of the war, GHQ strongly urged the Government of Japan to restore the communications network, with most of Japan's telephone infrastructure

destroyed by fire in the hostilities and any surviving facilities functioning at a drastically reduced level. This would prove advantageous to the re-establishment of NEC.

In June 1950, the Radio Act, encompassing the Wireless Telegraphy Act, Broadcast Act, and the Radio Supervisory Committee Establishment Act, came into effect and opened up the broadcasting business to private interests. In September of the following year, NEC fitted out two radio stations owned by Japan's first private broadcaster with all the necessary equipment and continued to provide broadcasting systems to a succession of private broadcasters granted second-phase licenses.

A worldwide radio boom expedited the development of the portable radio. NEC started manufacturing a series of miniature vacuum tubes (MT tube) for dry-cell batteries from July 1949. These tubes would go on to become a mainstay component in radios and televisions.

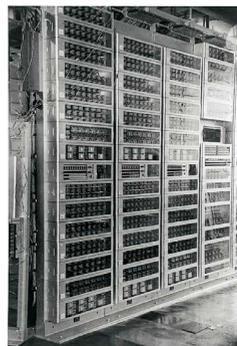
NEC continued to maintain a close relationship with the Nippon Telegraph and Telephone Public Corporation, which commenced operations in 1952. NEC supplied the company with the first Japanese-made crossbar switching system for telephone exchanges in September 1956. This system went on to play a pivotal role in NEC's longstanding success.

Meanwhile, NEC was establishing an unrivalled position in microwave communications research after GHQ relaxed restrictions on the once prohibited field. NEC achieved practical application of the world's first solid-state (semiconductor) microwave communications line in 1963. NEC's solid-state microwave communications systems were adopted by the Nippon Telegraph and Telephone Public Corporation, Aviation Bureau of the Ministry of Transport, Japan National Railways and electric power companies, and even went on to become a chief export to overseas markets.

In the field of satellite communications, NEC installed a high-sensitivity receiver system at the



Main entrance of the reinstated Nippon Electric Company



Prototype of the crossbar switchboard

Ibaraki (Juo) Space Communications Test Center, Japan's first satellite communications earth station, in November 1963. This receiver system contributed to the success of the first television test broadcast between Japan and the US on the 23rd of the same month. The reputation of NEC's satellite communications technologies continued to grow as the company built up a proven track record in the international broadcasting of live sporting events and other television coverage.

The establishment of the Aerospace Development Division in May 1965 provided NEC with the opportunity to start a full-scale space business. Together with Mitsubishi Electric, NEC supplied the Institute of Space and Aeronautical Science of the University of Tokyo (later the Institute of Space and Aeronautical Science of the National Research and Development Agency) with a control radar system for the Lambda rocket. The Lambda 4 was successfully launched on February 11, 1970, with an NEC satellite fitted to its final stage rocket. "Ohsumi," Japan's first man-made satellite, was born.

Home electronics business rides the wave of high growth with televisions and other appliances

Japan was rushing into an era of unprecedented high growth by the second half of the 1950s. NHK had commenced television broadcasting to the Tokyo area in February 1953, but the suspension of research during the war years and GHQ-imposed restrictions after the war meant that NEC's television research had not kept pace with the start of these broadcasting activities.

However, Television Osaka and the Chubu-Nippon Broadcasting Company were granted temporary broadcasting licences in 1954 and both companies placed orders with NEC on the success of its domestic production activities. These orders triggered the supply of large quantities of broadcasting equipment to television stations all over the country. NEC went on to play a high-level role in the development of such technological innovations as color technology, compact broadcasting systems, and unmanned transmitting stations.

The boom in home electronics arrived in the 1950s just as NEC was stepping up efforts to foster private-sector demand and reduce its reliance on Nippon Telegraph and Telephone Public Corporation. NEC spun off the Radio Division, located in Otsu City, Shiga Prefecture, in June 1953 to form the independent New Nippon Electric Company, Ltd.. Although vacuum tubes accounted

for approximately 80% of initial sales, the new company transformed into a comprehensive electronics manufacturer by expanding in-house production of televisions, audio equipment, refrigerators, washing machines, and other appliances in the late 1950s.

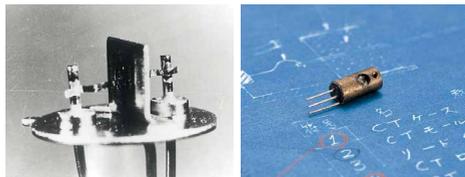
Focused computer development through proactive investment in semiconductor technology

The era of high growth was also an era of technological innovations. The most significant of these was the progress made in electronics. NEC's proactive stance on expanding into electronics-related businesses during this time was due to its early recognition of semiconductors as the new element to replace vacuum tubes.

The transistor was invented by William B. Shockley and associates in 1947, but Hiroe Osafune and others at NEC's Tamagawa Plant were early converts to the need for research and development into this field and advised their superiors. Research commenced on the condition that no extra money would be available for the project given the prevailing business conditions. In 1950, senior engineer Masatsugu Kobayashi embarked on an overseas inspection tour during which he obtained a sample transistor from Bell Laboratories. Returning to Japan, Kobayashi immediately ordered a study of this sample, and the following year, NEC successfully produced its first germanium point-contact transistor.

A turnaround in the business environment in 1953 reopened NEC's research laboratories, with Masatsugu Kobayashi being appointed Director. The basic strategy of the new facilities emphasized three areas: close contact with production plants, joint research and development between business departments, and cooperation on the industrialization and commercialization of research outcomes.

Japan's first dust-free, impurity-free, and window-less transistor-specific factory commenced operations within the Tamagawa Plant in April 1958. In mass production from 1957, portable radios using transistors instead of



Germanium point-contact transistor and alloy transistor

vacuum tubes became a driving force in the home electronics boom in Japan.

Developments in semiconductor technology spurred on the progress of computers and communications devices and even expanded related business fields. NEC of the late 1950s had also transformed from a manufacturer of communications devices to a comprehensive electronics manufacturer. NEC

established a computer research group in the company's research laboratory in the 1950s, and in March 1958, this group completed the NEAC-1101 Parametron Computer using logic elements called parametrons for greater stability than vacuum tubes.

Under the guidance of the Ministry for International Trade and Industry's Agency for Industrial Science and Technology Electrotechnical Laboratory (now the National Institute of Advanced Industrial Science and Technology), NEC completed the NEAC-2201 transistor-based computer in September 1958. This was the world's first public demonstration of a working transistor computer. From 1958 to 1970, NEC maintained its industry-leading sales ranking for domestically produced computer units.



NEAC-2201 transistor-based computer

Koji Kobayashi appointed President and international business development

Vice-President Koji Kobayashi was appointed President on November 30, 1964, as NEC continued its growth as a comprehensive electronics manufacturer.

Kobayashi called for "internationally first-class corporation" and "internationally first-class products" to be NEC's corporate slogans and mapped out a clear direction for NEC to become a multinational company. Kobayashi also declared that computers, world-leading communications, and other elements of the electronics business must be moved forward and would form a new pillar to stand alongside the existing domestic communications business.

A number of management innovation programs were also unveiled to achieve the slogans adopted by Kobayashi. Specifically, the company was reorganized into divisions and a management structure put in place based

on a top-management group rather than converging at a single “point” at company president. The ZD (zero defects) movement was also rolled out across corporate activities.

The 1960s were also the era in which digital systems emerged to replace analog systems in communications technology, with NEC actively promoting this technologically significant initiative. In 1965, NEC delivered a PCM-24 digital transmission system using pulse code modulation (PCM) to the Nippon Telegraph and Telephone Public Company.

This was the second successful practical application of PCM in the world after the first unveiling of this technology in the US. It was this PCM system that marked the start of digital transmissions at NEC and its development formed the foundation of future digital communications.

NEC was also taking giant steps forward in the field of microwave communications, and by 1978 was exporting microwave communications circuits to over 60 countries. NEC was also making significant progress in satellite communications, and by January 1973 had delivered 50 satellite communications earth stations. With a 50% share of the international satellite communications market in earth stations, and a more than 60% share in coastline stations, NEC became the world leader in this field.

Rapid progress of semiconductor technology drives computer development

Advances in semiconductor technology produced the integrated circuit (IC) and large scale integration (LSI). After receiving a request from Hayakawa Electric Co., Ltd. (now Sharp Corporation) for a more compact calculator, NEC developed the MOS (metal oxide semiconductor) calculator IC in 1966. This led to the development of the LSI microcomputer. NEC completed the first Japanese-made microcomputer in April 1972, not long after the world’s first unit was unveiled by US-based Intel Corporation.

At the start of the 1970s, the six manufacturers that made up the domestic industry were reorganized into groups under the direction of the Ministry of International Trade and Industry, which moved computer development forward



Koji Kobayashi

and resulted in NEC and Tokyo Shibaura Electric Co., Ltd. (later Toshiba Corporation) developing the ACOS Series 77 range of computer systems. By June 1978, the ACOS Series 77 accounted for a little over 40% of the market share for new series released by companies in Japan.



NEAC System 100/F

Meanwhile, NEC released the NEAC System 100 in August 1973 that eliminated the need for specialist computer operators. This type of computer was labelled the "office computer" by the Japan Electronic Industries Development Association (later Japan Electronics and Information Technology Industries Association), and the name proved to be widely popular.

Evolution to a global IT corporation centered on the C&C strategy 1977-1998

Digitalizing communications meant it became possible to deal with communications and computers in the same domain using digital technologies. At a seminar held at the international communications expo INTELCOM 77, held in Atlanta, Georgia on October 10, 1977, NEC Chairman Koji Kobayashi, unveiled the company's new concept of "integrating computer and communications technologies."



Chairman Koji Kobayashi delivering a speech at INTELCOM 77

This day marked the beginning of NEC's commitment to operations that follow the C&C (Computers and Communications) philosophy. In today's world the integration of computer and communications technologies may seem self-explanatory, but at a time when the Internet had yet to appear, this was a vision of the utmost foresight and innovation.

Under the forward-minded C&C philosophy, NEC greeted an era of rapid progress. As semiconductors took over the world, NEC's reputation grew and NEC became an acclaimed brand, particularly in overseas markets.

Rapid advances of semiconductor business parallels promotion of C&C

In June 1980, as the C&C strategy was being rolled out under the Chairmanship of Koji Kobayashi, Executive Vice-President Tadahiro Sekimoto was appointed company President. It was a brave HR selection given the new President was just 53 years old. At his first new year's address, Sekimoto encouraged employees to view the 1980s as a time of radical change and work together to quickly, intensely, and pointedly take on this challenging era. Based on the notion that a company's development is linked to its social contributions, Sekimoto highlighted the need for NEC itself to be an "innovation leader" and commit to pushing the C&C strategy both domestically and internationally. Working alongside Chairman Koji Kobayashi, Tadahiro Sekimoto established a powerful top management structure.



Tadahiro Sekimoto

The world was then hit with two oil crises, in 1973 and 1979, and Japan's main industrial base shifted from heavy manufacturing in steel, shipbuilding, and chemicals to "smaller and lighter" operations, headlined by the automobile, electrical appliances and electronics industries, that were more energy and resource efficient. This era provided yet another strong boost for NEC.

Sparked by NEC's development of 4Kbit DRAM (Dynamic Random Access Memory) in 1974, Japanese-made DRAM went on to dominate the global market in the 1980s. By 1983, Japan's share of the global market had risen to 70%. Boasting an extensive portfolio of products, NEC's semiconductor business experienced remarkable growth and in 1985 became the world's leading semiconductor manufacturer, with output nearing US\$2 billion and a market share of 8.2%. NEC maintained this number one ranking until 1991.

NEC's brand value dramatically increases as the 98 series becomes synonymous with personal computers

NEC released the TK-80 microcomputer training kit in August 1976 to uncover potential demand for microcomputers that had thus far only been used in cash registers and sewing machines. The Bit-INN support center was opened

in Tokyo's Akihabara district at the same time and soon became popular with not only professional engineers but also university and high school students.

A predecessor to the personal computer with built-in programming software appeared in the US around this time. NEC moved to request the programming software from Microsoft Corporation, headed by Bill Gates, which at the time had about 10 employees. Upon release of NEC's PC-8001 8-bit personal computer with Microsoft's BASIC programming language in September 1979, the computer became a megahit and went on to sell around 250,000 units over the following three years.



PC-9801

The 16-bit PC-9801 personal computer featuring Japanese processing and color graphic display functions was released. Total shipments of the PC-98 series topped the one million unit mark by March 1987, and the range was an overwhelming presence in the 16-bit personal computer market with an over 90% share. The 98 series boosted NEC's brand value and even became synonymous with personal computers in Japan as the so-called "people's computer."

At a time when closed architecture was common in the personal computer market, the PC-98 series' greatest strength was its recognition as the defacto personal computer standard in Japan, guaranteed by overwhelming market share based on its advanced Japanese-language processing capabilities.

The 8-bit personal computer business was later integrated into the operations of New Nippon Electric Company, and by March 1983, personal computer sales had eclipsed the sales of color televisions, the company's previous flagship product. In July of the same year, New Nippon Electric Company changed its name to NEC Home Electronics Co., Ltd..

As one undertaking in the celebration of its 90th Anniversary, NEC completed construction in January 1990 of its new head office building, the NEC Super Tower, located in the Mita section of Tokyo, where the company was founded. The NEC Super Tower has 43 stories aboveground and four stories underground, and is an intelligent building fitted with state-of-the-art technologies and functions.

NEC changes course to become a global company in the post-bubble economy

The 1990s opened with the collapse of the bubble economy. Banks and securities firms failed one after the other and Japan crashed into a period of economic stagnation later known as the “lost two decades.” Paradoxically, it was also a time of fierce global competition and advances in network technology.

With the idea that the 1990s could be the turning point at which NEC broke from its shell and embraced growth, President Tadahiro Sekimoto announced NEC’s Corporate Philosophy and a Management Commitment providing basic guidelines for conducting business in 1990 just as construction on the new headquarters was completed. NEC’s business activities would be expanded by engaging the C&C concept, developing business structures, challenging new fields, and boosting existing ventures. In encouraging further progress, there was an awareness on the part of Sekimoto that NEC needed to establish a corporate identity and reform management under a long term vision.

A rapidly appreciating yen and escalating US-Japan trade tensions in the mid-1980s pushed NEC to globalize as the export-driven manufacturing sector found it crucial to expand business activities overseas. Entering the 1990s, overseas business divisions turned to new prospects aiming to beat out international competition. In China, NEC had already received requests in 1985 from Chinese counterparts for technical cooperation related to electronic switching systems and LSI. This led NEC to pursue proactive business expansion, and by the end of 1998, the number of local NEC subsidiaries in China had reached 19. With the aim of also capturing an overseas share of the personal computer market, NEC set its sights on Packard Bell, which held close to 50% of the home-use personal computer market in the US at the time. NEC went on to acquire a stake in Packard Bell (19.99%) and finalize a partnership arrangement in August 1995.

Rapidly developing IT technologies radically change business structure

NEC’s Systems Division adopted a strategy of prioritizing the solutions business in the 1990s as network and open technology development was pushed forward by the information processing industry. Following the announcement

in April 1992 of "Solution 21" that consolidated system provisions for the client server era, the division implemented a range of solution proposals and offerings based on these guidelines.

Meanwhile, the Computer Business Group, set up in July 1994, focused its efforts on making general-purpose and office computers more open

and cheaper. The main pillar of this strategy was the Express5800 series. This enterprise-level workstation server was based on Intel architecture and employed the Microsoft Windows NT operating system. Not only did this server facilitate NEC's full-scale entry into the open systems market, it went on to become one of the leading open system servers.

Asynchronous Transfer Mode (ATM), the technology underpinning broadband, started to attract interest in the world of communications, and in 1991, NEC developed a prototype ATM switch.

In the field of transmission where optical communications were the norm, the spread of the Synchronous Digital Hierarchy (SDH) system contributed to NEC delivering a backbone transmission system capable of transmission speeds of 10 Gbits/second to Nippon Telegraph and Telephone Company (NTT) in 1995. Fiber-optic communication systems were being employed as major international communications infrastructure in submarine cables worldwide, and ended up circumnavigating the globe when the Indian Ocean fiber optic submarine cable was completed in 1994. SDH also became a mainstay of the Microwave Communications business, and was supplied in large numbers to communications providers throughout the 1990s.

In the field of satellite communications, the start of commercial operations by the International Telecommunications Satellite Organization (INTELSAT) in 1990 led to NEC delivering Intelsat-compatible Satellite Switched Time Division Multiple Access (SS/TDMA) systems to satellite communication base stations all over the world.



Express5800 Series

Advent of the Internet age and the rapid spread of mobile phones

The Internet emerged from the rapid advance of technological innovation during the 1990s. In 1993, NEC commenced an Internet connection service grown from the PC-VAN personal computer communication network service that began in April 1986, and went on to launch the diversified Internet services provider, BIGLOBE, in July 1996.

The 1990s were also a time of accelerated demand for mobile communication devices such as car and portable phones. NEC was involved from the very beginning in the development of the Personal Digital Cellular (PDC) telecommunication system using new frequency bands (800 MHz, 1.5 GHz) being undertaken by NTT spin-off NTT Mobile Communications Network, Inc. (later NTT DOCOMO) under its mobile communications business started in July 1992.

Totalling less than one million in 1990, the number of mobile phone subscribers in Japan (portable and car phones) exploded to around 47 million by the end of 1998. In addition to its business providing systems to communications carriers, NEC started directing efforts to the supply of mobile devices (handsets) from 1993, and following its initial Digital Mova N offering for NTT DOCOMO, the company went on to release new model handsets for all carriers nearly every six months.

Confronting diverse challenges as NEC's 100th year approaches

NEC's consolidated net sales had reached 4.90 trillion yen by 1997 and the company was expected to grow and develop further with the coming of a fully-fledged broadband and Internet age.

However, in September 1998, with NEC's 100th year anniversary just around the corner, a breach of trust incident occurred with the Japan Defense Agency Central Procurement Office when an NEC subsidiary servicing the agency was found to have fraudulently overcharged on government contracts.

At the time, the Japanese economy was in the midst of a serious, prolonged recession following the collapse of the bubble economy, and NEC's US subsidiary, Packard Bell NEC, was struggling under huge losses resulting from a

sudden deterioration in the overseas personal computer business and a significant downturn in the semiconductor market, especially for DRAM.

And so it is along this turbulent route that NEC steps forward into the next 100 years.

Part. 3

TOPICS

Kicking off 20 years of upheaval and change

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- Demise of multi-directional business expansion and the rise of the selectively focused business policies of the 2000s

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Challenges for the next 100 years

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- The society NEC aims to create and the Tokyo 2020 Games
- “Changing NEC” with the next 100 years in mind





“JDA incident” puts NEC on the road to stronger compliance

Ensuring on-going awareness of past compliance breaches



The Japan Defense Agency Central Procurement Office breach of trust incident was uncovered in 1998 in the period between high-growth expansion and NEC’s shift to selectively focusing on fewer businesses after the collapse of the bubble economy. This incident prompted NEC to implement measures to enhance compliance. Times may continue to change but this lesson should never be forgotten.

The incident that rocked NEC in its 100th year

On September 3, 1998, as NEC was poised to celebrate its 100th anniversary, the company was hit with a sharp blow. NEC employees were arrested in relation to dealings with the Japan Defense Agency by Group companies, Toyo Communication Equipment and Nico Electronics. The following day, NEC offices were raided by the Special Investigation Division of the Tokyo District Public Prosecutors Office. The two Group companies were suspected of causing financial damage to the state by overcharging (inflating invoices) the Japan Defense Agency for equipment contracts, illegally reducing the refund that should have been repaid to the agency’s Central Procurement Office, and promising a senior advisory post at a NEC Group company after retirement to a procurement office official in a quid-pro-quo deal for this reduction.

In the end, NEC was assumed to be systematically involved in the crime. A total of 12 people were arrested, including serving head office and Group company directors, with NEC offices raided four times. In October, the situation had unraveled to the point that Chairman Tadahiro Sekimoto tendered his resignation.

On October 12, 1999, the matter was put to rest when all 12 employees

were found guilty and given suspended prison terms by the Tokyo District Court. This scandal has taken its place in NEC history as one of the company's most serious challenges and in its aftermath NEC saw it necessary to improve internal controls and compliance-related systems.

Overbilling by padding man hours marks the start

The scandal originated from overbilling of the Japan Defense Agency for the supply of equipment by NEC Group companies, Toyo Communication Equipment and Nico Electronics. Despite equipment contracts being exchanged between the Japan Defense Agency and Toyo Communication Equipment and Nico Electronics, both companies inflated the number of billable man hours and overcharged for equipment delivered.

At the time, four companies, including Toyo Communication Equipment and Nico Electronics, were found to have overcharged the agency, but it came to light that the refund rate for Toyo Communication Equipment and Nico Electronics was lower than the refund rate for the companies unrelated to NEC, thereby reducing the amount to be repaid by the NEC Group companies. This story came to the attention of the Japanese Parliament's Budget Committee in November 1997, and was picked up by Japanese newspapers soon after.

By the end of the long spring holidays (Golden Week holiday) in 1998, the Special Investigation Division of the Tokyo District Public Prosecutors Office had already commenced a private investigation. In the lead up to raiding NEC offices, special investigators interviewed employees from July through to August of that year at a rate of approximately 10 people a day. NEC employees were finally arrested on September 3, 1998.

The Deputy Manager of the Defense Agency's Central Procurement Office and chief contact on the agency side, was also arrested on the same day on the suspicion of breach of trust for granting a reduction in amounts to be refunded to the agency. Large-scale reductions on refunds and preferential repayment terms were the result of negotiations conducted between the Defense Agency official and those in charge of the contracts at Toyo Communication Equipment and Nico Electronics. NEC employees that played a central role in the refund reduction negotiations were arrested as accomplices and charged with crimes committed during this process.

After raids by the Special Investigation Division of the Tokyo District Public

Prosecutors Office, NEC established the “Procurement Issue Inquiry Committee,” chaired by an Executive Managing Director and assigned to conduct an internal investigation. This investigation confirmed cases of overbilling in National Space Development Agency (NASDA, later JAXA - Japan Aerospace Exploration Agency) contracts as well as with the Japan Defense Agency, and reported these findings to both agencies. Repayments were then recalculated and resulted in NEC headquarters repaying approximately 60 billion yen (including interest), including 31.8 billion yen to the Japan Defense Agency, 6.2 billion yen to NASDA and varying amounts to NEC affiliates.

At the trial held at the Tokyo District Court, all 12 NEC defendants accepted the charges and were handed down the two and three-year sentences petitioned by the prosecution, suspended for four years.

This incident damaged the NEC brand greatly and its impact showed up in the company’s business results. First, the Defense Agency suspended NEC’s designated contractor status and then government agencies and local authorities followed suit. In the end, more than 630 organizations stopped nominating NEC for business, delivering a punishing blow to a company that relied on government contracts.

Policies to strengthen compliance

With this incident, NEC came to profoundly regret sticking by its internal control system and maintaining a distinct lack of awareness towards compliance, and as a result adopted a range of measures to prevent the reoccurrence of such a scandal.

One measure was the adoption of a Code of Conduct. NEC had already adopted a Charter of Corporate Behavior in June 1997 in a commitment to such principles as “fair, transparent and free competition,” “steadfast customer focus” and “positive contributions as a good corporate citizen with strong environmental awareness,” but given the events that had occurred, NEC decided to establish the NEC Code of Conduct in April 1999 to outline the standard of conduct expected of every employee from a compliance perspective.

The NEC Charter of Corporate Behavior and NEC Code of Conduct were revised in March 2004 to become the NEC Group Charter of Corporate Behavior and NEC Group Code of Conduct after growing interest in subsequent corporate social responsibility (CSR) activities necessitated a review of the

original documents. The revised guidelines were then widely adopted not just by NEC headquarters but by all Group companies.

The Employee Consultation and Reporting Desk was set up in April 1999 as an internal control system for employees to expose latent compliance breaches in the workplace. This was changed to the NEC Helpline in 2003 to enable anonymous reporting via third parties. The system was renamed again in 2011 to better clarify its purpose and became the Compliance Hotline.

Changes were also made at the time to the organizational structure. The Good Corporate Behavior Promotion Division was set up in 1998 with the aim of promoting conduct in line with the NEC Charter of Corporate Behavior. In the following January, the Corporate Auditing Bureau, reporting directly to the President, was established to centralize and reinforce auditing functions dispersed across multiple in-house departments.

The Good Corporate Behavior Promotion Division was reorganized into the Risk Control and Compliance Division in 2007 to oversee the risk management functions demanded by the Companies Act that came into force in May 2006, and later became the Internal Control Promotion Division in 2011 when it also took over internal financial control functions.

These types of compliance promoting activities have little efficacy if they are not common knowledge to people both inside and outside the company. It is for this reason that NEC started to publish the CSR Annual Report in 2004 to give the public a clear and complete picture of NEC initiatives related to the promotion of CSR. NEC Business Ethics, a compliance-themed forum, has been held every year since 2001, and has become a platform for the President himself to emphasize the importance of compliance for all employees, as well as an opportunity for in-house audiences to learn about the status of compliance activities globally through presentations by specialist speakers from the legal and corporate worlds.

Repeated scandals and preventative measures

Despite these initiatives, NEC received notifications from the Fair Trade Commission in 2016 and 2017 for violations (bid-rigging) of the Antimonopoly Act regarding three transactions: one for nationwide wireless digital emergency fire-fighting equipment and one deal each for Tokyo Electric Power and Chubu Electric Power for electrical power security systems.

In the Tokyo Electric case, NEC was not directed to cease and desist from violating the act nor pay surcharges because the company was the first to petition to the Japan Fair Trade Commission's surcharge reduction and exemption system. In the remaining two cases, however, cease and desist orders were issued and NEC was ordered to pay surcharges totaling approximately 1.4 billion yen. In addition to the Japan Fair Trade Commission's punishments, NEC was banned from participating in contracts with over 1,000 government agencies and local authorities nationwide for up to two years. NEC also paid damages totaling many billions of yen to the contract partners in the three cases, including both electric power companies.

In response to these three violations, NEC implemented a number of measures. These included the Chairman, President and relevant Directors voluntarily relinquishing a portion of their compensation, holding approximately 140 face-to-face training sessions across the country, requiring employees to sign a Declaration of Conduct committing to best compliance practices, implementing in-house leniency programs (self-reporting), conducting competition law-themed audits, and creating a new Chief Compliance Officer (CCO) role.

In 2017, NEC designated November 18, NEC Compliance Day. This was the date on which the Japan Fair Trade Commission conducted an on-site inspection in relation to the Antimonopoly Law violations pertaining to the wireless digital emergency fire-fighting equipment deal. On November 18 every year, NEC conducts measures to reconfirm the importance of compliance in the minds of employees across the entire Group, including opening the annual NEC Business Ethics forum.

In another move to strengthen compliance, NEC revised its existing NEC Group Code of Conduct to establish a new Code of Conduct in October 2019

Poster for NEC Compliance Day



“JDA incident” puts NEC on the road to stronger compliance

in light of such initiatives as Environment, Social, Governance (ESG) and the UN’s Sustainable Development Goals (SDGs), as well as growing social awareness towards the expected actions of a global corporate citizen using ICT to advance resolutions to social issues. This code is the fundamental rulebook underpinning all conduct and, when practiced in tandem with the Code of Values, which specifically outlines the desired behaviors of the time, encourages a better NEC culture through recognition on the part of every employee that integrity is the responsibility of the individual.

The term, “good corporate citizen,” appears in the NEC Group Charter of Corporate Behavior. To achieve this, every employee must keep in mind NEC’s past indiscretions and maintain efforts to weave compliance into the NEC culture by acknowledging the role compliance plays in their work and committing to the behaviors described in the Code of Conduct.



Demise of multi-directional business expansion and the rise of the selectively focused business policies of the 2000s

The difficult road to management reform and corporate culture improvement



With slower growth in all major businesses, NEC posted significant losses across the whole Group in fiscal 1998. As a result of these losses, NEC launched efforts to reform its management system and change its corporate culture. This marked the start of a difficult road upon which NEC would look to alter the course it had been pursuing since the era of high growth—multi-directional business expansion—and change to a selective business focus under post-bubble economy conditions.

Significant losses prompt departure from antiquated structures and cultures

NEC initiated major changes in 1998. These initiatives to create a new management and corporate culture were a concerted effort to distance NEC from the issues stemming from outdated structures and corporate culture that had plagued the company since the high-growth times.

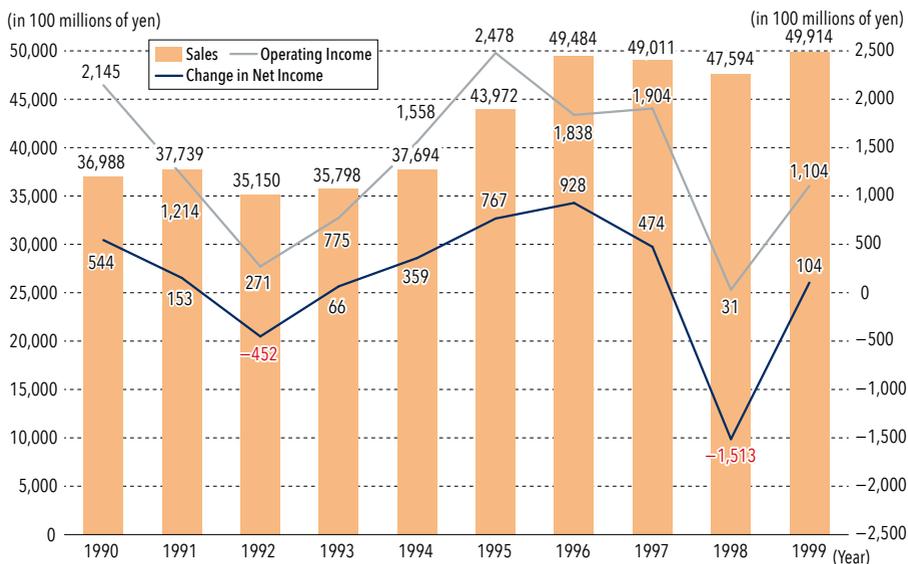
NEC had been intent on pursuing business expansion since the 1980s and invested money and people into every business opportunity. Consolidated net sales that totaled approximately 1 trillion yen in fiscal 1980 had become 5 trillion yen by the mid-1990s. Whilst growth appeared steady, there were internal strains gripping the company. One indication was the debt/equity (D/E) ratio, which expressed interest-bearing liabilities in terms of relative portion of shareholder equity. The D/E ratio is a measure of a company's financial soundness and the standard figure is generally considered to be one times shareholder equity. At the end of March 2019, NEC's D/E ratio was 0.64; in the 1990s it trended around the two mark.

During periods of continual growth, companies can continue to prioritize expansion over financial health and rely on debt to move businesses forward without too many obstacles, but when the collapse of the bubble economy sent the Japanese economy into recession in 1991, this would soon become a problem with serious repercussions for NEC's management.

Two significant structural issues formed the backdrop to this situation.

The first was corporate governance. In the 20 years from 1980, NEC had rapidly grown into a corporate giant, increasing consolidated net sales by approximately five-fold, boosting employee numbers from 60,000 to 158,000, and increasing consolidated affiliates from 33 to 165 companies. During the same period, the management system remained, for the most part, the same, and as authority converged on the President and business operations continued to rely mainly on this leadership, this created a "closed-door" style management. Moreover, ballooning and complex structures and systems resulting from business expansion further impeded communication between management and employees and became obstacles to effective information and problem sharing between business departments.

Sales (consolidated) / Operating Income / Change in Net Income (1990–1999)



The second issue was collusion on operating revenue and the resulting “lenient” structure. Profits from some businesses would make up for losses in others, and while NEC as a whole was making a profit, then everything was thought to be fine. This was a constant thread through the mid-1990s.

From 1994 to 1997, NEC generated profits of 35.9 billion yen, 76.7 billion yen, 92.8 billion yen, and 47.4 billion yen, respectively. When compared to the 45.2 billion yen in losses NEC posted in 1992, it appeared that the company was getting back on its feet, but the reality was very different. In fiscal 1994 and 1995, Personal Computers generated a significant loss, but the profits made by Semiconductors, which posted healthy results on the back of the dot-com bubble, covered this loss. In fiscal 1996 and 1997, losses were again posted by the Personal Computers, Home Electronics, and Electronic Devices businesses, but even these losses were not considered serious because Communication Infrastructure was performing strongly on an expanding mobile phone market. However, the attitude that NEC as a whole was profitable had diluted the sense of urgency throughout the organization and resulted in insufficient measures to look into the causes of problem businesses and implement improvements.

And so in fiscal 1998, when main-line businesses such as Communications, Computers, and Semiconductors all experienced a slowdown in growth, NEC suffered a massive loss of 151.3 billion yen. This result made it clear that in an era of dramatic change, NEC would also have to change.

Start of initiatives for structural management reform

In March 1999, newly appointed President, Koji Nishigaki, addressed company employees for the first time since taking office and conceding that NEC’s heavy losses were not only due to recession and the previous year’s incident with the Japan Defense Agency Central Procurement Office, made the following remarks.

“Just as technological innovations typified by the Internet are leading an information revolution, our surrounding business environment also continues to change rapidly. We are seeing once high-earning businesses turn into unprofitable businesses in the blink of an eye. Persevering with a management regime that is soft on “back scratching” will not help us survive when faced with change so quick and dramatic that ‘yesterday’s wisdom no longer applied.’”

Coinciding with his appointment, Nishigaki established the Management

Demise of multi-directional business expansion and the rise of the selectively focused business policies of the 2000s

Koji Nishigaki
(appointed President in 1999)



Akinobu Kanasugi
(appointed President in 2003)



Kaoru Yano
(appointed President in 2006)



Reform Committee consisting of himself as Committee Chairman and 10 Directors. Adopting a strong sense of urgency, this committee made the first moves towards reforming NEC.

Nishigaki's first reform was to reorganize NEC's management structure to strengthen corporate governance. Despite its corporate giant status, NEC had maintained a system whereby one individual managed all businesses. Reflecting on the distortion this had brought to NEC management, Nishigaki implemented changes to decentralize authority with the aim of speeding up decision making, improving transparency, and better defining responsibilities. These led to the introduction of the in-house company and executive officer systems. Existing businesses were reorganized into three in-house companies: NEC Solutions servicing corporate, individual and government sector customers; NEC Networks servicing network operators; and NEC Electron Devices offering device solutions. Then the authority to execute these business operations was largely transferred to the Executive Officers, and a clear division was made between business execution and supervisory functions. These systems were launched in April 2000. Following on from this, the Management Advisory Committee and Compensation Committee were established in January 2001, both including external experts and aiming to improve the transparency and soundness of NEC's management.

Also weighing heavily on Nishigaki's shoulders at the time was the need

to reform business, cost, and financial structures. The biggest of issues were with Packard Bell NEC, the underperforming overseas computer business, and NEC Home Electronics. Nishigaki had to make a tough call on companies that had already lost market competitiveness. Packard Bell NEC's withdrawal from the consumer personal computer market was announced in May 1999. NEC Home Electronics terminated business activities and the company was dissolved in March 2000. Nishigaki went on to implement a succession of bold business restructures, including the large-scale integration of software-related Group companies in April and October 2001, the spinoff of personal computer-related businesses in October 2001, and the spinoff of semiconductor businesses, except Dynamic Random Access Memory (DRAM), in November 2002. Furthermore, Nishigaki also adopted a series of fund-raising measures in January 2000 to effect structural reform and reduce fixed costs commencing with the sale of the headquarters building in a securitization scheme.

There was one more technology shift happening at the time that formed the backdrop to the decision to implement these drastic reforms. This shift was the spread of the Internet. For NEC, which had continued to support Japan's communication infrastructure since its inception, the changing form of communications as a result of the Internet held deep meaning. This is exactly what Koji Nishigaki meant when, in his first address to employees after his appointment to the position of President, he predicted that NEC's high-earning and profitable communications business would be greatly impacted by the Internet, so much so that it could quickly become unprofitable. The rapid spread of the Internet via evolving broadband and mobile technologies was changing society. NEC would not survive without implementing reforms to respond to this change.

The promotion of Internet-focused business strategies would be the policy chosen to achieve these reforms. In September 1999, NEC announced that it would concentrate company-wide efforts into Internet fields under a concept called "Invitation to The Internet." This concept envisaged a shift towards "solutions provision" to resolve issues faced by customers, as well as the promotion of Internet-related businesses by each of the three in-house companies. In addition, BIGLOBE, which provided a range of Internet services, would be positioned at the core of operations and act as the driving force for growth across the entire NEC Group.

NEC confronts an era of change with reforms

In 2000, NEC greeted the new century with a new system and bounced back from previous losses to post 66.3 billion yen in profit on consolidated sales of 5.35 trillion yen; the first time the company had ever surpassed the five trillion yen mark. While NEC was looking to step out from these results towards reform and growth, the company would be exposed to more troubled waters where “yesterday’s wisdom no longer applied.” The first wave to hit was the collapse of the so-called IT bubble. The prosperity of the IT market in the 1990s, a time known as the “dot-com bubble” in the US, led to the creation of a diverse range of products and services that used the Internet, but when company growth failed to match share market forecasts, an interest rate hike by the US Federal Reserve Board (FRB) in 2001 contributed to plummeting share prices. The ensuing IT recession impacted the entire global economy and soon pushed the Japanese economy into a genuine state of prolonged deflation.

The semiconductor business at NEC was hit particularly hard and the group as a whole lost 307.9 billion yen in 2001. In 2008, the “Lehman Shock” occurred when the American investment bank, Lehman Brothers, failed and triggered a global financial crisis. In 2008, NEC once again posted losses, this time totaling 296.6 billion yen.

The reorganization and reform of NEC’s businesses continued on as these events unfolded, first initiated by Koji Nishigaki but moved forward by subsequent Presidents, Akinobu Kanasugi (appointed in 2003) and Kaoru Yano (appointed 2006). In addition to changing the in-house company system to one favoring business lines, Kanasugi pushed ahead with reforms that aimed to concentrate management resources in the IT Solutions and Network Solutions businesses and merge other businesses in an effort to respond to the rapid changes occurring in the business environment. Yano turned the company’s business focus towards the Next Generation Network (NGN) and then presided over the building of a business structure under the corporate slogan, “One NEC,” to once again demonstrate the synergies of a united NEC. Meanwhile, further business selection and concentration policies were being conducted during this time, as unprofitable divisions continued to be rationalized.

These series of developments at NEC also drew some external criticism,

with many labelling the frequent changes in management policies and structure confusing. But the fact remained that NEC was finally seeing a turnaround in fortunes amid tough conditions, due in some part to the desperate efforts of President Koji Nishigaki, and that the choices made were unavoidable risks in the battle to survive and ensure NEC's cost and financial structures did not deteriorate all over again. At the same time that these frontline structural reforms were being implemented, less noticeable but no less essential reforms were being constantly promoted behind the scenes to rehabilitate NEC. These included company-wide activities to streamline production systems and reduce total materials costs, shifting focus to make research more market-oriented, strengthening compliance, and promoting more sustainable management. Internal operational processes and systems were also being reformed at this time, but these reforms became vastly more significant when NEC—acknowledging the seriousness of the company's delisting from the National Association of Securities Dealers Automated Quotations (NASDAQ) exchange in the US in October 2007 and termination of its registration with the US Securities and Exchange Commission (SEC) the following year—used them to restore trust in NEC's accounting practices. It should always be remembered that steadily pursuing these efforts formed the support base for NEC's present competitiveness.

In addition, a number of important policies were being developed at this time, including "NEC Group Vision 2017" and the "NEC Way," which addressed NEC's objectives for the future and led to NEC's current principles governing conduct. Together with the One NEC program, these policies embodied the Group's intention to move in the same direction as one integrated force so that NEC could overcome the difficulties of the past and look forward to making on-going contributions to society in the future.

However, it was not easy for an organization as big as NEC, employing as many as 150,000 people across the entire Group, to redirect its objectives at the speed necessary to keep up with the world economy and the rapid pace of technological evolution and change. During this period, NEC's net sales continued to decline from a peak of 5.35 trillion yen in the year 2000 to 4.66 trillion yen in 2002 and 3.58 trillion yen in 2009. Businesses that had traditionally supported NEC—Semiconductors, Personal Computers, and Mobile Phones—also started to disappear, one by one, from the Group. If NEC had

Demise of multi-directional business expansion and the rise of the selectively focused business policies of the 2000s

been able to fully implement the reforms as first intended, the outcome may have been different.

Along came the collapse of the dot-com bubble and the Lehman Shock. The timing of these overlapping external factors could not have been worse. Looking back on NEC's management reforms during this era, it may be possible to look at these factors as reasons for the lack of results yielded by these initiatives. However, every country and every company all over the world were equally affected by these shake ups. What were the differences between NEC and companies that acceptingly transformed themselves, and/or companies that looked past the upheaval to find business opportunities? Ensuring that necessary reforms were implemented depended on reflecting deeply on these differences and identifying what was lacking at NEC and what form the company should take in the future. This would be an enduring issue well into the tenure of Nobuhiro Endo, who was appointed President in 2010.



The road from “world number one” to business withdrawal

Semiconductor business struggles in a dramatically changing global market



The Japanese semiconductor industry took the world by storm in the 1980s. NEC led the way and maintained its top-class ranking into the 1990s. However, the arrival of new players and business models around the year 2000 brought significant change to the business environment. Failing to get on board, NEC’s DRAM, microcomputer and System LSI businesses travelled down a very grim path.

US-Japan Semiconductor Agreement transforms semiconductor industry

From the 1970s through to the 1980s the Japanese semiconductor industry achieved remarkable growth. NEC’s semiconductor business, which was at the forefront of this growth, held the world’s third largest market share (5.4%) in 1980 with an output worth 767 million US dollars, but had increased this to nearly 2 billion US dollars by 1985 to capture the top position (8.2%). NEC continued its reign at the top, and besides dropping to number two in 1992, managed to keep its number one ranking until the end of the 1990s.

The rise of Japanese semiconductor manufacturers sent the US into a panic. By the mid-1980s semiconductors were no longer just a source of industry competition but had become a political issue between the Japanese and US Governments. A central component in a wide range of products, semiconductors were known as the industrial sector’s most important and indispensable product. This being the case, the US Government could not overlook a decline in its own semiconductor industry. After tough negotiations between the governments, the US-Japan Semiconductor Agreement was signed in 1986. An appendix to the agreement targeted a “20% market share for foreign companies in the Japanese domestic market.” Both governments agreed to also

monitor export prices of semiconductors to prevent dumping activities.

Nippon Electric Company's 100 Years of History described this agreement as changing the subsequent nature of semiconductor trade between Japan and the US to one of "government-based export control." The publication also went on to note that the US-Japan Semiconductor Agreement ended up "creating opportunities for Korean manufacturers to dramatically increase their market share."

As a way of increasing foreign share of the Japanese domestic market, some Japanese semiconductor manufacturers pursued OEM agreements with Korean technical partners to provide Korean-made products to their Japanese customers. Although NEC did not source any OEM products from Korea, the company did maintain technical exchanges with Korean manufacturers.

The US-Japan Semiconductor Agreement remained in place for ten years. By 1993, semiconductor production in the US had outstripped that of Japan. By the mid-1990s, foreign companies had boosted their share of the Japanese semiconductor market to 25–30%. The agreement came to an end in July 1996, influenced in part by the launch of the World Trade Organization (WTO), but also by the fact that Korean and other foreign manufacturers were making significant inroads into the US market and diluting the threat posed by their Japanese counterparts.

During the course of the agreement, Japanese semiconductor manufacturers adopted less than efficient business strategies for a business that typically reduced costs by focused investment in larger plants, by opening up small-to-medium sized production facilities in semiconductor consuming countries in the West and Asia in an attempt to reduce export volumes. Although production bases were later integrated, Japanese manufacturers found themselves in a situation where they were unable to compete with Korean and Taiwanese manufacturers on cost as these manufacturers had made intensive capital investments into single plants in their own countries where labor and electricity and other utility costs were low.

Sudden rise of the "fabless + foundry" model

In parallel to the circumstances surrounding the semiconductor industry, the industrial structure itself was undergoing an obvious change. This change was the arrival of the "fabless and foundry" business model.

The two key benchmarks for maintaining a dominant position in the semiconductor market are to increase chip density and improve accumulated output. Increasing chip density enables higher performance semiconductors to be produced for the same cost, while improving accumulated output significantly reduces costs by lifting production proficiency levels. In other words, it would become important to establish cutting-edge precision processing technologies to increase chip density and be first to release these to the market as next generation products.

The general-purpose dynamic random access memory (DRAM) was particularly susceptible to stringent cost demands and competition among manufacturers to develop precision production technologies to increase chip density was intense. NEC and other semiconductor manufacturers adopted strategies to develop state-of-the-art precision technologies for DRAM and apply these technologies to other semiconductor products as well. As semiconductor production equipment increased in size and became more expensive over this period, huge capital expenditure was sought to sustain semiconductor businesses and maintain competitiveness. In advanced technology fields, minimum capital expenditure levels grew every year and it became impossible to invest efficiently in small-scale production. Players producing large volumes in larger plants became sector leaders on the basis of production costs and changed the structure of the industry.

This trend became increasingly pronounced from the 1990s, and as general-purpose semiconductor production equipment became more popular, companies emerged offering contract “foundry” services that specialized only in semiconductor production with no development activities. The “fabless” business model, which specialized only in semiconductor design and contracted actual production to foundry operations, appeared from the 1980s in fields other than DRAM and semiconductor memory, and was mainly adopted by startups with little capital resources.

As this fabless and foundry combination became an industry standard in the 1990s, Taiwan and other countries rapidly expanded production capacity. Another undeniable factor behind this expansion was the strong support provided by the governments of these countries that Japanese manufacturers missed out on at home.

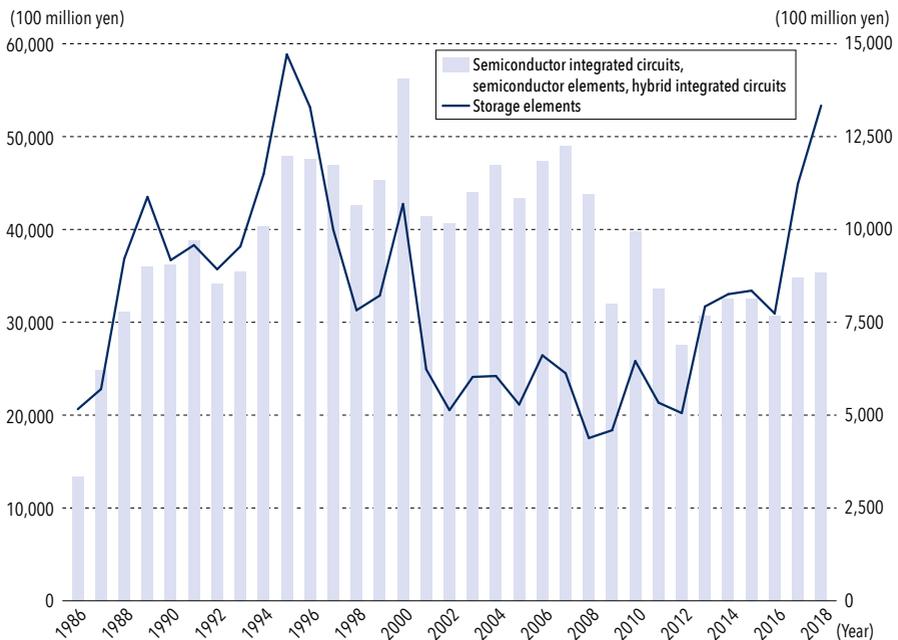
Meanwhile, many Japanese semiconductor manufacturers, including NEC,

The road from “world number one” to business withdrawal

maintained a vertically integrated business model known as integrated device manufacturer (IDM). The reason NEC did not choose the “fabless and foundry” route was because of the strong connection between the design and manufacturing processes. Production technologies using knowledge based on the vertical integration model and sophisticated production sites had been the driving forces behind NEC’s number one ranking in the semiconductor industry. Moreover, a structure of mutually competitive semiconductor plants all over Japan promoted further upgrading. These circumstances made it difficult to adopt the “fabless and foundry” approach where one function or another is handed over to an outside company.

It should also be taken into consideration that pivoting from the vertical integration model would have come at the cost of a large-scale corporate reshuffle, and such a drastic change in strategy would not have been realistically possible in the early 2000s when preserving Japan’s lifetime employment system pushed up the social costs of restructuring and reorganization activities.

Changes in Japanese Semiconductor Production (1986–2018)



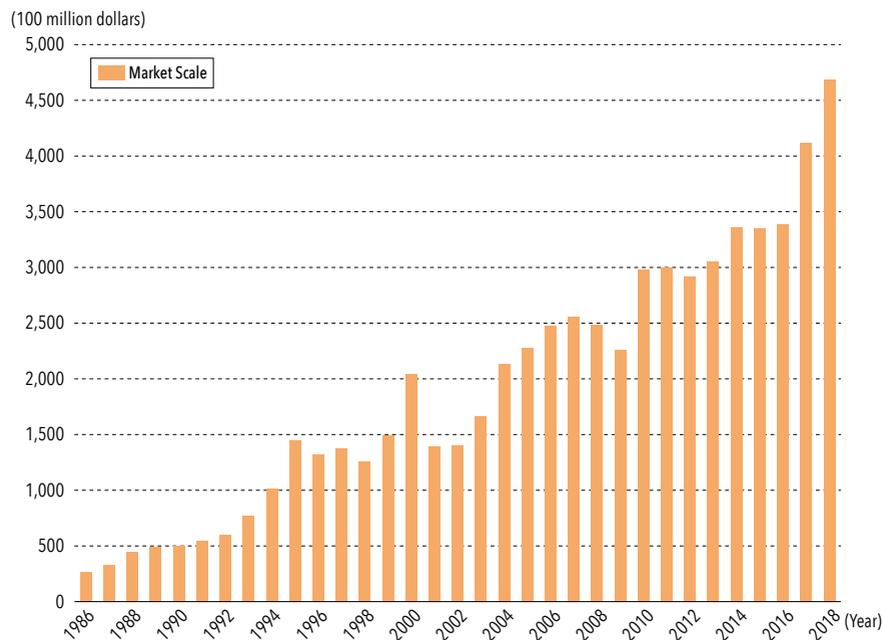
Source: Ministry of Economy, Trade and Industry's "Yearbook of Current Production Statistics - Machinery" (formerly the "Yearbook of Machinery Statistics")

Yukio Sakamoto invited to become President and implements structural reform

The US-Japan Semiconductor Agreement managed to stabilize semiconductor prices, but this situation was brought to an end in 1996. The origins for this lay with the “Micron Shock” initiated by the US-based Micron Technology, Inc. The company had found success manufacturing cost-competitive DRAM by extensively overhauling the design and production processes used in semiconductor manufacturing. DRAM prices declined sharply as price competition intensified.

Major DRAM manufacturers in Japan experienced across-the-board losses in their semiconductor businesses. In fiscal 1998 operating losses for semiconductors stood at 54.5 billion yen for NEC, 90.3 billion yen for Hitachi, 68.7 billion yen for Toshiba and 83.3 billion yen for Fujitsu. Meanwhile, Korea’s Samsung Electronics, which had concentrated investment in a single domestic location and intensively increased DRAM production at this massive plant, was

Changes in Global Scale of the Semiconductor Market (1986–2018)



expanding its market share. Samsung’s share of the market, which was less than 10% around 1997, rose to more than 20% over the next few years, and by the first half of the 2000s had exceeded 30%.

It was already obvious to the Japanese semiconductor industry that if it did not switch to a more progressive business model it would not be able to fight global competition. This would require capital expenditure equal to or greater than that of competitors in Taiwan and Korea. However, NEC in the 2000s was pursuing a group-wide reorganization of business operations in challenging management conditions and was not in a position to provide a constant stream of funding to its semiconductor business.

Amid this situation, Japanese semiconductor manufacturers were pressing ahead with efforts to realign the industry. In 1999, Fujitsu decided to withdraw from the DRAM business, with Toshiba following suit in 2001. NEC announced in June 1999 that it would form a joint venture DRAM company with Hitachi. The venture aimed to combine the resources of the two companies and increase operational scale to boost price competitiveness. Operational requirements also called for the company’s volatile semiconductor business to be cut loose from headquarters to reduce its impact on group performance as much as possible.

In a fifty-fifty investment split, NEC-Hitachi Memory was launched in December 1999 and renamed Elpida Memory in September 2000. The equally owned joint venture company set up meant NEC and Hitachi could halve the venture’s impact on their respective balance sheets. For NEC, which was in a more vulnerable financial position than others in the industry, structural reform of its semiconductor business was a pressing issue that needed addressing and therefore business restructuring measures were critical. However, the October 24, 2001 edition of the *Nikkei Business Daily* noted that, “from his appointment as NEC President, Koji Nishigaki had thought about shedding the company’s DRAM business due to volatile earnings to focus on system LSI, but a favorable semiconductor performance in fiscal 2000 delayed the start of reforms.”

The process to integrate NEC-Hitachi Memory and Elpida Memory operations was implemented in three stages from 2000. The first stage brought together design and development activities, stage two merged sales functions and the final stage combined production functions. However, an event occurred

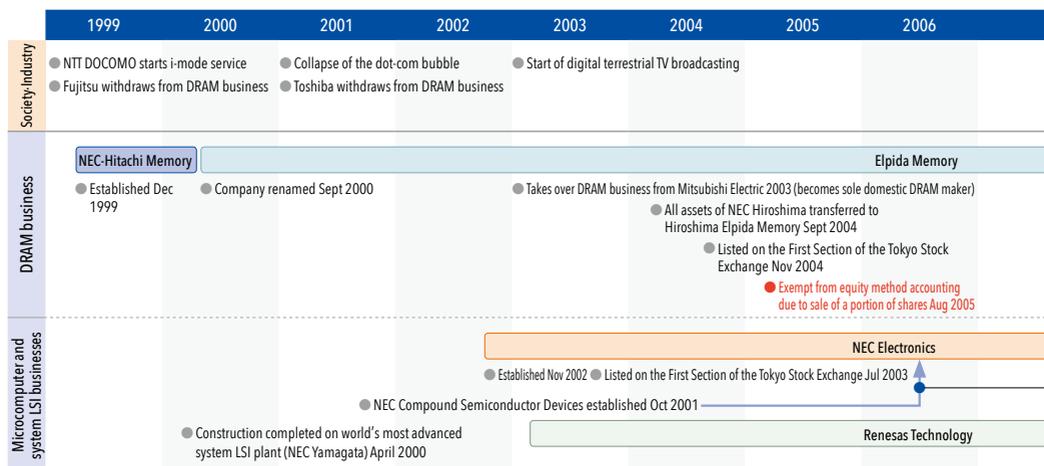
while this integration process was underway that would greatly impact not just semiconductors but the entire IT industry.

From 2000 through 2001 the industry witnessed the collapse of the dot-com bubble.

The arrival of new communication and Internet businesses created by IT companies and the associated expectations for growth resulted in excessive capital flowing into the IT industry. This excess created the dot-com bubble and was eventually the source of its collapse. Semiconductor demand fell worldwide and the price of DRAM in particular dropped to a level well below Elpida Memory's profit line. Within the company structure Elpida Memory managed development and sales while NEC and Hitachi looked after production. As such, any volatility in the DRAM business had a direct impact on the business performance of the two parent companies. In fiscal 2001 NEC's semiconductor business posted an operating loss of 148.2 billion yen.

In response to this situation, NEC and Hitachi decided to invite management executives for Elpida Memory from outside the company. A management framework requiring consensus from two major corporations often made it difficult to make swift decisions on business strategy. The companies concluded that this structure needed to be altered to better respond to a dramatically changing business environment. Recruited in to oversee this was Yukio

Timeline: History of the Semiconductor Business

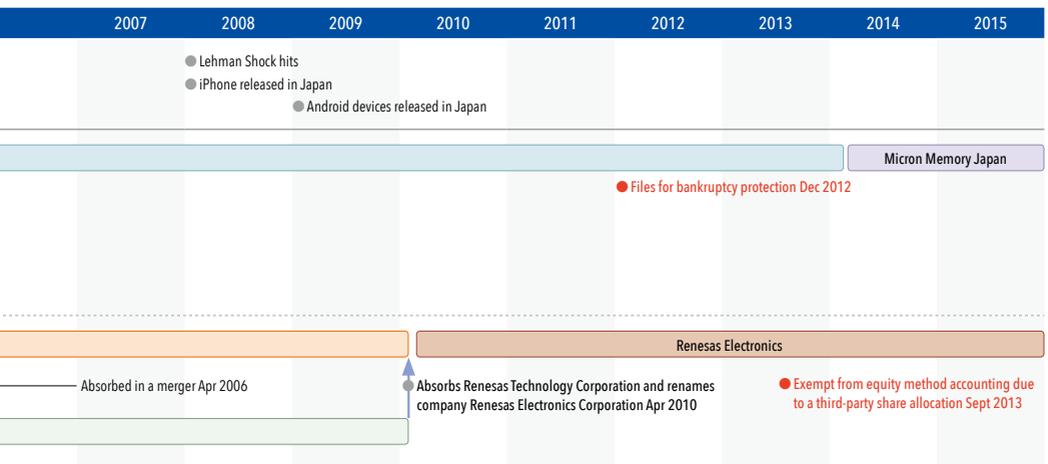


Sakamoto, who at the time was President of UMC Japan, the Japan affiliate of Taiwanese semiconductor foundry UMC Electronics.

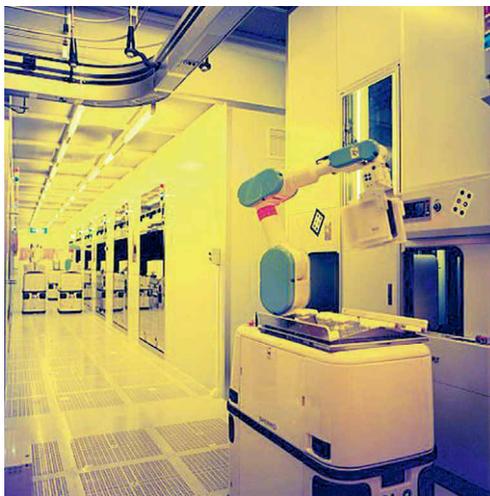
Injection of external capital and concentrated investment into the Hiroshima Plant

Yukio Sakamoto was appointed President of Elpida Memory in November 2002. Initiating business reforms soon after, Sakamoto hammered out and implemented the following policies: list on the stock exchange as early as possible; establish a fifty-fifty split between in-house and foundry production; focus efforts on mobile and consumer products; reward employees with stock options and other awards; and run organizations without discrimination based on company of affiliation, educational background, age, or gender.

The Hiroshima Plant (NEC Hiroshima) was positioned as Elpida Memory’s main plant. Prior to Yukio Sakamoto’s appointment as President, the plant was already set up in September 2002 to process 3,000 300mm semiconductor silicon wafers per month. Sakamoto, however, realized it was difficult to recover fixed costs at this level and decided to increase output. In the February 24, 2003 edition of Nikkei Business, Sakamoto stated that “in terms of in-house production capacity, we think the minimum level at which we can generate profits is 15,000 300 mm wafers a month. We have recently reached the point



Inside the plant of NEC Hiroshima



of procuring the 80 billion yen in capital investment needed to achieve this capacity.”

In addition to NEC and Hitachi, financing came from Intel Capital, the investment arm of Intel, semiconductor production equipment manufacturers Canon and Nikon and other customers and retail outlets. More than 80 billion yen was raised to boost production capacity at the Hiroshima Plant to 15,000 wafers a month.

Constructing integrated manufacturing facilities that could manage all processes, from R&D through to mass production, was a major pillar of Elpida Memory’s business strategy, and lifting production capacity was the first step. Intensive investment in the Hiroshima Plant was fundamentally important for increasing production efficiency, and capacity was steadily expanded to 18,000 wafers a month by the spring of 2004. Additionally, the company’s strategy to focus attention on “Premium DRAM” servers, digital home appliances and DRAM for mobile devices proved to be a match for market demand at the time and Elpida Memory’s earnings started to rebound.

Meanwhile, organizational innovations were also being adopted. In January 2003, NEC and Hitachi decided to stop seconding senior managers to Elpida Memory on an alternate basis and called back dozens of employees

to significantly reduce organizational complexity. This measure was put in place to streamline the organizational chart and speed up decision-making processes.

Loss-making from its very beginnings, Elpida Memory was back in the black by the first quarter of 2004 and was successfully listed on the First Section of the Tokyo Stock Exchange in November of the same year. After the listing, NEC and Hitachi both made large market gains by reducing their holdings in the company. A gradual sell off of shares saw Elpida Memory break away from the two affiliates in fiscal 2006.

Elpida Memory performed well under Yukio Sakamoto’s business policies, boosting operating profits to 68.4 billion yen and current net income to 52.9 million yen in fiscal 2006. In 2008, however, the DRAM market took a turn for the worst. Demand instantly contracted with the September collapse of Lehman Brothers. The DRAM price fell to a third of the previous year’s price, and Elpida Memory recorded a net loss of 178.8 billion yen in fiscal 2008.

The company averted a crisis by receiving the first approval for financial aid under the Amended Act on Special Measures for Industrial Revitalization and Industrial Innovation and was granted 30 billion yen in preferred share financing by the Development Bank of Japan. However, falling DRAM prices and a surge in the value of the yen to around 80 yen to the US dollar also affected performance and the company finally filed for proceedings under the Corporate Reorganization Act in February 2012. Less than six months later a sponsor agreement was signed with Micron Technology.

Ironically the DRAM price recovered rapidly soon after. The worldwide uptake of smart phones and other mobile devices, as well as ongoing consolidation of companies operating DRAM businesses, meant market conditions suddenly benefitted the seller. There were more than a few in the Japanese semiconductor industry unhappy about Elpida Memory’s exit from the market, with some lamenting, “if only it could have held on for one more year.”

Breakup of the semiconductor business into independent companies and the establishment of NEC Electronics

Microcomputers and system LSI stood alongside DRAM as the major pillars of NEC’s semiconductor business. Microcomputers are semiconductors specialized for computation and other similar processes, and in addition to uses

Kaoru Tosaka, President of NEC Electronics, at the company's listing on the First Section of the Tokyo Stock Exchange



in home electronics, are installed in vehicle engine control units (ECU) and a large number of other products. System LSI, on the other hand, are loaded with a wider range of functions, including calculation, communication, image processing and data storage, and provide the core functions in flat-screen televisions, game consoles and smart phones.

From 2000 onwards comprehensive electrical manufacturers were stepping up moves to cut loose their businesses in the microcomputer and system LSI fields. In addition to the sudden expansion of the mutually complimentary fabless and foundry model in the 1990s, the major reason for this was the view that it made little sense for comprehensive manufacturers to operate businesses characteristically different from others in their portfolio that required significant capital expenditure for R&D and production equipment. The collapse of the dot-com bubble also increased the sense of crisis felt by all companies in the sector and prompted structural reform. As a result, global manufacturers, including Siemens of Germany, Motorola and Lucent Technologies of the US, and Philips of The Netherlands, spent the years up to the mid 2000s shedding their semiconductor operations.

The birth of NEC Electronics can also be regarded as part of this global trend. In November 2002 NEC moved to spin off its entire semiconductor business except the DRAM division. The following July, NEC Electronics was

listed on the First Section of the Tokyo Stock Exchange. The company later held a public offering, and although NEC sold off some of its shareholdings, it maintained a 70% stake in the company and kept its voting rights.

There were a number of reasons for the establishment of NEC Electronics.

Common among many Japanese semiconductor manufacturers, not just NEC, was the tendency to invest in semiconductor operations when the company as a whole performed well but to delay investment when results were sluggish. In addition to the large-scale increases in capital expenditure needed, volatile market conditions placed major constraints on loans from financial institutions. In contrast, spinning off businesses and reinforcing self-funding structures to expand direct financing routes allowed for more opportune capital investment decisions. Being a business unit within a comprehensive electrical manufacturer has its benefits from the perspective of maintaining a credit standing in an era of comparatively low investment, but at the time the “binding” elements of this arrangement were also becoming more obvious. The time had come to flatten the organizational structure and understand market needs faster so that top management could make quicker decisions on such matters as capital expenditure and development strategies.

There were also demands within the system LSI business for a stronger interface with customers from the initial design stage, but some of these customers were also NEC competitors. It would be more advantageous for customers to deal with an independent company rather than a business unit of NEC when sharing information or building cooperative arrangements.

NEC Electronics was still expected to play a major role in NEC. The added value in many of the products provided by NEC centers on the embedded semiconductor. Unlike general-purpose products like DRAM, comprehensive electrical manufacturers like NEC needed to maintain system LSI operations as a core business as these products were loaded with original specifications directly connected to the added value of products like ACOS series mainframes and SX Series supercomputers.

NEC’s Annual Report 2002, released in the third quarter of 2002, positioned Electronic Devices, including NEC Electronics’ business, alongside Computers and Communication Equipment as the three major pillars of the company. The following year’s Annual Report described NEC Electronics as “looking to expand globally as a semiconductor solutions provider that uses differentiated

technologies to satisfy customer requirements, as well as focus management resources as a specialist semiconductor solutions company focused on high value-added system LSI to build a financial structure more suited to the characteristics of an investment-intensive semiconductor business.”

NEC maintained its relationship with NEC Electronics while preserving the independence of the new company. The balancing factor was NEC’s 70% shareholding.

Lehman Shock and the launch of a 300 mm wafer plant in Yamagata

NEC Electronics kicked off with 752 billion yen in consolidated net sales in the March quarter of 2003. The company employed 24,000 people and had expanded to 12 production and sales bases across the globe. It implemented organizational reforms to reduce the distance between factory floor and top management by emphasizing the importance of speed and pledging “management decisions to be made four times as fast.”

At the same time, the company was also pushing for stronger relationships with customers. The creation of a new CS department was typical of these initiatives. A mixed team of about 40 sales and technical personnel worked to improve the level of satisfaction of major customers. A specialist consulting sales team was also created to engage with customers and consider uses for semiconductors. It was a team geared to “working closely with customers right from the design stage,” which was an essential service in a company like NEC Electronics but not necessarily a good fit for a NEC business unit.

In an interview for the January 2004 edition of Nikkei Micro Devices, NEC Electronics President Kaoru Tosaka was quoted as saying, “the system LSI business requires us to create a good relationship with our customers. It takes time to build up an appreciation for our technological capabilities and productivity. If we do not do our jobs properly and fail to develop a proven track record, we will not win any major contracts.” A colleague that worked with Tosaka at the time offered the following recollections.

“Kaoru Tosaka continually talked about “being customer oriented.” He encouraged us to not just listen to customers but always be aware and think deeply about ‘what they want,’ ‘when they want it’ and ‘why they want it.’”

NEC Electronics dealt in a wide range of products and had customers across a diverse range of industries. The company’s number one product was LSI for

mobile phone handsets. This system memory combined liquid crystal drivers, baseband LSI, NOR flash memory and pseudo SRAM. The next best sellers were signal processing LSI for DVD recorders, promising high future growth, and high-density LSI. Although not a rapid growth market, vehicle microcomputers proved to be a stable and solid business for the company.

At the same time, NEC’s mobile phone handset business was enjoying its golden age, and digital home appliances, such as LCD televisions, and DVD players and recorders, were also gaining in popularity. Capitalizing on these conditions, NEC Electronics got off to a strong start and decided to invest in a plant in Yamagata Prefecture to further expand business operations. Instrumental in this decision was the company’s July 2003 listing on the Tokyo Stock Exchange. The listing proved popular with the initial price of 5,350 yen representing a 27% gain on the 4,200 yen offering price. A person related to the company at the time recalled the following.

“The listing brought in sizeable capital. Mobile phone LSI, game consoles, LCD TVs and other products were performing well and there was a growing feeling that Yamagata could be a success.”

Still there were some within the management ranks that thought the company should be using foundries instead of opening its own plant. They reasoned that it was a highly risky investment given it was unclear if the plant could maintain an adequate operational rate, but their conservative stance was drowned out by others within the company, and ultimately the deal was signed. A person involved in the discussions at the time recalled the situation.

“Before the company had a 300mm wafer plant, some customers said they had ‘concerns about future cost competitiveness’ and even refused to listen to proposals from our sales reps. Not only the Sales Division, but the Development Division also wanted the company to have its own plant. This was because process engineers, who were the stars of the company at the time, would lose their jobs if production was outsourced to foundries.”

Approximately 60 billion yen was invested into state-of-the-art equipment for 300mm semiconductor silicon wafer production. The plant was started with the minimum investment necessary to maintain an adequate operational rate. This scale of investment, however, was nowhere near enough to keep up with foreign manufacturers on cost competitiveness, and in the end total investment blew out to 200 billion yen. These fixed costs would later have a

direct effect on the management of NEC Electronics when market conditions deteriorated.

Launch of Renesas Electronics

NEC Electronics adopted a consistent customer-oriented approach in an effort to build close relationships and meet the needs of its customers as diligently as possible. However, the more the company built these relationships the more customers demanded diversified low-volume production contracts that lowered design and production efficiency, reduced versatility and even undermined price competitiveness. Many Japanese manufacturers in particular were “building in” dedicated hardware for their own products rather than use general-purpose alternatives. This tendency was visible in many industrial products such as IT devices and digital home appliances, and manufacturers supplying the semiconductors embedded in these products were greatly affected by the business trends and market conditions of their customers.

Profits from system LSI used as core devices in hit or long-selling products grew significantly. Conversely, however, any products launched by customers that failed to provide the expected windfall would lead to sudden production cuts on semiconductors developed specifically for the failed product and any losses arising from this would inevitably fall on the manufacturer. Moreover, NEC Electronics’ committed customer-oriented approach also turned thinking within the company inwards as the misguided message to only focus on the wishes of the small number of major customers squaring off against the company took hold, and made it difficult to grasp both market-wide changes and the needs of end users who would ultimately use the products.

One of the measures used to shed this structure was a platform strategy. The company would move away from using original hardware to realize functions and performance improvements in products of specific companies to developing advanced products available to a range of manufacturers for wide coverage across the entire market. Microsoft and Intel achieved great success with this strategy in the personal computer field. Their products were adopted by personal computer manufacturers all around the world because they provided platforms that anyone could use to create the latest personal computer and shared most of the added value in personal computers.

NEC Electronics also debated platform strategies. Within LSI there is

something known as application-specific standard products (ASSP). These products are designed and developed for specific purposes under the guidance of semiconductor manufacturers and sold with no particular customer in mind. A person close to the action at the time had this to say.

“There were discussions on developing ASSP in relation to chips for DVD recorders and the like, but this would have required product planners and engineers with full knowledge of the end product. Unfortunately, being a semiconductor manufacturer, NEC Electronics did not have people with such skills sets. It just could not break away from its old habit of engaging one-on-one with clients to meet their specific needs.”

NEC Electronics continued to post a loss in fiscal 2005 and 2006. Although the company moved into the black in fiscal 2007, figures fell sharply the following year on the back of the collapse of Lehman Brothers. Demand plunged, and in fiscal 2008, NEC Electronics posted an operating loss of 68.4 billion yen (73.4 billion yen decrease on the previous year) on sales of 546.5 billion yen (20.5% decrease on the previous year).

NEC searched for a way to integrate NEC Electronics with an industry peer to radically revamp the business. In the end it was decided that the company would join with Renesas Technology, a company founded as a spin off and merger of the semiconductor divisions of Mitsubishi Electric and Hitachi. Quoted in the December 7, 2009 edition of Nikkei Business, NEC President at the time, Kaoru Yano, said “we thought about whether we should restructure with a complementary business or with a competitor. We decided to go with a competitor.”

Restructuring while building a relationship with a complementary partner had the benefit of being able to provide one-stop services for a wide range of products. However, joining with an existing competitor would give the company an overwhelming competitive edge in its field and enable it to increase profitability and market control.

There was a strong backlash within NEC Electronics to the decision. The Sales Division, which had battled furiously with Renesas Technology over the years, was not so easily sold on the idea of today’s rival becoming “tomorrow’s colleague.” While visiting customers to explain the situation, division reps were said to have faced angry comments like “Why do you think we were using a dual-vendor system all these years?” Multi-sourcing acted as a risk

management tool for these customers. When their two suppliers become one, customers were forced to revise their procurement strategies, but it was not that easy to engage new suppliers in the microcomputer field. Stabilizing the operations of their existing microcomputer suppliers, however, would reduce their concerns over supply. Round after round customers were also made aware of medium-to-long term benefits of the merger.

In April 2010, Renesas Electronics was born. The company, initially an equity-method affiliate of NEC, Mitsubishi Electric and Hitachi, looked to strengthen its financial base by conducting a capital increase in 2013 through third party share issuances to nine companies, including the Innovation Network Corporation of Japan (INCJ, Ltd.) and customers such as Toyota and Nissan. This resulted in NEC lowering its shareholder ratio and stepping down as major shareholder, leaving INCJ as the principal shareholder of the company. Although Renesas Electronics continues to move forward with restructuring efforts, the company has lived up to President Kaoru Yano's words and as of 2019 was still ranked number one in the global microcomputer industry.

NEC's past glories and changes in the global market

Japan's semiconductor industry, which had dominated the world in the 1980s, has retreated from the frontlines and is just barely managing to maintain a presence in microcomputers, flash memory, image sensors and a few other fields. Meanwhile, semiconductors themselves are integral to many of the world's products and this field continues to expand. Why is it then that NEC, once the proud world leader, is nowhere to be seen?

The arrival of fabless and foundries and the huge capital expenditures required to maintain business continuity and competitiveness are to blame. As the times changed and semiconductor industry practices shifted dramatically, NEC failed to select an operational path suited to this scenario. Koji Nishigaki, who presided over the senior management team as President from 1999 to 2003, recollected the following in the November 27, 2006 edition of Nikkei Business.

"With debts totaling more than 2.3 trillion yen, it was my mission to ensure NEC did not collapse, by whatever means possible. At the time we said it would be a shame to waste our technology, so we dabbled in various businesses. To do any of them properly would have required investments of between 100s

of million and 1 trillion yen. We just did not have that sort of money available. We saw no choice but to sell the business.”

And so, NEC, a known comprehensive electrical manufacturer, looked to make a fresh start as an Internet solutions provider and moved business focus in that direction. Within NEC this naturally necessitated a change in status for the semiconductor business. There is little doubt that this contributed to the decision to cut the semiconductor business loose, but it was not the only reason.

An employee working at the Digital Home Appliance LSI Business Division at NEC Electronics described an episode indicative of the conditions at the time.

“We proposed LSI to a foreign manufacturer of high-performance TVs. Comparisons of prototype screens showed that our product was virtually indistinguishable from products using LSI of a Taiwanese manufacturer until you compared images in slow motion when there was a perceivable difference. This subtle difference was intentional and developed to be a point of competitiveness, but how many people in the world really look for that level of performance from their TV? The TV manufacturer heaped praise on our technology but would not pay for it. I presume it was the same story in other fields as well.”

In the era when you just had to “create quality products and they would sell” NEC and other Japanese companies dominated the global market with an arsenal of high performance, high-quality products. Around 2000, however, emerging markets started to rapidly expand. These emerging markets, which lacked the maturity of more advanced markets, were calling out for cheap products of a sufficient quality and performance to meet their needs. Companies in countries like Korea and China experienced enormous growth by spotting this newly formed “value.” Most Japanese companies, on the other hand, could not escape their past successes and ended up being forced from the market.

When an industry changes shape so dramatically, how do you grasp this change and create a new business model without getting caught up in the glory of past successes? Businesses everywhere are still grappling with this challenge. In this sense, there is much to be learnt from the path taken by NEC’s semiconductor business.



Decisions under growing and unavoidable commoditization

NEC's personal computer business leading up to the partnership with Lenovo



The birth of the PC-98 series, known as “the people’s computer,” propelled NEC’s personal computer business into a golden age that spanned the 1980s and continued into the mid-1990s. Soon after the business would face the commoditization of personal computers as wide-spread use of the Internet brought about major changes in lifestyle. This set NEC on a path to expand operations in overseas markets. This is the path the company took.

The PC-98 series turns NEC into a household brand

NEC’s personal computer business was launched with the PC-8001 model in 1979 and enjoyed rapid growth with the 1982 release of the PC-9801, the inaugural model of the PC-98 series. This growth cemented the company’s position as a driving force in the Japanese personal computer market. By 1992 the company had shipped 5 million units of the PC-98 series, expanding this to 10 million units by 1995 and 20 million units by September 1998. The Japanese personal computer market boomed during this time, with domestic shipments exceeding 2 million units in 1990 growing to more than 7.5 million units by 1998.

There was a deliberate strategy underpinning the rapid progress of the PC-98 series.

As outlined in NEC Corporation 100th Anniversary Book, “the basic strategy was to inherit the use of software assets of PC users, enhance the service support structure to be responsive to client needs and focus on cooperating with independent software and hardware vendors.” Many technically creative third parties gathered on the periphery of the PC-98 series with its strong bent to

building collaborative partnerships or “ecosystems” and provided a range of usages to meet client needs. Product designs that emphasized both sophistication and asset value, the high quality of Japanese-made products, and comprehensive service support offered locally also instilled a sense of reliability and security in users and helped to solidify NEC’s brand image.

Meanwhile, NEC was quick to pick up on the advanced technologies emerging overseas and moved ahead with product development. One of these developments was the installation of operating systems (OS). In initial personal computer models operations were controlled with programming language, but around 1980 it was becoming more common in the US for applications to be run on OS. Foreseeing the spread of this innovation to Japan, NEC was quick to join up with Microsoft to launch the PC-9801F personal computer with Microsoft MS-DOS operating system in 1983. On the hardware side, NEC was also developing products equipped with Intel CPU, starting with the PC-98XA high resolution personal computer launched in 1985. These models were released alongside products with NEC-made CPU. These relationships formed with Microsoft and Intel continued for many years and were expanded even further to play a major role in the development of the Express5800 series personal computer servers.

By the latter half of the 1980s IBM PC/AT compatible computers had become the world standard in personal computers, and US companies such as Dell and Compaq had captured a large share of the global market by releasing compatible machines. These offerings did not support the Japanese language,

PC-9801–The first model of the PC-98 series



however, and therefore could not check the growing market share enjoyed by the PC-98 series, which offered “kanji ROM” features as standard.

Capturing market share in the personal computer market led to the NEC becoming a household brand. In addition to product appeal and ecosystem creation, NEC’s advertising and other marketing strategies and retail store-based sales strategies also proved successful. Once unknown among general consumers due to a focus on products for telecommunications carriers and government agencies, the NEC name started to build a social presence and together with the PC-98 series greatly boosted the overall performance of the NEC Group.

In the latter half of the 1990s, computers moved out from the domain of specialist engineers and, living up to their name, became “personal computers” used in everyday operations by businesspeople. As this situation unfolded many companies were also adopting NEC personal computers on the back of the company’s solid brand image in the consumer products market. NEC personal computers played a part in the total solutions delivered when building corporate business systems due to their high affinity with the hardware and systems of key enterprise systems and the comprehensive support services on offer. The consumer and corporate sides of the personal computer business engaged in some friendly rivalry to both compete and cooperate to increase personal computer sales.

DOS/V transforms the Japanese market and the Compaq Shock hits

The PC-98 series had made a name for itself as the “people’s computer,” but as the world entered the early years of the 1990s the market environment changed significantly. In 1990, IBM Japan released the DOS/V machine, a personal computer with OS for IBM PC/AT compatibles that could handle the Japanese character set via software alone. Japanese personal computer manufacturers soon lined up to adopt DOS/V as it eliminated the need for “kanji ROM,” the selling point of the PC-98 series, and DOS/V machines expanded their footprint in the market. In 1992, the industry was hit by the “Compaq shock.” The US company, Compaq, inserted itself into the Japanese market by offering PC/AT compatibles at half the standard retail price of the time. Domestic manufacturers were soon forced into a price war that they did not want. Looking back over the history of personal computers in Japan the

“Compaq shock” was a clear indication of the growing commoditization of personal computers.

In a further step in the same direction, Microsoft released Windows 95 in 1995. The Windows 95 OS, with an easy-to-use graphical user interface (GUI) and full network functions, set off a personal computer boom that resulted in the Windows series becoming the de facto standard. In response, NEC released the PC98-NX series in 1997 and labeled it the “new world standard in personal computers,” which were neither part of the PC-98 series nor PC-AT compatible models (more precisely, they conformed to new design standards derived from PC-AT compatible models).

And with that, it had rapidly become difficult for manufacturers to differentiate their own products from others.

High added-value strategy to break away from commoditization

If the trend toward commoditization continued, and not just with personal computers, pricing would become the major criterion on which users would choose a product. In an attempt to break away from this situation NEC decided to shift course and offer value-added proprietary functions to the Japanese market from 1990 onwards in a counterattack against overseas manufacturers.

NEC looked to differentiate itself in the desktop personal computer market with ultra-quiet models with water cooling systems and All-in-one PCs with space-saving liquid crystal monitors. The company rolled out a variety of notebook personal computer models that highlighted light weight, power-saving and design-driven features compatible with mobile use. It also released models with enhanced security functions for business users that replaced ID cards and passwords in personal identification operations with such technologies as fingerprint authentication and FeliCa contactless IC cards. A diverse range of other functions were also adopted to set NEC apart, including designs evoking the image of Zero Halliburton’s aluminum attaché case and “scratch repair” coating on top panels for quick removal of fine scratches. Ongoing initiatives in the area of domestic production to ensure high product quality and the delivery of full-service support from local bases were also maintained to instill a sense of reliability and security in users.

This added-value strategy increased earnings somewhat, but the Japanese market was being won over by the lower prices offered by commoditization.

LaVie Z with Zero Haliburton design



Fortunes turn after Packard Bell buyout and withdrawal from overseas markets

As price competition intensified, NEC took action to expand its operations. This action was the take over of the US personal computer manufacturer Packard Bell. NEC had entered a capital and business alliance with the manufacturer in 1995, and in July of the following year, NEC's overseas personal computer business was integrated into the alliance to form Packard Bell NEC. In October of the same year, a joint venture company, Packard Bell NEC Japan, was also added.

NEC could no longer keep up with overseas manufacturers and their global markets by simply expanding domestic operations. The company looked to break out of this situation by offering Windows-based products through Packard Bell in international markets and trading on the uniqueness of the PC-98 series in the Japanese market. A person involved in the personal computer business at the time said this about the buyout.

"Even our share of the domestic market was decreasing as commoditization took hold. Buying out Packard Bell was supposed to substantially save us and turn this situation around. Taking over the company would allow us to go to battle against the world's top manufacturers and come out on top. That was the scenario at least."

However, the global personal computer market was not a peaceful enough place for NEC's scenario to proceed as planned. This period saw a gamechanger enter the global personal computer market that differed from the very products

commoditized by the market. This gamechanger was the adoption by manufacturers Dell and Gateway of a marketing method combining Internet sales with a build-to-order (BTO) production approach. These manufacturers sold personal computers on the basis that users could freely determine the type of CPU, memory and/or hard disk capacity or other components they wanted. Packard Bell NEC also adopted BTO production and Internet sales, but the company experienced a number of challenges, including issues with quality and financial instability, and posted a loss from fiscal 1995.

NEC provided multiple financial lifelines to Packard Bell NEC totaling in excess of 1.5 billion US dollars. Initiatives to restore performance and improve financials, including reorganizing the sales network, reducing staff numbers and switching to NEC-branded products, were also implemented but none proved successful and the company's deteriorating earnings began to impact on NEC's overall performance. NEC decided in May 1999 that Packard Bell NEC would withdraw from the consumer personal computer market to specialize in personal computers and servers for the corporate market.

At the same time, NEC's personal computer business was being restructured on a global scale. In Japan, Packard Bell Japan, which had been trying to develop Internet sales, was dissolved in June 1999. NEC personal computers were being sold in Europe, the Middle East and Africa through Packard Bell NEC Europe BV, but the personal computer businesses of all other regions, except Japan and China, were soon integrated into the company as well because of its track record of solid sales and stable market conditions. The company name was changed to NEC Computers International B.V. While maintaining the Packard Bell brand for personal computers and other consumer digital devices, the new company expanded sales of enterprise-grade servers and SI operations but separated off the consumer business as Packard Bell B.V. The consumer business in Europe was sold in 2008, and when NEC withdrew from the same business in the Asia Pacific region in 2009, the company's only remaining presence in the personal computer market was in Japan.

Global financial crisis arises while NEC rebuilds operations

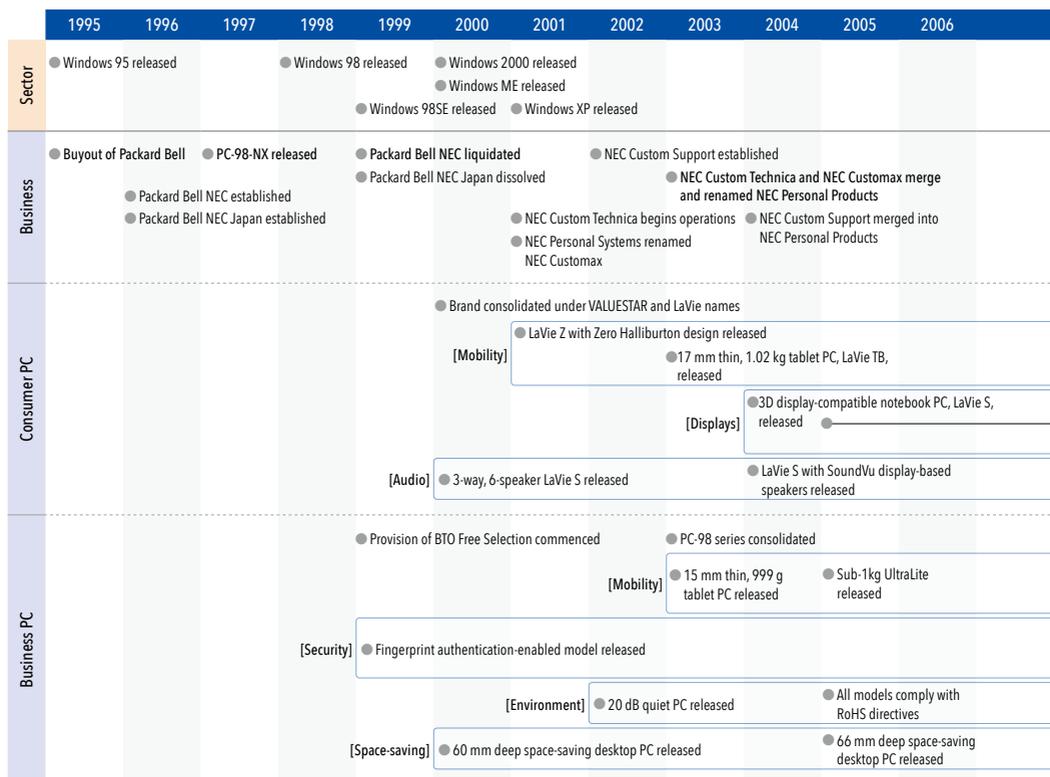
NEC's domestic personal computer business held onto its number one position in spite of continued adversity in overseas markets, including the development of a global market, the commoditization of products, the spread of BTO

production and the popularization of Internet retailing. With the NEC Group handling everything in an integrated chain of operations, from development and production through to sales, fixed costs continued to mount, however, and earnings failed to improve.

The personal computer business was NEC's flagship brand and therefore it was imperative to maintain market share. The production schedule required to ensure market share created excess stock and led to discount selling and decreasing profit margins. By the latter half of the 1990s this situation had become the norm.

NEC initiated a reorganization and consolidation of its personal computer business from 2001 onwards to overcome this situation and improve profitability. In October 2001, the personal computer-related business was split

Timeline: Changes in the Personal Computer Business



compatibles that had become the global standard was the clearest indication yet that the structure of the industry was changing. Within the personal computer sector, job specialization was taking hold internationally, with production being outsourced to China and South-East Asian countries with lower labor costs. Vertically integrated structures, where one company is responsible for the entire supply chain, from design through to production, were no longer viable business models.

To make matters worse Lehman Brothers collapsed in the fall of 2008. Results for NEC Personal Products plummeted, and the company posted a 13.2 billion-yen loss in fiscal 2008. NEC initiated measures to restructure its personal computer business.

Decisions to ensure the future of the NEC brand

After a year of negotiations, it was Lenovo that was chosen to partner with NEC in its restructuring efforts. In January 2011, NEC and Lenovo announced the formation of their joint venture company, Lenovo NEC Holdings B.V. NEC would own 49% of the new company to Lenovo's 51%. NEC Personal Computers was established under the umbrella of the joint venture company after a number of aspects were confirmed, including retention of the NEC brand and cooperation on an equal-partnership basis. While continuing to sell personal computers to corporate clients, NEC transferred NEC Personal Products' entire personal computer business to the new company. NEC's personal computer business became a joint venture with Lenovo with the launch of NEC Lenovo Japan.

"Some argued that a joint venture with Lenovo would mean 'letting go of a personal computer business regarded as a symbol of NEC.' However, at the time, NEC felt it had little choice but to partner up with the outside world as products became more commoditized with the emergence of global standards such as IBM PC/AT compatibles and Windows OS, and the practice of job specialization took hold around the globe. NEC was not able to establish a foothold in the global market against such changes. In contrast, NEC still held the largest share of the domestic market when the collaboration with Lenovo was announced. This was the reason NEC could partner with Lenovo and why Lenovo wanted to retain the NEC brand. NEC's decision to go with Lenovo was a first for Japanese personal computer manufacturers. In the years following, other domestic manufacturers would also head down the same path."

While enjoying the business value of being the top shareholder in the domestic market, NEC was able to hand over operations to the joint venture company and also maintain operations at its production based in Yonezawa.

“Employees at the Yonezawa Plant felt a growing sense of crisis and continued to implement a range of innovations and improvements amid a very challenging situation. They also learnt from the business models of their competitors and established a faster build-to-order production system. The Yonezawa Plant is now recognized for its ongoing commitment to production technology innovation in the NEC Lenovo Japan group.”

The role of the Yonezawa Plant was expanded further, and production of the ThinkPad series commenced at the plant after Lenovo took over operations from IBM. This knowhow was also rolled out to production sites in China and other locations and contributes to Lenovo’s growing competitiveness. NEC’s exceptional quality standards and the high level of service and support provided by bases in Japan continue to be instrumental in delivering a constant sense of reliability and security to users.

In the last 20 years the personal computer sector has seen repeated movements to deliver new value by breaking down existing business models. Moreover, these moves have played out on a global stage. Nevertheless, NEC has been committed to finding ways to maintain a presence in such a global market. NEC’s present standing is not what it was, but NEC’s brand name and reputation for quality continue to live on today. NEC’s presence will continue to change in response to changes in the market. NEC will also continue to create new changes of its own. If the path travelled by NEC’s personal computer business reveals anything, it is that this is the only way to survive in the market. When considering the road forward for NEC it would be wise to be reminded of this once again.



“N brand” gets left behind by a changing market

The demise of a once dominant mobile terminal business



Just as i-mode was the world’s first mobile phone-based Internet access service, there was also a time when Japan’s mobile market led the world. NEC’s mobile terminals had captured the top share of the Japanese market, the world’s most advanced at the time, and had set its sights on international expansion. However, fundamental changes in product structure, a lack of preparation for overseas markets and other challenges ended up intervening to deny NEC the success it had envisaged.

Domestic leader in flip mobile phones

Mobile phones spread rapidly in Japan with the welcomed arrival of the digital second-generation cellular network (2G) in the mid-1990s. During this time innovation emerged that pioneered the world of mobile Internet. In 1999, NTT DOCOMO started the i-mode service that offered Internet access over mobile phones. This transformed the humble portable phone into an information terminal that could be used for gathering information, sending and receiving emails, taking photos, purchasing content and paying bills. Getting behind this convenience, the number of i-mode subscribers skyrocketed from within the first year.

As this situation unfolded NEC mobile terminals, along with the company’s personal computers, contributed significantly to the exposure of the NEC brand to society. Quick to the market, NEC’s flip mobile phones increased in popularity. The N501i HYPHER, NEC’s first i-mode compatible mobile phone, was released in March 1999. The model soon enjoyed a significant following due to its foldable design and user-friendly features, including a large, high-visibility

screen suitable for the i-mode service and easy-to-use keyboard. In March 2001, the N503i HYPER, which supported gaming and other i-appli (applications for i-mode terminals), went on sale. The sales volume in the domestic market was the driving force behind the model capturing top share in its first year on the market. Continuing on from this, a diverse range of models captured the needs of the market, including the camera-ready JN05 and N504iS made for J-phone (later to become SoftBank), as well as the slim-profiled N703iμ and N705iμ, and mobile phones carrying NEC's "N" model numbers helped spread the NEC brand name among consumers.

NEC was able to build a rock-solid position in the mobile phone market because of an "ecosystem" that organically linked the company to various players, especially telecommunications carriers. NEC sold products by building close relationships with telecommunications carriers and equipment and infrastructure vendors and working with them to create next-generation technology and standards.

The analog based first-generation cellular network (1G) was still in use when such mobile communications as car phones and portable phones first appeared, but digital communication technology was soon to grow rapidly. 2G emerged in 1993, 3G in 2001, and in 2010 fourth-generation cellular network (4G or 3.9G) commenced commercial services in Japan. Fifth-generation cellular network (5G) is expected to launch in 2020.

About every 10 years new technologies were commercialized and infrastructure built to prepared standards so products could be delivered to users. Companies in this business had to therefore adapt to new environments to survive. This was arguably a major feature of the mobile terminal business.

NEC had long been involved with communications infrastructure in Japan, and within this ecosystem, the company maintained a key-player status in both the mobile terminal and supporting infrastructure fields. For example, when NTT DOCOMO looked to

N703iμ i-mode compatible terminal for NTT DOCOMO



introduce a 3G service called FOMA in 2001, NEC provided a compatible terminal, the FOMA N2001, for monitor testing conducted in May of the same year. This model was released as a first-generation FOMA mobile phone when full-scale services were launched in October 2001.

Later, an employee involved in developing strategy for the mobile terminal business had this to say.

“Up until 3G, NEC had played a major role in the ecosystem involved in mobile communications development. From before the arrival of mobile phones, pagers, car phones and other such businesses had long been committed to Japanese communications standards, and as such I think the engineers prided themselves on supporting Japan’s mobile communications industry over the years but also on creating the mobile phone standards of the future.”

NEC’s mobile terminal business enjoyed a golden age in the early 2000s thanks to its key role in this ecosystem of telecommunications carriers. In 2001, NEC’s share of the domestic market exceeded 25% and year after year brought in operating profits in the tens of billions of yen.

NEC heads overseas with i-mode

On the back of success in the mobile phone market in Japan, NEC took steps to expand globally in the early 2000s. NTT DOCOMO was eyeing overseas expansion with its i-mode business, and NEC, as well as other Japanese mobile terminal manufacturers, saw this as an unmissable opportunity.

i-mode technology and services were some of the most advanced in the world at the time and NTT DOCOMO’s business model of involving content providers was lauded as a successful example of open innovation. The aim was to spread this business model overseas and popularize mobile Internet across the world. With its sights set on this goal, NTT DOCOMO made a string of investments from 1999 through to 2000 in telecommunications carriers such as KPN Mobile in The Netherlands, Hutchison 3G UK Holdings Limited in Britain and AT&T Wireless Services in the US.

At the same time, NEC was also picking up speed on the development and sale of mobile phones for the overseas market. However, the company faced higher hurdles than expected. This was the period between 2G and 3G, and carriers in Europe and the US, where 2G infrastructure was well established, were wary about investing in 3G. Launching in these markets necessitated 2G

compatibility, but there were some technical barriers. At the time, Japan used the PDC telecommunications standard, while Europe, the US and other parts of the world used the GSM standard. NEC aimed to deliver dual models that could support both 2G and 3G GSM networks, but was not able to develop products for a system different from Japan’s PDC at a pace acceptable to the market.

“It was not easy to comply with the development specs for GSM-compatible terminals. I suppose all Japanese manufacturers had the same problem, not just NEC, as the standard had largely been decided by European countries.”

NEC was no more successful in the Chinese market. Hearing that China was transitioning to 3G, the company considered capturing the Chinese market with 3G-compatible mobile phones. These proved expensive, however, and infrastructure migration did not progress as fast as NEC expected. The company’s sales strategy is also likely to have contributed to the failure in China. In terms of strategy, two plans were given the most consideration: target the “volume zone” or beat out the competition with high value-added products. The first plan consisted of selling 100 million units priced at \$100–200 each, while the second one outlined selling one million units priced at \$1,000 each. NEC chose the latter option, but in no way was it a resounding business success.

More miscalculations were made when NEC attempted to build a sales channel. In Japan, NEC supplied terminals to telecommunications carriers, who then sold them in retail stores across the country. However, overseas markets were already crowded with terminal manufacturers, and newcomers were expected to open up their own sales channels. This required much more energy than initially expected. Telecommunications services are often influenced by the expectations of individual governments, but NEC failed to adequately respond to this, even in such areas as gathering policy information and communicating with government officials.

A number of reasons can explain NEC’s struggles, but essentially the company’s grand design for its overseas operations just was not detailed enough to succeed.

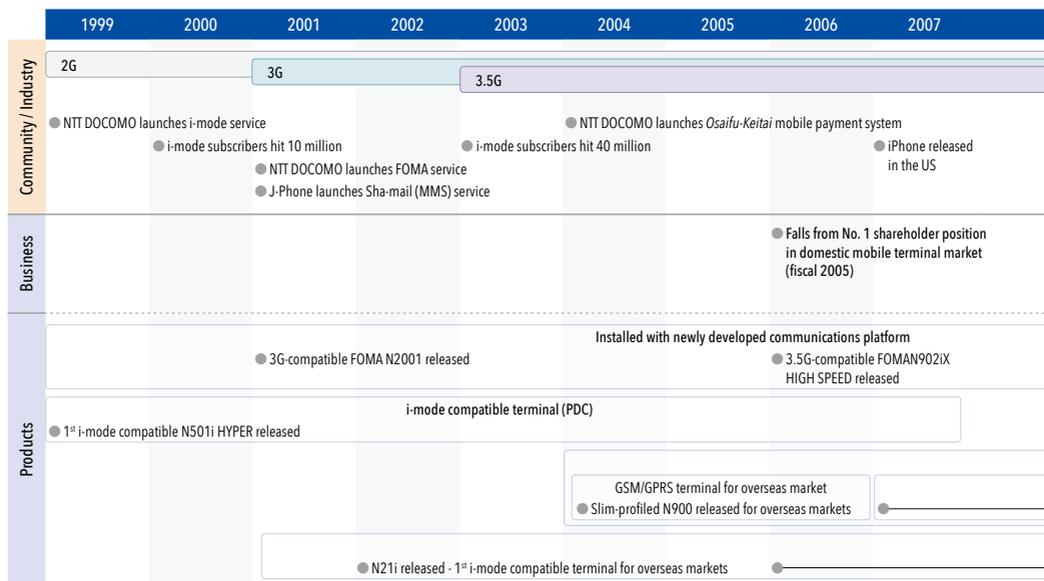
NTT DOCOMO was also struggling to make inroads overseas and, on the back of extraordinary losses totaling one trillion yen in 2007, the company made the decision to withdraw from international markets. Without a successful roll out of global i-mode services there would be no demand for i-mode compatible mobile phones. From 2004 to 2006, NEC’s mobile terminal

business also posted losses of approximately 100 billion yen. The company gave up on its plan to distribute i-mode compatible mobile phones overseas and turned its focus to the Japanese market.

Changing technical environment of the mobile terminal business

The building of mobile communications infrastructure is a core business for NEC. And for a while, the infrastructure construction technology and expertise gained by supporting the market from its earliest of days also helped NEC develop mobile phones optimized for this infrastructure. It was a natural fit for companies building infrastructure to also develop communication terminals and for that reason companies all over the world, including Finland’s Nokia, Sweden’s Ericsson and China’s Huawei, were expanding their businesses in the same way. However, as digital technologies evolved, and specifications were increasingly standardized on a global scale, the need for the infrastructure side of a business to fit with the terminal side diminished. Conventional ecosystems, where infrastructure expertise was used to develop terminals and terminal technology influenced infrastructure development, were starting to collapse.

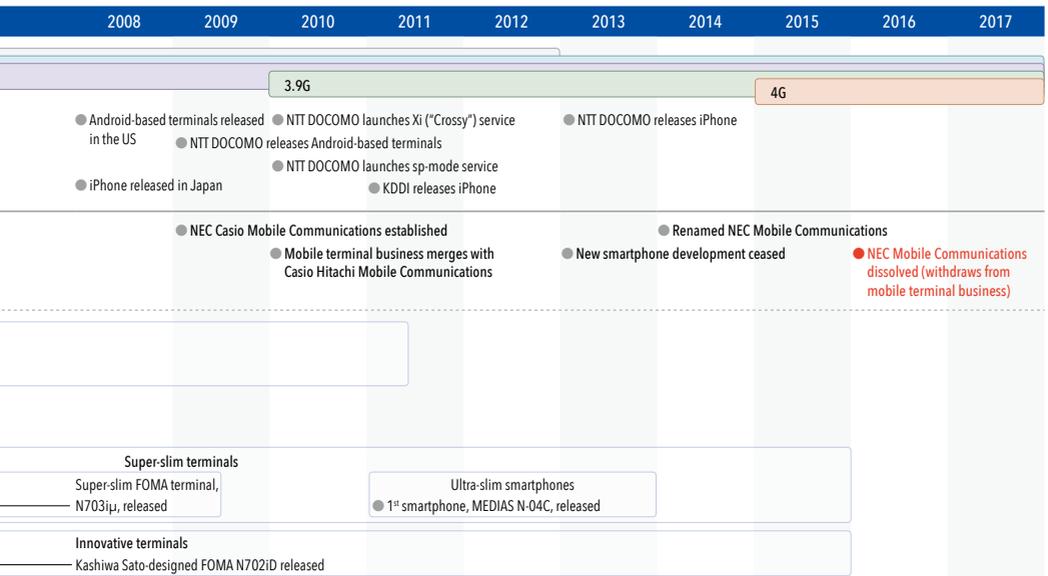
Timeline: Changes in the Mobile Phone Terminal Business



"N brand" gets left behind by a changing market

"I think the turning point came in the early 2000s during the transition from 2G to 3G. Until then NEC's 3G-related technology had been attracting enough attention from overseas companies to consider technical collaborations, business mergers and the like. Then came the digital age and it was no longer so necessary to align with the infrastructure NEC was so famous for, and I feel that's when we lost our advantage."

Influencing this was the rise of Qualcomm, the US designer and developer of semiconductor and mobile communications technologies. Entering the market in the transition period between 2G and 3G, Qualcomm's mobile phone chips went on to change the history of mobile communications. The manufacturer had acquired a number of patents on the back of successfully commercializing mobile phone terminals that supported the CDMA system adopted by 3G. Qualcomm then grew on the basis of its business model of charging licensing fees to manufacturers all around the world to whom they supplied their patented mobile chips, which were essential to the development of CDMA mobile phones. As a result, QUALCOMM mobile phone chips all but monopolized the 3G and then 4G markets.



“Back in the day when all manufacturers were developing and producing chips to make mobile phones, a strong selling point of NEC terminals was their high performance, high-quality chip sets. It might be a little extreme to say, but from the middle of 3G onwards it was as if any manufacturer could make a mobile phone by simply buying chips from Qualcomm. Once this is the case, a manufacturer’s competitiveness becomes increasingly dependent on procurement capabilities suited to market scale and the lower costs derived from these capabilities. What happened when the personal computer market was flooded with PC/AT compatibles, DOS/V and Windows is what happened to the mobile phone market as well.”

NEC’s ecosystem of communications carriers also underwent a transformation in response to this structural change. The value of NEC’s expertise, accumulated over years of cooperative relationships, was falling away.

From feature phones to smartphones

Then a new product caused a seismic shift in the mobile phone world. In 2007, Apple released its iPhone smartphone. In the Japanese market the 3G-compatible iPhone 3G was released by SoftBank Mobile in 2008. The Android software platform for mobile phones first appeared in 2003 and was bought by Google (later Alphabet Inc.) in 2005. From 2008, Korean, Taiwanese and Chinese manufacturers also turned to selling Android terminals.

Initially, the domestic industry showed little interest in smartphones as conventional feature phones were easy to operate and offered an abundance of specialized functions for the Japanese market. However, as functions and performance rapidly improved, it soon became apparent that smartphones were superior technology. In Japan, full-scale uptake of smartphones occurred from around 2010 onwards. Within in just a few years, smartphones had become the top mobile phone terminal in the domestic market.

By offering users the ability to download preferred applications to their own devices, smartphones have become extremely useful information terminals. If feature phones and their pre-loaded essential applications were the “box lunch” of phones, then smartphones were the “cafeteria” option allowing users to freely choose applications.

Users downloaded applications from Apple’s App Store for iPhones and Google’s Google Play for Android-based smartphones. Developers of hit

applications made a lot of money and talented engineers from all over the world competed to join developments. The new ecosystems created by the iPhone completely debased the long-held business structure of manufacturers designing products and developing software to better differentiate their terminals from the competition.

Slow to smartphone development, Japanese mobile terminal manufacturers were plunged into a crisis. Being unable to provide attractive smartphones that could compete with overseas manufacturers, the share of the market captured by Japanese manufacturers for even the domestic mobile phone market dropped significantly, and momentum gathered behind efforts to reorganize the industry and effect drastic business reform. NEC spun off its Mobile Terminal Unit, which oversaw the company’s mobile phone business, to establish NEC Casio Mobile Communications Co., Ltd. in December 2009. This laid the foundations for NEC’s mobile terminal business to merge with those of Casio Computer Co., Ltd. and Hitachi Ltd., and in 2010, a joint venture of two companies, Casio Hitachi Mobile Communications, was absorbed into NEC Casio Mobile Communications. At the time of business integration, NEC was nursing operating losses of approximately 5 billion yen, while Casio Hitachi Mobile Communications was enjoying operating profits of approximately 1 billion yen. As a result, the new company was unable to realize a structure that made use of the mutual strengths anticipated when it was first established and there was no coming back.

Withdrawal from the mobile terminal business

NEC made another miscalculation as well: its renewed challenge for overseas markets. For products with established global markets, scale is what decided business success or failure. At the time, you had to be big enough to negotiate with Qualcomm and Google if you were to succeed in the mobile terminal business. To obtain technical information from either company, influence processes like standards development or obtain procurement advantages, you had to occupy a certain position in the market. To that extent, it was vital to the future of NEC’s mobile terminal business that the company gained scale by expanding internationally.

NEC Casio Mobile Communications aimed to position itself in the global market. Pre-merger Casio Hitachi Mobile Communications had been supplying

terminals with Qualcomm chips to the North American market and enjoyed a certain level of presence. The new company looked to take advantage of this sales channel.

Entering the global market with smartphones in 2011, NEC Casio Mobile Communications announced that it would sell 5 million units outside Japan by 2012, up from the 900,000 units sold in 2010. However, due to its late entry into the smartphone business, this plan derailed as the company failed to develop competitive products. Following on from i-mode's ill-fated debut overseas in the 2000s, this was NEC's second failure in the global mobile terminal market. Insufficient planning and a lack of overall strategy were blamed for the first failure, but were these reasons sufficiently examined when the company planned this second foray into overseas markets? Given the outcome, it has to be said that NEC did not take the opportunity to learn from its past mistakes.

A business downturn in the US and sluggish sales in Japan of products made for NTT DOCOMO. The combination of these issues saw NEC's mobile terminal business post significant losses in 2011 and again in 2012. It was forecasted that losses would reach 100 billion yen in the three-year period up to 2013. In response, NEC abandoned development of smartphones for NTT DOCOMO in July 2013. The company then bought out all shares held by Casio Computers and Hitachi, making NEC Casio Mobile Communications a wholly owned subsidiary of NEC, and went on to rename the company NEC Mobile Communications. The same company was dissolved in 2016 because "business had dropped to a scale no longer efficient enough to operate as an independent company" and with this NEC withdrew from the mobile terminal business in both name and substance.

"We explored selling the business, rather than withdrawing from the market, and approached all the candidates we could think of. However, our decision to do this was a few years too late. Unlike the personal computer business, which had maintained its top-ranking status in the domestic market, the mobile terminal business was experiencing declining competitiveness at the time and no one showed any interest."

This was the biggest difference between the two businesses: the personal computer business had managed to preserve the NEC brand by merging with a partner while it was still competitive and enjoyed a certain level of business

value. While undeniably an extremely difficult decision, NEC’s mobile terminal business could have also opened the way to a different future if it had reacted a little quicker to changes in the market.

Following the fate of the personal computer business, NEC lost its mobile terminal business and then in 2014 sold BIGLOBE to Japan Industrial Partners, Inc. Although its consumer business was shrinking, NEC was moving forward with reforms to become a company more focused on its Solutions for Society business.

However, the legacy of the mobile terminal and other consumer-oriented businesses continues to linger within NEC even today. This is implied and/or noticed in both direct interaction and communication with consumers. Still today, even as the company focuses on the Solutions for Society business, consumers are always at the forefront of NEC’s direct engagement with corporate and government customers. No matter what the solution, it is vital to understand how much of a mental picture consumers have of the value NEC provides.

Another point that should never be forgotten is that by continuing to pursue these values, even small initiatives have the potential to develop into major businesses. Even the mobile terminal business, initially considered a minor venture at the very beginning, later blossomed into a business that once symbolized NEC. This was also so for the personal computer and face recognition businesses. NEC’s journey has seen so many similar examples. This dynamism is arguably part of NEC’s DNA.

Ultimately the most important approach is to champion a global perspective whatever the business, keep delivering new business models in line with market changes, and at the same time generate new changes of your own making. NEC’s mobile terminal business was increasingly unable to break away from the comfort of an ecosystem rooted in the local market. Over time NEC found itself left behind as new players appeared in the global market to break down existing frameworks and deliver unprecedented value. We must always bear it in mind that this danger is not unique to mobile phones and can happen to any business in the IT world.



Pioneering success and change in business

Unable to maintain first-mover advantage BIGLOBE Business



BIGLOBE, once positioned as the driving force of NEC, was not simply a provider of Internet connectivity. Spotting the potential of the Internet beyond a new means of communication, BIGLOBE became a forerunner in the open innovation and platform businesses that linked this potential to growth.

Internet service that seized the new currents of change

The year following Nippon Telegraph and Telephone Public Corporation's privatization in 1985, NEC commenced its PC-VAN PC network service. The PC network provided data communications to multiple users via a host computer connected to their personal computers. By signing up with a PC network service provider, users could access e-mail, electronic bulletin boards, chats, forums and other such services. PC-VAN had reached 500,000 subscribers by 1992 and was predominately accessed by users of NEC's PC-98 series personal computers. The service had by then grown to become Japan's leading PC network service.

The Internet appeared on the scene at the same and Windows 95, which was released by Microsoft in 1995, soon became a mega-hit.

PC networks were closed networks accessible only to service subscribers and consisted of user personal computers and the host computer of the service provider. In comparison, the Internet, with its interconnections between multiple networks, allowed users to access all information on the Internet without a connection service provider. The Internet rapidly spread across the world because of this high level of convenience and the arrival of Windows 95, with its full lineup of network functions, and even enjoyed a meteoric rise in Japan.

Against this backdrop, NEC started the “mesh” Internet service provider (ISP) business in 1995 in addition to its PC-VAN business, and in the same year opened “The Cyber Plaza” portal site to deliver a range of content over the Internet. In 1996, NEC consolidated these services and launched the all-around Internet services provider, BIGLOBE.

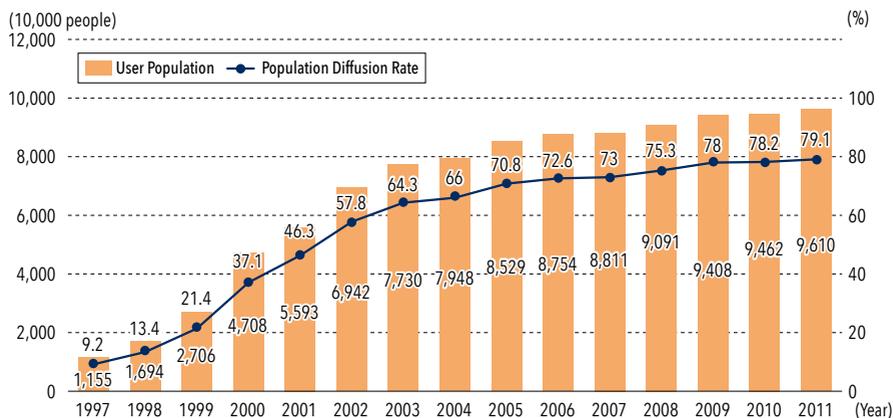
BIGLOBE rode the wave as the Internet’s popularity exploded and by September 2002 the service had grown into a domestic leader with more than 10 million subscribers. With Japan’s Internet population nearing under 70 million by the end of 2002, this figure shows just how many of the country’s subscribers BIGLOBE had attracted.

BIGLOBE did not limit itself to simply being an ISP business with a large pool of subscribers. It also took on the challenge of forward-looking innovation in the service’s three major pillars of business - ISP, platform services and broadband media - and later in such areas as electronic commerce (EC), cloud computing and digital marketing.

Active investment in network platforms brings rapid growth

At the time, communications via personal computer used telephone lines and most users subscribed to a pay-as-you-go billing system that connected them to a host or access point on demand and charged communication fees on total connection time. As well as Internet access fees, users also paid telephone

Changes in the Internet User Population from the late 1990s to approximately 2010



Source: “Communications Usage Trend Survey,” Ministry of Internal Affairs and Communications

charges for connections to host or access points, and as such the availability of multiple access points as close to home or office as possible became an important factor in choosing personal computer communication services and ISP. PC-VAN, however, fell behind in building access points and other infrastructure due in part to the view of NEC's personal computer business that these developments were little more than an added bonus. As a result, PC-VAN carried many dormant subscribers that did not use the service because they could not gain access even when they attempted to connect.

Without an accurate understanding of otherwise fundamental needs, this situation might have likely become a hindrance to growth of the PC network service business.

Meanwhile, a number of people in positions of responsibility at the time were focused on growth potential and directly petitioned NEC senior management on the need for capital investment. From analysis of access point log data, fairly accurate predictions were made of the natural income undoubtedly lost in the pay-as-you-go business model.

President and CEO at the time, Hisashi Kaneko, who had just come from a posting as President of NEC America, was concerned by Japan's lack of established e-mail communications given they were already commonplace in the US. Kaneko immediately gave the go-ahead to capital investment plans and access points were installed across the country.

The Japanese Internet population that was just over 10 million in 1997 ballooned to more than 55 million in 2001, and during that time BIGLOBE dramatically increased subscriber numbers by actively conducting promotion activities while strengthening network platforms to enable convenient access. Attracting the most subscribers in Japan not only provided a significant revenue source for BIGLOBE but went on to become a major asset underpinning future growth.

Pioneering platform services

At the time of its launch, the BIGLOBE service had two types of subscribers: ISP subscribers that used Internet connection services and value-added subscribers that connected from other ISP over the Internet to access content and services delivered by BIGLOBE. In September 2002 there were 5 million of each type of subscriber, but income derived from communication charges to ISP subscribers was the more lucrative revenue stream for BIGLOBE.

The spread of the new media, the Internet, also significantly influenced the distribution of content. Although publishers, television stations and other existing media companies had explored ways to develop their own content using the Internet, they were greatly hampered by a lack of delivery platforms and associated operational expertise. To these companies, BIGLOBE looked like the perfect partner as it offered both a platform service business to provide content delivery and EC site platforms and a broadband media business to provide diversified content.

From its origins as The Cyber Plaza, BIGLOBE was positioned as a “virtual electronic plaza that offered, among other activities, the transmission, provision, exchange, distribution and sale of information for a wide range of companies and individuals.” As evident from the terms “companies,” “distribution” and “sales,” BIGLOBE was never just an ISP, but was more oriented to business targeting information-centric BtoC, BtoB and BtoBtoC business models. From 2010 onwards business models that monetized “platform offerings” and “content delivery” were commonplace, but in the early 2000s BIGLOBE was undoubtedly a pioneer and already engaging in these ventures.

“In the publishing arena, companies such as Shogakukan Inc. and Kodansha Ltd. delivered us content. Even publishers who did not have their own distribution platforms used BIGLOBE so they could focus on the content that were their core business. Famous photographers such as Tatsuo Watanabe and Kishin Shinoyama also provide content when approached by publishers they regularly associated with rather than an IT company like NEC. We were able to expand business in the same way not just in publishing but for other content as well.”

Being a provider of delivery services, BIGLOBE was drawn to providing services that involved costs and/or expertise, such as security and authentication or billing and payments. In a nod to the popularity of delivered content, NEC also began outsourcing areas in which it lacked expertise to content providers so that it could concentrate efforts on creating highly reliable platforms.

In the early 2000s, gravure photos and fortune-telling were hot-selling Internet content. In addition, BIGLOBE offered an array of other content, such as news and travel, gourmet cuisine and music. TV stations like Nippon Television Network Corporation and TV Asahi Corporation also used BIGLOBE to deliver content. BIGLOBE was chosen by leading content providers because

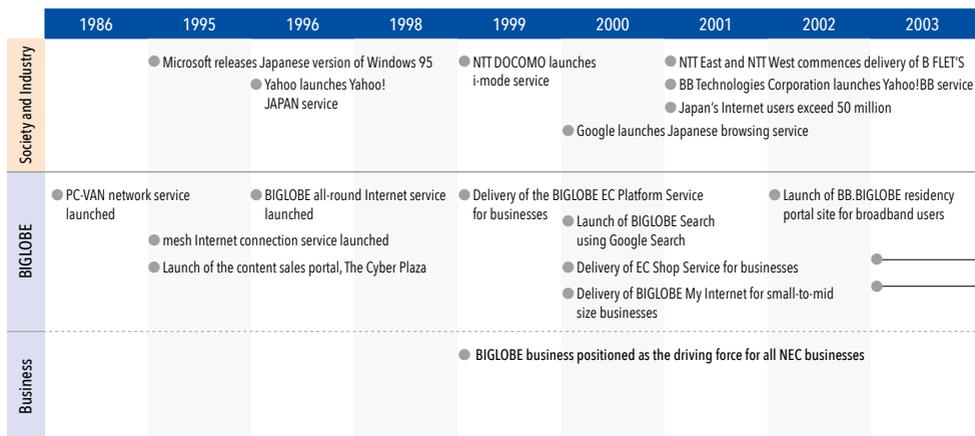
of its strong reputation for service quality, reliability and stability. The service built up a track record of achievements by being flexible in its response, such as enhancing infrastructure when traffic surged at popular events, and in doing so further instilled confidence among its customers.

The BIGLOBE platform was also provided as an IT platform to support the businesses of regular companies. As the "BIGLOBE Corporate Subscriber Service," this IT platform business model provided a range of services, such as housing and hosting, e-mail, EC shopping, Web site construction for small-to-mid-size companies and client management, and was a pioneering example of best practices in the open innovation and platform business activities that later led to SaaS and cloud computing.

Even businesses that are commonplace today like digital marketing determine the most effective delivery volume and frequency of services using mail magazines by observing subscriber responses such as opening rates and link visits. As of 2001, this advanced setup had already been created by BIGLOBE.

Billing systems consisting of "system usage fee + revenue sharing" capable of providing stable revenue also contributed greatly to the growth of the platform services business. Creating popular content generated a cycle whereby BIGLOBE attracted more registered subscribers and greater subscriber numbers attracted even more popular content. In comparison to the conventional hardware-based businesses operated by NEC, the BIGLOBE business

Timeline: History of the BIGLOBE Business



was also faster at generating income, with credit card companies depositing monthly service charges from users into the company account the following month.

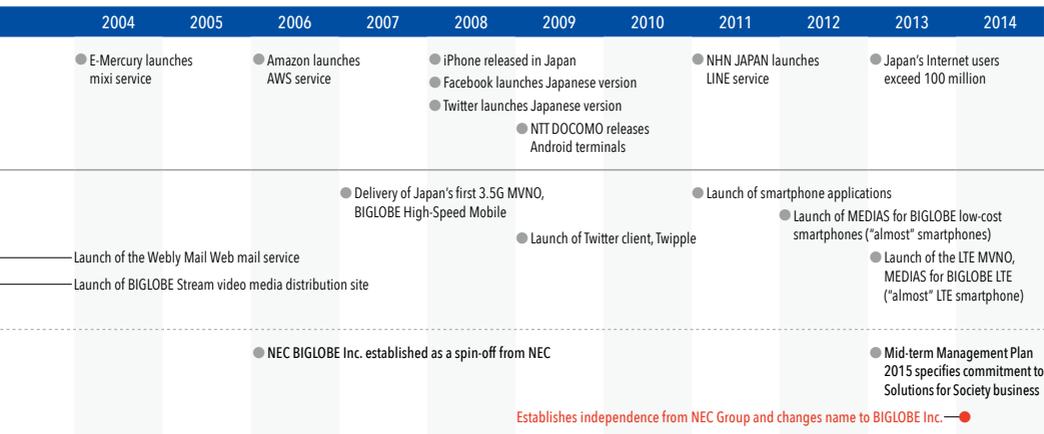
In this way, the BIGLOBE business rode the wave of Internet expansion and continued to grow steadily in both subscriber numbers and sales.

Accumulated technologies, expertise and synergies drive all NEC operations

In 1999 NEC committed to becoming an Internet solutions provider and to that end positioned BIGLOBE as the key force driving all of the company’s businesses. Underlying this commitment was a decision to look forward to the Internet age in the expectation that it would have flow on effects on existing businesses and change the company’s business structure.

“At the very start of Internet expansion Web-related technicians were extremely scarce, even within the NEC Group. Therefore, a real effort was made to train technical teams through on the job development activities, with cooperation from external sources as well as from within the group. I feel BIGLOBE played a significant role in training up web technicians within the NEC Group.”

Highly receptive technicians from within the Group all came to be involved in BIGLOBE’s key infrastructure as the business moved forward with pioneering



initiatives, including the introduction of new Web technologies and service-oriented architecture (SOA) offering outstanding scalability and flexibility. Technicians and engineers reared on the challenge of developing advanced technologies did not just help grow BIGLOBE as a stand-alone business but also accumulated a wealth of expertise and assets for NEC.

Through BIGLOBE even the building of a customer relationship management (CRM) platform to foster relationships while reaching out to each and every client turned out to be a significant outcome. BIGLOBE was a BtoC business in which NEC came face-to-face with its consumers and because the number of customers it managed was much larger than NEC's corporate-oriented businesses, it adopted a distributed-model of advanced architecture even for CRM database configurations. The technologies and expertise gained by BIGLOBE constructing and operating systems would go on to contribute greatly to the SI Services business rolled out by NEC in the corporate market.

"Teams would often ask us if we would join them when they were going to pitch solutions to companies and organizations as their clients wanted to hear about BIGLOBE developments. This also strengthened trust between divisions and facilitated cooperation in a variety of ways."

BIGLOBE also enjoyed a certain degree of synergy with the hardware business as well. Around 2005, BIGLOBE was running 6,000–7,000 servers and procuring more than 1,000 new units annually. Customers that could be counted on for regular shipments of this size were worshipped by the server business, while BIGLOBE also enjoyed the benefit of being able to procure low cost, high-quality servers from within the company. When procurement volumes were at their highest, servers supplied to BIGLOBE even carried a specific model number.

There were also synergies with NEC's personal computer business, which held the top position in the domestic market. It held that a certain number of users that purchased NEC personal computers would choose BIGLOBE as their ISP if the BIGLOBE icon was displayed on the desktop screen. As such BIGLOBE moved to pay the Personal Computer Business Division a sum that consisted of multiplying customer acquisition costs per account by number of registrations. In doing, so a new relationship was forged where an increase in BIGLOBE subscribers would also contribute to the earnings of the Personal Computer Business Division.

Arrival of global corporations and the new wave of broadband, mobile and cloud services

Expected to drive all of NEC's businesses, BIGLOBE grew rapidly by capturing the zeitgeist of an expanding Internet. However, the Internet market, which continued to spread across the globe, had reached one of the era's turning points with the advent of giant platform service companies, boasting tens of millions of users worldwide and delivering core services such as browsing, advertising and EC. These new companies centering on "mobile," "broadband" and "cloud" offerings also pulled in conventional Internet services, including BIGLOBE and plunged them into a stage of destructive growth.

Established in 1998, Google LLC (later to become Alphabet Inc.) grew rapidly with a business model that incorporated proprietary advertising technology in its high-level browser service, and by 2003 had topped 1 trillion in sales in the space of five years. With outstanding technical capabilities and an innovative business model, the company became an instantaneous and influential presence on the Internet business. Yahoo! Inc., Amazon.com, Inc. and other US Internet companies that managed to survive the so-called dot-com bubble in 2001 also grew into corporate behemoths with significant influence on the Internet services market and started making inroads into markets around the world, including Japan.

The domestic Internet market also witnessed not only rapid globalization as these sorts of players arrived, but also the rise of Yahoo!Japan, which, although under license for Yahoo!, expanded on a strategy of Japan-specific business developments, and home-grown ventures with huge customer bases in Internet services, such as Rakuten, Inc. which had quickly and successfully attracted large numbers of sellers and member customers to its EC site. As this situation unfolded, BIGLOBE and other players engaged in ISP-based Internet businesses watched their presence in the content and services market rapidly weaken.

The trend towards "mobile" and "broadband" in communication networks also brought about significant structural changes in the ISP business.

The pioneer in mobile broadband services was NTT DOCOMO's i-mode. Launched in 1999, this service proved to be wildly popular and subscriber numbers, which stood at 10 million in December 2001, climbed to over 40

million by October 2003. Although a domestically based service, it provided diversified content to a massive user base, with users paying a nominal usage fee for i-mode as part of their monthly charges to NTT DOCOMO. The days of the ISP provider were over and NTT DOCOMO's ISP business was incorporated into its mobile phone service. Companies that provided attractive content using i-mode also grew bigger with the advent of this structure, and i-mode became a formidable rival to conventional ISP and content providers.

The rising tide of mobile Internet gained further momentum with the tidal wave that was the arrival of the smartphone. Apple's iPhone was first released in Japan in 2008. Ten years later it could only be said that the smartphone had become an essential technology of everyday life. New economies centered on mobile phones and applications were being constructed over conventional Web-based Internet on a massive scale that even involved developing nations. Surrounded by this, even i-mode soon lost competitiveness.

As the broadband trend continued, BIGLOBE's ISP business was also impacted by the appearance and rapid spread of asymmetric digital subscriber lines (ADSL). An environment emerged that eschewed pay-as-you-go billing via conventional dial-up connections in favor of the high-speed comfort of permanent connectivity at fixed rates. Coupled with the impact of price destruction caused by SoftBank's rollout of the Yahoo!BB broadband service, BIGLOBE was forced to conduct a fundamental review of its business model and portfolio of dial-up access points across Japan.

By 2007, the number of mobile phone subscribers in Japan had reached 100 million. Once Internet access from mobile phones became available, mobile carriers became the providers of Internet connection services. The transition to ADSL and later to fiber optic lines made a "comfortable Internet connection environment" less of an option and more of a necessity, even for home Internet connections, and user interest shifted to accessing mobile and broadband services such as SNS, video streaming and social gaming.

In response to the changing environment, BIGLOBE pushed ahead with expanding services by launching the BB.BIGLOBE portal site for broadband users in 2002, and the video media portal site BIGLOBE Streaming, SaaS email service Weibly Mail, and blog service Weibly Blog in 2003. However, one of the major pillars of the BIGLOBE business had been severely shaken and by around 2010 discussions were taking place on the ongoing viability of the ISP

business for personal computers.

The rapid uptake of cloud services in response to the evolution of the broadband environment also became a factor in the transformation of the BIGLOBE business. Commercial services of Amazon Web Services (AWS), Amazon.com's cloud services offering, commenced in 2006. Soon a variety of cloud services appeared in each of the infrastructure, platform and services layers and in 2010 it was predicted that corporate information systems would also shift to cloud computing. This shift would change the shape of the SI business as well. NEC's SI business found it needed engineers with the Web skills and SOA expertise gained on BIGLOBE developments, and many of these engineers transferred to SI or other business-side divisions.

BIGLOBE splits from NEC amid restructuring

As the environment surrounding BIGLOBE's three key businesses – ISP, Platform and Broadband Media – changed, NEC's entire consumer business reached a major crossroads. Profitability in the personal computer business declined sharply as a result of increasing commoditization, and the spread of the smartphone was even throwing shadows over the mobile terminal business, which had once boasted the largest share of the domestic market on the back of user demand for i-mode services.

In the face of a shift to broadband, mobile and cloud services, NEC steered a course towards completely reorganizing its operations to focus on the core operations of SI for businesses and communication carrier-related services. There would be no choice but to also change the status of BIGLOBE, once considered the driving force of the company.

At this point, NEC had two main options to ensure BIGLOBE's continued growth.

The first was to specialize in platform services. Developing a platform services business early on, BIGLOBE, along with the NEC Central Research Laboratories, was a repository of high-level technologies and expertise. However, when giant platformers like Google and Amazon.com appeared, NEC had limited resources available to invest in BIGLOBE to ensure its survival against such competition as it attempted to expand business on the world stage.

Amid the rapid spread of mobile networks, BIGLOBE could not avoid competing against communications carriers if it was to expand as a platformer.

However, these carriers were also customers of the communications business that underpinned NEC operations. For NEC, which had long conducted business activities within ecosystems of communications carriers, it would not be an easy decision to secure BIGLOBE's future growth by pursuing the path of platformer and provider of network services.

The other option was to take the path of a specialist content provider. The basic business model of delivering a diverse range of content, such as gaming and video streaming, over the Internet and deriving returns from advertising and EC was already well established. Although BIGLOBE had been quick to start distributing content and streaming video, it had a critical issue with journeying forward to becoming a content provider. That issue was that BIGLOBE lacked know-how on actual content. It would be a massive risk for NEC to pro-actively invest in a sector that it had no real feel for.

In contrast to BIGLOBE's inability to radically shift its business model, despite the dramatically changing environment surrounding its business operations, a succession of new trends, and venture companies, hit the Internet market and BIGLOBE's dominance was soon lost.

To break from this situation, NEC took the decision in 2006 to spin off the BIGLOBE Business Unit as a separate company and restart it as NEC BIGLOBE Inc. with some start-up capital from external investors such as Sumitomo Corporation, Sumitomo Mitsui Banking Corporation, Daiwa Securities Co., Ltd., Dentsu Inc. and Hakuhold Inc.. Although the intention was to supplement areas in which NEC lacked sufficient expertise, such as EC, online advertising and entertainment-based content, by cooperating with equity investors, NEC retained control of business operations and therefore could not take full advantage of outside talent, ideas or expertise.

In 2013, NEC announced its "Mid-Term Management Plan 2015" which clearly spelt out plans to "commit to a Solutions for Society business" and take up the challenge of solving societal issues with IT and network technologies. As a consequence, NEC BIGLOBE, which was a BtoC business, was sold to the investment fund, Japan Industrial Partners, Inc., in 2014 and became BIGLOBE.

NEC had already transferred control of its personal computer business to a joint venture company established with Chinese PC manufacturer Lenovo Corporation in 2011. The previous year, the company's mobile terminal business

had been split from NEC headquarters and set up as NEC Mobile Communications. As NEC's business strategy changed and the areas in which BIGLOBE could leverage synergies with other businesses diminished, continuing business operations as part of the NEC Group could have very well led to declining technological capabilities and services. In what was last-minute timing, BIGLOBE survived with its business value intact.

Reexamining the business that was BIGLOBE

From 2000 onwards, US IT companies like Google, Amazon.com, Facebook and Apple experienced rapid growth with the expansion of service-type businesses. BIGLOBE had embarked on business development just as advanced as the services and platforms offered by these businesses that had brought major change to society.

Started as a demonstration of NEC's venturing spirit and quick to spot the tidal wave spread of the Internet, BIGLOBE had been successful in switching business models away from personal computers. However, NEC could not continue to transform a business model like BIGLOBE to suit environmental and technological changes as the new trends of broadband, mobile and cloud emerged. In the background there were undoubtedly also issues with genetic make-up. A huge organization like NEC can not respond to change as quickly as a start-up venture.

Even today, NEC operates in an ICT world where innovations in technology and business models continue to pivot around the Internet at breakneck speed. NEC has much to learn from reflecting on the challenges BIGLOBE faced and the fact it could not continue to grow the BIGLOBE business if it is to survive the competition in today's world.



From “things” to “solutions”

Learning from three SI projects that became vital infrastructure for society



In the past 20 years, NEC’s operations have transformed significantly from the business of “selling things” to that of “providing solutions.” Among NEC’s operations are projects in various fields such as distribution, telecommunications, and finance in which NEC has played a significant role. These projects have become a source of not only revenue but also valuable knowledge and expertise for the construction and operation of important infrastructure that contribute to solving social problems.

The arrival of the total solutions era

In the 1980s, corporations rapidly began adopting IT; since then, as needs have diversified and technology has become more sophisticated, customers have come to want not only the simple provision of hardware and software but of a single system combining and operating the two in an optimal, individualized way. In the face of these changes, NEC’s system business also made a large shift to provide “total solutions” to meet this demand.

In the past 20 years, NEC has provided diverse information systems to a wide variety of customers such as corporations and public institutions. Of these systems, three exemplary projects are the comprehensive store information system for Seven-Eleven Japan Co., Ltd.; CiRCUS, the i-mode gateway system of NTT DOCOMO Inc.; and the core banking system for Sumitomo Mitsui Banking Corporation.

The comprehensive store information system that supports Seven-Eleven

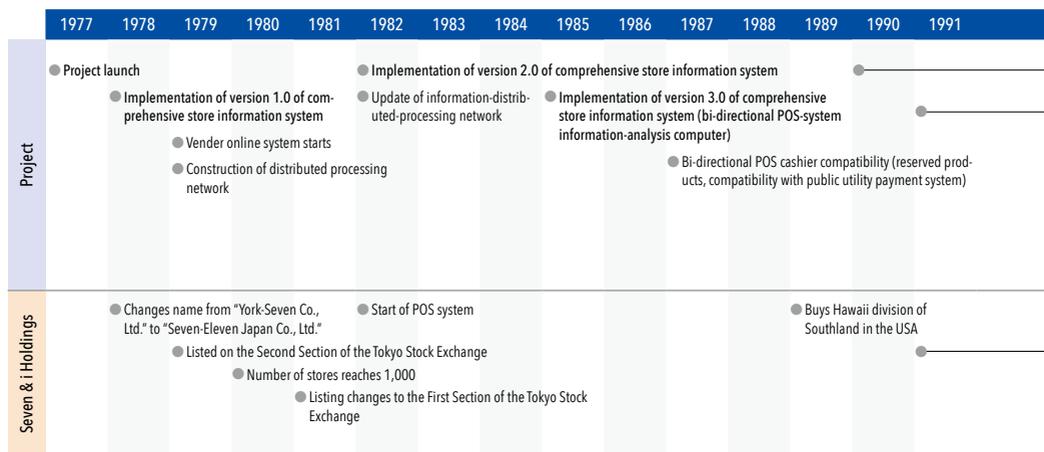
Seven-Eleven Japan, which manages convenience stores all over Japan, has

Thus, the SC adopted Microsoft Corporation’s Windows NT for its OS and Oracle Corporation’s Oracle Database for its database administration system. At the time, most systems used CRT displays, but the Seven-Eleven system instead adopted a 14.1-inch color LCD display, connected all stores via one of the largest networks in the world combining satellite communication and Integrated Services Digital Network (ISDN), and enabled the transmission and reception of large amounts of data with this innovative design. One person who participated in the project describes it as follows.

“What changed significantly in version 5.0 of the system was that the stores became capable of handling a variety of data. The headquarters center became able to send data such as weather reports or product information to stores. Product information included things such as images of new products and their sales points as well as marketing information from manufacturers, such as how many TV commercials will be aired, and so forth. With this information as a reference, stores became able to determine when to make orders and in what quantity to make them.”

Version 5.0 of the system was also the first to install a communication function for employees in the store. Store staff became able to utilize relevant information they noticed, such as upcoming neighborhood events, school sports days, or the state of nearby construction sites, when placing orders for products. In 2003, Seven-Eleven Japan was able to reduce costs by converting

Timeline: Changes in the Development of the Seven-Eleven Japan Comprehensive Store Information System



to paperless slips and business forms and preserving data digitally.

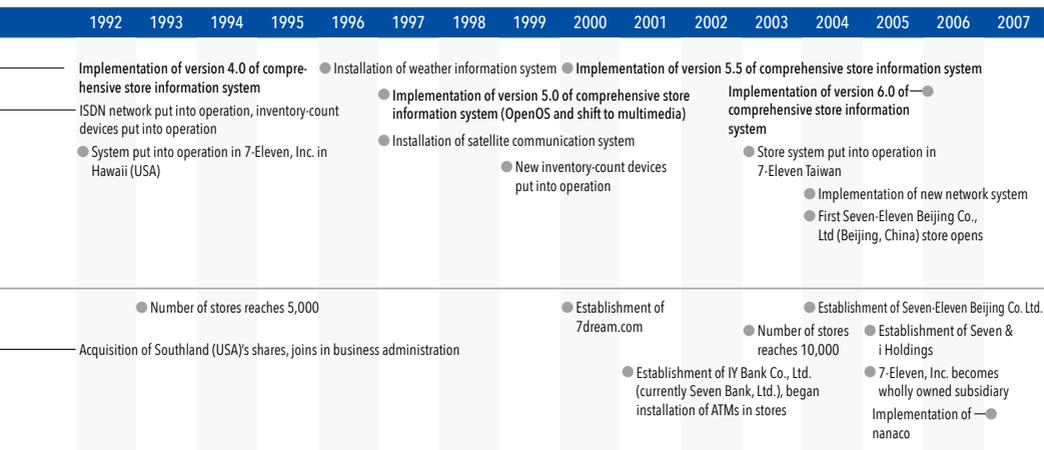
In version 6.0 of the system that was released in 2006, the in-store network went wireless. Until then, employees had to go to the SC in the back room to view product information, the product line-up, and information analysis; now, they could access all this from the graphic order terminal (GOT) used for entering product orders. Thus, employees became able to check necessary information while continuing to place orders on the sales floor. In addition, the system became able to handle a larger amount of data with the integration of optical fiber.

Partner to a business that clears the way for the next generation of retail

Renewals of the comprehensive store information system are often conducted at intervals of seven to eight years. In the field of IT, technology and services evolve at a neck-breaking speed, so careful considerations are conducted at each renewal of the system to ensure that it will not become obsolete in the intervening seven to eight years.

For example, version 5.0 of the system enabled application updates for all store SCs nationwide to be conducted from the headquarters center via the network when necessary.

“We reduced the dependency between programs for applications running on the SC as much as possible and adopted a ‘loosely-coupled’ architecture, which enables simple rearrangement, as if with blocks. We implemented this



way of thinking from version 5.0 of the system onward.”

These functions are taken for granted in the current system, but it was an innovative design for 1997.

However, the same approach does not work for hardware. When an update is necessary, staff must go in person to all the stores in Japan and change the relevant parts, which takes a tremendous amount of time and labor. Thus, especially careful consideration was given to the hardware specifications and stability of quality.

“As long as the SC is hardware, there’s the chance that it could break. For example, if the likelihood of the hard disk breaking were to increase by 1%, and 10,000 stores were using said disk, then the number of hard disks that break would increase by 100. It would take a support unit of 100 people in total to change the hard disks, which would increase costs. This is why we are extremely careful when selecting parts.”

In development, ease-of-understanding and operability are also important components. The number of SC and GOT users is in the hundreds of thousands and includes store owners, store managers, and part-time staff. While some staff members are accustomed to using information appliances such as computers, other staff members will be holding such a device for the first time; thus, thoughtful consideration of usability is a must.

“Version 5.0 of the system was released in 1997, so although computers were becoming popular with Windows 95, there were also many users who were not accustomed to them, so we had trouble with designing and developing the screen designs and general user interface. We considered it for a long time with the Seven-Eleven Japan project manager and fine-tuned the system so that any user would be able to understand and operate it intuitively. We would make a prototype, revise it, and just repeat this process over and over.”

NEC’s relationship with Seven-Eleven Japan is a true partnership and has brought NEC abundant knowledge in the fields of distribution and retail. Seven-Eleven Japan’s information system is used by hundreds of thousands of people, so there are some users who operate the system in ways that the developers did not imagine; the developers have been frequently surprised by the gap in their awareness and that of users. By improving the system while having these realizations, NEC has accumulated technological ability and expertise that it has utilized in providing other distribution- and retail-related solutions.

Among retailers around the world, there are few corporations that use leading IT to the extent that Seven-Eleven Japan does. With this frontrunner that cleared the way in the retail industry, NEC will continue to take on the challenge of creating various new innovations.

Take the utilization of AI, for example. In the retail industry in recent years, minimizing both loss from unsold products and sales-opportunity loss caused by a lack of stock has become a serious challenge for management. In particular, loss from food products has become a social problem that demands an effective solution. Considering these circumstances, Seven-Eleven Japan has evolved the information environment in its stores in a variety of ways to increase precision in product orders. In the future, some portion of product ordering will likely be performed by AI.

Some demonstration experiments are already being conducted in relation to IoT. The SC has remote administration, as mentioned above; if a similar system could be implemented to collect information from in-store equipment such as the coffee machine, refrigerated-goods case, and drink case, energy consumption could be reduced and maintenance could be made more efficient.

Convenience stores provide diverse products and services from a small-scale store, so making operation more efficient is a constant challenge. Many of these challenges can be resolved through digital transformation, and expectations for the new value that NEC’s total solutions can provide are high.

The next-generation gateway system that supported i-mode’s rise to success

In the same way that convenience stores significantly changed society in the area of distribution, there is a service that significantly changed society in the area of telecommunications: NTT DOCOMO’s i-mode. Beginning in February 1999 as an Internet-connection service for cell phones, i-mode was explosively popular, exceeding 10 million subscriptions in 2000 and 40 million in 2003. This service led the world in opening up the field of mobile Internet, changing mobile phones from simply portable telephones to information terminals. That achievement is enormous, and since the service’s appearance in the market, it has been examined from various angles as a representative example of “open innovation.”

What supported i-mode’s rise to success was the gateway system CiRUCUS that began operation in December 2002. A gateway system is a platform that

provides services such as the transmission and reception of messages on mobile phones and access to websites. Along with NTT DOCOMO, NTT Data and NEC also participated in this project.

The new gateway system's implementation was decided in December, 2000. Although the system was mission-critical and would bear the burden of a massive amount of transactions, the actual time given for its development was just over a year. A large reason behind the rushed production was the fact that the first-generation gateway system was unable to keep up with the rapid increase in traffic; from around the spring of 2000, i-mode had been suffering from repeated network disturbances. The situation was related to the foundation of the service, so NTT DOCOMO decided on a prompt update of the gateway system, but this meant a challenge where failure was unacceptable for NEC.

"At the time, NEC was providing an Internet-connection service called 'BIGLOBE' and was distributing a variety of content on that open and mission-critical platform. The technical capability and expertise we had cultivated therein was certainly recognized; however, while BIGLOBE had some hundred million users, CiRCUS was to have some 10 million users—it was on a different scale. The desired level of availability and scalability was also that much higher. Simply applying the technical capability and expertise we had cultivated with BIGLOBE was not enough to solve the problem," one of the project members reflects.

The requirements for CiRCUS were high performance, high availability, and scalability. Because of NTT DOCOMO's bad experiences with the old system, they wanted an extremely high standard to be met for these three factors.

First was high performance. i-mode has three basic features: the transmission and reception of email, relaying to the Internet, and relaying to the official content server. The massive amount of processing (namely, tens of thousands of transactions per second) necessary to provide these services must be conducted in a short amount of time.

The goal for high availability

NTT DOCOMO's i-mode gateway system CiRCUS



was set to 99.9999%. This was a very high standard that meant that the average error time, i.e. the amount of time each individual user is affected by a network disturbance in a given year, would be only 32 seconds. In addition, a warehouse was prepared within Tokyo exclusively for stockpiling parts. This way, even if a network disturbance occurred, staff from NEC Fielding and other participating vendors could respond 24 hours a day, 365 days a year. This preparation was also for the sake of enabling high availability.

Then there was scalability. When CiRCUS began operating, i-mode already had over 30 million users. That number would continue to grow, reaching 50 million users in a few years. Even if we could predict this future growth, preparing equipment with 50 million users in mind from the start would not be efficient. Equipment must be sequentially augmented while accounting for increases in subscribers and traffic, so scalability is vital. In addition, we considered not only the hardware and system specifications but went as far as to consider what was the most efficient way to proceed when delivering and installing servers and shipments from storage to the data center when increasing capacity.

A member of the CiRCUS project looks back on it as follows.

“We made a system such that we could have everyone, including the foreign vendors participating in the project such as the American Hewlett-Packard Company (later Hewlett Packard Enterprise Company) and the storage equipment company EMC (EMC Corporation/later Dell EMC Corporation), fully cooperate. CiRCUS’s server uses Hewlett-Packard’s HP-UX, and Hewlett-Packard made an exclusive team to conduct tests, debug, and so forth. Meeting NTT DOCOMO’s strict requirements would mean HP-UX’s quality also improved, so Hewlett-Packard was very positive about working on it.”

All the members of NEC’s project team also learned a great deal as they aimed to fulfill their lofty goals in a limited time in a setting in which they were constantly expected to resolve multiple problems simultaneously.

Mobile Internet that became a part of social infrastructure

The transition from the first-generation gateway system to CiRCUS was conducted over a number of months, starting in December 2002 when CiRCUS began operation. When operation began, there were 400 servers, 1,000 network units, and a total of 280 km of cables. The operation of a massive, continuously growing mission-critical system would be no easy feat.

In 2005, the number of users accessing the Internet in Japan from mobile devices exceeded that of users accessing it from computers. Users are constantly carrying the devices they use, so i-mode shows traffic traits that closely reflect users' lifestyles. For example, users may check their email when they wake up or on their lunch break. After a popular TV drama airs, messages exchanging thoughts and impressions on the show are exchanged.

In a given year, traffic is highest from New Year's Eve through New Year's Day. New Year's greetings (i.e. "Happy New Year!" messages) result in triple the average traffic. Since its implementation in 2002, CiRCUS has continued to handle a massive amount of traffic and has done so without facing significant problems. Even when the Great East Japan Earthquake of 2011 occurred, CiRCUS did not stop running. Some areas were cut off from telecommunications due to problems such as damage to base stations, but i-mode itself was never cut off. A project member who was visiting NTT DOCOMO at the time the earthquake occurred looks back on it as follows.

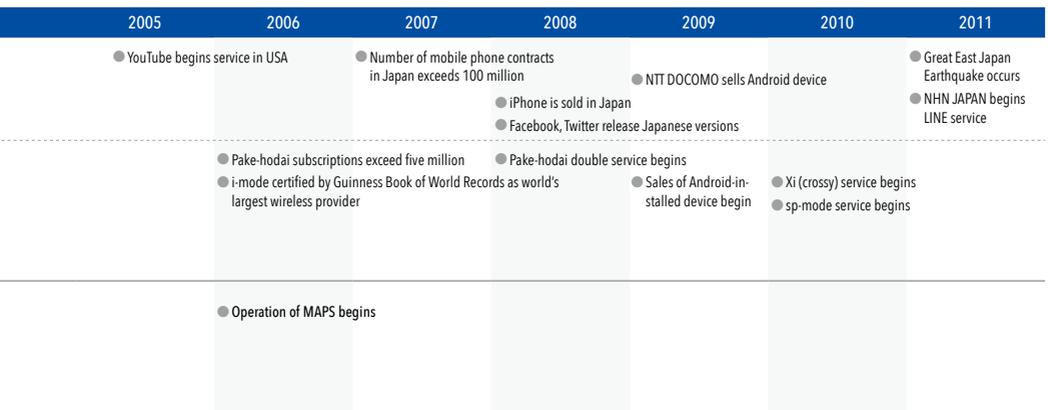
"As soon as the earthquake happened, I rushed to the operation room. I turned on the TV, and footage was playing of the affected areas and the tsunami. In the affected areas, I think there were people who sent a final message to their families. We could not let those messages fail to send because of a system error. I was made acutely aware of the important role i-mode played in society. To this day, I have not forgotten the feeling I had then of, 'this system must not go down.'"

Timeline: Development of CiRCUS

	1999	2000	2001	2002	2003	2004
Society/Industry		<ul style="list-style-type: none"> ● Number of mobile phone contracts in Japan exceeds 50 million ● Google begins search engine service in Japanese 				<ul style="list-style-type: none"> ● E-Mercury begins mixi service
NTT DOCOMO	<ul style="list-style-type: none"> ● i-mode service begins 	<ul style="list-style-type: none"> ● Number of i-mode subscribers reaches 10 million 	<ul style="list-style-type: none"> ● FOMA service begins ● i-app service begins ● Number of i-mode subscribers reaches 30 million 		<ul style="list-style-type: none"> ● OsaiFu-Keitai service begins ● Number of i-mode subscribers reaches 40 million 	<ul style="list-style-type: none"> ● Pake-hodai (subscription) service begins ● Pake-hodai subscriptions exceed one million
Project		<ul style="list-style-type: none"> ● Implementation of CiRCUS is decided 		<ul style="list-style-type: none"> ● Beginning of transition to CiRCUS 	<ul style="list-style-type: none"> ● Completion of transition to CiRCUS 	<ul style="list-style-type: none"> ● Operation of CiRCUS back-up center begins

i-mode became an extremely convenient service by supporting infrastructure with highly reliable telecommunications. The public primarily uses smartphones now, but mobile phones were able to evolve into a part of social infrastructure with which people can feel at ease in exchanging not just voice messages but a variety of information, because telecommunications infrastructure was supported by a service like i-mode. By maintaining a high level of reliability like other parts of social infrastructure that society cannot do without such as electricity, gas, and water, i-mode won the trust of its users and opened the door to mobile Internet. The project to construct CIRCUS, the massive, mission-critical system that supports i-mode, brought a large shift to society and the times we live in.

Domestic users of i-mode peaked in 2009, when smartphones began to gain popularity in earnest. In September 2010, sp-mode, an Internet-connection service for smartphones, was released and has been provided since then simultaneously with i-mode, gradually transitioning from one to the other. NEC continues to handle the system construction and operation of sp-mode’s service platform, Multi Access Platform System (MAPS). When sp-mode service began, the system functions could not keep up with the rapid increase in smartphone usage, and for a while, the service faced serious difficulties. NEC pronounced a “state of emergency” within the company and responded, ultimately enabling the provision of a stable service platform. Accumulating efforts such as this, NEC will continue its strong, deep relationships with clients.



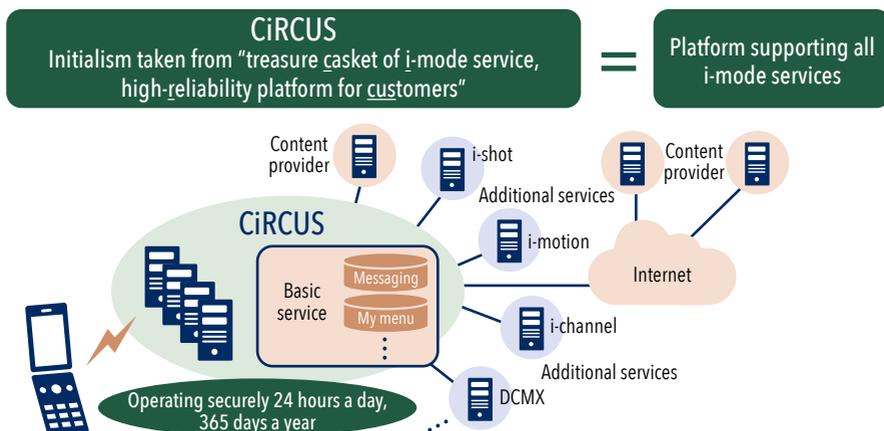
Constructing Sumitomo Bank's core banking system that runs non-stop, 365 days a year

Like i-mode, greater importance has been placed in the past 20 years on not just systems in which regular users can see the exchange of information, but also on corporate information systems that are not normally seen. Take the implementation of information systems in the field of finance, for instance. In the 1980s, most Japanese banks were transitioning to the third online system with the goal of improving management of sales and revenue via the aggregation of management information and improvement of the information system.

NEC, which was advocating "C&C" and trying to expand business from telecommunications into the world of computers, was eager to handle the core banking for a main bank like Sumitomo Bank. NEC had been engaged in various fields such as hardware development and performance enhancement as well as engineering, and these efforts paid off in the 1990s. Sumitomo Bank chose NEC, which had supported its information system construction and operation until then, as its partner for constructing its post-third-online-system core banking system.

Having been selected, NEC provided the giant-scale mainframe ACOS System 3800, which was commercially released in 1990, to Sumitomo Bank. At the time, the ACOS System 3800 had the highest level of performance in the

Overview of CiRCUS's Role in i-mode Service



world; it used a multiplex configuration, which coordinates multiple systems, and mutual standby mode, in which systems mutually back each other up. With its high scalability and availability, the ACOS System 3800 was a hit product that significantly increased sales in the giant-scale mainframe market.

The core banking system for Sumitomo Bank, made with the ACOS System 3800 as its base, was also easy to scale out; in other words, the computers making up its system could be increased to improve its processing power because of their distributed construction. Koji Nishigaki, who went on to be NEC's president, said the following in *Nikkei Computer* (June 7, 1999 issue) about this innovative core banking system that had excellent scalability, reliability, and availability.

“We built Sumitomo Bank's 24-hour, 365-day nonstop core banking. This system is the best in the world. Sumitomo Bank is surely the only bank truly capable of 24-hour nonstop full banking. At the very least, they're the first capable of it.”

Integrating systems trouble-free after a large-scale merger

In October 1999, only a few months after this interview, the merging of Sumitomo Bank and Sakura Bank was announced. In the 1990s, Japan's financial institutions were overwhelmed with handling the collapse of the bubble economy; in the latter half of the 1990s, large-scale reform of the financial system was conducted, and financial institutions successively reorganized. This was the background for the news of Sumitomo Bank and Sakura Bank merging.

Sumitomo Bank and Sakura Bank's information system departments naturally began preparations for the merger; NEC, which was in charge of Sumitomo Bank's information system, also promptly began working towards integrating the systems. The banks would merge in April 2001. The time remaining was limited. Someone involved at the time reflects on it as follows.

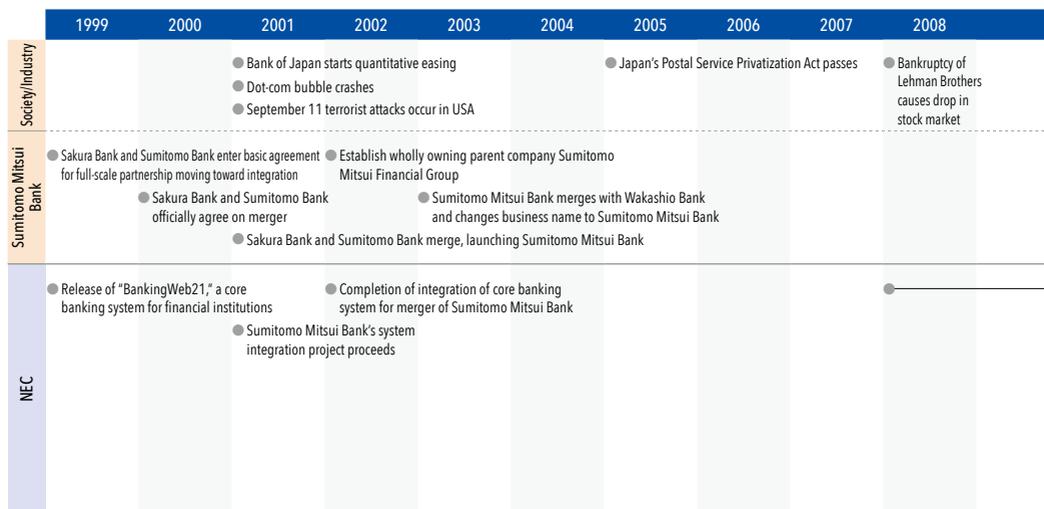
“Sumitomo Bank and Sakura Bank set up an integration preparation committee and began making considerations. They discussed the integration of all the systems: not only the core banking system, but the branch devices and the whole bank system. Ultimately, for all but a few systems, they decided to basically use one or the other's version for each system; for core banking, they decided to use Sumitomo Bank's system. I believe this was a result of our system, which was built as a post-third-online system, being highly appraised

for its innovation and reliability.”

By “Day 1,” April 1, 2001, the day of Sumitomo Mitsui Bank’s launch, the system had to function as one system from the client’s point of view. At this point, NEC made a structure utilizing both core banking systems, with a broadcast system bridging them. Then, NEC set “Day 2,” the date by which to fully integrate the two core banking systems, in July 2002. The development period was effectively about two years; NEC was able to have the system operating without trouble on schedule.

The integration project was able to proceed smoothly in part because of the hardware renewal project that had been underway with Sumitomo Bank since the latter half of the 1990s. The plan was to update the Sumitomo Bank data centers in west and east Japan such that the former would be the main data center and the latter would be the sub data center, as well as to install a new mainframe, “Parallel ACOS Series PX7800SV.” However, as this project was entering its most important stage, the merger was announced. Sumitomo Bank’s mainframe was already the newest available, so processing power was significantly improved. Distributed processing was possible, so by increasing the mainframes, scaling out could also be easily accomplished. From the data center’s storage capacity, the plan shifted such that east Japan would be the

Timeline: Development of Core Banking System for Sumitomo Bank/ Sumitomo Mitsui Bank

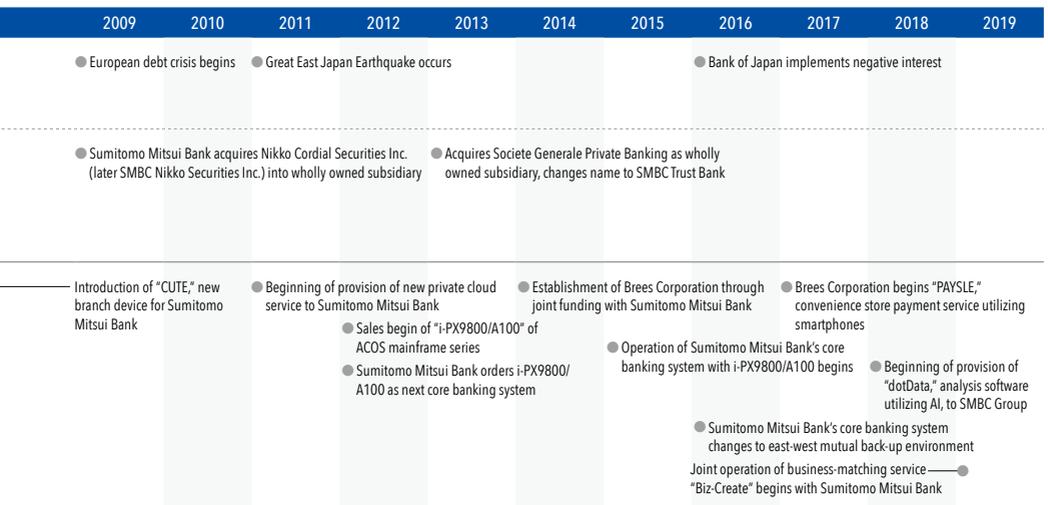


main data center and west Japan the sub data center, which was the opposite of the original plan; however, this project that had proceeded on the basis of the distributed structure of the post-third-online core banking system became the base for “Day 2” and was a necessary factor for a successful, smooth transition.

The largest project after the integration of the core banking systems was updating the hardware. In this project, NEC made a significant decision about the ACOS series. In the ACOS series after the Parallel ACOS Series PX7800SV, which was equipped with an NEC-made CPU, NEC had used Intel Corporation’s Itanium Processor Family (IPF). This became the primary point of discussion regarding Sumitomo Mitsui Bank’s hardware update. A project member looks back on it as follows.

“While still at the conceptual stage, we thoroughly discussed what kind of performance would be required from the next system platform. We focused on whether or not the IPF-equipped ACOS series would be able to provide the performance that Sumitomo Mitsui Bank would require. After repeated, careful considerations and investigation, the decision was made to forgo IPF in favor of again developing the NOAH series.”

It was a return from the Intel-made CPU to the NOAH series developed by NEC. In 2012, for the first time in approximately 10 years, an ACOS series



equipped with “NOAH-6” called “i-PX9800” was released, and it was this product that was adopted for Sumitomo Mitsui Bank’s new core banking system in 2015. It was a bold decision; enabling it was the fact that NEC designed NOAH-6 as a fables company and outsourced production to a foundry, thereby reducing risk.

In September 2016, Sumitomo Mitsui Bank changed its core banking system to an east-west mutual back-up environment; once again, NEC took part in this project. Prompting the change was the experience of the Great East Japan Earthquake. When operating with a main-and-sub environment, the main side will always require that operation personnel be present. However, in the event of a large-scale disaster, even if the system switched over to the sub side without any problems, transferring the operation personnel would be difficult. NEC took measures to create a stronger business continuity plan (BCP) that reflected the experiences of the Great East Japan Earthquake.

The close relationship that NEC cultivated with Sumitomo Mitsui Bank over many years has created a ripple effect in various fields. For example, the development of the integrated operation management software “Web-SAM” (referred to as “Masterscope” outside Japan) originated from hearing about the struggles of those involved with Sumitomo Mitsui Bank regarding the increase in management labor hours in a multi-vendor environment. The open core banking system for regional banks, “BankingWeb21,” would also not have come to fruition without NEC’s experiences with Sumitomo Mitsui Bank. Clearing the strict requirements unique to a megabank built NEC’s reputation and has positively affected projects in various other fields.

NEC’s goal of providing social value in the digital age

These three projects are a representative examples of the system integration business NEC has devoted itself to in the past 20 years with the goal of providing solutions. During system update periods, in particular, all the projects generate business worth tens of billions of yen in a given year, and the revenue NEC received in the past 20 years from the clients at the center of these three projects is as much as one trillion yen. In exchange, NEC bears the great responsibility that this social infrastructure must fulfill.

Although the clients’ business areas differ, people deeply involved in each of the projects all emphasize NEC Group’s common attitude of never giving

i-PX7800 (left) and i-PX9800 (right)



up and completing the job no matter what. Facing difficult challenges head-on and finding the best way with clients, NEC has refined its skills in system integration and total solutions. While the same can be said for technical and solution-related expertise, the deep bonds built with clients have surely been a valuable foundation supporting this immense business over many years.

NEC must continue to preserve this business as its strength for as long as possible, but there is no guarantee that the business will continue to be a strength in the future. The effects of digitalization are undeniably starting to be felt in the field of solution business as well. These effects are not limited to the changes in information systems brought with open and cloud computing; they are large changes that affect how NEC and its clients do business itself.

For example, if one considers cashless payment and unattended stores (both phenomena that are already beginning to appear), there is no guarantee that retail in the form of a convenience store will still exist as it does now in 10 years. Whether the client is the biggest mobile carrier in Japan or a financial institution referred to as a megabank, digitalization is capable of changing everything that makes up a corporation, be it its business model, business area, company organization, or way that its employees work. How to handle these large changes and lead one’s company to new growth is a question that all corporations are looking to answer.

In digital society, as NEC continues to provide excellent value to society and engage in co-creation with its clients, we build infrastructure that is vital to people’s everyday lives. The large-scale projects that continue to support this infrastructure grant NEC not only revenue and technical capabilities, but more so, expertise for the creation and provision of profound value.



Twenty years of progress and evolution in rapidly changing telecommunications technology

The challenge for engineers enabling "constant connection"



For the field of telecommunication technology and infrastructure, which can be seen as NEC's "origins," the past 20 years have brought more upheaval and challenges than the entire 100 years preceding them. The world of telecommunications is dramatically changing; how is NEC, which has supported "constantly connected" networks, connecting our business to the new era?

Twenty years of upheaval in the field of telecommunication technology and infrastructure

In the 120 years of NEC's history, the field of telecommunication technology and infrastructure, which can be seen as our "origins," has never changed as radically as it has in the past 20 years.

"For the first 100 years after its invention, a telephone was simply a telephone. However, in the last 20 years, how we communicate has changed a surprising amount, and this change in communication came to change our lifestyle itself. That's what the past 20 years have been like."

A long-term supervisor of telecommunication infrastructure business looks back on it as follows.

"The history of NEC is 120 years of supporting the foundation of telecommunications, which started with the telephone. We're proud to be involved in this field."

NEC's engineers have continued technical development to support telecommunication infrastructure with telecommunication carriers to meet changing demand over the years. This has been a strenuous task at times, but meeting client demand and contributing to social transformation has also been a joy.

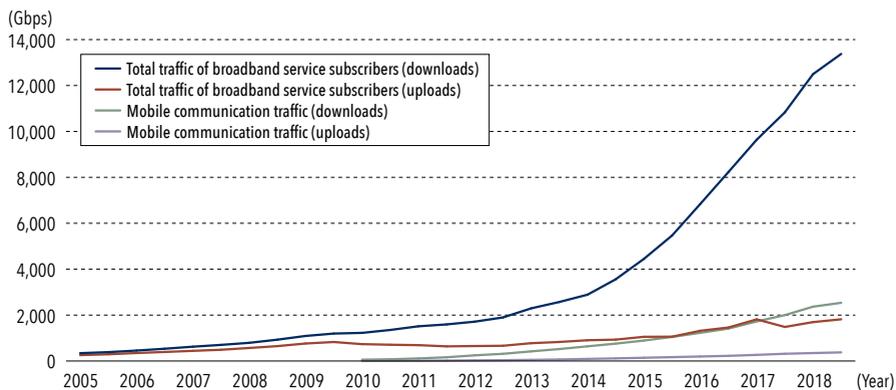
The technical expertise and dedication of NEC and telecommunication carriers ensure that the telecommunication infrastructure supporting telecommunication services continues without interruption. NEC's work in telecommunication infrastructure was also able to develop as a business because of the "ecosystem" formed with the relationship between NEC and telecommunication carriers as a foundation. However, these conditions changed completely in the past 20 years; ways of using telecommunications dramatically shifted with the development of technology, and the wave of globalization surged forward. As the field of telecommunications went through dramatic upheaval, what path did NEC's telecommunication infrastructure business take?

The shifting trend from voice calls to data communication

The first shift in trends in the field of telecommunications that occurred in the past 20 years is that of the change of priority from voice to data communication.

"When telephones were only used for phone calls, networks were made with different specifications in every country for connecting voice calls via the circuit switch method. However, international standardization increased with the spread of the Internet, and mutual communication became possible even between different countries and manufacturers. It's like the shift to open-architecture happening now. While chances for NEC to expand abroad increased, international vendors also entered the Japanese domestic market."

Trend in Internet Traffic in Japan

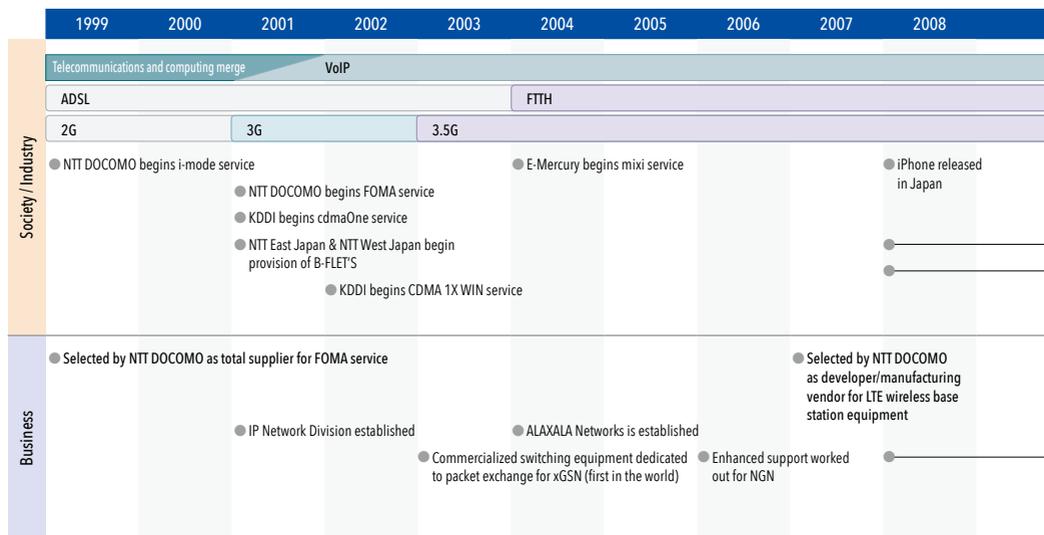


Source: Ministry of Internal Affairs and Communications, "Aggregation/Estimation of Internet Traffic in Japan"

The Internet is technology that originated in the USA, and American corporations led the way in the Internet's expansion and development of relevant equipment. NEC was prompt to develop a cooperative business relationship with one of the leading companies in this area, Cisco Systems, Inc. At the time, Cisco Systems was still a venture company; NEC handled its products and services, from quality control to sales, for the Japanese market, providing them with the NEC brand. However, soon after, Cisco System's pioneering business rapidly expanded on a global scale, and the market of Internet-related data-communication devices came to be dominated by the "Cisco brand."

In this period of Internet expansion, NEC focused on technology for enabling both voice calls and data communication with existing analog networks. One such technology was Asynchronous Transfer Mode (ATM), which NEC worked on developing starting in the 1980s. In 1996, NEC began providing a new-generation communication system, "ATOMIS Series." This series contributed to the construction of large-scale networks for telecommunication carriers and universities. It further went on to support the network for NTT DOCOMO's 3G cell phone FOMA, becoming a product that supported telecommunications in the 2000s.

Timeline: Business for Network Carriers Over Time



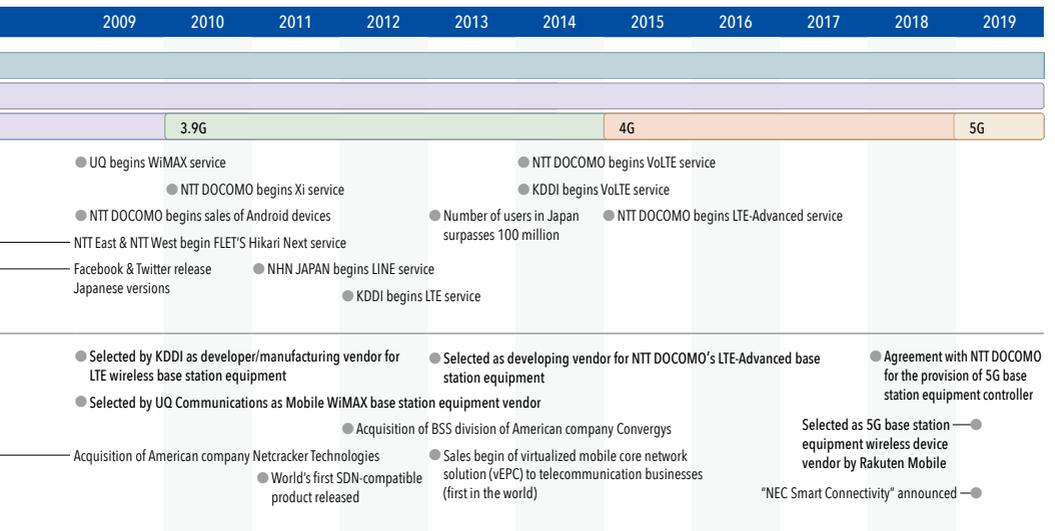
Twenty years of progress and evolution in rapidly changing telecommunications technology

Shift in communication networks from analog to ADSL, FTTH

While the Internet was rapidly spreading, advancements were also made in constructing high-speed data-communication networks using optical fiber for existing voice-call circuits. At that point in time, however, a groundbreaking technology was introduced: asymmetric digital subscriber line (ADSL). ADSL enabled communication speeds of 500 k to 1 Mbps with existing circuits, thereby increasing broadband Internet speed without having to wait for the establishment of optical fiber communication networks. ADSL thus brought the Internet to many average households.

NEC Australia Pty. Ltd. had already been producing ADSL equipment in Australia, so NEC was able to provide NTT East Japan with ADSL modems and obtain many market shares. Simultaneously, NEC focused on the upcoming transition to fiber to the home (FTTH), i.e. communications enabled by optical fiber in average households, and contributed to the construction of the necessary infrastructure for FTTH by developing access technology with optical fiber and commercializing equipment.

User contracts for FTTH exceeded those of ADSL in 2008; FTTH became the



main type of wired, high-speed access network and supported various Internet use ranging from that at homes to that in businesses.

Enabling larger capacity for optical fiber with new technology

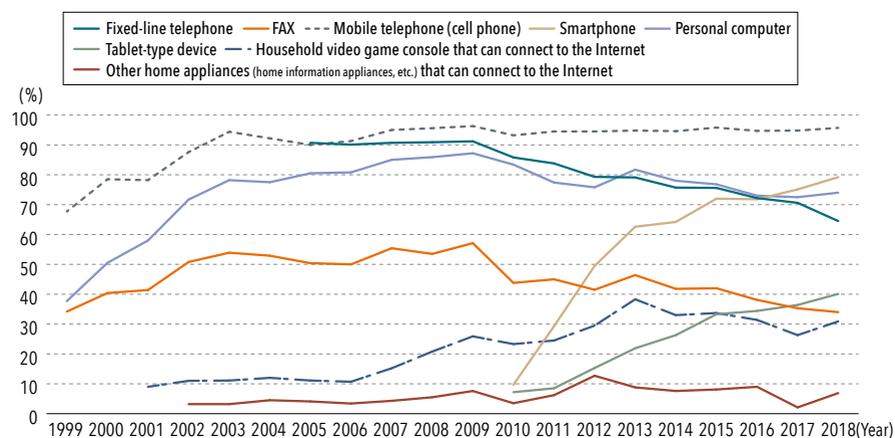
In this manner, Internet connection via broadband spread rapidly, and thus the need to increase the bandwidth of the backbone network supporting said Internet became an urgent problem requiring a solution.

The key to that solution was a technology known as “wavelength multiplexing.” The commercialization of wavelength division multiplexing (WDM), a technology that enables large-capacity data transmissions through multiple-wavelengths of light, was on the horizon in the latter half of the 1990s.

NEC developed WDM equipment with a capacity of 10 Gbps x 160 wavelength, the largest capacity in the world at the time, and supplied it the American company AT&T Inc. NEC also proceeded with development aimed at domestic companies. A staff member involved at the time recalls the following circumstances surrounding WDM.

“Initially, NTT was not especially proactive about adopting WDM. After all, the optical fiber network that NTT had prepared for the whole nation at the beginning of the 1990s was high quality; even with the existing set-up,

Percentage of Households in Possession of Information Communication Devices Over Time



Source: Ministry of Internal Affairs and Communications, “Survey of Telecommunication Usage Trends”

* “Mobile telephone” includes PHS devices. From 2009 to 2012, PDAs were included in this category. From 2010, the number of smartphones are included in the total number for mobile telephones.

Twenty years of progress and evolution in rapidly changing telecommunications technology

large-capacity transmissions of about 10 Gbps were possible. However, new telecommunication carriers that were entering the market and international telecommunication carriers had technical problems with their optical fiber, and there was demand for larger memory capacity with WDM. The relatively low-speed 2.5-Gbps WDM equipment that NEC developed met those needs, so domestic and international telecommunication carriers other than NTT were very eager to implement the technology.”

From the 2010s onward, circumstances such as the spread of smartphones further increased demand for bandwidth for the backbone network, and new technology was also commercialized. That technology was “coherent optical transmission.” NEC produced transmission equipment called “SpectralWave DW7000” that adopted this technology in 2011. It would go on to support the increasing bandwidth of the backbone network.

The wireless core network that transformed into social infrastructure

One other immense change in the past 20 years in the world of telecommunications has been that mobile devices such as cell phones and smartphones have become social infrastructure. Who would have imagined that the cell phones that first appeared in the 1980s—equipment that had to be hung from one’s shoulder and carried about—would become these small devices that nobody can live without in just 30 years?

Supporting this evolution has been the central component of the mobile communication system: the wireless core network. When cell phone service first began, NEC was one of the four companies that supplied NTT with the “Type-D Digital Electronic Switching System” that was central to the construction of NTT’s wireless core network.

In the latter half of the 1980s, the Type-D Digital Electronic Switching System performed sufficiently to support the wireless core network, but those circumstances changed dramatically in 1999 with the beginning of the world’s first cell phone IP connection service, i-mode.

The spread of i-mode also meant an increase in data sent in packet communications, through which users send messages and view websites on their cell phones. Until then, both voice calls and packets had been processed with the same hardware; now, to preserve their respective service quality, it was necessary to divide them into circuit switching and packet switching. A staff

member who was involved in the wireless core network comments, “This was the first turning point for the wireless core network.”

To divide circuit switching and packet switching, dedicated switching equipment had to be prepared for each of them. This was achieved by xGSN (Serving/Gateway GPRS Support Node), the node that makes up the packet network for the cell phone network, which NTT DOCOMO introduced in 2003.

NEC developed the dedicated packet-switching equipment for xGSN and supplied NTT DOCOMO with it.

“Packets increased suddenly, and there was a pressing risk of transmission failure, but we could not allow any problems to occur. Thus, the transition to xGSN was conducted on the basis of a simultaneously urgent and careful plan. Starting in areas with few users and accumulating knowledge and experience, we switched all the switches in the country in approximately three months. Construction could only be done at night when there is less communication traffic, so it was a hard project in which we often had to work through the night.”

Responding to the spike in traffic brought by smartphones

Another great change, however, was soon to come: the introduction of the smartphone.

Until around 2005, increases in the amount of packets were caused by communications through i-mode; in other words, they occurred solely due to human operations. However, this changed significantly with the introduction of the smartphone. Devices changed such that they were constantly connected to the network and conducting transmissions, resulting in a marked increase in the amount of traffic.

Fourth generation (4G) wireless communication system Long-Term Evolution (LTE) service, which enabled higher-speed, greater-capacity communication, began in the 2010s. NTT DOCOMO began providing LTE service under the name Xi in December 2010. NEC developed a packet-switching system for LTE called “Evolved Packet Core (EPC),” supplied it to NTT DOCOMO, and supported the spread of LTE.

Cell phones and smartphones continued to evolve. The usefulness of social networking sites such as Twitter gained attention, and messaging applications such as LINE gained popularity. YouTubers, individuals who share their own

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videos, appeared, and the popularity of Instagram, a site centered on sharing photo content, continued. There's no telling what kind of app or service will gain popularity next. This also means there's no telling when the amount of traffic on the wireless core network will suddenly increase next.

NEC has continued to handle these changes by controlling the wireless core network with software. Without focusing on hardware, and by flexibly controlling changes in structure and increases in traffic increase with software, NEC is able to appropriately handle severe fluctuations in the state of usage. NEC's engineers have continued their efforts to provide "connection" as an ordinary part of everyday life.

Continuing to support the radio access network

Other than the wireless core network, there is one other infrastructure that supports mobile communication systems: the radio access network (RAN), which supports devices' radio access. In this area as well, NEC developed a dense multiband large-capacity base station called "BS-2201." Unlike equipment of other companies, BS-2201 could function with multiple frequency bands while being only one piece of equipment; further, it had a large communication capacity of 2880 channels. Approximately 25,000 units were supplied in Japan alone, and in fiscal year 2006, NEC's product share reached 80%.

During the same time period, the development of LTE technology, which would be the successor to 3G, began in earnest. LTE was internationally standardized, so when service began, all global vendors would become competitors. With this future for the market in sight, NEC aimed to differentiate its base station equipment by making it smaller and successfully reduced the size to approximately half that of the 3G period. A staff member involved at the time remarks the following.

"It did not have much leeway performance-wise because of having been made smaller, but its small size was received very well by installation divisions, and we supplied many places with it."

Along with the smaller scale, making it 3G/LTE-shared enabled it to be compatible with detailed area design. This was another strength for the equipment. NEC supplied NTT DOCOMO with approximately 30,000 units and reached an accumulated total 45% market share. In addition, NEC supplied LTE base stations for the cell phone service provided by KDDI CORPORATION through au.

Next, NEC developed “BS-3201,” which enabled even larger capacity. By getting ahead of other companies, NEC independently achieved a 100% market share for fiscal year 2014.

“While the equipment we produced for early LTE was well received for its small size, its performance was just barely sufficient. When we developed BS-3201, other companies were catching up with our small scale, but NEC went the opposite way, shifting direction to focus on processing capability. I think this was the key to our success.”

Following LTE, various new technologies were standardized one after another, such as the more sophisticated, higher-performing LTE-Advanced, and Voice over LTE (VoLTE), which sends voice audio as an LTE data transmission. Telecommunication carriers must promptly provide services responding to these new technologies. Being able to flexibly and swiftly respond to such demands through software updates was one significant trait of BS-3201. This concept was well received, and for high-density equipment for NTT DOCOMO, NEC obtained an accumulated total market share of 54% for fiscal year 2017.

Global developments following international standardizations of telecommunication standards

NEC also aimed to break into the global market. One impetus for this was the international standardization of telecommunication standards conducted with 3G. For NEC, this shift was a chance to sell its products on the global market. With this in mind, NEC established a joint venture with the German company Siemens AG in 1999. Japan was ahead in 3G, so NEC had overwhelming technical capability. However, Siemens AG, being a global vendor, had ample connections with clients primarily in Europe. The aim was to develop a global 3G radio base station business by combining NEC’s technical capability and Siemens AG’s sales capability. At its peak, this business secured 15% of global shares.

Some technology manufactured by NEC went on to become the global standard. The optical overhang system, which facilitates the expansion of an area of cell phone service, is one such technology. It can increase the freedom with which radio base stations are installed and helps expand cell phone service area. Domestically within Japan, it was adopted by NTT DOCOMO, but NEC simultaneously aimed for its global standardization. NEC formed a joint

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forum with Siemens AG and the main cell phone infrastructure vendors from around the world in which they defined an open interface for the optical overhang system. In 2005, NEC and Siemens AG produced a base station product utilizing that open interface and supported area expansion for carriers in various nations.

In this way, NEC's advance into the global market appeared to be progressing smoothly, but the situation soon made an about-turn: Siemens AG's telecommunication business was acquired by the Finnish company Nokia Corporation. Behind this acquisition was the fact that telecommunication equipment vendors were rapidly disappearing due to circumstances such as the rebound from the post-2000 telecom bubble and a price collapse in the telecommunication equipment market caused by Chinese vendors gaining prominence. With Nokia's acquisition of Siemens AG, NEC and Siemens AG's collaboration came to a close. However, a staff member who was involved in the companies' collaboration looks back on it as follows.

"The collaboration we had with Siemens AG is still of great value to us to this day. We were able to hear about product line management, a way of thinking that was not yet widespread in Japan, and we learned how to plan our own products and strategize without simply providing whatever telecommunication carriers requested."

This would become an important lesson as NEC's telecommunication business evolved.

The end of the ecosystem that supported NEC's business

The shift from voice calls to data communications, the introduction of smartphones, the development of international standards and the competition with global vendors that came with them—through all these changes, NEC had continued its business based on an ecosystem centered around Japanese domestic telecommunication carriers. However, the massive wave of change occurring in the world of communications carried enough strength to change this framework from its foundation.

For example, looking at the introduction of smartphones from a different angle reveals one other change that occurred that would have an enormous effect on NEC's business: the shift to businesses represented by players such as Apple Inc. and Google LLC (later Alphabet Inc.), players who provide users

with added value and are referred to as over-the-top (OTT) by telecommunication carriers. These OTT businesses do not invest in telecommunication infrastructure themselves, but rather gain revenue by providing value-added service over telecommunication networks. This forces telecommunications carriers to configure networks that can support the increases in traffic resulting from OTT services, while the revenue from said services is seized by the OTT businesses. As a result of these circumstances, telecommunication carriers pursued even more efficient investments in networks in order to have competitive prices and maintain service. Aggravating this situation was the entry of global vendors to the market, resulting in the price collapse of telecommunication equipment. This naturally affected NEC, which had supplied telecommunication carriers with various equipment, as well. The business model of developing products that met the high-performance, high-quality specifications requested by telecommunication carriers (backed by abundant investment capital) and gaining revenue by stably receiving compensation—in other words, the business model NEC had followed until then—was already non-sustainable.

Searching for solutions amidst changes; new challenges

NEC set to work to respond to these changes. As telecommunications rapidly shifted to IP, NEC established a new “IP Network Business Division” in 2000, bringing together resources that had been spread out over a number of divisions until then and beginning development of routers in earnest. In 2001, a mobile network device development team was put together, bringing the staff of the division to an impressive 700 people.

In addition, NEC and Hitachi Ltd. jointly launched a router and switch company, ALAXALA Networks Corporation, in October 2004. This was in response to a request from the Ministry of Economy, Trade and Industry, which raised the importance of developing domestic router technology, as the Japanese domestic router market was dominated by international corporations.

Then, in 2006, Kaoru Yano became NEC’s president, and NEC came out with a policy for enhancing support for the next-generation network (NGN) as the core theme for “proactive management.” NGN is an IP-based next-generation network. This new policy was NEC showing its intention to take the rapid shift to IP as a chance to develop its business further.

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NEC also began exploring possibilities for global expansion once more. Specifications for IP-based NGN-compatible equipment are generally globally standardized, so expanding internationally is possible through customization. However, a staff member involved in this work looks back on the challenge with a troubled expression.

“NGN has enough impact to change the ‘telephone culture’ that’s been built up over the past 100 years. However, when converting to NGN, people wanted ‘compatibility with all the specifications and functions of existing telephones.’ In other words, detailed service that understands that nation’s ‘telephone culture’ is required. ‘Telephone culture’ is different in every country; our service would not be accepted unless it was specifically attuned to the country in which the country was based. I found that the work was not straightforward.”

NEC had developed and supported Japan’s telephone culture over a long period of time, but on the global market, everything was different. Thus, NEC significantly shifted its strategy for global expansion for telecommunications carriers, deciding to add corporations that thoroughly understood international business to the NEC Group.

From around 2006, NEC began searching for compatible international corporations, at which point it came across the US company Netcracker Technologies Corp. Netcracker Technologies was a corporation that provided an operations support system (OSS), a work-support system for telecommunication carriers. This company already had inroads in the global market and the potential to expand even further. In 2008, NEC acquired Netcracker Technologies. NEC then acquired the American company Convergys Information Management Group Inc.’s business support system (BSS) business in 2012, which it merged with Netcracker Technologies. A BSS is a system that supports business by managing contract-user information and paid models. Convergys conducted call center business for telecommunication carriers, and its BSS had already been adopted by over 150 companies worldwide.

Merging Netcracker Technologies and Convergys’s BSS business also created synergy. Netcracker Technologies began providing “Telecom Operations and Management Solutions (TOMS),” a comprehensive operation support solution that combined OSS and BSS, and secured its place in the global market.

“If we had expanded into the global market with hardware alone like in the

past, we might have been crushed by price competition. However, NEC Group now has TOMS, a solution that's competitive on the global market. This is a great strength for our business."

Expectations placed on new NFV/SDN technology and dissonance with the market

NEC also tried its hand at the development of new technology, the primary examples of which were network functions virtualization (NFV) and software-defined networking (SDN). NFV is technology that virtualizes and implements functions borne by hardware that composes a network; SDN is technology that conducts network control with software instead of network equipment.

From the latter half of the 2000s, the shift in the world of IT to "virtualization" became striking. Virtualization enables multiple devices to be virtually configured within the same single physical device. Without being dependent on hardware, this technology enables increased flexibility in system configuration through software. Utilizing this virtualization technology in the area of telecommunications and networks eliminates physical restrictions and enables flexible network configuration, efficient operation management, and improved security.

For NFV, NEC tested and developed various technologies with global telecommunications carriers, including "vEPC," a virtualization of Evolved Packet Core (EPC), the core device of an LTE network; and "vCPE," a virtualization of customer premises equipment (CPE), network equipment installed in places such as households. For SDN, NEC led the world in development with such efforts as its joint research conducted from 2007 with Stanford University on OpenFlow, which is one technology for achieving SDN. OpenFlow enables changes to be made remotely to whole installations by adjusting network settings rather than changing each installed device individually. It enables multiple, labor-requiring network settings to be executed extremely simply.

NFV/SDN would dramatically change telecommunication carriers' and corporations' networks. Envisioning this future, NEC produced the "UNIVERGE PF Series" as the world's first SDN product in 2011. In the Mid-term Management Plan 2015 SDN was made part of the growth strategy in the Mid-term Management Plan 2015, and in April 2014, the "SDN Strategy Division" was

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established. In July of the same year, products and services were systematized as “NEC SDN Solutions.”

Virtualization of networks with NFV/SDN is extremely useful as it reduces the costs of adding and changing equipment, reduces operation costs, and increases efficiency; as the lead SDN developing vendor, NEC proactively made many proposals for its implementation. However, obstacles such as the ability to pass on network assets and implementation costs made carrying proposals over to actual changes in existing networks more difficult than NEC had imagined.

Considering these circumstances, NEC reexamined its SFV/SDN-related business strategy. Netcracker Technologies’ TOMS was equipped with a function called “orchestration,” which automatically set up and managed virtualized devices. From this, NEC made proposing business improvement that utilized this orchestration function combined with the implementation of NFV/SDN one part of its new business strategy. In addition, as IoT spread to the manufacturing industry, NEC worked to expand areas of SDN utilization, proposing products and services that reduced the cost of implementing and operating SDN, focusing attention on the small and mid-size business market, and increasing coordination with businesses creating infrastructure systems.

A new “network service” for the generation following these past 120 years

In the field of mobile communication systems, a next-generation service called 5G will begin by 2020. 5G, which fulfills the many requirements of high-speed broadband, ultra-low latency/high reliability, and ability to connect to a large number of devices, will surely change the world of telecommunications more than ever before. Network needs will diversify even further.

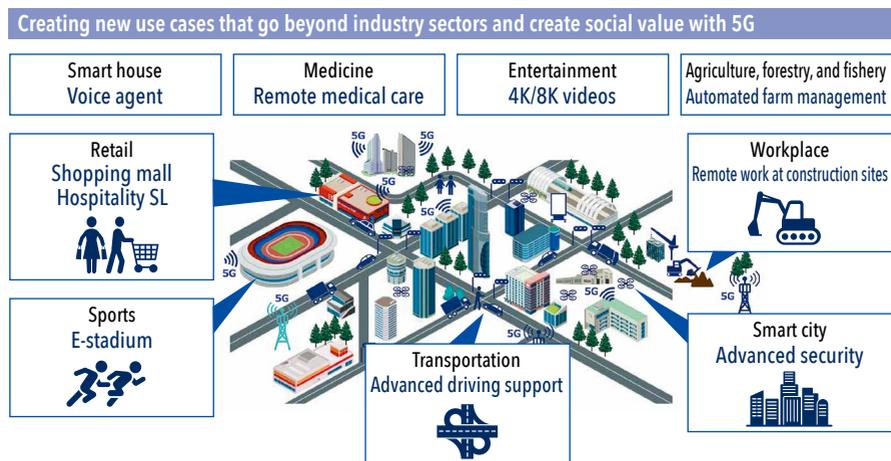
Preparing for this new era, NEC significantly transformed its telecommunication business structure in 2018. To “expand into the service provider, manufacturing, distribution/service, and municipality markets with the network strengths we have cultivated in the telecom carrier market,” NEC changed the name of the “Telecom Carrier Business Unit” to the “Network Service Business Unit.” This expressed NEC’s dedication to pioneering new business that would not depend on the past ecosystem that existed between NEC and telecommunication carriers.

In the following year, 2019, NEC made this determination more concrete

with the announcement of its new business brand, “NEC Smart Connectivity.” With the spread of 5G and IoT, concepts that seemed like the stuff of dreams, such as autonomous cars, facility surveillance and package delivery via drone, and unattended on-site work in dangerous regions, are becoming realities. What these technologies require is a network that exceeds any prior networks and connects truly everything, able to stably send and receive massive amounts of data without latency and without being affected by changes in the environment. To realize such a network, NEC Smart Connectivity is a declaration that NEC will aim to create new business, gathering together our knowledge from 120 years of network infrastructure construction that has supported “uninterrupted communication” and our expertise from providing service to various industry corporations and municipalities.

To that end, NEC has enhanced its structure. With an aggregate 500 employees in the corporation/municipality network division and telecommunication network division, NEC has established a team structure that will propel business forward together as a group. Advancing co-creation of 5G utilization as well, NEC is steadily achieving results in areas that did not exist before, such as remote construction systems for heavy machinery, testing of remote medical care in combination with 4K high-definition video imaging, and experiments using augmented reality (AR) in combination with sports viewing.

New Services NEC will Create with 5G



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Even as we move to the era of 5G and IoT, the technology and experience that NEC has cultivated over these past 20 years will become a foundation from which the company can provide the network required by this new era. With 120 years of history, and having overcome the past 20 years of radical changes, NEC will continue to provide new value through “constantly connected” networks.



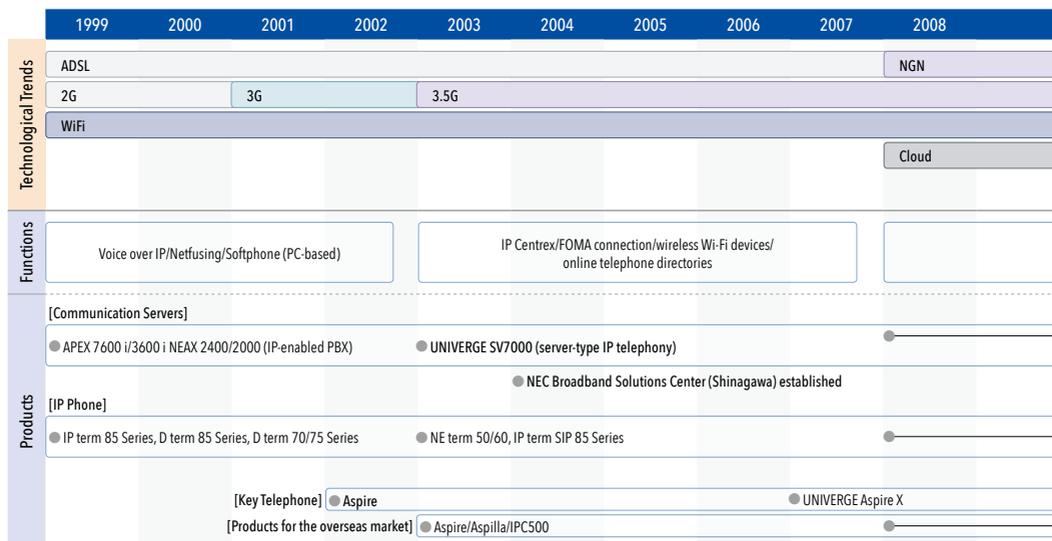
Platforms connecting to the future

The platform products that supported NEC throughout an era of change



Over the past 20 years, NEC has shifted the focus of our business from the provision of hardware to the provision of solutions. Even amidst fierce competition, NEC's platform products have evolved to accept new trends such as cloud computing, AI, and IoT. These platform products have continued to support NEC as the foundation of our solution business. Grounded in advanced technical capability and devoted manufacturing, NEC's DNA continues to meet the needs of this generation and the next.

Timeline: Changes in UNIVERGE Business



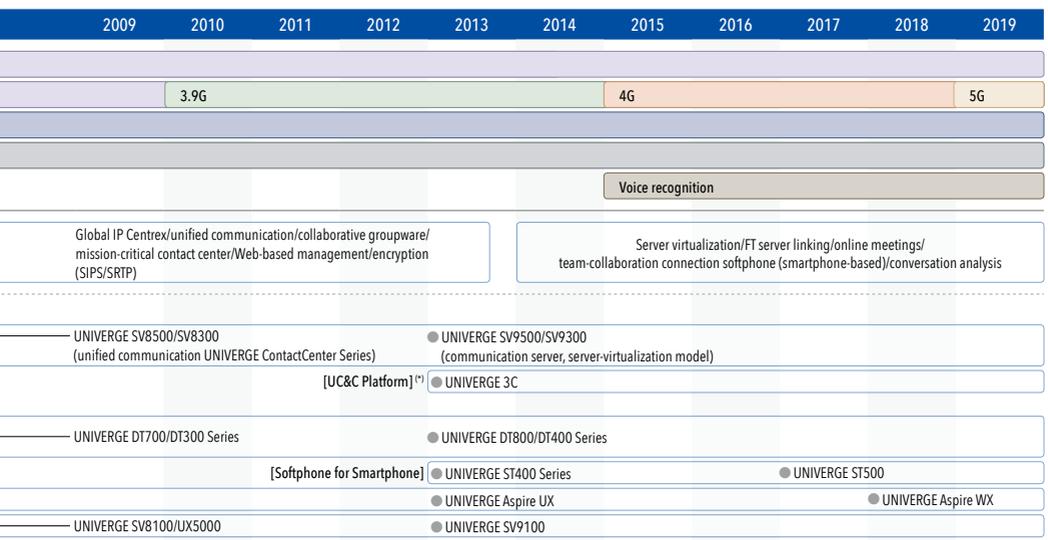
* Unified communication & collaboration

Predicting innovative changes in work style with UNIVERGE

Advances in IT and networks have changed platforms significantly over the past 20 years.

Working while on business trips or at home in the same way as one would in the office, or seamlessly communicating with people abroad while in Japan, have become normal parts of our everyday work styles. However, in 2000, this sort of work style was still only an aspiration. NEC's network product family "UNIVERGE" played a large role in making these aspirations a reality. By converging diverse networks, UNIVERGE enabled communication using various media without the restrictions of time or place and significantly contributed to new ways of working and greater business efficiency.

The prototype for the integrated IT/network solution UNIVERGE came in the form of "APEX 2400 IMS," a digital private branch exchange (PBX) developed by NEC in 1982 for private-sector corporations. Although APEX 2400 IMS was a PBX, attaching a module enabled it to send and receive fax messages and voice mail, and it could connect to IBM Corporation host computers. These and other groundbreaking functions are what set APEX 2400 IMS apart



from prior PBXs.

As the use of digital lines increased, and Internet Protocol (IP) became the standard for digital communications, NEC also made the decision to convert its digital PBXs to IP. Following this, in 2003, UNIVERGE was announced as a new brand for providing the diverse products that compose systems, such as Voice over IP (VoIP) servers, high-speed routers, multi-layer switches, wireless LAN systems, mobile IP systems, and network servers, as “Integrated IT/ Network Solutions.”

UNIVERGE was coined by combining the English words “universal” (in the sense of “having a wide range of uses”) and “convergence.” UNIVERGE’s concept was “enabling communication of various forms from anywhere with anyone, regardless of what sort of media is being used, and supported by broadband networks.”

Demonstrating the office of the future with an actual workplace

When UNIVERGE was introduced in 2003, broadband was still in the process of gaining popularity in Japan. Broadband use was rapidly increasing in households primarily via asymmetric digital subscriber line (ADSL), a service started in 1999; however, the communication environments in most corporations were narrowband. NEC could attempt to explain to these corporations that shifting their internal networks to broadband would create numerous benefits such as efficient and effective work coordination, improved productivity, and enhanced competitiveness, but inevitably, many corporations could not understand specifically how their work style would change and how this would be beneficial to corporate management. UNIVERGE was a groundbreaking concept, but many people could still only see it as the stuff of daydreams.

Inside the NEC Broadband Solutions Center



Facing this situation, NEC established the “NEC Broadband Solutions Center” on the third floor of the East One Tower at Shinagawa Station’s east exit in January 2004. NEC fully implemented UNIVERGE solutions in a futuristic office that used mobile devices as internal lines by utilizing broadband Internet and wireless LAN. Clients could come and actually see NEC employees working in this office with this new work style; in this sense, the facility could be called a “display window” for UNIVERGE.

With UNIVERGE, employees could participate in meetings from convenient places at convenient times, without returning to the office from their current destinations, and could smoothly seek feedback from others without using paper materials. NEC succeeded in showing clients who came to experience this new broadband-utilizing work style that it was no longer just the stuff of daydreams.

An employee who was involved in establishing the center looks back on it as follows.

“What can be achieved when we combine IT and networks? Actually showing clients the answer to that question was extremely effective. We were quite open at the center, even accepting visits from competing companies. This kind of innovative change was not going to catch on if NEC was the only one promoting it. We felt NEC ultimately stood to benefit if society as a whole, including competitors, got involved. As it happened, some clients who visited the center went straight on to contract services with us.”

UNIVERGE’s success was not solely because this new method of internal company communication was appealing; another contributing factor was that the results of unceasing technological development conducted from a client viewpoint had been poured into the development of UNIVERGE. For example, with UNIVERGE, clients could continue to use legacy systems, such as existing telephones and metal lines that had been used from before the switch to IP, in the same way they had been used up until then. These types of functions were very appealing to corporations that wanted to change their offices while incurring minimal costs. These ideas centering a client viewpoint were successful, and the telephony server “UNIVERGE SV700 Series,” the main part of the UNIVERGE system, became a hit product reaching a value exceeding 50% of the Japanese domestic market share. This popularity has continued for succeeding models.

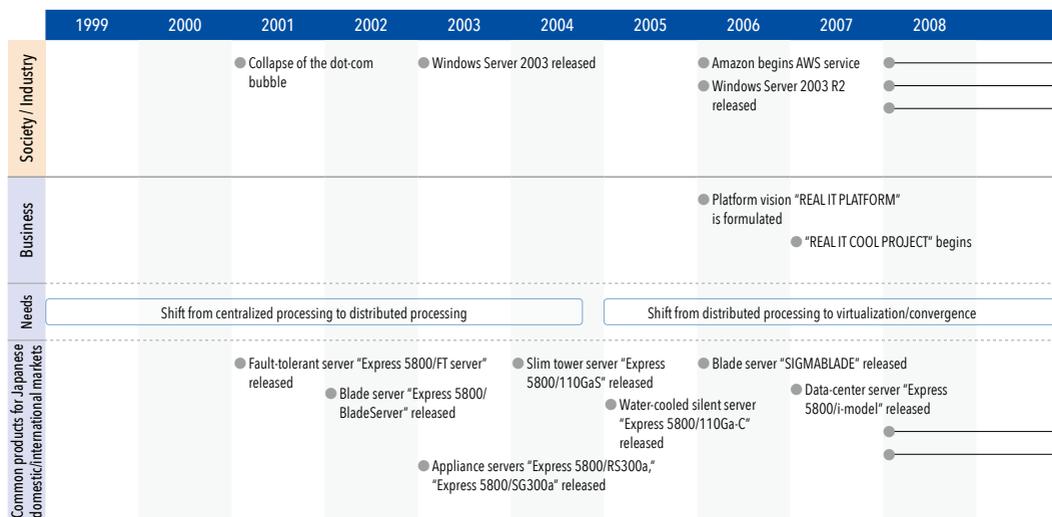
Entering the 2010s, cloud computing rapidly gained popularity, and NEC

moved to make UNIVERGE cloud-compatible as well. One prominent example of its implementation is a network constructed for a trading company from 2011 to 2014; the network would use the cloud to control a hundred-some branch offices scattered across the world with telephony servers based in only three locations. Even in the unlikely event that the network connecting these three base points lost its connection, “survival equipment” that could maintain only the switch operations within each base point was installed at every office, securing the client’s peace of mind that their business would not be brought to a halt. The system could be called the culmination of the technology that UNIVERGE had built up.

Offices and work styles change with advances in technology. Naturally, UNIVERGE also changes. The person currently leading UNIVERGE’s business depicts the future as follows.

“By combining UNIVERGE with AI and face recognition technology, which are NEC’s forte, we can provide added value that other companies can not. For example, in the medical field, by linking peripherals such as network cameras, nurse-call systems, and door-locking equipment, we can enable the timely provision of information such as video of hospital rooms or patients’ conditions to the smartphones that nurses carry. At the same time, we can contribute

Timeline: Changes in Express 5800 Series Business



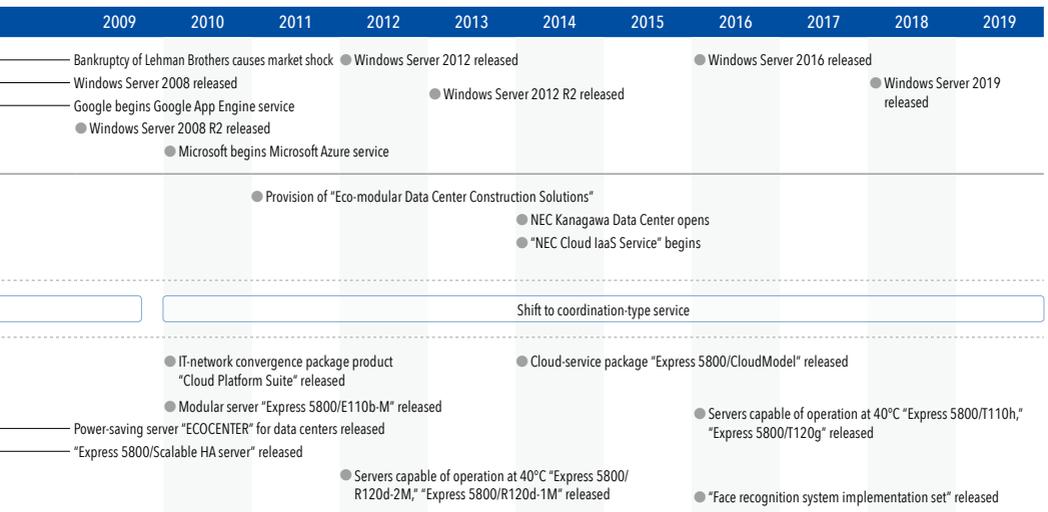
to improving security within hospitals. A system where AI provides accurate support will also surely become possible someday. In the future, I'd like to expand our scope of application beyond our existing customers to industries and areas that have not yet sufficiently digitized. Collecting and analyzing data efficiently with IoT and AI enables resources that would otherwise have been used on those tasks to be focused on things that require humans to do them. UNIVERGE can realize that kind of system."

In Japan, where the population is aging and the birthrate is declining, UNIVERGE will continue to evolve, aiming for the realization of greater safety, security, fairness, and efficiency.

The flag-bearer for open architecture: computer servers shift to a cloud-base

Of NEC's platform product families sold in the past 20 years, one that achieved an especially large contribution was the "Express 5800 Series," which maintained the leading position in number of shipments in the Japanese domestic server market for 22 consecutive years, from immediately after it went on sale in 1994 until 2017.*

Behind the sustained popularity of the Express 5800 Series are a variety of factors, such as how the series has constantly responded to changes in the



market environment; how it has meticulously met client needs with built-to-order (BTO) products; how NEC constructed an order, production, and shipping system to fulfill orders quickly; and how the Express 5800 Series has contributed to constantly providing solutions for clients through a swift and careful support system. However, the path to creating this popular series was by no means a smooth one.

Until the beginning of the 1990s, business computers (called *ofukon* in Japanese, short for office computer) such as S100, S3100, and S7200 were at the core of NEC's office-computer enterprises. However, in 1992, the American company Compaq Computer Corporation introduced a low-priced IBM PC/AT compatible computer into the Japanese market, causing market prices to drop by a large margin; the market experienced "Compaq shock," which enabled Compaq to dominate the server market as well, seizing the top market share. Thus, a response to networking, open architecture, downsizing, and multimedia was necessary for computer systems as well.

NEC could take various measures, but they would not immediately lead to results. It was then that NEC learned that the American company Microsoft Corporation would hold a press conference at a hotel in Tokyo about Windows NT 3.1, its new OS for servers. An employee who was involved at the time recalls it as follows.

"This was essentially an announcement that in the near future, Windows NT would replace UNIX servers and dominate the market for business computers and mainframes, so NEC arranged some time before the press conference to hear what Microsoft had to say. In that meeting, we felt that this was an OS with potential."

However, at that point in time, Windows NT was still in the process of development, and as a product, it was still insufficient in terms of functionality and degree of completion. Therefore, to ensure the future of this OS, NEC dispatched approximately 30 engineers to Microsoft to assist in the development process.

Then, in November 1994, NEC announced an IBM PC/AT compatible server equipped with Windows NT. That server, named the Express 5800 Series, included the "200 Series," which was equipped with NEC's RISC-type CPU, the main type used for business computers such as those at work stations. The line-up also included the "100 series," which was equipped with Intel Corporation's CPU. As a computer server, the Express 5800 Series, which adopted

Intel Architecture (IA), had a large impact not only on the server industry but also within NEC itself.

“Until then, NEC had produced everything from CPUs to OS internally. Although Windows had been installed as OS at some point, architecture was all developed by NEC. Even within NEC, there was considerable pushback against releasing an open architecture product like the Express 5800 Series, which had Intel Architecture with Microsoft OS.”

However, if we averted our eyes from the tremendous trend that was open architecture, we would not be able to continue providing the value that our clients sought. If NEC could provide a platform with Microsoft and Intel that would lead the generation and have that platform accepted by clients, we could receive tremendous confidence in our services. With these considerations backing the decision, the Express 5800 Series was released into the market. It was very well received, upending the position Compaq had held with approximately 50% of Japanese domestic market shares. In its first fiscal year, it shot to the top market share.

Continuing to respond to changes in technology and needs

From the start of sales of the Express 5800 Series in 1994 until midway through the 2000s, NEC focused on improving the server functions and capabilities as hardware. The transition from business computers to IA servers was continuing, and the entry of international manufacturers to the market pushed prices down while advancing open architecture. NEC had secured the top market share from international manufacturers by being the first to provide an IA server equipped with Windows NT. As the commodification of IA servers advanced, NEC enhanced the Express 5800 Series' presence, adding value not provided by other companies. We introduced various products into the market, such as a new style of product called a “slim tower server,” a “water-cooled server” that aimed for silent operation, and a “fault-tolerant (FT) server” that achieved increased availability with the application of mainframe technology.

In the latter half of the 2000s, a technology called “virtualization” was introduced, which enabled a system in which one physical server could function as if it were multiple servers. Then, in the 2010s, technology known as “cloud computing,” which enabled the provision of computing resources as services through virtualization, spread on the market. Noting the increase in

demand for data centers to support cloud computing, NEC released a blade server suitable for virtualization convergence. NEC then focused on developing a product that emphasized a greater conservation of space and electricity. For the highly space-saving rackmount server “i-series,” the small-scale “half server,” two of which could be stored back-to-back in a rack space the height of one unit (1.75 inches), was a big hit. NEC also produced models that could operate even in room temperatures of 40°C, enabling significant reductions of electricity consumed by air conditioning.

However, NEC could not have maintained the top market share simply by continuing to introduce new technology into the market. NEC sustained its position at the top for close to a quarter century by earnestly listening to the feedback of clients and sales partners and always striving for improvement as a united manufacturer and retailer.

For example, the virtual PC Thin-Client system, which aimed to realize the innovation of work style that NEC proposed with UNIVERGE, was produced in the Express 5800 Series as the “Virtual PC Center (VPCC)” in 2006. Since then, by providing a safe and secure computer work environment unrestrained by location, it has continued to evolve while incorporating the various needs of working people and corporations. The role fulfilled by servers has also grown significantly, and the concept of “servers and clients” is already becoming a thing of the past, but even now, the technology cultivated through the Express 5800 Series is supporting systems of the cloud-computing era through platforms.

“Express 5800 Series is the server brand name, but to interpret it with a wider viewpoint, you could also say it’s ‘a presence that continues to provide things that meet customer needs.’ Without forgetting that basic mindset, we’ve continued to meet the needs of the era and of customers. NEC has inherited this as our DNA and believe we should pass it on to the next generation.”

The “Earth Simulator” that shocked the world

There is one other enterprise that cannot be forgotten when discussing NEC’s platform business: supercomputers. NEC’s supercomputer business, which started in 1983 with the sale of “SX-2,” targeted markets that required computing performance of maximum speeds, such as scientific calculation. As a “technology flagship,” this business also represented NEC’s excellent technological capabilities. The performance of NEC’s supercomputers demonstrated

a significant presence globally, and in the latter half of the 1990s, they even went so far as to cause trade friction between Japan and the USA. Then, in 2002, this was demonstrated even more vividly by the “Earth Simulator,” for which NEC took part in development.

The Earth Simulator was, as its name suggests, a supercomputer that made a virtual Earth. It was developed through a Japanese national project that aimed to contribute to the sustainability of human society and the planet through various supercomputer capabilities, such as predictions of climatic changes such as cool summers and mild winters, predictions of marine phenomena such as El Niño, accurate forecasts of the courses of typhoons, predictions of changes in ecosystems, and clarification of the mechanisms of changes inside the Earth. The project was begun in 1997 by the Science and Technology Agency. The National Space Development Agency of Japan (later Japan Aerospace Exploration Agency: JAXA), Japan Atomic Energy Research Institute (later Japan Atomic Energy Research Institute: JAEA), and Japan Marine Science and Technology Center (later Japan Agency for Marine-Earth Science and Technology: JAMSTEC) worked on development together; NEC contributed to production. Creating the desired supercomputer would be an extraordinary feat: it required 1000 times the performance of the fastest supercomputer of the time.

When the project began, NEC’s latest supercomputer was the “SX-4,” which had been released in 1994. To achieve the performance required for the Earth Simulator, the 32 chips comprising the processor needed to be condensed into one. Therefore, NEC changed the wiring inside the processor from aluminum to copper wiring, which has less electric resistance and can reduce latency time. In addition, 57 million transistors were successfully mounted on the 20-mm square chip. With LSI packaging technology, a build-up circuit board was adopted, and high density was achieved with 30 times the wiring capacity and miniaturization of wiring width.

It became clear that the air cooling method planned at the beginning of development would be insufficient for

Earth Simulator



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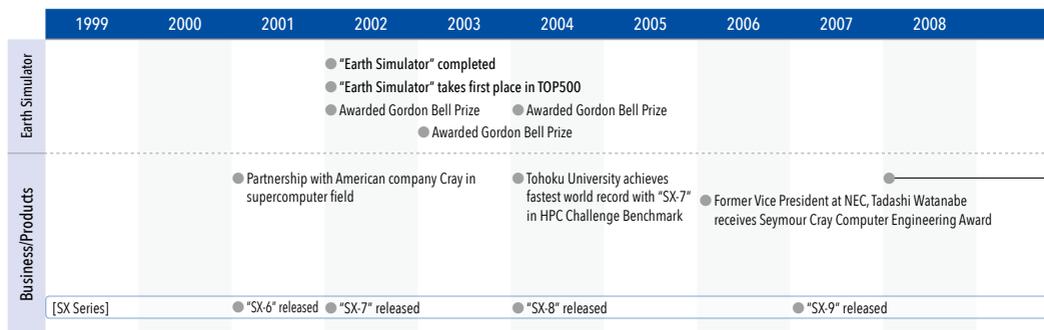
the cooling of the heat generated by the high level of electricity consumption (estimated at 140 W per processor), so NEC explored various other options. We arrived at a new technology called a “boiling heat sink,” wherein heat is dissipated through the boiling and condensation of refrigerants enclosed within the computer, and succeeded in significantly overcoming the technological limitations of the time.

In the Earth Simulator development project, NEC collectively handled semi-conductors, hardware, and software, as well as development and manufacturing in each field, delivery and installation, and even on-site adjustment. With over 26 divisions and over 11 affiliated companies involved, it was a major project that truly assembled the collective effort of the NEC Group.

The developed Earth Simulator went on to record an achieved performance of 35.86 teraFLOPS (a speed of 35.86 trillion calculations per second) in the LINPACK Benchmarks, which evaluate the operation capability of systems, in June 2002. In the TOP500 list, which ranks the calculating power of the world’s supercomputers, the Earth Simulator took an unrivaled first place, becoming the fastest supercomputer in the world. This news was met with great surprise in the USA, where the *New York Times* likened it to the shock of the Soviet Union developing the satellite Sputnik before the USA, even referring to it as “Computenik.”

The Earth Simulator maintained the top rank in the world for approximately two and a half years, receiving the Gordon Bell Prize (essentially the “Nobel Prize” of supercomputers) for Peak Performance, Special Accomplishment Award, and Special Award for Language in November 2002. The Earth Simulator won the Gordon Bell Prize for Peak Performance again in 2003 and 2004.

Timeline: Changes in Earth Simulator Business



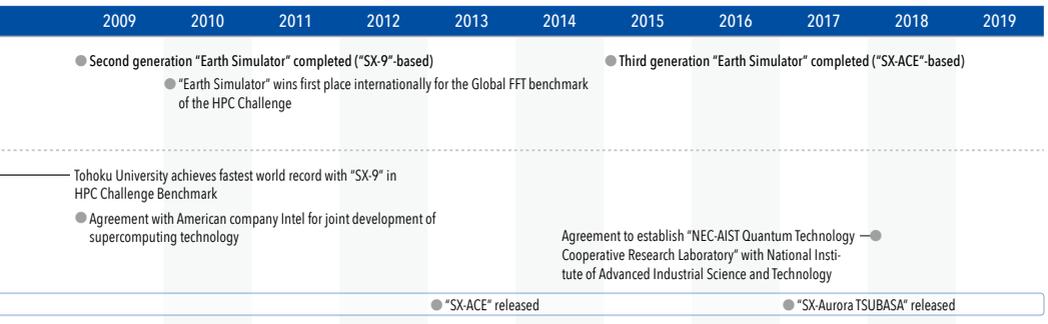
From a flagship to a value creator in a data society

The spectacular success of the Earth Simulator was more than appropriate as a flagship for NEC. With this as an impetus, it seemed that NEC's supercomputing business would continue to make great advances, but business development after that was not always smooth sailing.

With improvement in performance, the costs for developing particularly the heart of supercomputers, the operation processor, became tremendous, which strained computer business as a whole. NEC's semiconductor business, which had supported the high-level technology required for processor development, was made into a spin-off company in 2002; this also had considerable impact in weakening the synergy of NEC's hardware operations, which included its supercomputing business.

In addition, NEC could not open up a market large enough to cover the costs associated with development, and the insufficient scope of the business's expansion became a problem. From a user standpoint, supercomputers were expensive and required the development of specialized applications to run on their vector processors; thus, even among potential clients such as nations, universities, and corporations, those who considered implementing supercomputers were limited to extremely advanced research divisions in promising fields capable of accumulating a large amount of funding. Costs necessary for sales were not low, either.

Further, the wave of open architecture that had hit the field of servers and business computers were pushing into supercomputing. From 2000 onward,



the supercomputer market saw the appearance of more and more systems that achieved high-speed processing performance by connecting multiple low-cost generic CPUs instead of using a specialized vector processor.

In the midst of these circumstances, NEC initially joined Fujitsu and Hitachi to play a part in the Japanese government's supercomputer project "K," a project that began in 2005 and was to be the successor to the Earth Simulator. However, in 2009, NEC decided to withdraw from the project. Although supercomputing had been NEC's flagship, a technology-driven business model that required bearing vast development costs had its limitations.

That being said, the technology and experiences cultivated with the Earth Simulator were well utilized in supercomputers and server technology introduced after that. Various technology that had been assumed unachieved for another four to five years became useable with the SX Series that followed.

The "SX-ACE" that went on sale in November 2013 enabled high application performance with a multicore vector CPU while considerably reducing energy consumption and area required for installation relative to previous models. This was followed by the "SX-Aurora TSUBASA," which went on sale in October 2017. Adopting a hybrid configuration that combined a vector processor and Intel's x86 processor, its smallest configuration is a model that stores a vector engine on a single PCI card, providing a new style of computer wherein vector processing can be utilized as necessary.

As human society moved from the big data boom to the full-fledged era of AI, we shifted from an information society to a true data society. People are growing increasingly aware of the importance of computing power capable of immediately processing massive amounts of data. With efforts for the development of new technology like quantum computing, NEC's supercomputers will continue to overcome new challenges to provide value in our data society.

Aiming for platforms that will continue to support the future of NEC

What can we learn by unraveling the history of products and technology such as UNIVERGE, the Express 5800 Series, and supercomputers that have supported NEC's platform business, a business we have continued throughout the years? We can learn the value of persistently challenging ourselves to improve our technical capabilities, to use our refined technology as a foundation, and to continue listening to the needs of the market. We must not forget that the

most essential components that support NEC's business are our refined technology that surpasses that of other companies and our mentality of always observing market needs and pursuing the essence behind them.

The Earth Simulator that began operation in 2002 continued to evolve after that, updated to the "SX-9"-based second generation in March 2009 and the "SX-ACE"-based third generation in June 2015. During this period, processing performance was improved by 32 times, while electricity consumption was reduced to close to a third of what it had been, with NEC supplying all of these systems. The Earth Simulator continues to operate to this day, meeting the various high-speed calculation processing needs of primarily those in the fields of earth science.

In addition, with the high-performance server group configured by the Express 5800 Series at its core, NEC created a data center that combined the electricity-saving and air-conditioning technology cultivated through our platform business, various network technology, and safety technology such as face recognition that secures safety and security. To meet the wide range of needs of the cloud-computing era, the data centers were expanded into Kanagawa, Kobe, and Nagoya, supporting customers' creation of value with NEC's own cloud service.

Also, the Broadband Solutions Center, which opened in 2004 to showcase the work style that the UNIVERGE Series would enable, evolved in 2010 into the "NEC Innovation World," becoming a space where visitors could experience various NEC technology and solutions not limited to work style. Then, in 2019, the facility, which had been in Shinagawa, was moved to the first floor of NEC's headquarters in Shiba, Minato ward, and renewed as the "NEC Future Creation Hub," a collaborative, creative space where NEC and partners work together to create social value and bring new innovation to life. As a base that embodies NEC's brand statement, "Orchestrating a brighter world," this facility will continue to showcase NEC's future.

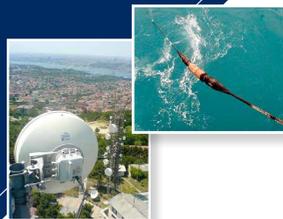
The DNA that NEC cultivated in our platform business will be passed on to the new NEC of the future.

* 1996–2017 Japanese Domestic x86 Servers (Number of Shipments) / Source: IDC Japan, Japan Quarterly Server Tracker CY17Q4 (share by company) / When the difference in vendor shipment results is less than 1%, IDC counts this as a tie (i.e. ranks the vendors the same).



Tackling global-scale challenges with technology and people

Accomplishments secured through diligent technological development and letting go of past successes



From the 2000s, NEC worked to expand into various areas of the global market. Some business ventures were withdrawn after failing to produce the anticipated results, while others grew to demonstrate NEC's presence as a global player. What these businesses that successfully grew had in common is that they were grounded in technology and started with a global perspective.

Two business enterprises that continued to take on the rough seas of the global market

Looking back at the past 20 years, two prominent examples of NEC business enterprises primarily conducted outside of Japan are our submarine optical cable business and our PASOLINK business. The super-compact microwave communications system "PASOLINK" competes with rivals on the global stage. Our submarine optical cable business has come to secure a large market share in the past 20 years.

Both of these business enterprises' competitiveness on the global market is grounded in the refined technology that NEC cultivated domestically over many years. Their competitiveness is the result of NEC not resting on our laurels of success in Japan, accurately assessing local needs, and striving to make what clients wanted a reality. Further, both of these business enterprises have been able to survive even when shaken by the adversities of the massive global market and facing crises time and time again.

PASOLINK: Growing with demand for mobile backhaul

The first product for the super-compact microwave communications system

PASOLINK was put onto the market in 1984. A member of the Wireless Solution Division who has been involved with PASOLINK for many years looks back on the dawn of the business as follows.

“Initially, the business was started as a simple communication system for use in, for example, line leasing services, primarily for corporations. After I entered NEC, I handled trunk microwave systems, which are large within the category of microwave communications systems. At that time, a neighboring group of a few of my coworkers were working on developing PASOLINK. Our clients included the British Telecommunications plc (later the BT Group plc). It was a small market, and I did not even imagine that it would turn into a big business in the future.”

That was completely reasonable: in Japan, telecommunication infrastructure was becoming more established, so the market need for simple wireless communication systems was assumed to be limited to situations such as use within corporate offices.

This all changed from 1997 to 1998. The Swedish company Telefonaktiebolaget LM Ericsson pioneered the idea of implementing a microwave communications system not as a simple wireless communication system for corporations, but rather, as mobile backhaul that connects cellular phone base stations to other base stations. NEC also took up this idea.

Compared to a wired system, a wireless system using microwaves could be connected more cheaply and constructed more quickly. Such a system was extremely effective for mobile backhaul. In Europe, the installation of optical networks had not progressed as much as it had within Japan; constructing physical lines in historical cities with cobbled roads was expensive. These and other unique circumstances meant there was demand for PASOLINK. In emerging nations that lacked established telecommunication infrastructure between cities, PASOLINK could be an effective solution by providing wireless communication infrastructure at a lower cost and higher speed than wired communications.

The global market was undoubtedly larger than the Japanese domestic market. With this conviction, NEC set the global market as the primary target for PASOLINK business and proceeded with development while taking in local needs and strengthening investment. NEC’s predictions were on the mark; as cell phones spread from 2000 onward, the market expanded, and PASOLINK’s business increased.

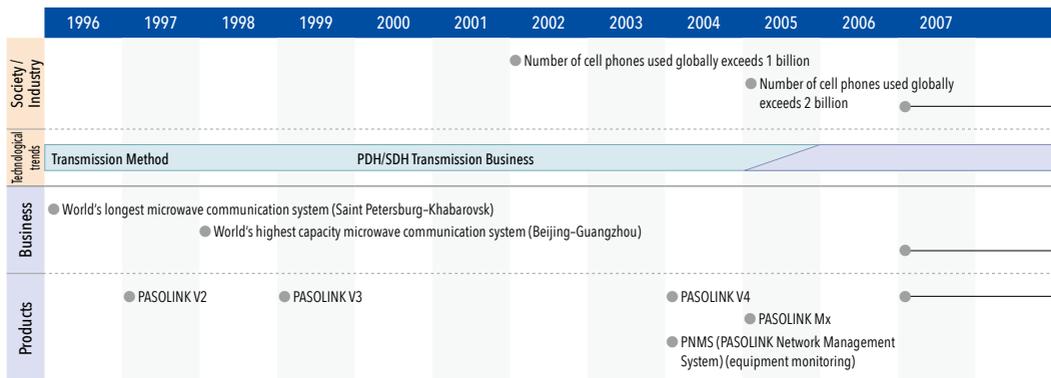
Reducing costs with the collective efforts of all relevant divisions

Aiming for further growth, NEC worked toward the application of advanced technology such as larger memory capacity by assigning personnel from the field of trunk-type microwave communication systems, for which we have over 80 years of history and experience, and applying their technology and know-how. An employee who was involved at the time looks back on it as follows.

“The manufacturing team, development team, and sales team all demonstrated their respective strengths while coordinating with each other. The Fukushima Plant’s manufacturing team improved productivity by implementing the Toyota Production System. The development team implemented a shared platform, introducing a system that made it easy to meet customization requests at a low cost. The sales team developed close relationships with clients, regularly communicating with especially major clients, obtaining necessary specification information, and making product roadmaps with them. The sales team also gave relevant divisions information and feedback in a timely manner.”

Through these efforts, NEC was able to provide careful service adjusted to client needs, delivering PASOLINK with high-functionality to clients in the European market that sought high-level, advanced functions and supplying low-cost PASOLINK with simple functions to clients in emerging nations such as India. As a result, NEC’s PASOLINK business grew to secure the top market

Timeline: Changes in PASOLINK Business



Source: Ministry of Internal Affairs and Communications, "2017 WHITE PAPER: Information and Communications in Japan"

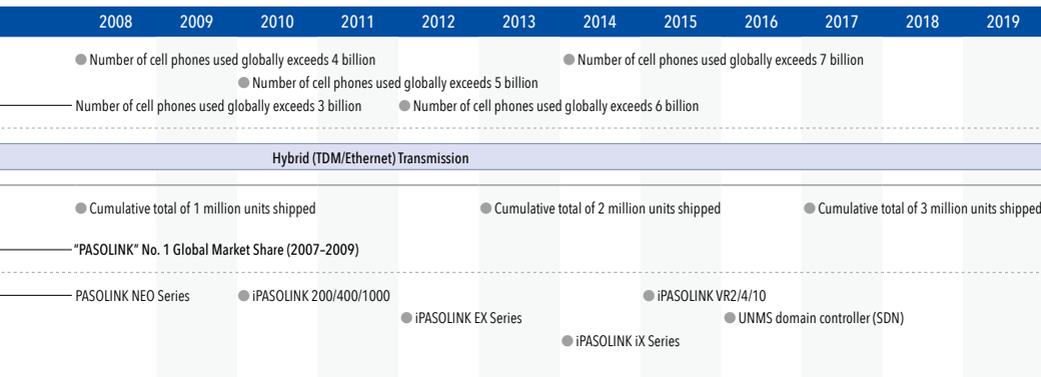
Tackling global-scale challenges with technology and people

share from 2007 to 2009.

Around 2010, when the transition from third-generation (3G) to fourth-generation (4G) mobile communication systems was beginning, the demands PASOLINK had to fulfill changed once again. Now it had to be IP-compatible. Along with wireless performance, demand rapidly increased for IP-compatible functionality as Internet-accessing smartphones spread. Therefore, the PASOLINK division reached out for help from the domestic telecommunications equipment development team, which had IP-related technical knowledge, and developed a product together. This was the period in which the focus of the field of telecommunications equipment development shifted from hardware to software.

“In other words, it was a period in which mobile backhaul, which had previously been simply ‘piping’ for moving data, changed to ‘high-functioning telecommunication infrastructure.’ All the nations of the world made up the market, so desired specifications and functions also varied depending on the country or business. NEC had core technology that we had accumulated internally, and it was this core technology that enabled us to meet these diverse needs and demands.”

However, the PASOLINK business has had its ups and downs as well. First, there was the market shock in 2008 following the bankruptcy of the Lehman Brothers, which curbed global capital investment. Then, there was the collapse in prices caused by the Chinese company Huawei Technologies Co. Ltd.’s launch of low-price products into the market. Market prices plummeted, and

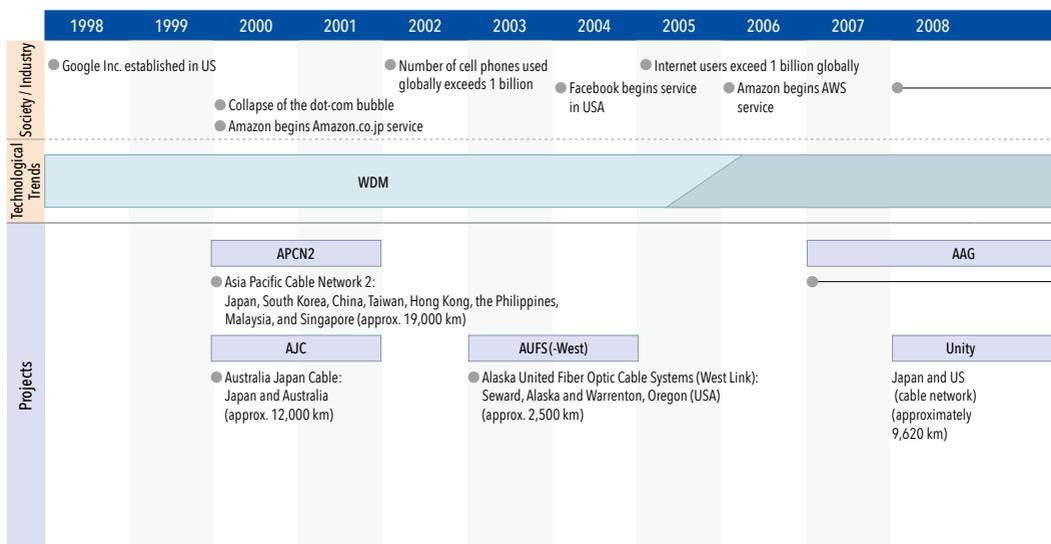


PASOLINK’s sales also decreased.

The PASOLINK business had demonstrated its presence on the global market, but it was pulled into a price competition by the introduction of low-price products. The business was driven into such a difficult position that the “Progress on Mid-term Management Plan 2020” report, published with the fiscal year 2017 (March 2018 period) financial overview, noted, “We will urgently enact measures to make mobile backhaul business, which has continued to produce a deficit, profitable.” A situation in which a highly profitable business suddenly falls into a deficit with the appearance of a new technology or player, which NEC had experienced many times over the past 20 years, occurred for the PASOLINK business as well.

A business cannot survive if its business model cannot be innovated to meet changes in the market. The PASOLINK business also needed innovation. To convert it to a slim and simple business and organizational structure that could compete with competitors, NEC reworked the PASOLINK business, re-examining factors such as its organizational structure, processes, and product lineup. Along with conducting various measures aimed at improvement, NEC has implemented a new partner strategy, aiming to enhance competitiveness,

Timeline: Main Submarine optical Cables Laid by NEC



Source: Ministry of Internal Affairs and Communications, "2017 WHITE PAPER: Information and Communications in Japan"; Submarine Cable Map (<https://www.submarinecablemap.com/>)

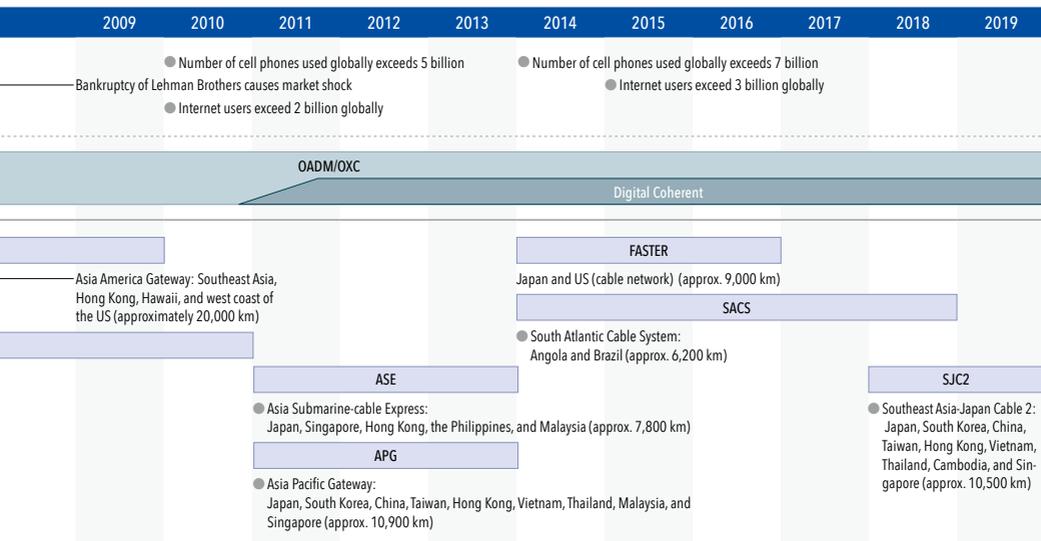
Tackling global-scale challenges with technology and people

improve profitability, and increase efficiency.

One part of that strategy is NEC's collaborative business relationship with the Israeli company Ceragon Networks, Ltd., announced in April 2019. This collaboration aims to increase product competitiveness and change business and cost structures by efficiently developing advanced mobile backhaul technology for fifth-generation mobile communication systems (5G) and beyond, with NEC and Ceragon Networks sharing their technology and expertise. In addition, NEC advanced a collaborative business relationship with Aviat Networks Inc. in the US in June 2019. This collaboration aims to increase business efficiency and improve profitability by combining Aviat Networks' maintenance and service network that spreads across all of North America with PASOLINK Series products. Proceeding with this partner strategy, NEC aims to strengthen business structure and improve profitability. We will continue to innovate so that we can grow as a leading global company.

A market outside Japan where the submarine optical cable business could grow

The submarine optical cable business has experienced even greater ups and



downs than PASOLINK has.

NEC got involved in a submarine cable project for the first time in 1964, supplying land-side terminal equipment to the American company AT&T Inc. when they laid the Trans-Pacific Cable 1 (TPC-1), which was the first submarine cable connecting Japan and the USA. After that, the cables used switched from coaxial to fiber optic cables, and in Japan, Kokusai Denshin Denwa Co. Ltd. (KDD, later KDDI Corporation) came to construct trans-pacific cables. NEC accumulated technology by developing and supplying repeaters and terminal equipment in accordance with KDD's specifications. An employee who has been involved in the development of submarine optical cables since joining NEC gives the following comments.

"At the time, a few people did development in a small room of an old building with a triangular roof at the Tamagawa Plant. I honestly did not have the impression that our division would lead to any significant business."

A change in technology provided a turning point. Up until then, many operations were necessary to conduct submarine repeaters; an optical signal had to be changed to an electrical signal within the relay, amplified, and then played back again and relayed as an optical signal. As the development of optical transmission technology progressed, however, an optical amplifier that could directly amplify and relay an optical signal adopted in the Trans-Pacific Cable 5 Cable Network (TPC-5CN), which began operation in 1996. At the time, NEC was researching direct optical amplification primarily at the NEC Central Research Laboratories. Utilizing this technology enabled transmission speed to be increased to 5 Gbps, 10 times its previous speed.

In the 1990s, the progressing liberalization of communications also brought changes to submarine optical cable projects. A market emerged for laying cables not only within one's own nation but connecting to other nations. As this market emerged, so did the American company AT&T and the French company Alcatel as global system suppliers that made up most of the market. At the time, Alcatel requested that NEC become an equipment supplier, leading to an incident in which the division head who went to meet with Alcatel returned to Japan indignant at Alcatel's conditions, which treated NEC like an unequal subcontractor. Business would not grow if NEC was a subcontractor. Thus, NEC shifted course to expand our business into that of a complete system supplier, providing not only terminal equipment and repeaters, but

submarine cables as well.

As a result, NEC successfully received the order for the Asia Pacific Cable Network 2 (APCN-2) in April 2000 and supplied a submarine optical cable system compatible with 10 Gbps wavelength division multiplexing (WDM) in 2001. NEC was thus able to make itself known to the world as a system supplier for submarine optical cables.

The intense ups and downs of the “rollercoaster division”

Following its success with APCN-2, NEC’s submarine optical cable business received orders in 2000 for the construction of the Australia Japan Cable (AJC), connecting Australia and Japan, and for the East Asia Crossing 2 (EAC2) project. This development could be seen as the forerunner for NEC’s “One to many”-style of business expansion wherein proposals are made for numerous projects from a core technology based on the NS method that NEC developed, instead of NEC working as another company’s subcontractor.

In meetings in which vendors vied for orders, NEC faced many American and European competitors that excelled at presentations.

“We just did not say ‘no.’ We’d say ‘yes’ even to things that seemed unlikely to be achievable and would commit to that ‘yes,’ thereby receiving the project order. After receiving the order, we’d encourage ourselves by thinking,



Laying submarine optical cable



we already said 'yes' to this ourselves, so we've got to get it done on way or another. We pushed development forward while battling a lot of heavy pressure."

The submarine optical cable business grew rapidly by accepting not only the aforementioned three major projects but also relatively small projects for nations in Southeast Asia, where there are many small islands. The number of division staff was increased to about 50 to 60 people to match the business expansion; when the three major projects were at their peak, the division had expanded to include 200 members. This was the height of the submarine optical cable business.

However, circumstances changed abruptly. With the completion of the three major projects, demand for submarine optical cable plummeted. One reason for this stark drop in demand was that non-telecommunication businesses—namely, private cable companies—had taken advantage of the Internet bubble to build many submarine optical cables primarily in the Atlantic Ocean. This was in anticipation of an increase in telecommunication demand, but it made the business of submarine optical cables the target of speculation. Then, when construction speed outpaced the speed by which telecommunication demand was increasing, the relative demand for submarine optical cables decreased. New investments for fiber optic cables ceased, and the market bubble burst.

NEC's large-scale submarine optical cable projects also decreased dramatically. The division that had over 200 members at its peak had its employees reassigned to other divisions; in 2005, there were approximately 20 members left. Of those division members, only three were engineers. The existing submarine optical cables, terminal equipment, and repeaters required ongoing maintenance, so the division was left with the minimum staff necessary to complete this work.

An employee familiar with the events of the time recalls, "The market may have shrunk, but our staff numbers also decreased, so it was by no means an easy time for us. We could not spare the labor for new development, so we accepted small project orders that we could fulfill with the inventory we had. However, if we did not keep up with technological developments, we would not be able to meet future market demands, so with our sparse resources, we continued researching how to achieve a post-10-Gbps transmission method."

The engineers had a strong will, and continued to research new technology, undiscouraged by the deterioration of the market environment and decrease in division size.

This period of patient endurance continued for a few years, but in 2006 to 2007, vitality returned to the market. Circumstances also brightened for NEC's submarine optical cable business, with NEC receiving an order for the Trans-Pacific Express (TPE), a trans-pacific cable by a consortium of many participating corporations. The submarine optical cable division had kept research and development alive; this would become the bud for future business growth.

"Competing submarine optical cable businesses had suffered through the same rough circumstances that we had, and on a global scale, a number of companies were bought out or withdrew from the market. Even within NEC, the business's ups and downs were so drastic that we were sometimes called the 'rollercoaster division,' but we managed to keep the business going and did not give up on developing new technologies, and this enabled us to revive our submarine optical cable business when the market improved."

For example, a product of NEC's continued technological development was utilized in the commercialization of technology that contributed to the increased capacity of submarine optical cables. From the end of the 1990s to around 2010, submarine optical cables carried information in accordance with the optical intensity; for a long period of time, 10 Gbps were carried per wavelength. These circumstances were transformed by transmissions using digital coherent optical transmission technology, which uses the characteristics of a light wave to enable the sending and receiving of large amounts of data. Through continued research and development primarily at the Abiko Plant, NEC succeeded in commercializing equipment featuring digital coherent optical transmission technology that enabled 100 Gbps per wavelength. This product was selected for the Asia Submarine-cable Express (ASE) project, led by NTT Communications, a large-capacity submarine optical cable connecting major Asian cities, which was completed in 2013.

In addition, when the market recovered, the Japanese cable manufacturer OCC Corporation, was having difficulty continuing its business due to the after-effects of the collapse of the telecommunications market bubble. At the time, NEC was a submarine optical cable system supplier but did not have the refined technology necessary for manufacturing submarine cables. Therefore,

in 2008, NEC welcomed OCC as a group company. Thus, NEC gathered all the technology necessary for the construction of submarine optical cables—terminal equipment, repeaters, and even cables themselves—and became capable of providing total solutions.

The ability to discern what clients want

These business enterprises have continued to compete in the global marketplace, which differs from the market based in Japan. Looking back on the paths these business enterprises have taken, two primary factors that have supported them become apparent.

The first is that, when expanding a business into the global market, one must focus on the needs of global clients from the start. Since its establishment, NEC has continued to support Japan's social infrastructure, but this also means that many of NEC's business enterprises are strongly tied to Japanese society. This corporate origin and past successes of made-in-Japan products sweeping the globe also affected NEC's global business enterprises. When launching in the global market, NEC often took a business strategy of balancing the functions and performance of international products with those desired by Japanese domestic clients or of globally expanding on products supported by Japanese clients.

However, for the PASOLINK and submarine optical cable enterprises that are actually competing on the global market, NEC separated the global and Japanese domestic markets, providing what clients in each market wanted respectively. Both of these business enterprises also had a small market scale within Japan, where social infrastructure was established early on. Even so, they were able to find success by turning to the global market for a place to utilize their cultivated technology, determining the needs of clients and partners, and reflecting those needs in products and services—in other words, by simply and straightforwardly continuing to approach business from a client point-of-view.

The second factor supporting these businesses was their efforts to build trusting relationships with partners and clients by determining what not only a few but many clients needed on the basis of close communication with partners and clients.

In the PASOLINK business, changing the quality of communication is

increasingly necessary due to the diversification of clients. Until recently, we closely coordinated with a limited number of Europe's main telecommunications carriers, and the development of technology was their primary demand. In recent years, however, telecommunications carriers around the world, not only in Europe, have come to demand direct communication. For example, a presentation with the same content will be received differently in the UK than it would be in India, and the clients' interests will also differ. One must gain a strong sense of this difference in order to develop trusting relationships in various different nations and regions.

In the submarine optical cable business as well, the client base has expanded to include not only primary telecommunications carriers but also players known as over-the-top (OTT) media services, such as Google LLC (later Alphabet Inc.), Microsoft Corporation, and Facebook, Inc., who provide content services using telecommunications carriers' lines. What OTT players need from submarine optical cables differs from what conventional telecommunication companies need. The submarine optical cable business division must develop and provide products that meet these evolving needs, or it will end up as a "rollercoaster division" again. We cannot meet the needs of only a select number of clients; we must make products that satisfy many clients. Doing so requires both technical capability and global communication skills.

Members of the PASOLINK and submarine optical cable business enterprises both agree, "People are mistaken if they think global business is 'dry,' as in, unemotional, matter-of-fact, and all about practicality. Nowadays, business in Japan is actually much drier. It's important to understand that in global business, significant emphasis is placed on connections between individuals and trusting relationships."

Many people in Japan think that the concept of "*giri-ninjo*," or "duty and feelings," does not apply to global business. However, one-to-one frank, open communication is even more important when working with someone from a different historical and cultural background. Without such communication, reaching agreements in business is difficult.

Close communication enables us to discern our clients' needs and assess changes in the market. A practical, matter-of-fact attitude is required in the critical aspects of business, such as the timing for future decisions. Developing trusting relationships through human connections is what has enabled the

PASOLINK and submarine optical cable business enterprises to maintain their presence on the global market.

The “key” to global business

The challenges these two business enterprises have undertaken on the global market hold the potential to become the “key” to NEC’s future growth.

Namely, we must determine the true needs of clients in different nations and regions for which we provide products and services and innovate ourselves without being hung up on our past successes or limited by the Japanese market. We must develop communication skills, meet clients face-to-face, and foster trusting relationships. Finally, we meet clients’ needs with the leading technology that NEC has continuously cultivated.

Regarding key points for surviving on the global market, a member of of PASOLINK lists, “The fundamental ability to meet clients’ expectations and provide full-turnkey value-added solutions, and the ability to utilize our company’s strengths to harmonize the entire system.” These comprehensive capabilities and strengths are also the foundation for competitiveness in the field of submarine optical cables.

NEC will continue its innovation, constantly assessing changes in the market and technology as we push business forward with the talents of our employees and our cultivated technological capability. This is the foundation that will lead to success for business on the global market and is indispensable to NEC’s growth.



Taking on the challenge of “Hayabusa” and the space business enterprise that followed

The business found from the trusting relationships formed through undertaking Japanese space development



Illustration: Akihiro Ikeshita

NEC has consistently developed and manufactured spacecraft, starting with Japan’s first satellite, “Ohsumi.” One of these spacecraft, the asteroid explorer “Hayabusa,” gained widespread attention in 2010 for taking a sample from the asteroid Itokawa and returning it to Earth. Since then, NEC’s space business enterprise continues to take on new challenges, aiming for new areas while adapting to the changes of our times.

The challenge of Hayabusa with the goal of demonstrating technology

“I knew people on the Internet and so on were excited about Hayabusa returning to Earth, but I did not expect everyone to get as excited about it as they did. On that day, I did capsule separating operations into the night before going home; the next day, when I went into work, I was suddenly told, ‘They’re going to interview you for TV.’ I quickly tidied up my hair and shaved during my lunch break. See, I had been so busy until the day before that I had not even had time to do that. I quickly tidied up my hair and beard during my lunch break. See, I had been so busy until the day before that I had not even had time to shave.”

So recalls an NEC engineer who worked as a project manager on the manufacturing-side for the Hayabusa project.

In May 2003, a single explorer was launched and began its journey into interplanetary space. Its development code name was “MUSES-C,” and after its launch it was named “Hayabusa.” This asteroid explorer’s ultimate objective was an asteroid sample-return—in other words, to take a piece of an asteroid back home to Earth. In September 2005, Hayabusa arrived at the asteroid

Itokawa, after which it took a sample, and finally returned to Earth in June, 2010. The explorer faced many difficulties during its journey, but the Japan Aerospace Exploration Agency (JAXA) and many engineers united to surmount these obstacles, becoming the first to successfully carry out such a mission.

Hayabusa is often discussed in this manner, with an emphasis given to this “story-like” narrative. However, what the engineer quoted above felt about it was somewhat different.

“Various people said to me, ‘I was so uplifted,’ or ‘I want to hear about your experience.’ I wanted to meet their expectations, so I did my utmost to explain and accurately communicate what we gained with Hayabusa. However, I received many questions along the lines of, ‘How did all of this make you feel?’ and I felt uncomfortable with this demand for the kind of story you would find in a documentary-style TV show.”

What was behind that discomfort? To understand the answer to that question, one must know the intended goal of the project known as Hayabusa.

Hayabusa is called an “asteroid explorer,” but it is also an “engineering test spacecraft” with the name “Scientific Satellite No. 20 MUSES-C.” The project was primarily conducted as an engineering experiment with the goal of demonstrating the technology necessary at each step in Hayabusa’s journey: propulsion by and long-distance continuous operation of the ion engine for arriving at the target asteroid; acceleration using planetary gravity, known as “swing-by”; autonomous flight control and guidance; scientific observation of the asteroid; touchdown (landing) on the asteroid and obtaining a sample; leaving the asteroid; and finally, reentry into the atmosphere and collection of the sample-storage capsule.

“In a sense, obtaining and returning with a sample was a huge ‘bonus’ given that the goal was purely to demonstrate technology. From NEC’s point of view as the manufacturer, we wanted to achieve that goal and get that ‘bonus,’ but demonstrating technology requires that you take on challenges. We took on the challenge of a planned touchdown, which only Hayabusa could accomplish, and although Hayabusa suffered

“Ohsumi,” produced by NEC



various problems along the way, that was the result of taking on a challenge in order to gain many 'lessons learned.' These gains we made through undertaking this challenge were what was most important, but in the midst of the excitement at the time, I felt frustrated at my inability to express that well."

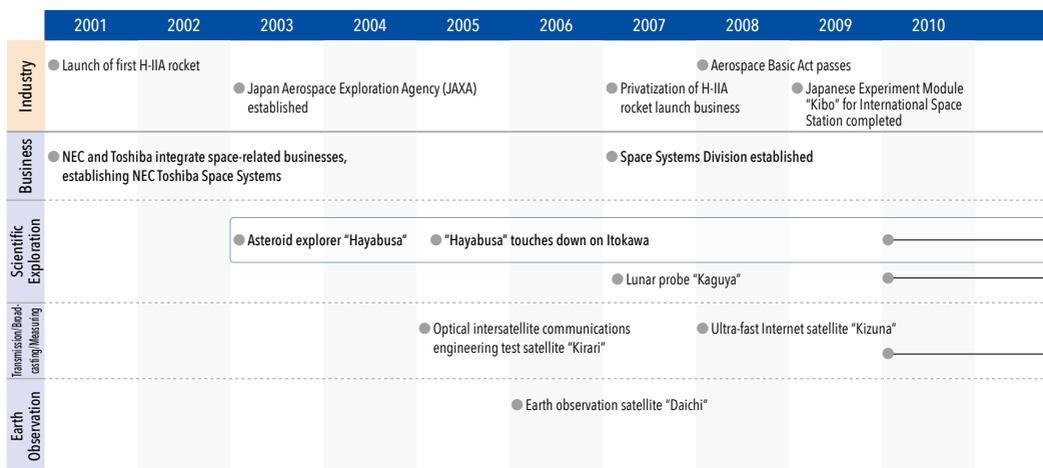
The trusting relationship built up over many years that was behind the project

NEC's involvement in space began in 1956 when it developed and manufactured equipment for the University of Tokyo's Production Engineering Laboratory's Kappa rocket launch experiment; the equipment sent and received measurement data from the rocket in the sky to the ground. Then, when the University of Tokyo began planning for the launch of a satellite at the beginning of the 1960s, NEC participated in research from the early stages, accumulating expertise on designing and producing satellites.

The University of Tokyo established the Institute of Space and Aeronautical Science (ISAS) to meet the expanding scope of research, and in February 1970, ISAS launched Japan's first satellite, "Ohsumi," which was also produced by NEC.

Over the 50 years following Ohsumi, NEC has received orders for and produced many of Japan's scientific satellites and engineering test satellites.

Timeline: Changes in the Space Development Business



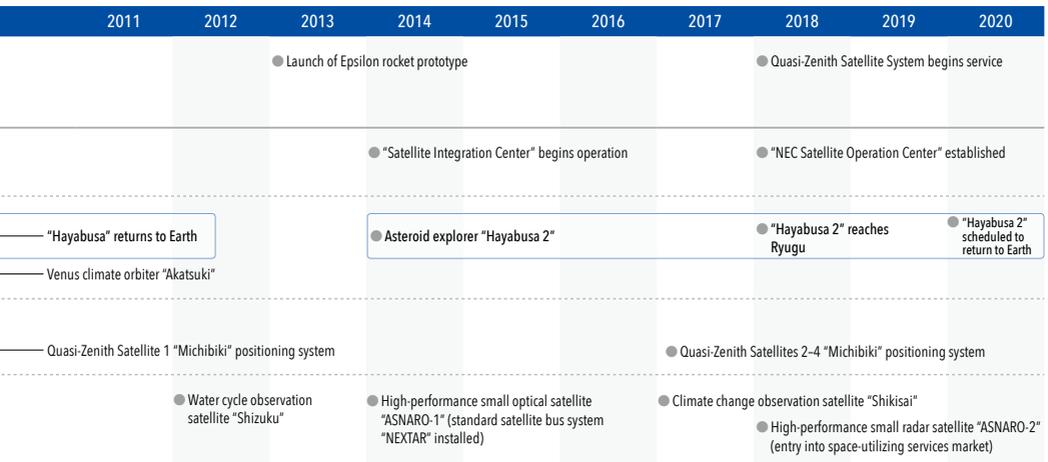
Taking on the challenge of "Hayabusa" and the space business enterprise that followed

From a satellite's conceptualization stage, NEC's engineers participate in the review team, respond to the needs of researchers, and work out the details of the satellite's design. The engineers and researchers create better satellites together by overcoming the distinction between "laboratory" and "manufacturer," speaking candidly together, and sometimes even having fierce debates. This relationship continued even after Tokyo University's Institute of Space and Aeronautical Science developed into the Institute of Space and Astronautical Science (ISAS) under the direct control of the Ministry of Education, Science and Culture.

Satellite development is time-consuming work; it takes five to seven years to develop the satellite itself and ten or more years when including the review stage before that. Many satellites and probes were produced over the years through ISAS and NEC's close, cooperative relationship.

What NEC gained from a "mass of challenges"

Hayabusa had various new technology incorporated into it such as the extremely fuel-efficient "ion engine $\mu 10$ " for which NEC was involved in development and production and a reentry capsule for delivering the asteroid sample to Earth when entering the atmosphere. Despite carrying all this new technology, Hayabusa also had to be made light enough that the M-V rocket operated by ISAS



would be capable of launching it. The weight limit was ultimately 510 kg. A rocket from the USA, a nation with advanced space development, could handle four times this weight or even more, but in Japan, the rocket would not even be able to lift off unless Hayabusa was within this weight limit.

"We gained an enormous amount through developing an aircraft that presented us with such a mass of challenges," reflects an NEC project manager.

What was gained? A renewed awareness that lessons learned through taking on challenges in technological development are more important than anything. Hayabusa is often called "a project that had many problems."

"As the manufacturer, we had to reflect on a number of the problems that occurred and strive to prevent their reoccurrence. However, writing off all the things that occurred as 'problems' feels wrong when you consider Hayabusa as a challenge undertaken with an engineering prototype and the results of that effort. For example, Hayabusa failed at its first attempt at touchdown, but that was because the obstacle sensor detected an unexpected irregular object. We had anticipated various scenarios regarding obstacles, but it was not until Hayabusa got to Itokawa that we learned that our hypothetical scenarios had not been perfect. There were many of these 'things we only learned once we tried actually doing them' during the development and operation periods. With the Hayabusa project, we strove to open up new regions of the unknown, and we found that using the lessons learned in doing so to lead us to our next step was important. This was a 'standard of value' that was gained. Gaining this standard of value could be considered a positive result not just for NEC but for the project as a whole."

This positive outcome has been demonstrably reflected in "Hayabusa 2," the finalized version of the explorer launched in December 2014 with the goal of touching down on the asteroid Ryugu and completing a sample-return.

A great amount was gained through Hayabusa, but the struggle involved to get there was also extraordinary.

"It was like a mission that would only succeed after linking many new technologies with a single-stroke sketch. A bunch of new technologies had to be crammed together, and we also had to meet a very strict weight requirement. Normally, the circuit board for electric components would be fixed in an aluminum chassis, but the aluminum was changed to magnesium, which was then thinned. The screws were also changed from stainless steel to aluminum and

Taking on the challenge of “Hayabusa” and the space business enterprise that followed

“Hayabusa” separating its capsule as it prepares for the return to Earth



Illustration: Akihiro Ikeshita

then to titanium. The weight of everything was reduced one gram at a time, and we kept making things lighter until we could not cut anything else.”

The value gained through these steady accumulated efforts must not be forgotten either.

Hayabusa hones the skills of the project members

For the Hayabusa project, NEC established a system under which two managers, one each from the older and younger generations, were assigned to work together to lead the project. The older of the two worked as a project manager, overseeing the entire project; the younger manager was positioned as a system manager who coordinated feedback from each division in the company and adjusted the interfaces between installed equipment. By proceeding with the project under this set-up, the system managers could learn and develop into the next generation of project managers.

From November 4 to 26, 2005, Hayabusa attempted touchdown on the asteroid Itokawa, the first planned touchdown on an asteroid in history. After five attempts including rehearsal, it finally succeeded, but this success was followed by a series of problems. On December 9, communication with Hayabusa cut off.

“On the way to Itokawa, the reaction wheels that control positioning malfunctioned, and Hayabusa’s hardware was not in ideal condition, so the

planned method for touchdown also had to change. However, nobody had experience with this kind of operation, and nobody knew what would happen. The experience enabled the employees involved in operation to hone their skills, and young personnel also matured because of it. Hayabusa was a project for demonstrating technology, but I feel that it was also a project that fostered the professional growth of our employees.”

After losing communication, contact was regained with Hayabusa on January 23, 2006. NEC’s engineers continued to support the Hayabusa project until the explorer’s dramatic return to Earth on June 13, 2010. At the same time, these engineers were trained by and grew from their experiences on the project. A project member who worked as a system manager for Hayabusa went on to work as a project manager for the Venus climate orbiter “Akatsuki” and Hayabusa’s successor, “Hayabusa 2.” Now, young engineers working under this project manager’s leadership are gaining experience as system managers, growing each day, and will one day go on to be NEC’s next generation of project managers.

Technology that developed and people who grew with Hayabusa

Professional development of employees was not the only thing NEC gained through the Hayabusa project. Hayabusa travelled far away from Earth to distances that take even radio waves at least 20 minutes to traverse; thus, ISAS and NEC developed an autonomous function that would enable Hayabusa to operate on the basis of its own judgment of the surrounding environment and the explorer’s condition. This technology has been utilized in NEC’s commercial satellite bus “NEXTAR.” In addition, the idea of the PIM bus that handles data within the satellite was adopted as a protocol for the spacecraft telecommunication standard “SpaceWire.” The expertise in reducing weight and energy consumption that NEC gained while developing Hayabusa has been utilized in NEC’s technology for the production of satellites that NEC has been involved in since then.

2019 marked thirty-four years since the beginning of Hayabusa’s conceptualization, sixteen years since its launch, and nine years since its return to Earth. Space research and development is a drawn-out business that can take up most of a lifetime.

During the period since Hayabusa’s initial conceptualization, various

Taking on the challenge of “Hayabusa” and the space business enterprise that followed

changes occurred in Japan’s space research and development environment. Along with JAXA’s establishment in 2003, the organizational cultures of the National Space Development Agency of Japan (NASDA) and ISAS began to combine. This coupled with the increasing size and complexity of satellites and probes led to a project management method adopted from the American National Aeronautics and Space Administration (NASA) becoming the main method of project management. ISAS and NEC’s relationship also shifted in accordance with these changes.

The production of a single scientific satellite or explorer such as Hayabusa will not lead to large business projects in and of itself. Likewise, technology developed therein will not be adopted simply because it is “advanced technology that was used in Hayabusa.” This type of project will only lead to business when the technology developed therein can be provided as solutions that account for client needs.

“Even so, sending a single ‘prototype’ into space is important. When developing technology, predicting what’s going to be profitable is difficult. However, if we ever stop developing technology, everything we’ve cultivated up to that point will be lost. This is why continuing development and exploring all sorts of possibilities is important, even on a small scale. I think this mindset is what enables NEC to acquire technology and professionally develop personnel.”

Advancing from satellite research and development into commercialization and business

NEC’s space business enterprise had continued to contribute to Japan’s space development, but it found a new turning point in the latter half of fiscal year 2000: the shift of emphasis from satellite research and development to satellites for practical use. Behind this shift was the passing of the “Aerospace Basic Act” in 2008 and following this, the 2009 Cabinet Office’s formulation of the “Basic Plan for Space Policy.” This Basic Plan for Space Policy was a plan regarding Japan’s space development over a five year period, with considerations made for the ten years in the future. It clearly specified a policy of “switching from being led by research and development to being led by usage needs and based on refined technological capabilities.” NEC responded to this new policy.

NEC had been restructuring since the end of the 1990s. As part of this

restructuring, its space business enterprise was made into a spin-off company in 2001, and “NEC Toshiba Space Systems Ltd.,” which was established through a joint venture with Toshiba Corporation, had thus been handling space-related business. However, in 2007, the main part of the space business enterprise, with the system integration division at its heart, was returned to NEC, and the Space Systems Division was newly established.

The aforementioned Aerospace Basic Act also lists “contributing to the securement of peace and security for international society and Japan’s national security” as one objective for space development. Therefore, NEC enhanced its structure in order to create synergy with the Defense Business Division for practical-use satellites in the field of national security. In 2014, a new company building called the “Satellite Integration Center,” where satellites are assembled and tested, began operation at NEC’s Fuchu plant, increasing the company’s productive capacity.

As NEC stepped up its business in this manner and shifted focus from satellite research and development to commercialization and business, the existing problem of profitability became even more apparent than before.

Facing these circumstances, NEC is reconsidering space-related enterprises as a business and beginning various innovative changes. NEC is also reevaluating how we are involved in projects, clearly defining the areas we handle at each step of the project process: conceptualization, development, production, and operation. Constantly inspecting costs and other aspects, NEC aims to

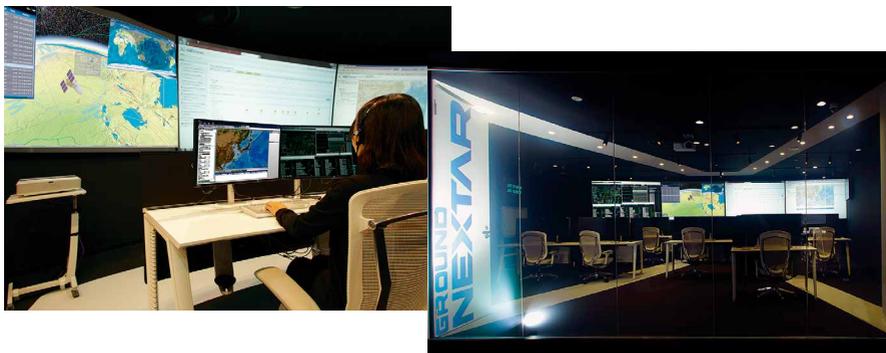
“Hayabusa 2” after arriving at Ryugu



Illustration: Akihiro Ikeshita

Taking on the challenge of “Hayabusa” and the space business enterprise that followed

NEC Satellite Operation Center



move to a method of advancing projects under suitable management.

The “NEC Satellite Operation Center,” established in April 2018, is one effort toward innovative change. The field of space development is surpassing the limits of research and development and evolving into an era of providing services using space technology. In addition to developing satellites and related ground systems at the NEC Satellite Operation Center, NEC also conducts satellite control, mission operations, and sale of images and image information using Earth observation satellites owned by NEC. By conducting this variety of work at the NEC Satellite Operation Center, we aim to develop space-utilizing service enterprises as a business. This is the first independent operation of satellites by a Japanese domestic manufacturer.

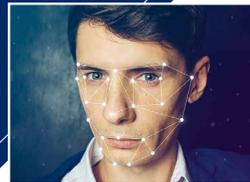
As part of the center’s operations, in September 2018, sales began of images taken by the high-performance compact radar satellite “ASNARO-2.” In addition, the NEC Satellite Operation Center’s control system, “GroundNEXSTAR,” is sold as a package that can be combined with not only ASNARO-2 but other companies’ satellites as well. This is in anticipation of a future in which GroundNEXSTAR is more widely utilized within the space industry.

The personal growth and technology that NEC has gained through our space development efforts are irreplaceable. Both those human resources and that technology will be vital in pushing this business into the oncoming era of practical satellite use. To evolve as a business, NEC must greatly expand our horizons outward and continue to explore the value that our space enterprises can provide society as we develop our personnel and refine our technology.



Changing the world with what grew to be “the leading technology”

The world’s best face recognition technology, created through persevering research and development



Various technologies make up our AI technology brand “NEC the WISE.” Of these technologies, NEC is a world leader in face recognition in particular. AI has been gaining attention since the beginning of the 2000s with the Third AI Boom, but its origins go back as far as the 1960s. NEC’s foray into artificial intelligence began with the development of a system that automatically read postal codes, evolved into fingerprint identification and culminated into world-class face recognition technology.

“Black box” type AI and “white-box” type AI

The concept of artificial intelligence, or AI, is an old one. It was first proposed in 1956 at the Dartmouth Summer Research Project on Artificial Intelligence, organized by John McCarthy of the American university Dartmouth College. AI saw many a rise and fall, shooting to prominence at the cutting edge of research and development only to fade from interest when researchers got stuck. In the 1950s to 1960s, research proceeded with the expectation that machine functioning equivalent to that of humans would be quickly achieved. However, the initial AI Boom faded as the difficulty of real-world applications became clear. The 1980s saw the second AI Boom with the appearance of expert systems, which teach computers information in the form of rules, and neural networks, which mimic the functions of neurons. However, research fizzled out when it again became clear that the scope of real-world applications was limited.

The current Third AI Boom came after entering the 2000s. Factors prompting this third boom included the increase in computer processing speeds;

machine learning, which trains exponentially larger neural networks with exponentially larger amounts of data (i.e. “big data”); and the creation of technology called deep learning, in which the AI learns for itself the elements that define information.

Machine learning and deep learning have been the basis for advances in AI technology in recent years. One characteristic of this type of AI is that it can give results for analysis, but it cannot explain the step-by-step reasoning behind the process by which it arrives at its results. All that can be said by way of explanation is “these were the results the AI gave after it was trained,” and the “why?” behind the results is completely opaque—a black box. This type of AI is useful in areas where the goal is clear and efficiency is a priority, such as security and quality control, but its applications are limited as a means of support for human decision-making, such as in business-management decisions, new product development, and interpersonal care. This is because people cannot rest assured in accepting an outcome for which the only explanation is, “we do not know why, but these are the results that the AI said were correct.”

What NEC focuses on is the ability to use both the “black-box type AI,” described above, and “white-box type AI,” for which it is possible to explain to people how the AI gets its results, as necessary in accordance with one’s objectives. The AI technology brand we are developing, “NEC the WISE,” provides both black-box and white-box solutions by visualizing and analyzing real-world data, and returning deep knowledge as prescriptions for the real world. By putting data through these three processes and returning it to the real world as “value,” NEC aims to “maximize human intellectual creative activity” with NEC the WISE.

The start of research: an automatic reading-and-classifying machine for postal codes

Of the technologies that make up NEC the WISE, recognition technology is one that NEC has researched, developed and refined over many years. Recognition technology supports the process of “visualization” with feature extraction, a method in which feature values of target images are extracted, compared and classified. This technology is the core of biometric authentication solutions such as fingerprint identification and face recognition.

NEC’s roots in this technology can be traced back to the postal code system

implemented in July 1968. The Ministry of Posts and Telecommunications of the time implemented postal codes with the goal of making postal delivery more efficient, but technology that enabled a machine to read hand-written digits was necessary for sorting postal items. Research with the aim of enabling a machine to read different people's unique, hand-written characters led to the technology that later became known as optical character recognition (OCR), which determines what a hand-written character is by capturing the structure of characters as feature values, such as lines and endpoints, and comparing these feature values. Using this technology, NEC developed the automatic postal code reading-and-classifying machine "NAS-5B," which the Ministry of Posts and Telecommunications adopted with the implementation of the postal code system.

The technology developed here of extracting and comparing feature values and then identifying them was not limited to reading postal codes; it had unlimited potential.

In the 1970s, NEC proceeded with research that applied this technology to the matching of fingerprints. Fingerprints are unique to every individual and do not change over one's lifetime, so they are an excellent method for identifying people. Prior to the 1970s, fingerprints obtained at crime scenes were manually matched with a vast amount of existing fingerprint data, one case at a time, a process that was tremendously time- and labor-consuming. NEC's research began in 1971, and after 10 years, the first commercial device was adopted by the National Police Agency in 1982, and operation began. Following this, many police and judicial branches around the world began using the

Automatic postal code reading-and-classifying machine



system, starting with the San Francisco Police Department in 1984, and the automation and increased speed of fingerprint matching via machine contributed significantly to making society safer and more secure.

NEC continued to commit efforts to research and development of this technology. For the field of automated postal systems, NEC also developed a system that implemented a method of hand-written kanji-recognition in 1993. When postal codes were changed to seven digits in 1998, NEC developed a faster, more precise automated reading machine and met the needs of all of Japan’s post offices for replacement of their prior automated reading machines.

The next goal: recognizing human faces

Entering the 2000s having satisfied the demand for automatic postal code reading-and-classifying machines, NEC deemed it necessary to uncover the next market demand. NEC decided to focus its efforts on face recognition technology, which recognizes a human face, compares it against a database, and determines if the person is who he or she claims to be by whether or not the face and data match. The research itself had begun earlier in 1989 with sponsored research undertaken for the Security Electronics and Communications Technology Association (later the Security Communications Association), but at that point it was still exploratory, small-scale research.

Initially, the research into measuring and comparing the shape of the face in 3D was pursued. This was because people are not always facing directly forward in photographs, and thus being able to recognize faces even in images taken from the side or diagonally is ideal. Further, if face recognition were possible for video and people’s movements could be discerned, the areas in which the technology could be applied would increase. NEC’s researchers also wanted to develop 3D recognition as a logical next step following 2D recognition of characters and fingerprints. For these reasons, NEC attempted measurement in 3D, but challenges such as the limited computer processing capabilities at the time and the need to measure faces in 3D beforehand meant researchers did not have much success.

Thus, the research team shifted course. They narrowed their research target down to face recognition of 2D images of faces looking directly forward. Doing so would enable them to utilize the 2D image identification technology they had developed with the automatic postal code reading-and-classifying

machine and automatic fingerprint identification system. A researcher who participated in the launch of the research gives the following comments.

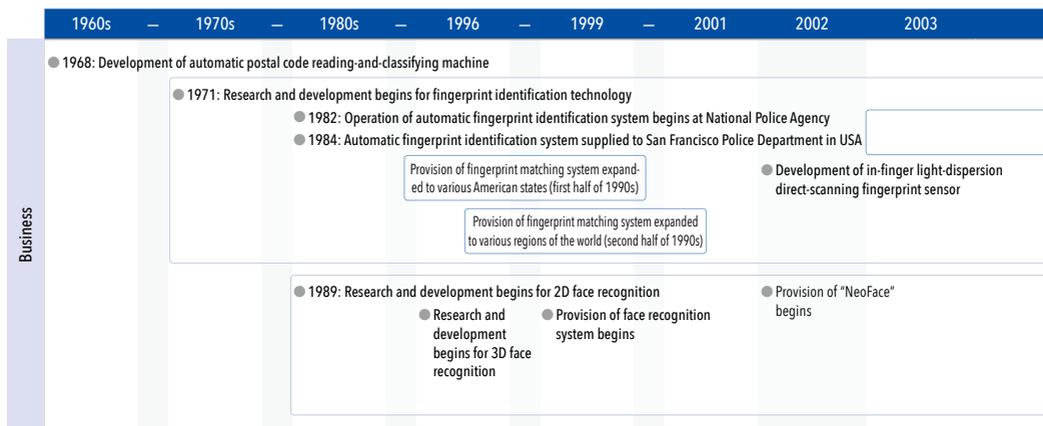
“We were developing 3D face recognition for video analysis, but 2D face recognition is only accurate for faces viewed from the front, so it is not suited for video analysis. However, from around 2000, digital cameras had started to gain popularity with the general public, so we hit upon the idea that technology for recognizing faces in images could be useful for video searching. Our thinking was that members of the general public mainly take snapshots of people, so that results in many photos showing faces. However, we did not have a specific idea for a product; I guess you could call it ‘producer-driven basic research’ backed by the idea, ‘we can probably use this for something.’”

At the time, numerous international corporations had already gotten a head start in the area of face recognition, so NEC needed to develop technology that would surpass these rivals if it wanted to produce a product and enter the market. The NEC Central Research Laboratories team utilized the technology that NEC had developed thus far and restarted their research with the goal of surpassing other companies’ technology in two years.

Extracting feature values from faces in images

NEC’s face recognition technology had its fresh start. This new face recognition could be seen as essentially a set of two technologies: one that distinguishes and selects the face portion from a 2D image, and one that takes the

Timeline: Changes in Biometric Authentication

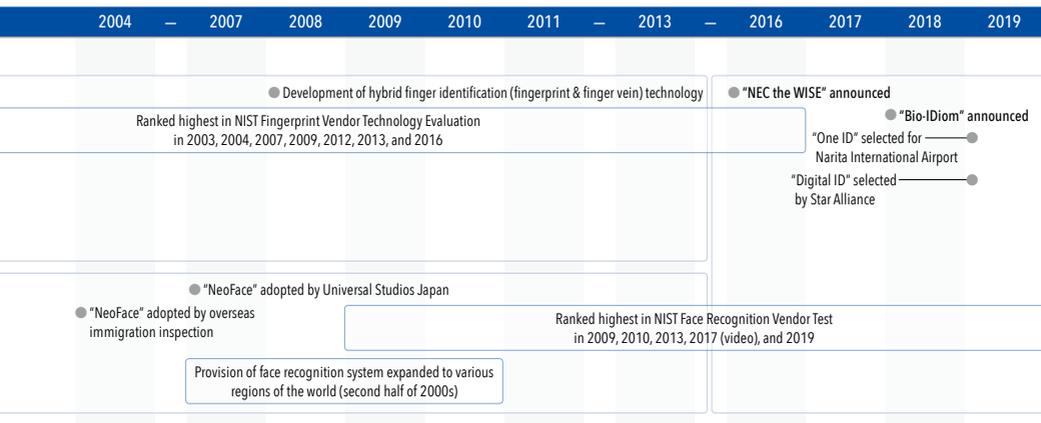


Changing the world with what grew to be “the leading technology”

selected face and extracts the feature that are key to recognition, such as the space between the eyes and the nose, and converts them into numeric values. The data thus obtained is compared to the pre-registered feature value database and analyzed on the basis of how much the values differ. In this way, the technology can automatically determine if a person in an image and one in the database are the same individual.

This is how the technology works, but extracting the precise feature values is no easy task. This is because feature values fluctuate with various factors such as gender, race, hairstyle, makeup, glasses, how the light hits the face, expressions, and changes over the years related to growth and aging. The technology could never be applied commercially if its recognition accuracy decreased because of these factors. The only way to increase its accuracy was to have the prototype system process a variety of diverse facial data, examine if and how this improved accuracy, and continue to improve the system. To that end, NEC needed a vast number of photographs of faces. The research team first collected face shots of NEC employees, but the data was insufficient for making a system that was to be applicable worldwide.

“We also worked with a staffing agency so that we could collect varied and diverse facial data of men and women of all ages. When we did so, we asked the people sent by the staffing company to bring photos of themselves from when they were young so that the system could learn to handle facial changes over the years. We could not secure diverse data with only Japanese people,



so we also worked with a modeling agency that managed many foreigners. We obtained facial data from this agency's models so that the recognition accuracy would not decrease regardless of differences in skin or eye color."

So reflects Hitoshi Imaoka, an NEC fellow who has taken part in the research from that time.

"We would ask for ten people at a time from each age group to come, for example, and then we would photograph them in a make-shift studio. People with appearances that we were not accustomed to would be lined up at the entrance to the laboratories, so other staff looked at us a bit suspiciously, like, 'what in the world are they up to over there?' Once, a woman came with her baby, so while she was being photographed, I was outside looking after her child. 'AI research' might sound grandiose, but in reality, much of it is just the accumulated effort of this kind of modest work."

Changes in society with biometric authentication in the spotlight

Now, face recognition has become one of NEC's world-class technologies, but back then, it was producer-driven basic research, and getting upper management to understand was difficult. Executive staff sometimes made harsh remarks about the results of the research and its future.

Fingerprint identification also faced difficulty. After operation of the automatic fingerprint identification system began at the National Police Agency, the system was adopted in many police branches around the world over the course of the 1990s, a trend that began when NEC supplied the San Francisco Police Department in the US with the system in 1984. The product grew to secure one third of the global market share. Despite obtaining this large share in the field of criminal investigation, however, it was not expanding into other areas.

In addition, around the year 2000, NEC's main business was the sale of hardware. NEC's business strategy was still in a transition period as the company shifted to providing "solutions" that solve customers' problems by combining hardware, software, and services. At the time, this solution-providing business strategy had not sufficiently taken hold yet.

"Nowadays, everyone understands that software is also important for solutions. Back then, though, people were not particularly aware of that. Some people thought of software as basically just 'something to spice up hardware

to help sell it.”

Under these circumstances, NEC decided that this technology could be utilized for identity verification in places such as medical and financial institutions—in other words, the technology could be used for ID-related solutions. Thus, from the latter half of the 1990s into 2000, NEC devoted efforts to developing a fingerprint identification solution for “national IDs,” unique IDs issued to each individual citizen of a nation, primarily promoting implementation overseas and endeavoring to open up the market.

However, the circumstances were changed dramatically by the 9-11 terrorist attacks that occurred in the United States on September 11, 2001. After these attacks, greater importance was placed on the necessity of public safety for achieving safe and secure civil life. There was suddenly heightened interest in biometric authentication as an effective method for identity verification systems such as immigration and emigration control, national IDs, and driver’s licenses. The unprecedented tragedy of the 9-11 terrorist attacks unexpectedly led to the rapid expansion of the biometric authentication market outside police branches.

NEC could not overlook these new market needs. As the number of places utilizing biometric authentication increased, NEC made advances in both fingerprint identification and face recognition technologies that took the world by surprise. In 2002, NEC began sales of “NeoFace,” the face recognition system based on the results of NEC’s research up to that point. When it first went on sale, NeoFace could only verify faces viewed from the front, but because passport photographs are always facing forward, this system was sufficient for use in immigration and emigration control. NEC established immigration and emigration control as its first market and worked toward NeoFace’s implementation.

NeoFace was first implemented for immigration and emigration control in 2004. Once it actually began operation, the system was able to detect a massive number of attempted illegal entries using fake passports.

Building on this success, NeoFace steadily expanded its uses into other fields. In 2007, the system was adopted by Universal Studios Japan, the theme park operated by USJ Ltd. (later USJ LLC), drawing attention as the first case of the system’s implementation within Japan. Identity verification for annual pass holders could now be completed in approximately one second; all

pass holders had to do was turn their face to the verification monitor screen. NeoFace was able to let people in by quickly and simply having them show their faces, while also helping to prevent abuse and misuse of annual passes.

NeoFace was thus gradually building a reputation for itself, but NEC was compelled to advance research and development even further. At the time, NEC was hosting an event called “Face Summit” with overseas affiliates involved in the sales of the face recognition system; one of the overseas affiliates present strongly demanded that NEC should demonstrate the difference between NeoFace’s performance and that of other companies’ systems via an objective third-party evaluation. This prompted NEC’s further research and development.

Obtaining the best results in the US National Institute of Standards and Technology benchmark

NEC needed to demonstrate definite proof that anyone could understand of its product’s superiority to users comparing and considering various companies’ products. To obtain that “definite proof,” NEC decided to participate in an evaluation test conducted by a third party.

NEC selected the US National Institute of Standards and Technology

Admittance to Universal Studios Japan using face recognition



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(NIST)’s vendor evaluation project, which major vendors from around the world participate in. All vendors who participated in the project would have their real company name made public, so the damage incurred should NEC do poorly would be severe. Internally, the goal for the challenge was explained as being to rank within the top three vendors no matter what, but for the engineers, the goal was always to reach the top.

This was when NEC made a shift in its technology policy to ensure victory over its rivals. The face recognition system verifies identities by comparing scanned facial data with data registered in its database to see if they match. NEC decided to switch the method for this comparison from model-based to learning-based. Model-based comparison, which had been used up to that point, is a method wherein humans think of various rules, e.g., “if this requirement is fulfilled, two faces can be considered to resemble each other,” and incorporate those rules into the program. Learning-based comparison, in contrast, is a method wherein an AI program generates the rules for making judgements by itself. NEC decided to incorporate the core technology of the Third AI Boom that began in the mid-2000s.

With this policy shift, the system’s accuracy improved swiftly and dramatically. In 2009, in the still-image face recognition category of the Multiple Biometric Grand Challenge conducted by NIST, NEC took a decisive first place far above the second place and lower scoring vendors. NEC thus obtained the evaluation that it possessed the top authentication technology in the world. The technology NEC had continuously developed had now been highly evaluated by a third-party institution.

“The 2009 benchmark only evaluated authentication for images facing forwards. However, not all the images were like ID photos; there were many difficult images with poor image quality or shadows because of the lighting. Nonetheless, we were able to take first place on our first try.”

Development to improve the accuracy of the face recognition technology continued, and following 2009, NEC went on to take first place for three consecutive years in the NIST benchmark for still-image face recognition. NEC has also placed first for video face recognition and for iris recognition. Including video, NEC has ranked in first place for face recognition five times, but competition in this field is fierce. The pressure was so intense that some engineers had nightmares in which NEC dropped to second place.

Unanticipated applications as use of face recognition technology increased

Taking first place in NIST's benchmark, NEC obtained "definite proof" of its product's superiority that could convince users. All that was left was to see how much this could be expanded into a business. NEC's researchers took it upon themselves to do TV and newspaper interviews in which they discussed coming in first place in NIST's evaluation and patiently explained the technology itself. Through these efforts, NEC's face recognition technology came to be widely known. Use of the technology gradually expanded, and the face recognition system came to be used in new areas.

In 2014, it was implemented as an admission system for the concert of a well-known girl band. The entertainment industry had struggled for many years with countermeasures against ticket scalping. NeoFace was implemented as a solution. Fanclub members registered photographs of their faces online before the concert and then showed their member cards when admitted on the day of the concert. By comparing the membership cards with their linked facial photograph data, NeoFace could prevent people who had bought scalped tickets from entering. In addition, announcing that this system had been implemented could deter people from scalping tickets in the first place.

Fields of application also opened up that NEC had not initially anticipated. For example, after the Great East Japan Earthquake on March 11, 2011, a company was conducting a project to return albums that had been retrieved after being washed away by the tsunami to their owners. This company reached out to NEC, wanting to use NeoFace. With NeoFace, the faces in the retrieved photos were converted to data that was matched to the faces of people who came searching for albums. In this way, the system contributed to swiftly and accurately returning these albums to their owners.

Further, it is now known that face recognition technology can be used to identify more than just faces. For example, this technology can be applied in research for image diagnoses for cancer. When a system that was trained ahead of time with many images of cancer conducted image diagnosis, the system was able to detect cancerous lesions with the same or greater accuracy than an experienced physician. In the field of manufacturing, this technology can identify products individually rather than by production batch, thereby enabling the identification of "object fingerprints," the minute features that

appear on the surface of individual products, and improving traceability.

“We are also researching a technology known as otoacoustic authentication. The shape of the ear canal differs between individuals, so if you emit a sound into someone’s ear with earphones and then pick up its reverberation, you’ll get different results for everyone. This can be used to determine and verify who is wearing a pair of earphones. You can thus make a system where only those with access authorization can receive communications. We anticipate this technology will be useful in fields that require higher levels of security, such as medicine and security.”

Toward greater business expansion on the global market

This “leading technology” that had evolved so far as to obtain a high evaluation in the NIST benchmark now aimed for greater business expansion on the global market. An employee involved at the time comments, “Internationally, many people tended to know of NEC as just ‘a display company,’ but after placing first with face recognition, we received many offers from customers and partners who wanted to use or evaluate our technology,” showing how great an impact this technological capability had on business.

However, there were also setbacks in this process. This was the period NEC was shifting its business style. To reduce cost with improved development efficiency and lower SI risk, NEC was moving from its prior business style of making systems one-on-one for each customer to a style of making global platforms that incorporated requirements shared by many customers and providing systems and services with said platforms as foundations. It was during this period that a fingerprint identification project that had been proceeding in one country ended in the cancellation of the contract.

“What we call global business is really an ‘aggregation of local businesses,’ and we have to meet the differing demands of each customer therein. To approach this, we decided to make the core technology parts such as the fingerprint-identification and face-recognition matching engine into a platform and customize the applications that run on that platform for each project. We tried to optimize development by switching to this kind of architecture, but because we were in an ‘in-between’ period with technology, we had no choice but to proceed with a product that was not fully developed. In the end, that meant the project was unable to fulfill the user’s required specifications, and

ultimately, it ended in the cancellation of the contract.”

So reflects an employee familiar with the project. However, transitioning to a global platform, albeit while overcoming a failure such as this cancelled contract, secured many benefits such as shortened delivery times, reduced costs, and lower SI risk. This bitter experience led to future success.

Now, face recognition is acknowledged both within and outside NEC as “the leading technology” that represents NEC. Research that was seen as “something to spice up hardware” grew to be a technology that supports NEC, with over 1,000 systems supplied to approximately 70 countries and regions.

Aiming for even greater business expansion, NEC conducted large-scale M&A: namely, the acquisitions of Northgate Public Services, a company that provided various integration solution platforms and had a solid customer base in the United Kingdom’s central and regional government, and KMDS A/S, the largest IT company in Denmark. NEC aims to expand its safety business from Europe to the entire world by connecting the common-task platforms owned by these acquired companies with NEC’s biometric authentication and AI technology.

What core technologies will be required to provide the solutions society seeks? We can make predictions, but nobody knows for certain. Indeed, NEC’s face recognition technology began not from a grasp of clear market needs but from research based on the idea that the technology could eventually be used for something. Despite this, the research team managed to continue their work, and over the course of time, society changed, enabling this research to grow into one of NEC’s preeminent technologies.

One of the researchers who launched the face recognition technology research says, “Technology comes down to people. If you cease research and the people involved leave, then the related technology will stop developing. If you then want to recover from ceasing development, you have to expend vast resources and start over from the beginning. Of course, we need to optimize development costs and focus on select areas, but I think we also need to make decisions with the understanding that we cannot know the future.”

That being the case, nobody will use a technology unless they know the technology exists. Mr. Imaoka, who took over face recognition research and later became team leader, shares the following.

“We want people around the world to use the technology we’ve made. For

them to use it, we first need them to know about it. That’s why the researchers go out and promote the technology themselves. We also make organizations and research groups to gather talented staff. The principles behind our behavior are simple. However, unlike research conducted at places such as universities, we belong to a corporate laboratory, so we cannot cut ourselves off from business. Ultimately, what we research must be sellable as a product or a solution. What is needed to make it sellable? I believe it’s important for us to continue asking that question.”

These thoughts would later take shape as a biometric authentication brand. In 2018, NEC widely announced its world-class biometric authentication technology (for faces, irises, fingerprints, palm prints, finger veins, voice, and otoacoustics) under the name “Bio-IDiom,” garnering a strong response.

Bio-IDiom offers “multimodal authentication” by combining multiple methods of biometric authentication technologies that can be used differently to match varying customer and on-site needs. This unique idea was received very well, with Bio-IDiom winning the Good Design Best 100 Award at the 2018 Good Design Awards hosted by the Japan Institute of Design Promotion.

Toward AI that helps and cooperates with people

Authentication technology, best known for face recognition, has even expanded beyond the areas discussed here. In distribution and retail, this technology makes the shipping inspection process at product warehouses more efficient, has marketing uses such as optimizing item lineups in stores, and is undergoing field testing for use in unstaffed stores. In the service industry, this technology improves customer service by detecting the arrival of VIPs. In fields where large-scale events are held, such as finance, city infrastructure, sports, and concerts, this technology combined with behavior-detecting technology provides safety and security. In these and other ways, authentication technology meets the needs of customers through varied and diverse solutions and field testing.

In February 2019, NEC’s biometric authentication technology was selected for implementation in boarding procedures at Narita International Airport. With this new boarding process, called “One ID,” travelers can register a photograph of their face during initial procedures, such as check-in. This will then enable travelers to pass through the following procedures, such as baggage

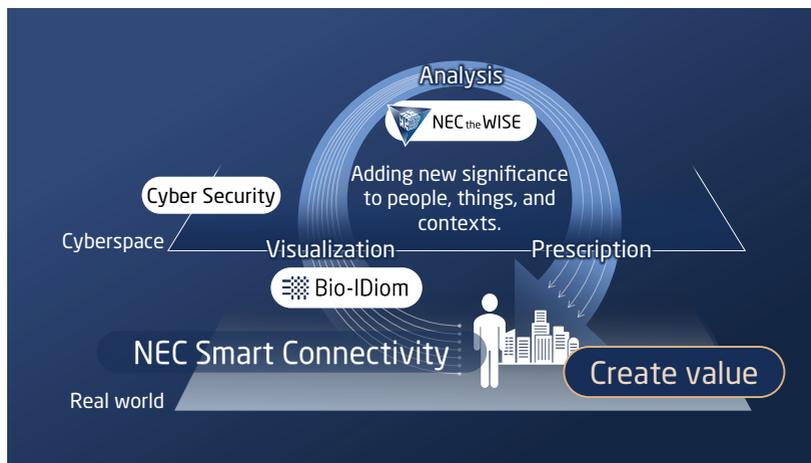
drop-off, security screening, entrance, and boarding by simply showing their face, without having to present boarding passes and passports.

Further, in July 2019, NEC announced a partnership agreement with Star Alliance, the global aviation alliance, to develop a platform utilizing biometric authentication. The platform will provide services that will enable seamless boarding procedures for passengers of alliance-member airline flights and improve the quality of passenger experience. In the future, this system will not be limited to airports, but expand into cities with applications such as hotel check-in and convenience store payment, providing users around the world with safe and pleasant travel experiences while also aiding in resolving social issues such as labor shortages.

As “AI applications in the real world” rapidly increase in this way, some people voice concerns about whether or not “AI with ability that surpasses that of humans” can coexist with humans. NeoFace can match 30 million units of data in one second (as of 2018); indeed, this level of speed and accuracy is impossible for humans.

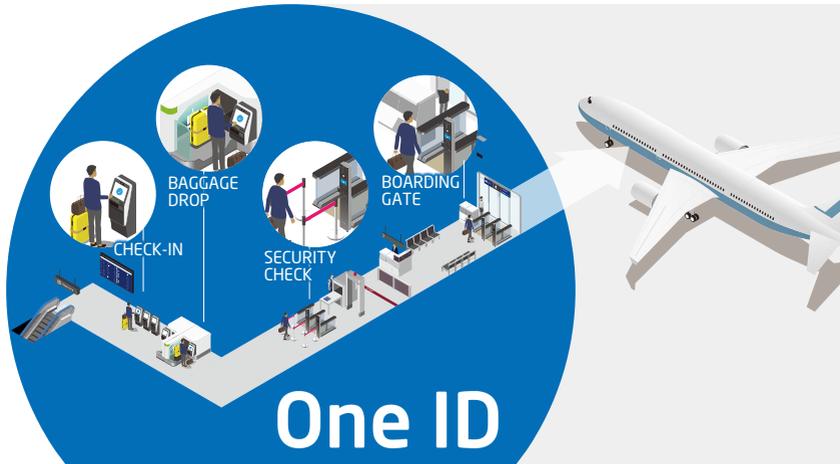
However, tasks that must be conducted without absolute data available, such as business-management decisions and interpersonal care, and jobs that require careful attention to differing situations and the subtle emotions of others cannot entirely be entrusted to AI alone. Machines can manage tasks

The Creation of Value through NEC Technology



Changing the world with what grew to be “the leading technology”

Concept image of boarding procedures with One ID at Narita International Airport



in which an immediate and definitive result is necessary, enabling people to focus on tasks that only people are capable of. This world in which AI and humans work together will be sustained by NEC the WISE. The future NEC is striving toward is just beyond that horizon.



The society NEC aims to create and the Tokyo 2020 Games

To pass on new legacies to the next generation



NEC aims to create our envisioned “sustainable society” as a creator of social value in a world facing many issues. As a Gold Partner of the upcoming Tokyo 2020 Olympic and Paralympic Games, NEC is working to use this opportunity to create “the ideal society.”

The “sustainable society” NEC aims to create

The United Nations predicts that in 2050, the global population will reach 9.7 billion people, and increasing concentration of populations in urban areas will lead to even faster consumption of resources. Compared with 2018, greenhouse gas emissions are predicted to increase by 1.5 times, and demand for water, food, and energy is predicted to increase by 1.6 to 1.8 times. Many challenges must be overcome to create a “sustainable society,” such as climate change, natural disasters, and concerns over social unrest from economic disparity.

In the face of these challenges, NEC aims to realize a safe, secure, efficient and equal society by creating new social value with a “digital transformation” using ICT such as AI and IoT and through “co-creation” with customers, partners, citizens, government agencies, and international organizations.

As part of our activities as a Social Value Innovator, NEC is supporting the Tokyo 2020 Olympic and Paralympic Games (Tokyo 2020) to be held in 2020. NEC sees this international competition as the ideal opportunity both for Japan to develop as a society and to create a legacy for the future of overcoming social issues.

In February 2015, NEC entered into a partnership agreement with the Tokyo Organising Committee of the Olympic and Paralympic Games as a Tokyo

2020 Gold Partner. The categories of NEC's partnership agreement are "Specialist Public Safety Equipment & Software" and "Network Equipment," two areas that efficiently support a safe and secure society. The former category includes technology such as biometric authentication and behavior detection and analysis, while the latter includes software-defined networking (SDN) and both wired and wireless networks.

An employee in the Tokyo Olympic and Paralympic Promotion Division, who has evaluated and implemented methods by which NEC will support the event, shares the following.

"We decided we wanted to contribute to supporting the Olympic games, the grandest celebration in the world, with NEC's 'best-in-the-world' or 'first-in-the-world' technologies that we pride ourselves in. There are numerous products and services that fit this description, but we are particularly proud of our biometric authentication, best known for face recognition, with the highest accuracy in the world. Also, SDN, which enables network configuration to be flexibly defined with software, is a common technology now, but NEC was the first in the world to commodify it. Thus, we negotiated the partnership with these two technologies at the center."

This is the first time that "public safety" has been a sponsorship category

At the announcement meeting for the "Tokyo 2020 Sponsorship Programme"



for the Olympics and Paralympics. NEC is fully devoted to creating the new social value of public safety and is focusing on making it a legacy of these Olympic games.

NEC was also an official sponsor of the Rugby World Cup 2019, which was held in Japan the year before Tokyo 2020 was originally scheduled to be held. NEC's sponsorship category was "Public Safety" for this event as well, with biometric authentication, SDN, and wireless communication included in the category.

NEC could create a legacy even more quickly than anticipated if it could utilize its advanced technologies at these two international sports events consecutively held in Japan and make the public aware of the social value these technologies provide. This thinking was part of what led NEC to support both events.

The legacy of the 1964 Tokyo Olympic and Paralympic Games

The previous Olympics held in Tokyo, the Tokyo 1964 Olympic and Paralympic Games (Tokyo 1964 Games), saw the creation of the Tokaido Shinkansen bullet train and the completion of the Shuto Expressway, two important parts of transportation infrastructure that continue to play a large role in modern

Parabolic antenna used for satellite transmission in the Tokyo 1964 Games



Japanese society. The Olympics of half a century ago left a legacy that continues to the present.

A significant legacy was left in the field of information and communications technology. The automatic timing system and real-time announcement of results, which are taken for granted in modern sports, were first implemented at the 1964 games.

One endeavor that had especially great impact on people was the achievement of the first satellite transmission of the Olympics in history. Until then, Olympic events had been recorded on video tapes that were then flown around the world to be broadcast. Thus, the public would learn about athletes' performances and rankings from newspapers first and see footage of the events after. However, the Tokyo 1964 Games marked a turning point: from then on, footage of large sports events was broadcast in real-time around the world.

The Tokyo 1964 Games' satellite transmission was truly achieved through the united endeavors of Japan's relevant government agencies, broadcasting organizations, and companies. An American satellite was used, but technical difficulties continued to delay its launch further and further. The satellite was finally launched successfully a mere 53 days before the Olympic opening ceremony. However, those involved continued to work night and day without giving up, succeeding in broadcasting the opening ceremony and various sporting events to the other side of the Pacific Ocean in real-time.

As with the achievement of satellite transmission in 1964, the upcoming Tokyo 2020 will also surely see the creation of innovation and new legacies through the united efforts of all of Japan, overcoming the limits of affiliation and self-interest. NEC hopes to contribute to these efforts.

What NEC can contribute to Tokyo 2020

The core technology in the field of public safety, which NEC is striving to make a legacy of Tokyo 2020, is face recognition, which boasts the top performance in the world. In August 2018, NEC announced that it would supply a system using this face recognition technology for verifying the identities of those involved in the Games such as athletes, organizing staff, volunteers, and media personnel—approximately 300,000 people in total—when they entered the event venues. This will be the first time a face recognition system is used at the Olympics and Paralympics for admitting people involved in the event.

A photo of an individual's face is taken when the individual passes through the entrance gate. The individual then touches his or her ID, which has that individual's ID information built in, to the equipment set up at the gate, and his or her ID is verified. The photo taken of the individual's face and the ID card information are matched to a pre-registered facial image, checking that the individual passing the gate is indeed who that individual's ID claims to be. Identity verification systems using NEC's face recognition technology have been used at event venues such as concerts. The Tokyo 2020 system is also a "walk-through" system that can verify people while they pass the gate without the need for them to stop. The employee in charge of this system shares the following.

"We aim to smoothly and precisely verify identities with NEC's face recognition technology, which is the fastest and most accurate in the world. Obviously, rigorously checking IDs is our objective, but we also aim to achieve this conveniently without forcing anyone to wait."

In past Olympic games, multiple events were all conducted within the grounds of one established Olympic Park. Thus, people could move freely between event venues once their identities had been verified once. However, the Tokyo 2020 event venues are spread out across the metropolitan and suburban area, so identities must be verified each time an individual moves between venues. People must not be made to wait for long hours in lines in the height of the summer heat to confirm their IDs. NEC's technology will contribute significantly to enabling the approximately 300,000 people involved in the Olympic games to move smoothly between venues. A similar system was used in the Rugby World Cup 2019 when admitting media personnel to Tokyo Stadium, where the opening match was held, and International Stadium Yokohama, where the final match was held.

Along with the face recognition system, a security-support system utilizing NEC's image analysis technology will also be implemented at the venues of Tokyo 2020, supporting the event's safe operation without disturbing attendees. ICT technology will provide safety to the estimated 10 million total attendees without the venues being noticeably under a strict state of alert. This is truly fitting for a celebration of peace.

Yoshihiro Mizuguchi, who is in charge of the Tokyo Olympic and Paralympic Promotion Division, gives the following remarks.

“Safety and security are the greatest priority at an event that so many people will attend. Japan is considered to have one of the safest societies in the world, so we do not often have the chance to think about public safety in our day-to-day lives. However, as society continues to globalize and diversify, there will be more situations where we have to consider how we can ensure safety. We hope the Olympics will be an opportunity for the public to become aware of this topic and to see that NEC is a company that provides solutions for achieving safety and security in the process. Of course, contributing to the success of Tokyo 2020 is our primary objective, but we’re simultaneously aiming for NEC’s public safety technology to be recognized and to create a legacy that lasts beyond 2020.”

In the field of networking, NEC will utilize SDN to prepare an ideal communication environment that can respond to network congestion and aims to establish information infrastructure that can smoothly transmit the highlights of the Olympics.

NEC is also aiming to create a service that combines SDN with image recognition technology following SDN’s use in Tokyo 2020. Such a service could provide smooth and efficient support. For example, the service could detect the pre-registered license plates of cars of wheelchair users with a camera and notify venue staff so the staff could go and greet the wheelchair users at their place of arrival.

Concept illustration of walk-through face recognition gate



There are numerous services of this sort for which the necessary technology exists, but various obstacles delay the creation of the service itself. Tokyo 2020 is important because they are a chance for all these services to be created at once. The Tokyo 1964 Games saw various dreams such as international satellite transmission, the Tokaido Shinkansen, and the Shuto Expressway all become realities. In the same way, Tokyo 2020 will provide a push toward the realization of the ideal society.

Making a soft legacy by creating an inclusive society

“Hard legacies” (tangible legacies) such as the face recognition system and SDN are not the only aspects of our ideal society that we can achieve earlier than anticipated. “Soft legacies” (intangible legacies) such as an inclusive society and diversity are also within reach. One such “soft legacy” is the success of the Tokyo 2020 Paralympics. Many companies and organizations, including NEC, are striving to ensure its success, their efforts represented by the phrase “Tokyo 2020 will not succeed without the success of the Paralympics.”

An employee who is working to promote the Tokyo 2020 Paralympic Sports and parasports overall says the following.

“We hope the Paralympics can be an opportunity as we strive for a truly inclusive society in which all of us, regardless of ability or disability, can enjoy life safely and with peace of mind. NEC is working together every day with the “Olympic and Paralympic Economic Assembly,” which Japan’s three major economic organizations come together to establish, alongside other cooperating companies to support Paralympic sports and make a working group for support, with the motto, ‘let’s fill the audience of the Paralympics to capacity.’”

NEC is also endeavoring to create an inclusive society that goes beyond simply cheering from the sidelines. Efforts to promote boccia, known as curling on land, are an example of this. NEC not only co-sponsors Japan’s special-needs schools’ national boccia tournament but is also advancing the “Boccia Promotion Caravan for Tokyo 2020” as an official Tokyo 2020 program. This is one effort to normalize parasports as a part of everyday life in order to create a truly inclusive society and consists of providing boccia ball sets to places such as welfare facilities, special-needs schools, and municipal governments.

“Boccia can be enjoyed by anyone, regardless of one’s ability or disability, from the young to the elderly, and it requires tactical skills. There’s no sport as

interesting as boccia,” says an employee in the Tokyo Olympic and Paralympic Promotion Division who is involved in boccia promotion activities.

It’s important that these activities become a legacy and not only something done once in four years. NEC aims to create an inclusive society in which no matter how many years pass, people can look back and think, “After Tokyo 2020, people with disabilities and able-bodied people came to interact in everyday life without discrimination.”

Realizing diversity and an inclusive society and diversity

Since before becoming a sponsor of Tokyo 2020, NEC has supported sports and using advanced ICT with the goal of achieving diversity in a prosperous society where anyone around the globe can fully demonstrate their humanity.

In particular, NEC has continuously supported parasports since the establishment of the Social Contribution Office in 1991, with activities such as cosponsoring international wheelchair tennis tournaments for over 25 years.

Building off of this experience supporting wheelchair tennis for over a quarter century, NEC is conducting various activities with the aim of creating an inclusive society that anyone can live in peacefully, regardless of age, sex, nationality, or disability. NEC’s efforts include lectures by Daisuke Uehara, an NEC employee and the silver medalist in ice sledge hockey (now referred to as para ice hockey) in the Vancouver 2010 Paralympics. These lectures provide opportunities for the world of parasports to become more widely known. Other NEC efforts include creating opportunities for able-bodied people to experience wheelchair basketball.

An employee who participated in a wheelchair basketball event comments, “I came to understand how wonderful the sport was by participating and now I want to share this wonderful sport with many people.”

“I was able to realize various things through experiencing the game for myself. For example, the basket is the same height for wheelchair basketball and able-bodied basketball, so even just throwing the ball as high as the basket while sitting in a wheelchair is hard, let alone actually scoring a goal. However, wheelchair basketball athletes do it with total ease. Actually experiencing the game for myself made me understand how amazing these athletes’ physical abilities and technique are, and it changed the way I watch matches.”

NEC also works with the “Challenge for Tomorrow! Academy” sponsored

by the Nippon Foundation Paralympic Support Center. This is an educational public-awareness program in which instructors, who are people with disabilities themselves, teach about their real daily lives and ways of thinking. Participants listen, learn from, and think together with these teachers. By getting to know each other, both those with and without disabilities can accept one another's differences, be considerate of one another, and learn how best to treat each other. Getting to know one another is the very foundation of building an inclusive society.

In addition, many NEC employees volunteer in various events. In 2016, over 10,000 people in total volunteered in events in Tokyo. Of companies with headquarters in Tokyo, NEC is the only one to have been awarded the Highest Volunteer Company Award.

Three hundred volunteers from NEC will be dispatched to Tokyo 2020. When recruiting volunteers, applicants far exceeded available spaces, showing the high level of awareness NEC employees have regarding volunteering.

NEC hopes to make this culture of volunteering another soft legacy of Tokyo 2020. NEC's "volunteer-support service" embodies this desire in a method befitting NEC as an ICT company. This service supports administrative work such as recruiting and assigning volunteers and contacting people on the day of an event with advanced ICT, and it was adopted for volunteer recruiting for the Rugby World Cup 2019.

Experiencing wheelchair basketball



Evolving from a single IT vendor to a coexisting, inclusive partner

NEC's greatest goals in becoming a Gold Partner of Tokyo 2020 are to create social value and contribute to the event, but there are also beneficial aspects for business.

"For example, we conducted regional, community-based activities through parasports, and in doing so, we developed new relationships with municipal governments. Until now, NEC has often been seen as just another IT vendor among many similar companies, but through these sorts of activities, people have come to see us as a company that can build a coexisting, inclusive society together as a partner."

Companies are recognized by society only when they contribute to that society. Being recognized as a company that actively contributes to society is extremely important for expanding globally as a business. NEC has actively contributed to society for a long time, but these efforts will evolve with our activities for Tokyo 2020 so that our social contributions will become more widely known.

Attitudes about business are also changing. Although NEC has advanced technology, the company's ability to combine and provide that technology in ways that can be utilized in the real world has undeniably come up short at times. Indeed, NEC once struggled to utilize the face recognition technology that is now expected to become a legacy of the upcoming Tokyo Games. An employee who works on the system has the following to say.

"The fact that NEC's face recognition is the most accurate and the fastest in the world has even been verified by the US National Institute of Standards and Technology (NIST) benchmark, which has international authority. We focused on refining this technology, and we provided it as a product. Maybe because we did many BtoB and BtoG projects, though, I feel like there were lots of things we left to our customers, such as considering what scenarios the technology could be used in, or what kind of know-how is necessary to actually use it. For example, when we were creating walk-through identification with face recognition, we accumulated expertise by verifying everything: the angle and height at which to set the cameras, where to touch the ID card, the length of the lane, and even the brightness and angle of lighting, external and otherwise. However, we did not do this kind of thorough information-gathering before."

NEC used to tend to think that simply developing excellent technology and providing it as a package was sufficient; this cannot be denied. However, when it was decided that NEC would be a supplier for Tokyo 2020, technology was repeatedly tested through trial and error in the actual sites that the technology would be used. In doing so, NEC came to have a comprehensive view of operations as a whole.

Dramatic changes in employees' mentalities from involvement in Tokyo 2020

Employees' mentalities have also changed with involvement in Tokyo 2020. One representation of that change is the slogan NEC announced as its concept for Tokyo 2020: "Come together!" or in Japanese, "Atsumarou ze." This slogan was designed to enable more people to more easily conceptualize the category of public safety.

"Tokyo 2020 will surely be very moving because many athletes and spectators from around the world will come together. However, many people getting together also creates risks. NEC is providing support to reduce these risks and

"Come together! (*Atsumarou ze.*)" sign hanging at the C&C User Forum and iEXPO 2018 venue



to ensure safety and security because we want many people to 'come together with peace of mind.' We decided on this phrase to express those feelings," says one employee in the Tokyo Olympic and Paralympic Promotion Division.

That being said, the "ze" at the end of the phrase has a forceful and informal nuance, a way of speaking that could be considered rough in Japanese. The style is a departure from prior NEC culture. It sparked debate leading up to its approval, but the employee in charge felt that the straightforward phrasing of this slogan was the only way to communicate NEC's strong feelings about Tokyo 2020, and this opinion was ultimately accepted.

This "unlike-NEC" slogan demonstrates NEC'S determination regarding the upcoming Olympic games, surprising those both within and outside the company. It also represents NEC's new movement toward breaking from past traditions and make a fresh start. Employees directly involved in Tokyo 2020 are not the only ones having significant changes in their mentalities.

"Employees often tell me that our company becoming a Gold Partner for an international event has given them pride in the company and the job they do. Employees' families seem to feel the same way. In an email I received, one employee wrote, 'My child said to me that I work at an amazing company, and I was so happy.'"

In recent years, NEC has continued to face difficult circumstances performance-wise, but the Tokyo 2020 partnership has stimulated significant improvement in employee motivation. These Olympics are obviously a chance to contribute to society and create a legacy, but they also hold the potential to trigger dramatic changes for NEC itself.

Tokyo 2020 is by no means the goal. For both Japan and NEC, they mark the starting line for evolving into something new.



“Changing NEC” with the next 100 years in mind

Efforts for the future after 20 years of radical changes



NEC marked the 100th anniversary of its establishment in 1999. The 20 years between then and 2019 were a trying journey for the company. Struggling with decreases in sales and operating profit, NEC had to let go of various business enterprises that had supported the company until then and was even forced to reduce personnel. Nevertheless, NEC strove to transform into a company that continuously created social value.

Through 20 years of unfulfilled growth

In fiscal year 2016, Takashi Niino’s first year as president and CEO of NEC, operating profit decreased by half, dropping to 41.8 billion yen. Fiscal year 2016 also happened to be the first fiscal year of the “Mid-term Management Plan 2018,” which was now off to a truly terrible start. Strongly sensing that the future of NEC was at stake, President Niino made the decision to withdraw the mid-term management plan that had already been made public. There was no turning back now. Knowing this, President Niino set out to transform NEC.

There are external factors that impeded NEC’s success over the past 20 years, such as the sharp appreciation of the yen, globalization of society and the economy that exceeded predictions, and the rapid growth of developing countries. However, the largest problems were NEC’s internal structure and culture that were unable to handle these external factors.

During NEC President and CEO Nobuhiro Endo’s time, there were reforms of inefficient internal structures, such as the reorganization of the production division, integration of back office tasks, and working to eliminate cost overruns, which were a significant factor in decreased profits. However, NEC still

had many rigid structures and internal procedures. Compared to companies that continue to grow, or companies that successfully return to a path of growth, NEC's speed of business was overwhelmingly inferior.

The world has changed over the past 20 years such that now, the only companies that can grow are those that can accurately assess changes in the market, technology, and world affairs, swiftly determine what to do next, and take bold action. Since its establishment, NEC had fulfilled customers' stringent requirements with excellent technology and earnest effort, but it had failed to keep up with the global trend of changing corporate culture and creating new business.

People had repeatedly voiced the need for transformative change, but at some point, this insistence died down without the change it called for being enacted.

President Niino recognized the dire urgency of this situation and launched a variety of projects, considering this to be NEC's last chance.

Two projects that have especially taken the lead in transforming NEC are the "NEC School for Social Value Creation," which develops leaders to drive NEC forward with an emphasis on the social value NEC can provide, and "NEC Group Culture Transformation Division: Project RISE," which aims to reform NEC's corporate culture from its foundation. The NEC School for Social Value Creation aims to transform NEC from a medium- and long-term perspective.

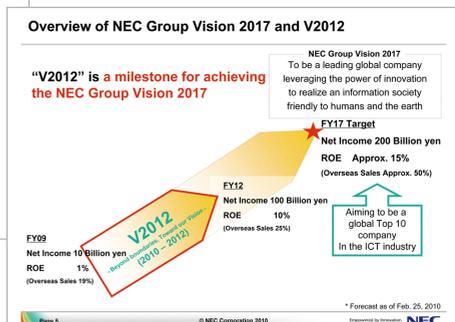
Materials announcing "Mid-term Management Plan V2012"

Empowered by Innovation **NEC**

Mid-term Growth Plan V2012

- Beyond boundaries, Toward our Vision -

February 25, 2010
NEC Corporation
(<http://www.nec.co.jp/ir/ja>)



Project RISE gathers human resources from outside NEC in a newly established division and works to achieve goals. At the root of both of these projects is the strong desire for NEC to continue to exist as a “Social Value Innovator” in 50 and even 100 years’ time.

The starting point for change : the “V Retreats”

Efforts such as the NEC School for Social Value Creation and Project RISE aim to determine the ideal future of NEC and develop the human resources and corporate culture that will move NEC toward that future. These efforts can be traced back to 2010.

Endo, who was selected as NEC’s president and CEO in March 2010, promptly began weekly management team meetings called “V Meetings.” The members involved in administrative decision-making came from various backgrounds within NEC, having worked on business enterprises all across NEC’s diverse fields. The goal of the meetings was to give the members a space to go beyond business domain and organization to discuss honestly and thoroughly the challenges NEC faced. However, these discussions did not seem to improve NEC’s performance, and the sales target of the “Mid-term Management Plan V2012” effectively had to be withdrawn.

The problems facing NEC kept piling up, but still the company could not change.

Feeling a powerful sense of crisis from this situation, NEC President and CEO Nobuhiro Endo began discussions for structural reform that included a 10,000-person reduction in personnel and for the formulation of the “Mid-term Management Plan 2015,” which would cover from fiscal year 2013 to fiscal year 2015. From June 2012, the management members of the time began expanding their discussions through retreats held once a month. The mission of this team, named “V Members,” was to “have top management consider, formulate, and implement the necessary company actions and method of management for NEC to contribute to people and society and continue to thrive for over 100 years into the future.” It may seem natural for the members involved in administrative decision-making to consider company actions and the method of management, but it was not so simple for NEC at the time. This was partially due to the repeated switches in strategy and organization that happened since the year of NEC’s 100th anniversary, 1999.

Koji Nishigaki, who became NEC's president in 1999, faced crises such as the Defense Agency Central Procurement Office Breach of Trust incident and massive financial losses; he decided to adopt an executive officer system and in-house company system with the goal of enhancing governance and accelerating decision-making. As a fundamental business policy, he focused on the rapidly expanding Internet. "BIGLOBE," which handled a variety of Internet-related business, was made the driving focus of the entire company under the concept "Invitation to the Internet." With various in-house companies such as "NEC Solutions," "NEC Networks," and "NEC Electron Device" also providing Internet-related solutions, NEC aimed to become an "Internet solution provider."

Akinobu Kanasugi, who took over management as president in 2003, felt the dramatic reorganization of business, which included converting semiconductor business into a spin-off company, had established an administrative environment capable of concentrating managerial resources on the remaining IT solution business and network solution business. Kanasugi decided to eliminate the in-house company system and reorganize under nine business-line systems in order to concentrate managerial resources and integrate business to respond to changes in the business environment, which now demanded solutions that went beyond the previous limits of business domain.

Then, when Kaoru Yano became president in 2006, he announced a switch from "defensive management " that prioritized improving corporate culture, to "proactive management " that focused on creating new products and services. Next generation networks (NGNs), which could demonstrate the strengths of the technology NEC had developed, were put at the center of business. The business segment was changed to IT/NW solutions, mobile/personal solutions, and electron devices, and organizations were restructured with the goal of coordinating and integrating technology. Sales, SI service, hardware development, software development, and others were integrated for each customer's business domain.

During that time, businesses that had sustained NEC or made NEC's name known to society, such as home appliances, semiconductors, computers, and mobile phone devices, were reduced in scale, made into spin-off companies, or even sold off due to the "selection and concentration" of businesses. All these decisions, when they were made, aimed to handle changes in the

business environment such as changes in technology, the collapse of the dot-com bubble, and the economic downturn precipitated by the Lehman Brothers bankruptcy in 2008. However, these frequent changes in business policy and organization put tremendous stress on employees on the ground.

What kind of company was NEC? How did NEC contribute to society? As organizations and structures were repeatedly changed, people started to lose sight of the overall direction NEC ought to be heading in and the value NEC could provide to society. Rather, people became more prone to prioritizing the smaller organizations they belonged to within the company. At some point, this mentality spread throughout NEC, leaving people with a sense of being stuck with no way out and serving to further foster an internally oriented mindset.

Unless NEC could dispel this awful culture that had taken root, it would never be able to achieve any mid-term management plans. If anything, the continued existence of NEC itself might be at stake.

So, what was to be done? The V Members agreed on the management team coming together as a monolith, honestly discussing the essential problems facing NEC, considering the ideal future of the company, and considering how the management team ought to be to make this future a reality.

Regarding the ideal future of NEC, the V Members expanded discussion on what kind of value NEC can provide to society as a company on the basis of interviews with customers, feedback from employees, and results of a survey on how society viewed NEC. What sort of vectors should NEC pursue business on to embody its corporate philosophy and vision and continue as a company for 100 more years? How could NEC rid itself of a structure in which the company's direction changed every time its leader did, and what should be passed on for sustainable growth?

After thorough discussion, the V Members compiled a statement in September 2012 about business vectors to pass on over the generations.

"As an infrastructure provider for world governments and companies, and as an independent actor, NEC Group will contribute to creating a safe, secure, efficient, equal, and prosperous society, with the goal of 'people living prosperous lives' in mind. We will continue to create and provide new value to improve people's lives, making tomorrow better than today and the day after tomorrow better than tomorrow."

This became the starting point for NEC’s transformation into a global Social Value Innovator. In April 2013, NEC announced Mid-term Management Plan 2015 formulated in accordance with this statement. This was when “Solutions for Society business” was once again defined as NEC’s business vector.

The management team also reverted to how it had been during the time that former chairman Koji Kobayashi, who advanced the concept of “C&C” (meaning “the convergence of computer and communication technology”), was president of NEC.

The V Members read Kobayashi’s publications and invited staff who had supported Kobayashi to engage in discussion so as to further understand what Kobayashi had thought about and been conscious of when envisioning NEC’s future during his time as an executive. As a result, the V Members decided to inherit Kobayashi’s thoughts on restructuring NEC’s leadership to achieve “point to area” management—in other words, his idea that “executives other than the president all act as representatives of the president; trusting relationships are to be maintained amongst executives, and information is to be mutually shared amongst them.”

The V Members concluded that the responsibility of the management team

The V Members
of the time and
their activities



was to create social value, strengthen the foundation of NEC as a company that achieves sustainable growth, and pass this on to future leaders. To that end, the management team must do “what should be done,” not simply “what can be done,” always keeping the ideal NEC in mind. Further, the management team must achieve management not of localized “points” but of overall “areas” by building a consensus through sharing the answers to the questions, “What will NEC do?” “How will it be done?” and “Why will NEC do it?” Finally, the management team must make the company one that grows stronger with each generation.

“At the retreats, the V Members called each other by nicknames. It might seem inconsequential, but they took any measures they could that would enable them to speak frankly and honestly with one another. They thoroughly and exhaustively discussed not only what had been good about NEC up until now and what should be preserved but also what had to be changed. We could feel their sense of urgency that if they did not reexamine themselves now, they would not be able to find a new future for NEC.”

So recalled the staff of the V Retreat Operations Office who observed the members in thorough discussion.

Business was not the only topic of discussion; the V Members also discussed ideals for people and culture. People would be the ones who would transform NEC into the type of company it aimed to be, one that would continue for 100 years. Employees who could accurately assess the true nature of things and develop creative business while transforming NEC as a company would be a wellspring of significant value. The management team was also responsible for establishing an environment that would develop human resources who could become such next-generation leaders.

NEC had also been shaped as a company by its culture. That NEC culture was becoming unable to keep up with the changes of the times. Digital transformations were progressing, and technology and society were changing more and more rapidly. The V Members concluded that it was the company executives’ duty to preserve a strong culture that fit these modern circumstances in order to continue the culture that had supported NEC for 100 years.

The ideal NEC personnel and NEC culture were not something that only the management team should think about, but rather, something each individual employee should think about in the same way that the management team

did, discussing and sharing ideas beyond the limits of business domain and organization. This would be a true implementation of the "point to area" management that Kobayashi advocated.

After this consensus was reached, from 2013 to present, activities like this have been expanding in scope; NEC School for Social Value Creation and Project RISE are products of such activities.

NEC School for Social Value Creation: developing personnel who can think 100 years ahead

One project that was conceptualized before President Niino's efforts toward dramatic, transformative change was the NEC School for Social Value Creation, the first term of which started in July 2016. The NEC School for Social Value Creation, as its name suggests, gives training for future leaders who will consider the creation of social value that NEC can provide and push the company forward; it can be considered a human resource development project for achieving the goal of "transforming into a Social Value Innovator" raised in the Mid-term Management Plan 2015.

What is worthy of special mention in this project is that it considers the company and society over a long-term span of 100 years. An employee who works on the project discusses the aim of this long-term thinking as follows.

"In our day-to-day work, we tend to end up only thinking about short-term profit. For example, a hundred years from now, the people who are making executive decisions now will no longer be with us. However, we want NEC to still be an indispensable presence in society in 100 years. Of course, our individual products and services will change. However, our corporate culture will remain no matter what. We want the employees who will go on to be members of top management to think beyond the end of their time in this world and to consider what kind of culture our company ought to have. The NEC School for Social Value Creation is a project for producing this kind of personnel and for developing NEC's corporate culture."

Discussion of the NEC School for Social Value Creation began around 2014 amongst management, the Corporate Planning Division, and the Human Resources Development Division. The concept originated in the idea that transformative change would be impossible unless the attitudes and mentalities of future leaders changed. Unlike prior training programs, which

simply teach managerial expertise, the NEC School for Social Value Creation implements a program targeted at mid-level employees and is based on the mentality of valuing leaders who think freely with a broader outlook and create an organizational environment that enables people to speak openly with one another.

Participants are sorted into one of two courses, the Executive Leadership Program (ELP) or the Advanced Leadership Program (ALP), depending on their level within the company. ELP is aimed at general managers who are potential future executive officers, and ALP is aimed at managers and proxy general managers who are potential future general managers. About ten people are selected for each program, for a total of about 25 participants. The programs begin in July each year and conclude in February of the next year, with training content largely consisting of the following four parts: “Co-creation Learning,” “Local Learning,” “Introspective Learning,” and the “NEC Transformation Project.”

Co-creation Learning is a program in which participants learn about changes in society and ideals for the company and leadership through discussion with

Activities at the NEC School for Social Value Creation



leading instructors from outside NEC and executive leaders from within NEC. Another important part of the program is learning about the history of NEC from its establishment. Learning the intentions of NEC's founders and internalizing NEC's corporate philosophy are vital parts of training for company leaders who will navigate the company through future hardships.

The training's main program is Local Learning, in which participants experience the front line of social issues for themselves. Teams travel not only to local areas in Japan but also to locations in other parts of Asia and in Africa. Participants learn what is happening in societies around the world with the goal of using this knowledge for the creation of social value.

Introspective Learning is a program in which participants put what they learned in each of the programs into words, solidifying and internalizing it. Through professional coaching, participants reexamine their personal leadership and aim for further growth as leaders.

In the final NEC Transformation Project, participants integrate everything learned up to that point and conceptualize how they would manage the future NEC, picturing themselves as the leaders of the company. At the training's completion ceremony, each participant imagines him or herself as CEO and makes their inaugural CEO speech.

Participants who complete the training speak of experiencing significant personal changes through the approximately six months of learning:

"First I thought, 'Are they going to make me come up with a business plan again?' But it turned out to be completely different from what I expected. I feel like I updated the OS of my mind."

"I had thought of business and social values as two separate things, but I was able to see their connections. I also remembered some 'forgotten feelings' that I had within me."

In particular, the impressions of participants after this training is well represented by the response, "I felt that I became more firmly centered and well-rounded." Before attending the NEC School for Social Value Creation, many participants felt they had simply completed tasks assigned to them by their managers, but after completing the programs, they discover what is important to them and what they earnestly want to accomplish. One general manager who participated in ELP shares how his worldview changed.

"In Local Learning, I went to a location just a little off the path of my

everyday commute. I was shocked to discover what it was really like there. I had not even been aware of what was happening near me right here in Japan. The intense experience of that shock has stayed with me.”

Future leaders of NEC consider not only the company but the society around them and are aware of how that society is changing. Creating these leaders is another important role of the NEC School for Social Value Creation. Participants in the training accumulate relevant experiences, broaden their horizons, become capable of responding to changes in society, and develop the ability to find new business from there.

The project considers the 100-year future of NEC, so it does not seek a specific answer to the question of “how NEC should be.” However, continuing to think about how a company should go about creating social value is vital for employees who will become the top company leaders.

The NEC School for Social Value Creation has grown in ways that were not initially anticipated. Some participants wished to give younger generations a chance to experience what they had learned in the program and conducted similar training within their divisions. As leadership changes, formerly rigid organizations are revitalized. The impact of this may not be visible in short-term performance. However, the NEC School for Social Value Creation is steadily creating results.

Project RISE: transforming the culture of NEC

The NEC School for Social Value Creation aims to transform NEC from a mid- and long-term perspective. By contrast, Project RISE sets periods with specific objectives, aiming to revise NEC’s corporate culture from its foundation.

The project’s central role is played by the Culture Transformation Division. This division’s activities were prompted by NEC’s alliance with General Electric Company (GE) in the latter half of the 2010s. President Niino found himself acutely aware of the difference in GE and NEC’s sense of speed. Like NEC, GE had been in business for some 100 years, so why were the two companies so different? President Niino felt NEC had many things to learn.

President Niino decided that to transform NEC’s corporate culture, a newly established division with members from within NEC and invited from outside of NEC would be appropriate. His powerful determination to transform NEC’s corporate culture within his time as the company’s president was at the root

of this decision.

Thus, the Culture Transformation Division was established on April 16, 2018.

President Niino invited Chika Sato, who had been the head of HR divisions at companies such as Microsoft Japan and GE, to be head of the division. Sato reflects on when she started her job at NEC as follows.

"My first impression was that the company was frozen in time. I started my career in a Japanese company over 30 years ago, and I felt like the workplace NEC was the same as or even older than what I had seen back then. It was its own world, like some sort of 'NEC village' that had been cut off from the outside. That may have been why the company felt completely devoid of diversity despite having over 100,000 employees."

President Niino had prepared the necessary structure and human resources. He decided to start NEC's transformative change by carefully listening to the thoughts of employees, tirelessly carrying out dialogues with a broad range of employees. From the results gleaned from these dialogues, the Culture Transformation Division began measures under three categories: "transformation of the evaluation system for officers and others," "work-style transformation for maximizing our divisions' and the company's output," and "communication that resonates with employees through the direct words of the president."

When operations actually began, however, the Culture Transformation Division members began noticing more fundamental problems not entirely covered by these measures.

Were executives making growth strategies with the future in mind? Or was the company plagued by bureaucracy, with employees simply looking to their higher-ups at every turn? Were employees' mentalities and ways of working up to date with the times? Was the state of human resources and evaluations appropriate? Were talented young employees being kept motivated? The problems felt mountainous.

Project RISE was set up in June 2018 primarily by the Culture Transformation Division in order to surpass these obstacles. The project's goals are to break out of NEC's "large-corporation disease" stagnation, eliminate bureaucracy, enact fair HR evaluation systems, and to fundamentally transform the HR system and work style. The project also set three specific numerical targets: "cut internally oriented labor time by 50%," "achieve an average of at

least 4.5/6 points from at least 50% of employees on Specified Item 3 of the Employee Survey,” and “obtain at least 50% survey responses from customers that place NEC as a strategic partner,” with 2020 as an initial cut-off point.

The Culture Transformation Division members are at the core of Project RISE, which is proceeding with the mutual cooperation of a top leadership team headed by President Niino, the employees of divisions relevant to the project’s various goals (such as human resources and sales), and a group called “Change Agent.” Change Agent consists of 31 employees seen as potential next-generation leaders, gathered from all throughout NEC Group. They play the role of communicating the messages of transformative change to their divisions and fields and of communicating feedback from the workplace back to the Culture Transformation Division and executives.

Project RISE was launched very recently, but it has already delivered significant change: the intentions of top leadership are now thoroughly communicated throughout the entire company. A member of the Culture Transformation Division comments, “Now, instead of one-way communication from the president, we hold frequent ‘dialogue sessions’ for mutual discussion. This also enriches discussions conducted later. People have started to raise their hands without prompting in meetings, and comments have gone from being negative and superficial to constructive, albeit strict.”

Change Agent’s activities



A dialogue session between President Niino and employees



It's important that each individual employee holds a managerial perspective in order to create a strong organization; these dialogue sessions are gradually making that happen. However, the culture of NEC that was built up over 120 years cannot be transformed easily, even if signs of change are starting to show. Sato says, "What's even more important is to continue to transform."

"Transformation is not supposed to be something a company has to rally itself into doing. It should be the company and the individuals working there naturally continuing to change in accordance with changes in society. Those who can not do that are not qualified to receive a salary. Without this kind of mentality, surviving globally in the future is unlikely."

Will NEC be able to destroy its corporate culture that is trapped in the past and continue transforming?

Sato speaks of NEC's future with anticipation.

"NEC is not the only one stuck in its old ways. I feel like there are old ways of doing things that ought to change all throughout Japan. However, if a company of NEC's scale can change, then Japan can change too. I decided to work with NEC because I believe this. NEC is a company with that level of influence. I hope NEC will make a comeback as a leading company paving the way to the future, like it did in the past."

For NEC to continue for 100 years onward

One hundred and twenty years since its establishment, NEC is striving to find its new form even through its struggles. Transforming the attitude and unifying the mindset of all of NEC's employees—over 100,000 people including Group companies—is no easy task. However, NEC will not be able to last until 2050, let alone 100 years from now, unless it can accomplish this.

NEC selected the corporate brand message "Orchestrating a brighter world" in 2015. This message expresses NEC's resolution to "demonstrate leadership and integrate excellent technology with expertise to realize a bright, hope-filled future for society in concert with the people of countries and regions across the globe."

To achieve this, contribute value to society, and build a better world, NEC must change. Each and every employee of NEC Group must transform so that someone reading this in NEC's 150th or 200th anniversary year will think, "They did an excellent job of overcoming hardship and executing transformative change."

Part. 4

INTERVIEW

President and CEO (Representative Director)

Takashi Niino



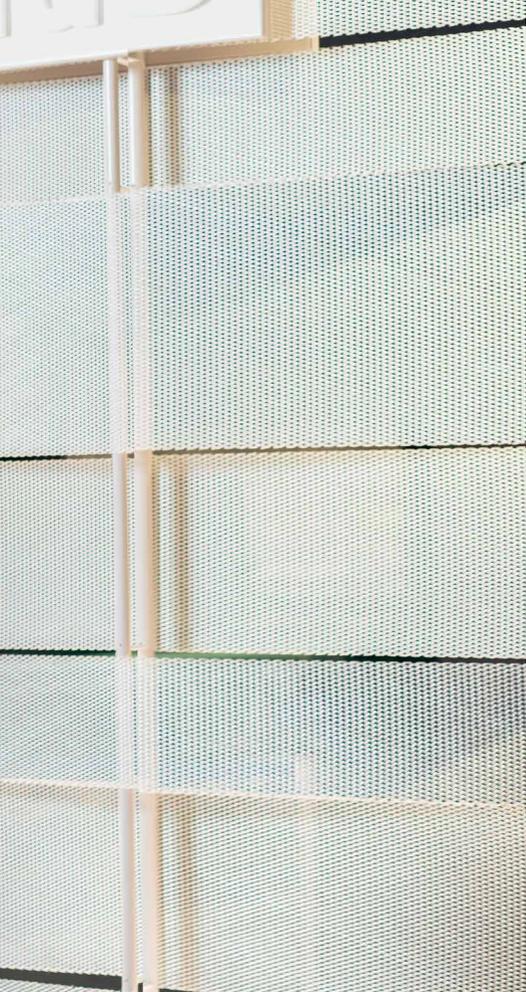


President and CEO (Representative Director)

Takashi Niino

**Achieving the transformative
necessary for the coming 50 and**

**Making NEC a “fighting group” with
a long-term perspective**



change 100 years

From a devastating first financial report to determination for the coming 50 and 100 years

I became NEC's president in April 2016. When I took this position, I thought about improving the company's value during my time as president and passing the baton that I had received from Chairman Nobuhiro Endo on to my successor. However, I did not initially give sufficient consideration to what the company would be like after I left my position as president.

This is no longer the case. Compared with the history NEC has created up to this point and the future it will create going forward, my time in charge of the baton is very brief. That made me realize that the 50 and 100 years following my time as president are much more important than my time in this position itself. NEC needs to develop a foundation, environment, and culture for continuing its business for many years and making even greater contributions to society. To do so, we must enhance our organizational strength and capability as a fighting group. These are the goals I want to devote myself to during my time as president of NEC.

I realized this in my first year as

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Takashi Niino

president. For fiscal year 2016—the first fiscal year of the “Mid-term Management Plan 2018”—our target operating profit was 100 billion yen, but we only achieved 41.8 billion yen. We had predicted some decrease in existing business in fiscal years 2014 to 2015 due to the decline in demand from telecommunications carriers and the dissipation of the special demand that “My Number”-related business had created in the public sector. With that in mind, new business enterprises were launched to make up for the decreased profit, but these businesses did not go as anticipated, leading to disappointing financial results.

These were our first financial results since I became president; I was devastated. Why had such a gap emerged between our goals and our performance? I knew we could not go on like this, and while reflecting on NEC’s past, I considered its future. This was how I determined that we needed to put more effort than ever before into developing ourselves as an organization that can compete in the long-term, rather than simply following the trends of our most recent performance.

This determination is behind the structural reforms that have been conducted since 2018. Even if NEC

did not meet its target profits, we would not immediately be forced to go out of business. We could get by for the time being without conducting difficult structural reform. However, where would that leave NEC in 50 or 100 years? I decided that change had to be made now.

NEC is a technology company. Our researchers and engineers earnestly strive to develop new technology. NEC is also a company that truly values its customers. We throw ourselves into our projects to please our customers. These are wonderful traits. However, we must earn enough profit for reinvestment if we are to continue to provide such value in the future. Without an operating profit of at least about 5%, reinvesting for assured growth becomes difficult, which then weakens our ability to support our customers.

One key aspect of the fiscal year 2018 structural reforms was the reduction of fixed costs. With this, roughly three thousand people left NEC Group to find opportunities elsewhere. Along with reducing fixed costs, we are also accelerating the shift of resources to growing areas. We aim to further improve the value we provide while developing an organizational character that can securely produce profit. I want to



implement one policy at a time to enhance NEC's competitiveness. We will aim for greater operating profit, from 5% to 10% and beyond. Transformative change is necessary on many fronts to accomplish this.

Thoughts on culture transformation and dedication to visiting work sites

One important theme from a long-term perspective is the transformation of corporate culture. The impact of this transformation will take a long time to be noticeable, but nevertheless, all we can do is implement one policy at a time and let our actions steadily accumulate. In April 2018, I established the Culture Transformation Division, which is now working with executive leadership to

transform the organizational climate and culture of NEC.

I felt that it was first necessary to visualize our employees' level of motivation and the level of enthusiasm in the workplace. We had conducted a once-per-year attitude survey for some time, but we increased its frequency to once-per-quarter and adjusted its content. We will analyze this survey data from various angles and utilize it for making improvements going forward.

I also have some personal initiatives that I have taken. Since becoming president, I have visited NEC sites within and outside Japan, held company town hall meetings, and conducted many conversations with people working on the ground. I have made over 30 such visits and met

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with a total of approximately 10,000 employees. However, this is still only about 10% of NEC's total employees. I would like to continue to conduct this sort of communication.

Looking back about 40 years to when I was in my twenties and had just entered NEC, executives seemed to be living in a different world than I did. Even so, as Japan's society and economy were making tremendous growth, I was able to clearly understand our goals as an organization and how each individual employee fit into achieving these goals.

However, we now live in a time of dramatic change. We change our policies more frequently than we used to. It's not easy for the entire organization to operate in an integrated, coordinated way on the basis of one strategy. This increases the likelihood of misunderstandings occurring amongst individual employees.

Employees will not know what they are supposed to do if there are discrepancies between management policy and what their direct supervisors say. Some employees will probably prioritize the instructions of their direct supervisors. A corporate strategy cannot be achieved if such discrepancies occur all throughout an organization. Careful communication is vital to prevent this type of

situation. That much is obvious, but thoroughly implementing such communication is difficult. This is precisely why I am so particular about visiting work sites myself.

Changing NEC's internally oriented culture to make it a fighting group

NEC is also reexamining our personnel evaluation and compensation systems. We have adopted various structures up until now, but the base structure has always been the seniority system and lifetime employment. This has left us with a system that is difficult to understand. How can we develop a system that fits this day and age and is highly satisfying to both new graduates and new employees who have prior career experience? This is an



Project RISE, which advances culture transformation

extremely important topic for us.

We are also working to change our internally oriented culture. At the company town hall meeting, the problem I heard mentioned most was that there are too many internal documents. People also told me that too much time is spent interacting between divisions. For example, when combining products and services to provide them as solutions to customers, an employee needs to request estimates from the relevant divisions and then wait until the estimates are ready. To reduce the time and labor used on such internally oriented work, I instructed all general managers to cut the time and labor spent on this work in half. Each division will determine where it needs to improve, and the general manager will commit to enacting said improvement. I also made the items for improvement of any given division visible to all members of that division. From now on, we will conduct regular reviews and check progress. Our workloads increase without us noticing. Processes that were necessary at first lose meaning as time goes on and are continued simply out of habit. There are more than a few examples of this. In our organization, I still feel the negative influence of a top-down structure.

One significant challenge for us is to develop a culture of coordinating “horizontally,” on the same level.

There have been attempts in the past to reform the company prompted by an awareness of this very problem. However, even if the entire company initially engaged in the efforts, that energy would fade out eventually. The same process has been repeated over and over again. At this rate, NEC will not be able to change. This can be said of any type of initiative, but once we decide to do it, we have to see it through to the end. With this powerful determination, I will change NEC into a fighting group.

Behind NEC’s culture transformation: a sense of urgency over the competition to acquire talented personnel

One objective of NEC’s culture transformation is to create a workplace in which employees maintain high motivation and work with enthusiasm. One reason for hastening these efforts is the sense of urgency regarding the intensifying competition around the world to acquire talented personnel.

Even central government offices and well-known global corporations can no longer attract talented per-

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Takashi Niino

Considering our past and thinking about what our future should look like, I decided to change NEC into a fighting group with the determination to “see every effort through to the end.”

sonnel through name-value alone. How can NEC appeal to students so that they will want to work here? It’s no exaggeration to call this the most important topic when considering the future of NEC in a few decades.

Personnel are hired from all over the world. We seek diverse employees, regardless of nationality, who will lead NEC in the digital era. About five years ago, we began hiring activities at the Indian Institutes of Technology. I was worried the first year that some of them joined NEC. This was their first time coming to Japan, and they could not speak Japanese. Would they stick with the company? Could NEC provide an environment that would enable them to do so? My worries, however, were unfounded. Since then, a number of graduates from the Indian Institutes of Technology have joined the company each year, and their retention rate is high. These accumulated experiences have also strengthened our relationship with the Indian Institutes of Technology.

Looking to diversify our human resources, we have also welcomed personnel who know the “outside” of NEC. For example, Senior Executive Vice President Akihiko Kumagai, who runs overseas business, and Chika Sato, general manager of the Culture Transformation Division, have both experienced the world outside NEC, with Mr. Kumagai having worked at GE Japan and Ms. Sato having worked at GE and Microsoft Japan. Such people who know the outside world positively influence their environments. I am always saying, “look outward,” and seeing how these new members of NEC conduct their work and interacting with them is one way of doing so.

Becoming a company that encourages taking on challenges through start-up support unique to NEC

Receiving support from the outside is necessary, but so is extending our support outward to others. I often hear of people who departed NEC going on to positions of responsibility

in large companies and start-ups. I find it slightly regrettable that they are no longer with NEC, but I am happy for the success of our former colleagues.

I say “former colleagues,” but a fair number of them actually continue to work with us in the present. There are numerous cases of former employees holding important roles as NEC’s partners working with us toward our goals. As this win-win network that includes NEC expands, it will eventually circle back to us in the form of various expertise and opportunities.

Ryohei Fujimaki, the CEO of the data-analysis start-up dotData, Inc., is one such partner of NEC. Mr. Fujimaki formerly worked on solution development as head researcher at NEC Research Institute; he took part in planning dotData, which NEC launched in Silicon Valley, as a main member. Later, seeing how passionate Mr. Fujimaki was, NEC supported dotData going independent.

A number of engineers transferred to dotData with Mr. Fujimaki, as did many intellectual properties. That being said, dotData and NEC coordinate in various ways, with NEC holding the company’s sales rights in Japan. The presence of Mr. Fujimaki chasing his dreams in Silicon



Valley is surely a powerful inspiration for the employees of NEC, too.

I think Japanese companies that support start-ups in this manner are rare. Others may be of the opinion that it is a waste to let go of a promising subsidiary. Indeed, maintaining a 100% investment may have a larger return. However, if investments require the consideration of

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our Japanese headquarters, we risk falling behind the speed of business in Silicon Valley. I decided that it was more important for NEC to become widely known as a “company that encourages taking on challenges” by supporting dotData’s independence.

There may be employees in research and development who are aiming to follow in Mr. Fujimaki’s footsteps. This is absolutely fine. If they have excellent technology and the willingness to take on challenges, they will have many chances to do so. If this atmosphere of encouraging employees to take on challenges fills our workplace, that passion is sure to come across to students who visit NEC.

Global growth is directly connected to NEC’s growth

How can we get ahead on a global scale? Enhancing our overseas business is a significant challenge we face when envisioning the future of NEC.

In 2018, NEC rearranged our organization to seriously take on the global market. Previously, enterprises such as global business and energy business had been considered “other” business. These “other” enterprises were combined with the manufacturing and sales function

of our telecom carrier business and the global operation of our system platform business in the newly established “Global Business Unit.”

Until then, each division had managed both its domestic and international sales. When NEC made expanding global business its goal, all divisions worked to increase their respective global sales. However, this usually left divisions relying on their domestic profit to support the promotion of global sales. The division as a whole would be making a profit, which would hide the deficit of the global business within that division. For a long time, we were unable to remedy this structural problem.

If we kept on like that, sustainably growing global business would be difficult to achieve. We cannot currently anticipate domestic market growth in Japan, so NEC will not be able to grow unless it does so globally. Therefore, we made it clear where the responsibility lies for the profitability of our global business by integrating the relevant business enterprises and bringing manufacturing and sales together. Leading the Global Business Unit is Senior Executive Vice President Akihiko Kumagai, who I mentioned above.

To expand business on the global market, we must eliminate our

unprofitable business enterprises and develop our profitable ones. We have to examine our products and solutions from the perspective of profitability and growth potential, and this may mean we have to consider withdrawing some businesses from the global market. Leaders will falter in their decisions if they are hung up on the past. This is why I brought in Mr. Kumagai. The aim of this structural reorganization is to overcome NEC's overemphasis on top-line growth; the reorganization is also a message from executive leadership that we are seriously taking on the global market.

This attitude is also clear in M&A. NEC acquired the Northgate Public Services (UK) Limited in 2018 and the Danish company KMD Holding ApS in 2019. NPS is an IT company with strengths in public-sector areas such as policing and justice. KMD, the largest ICT company in Denmark, is a world leader in its field and works on many digital systems for the government.

Until now, when expanding globally, NEC has entered the global market with businesses that originate in Japan. However, a business model that works in Japan will not work on the immense global market. We cannot meet diverse

global needs without developing platform-type business. Therefore, we incorporated companies with relevant strengths into the NEC Group.

Integrating companies like NPS and KMD with NEC's assets will make building a platform-type business easier. We can also create synergy by expanding NEC's authentication and AI technology globally. Connecting NEC's existing sites with its British and Danish sites and resources will also make strategizing in the European region easier.

Aiming to be a value-creation company with a new business model

I have used the phrase "fighting group." This phrase expresses my determination for us to "fight and win in a harsh business environment." For a long time, the crux of NEC's business was developing and providing high-quality products and systems that met customer requirements. We must change this business model from here on.

AI is being widely and fully implemented in Japan and around the world, and data is becoming increasingly important. Our new business model must be based on an awareness of these facts about the era we are in.

Challenges await us as we shift business models, but we must complete structural reforms and cultural transformation to create an ecosystem in which NEC can demonstrate its full potential.

We need to address questions such as, “What are NEC’s strengths?” and “What defines NEC?” With technological capability at its core, NEC has built infrastructure such as telecommunication systems for government agencies and for corporations and has provided platforms to society. We must continue relying on the technology and expertise we have accumulated through many years of experience and refining these strengths.

With this in mind, the mid-term management plan announced in 2013 aimed for the resolution of social issues and declared NEC’s transformation into a Social Value Innovator. When thinking of “the resolution of social issues,” one might primarily imagine solutions for government offices and municipalities, but that is only a narrow sense of the phrase. Now, many companies including NEC are developing business with the goal of resolving social issues. For example, a system that matches supply and demand will not

only streamline customers’ operations but will also help reduce waste. The use of AI and robotics can support solutions for social issues related to aging societies with falling birthrates and labor shortages.

We must shift to platform or recurring-revenue business in order to create greater value. These are the new business models we are aiming for. Of course, an immediate and total shift would be difficult. Our manufacturing and SI business for individual customers will likely remain in the future. However, looking at business as a whole, everyone must be on the same page.

With the SI-type business we’ve had up until now, we can only collect and use our customers’ and partners’ data within their designated scope, which limits value creation. However, a platform or recurring-revenue business collects and uses various customers’ data, and this enables us to give back greater value than with the existing business model.

Until now, we have been able

to provide great value by working closely with customers and striving to surpass their requirements. However, there are fewer and fewer areas for which this model is applicable. From now on, we must open our eyes and examine market and technology trends for ourselves, determine what we should and should not do, and design platforms.

To create such platforms, we cannot forgo collaboration with external players. We will increase the value we provide to customers by working with diverse partners such as large corporations, start-ups, and government agencies that are forward-thinking about open data. At the same time, creating an ecosystem in which NEC can demonstrate its full potential is also important. We are accelerating efforts throughout the company to establish a business model that will create such an ecosystem.

As we shift to platform or recurring-revenue business, there will surely be many challenges awaiting us along the way. I have renewed my belief that to see this journey through, we must complete structural reforms and cultural transformation.

Redefining the “NEC Way” to be simple and easily understood

The foundation for these structural

reforms and this transformation is the “NEC Way,” which summarizes the NEC Group’s purpose and values.

The NEC Way systemized the structure of management activities of NEC Group in 2008, aiming to realize the “NEC Group Vision 2017” that depicted our ideals for society and the company in 10 years. Since then, NEC’s goals for society and our various ways of approaching situations have been successively incorporated into the NEC Way in accordance with changes over time and in social demand. All of this has been important to NEC, but so much content was incorporated that the NEC Way became difficult to understand. A philosophy that does not convey its meaning is not a true philosophy.

Therefore, on the occasion of the company’s 120th anniversary, rather than create a new philosophy, NEC decided to take all the existing content of the NEC Way and decisively rework it into something simple and easily understood, something that each individual NEC employee could understand as “the norm” and could always bear in mind. This resulted in the redefined NEC Way.

This adjusted NEC Way stipulates NEC’s “stance as a company” and the “stance as good employees” that each

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individual in NEC Group should know.

We wanted to clearly stress the importance of knowing the answer to the question, "Why does NEC Group exist?" What immediately comes to mind for me when considering the purpose of NEC Group is the founding spirit of "better products, better service." Why did our founder, Kunihiko Iwadare, say "better" rather than "best"? We're told that his intended meaning was that we should not stop at what is best at any one point in time, but rather, we should always continue to pursue something better for our customers and society. Our products are different now from those of the time of our company's founding, but this spirit has always been passed on as NEC Group's DNA and will continue to be passed on.

"C&C," envisioned by NEC's then-chairman Koji Kobayashi in 1977, is also an important concept

for us when considering our purpose. "C&C" was a declaration to use computers and communication (C&C) to provide systems that enabled people to speak with anyone, anywhere, at any time and to aid developing nations so that they could participate in those systems. It was an extremely advanced idea at the time it was conceived. This concept was elevated to be NEC Group's very identity and is important to us to this day.

Now, mobile devices and the Internet can be used absolutely anywhere and everywhere; "C&C" has become a reality. "C&C" has been a part of everyday life for the younger generation since they were born; would it be fitting as a phrase to be included in NEC Group's purpose for the next 10 or 20 years? This became a significant point we focused on.

From the beginning, NEC has had the philosophies of "harmony with

NEC Way: NEC Group's Purpose and Values

- **Stance as a Company**

- **Purpose** Why does NEC Group exist?

- **Principles** How should NEC Group conduct itself to fulfill its purpose?

- **Stance as Good Employees**

- How should we conduct ourselves as individuals?

- **Code of Values**

- **Code of Conduct**

society” and “company growth contributing to society” at the root of its management, and “C&C” was a concept for achieving those ideals. In 2013, a shift to the expression “Social Value Innovator” was announced as a way to focus more on the value that NEC Group works to create while still being rooted in those original philosophies. In 2014, we settled on the phrase “Orchestrating a brighter world” to express this.

I want to continue using “Orchestrating a brighter world,” which appropriately expresses NEC Group’s new direction while adhering to the concept of “C&C,” to convey NEC’s new purpose.

NEC Group thus consolidated the concepts and expressions we want to value as a company in the “Purpose” and “Principles” of the new NEC Way.

“Purpose” and “Principles”

First, we summarized our devotion to contribute to the prosperity of society as our “Purpose,” with “Orchestrating a brighter world” as the basis.

Until now, NEC Group has used the phrases “corporate philosophy” and “vision” to express the company’s ideals and direction. The directions of developments in the world were easier to understand

in the past than they are now, and expressing our sense of purpose, ideals for ourselves, and our roles with a corporate stance that used first-person phrasing was more appropriate. However, we now live in a time where the future is unclear and uncertain, and we cannot fully express our corporate stance with such phrasing.

Thus, we set forth a “Purpose” developed from our corporate philosophy that more powerfully emphasizes the creation of social value through co-creation with various stakeholders. I hope to continuously pursue this “Purpose” for at least the next 10 years, i.e. until 2030, the goal year for the UN’s Sustainable Development Goals (SDGs).

This “Purpose” has two main points. One is the creation of social value. Since announcing our transformation into a Social Value Innovator in 2013, we have continued to say that we will create social value through the creation of the values of “safety, security, efficiency, and equality.” Creating these four values through the power of ICT and co-creation is a strength truly befitting of NEC.

The other main point is the creation of a society in which everyone can reach their full potential. This

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message has been a part of our corporate philosophy until now as well. It means, "Technology and business must enhance human potential to the fullest; if we can enable people to communicate their intentions and deepen mutual understanding through the provision of ICT, we can create a more prosperous world."

This philosophy also connects to the goals listed in the preamble of the SDGs, selected by the UN in 2015, "to ensure that all human beings can enjoy prosperous and fulfilling lives" and "to foster ... just and inclusive societies." We expressed the four values safety, security, efficiency, and equality in this order to more powerfully convey our intention to realize "just and inclusive societies." This is because we can create the value of "efficiency" quite naturally as long as ICT is our occupation, but "equality" requires that we be more aware of humanity.

A "sustainable society," as you

already know, is a society in which "the Earth and natural environment are appropriately preserved, and development meets the needs of the present without compromising the ability of future generations to meet their own needs." People expect the ICT industry to provide products and services that accommodate the natural environment and mitigate the effects of climate change. The words "promote a more sustainable world" also express our desire to meet these expectations regarding environmental challenges.

NEC Group's "Principles" are the basis for the actions NEC Group should take in accordance with its "Purpose." There are three Principles.

"Better products, better service," as discussed above, has been a valued principle of NEC Group since our foundation.

Next is "uncompromising integrity and respect for human rights," a principle that we must abide by

Purpose

\ Orchestrating a brighter world

NEC creates the social values of safety, security, efficiency and equality to promote a more sustainable world where everyone has the chance to reach their full potential.

Principles

- ❖ The Founding Spirit
"Better Products, Better Services"
 - ❖ Uncompromising Integrity and Respect for Human Rights
 - ❖ Relentless Pursuit of Innovation
-

as a company. “Integrity” refers to “high ethical standards and sincerity.” Breaches of compliances, a primary example of actions that lack integrity, not only decrease sales and profit but also diminish the trust that society has in NEC. For NEC to continue to be a Social Value Innovator that society trusts, the violation of the Antimonopoly Act in fiscal year 2016 must be the last breach of compliance we ever have. We resolved as an entire organization to always have a spirit of uncompromising integrity (high ethical standards and sincerity) and respect for human rights, and we declared this resolution in our “Principles.”

Lastly, the “relentless pursuit of innovation” is also a principle that supports NEC’s purpose. The “innovation” mentioned here does not only refer to technological innovation. It means the pursuit of a society and a company that is better today than yesterday, and better tomorrow than today, in any business or industry, co-creating with various stakeholders.

Stance as good employees “Code of Values” and “Code of Conduct”

Based on NEC Group’s stance as a company, the “Code of Values” (established in 2018) and the “Code of

Conduct” (revised in October 2019) are “active and spontaneous behavior for the creation of social value” and “the standards that must be abided by” for each individual member of NEC Group.

I’m sure everyone has already incorporated these codes into their daily activities, but when thinking about why we must adhere to these codes, I would like you to recall our newly revised “Purpose” and “Principles.”

The redefined NEC Way will be utilized in various situations from April 2020 onward as a foundation for NEC Group to make greater contributions to society, and I will continue to discuss it so that each member of NEC Group gains a deep understanding of and familiarity with it.

Finally, I would like to conclude with a message for everyone who has been involved with NEC up until now. Earlier, I used the word “ecosystem.” I also alluded to this when discussing Mr. Fujimaki at dotData, but

Code of Values

- ❖ Look Outward. See the Future.
 - ❖ Think Simply. Display Clear Strategy.
 - ❖ Be Passionate. Follow through to the End.
 - ❖ Move Fast. Never Miss an Opportunity.
 - ❖ Encourage Openness.
Stimulate the Growth of All.
-

Code of Conduct

1. Basic Stance

- Acts in good faith based on high ethical standards
- Awareness and responsibility as an employee of an ICT company
- Coexistence with local communities
- Fair relationship with stakeholders
- Prohibition on any act contrary to the Company's interests

2. Respect for Human Rights

- Respect for human rights
- Respect for privacy
- Respect for each other's way of life

3. Environmental Preservation

- Global environmental preservation using advanced technology and creation of a sustainable society
- Measures taken by each individual

4. Business Activities with Integrity

- Safe and reliable quality for all customers
- Information disclosure to, communication and joint creation with stakeholders
- Fair competition

- Relationship with distributors
- Responsible procurement
- Prevention of bribery and corruption
- Appropriate handling of entertainment, gifts, donations, and political activities
- Prohibition against involvement in antisocial acts
- Management of import and export
- Sincere publicity and advertising
- Accurate financial reporting
- Response to emergency

5. Management of the Company's Assets and Information

- Management and proper use of the Company's assets
- Management of confidential information
- Management of personal information
- Prohibition on insider trading
- Protection and utilization of intellectual property rights

Consultation and Report on Doubts and Concerns about Compliance

- Strict Maintenance of Confidentiality
 - Prohibition against Retaliation
-

partnerships can come in a variety of shapes, and we are entering an era in which a company's competitiveness will depend on many networks within and outside of the company.

If possible, I hope that past NEC employees will participate in such networks. In the past 20 years, NEC chose to withdraw, transfer, and sell off numerous businesses that had supported us until then. We conducted many structural reforms. As someone involved in executive management, I feel deeply ashamed.

However, I believe there is room for us to sympathize with one another. I want to strive forward to create new value together in cooperation

with such sympathetic, varied, and diverse people. I also want us to work diligently so that NEC's platform can develop into something with immense appeal that will draw in many players.



APPENDIX

- **Business Chronology**
 - **Trends in Sales (Consolidated), Operating Profit/Loss, Net Profit/Loss (FY1999-2018)**
 - **Trends in Number of Employees (Non-consolidated/Consolidated), Affiliated Companies (FY1999-2018)**
 - **Trends in Total Assets, Share Prices (FY1999-2018)**
 - **Changes in Business Segment**
- 
- A decorative graphic consisting of several overlapping, curved orange lines of varying thicknesses, extending from the bottom right towards the center of the page.

APPENDIX

1899 • Nippon Electric Company, Limited established (July 17)



Nippon Electric Company, Limited in 1899



Founder Kunihiko Iwadare (1857-1941)



Desktop-type Delville telephone (circa 1913)



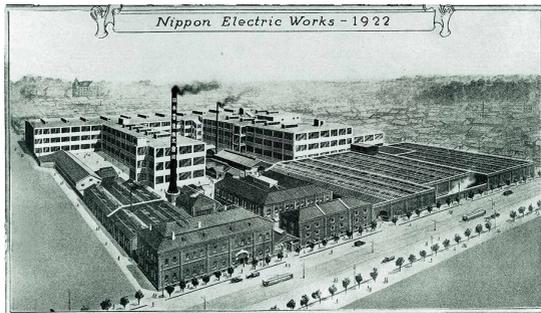
Early company employees (1909)

1919

- Produces domestic-made Type 1 common-battery switchboards for long-distance toll calls, installs them in Tokyo Central Telephone Office

1922

- No. 9 and No. 10 Plants finished, completing post-establishment plant-construction plans



Mita Head Office/Plant

1923

- Great Kanto Earthquake destroys many buildings at the Mita Plant, 105 employees lose their lives at work

1924

- Launches *Nichiden Geppo* (Nippon Electric Monthly), a PR/technical journal



First issue of *Nichiden Geppo*

1927

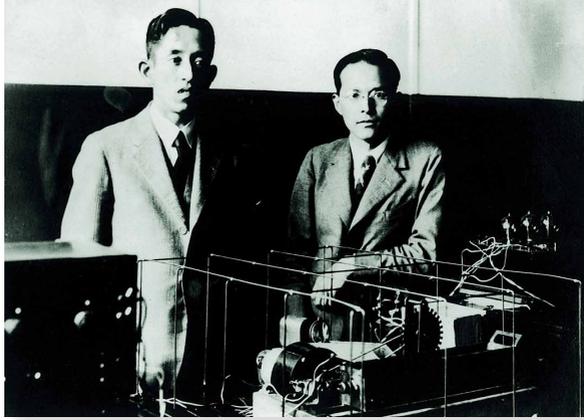
- Delivers the first domestic-made A-type private automatic switching system to Mitsukoshi Department Store



The A-type private automatic switching system delivered to Mitsukoshi Department Store

APPENDIX

- 1928 • Completes first domestic-made NE-type phototelegraphic equipment, successfully transmits scenes of Imperial Accession Ceremony of Emperor Hirohito



Yasujiro Niwa and Masatsugu Kobayashi
with NE-type phototelegraphic equipment

-
- 1929 • Produces first domestic A-type automatic switching system

-
- 1931 • Successfully produces original radio broadcasting equipment, supplies to radio station in Okayama



Nippon Denki's broadcasting PR vehicle
promoting the start of radio broadcasting

- 1936 • Tamagawa-mukai Plant begins operations



The newly completed Tamagawa-mukai Plant

- 1939 • Produces domestic-made prototype television set; the following year, conducts successful demonstrations at Hankyu Department Store in Osaka

Demonstrations of NE-type television sets at "Science of the Century Exhibit" in Hankyu Department Store in Osaka



- 1943 • Changes name to Sumitomo Communication Industries Co., Ltd.

- 1945 • Tamagawa-mukai Manufacturing Works heavily damaged in an air raid
• Changes name back to Nippon Electric Company, Limited (November)

Entrance of Head Office with name reverted to Nippon Electric Company, Limited



APPENDIX

- 1948 • Launches *NEC*, a new technical journal



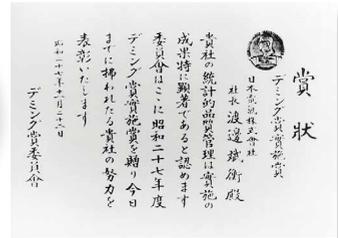
Cover of the new technical magazine *NEC*

- 1950 • Begins research into transistors

- 1952 • Becomes first company in the communications industry to receive Deming Application Prize



Deming Application Prize medal and certificate



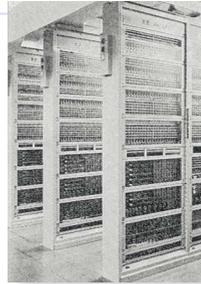
- 1953 • Delivers microwave pulse time modulation (PTM) multiplexing equipment to Tohoku Electric (Japan's first wholly automated microwave repeater line)
- Splits off Radio Receivers Division and transfers operations to newly established Nippon Electric Company, Limited

Tohoku Electric's 2-GHz microwave relay station



- 1954
- Successfully produces domestic-made television broadcasting equipment, receives orders from Television Osaka and Chubu-Nippon Broadcasting
 - Begins research into computers

- 1956
- Completes first domestic-made automatic crossbar switching system, installs it in Sanwa Telephone Office in Tochigi Prefecture



Automatic crossbar switching system

- 1958
- Develops parametron electronic computer, delivers them to Tohoku University
 - Develops first domestic fully transistorized computer, NEAC-2201



NEAC-2201

- 1960
- Begins development of integrated circuits (ICs)
 - Completes first commercial electronic automatic exchange in Japan, supplies it to Mitsukoshi Department Store



Early ICs

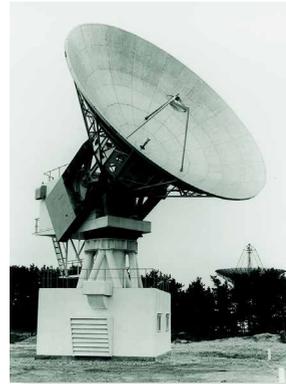
- 1961
- Implements business division system, forms five business divisions (Telecommunication Equipment, Radio, Electronic Equipment, Electronic Components, Consumer Product)

APPENDIX

1962 • Sagamihara Plant begins operations

1963 • Establishes Nippon Electric New York (now NEC Corporation of America)
• Issues American depository receipts (ADRs)

1964 • Fuchu Plant begins operations
• Trans-Pacific TV broadcasts of the 18th Olympiad in Tokyo are successfully implemented using NEC-supplied ground facilities for satellite communications



Antenna of the Kashima Satellite Communications Earth Station of the Radio Research Laboratories, Ministry of Posts and Telecommunications

1965 • Introduces Zero Defects (ZD) movement, leading its spread in the industrial world

• Completes Japan's first pulse-code modulation (PCM) transmission equipment



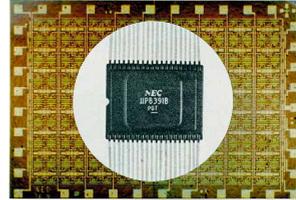
Workplace ZD group discussion meeting

PCM-24 terminal equipment



- 1968
- Successfully develops 144-bit n-channel metal oxide semiconductor (MOS) memory
 - Releases NEC's first color television, Auto Color Taiyo

The world's first
144-bit n-channel
MOS memory



- 1969
- Yokohama Plant begins operations
 - Establishes NEC Kagoshima, Ltd.; from here on, establishes local production subsidiaries in various regions

- 1970
- Delivers experimental satellite "Ohsumi" to the University of Tokyo's Institute of Space and Aeronautical Science
 - Establishes Pollution Prevention & Environmental Management Department, creating operation management system for preventing pollution

Experimental satellite "Ohsumi"



- 1971
- Develops fully automated mail-sorting system NS-100

NS-100



APPENDIX

1972 • Initiates “Operation Quality” program



Promotion of Operation Quality

1974 • Releases new computer series, ACOS Series 77

1975 • Begins operations of new Central Research Laboratories in Kawasaki
• Establishes NEC Software, Ltd.; from here on, establishes software branch companies in various regions

1976 • Releases new 4-bit microcomputer family, μ COM-41

1977 • The NEAX 61 digital switching system is announced in the US
• “C&C” (the integration of computer and communication technologies) announced at INTELCOM '77, held in Atlanta, Georgia, USA



Chairman Koji Kobayashi shares vision of “C&C” in his keynote speech at INTELCOM '77

- 1979
- “Declaration of the First Year of the C&C Era” is first full four-page New Year’s day advertisement in the Asahi Shimbun
 - Releases the PC-8001 personal computer

First domestic microcomputer training kit TK-80 (1976)



- 1981
- Establishes NEC Electronics (UK) and NEC Semiconductors (UK)
 - Releases new office computer family, NEC System Series

Queen Elizabeth II attending NEC Semiconductors (UK)’s opening ceremony (1983)



- 1982
- Abiko Plant begins operations
 - Releases 16-bit personal computer PC-9801

PC-9801



APPENDIX

-
- 1985
- NEC America's new Oregon plant completed, production of optical communication systems begins in earnest
 - Full-scale entry into VAN business
 - The SX-2 supercomputer demonstrates world's fastest performance at 1.3 GFLOPS



C&C-VAN service

-
- 1988
- Releases world's smallest tantalum electrolytic chip capacitor

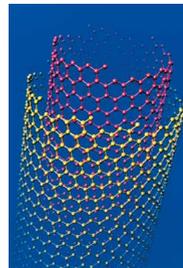
-
- 1989
- Tsukuba Research Center begins operations

-
- 1990
- Construction of new headquarters building (NEC Super Tower) completed



NEC Super Tower

-
- 1991
- Delivers 150-cc folding-type cell phone, Mova N, to NTT
 - Releases world's first notebook PC with TFT color LCD, the PC-9801NC
 - A unique graphite crystal is discovered and named "carbon-nanotubes"



Structural model of carbon nanotube

-
- 1992 • Announces “Solution 21,” formalizes SI business suited to the client-server era
-

- 1994 • Releases new open servers, Express 5800 Series



Express5800 Series

-
- 1995 • Develops the world’s first 1-Gbit DRAM (and in 1997, the world’s first 4-Gbit DRAM)
-

- 1997 • The Semiconductor Group becomes the only corporation awarded the first Japan Quality Award
-

- 1999 • Releases large-screen folding-type cell phone, Digital Mova N501i HYPER, for NTT DOCOMO’s i-mode service
- Establishes NEC–Hitachi Memory, Inc. through joint investment with Hitachi, Ltd.

Digital Mova
N501i HYPER

-
- 2000 • NEC Home Electronics concludes its business activities
-

- 2001 • Releases first FOMA device, FOMA N2001
-

APPENDIX

-
- 2002
- The world's fastest supercomputer, the ultra-high-speed parallel vector computer "Earth Simulator," is completed

Earth Simulator
© JAMSTEC



- Releases face recognition solution, Neo Face
- Establishes NEC Electronics Corporation

-
- 2003
- Develops kenaf-reinforced bioplastic
 - Constructs one of the world's largest mission-critical systems, the i-mode gateway system "CIRCUS"

-
- 2004
- Produces world's smallest, slimmest, card-shaped, camera-equipped mobile phone utilizing ultra-thin packaging technology

-
- 2005
- Tamagawa Renaissance City completed

Tamagawa Renaissance City



-
- 2006
- "BIGLOBE" made into spin-off company NEC BIGLOBE Inc.

-
- 2007
- Ultra-compact microwave communication system PASOLINK secures top global market share
-

2008 • Unveils the NEC Group Vision and Core Values

2009 • Establishes NEC Casio Mobile Communications Co., Ltd.

- NEC's face recognition technology ranks highest in the world in US National Institute of Standards and Technology (NIST) Multiple Biometric Grand Challenge (still-image face recognition category)



NEC's face recognition technology that ranked highest in the world

2010 • NEC Electronics Corporation merges with Renesas Technology Corp., launches Renesas Electronics Corporation

- Asteroid explorer "Hayabusa" successfully returns to Earth
- Begins mass production of high-performance lithium-ion secondary battery electrodes for automobiles



Asteroid explorer "Hayabusa"
Illustration: Akihiro Ikeshita

2011 • Releases UNIVERGE PF Series, the world's first OpenFlow-compatible product

- Establishes NEC Personal Computers, Ltd. through merger with Lenovo Corporation
- Launches Household Energy Storage System

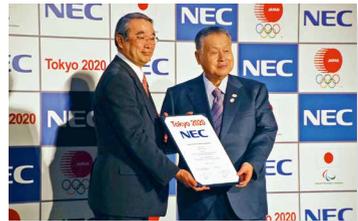
APPENDIX

- 2012 • Announces focus on Solutions for Society
- INTERPOL and NEC sign partnership agreement to enhance cyber security

- 2014 • Unveils “Orchestrating a brighter world” with the message of providing solutions for society

Orchestrating a brighter world

- 2015 • Becomes a Gold Partner for the Tokyo 2020 Olympic and Paralympic Games in the categories of “Specialist Public Safety Equipment & Software” and “Network Equipment”



Announcement meeting for the Tokyo 2020 Sponsorship Programme

- 2016 • Formulates artificial intelligence (AI) technology brand “NEC the WISE,” begins global development



NEC the WISE

人の知的創造活動を最大化する
NECの最先端AI技術群

- 2017 • Ranks highest in US National Institute of Standards and Technology (NIST) Benchmark Test for video face recognition technology
- Designates November 18 as “Compliance Day”



Compliance Day Poster

- 2018 ● Establishes NEC Satellite Operation Center, begins space-utilizing service enterprises



NEC Satellite Operation Center

- Announces biometric authentication technology brand "Bio-IDiom"



- Asteroid explorer "Hayabusa 2" arrives at asteroid Ryugu



Asteroid explorer "Hayabusa 2"

Illustration: Akihiro Ikeshita

- Completes construction of world's first South Atlantic Cable System (SACS)



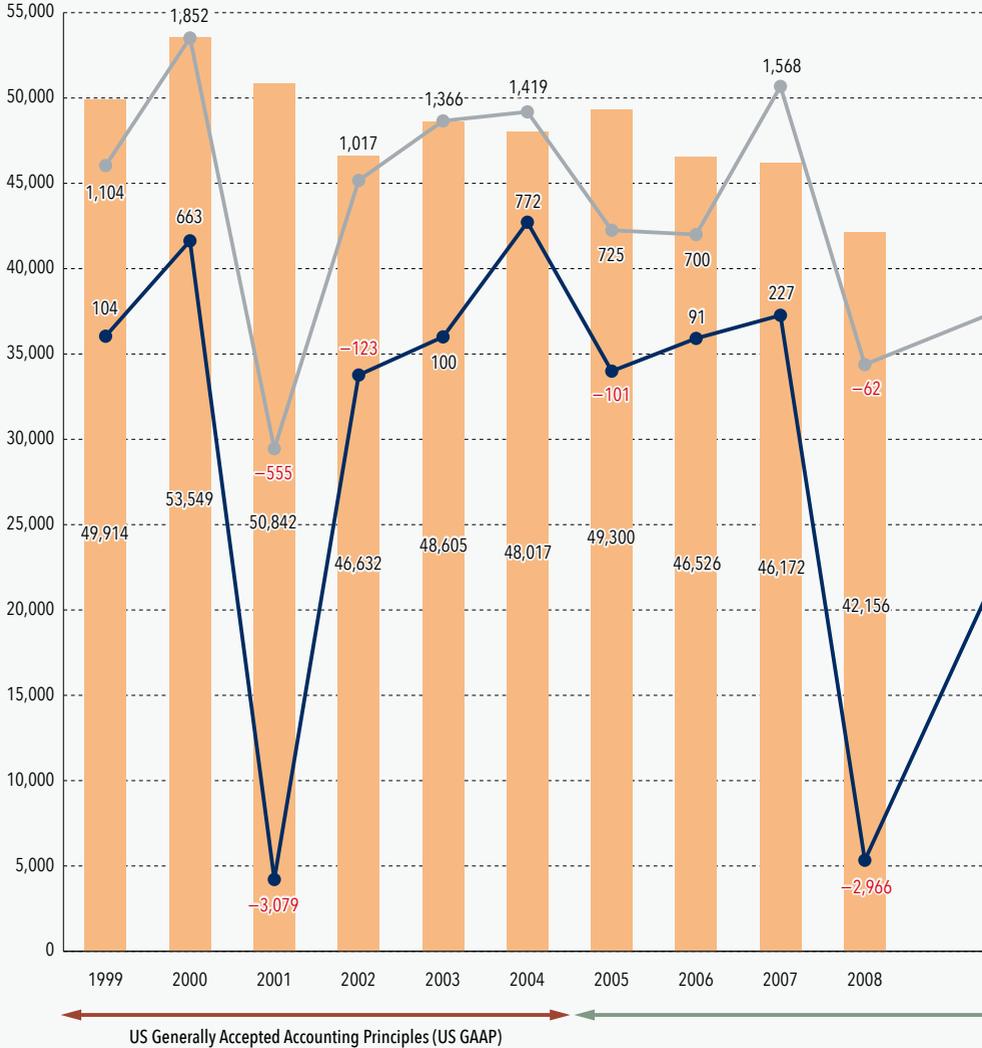
South Atlantic Cable System

- 2019 ● NEC's 120th anniversary

APPENDIX

Trends in Sales (Consolidated), Operating Profit/Loss,

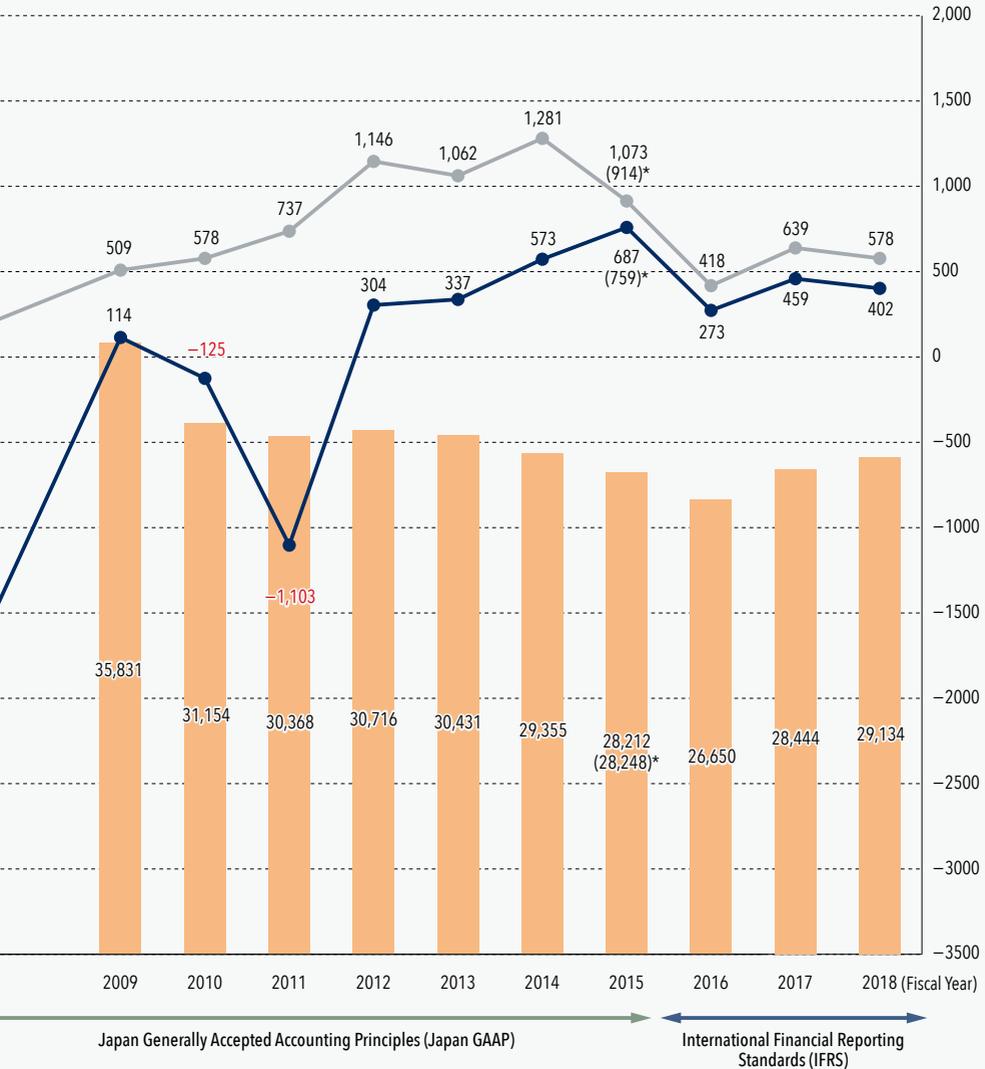
(Unit: 100 millions of yen)



* Values in parentheses for FY2015 are based on International Financial Reporting Standards (IFRS)

Net Profit/Loss (FY1999-2018)

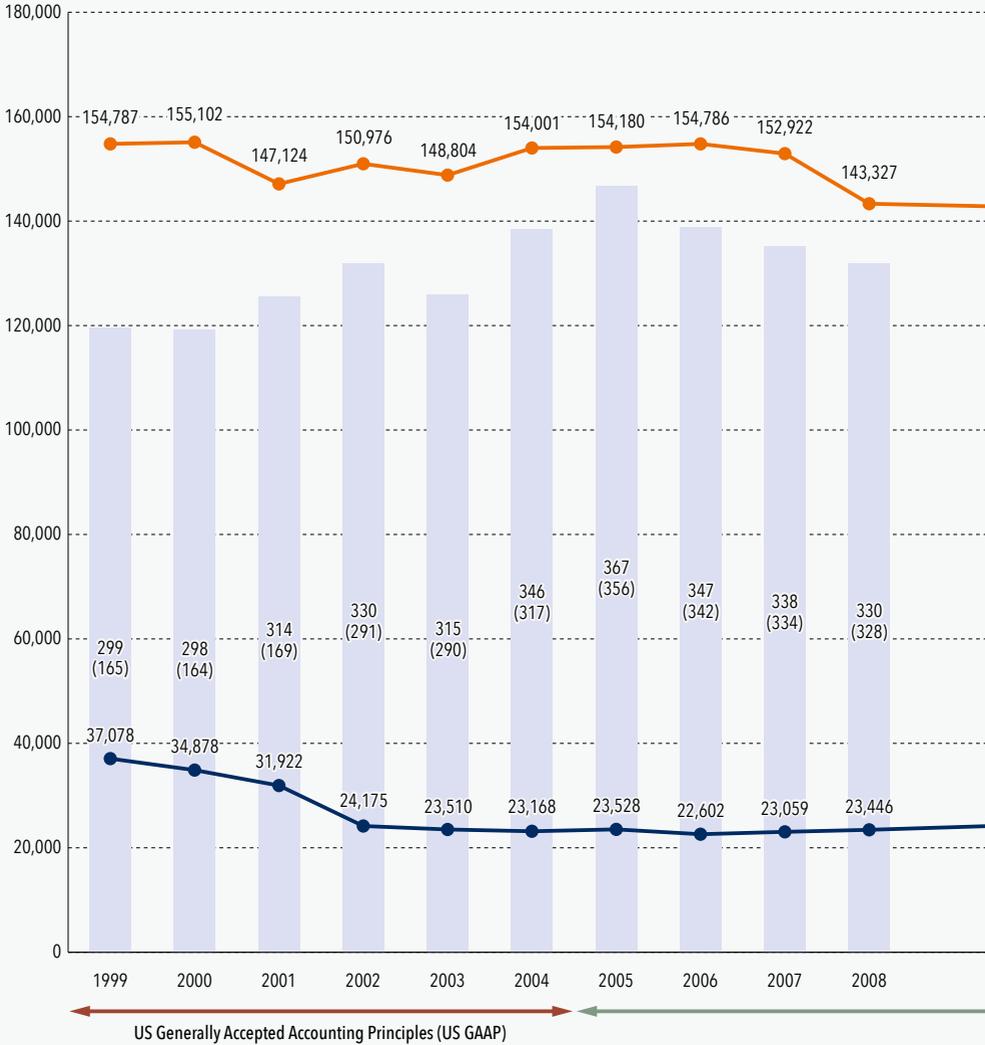
■ Sales (Consolidated)
 ● Operating Profit/Loss
 ● Net Profit/Loss
 (Unit: 100 millions of yen)



APPENDIX

Trends in Number of Employees (Non-consolidated/

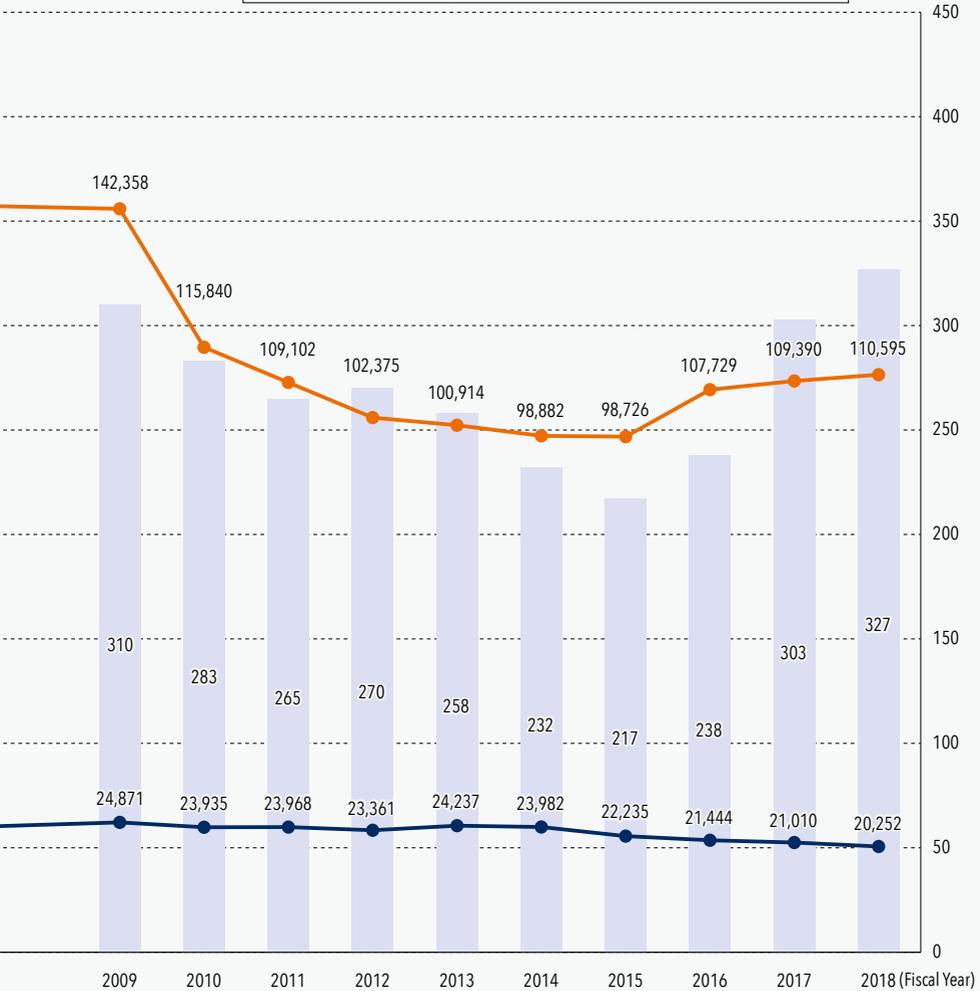
(Unit: Persons)



Values in parentheses for FY1999–2008 are number of consolidated subsidiaries. From FY2009 onward, number of affiliated companies =

Consolidated), Affiliated Companies (FY1999-2018)

● Number of Employees (Non-consolidated)
 ● Number of Employees (Consolidated)
 Number of Affiliated Companies
 (Unit: Companies)



Japan Generally Accepted Accounting Principles (Japan GAAP)

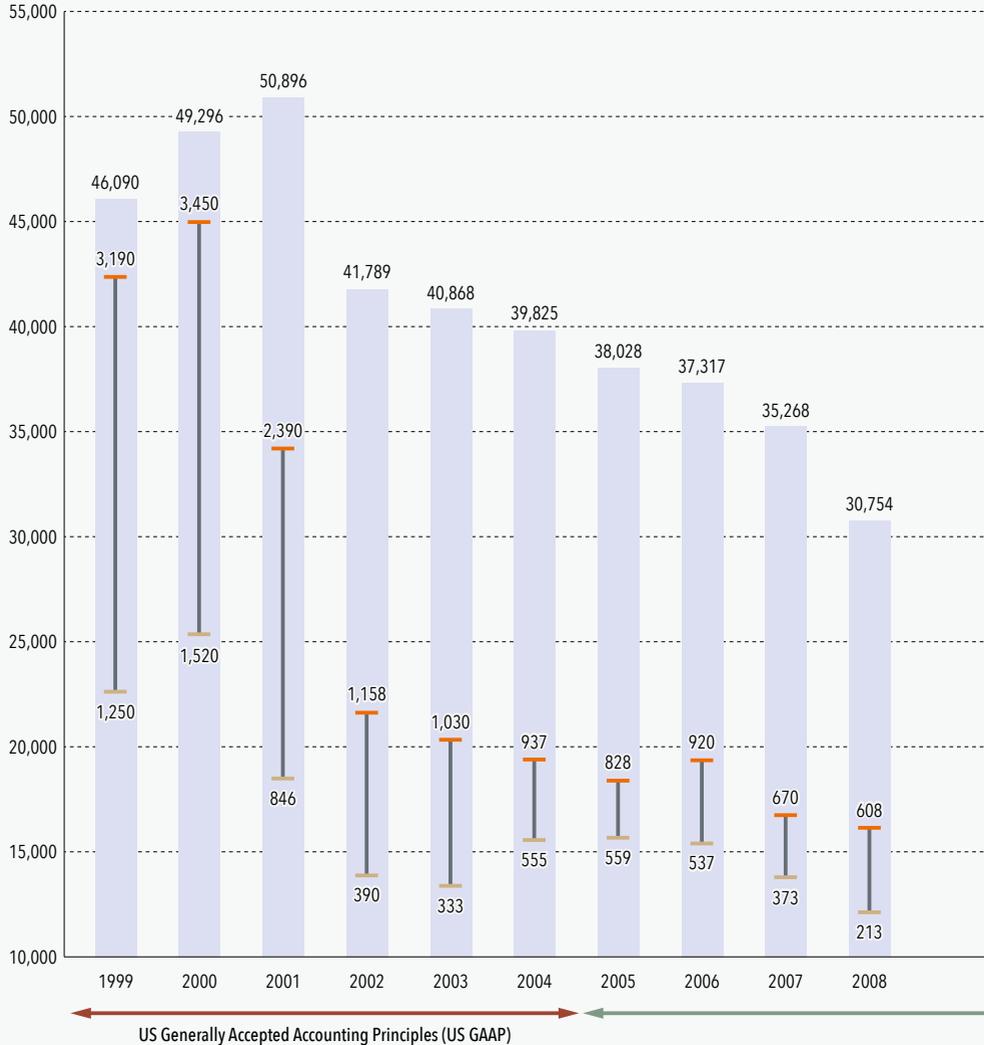
International Financial Reporting Standards (IFRS)

number of consolidated subsidiaries.

APPENDIX

Trends in Total Assets, Share Prices (FY1999-2018)

(Unit: 100 millions of yen)



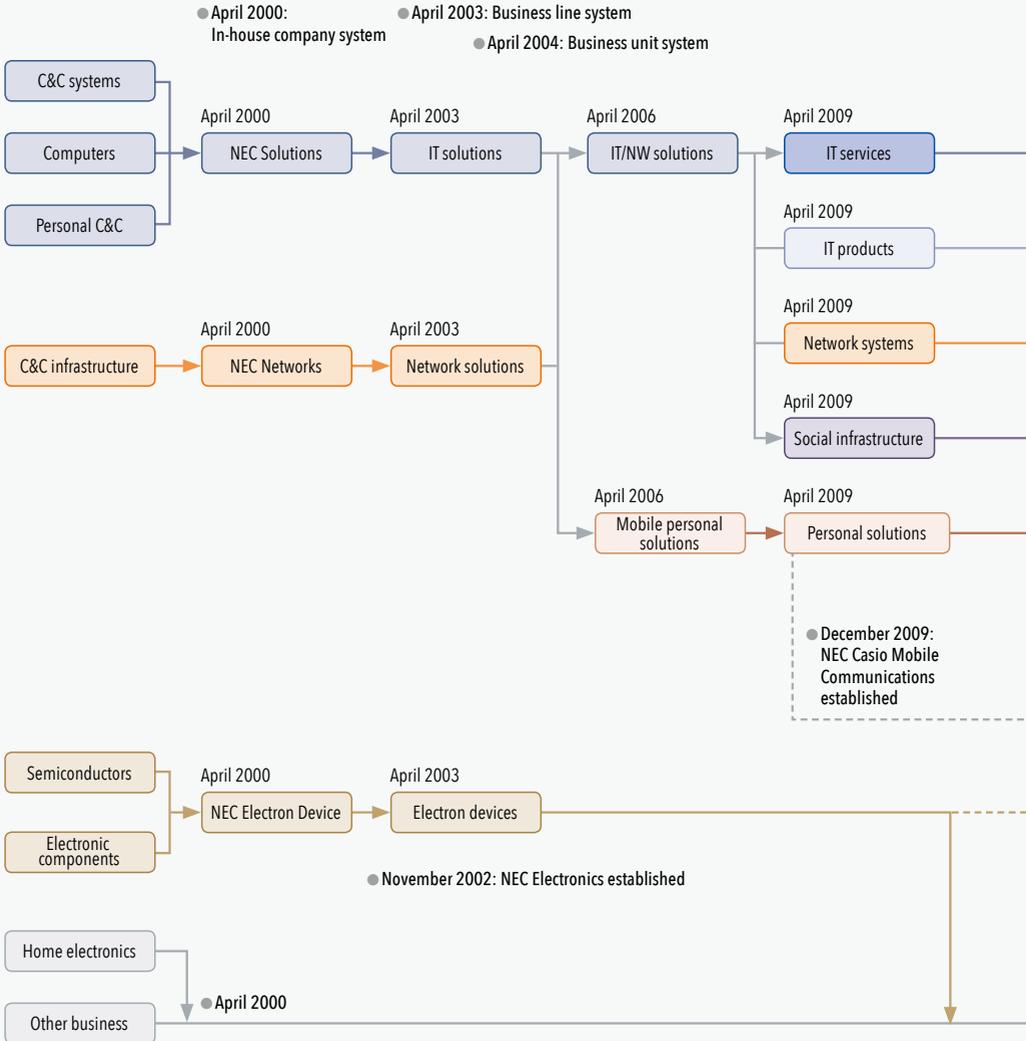
* Values in parentheses for FY2015 are based on International Financial Reporting Standards (IFRS) ** Highest/lowest share prices before

Trends in Total Assets Share Prices

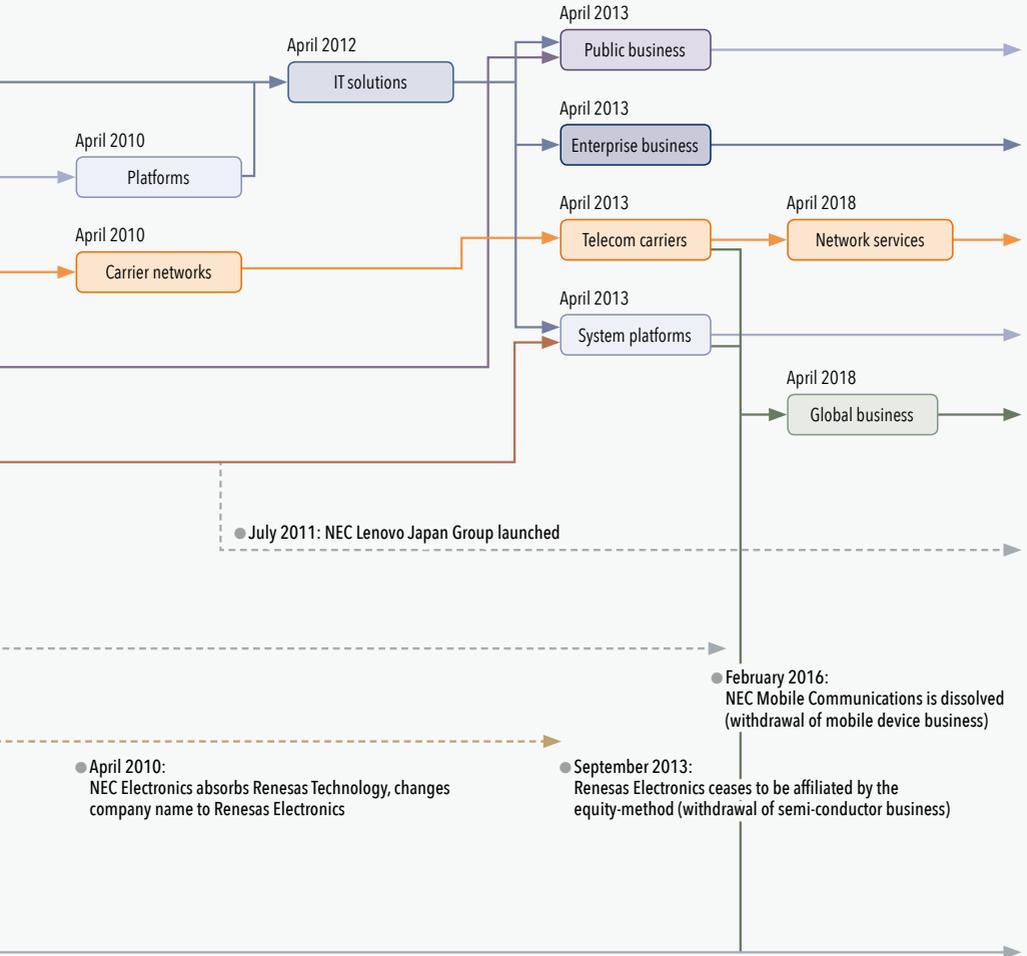


APPENDIX

Changes in Business Segment



Changes in Business Segment



Closing

Three years before NEC celebrated its 120th anniversary in 2019, the Working Group on Compiling NEC's Company History was set up in July 2016 to consider best practices for collating 120 years of corporate history. The Corporate Archives Office was formed in April 2017 to oversee information gathering for this Company History as well as archiving activities post-editing. The Company History Project was launched in May of the same year with Executive Vice President Hajime Matsukura heading the steering committee. Full-scale fact-finding activities started soon after under a company-wide compiling system.

The working group first established the basic policy and concept and then decided that the Company History would mainly chronicle historical events and interviews with people involved in key businesses over the last 20 years. In this recent 20 year-period more than a few of the company's operations, including the semiconductor business, mobile terminal business and personal computer business, were withdrawn from the market or sold off from the NEC Group. Identifying and interviewing people with knowledge on the background and circumstances of these events did not prove to be easy. However, recognizing how difficult it would be to gather information from those in the know that were willing to talk if these opportunities and even more time was lost, the group was keenly aware of the significance of these interactions and pushed forward with compiling efforts.

Looking back, these activities not only reaffirmed the exceedingly varied nature of the company's operations, but also reminded us once again of the necessity for a multi-faceted approach to understanding the intrinsic qualities of NEC. We made every effort to get to the heart of our organization so we could provide a complete picture and even sought out second opinions to corroborate interviews.

In compiling the material, we promoted information gathering and interview activities across the entire organization. We received support and cooperation from a multitude of people inside and outside the NEC Group, as well as from project members. From the initial planning stage to the writing, editing and release of this Company History, the team at Nikkei Business Publications worked tirelessly, and we would like to take this opportunity to thank them once again for their efforts.

This account stands as a history of NEC and a celebration of the company's 120th anniversary in a year that also welcomed the new Reiwa Era of imperial reign. All of us at the Corporate Archive Office would like to express our gratitude for the valuable opportunity to participate in the compiling of this Company History and it is our hope that this compelling account will help people gain a better understanding of NEC.

Yukihiko Sakuma

Director
Corporate Archives Office

March 2020

Explanatory Notes

- * In principle, this publication details historical events from before the founding of NEC and the NEC Group up until July 7, 2019.
- * Although kanji terms used here are based on those in everyday use, and kana terms are based on the Japanese Government's rules for modern kana usage, some proper nouns, technical terms and other such terminology may not adhere to these rules.
- * We have omitted honorific titles and avoided using honorific language for people belonging to NEC or the NEC Group. Full names are written in full the first time they appear in each section, but only family names are used thereafter. In principle, position and job titles are written as they were known at the time.
- * In principle, years have been expressed using the Western calendar, but where necessary both Western and Japanese methods are noted together.
- * Names of companies, organizations and other groups appear, in principle, as they were known at the time, and "(later known as ...)" has only been added when necessary. Official corporate and organizational titles are written in full the first time they appear in each section and abbreviated thereafter. Official corporate titles of overseas companies and organizations are written in Japanese and English the first time they appear in each section and abbreviated thereafter.
- * The names of companies, systems and products mentioned in this publication may be trademarks or registered trademarks of respective companies or organizations. The trademark symbol ™ and registered symbol ® have been omitted throughout this publication.

NEC Celebrates 120 years

120 Years, and the Road Ahead

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