R&D AND INTELLECTUAL PROPERTY STRATEGY

Based on its three long-term research visions, NEC is promoting R&D activities that contribute to realizing an "information society friendly to humans and the earth," while closely tying these activities to its intellectual assets and standardization strategies.

R&D STRATEGY

In order to create "an information society friendly to humans and the earth," which is asserted in the NEC Group Vision 2017, it is important to increase both human creativity and vitality, while developing a sustainable society. To this end, NEC has established three themes as the foundation of its long-term R&D efforts. These are: "Harmony between people and society, people and IT, and all people (Symbiosis)," "Creating a safe and secure society (Dependable)," and "Mutual prosperity and harmony with the earth (Ecology)." Based on this long-term R&D policy, NEC will focus on producing research achievements that contribute to the "C&C Cloud Strategy" related business and Smart Energy business.

In April 2012, NEC reorganized the R&D framework to speed up the contribution of R&D activities to business operations. The research organization was reorganized into the Cloud Research Group and the Green Innovation Research Group, in an effort to bolster the R&D framework

in the "C&C Cloud Strategy" and Smart Energy domains. In addition, NEC established the C&C Innovation Initiative with the aim of strengthening marketing functions led by NEC Central Research Laboratories. The C&C Innovation Initiative will work to explore potential needs through dialog with customers and markets worldwide and create new businesses. In other areas, NEC will accelerate "Global Open Innovation" through stronger partnerships with overseas universities and companies and by promoting R&D activities closely tied to local markets mainly in emerging countries. The goal is to contribute to global business expansion.

MAIN R&D ACHIEVEMENTS IN FISCAL 2012

In fiscal 2012, in the "C&C Cloud Strategy" domain, NEC developed data processing platforms designed to support the era of big data. For example, NEC developed high-speed and real-time stream processing technologies for big data enabling a processing speed of approximately 2.5 million events per second. NEC is also implementing R&D

BASIC POLICY ON OUR R&D

Enhance R&D Activities Based on Three Long-term Research Visions (SYMBIOSIS, DEPENDABLE, ECOLOGY) to Realize the NEC Group Vision 2017
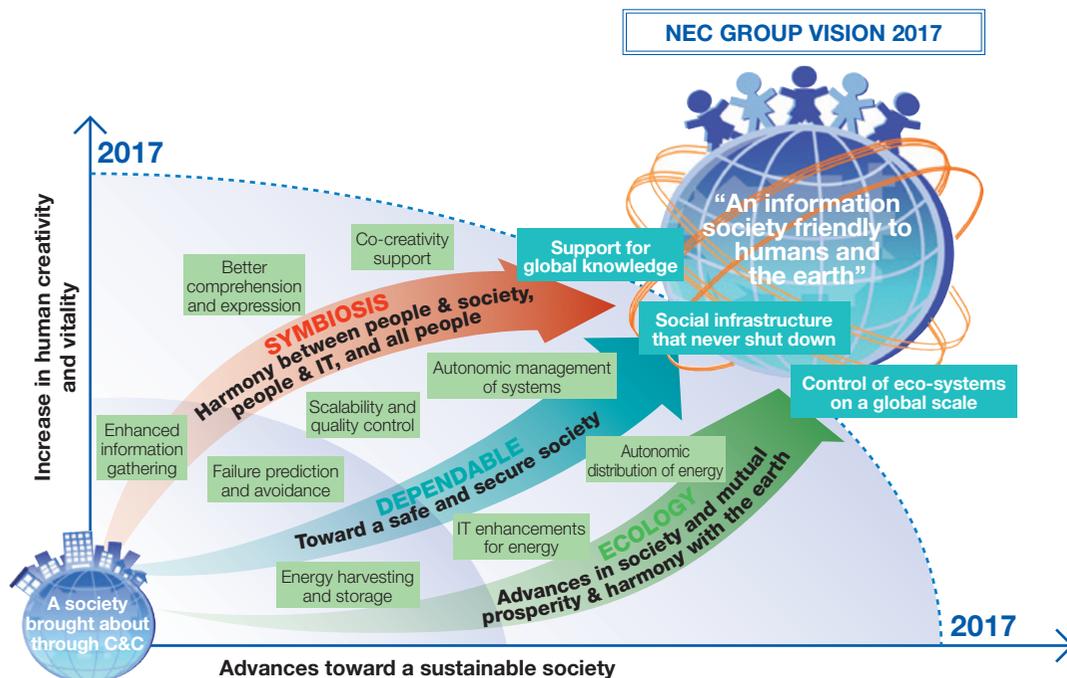
activities aimed at detecting early signs of deterioration in electronic devices, buildings and water pipes. To accomplish this, NEC has developed a vibration sensor that can detect tiny, abnormal vibrations that were previously difficult to capture. This was achieved by increasing sensor sensitivity roughly twenty-fold in comparison to existing sensors.

Furthermore, in the Smart Energy domain, rechargeable lithium-ion batteries are expected to find more and more uses in homes, buildings, power grids and so forth. NEC developed a technology for extending the life span of

lithium-ion batteries by more than twice the conventional life span. Elsewhere, together with Tohoku University, NEC is pursuing fundamental research aimed at developing next-generation LSIs that will reduce the standby power consumption of electronic devices to zero, and succeed in the development of its basic circuitry. These R&D achievements will contribute to the efficient use of energy.

Turning to the contribution of R&D achievements to business operations, NEC has adopted a proprietary analytical algorithm for rapidly detecting deterioration in system performance and identifying the cause in its WebSAM

Initiatives to Develop New OpenFlow Network Control Technology

OpenFlow is attracting interest as a new network control technology supporting simple and flexible operation of increasingly large and complex networks. NEC has conducted R&D activities as a core member of the OpenFlow Consortium, a standardization body for this technology, since its founding. NEC has pioneered R&D and commercialization of OpenFlow technologies. In 2011, NEC launched "UNIVERGE PF Series" (ProgrammableFlow), the world's first network control products equipped with OpenFlow technologies.

In fiscal 2012, NEC developed technology for automating the configuration of network equipment by using OpenFlow technologies in a cloud-based environment—one that

automates the operation of large numbers of servers and network devices. As a result, this technology simultaneously reduces security management and operation costs while enhancing networks. As one part of this development, NEC provides open source software that automates the control of IT and network resources for OpenStack, a cloud-based shared platform. In addition, NEC focused on R&D efforts directed at building efficient infrastructure for operators using OpenFlow technologies. To address burgeoning mobile communications traffic, NEC developed a dynamic policy-based mobile data offloading[*1] technology for mobile networks. This was done by installing OpenFlow controllers in networks, and

installing software with OpenFlow switch functions in mobile terminals. As a result, this technology allows networks to be utilized more efficiently.

OpenFlow is a technology that enables an SDN (Software Defined Network) to flexibly change the network functions and configurations using software. By achieving automation of network design and integration, along with network optimization matched to IT, SDN will help to drive the expansion of ICT services. OpenFlow is greatly contributing to NEC's active proposals regarding demonstration experiments and standardization work for the Open Networking Foundation (ONF), an SDN standardization organization that was established in March 2011. In April 2012, NEC joined forces with Stanford University and the University of California, Berkeley of the U.S., as well as various companies, to establish the Open Network Research Center (ONRC) and commenced related activities.

Leveraging its OpenFlow R&D achievements and product development experience amassed to date, as well as ONRC initiatives, going forward NEC will continue to actively pursue R&D activities aimed at applying SDN In a variety of fields, including cloud data centers, communication carriers, and service providers.

- **Priority:** efficient usage of mobile networks to deal with rapid growth of heavy and diverse traffic led by deployment of smart devices
- **Approach:** select appropriate mobile networks for each application based on control of mobile carriers
→ Advantages:
  - improve efficiency of network infrastructure for mobile carriers
  - improve performance and quality of applications for users
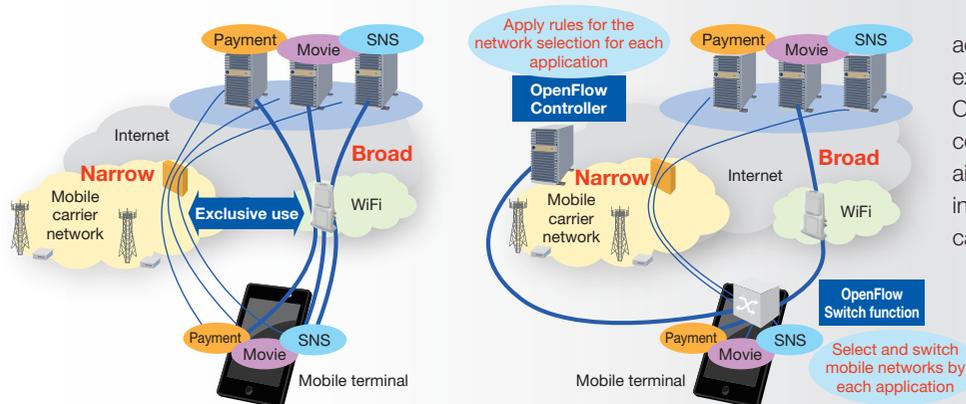
[*1] Mobile data offloading: To address growing cellular network traffic, this technique reduces network loads by diverting data traffic from mobile phones to non-cellular networks, such as wireless LANs.

Invariant Analyzer software, which analyzes system performance for large-scale cloud systems. Leveraging achievements originating from NEC Central Research Laboratories, NEC's R&D activities also contributed to the development of products such as a cloud-based recharging system and small-scale energy storage system.

Going forward, by continuing to implement market-oriented R&D activities, NEC will work to continuously drive innovation to support the NEC Group with an emphasis on enhancing R&D efficiency and accelerating the commercialization of new technologies.

INTELLECTUAL PROPERTY STRATEGY

The NEC Group owns approximately 64,000 patents worldwide, including approximately 22,000 patents in Japan (as of March 2012). NEC positions intellectual property as "the foundation for the NEC Group's business competitiveness and stability," and is working to strengthen its intellectual property from both quality and quantity standpoints. Specifically, NEC is concentrating on establishing a global patent network, to support achieving an overseas sales ratio of 50% as targeted in the NEC Group Vision 2017. In the "C&C Cloud Strategy" and the Smart Energy domains in particular, NEC is carrying out Group-wide strategic patent projects on a global basis to obtain strong patents and patents that are being utilized.

Furthermore, NEC believes that participating in standards initiatives will help create and expand businesses, and will also contribute to the stable offering of products and services. In addition to pursuing a business model that utilizes standardization, NEC is engaged strategically in standardization activities by actively participating in standardization entities both in Japan and overseas. Also, as part of external engagements with intellectual property, NEC is actively pursuing licensing activities to reduce business risks and expand business opportunities.

Development of High-Speed and Real-Time Stream Processing Technologies for Big Data Enabling Processing Speeds of 2.5 Million Events per Second

As a variety of digital information has become available, the amount of information accessible to society using sensors, mobile terminals and other devices has exploded. In this era of big data, it is crucial to create value by identifying useful data from the massive amount of information available. It is then important to process and analyze that data, so that it can be promptly fed back to the real world. NEC is focusing R&D efforts on data processing platform technology. This technology is set to become a wellspring of competitiveness for enterprises seeking to create value using big data.

In fiscal 2012, NEC developed stream processing technologies that can process big data gathered from numerous sensors and mobile terminals at high speeds and provide information in real time according to user conditions. Previously, the technique for performing this type of data processing was to first gather all the data into a database and then process it all at once. This made it difficult to provide information in real time. The latest technology developed by NEC processes only data that satisfy certain conditions based on a high-speed comparison of data gathered by sensors against predetermined conditions for required data. Through this approach, NEC has achieved the world's fastest processing speed of approximately 2.5 million events per second. This system has adequate processing power, for example, to smoothly process data updated every minute from all of the roughly 80 million vehicles owned in Japan, enabling users to monitor ever-changing information on traffic congestion and other parameters in real time.

NEC possesses the world's fastest data processing platform technologies and advanced data analysis technologies. Leveraging these strengths, NEC will strive to create new added value utilizing big data.

Achieved world's fastest processing speed of approximately 2.50 million events per second

Latest technology developed by NEC

Rapidly detect changes in the real world and take action

Extract useful insight and laws from big stored data

Rules — Insights and laws

Real-time processing of big data

High-speed processing of big stored data

Process without storing — Store

Big stored data

Big data processing platform

Sensors, terminals, IT systems (mobile phones, POS systems, automobiles, cameras, etc.)