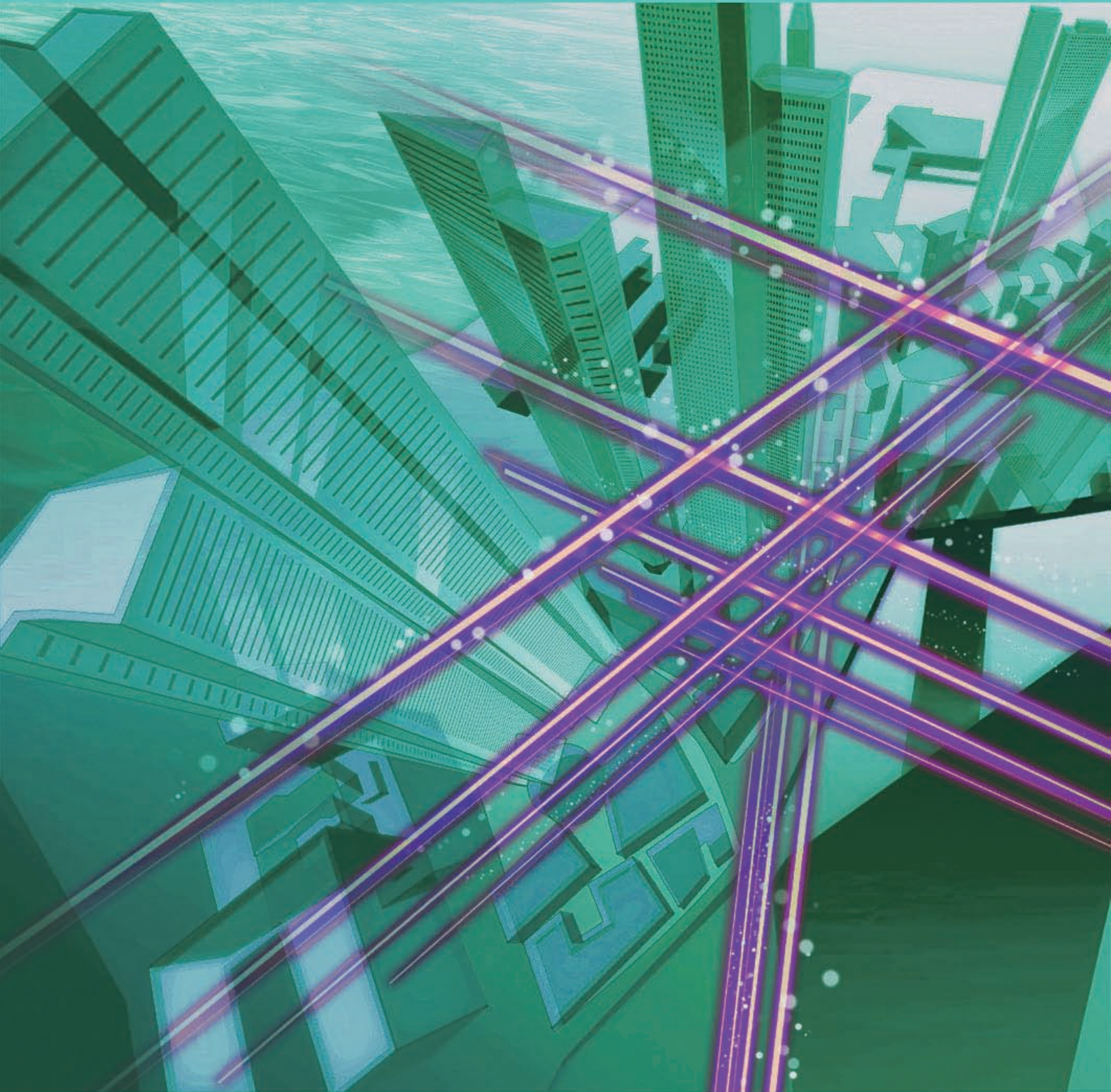


# NTT Technical Review

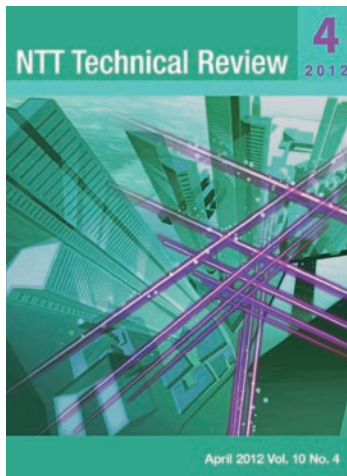
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# NTT Technical Review

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## Feature Articles: Keynote Speeches at NTT R&D Forum 2012

Satoshi Miura, President & CEO, NTT

Hikomichi Shinohara, NTT Senior Vice President, Director of Research and Development Planning Department

## Front-line Researchers

Hiroaki Gomi, Distinguished Senior Researcher,  
NTT Communication Science Laboratories

## Global Standardization Activities

Electromagnetic Compatibility Standardization Activities in the Telecommunication Field at the IEC/CISPR Seoul Meeting

## Practical Field Information about Telecommunication Technologies

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## External Awards/Papers Published in Technical Journals and Conference Proceedings

External Awards/Papers Published in Technical Journals and Conference Proceedings

## Age of Convergence

*Satoshi Miura*  
*President & CEO, NTT*

### Abstract

This article discusses the progress of convergence between information and communications technology (ICT) and a variety of industries, explains the role of ICT and the importance of innovation in these trends, and presents specific NTT activities. It is based on the keynote speech given by Satoshi Miura, President and Chief Executive Officer of NTT, at NTT R&D Forum 2012, held on February 15–17, 2012.



### 1. Importance of ICT as revealed by last year's earthquake

Let us first look back at the Great East Japan Earthquake of March 2011. It was a tremendous disaster. Telecommunications facilities were damaged to a degree that we had never experienced before. In the tsunami-stricken area, cables, telecommunication buildings, and mobile communications base stations were flooded and destroyed, rendering us unable to sustain communication services. In areas not directly hit by the earthquake, traffic rose sharply, making it necessary to restrict communications. People found that they could get better connectivity with packet communications carried over the Internet than with telephone calls. On top of that, we experienced the effects of the nuclear accident and wide-area power outages followed by scheduled rolling power blackouts. This disaster has taught us valuable lessons and reminded us of the vital importance of information communications technology (ICT) and the telecommunications infrastructure.

The first thing we did after the earthquake was to install special, free public telephones, satellite mobile phones, and free Internet booths to make a communications environment available as soon as possible (Fig. 1). At the same time, we started work on extending various methods of support: (i) setting up portal sites to provide livelihood-related support information to affected people; (ii) enabling free health consultations via free videophones at evacuation sites in

cooperation with relevant not-for-profit organizations to assist in the healthcare of evacuees; and (iii) providing free smartphones, tablets, and electronic textbook and reference-book content to assist in the reopening of school education.

For the future, we are implementing various measures based on the lessons learned from this calamity.

(1) Constructing disaster-resistant networks and providing early restoration

The most urgent task is to build disaster-resistant networks and put in place means to quickly restore damaged networks. We are taking a multifaceted approach, from providing multiple alternative links in transit networks, to facilitating the use of satellite communications, extending the life of backup batteries, and stockpiling fuel in preparation for prolonged commercial power outages. On the service front, we will introduce a service for sending voice files over a packet network by the end of fiscal 2012.

(2) Further promoting the use of ICT in normal times

When I visited disaster-stricken sites, I found sheets of paper with safety information written on them posted on the walls of evacuation sites: people had to look at every wall to search for information about their loved ones. And doctors were unable to prescribe the correct medicine for elderly people because their medical records had been washed away. I felt that support at the disaster sites could have been expedited if medical records and residence certifi-

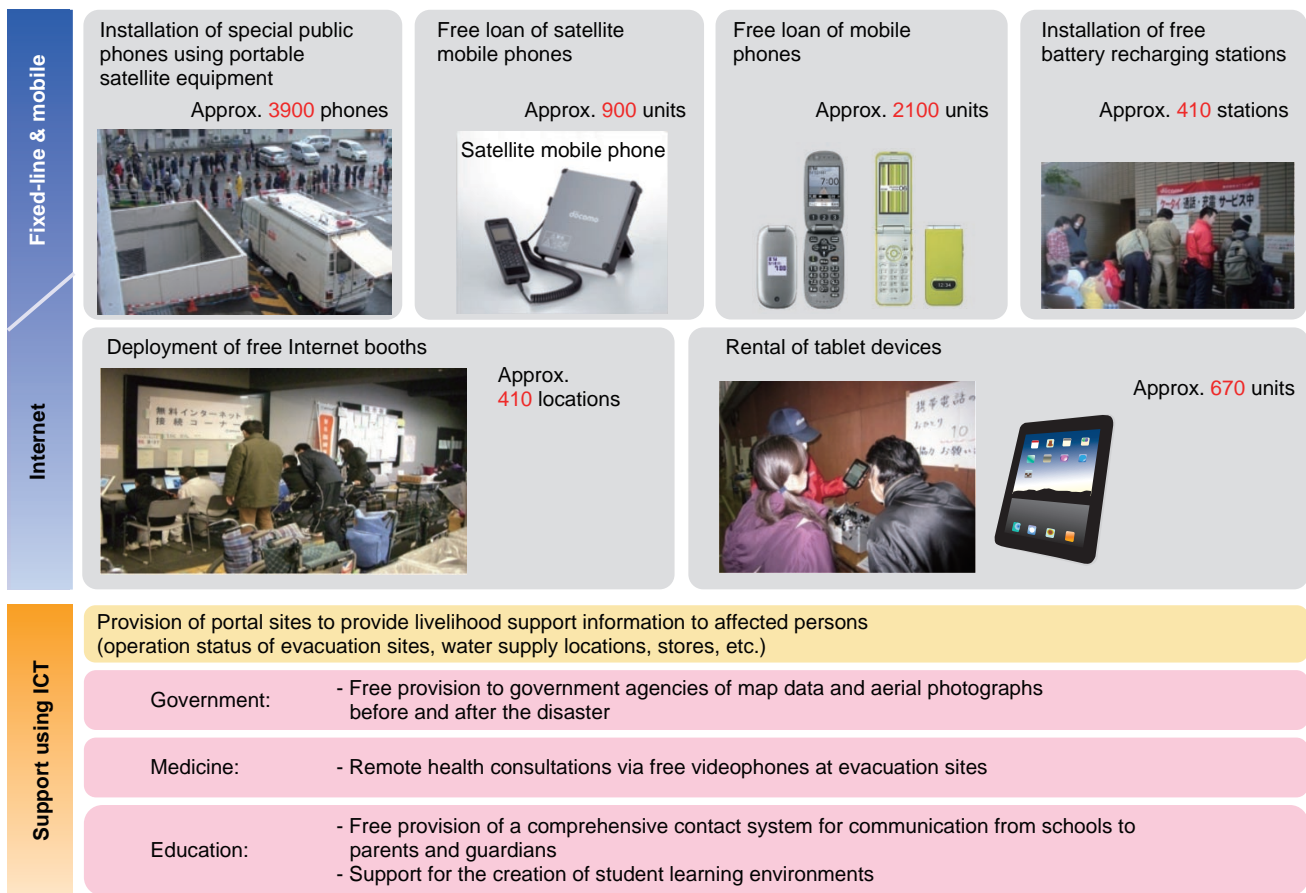


Fig. 1. Securing means of communication and use of ICT.

cates had been kept in electronic form and stored remotely in the cloud. Such services cannot be launched quickly after an emergency occurs. It is necessary to promote the use of ICT as part of normal life in order to prepare in advance for the next disaster.

(3) Utilizing social media

Individualized information, such as safety information, that cannot be handled by mass media was collected and posted via social media. In addition, various types of support sites were launched. Social media played a significant role in connecting people. However, they also revealed a downside, such as spreading false or harmful rumors. Although these negative characteristics must be reduced, we have rediscovered the potential of social media.

**2. Progress of convergence and the role of ICT**

We will now look at the current state of ICT from

viewpoints represented by three key phrases and two major trends (Fig. 2).

**2.1 Three key phrases**

(1) Multi-device access (mobile)

It has not taken long for smartphones and tablets to grow from their debut to a user base of more than 20 million in Japan, indicating steady progress towards multi-device access. While Japan has led the world in the use of Internet access from mobile terminals, the mobile Internet is now growing on a global scale. This development has given rise to new business models and new types of enterprise.

(2) Cloud computing

The rise of cloud computing is shifting the business world from *owning* to *using* computing resources. Businesses are now using systems in the form of inexpensive, fast services rather than owning their own physical systems. For cloud providers like us, the challenge is not just to provide individual cloud services independently but to make them work

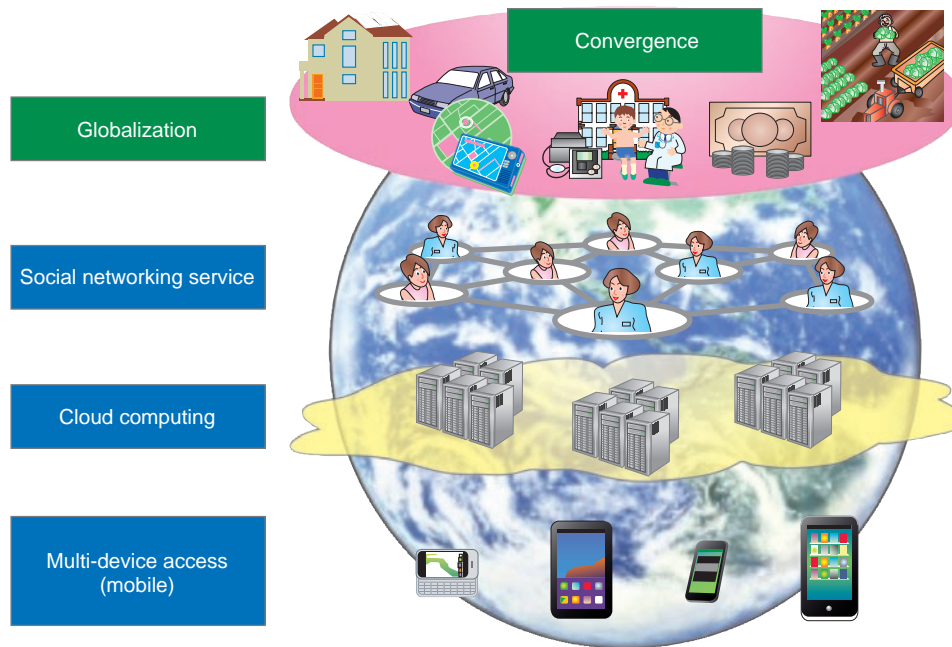


Fig. 2. Three key phrases and two major trends.

together and to automate all processes from the construction to the maintenance of cloud servers in a process that we call *orchestration*. It is also necessary to meet the needs of customers seamlessly and speedily, and not just domestically but globally.

(3) Social networking service

It seems clear that the fast and widespread propagation of information through social media assisted the “Arab Spring” revolution. And I already mentioned the significant role played by social media in the aftermath of Japan’s earthquake. Facebook is showing spectacular growth, with its user base now exceeding 800 million. The company applied to go public on February 1, 2012. Its market value is expected to surpass US\$ 100 billion. Various types of social networking services, including Twitter, and various types of enterprises have emerged and are increasingly exerting influence on society. Social media are also moving towards *socialization* by linking with other services.

2.2 Two major trends

(1) Globalization

Globalization, which started in the manufacturing industry, now encompasses all types of businesses and individuals. As domestic demand levels off and as the enterprises that are our customers increasingly

do business globally, it is impossible for us to satisfy their communications needs unless we become more global.

The NTT Group has adopted globalization as one of its business pillars in its New Medium-term Management Strategy. In line with this strategy, we have reinforced our service profile so that we can cover all ICT services on every layer and we have expanded our global area coverage, using mergers and acquisitions where appropriate. In the past, it was sufficient to concentrate on Asia, America, and Europe, but today we cannot meet our customers’ needs unless we cover every corner of the world. This is because demand for communications is rising in newly emerging countries, which are now a driving force for global economic growth. Today, the overseas companies affiliated with NTT number 450 (out of the total of 770 affiliated companies) and they employ about 48,000 people (out of the total of 235,000).

Since mergers and acquisitions are usually concluded at a premium cost, we believe that their role should not be just *addition* but *multiplication*, acquiring technologies, human resources, and time, and generating synergy between affiliated companies. There are still challenges in terms of how to maximize the total power of all the affiliated companies, including how to ensure overall governance. Howev-

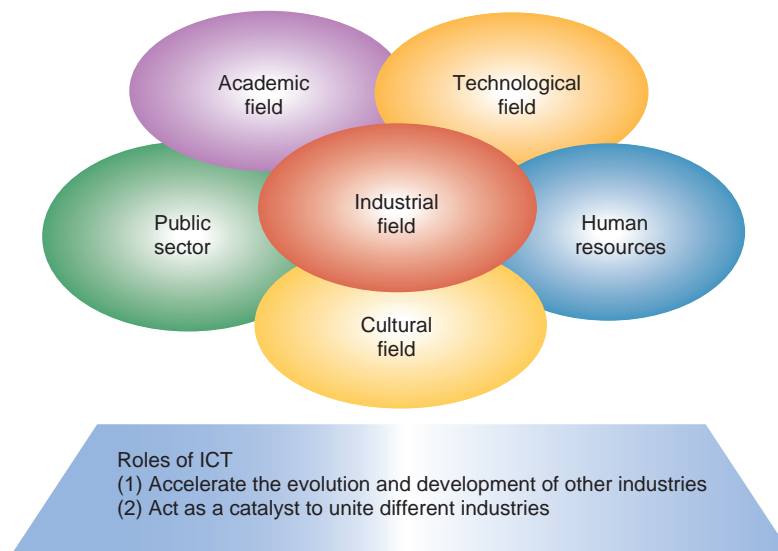


Fig. 3. Progress of convergence in various fields.

er, we are so far making steady progress, with sales from global business estimated to exceed US\$ 10 billion in fiscal 2011.

#### (2) Convergence

Convergence, which is one of the main themes of this article, has been evident in many fields (**Fig. 3**). It has long been actively sought in the technological and academic fields, such as biotechnology and genetic engineering, which arose from the convergence of biology, medicine, and chemistry, and in financial engineering, which combines finance and mathematics. If we look back at history, convergence has clearly been evident in culture and human resources.

Above all, it is in the industrial field that numerous cases of convergence are in progress, such as industry-government-academia collaboration, vertical integration in production, processing and selling of agricultural products, and medical tourism, which combines medical care and tourism and is gaining in popularity in Asia. Moreover, the convergence of ICT and many other industries will be accelerated as many kinds of objects are connected to the network, and various kinds of information are stored in databases. We believe that ICT has two roles to play in advancing these types of convergence.

(i) ICT will accelerate the evolution and development of those industries by being incorporated into other industries.

(ii) ICT will act as a catalyst for innovation by uniting different industries.

In the ICT world, the convergence of fixed-line and mobile communications (fixed-mobile convergence) and the convergence of telecommunication and broadcasting are now taken for granted. For example, a multimedia broadcasting service called NOTTV [1] will be launched on April 1 by mmibi to supplement existing services such as NTT's HIKARI TV [2] and NTT DOCOMO's BeeTV [3].

The convergence of ICT and different industries is also giving rise to new markets, new services, and new added value (**Fig. 4**).

### 2.3 Convergence of ICT and automobiles

The most typical example of such a convergence is the convergence of ICT and vehicles (**Fig. 5**). Today, automobiles are effectively moving information terminals. Electric vehicles, which have now begun to take off, can serve as batteries while they are parked at home, and by being combined with smart meters and Home ICT, they can become a key element of a smart home.

Various other activities are also in progress in this field, such as a telematics service, in which moving vehicles exchange information with information systems that make use of the GPS (global positioning system) data of these vehicles, and an intelligent transportation system, which aims to ensure the



Fig. 4. Convergence of ICT and other industries.

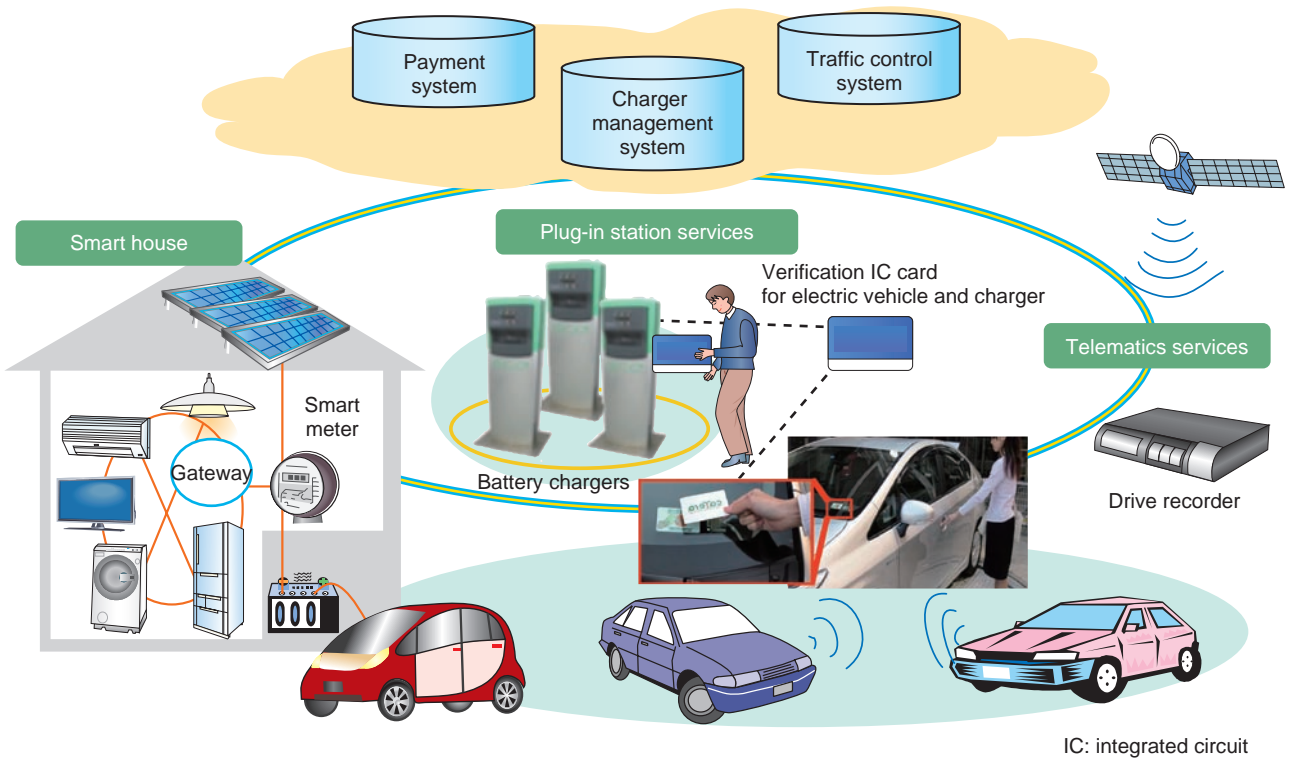


Fig. 5. Convergence of ICT and automobiles.

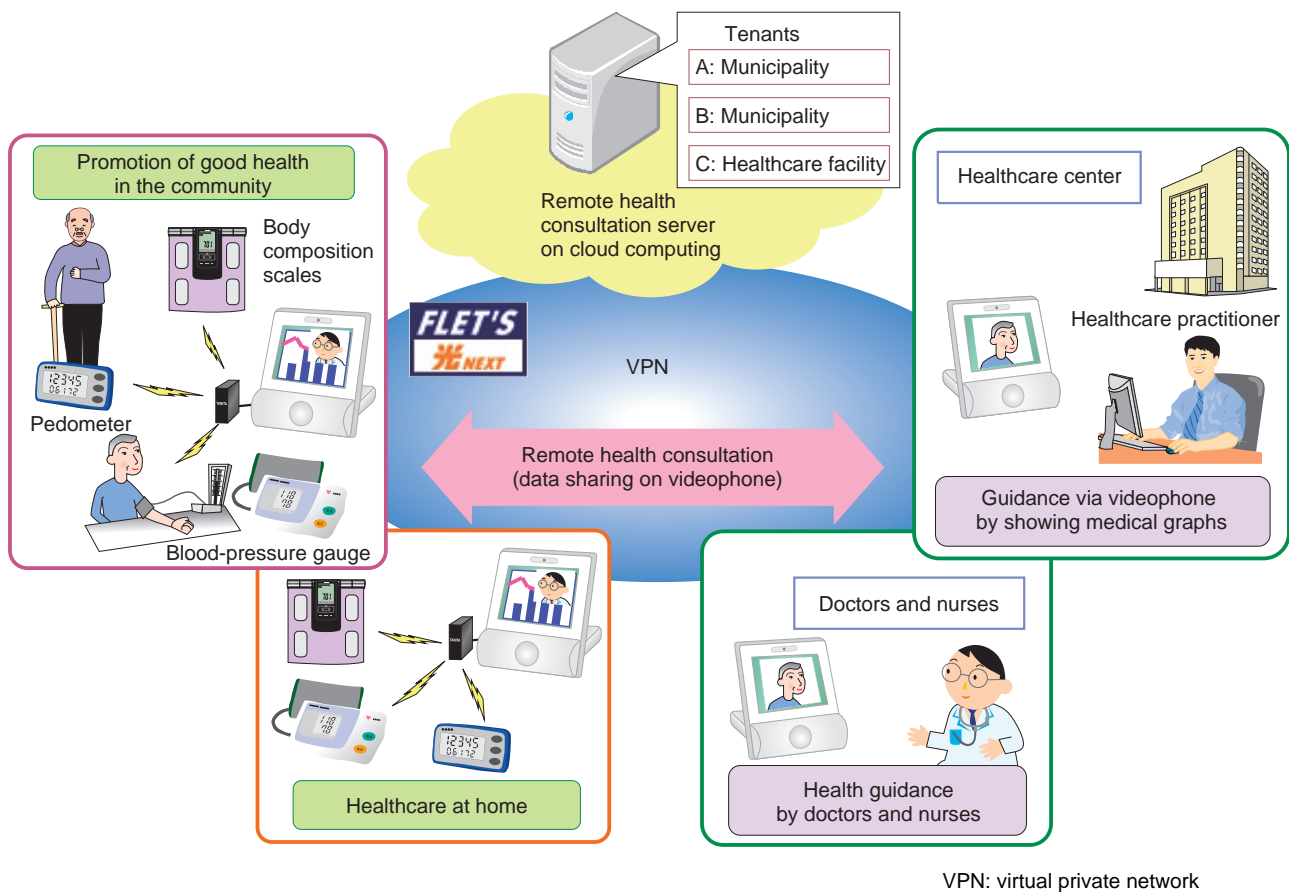


Fig. 6. Convergence of ICT and healthcare.

safety of vehicles by enabling them to communicate with the road and with other vehicles.

#### 2.4 Convergence of ICT and healthcare

To overcome the shortage of medical doctors in aging and underpopulated communities, NTT has been conducting trials of remote medical care in Tono in Iwate prefecture and in Kurihara in Miyagi prefecture. On the basis of this experience, we started a cloud-based remote health consultation service, called *Hikari Health Consultation* on September 1, 2011 (Fig. 6). Blood pressure data, pedometer readings, etc. of the users are sent automatically from a videophone to the management server. The user can receive health advice and instructions from a remote doctor or nurse while viewing his or her health data displayed in graphical form on the videophone.

We will apply ICT to assist in inter-hospital cooperation. We are also implementing a form of ICT convergence in the Future City Model Project spon-

sored by Keidanren (Japan Business Federation), which combines healthcare using ICT with an on-demand bus service.

#### 2.5 Machine-to-machine communication and big data

Today, all sorts of information, such as data from sensors, location data, and records of human behavior obtained from mobile phones, can be automatically collected and stored in digital form. After it has been anonymized to prevent personal identities from being revealed, huge amounts of such information (known as big data) can be analyzed to generate outputs useful for marketing, providing personal services, and solving social issues (Fig. 7).

In particular, the global expansion of mobile networks has made it easy to put communication modules into various types of objects, facilitating the collection of information (Fig. 8). For example, Komatsu keeps track of the status of construction



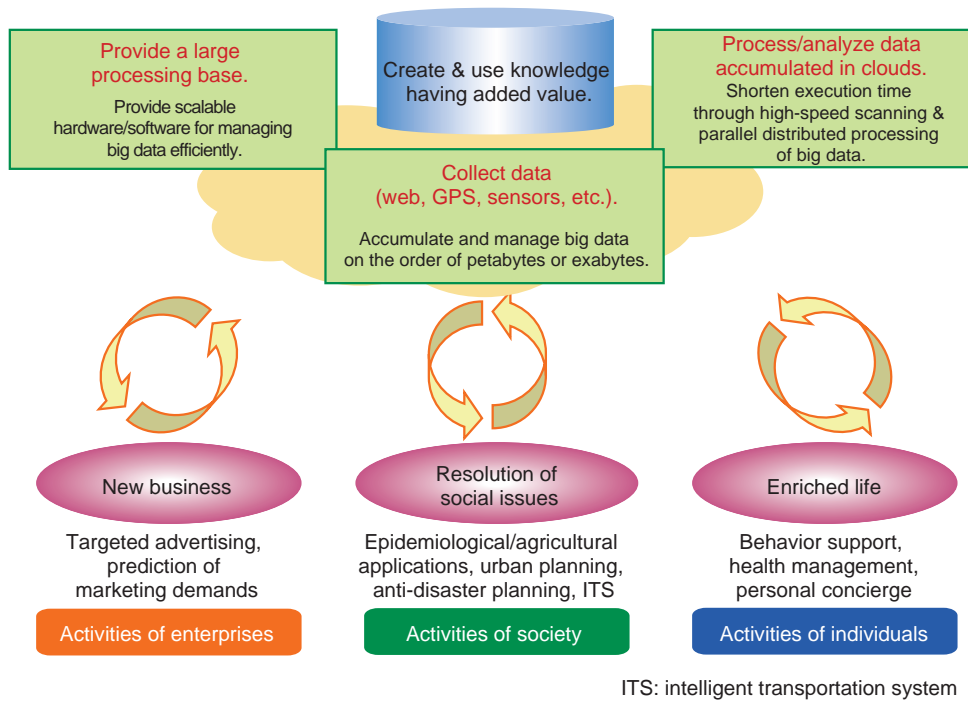


Fig. 7. New value creation by big data.

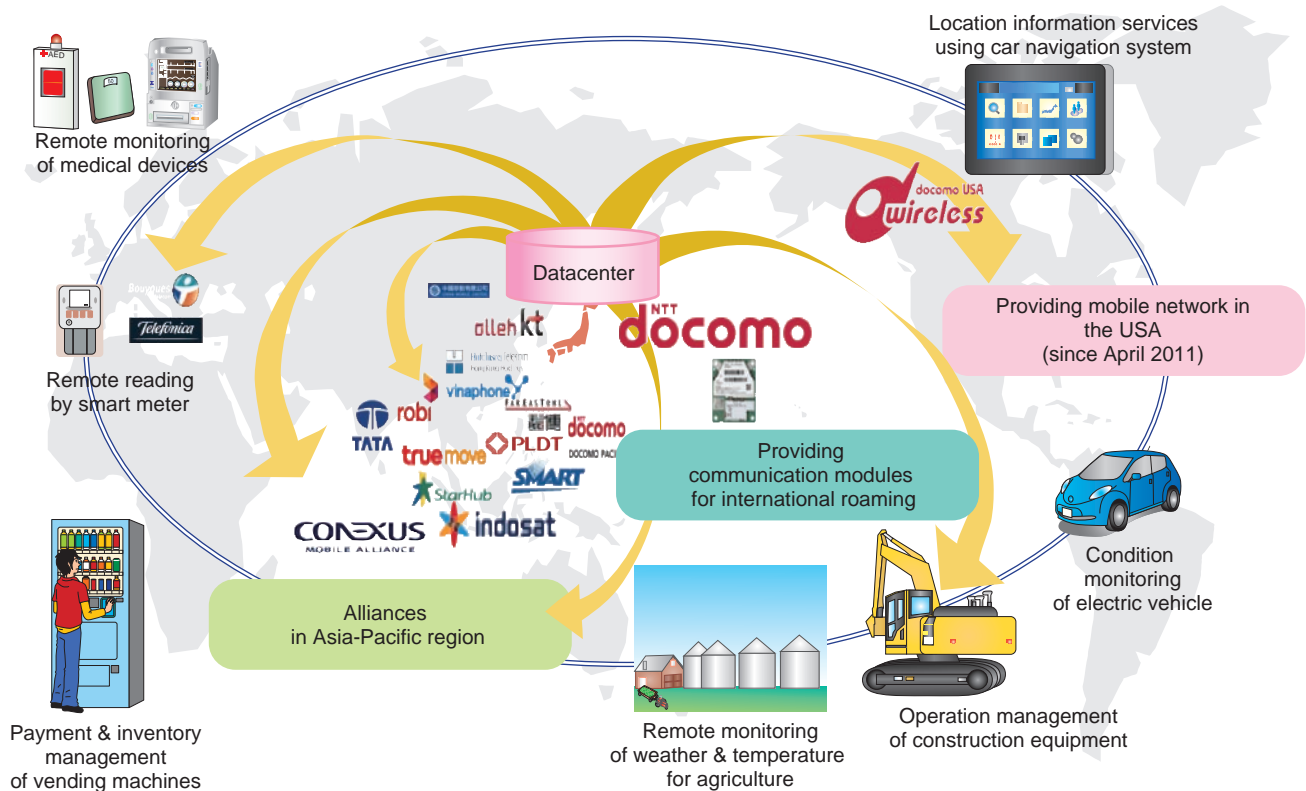


Fig. 8. Providing M2M solutions.

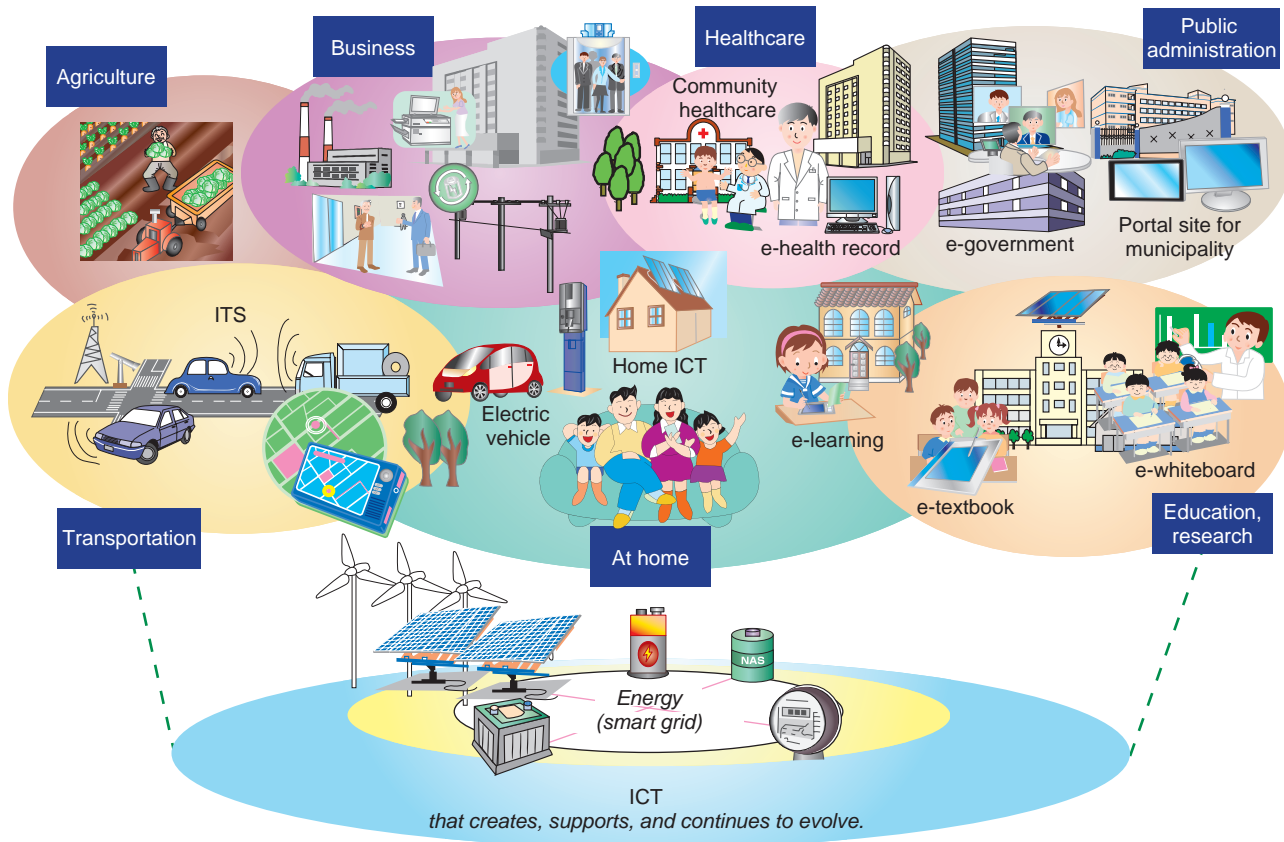


Fig. 9. The Age of Convergence as a society.

vehicles that it has sold around the world and uses the collected information for maintenance and repair purposes. Machine-to-machine (M2M) communication solutions are spreading in many other fields as well, such as inventory management for vending machines.

### 2.6 Smart community

The various types of convergence mentioned above will converge into a smart community. There will be convergence of energy and ICT, and then many kinds of objects and services in society, such as electric vehicles and other transport infrastructures, medical care, and city planning (architecture and civil engineering), will be integrated to make them more intelligent than before, and this will make for livable cities (Fig. 9).

## 3. R&D that drives innovation

Some shocking figures were made public this year.

One is that, as Japan continues to see its birthrate decline, the country's population is expected to plunge to below 90 million by 2050. Another is that the country experienced a trade deficit in 2011 for the first time in 31 years. These figures show that Japan has indeed come to a turning point. This is a time when new companies like Facebook are growing dramatically, while Motorola Mobility is bought by Google, and Eastman Kodak goes bankrupt. No enterprise can survive unless it changes. This is a time when Japan must change in order to survive. While some dispute it, others claim that Darwin said, "It is not the strongest of the species that survives, nor the most intelligent, but rather the one most adaptable to change." Whoever said these words, though, I could not agree more.

In the world of ICT, voice-call-centric communication has made way for IP-based communication (IP: Internet protocol), and various types of services have emerged and converged. We have entered the age when services count for more than networks (Fig. 10).

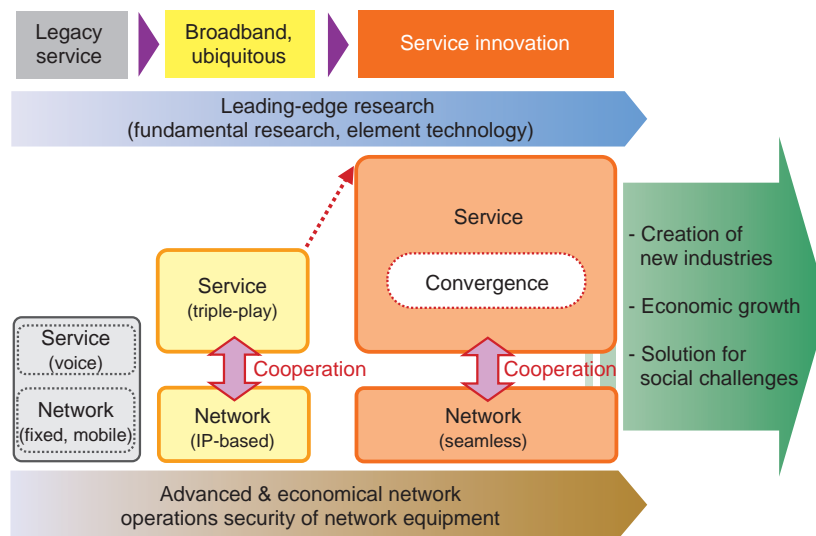


Fig. 10. Direction of R&D.

### 3.1 Importance of continuing to change to seek innovation

Against the abovementioned background, our research and development (R&D) must also change to achieve innovation. The recent shift in importance to mobility, services, software, and an open source approach reflects the current trend and is gaining momentum. Innovation is to be found not in the extension of current activities but where discontinuity occurs, or where we encounter something different. NTT's R&D must constantly incorporate new ideas. We are, for example, striving to recruit people from a wide range of fields to expand our diversity.

### 3.2 Importance of speed

In particular, we must accelerate the speed of R&D of services. R&D must be undertaken in collaboration with operating companies from an early stage. Efforts to achieve this include personnel exchanges between the laboratories and operating companies, such as a program in which newly recruited researchers undergo training in operating companies. NTT's Research and Development Laboratory Group has also undergone changes. Although this perception may not be right for every research field, we are in a time when we must often undertake R&D with the attitude that an 80% level of product perfection now is better than 90% level two or three years down the road.

### 3.3 Full-scale globalization of R&D

Ultimately, R&D itself must go global. NTT has traditionally pursued R&D, developed specifications, and conducted procurement on its own, but this is not the time for such self-dependence. We must aggressively seek information about the latest technologies available in the world and utilize open source software and incorporate them into our home-grown technologies. For this purpose, we reinforced our presence in Silicon Valley in the USA in January this year. We must continue to promote globalization through novel activities.

## 4. Future activities of the NTT Group

This article has looked at three key phrases and two major trends surrounding ICT. Among these, it has described service creation through convergence and innovation. Through its R&D, NTT will further invigorate its current activities while striving to create new services by continuing to change as it incorporates new information and technologies from around the world.

## References

- [1] NOTTV (in Japanese). <http://www.nottv.jp/>
- [2] HIKARI TV. <http://flets.com/english/bb/hikaritv/>
- [3] BeeTV (in Japanese). <http://pre.beetv.jp/>

## R&D to Create the Future of ICT

*Hikomichi Shinohara*  
*NTT Senior Vice President,*  
*Director of Research and*  
*Development Planning Department*



### **Abstract**

This article introduces NTT's research and development (R&D) activities aimed at making further innovations in order to move on from the Great East Japan Earthquake of March 2011 and create the future of information and communications technology (ICT). It is based on the lecture given by Hikomichi Shinohara, NTT Senior Vice President and Director of the Research and Development Planning Department, at NTT R&D Forum 2012, held on February 15–17, 2012.

### **1. One year after the Great East Japan Earthquake**

The earthquake that hit East Japan on March 11, 2011, and the tsunami that followed it caused severe damage to NTT's telecommunications facilities, destroying and flooding buildings, breaking cables and conduits, and felling the concrete masts of base stations for mobile communications. The services provided via about 400,000 fixed lines and about 2000 base stations were disrupted immediately after the earthquake and tsunami. The damage for fixed lines grew and peaked two days afterwards at about 1.5 million, while the damage for base stations peaked one day after the earthquake at about 6700 base stations. This was because NTT's batteries and generators sustained local power supply for some time after the outage of the commercial power supply, but then the batteries ran flat and the generators ran out of fuel so they could no longer support communication.

#### **1.1 Issues that needed to be addressed by NTT's R&D**

Confronted with this situation, the NTT Group worked together to restore service by rushing vehicle-mounted power generators and fuel to the stricken areas, but this all-out effort left much room for

improvement because the commercial power outage lasted longer and affected wider areas than NTT had ever imagined and because it was necessary to prepare for the scheduled rolling power blackouts implemented in areas beyond the disaster-stricken ones. Our disaster-countermeasures had been based on the assumption that a stable commercial power supply would be available after a disaster, but in future it will be necessary to be well prepared for the type of conditions that we faced this time.

Improvements in rapid restoration of communications include using satellite communications, particularly at evacuation sites. NTT's perception of future research and development (R&D) issues regarding the provision of earthquake-resistant communication services are shown in **Fig. 1**, broken down into three periods: normal times, the period soon after an earthquake, and several weeks later.

#### **1.2 R&D results achieved in the year since the earthquake**

The main R&D areas where we have achieved a certain level of progress during the year since the earthquake are described below.

##### **(1) Coping with prolonged power outage**

As a backup power supply for NTT buildings, we have started to develop a new type of battery that has an energy density several times that of conventional

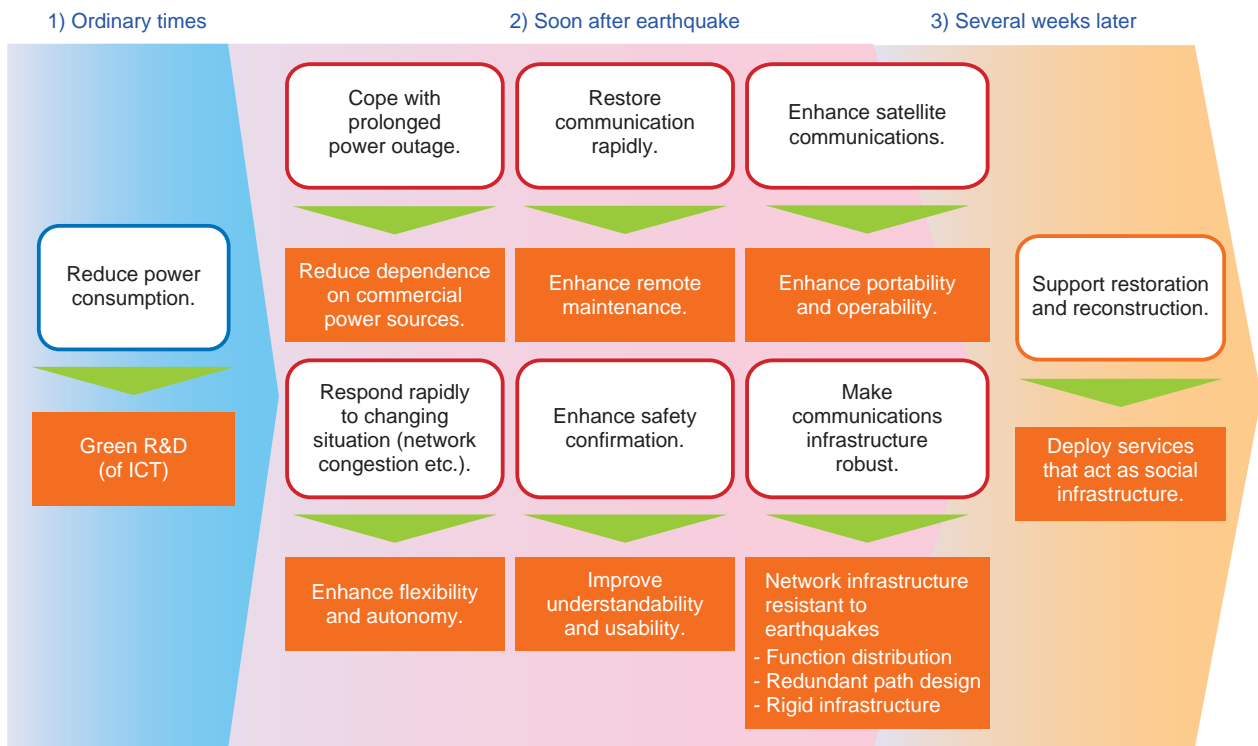


Fig. 1. Major R&D activities to be pursued.

lead batteries. We have designed a lower-power optical network unit (ONU) for installation in homes for fiber-to-the-home (FTTH) service. We reduced the power requirement from 5–10 W for the conventional model to less than 2.5 W, so that the new ONU can be powered by the battery of a portable personal computer through its USB (universal serial bus) interface. This development will enable services to continue even during the outage of the commercial power supply.

#### (2) Restoring communications rapidly

A ring network is designed to sustain communications through an alternative route if it is broken at one place. However, ring networks were broken in several places by the Great East Japan Earthquake, so it was necessary to put restored sections back into operation one by one; this type of operation was not anticipated when ring networks were designed. Over the last year, we have made significant progress in developing the capability to deal flexibly with a reoccurrence of this situation via remote control, which will lead to rapid restoration of ring networks.

#### (3) Enhancing satellite communications

We have completed the development of a compact

satellite communication earth station, which has solved the two major problems of the conventional satellite communication system: the high level of skill needed for aligning the satellite dish and the equipment's size and weight, which made earth station transportation a considerable effort. In addition, we are developing a mesh-shaped networking capability to allow communication between multiple evacuation sites and a broadband access capability to allow access to the Internet. The result is a compact, lightweight, and easy-to-use satellite communication system (Fig. 2).

#### (4) Enhancing safety confirmation

We are enhancing the existing safety confirmation service in three aspects: making it easy for anyone to use the service, making a variety of safety information available at one point, and eliminating barriers between text and voice so that people can access the same information from either a telephone or a PC.

### 1.3 Main R&D activities to be pursued

We have also identified R&D activities that we need to pursue in the medium to long term.

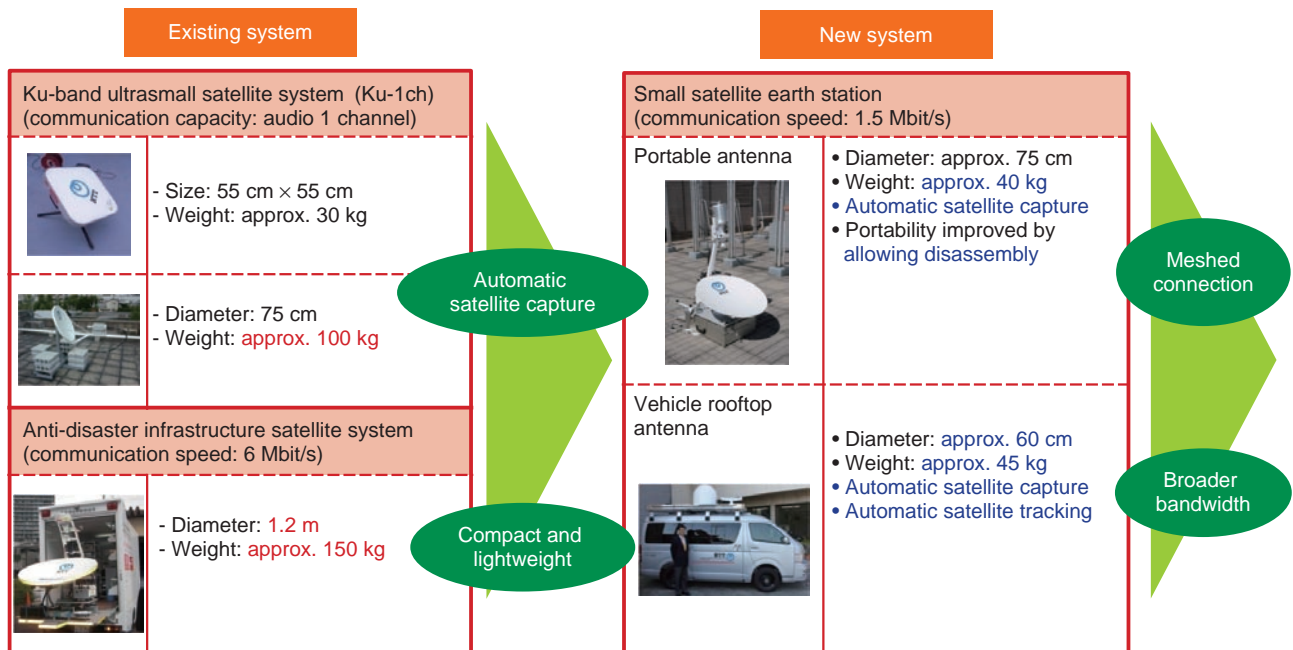


Fig. 2. Compact, lightweight, and easy-to-use satellite communications system.

(1) Robust telecommunications infrastructure (earthquake-resistant infrastructure)

Since the 1980s, we have continued to study anti-earthquake measures for infrastructures such as manholes and conduits. Just as we studied ways to prevent water leakage at the joints of cable tunnels and uneven ground settlement after the Hanshin-Awaji Earthquake Disaster (Kobe Earthquake) of 1995, we are now studying solutions to problems that emerged after last year’s earthquake.

(2) Flexible response to changes in the situation (supple network)

To ensure that services can be provided stably even in the event of an earthquake, we are strengthening our R&D in three areas: (i) a flexible network that allows facilities in unaffected areas and facilities that provide services deemed non-essential in the immediate post-earthquake period to be reallocated to more essential services, (ii) autonomous restoration from multiple failures, and (iii) a flat network that is free from bottlenecks in restoration from failures and in dealing with traffic fluctuations (Fig. 3). Specifically, we are pursuing R&D of flexible networking technology that virtualizes the network in any of its hierarchical levels and allows the virtual networks to be configured, assembled, and operated in a variety of

combinations.

(3) Lower power consumption: Green R&D (of ICT)

Our R&D of lower power consumption has until now focused mainly on reducing the consumed power base, taking this as an indicator of CO<sub>2</sub> emissions. However, learning from last year’s earthquake, we have begun to increase the emphasis on backup power supplies and peak-load-suppressed power supply in order to reduce the dependence on commercial power sources and we have begun to increase the emphasis on datacenter energy management to control the power consumption of all communications equipment according to the traffic load on the equipment (Fig. 4).

(4) Support for restoration and reconstruction (provision of social infrastructure services)

With a view to making a smart community a reality, we are studying community-wide energy management that coordinates distributed power sources, in addition to relatively small-scale energy management, such as a home energy management system and a building energy management system. In particular, we believe that NTT’s highly secure and reliable networks together with its high-performance, high-functionality home gateways can contribute greatly to

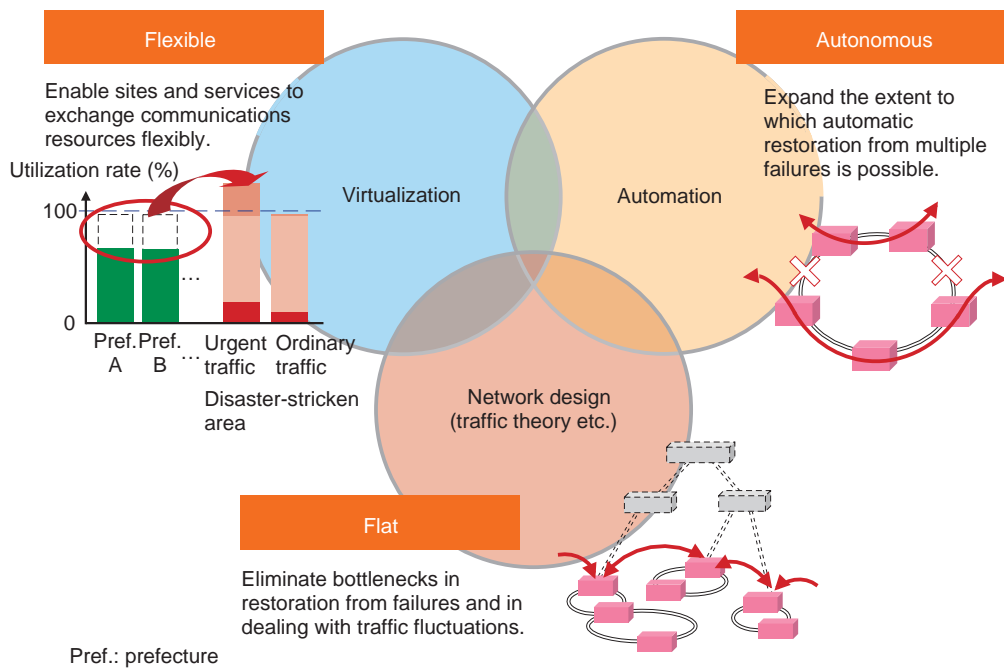


Fig. 3. Supple network: for continuously connected services.

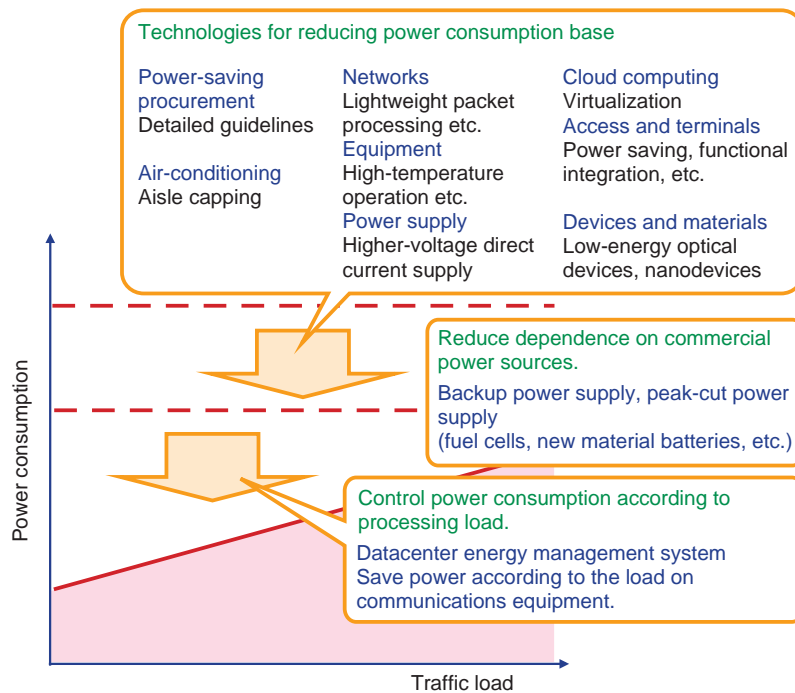


Fig. 4. Activities of Green R&D (of ICT).

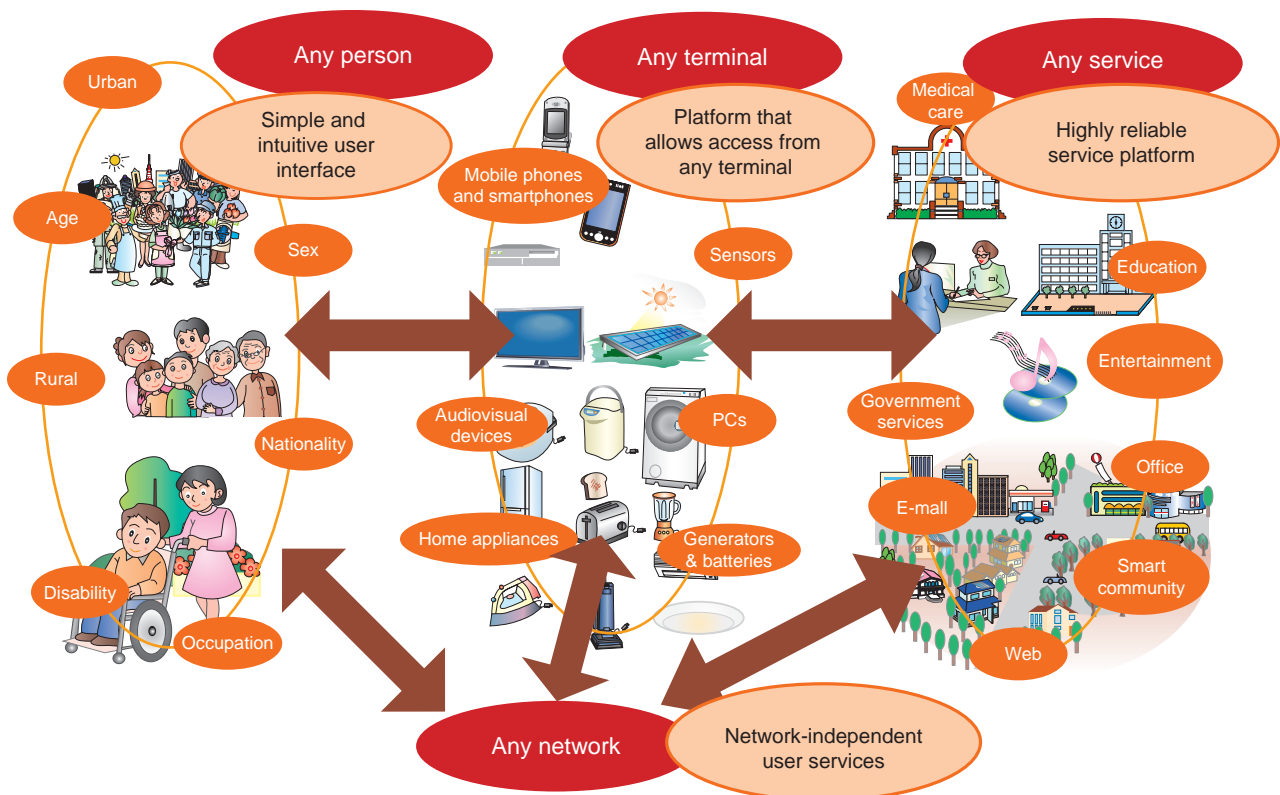


Fig. 5. Future to be brought about by ICT convergence.

such energy management.

We are also working on smart medical care, smart education, and smart administration. Some NTT Group companies are jointly participating in the reconstruction of towns as part of land readjustment projects in Arai Higashi and Tagonishi, Sendai, Miyagi, and in the Fukushima medical care service being trialed in Hinoemata, Fukushima. As a company in a country advanced in identifying and solving social issues, NTT considers it to be its duty to spread its technology and R&D know-how to the world.

## 2. The future to be brought about by ICT convergence

The 2011 earthquake has raised salient many issues regarding what ICT should ultimately provide. We believe that what ICT can provide to the future world is a higher level of security and sense of safety than today and new value through the organic linking of people, objects, and services by ICT, in what may be called ICT convergence.

Opinions expressed by customers after the earth-

quake have been very valuable in our search for the path to this future. For example, many customers found that the user interface of the disaster message dialup and disaster message-board services was too complex to use. Many wanted to access the Internet using terminals familiar to them rather than a mobile phone or PC. There were also some positive opinions, saying that at the time when the telephone service was disrupted right after the earthquake it was good that NTT kept its core network operating so that a variety of communication means, such as email and Twitter, were still available.

These opinions point to the future ICT world as being one featuring (i) a simple and intuitive user interface, (ii) network-independent services, (iii) a platform that allows access to the Internet from any terminal, and (iv) a highly reliable service platform. Simply put, this world can be characterized by four kinds of *any*: *any* person can access *any* service through *any* network using *any* terminal (Fig. 5). These are further explained in sections 2.1–2.4.



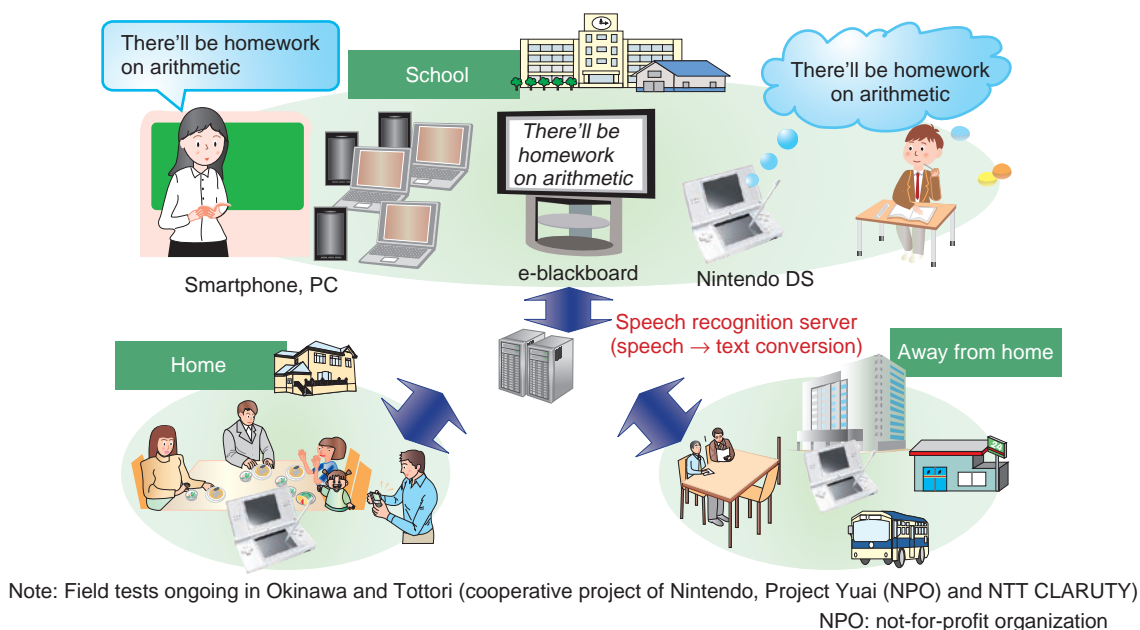


Fig. 6. Koemiru at a special-needs school.

### 2.1 Simple and intuitive interface (any person)

To enhance the user interface, NTT has been focusing its R&D on three fields: speech processing, language processing, and ICT design. In recent years, we have focused on adaptive speech recognition and synthesis, high noise-resistance in speech recognition, and statistical machine translation based on semantic understanding. We believe that accelerating these endeavors is the right course of action for our R&D directed towards service creation.

The Koemiru (see the voice) service that has been provided on a trial basis at schools for the hearing impaired in Okinawa and Tottori since January 2012 is shown in Fig. 6. This service is designed to assist children with hearing impairment in communication by displaying the speech of the teacher in text on the screen of a game machine or by linking game machines to allow children to write messages to each other. This service was reported on Japanese national TV and attracted considerable attention. We believe that bringing this trial service to commercial viability is an important mission of ours.

### 2.2 Network-independent user services (any network)

We believe that if the network is to become invisible to customers, it must meet five requirements: (i) it must connect a customer to an appropriate access

network, (ii) it must give users no discomfort in terms of speed or bandwidth, (iii) the charge must be affordable, (iv) it must allow services to be accessed from any terminal, and (v) it must enable services to be accessed without requiring special skills, in any situation. One direction that we are taking to satisfy these requirements is to study fixed-mobile interworking and convergence. Specifically, we are aiming to build an environment in which terminals can access both fixed and wireless networks transparently, the core network provides equivalent functions and performance for both networks, and service servers in both networks can work together to provide a variety of services. In addition, we will strengthen our study of network-initiated service control, in which terminals and networks work closely together to enable customers to be led to the most appropriate means of communication, at the network's initiative, at the time of a disaster.

### 2.3 Home platform that allows access from any terminal (any terminal)

To provide services that aim at multi-faceted value creation, such as those for a smart community, and are characterized by great convenience of use, it is important to enable a variety of terminals, whether IP (Internet protocol) terminals, non-IP terminals, or smartphones, to be connected and to work together

indiscriminately. NTT is studying Home ICT technology that enables all such types of electronic terminals to be connected and work together via a home gateway, which acts as a hub. It will become possible for the user to input a terminal interworking scenario, which, for example, determines that the user has left home when his/her smartphone has left the home's Wi-Fi area and automatically locks the door and turns off the power to lights and TVs.

#### 2.4 Highly reliable service platform (any service)

Service platform technology has evolved continuously: from the dominance of mainframes in the 1970s to the emergence of the PC and the Internet, to the server-client model and grid computing, which owe much to the availability of broadband access, and to the latest cloud computing. NTT considers cloud computing to be of critical importance as a service provision platform. Our R&D strategy related to the cloud is described below.

### 3. NTT's R&D strategy for cloud platforms: SCALE

NTT's R&D cloud strategy is called SCALE, which stands for security, cost-effectiveness, agility, and leverage: four keywords that characterize the clouds aimed at by NTT.

- (i) Security: security ensured by cloud security
- (ii) Cost-effectiveness: economy derived from the use of open source software
- (iii) Agility: rapid processing of big data
- (iv) Leverage: value added through total operation, including networking.

#### 3.1 Cloud security

We are taking a two-pronged approach to security: (1) technical development to establish a Center of Excellence (CoE) in security as represented by technology for compiling blacklists to prevent attacks and for detecting attacks, cryptographic technology to hide information, and traceability technology to look for traces left by attacks and (2) analysis and evaluation technology to exploit the above to provide sufficient defense and cloud operation that emphasizes the accumulation of know-how.

One recent result of this approach is secret distribution technology, which segments and encrypts a data file and stores the segments on different servers. If someone successfully steals a few segments, he or she cannot reconstruct the original data file. Con-

versely, if a few segments are lost as a result of a server failure, the original data can be reconstructed from the redundancy provided by the remaining segments. This technology has been further extended to secret *computing* technology, in which statistical data computation can be performed while the data remains encrypted, thus making it possible to process big data without compromising the privacy of the people from whom it originated. This technology is being used in joint research on clinical epidemiology with the Japan Adult Leukemia Study Group (**Fig. 7**). This is the first system in the world that creates a database of case data collected from hospitals and generates medical statistical data from it while keeping the personal information of patients confidential. With its processing speed having now reached a level sufficient for practical use, the system can be applied to other areas in the future, including epidemiological studies on diseases other than leukemia.

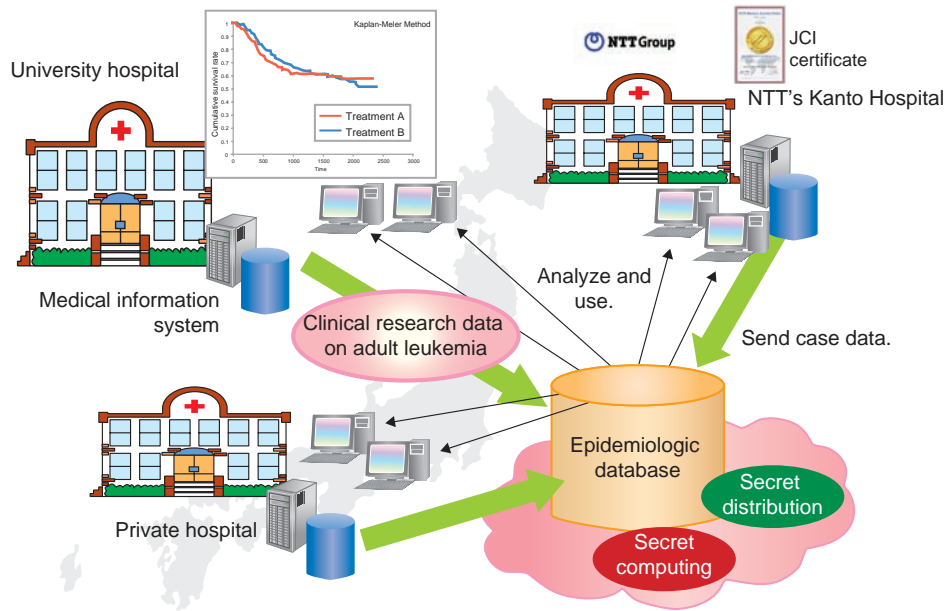
#### 3.2 Full-OSS cloud

One key to achieving economy in cloud computing is to use open source software (OSS) and build full-OSS clouds. However, OSS generally does not provide sufficient functionality or quality. To counter this problem, NTT has formed an OSS Center, whose mission is to enhance both the functionality and quality of OSS. In addition, with a view to providing a competitive edge to NTT's clouds, we are differentiating them by adding those features in which NTT excels, such as security, big data processing, and networking.

#### 3.3 Big-data platform

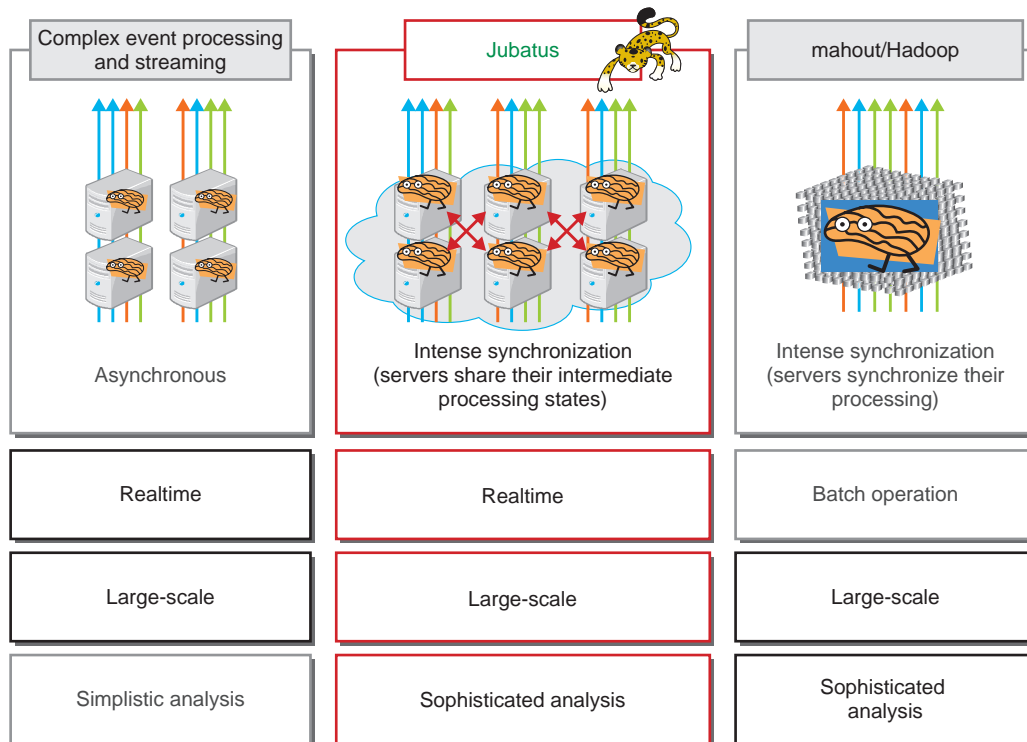
The processing of big data in clouds makes it possible to create valuable knowledge. The availability of such knowledge promises to encourage the emergence of new businesses and new markets that will assist in all aspects of the activities of enterprises, communities, and individuals. NTT will intensify its effort in this field.

Today, a big-data platform is usually implemented using a piece of OSS called Hadoop. This stores collected data and then batch-processes it periodically; thus, the resulting data is no longer realtime data. In other words, it lacks in freshness. Jubatus, a new technology that NTT has developed, enables data collected in real time to be processed in real time on a large scale and enables machine-learning-based data mining. (**Fig. 8**). Our strategy is to promote the use of Jubatus by offering it as OSS and thereby creating a new user community. We are hoping that it will be



JCI: Joint Commission International.  
 (<http://www.jointcommissioninternational.org/About-JCI/>)

Fig. 7. Example of application to clinical epidemiology research.



\* mahout is a machine-learning library operated on Hadoop.

Fig. 8. Realtime big-data analysis technology (Jubatus).

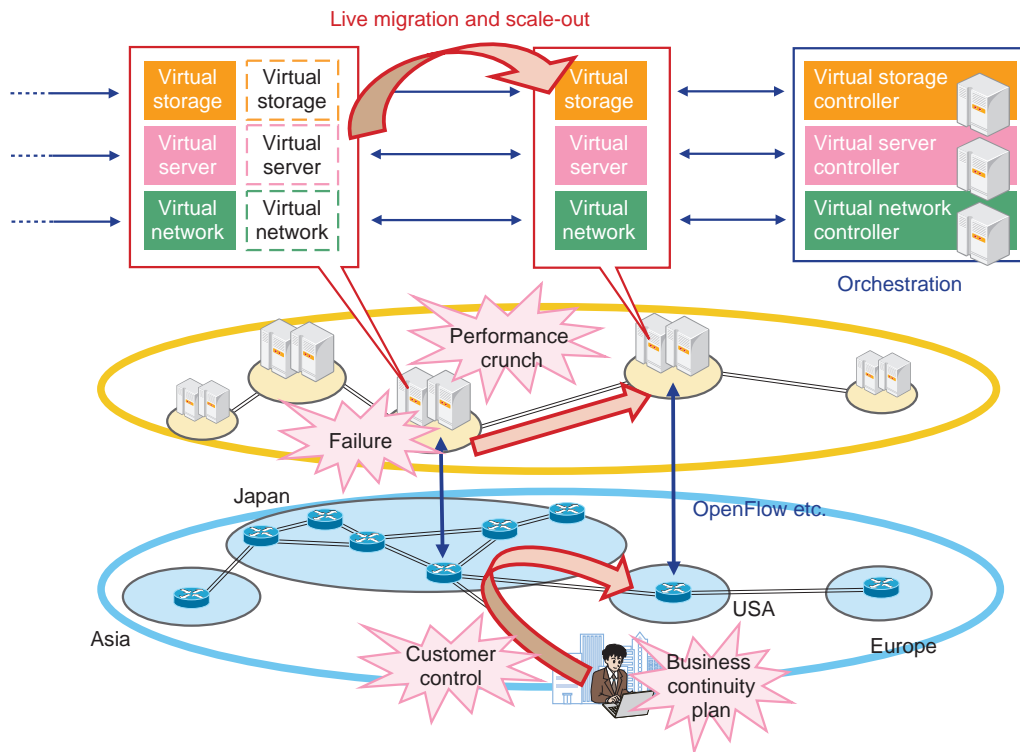


Fig. 9. Making user services portable.

used in new fields such as the machine-to-machine (M2M) market.

### 3.4 Interworking between clouds and the network

There can be various situations in which the operation of a cloud must be integrated with the operation of the network, for example, when a new system is needed to initiate a new service, when a large volume of backup data is generated in normal system operation, when the system’s performance requirements change in response to a failure or rise in demand, or when the system’s physical configuration needs to be changed to suit business relocation or a new business continuity plan. NTT has been seeking to facilitate the use of clouds in these situations, and the goal of being able to change a cloud service without service interruption, in order to meet customers’ ongoing requirements without requiring them to reconfigure their network devices, is now in sight.

For example, we have developed a technology that allows a customer’s service processing to be transferred from one server to another, without interruption to the processing, in response to a customer’s

request (Fig. 9). Specifically, a virtual storage controller, a virtual server controller, and a virtual network controller interact with real servers and the network to allow live migration or scale-out. This technology is applicable to a global-scale cloud service.

We believe that we can make the most of NTT’s strengths through services that integrate the operation of a cloud with that of the network in ways such as those shown in the previous example. NTT aims to achieve service orchestration by harnessing the totality of its carrier-grade networks, which will evolve to allow increased flexibility in functionality (Fig. 10).

## 4. Looking ahead to future developments

### 4.1 Aiming at further service creation

Challenges in the R&D of service creation include packaging services to turn our technical superiority into competitive superiority, identifying and reflecting the user’s viewpoint, and reducing time to market so that appealing services can be launched at the right time. To meet these challenges, NTT has launched a Service Incubation Project Team, which develops

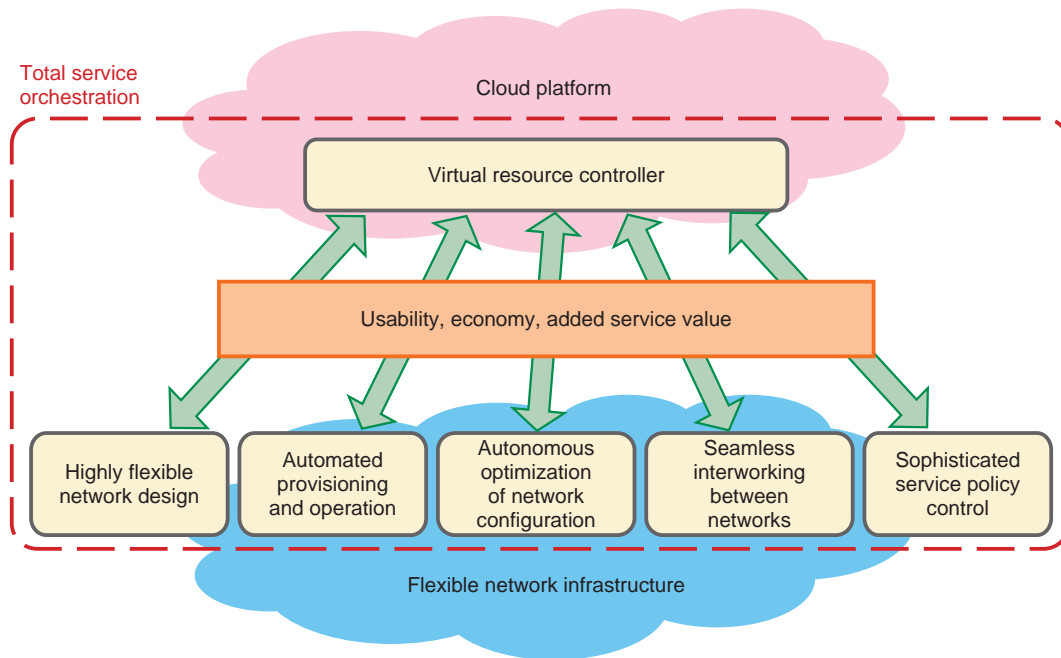


Fig. 10. Total service orchestration.

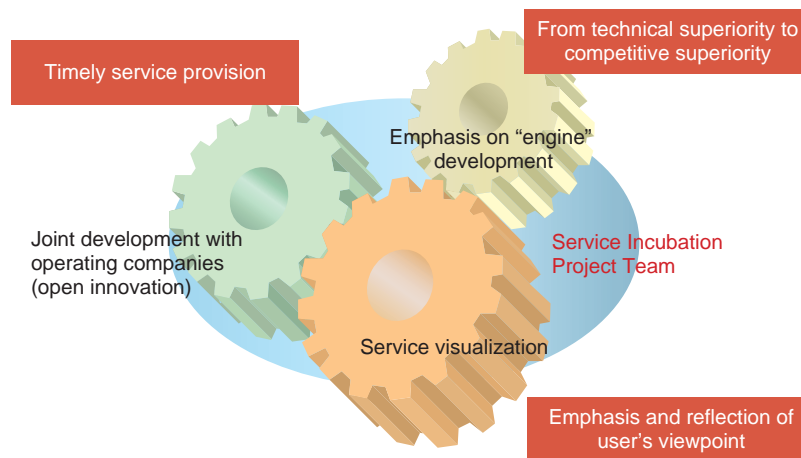


Fig. 11. Aiming at further service creation.

engines for differentiating services by using leading-edge technologies, develops prototype services to evaluate and verify the superiority of the engines, and promotes joint development of commercial services with NTT operating companies or open innovation with parties inside or outside the NTT Group (Fig. 11).

A specific example of such an engine is a lightweight, low-delay software codec engine. This allows

high-definition video to be played even on a low-end PC with a delay of only 100 ms, about 60% shorter than that of conventional codecs; this enables high-definition video communication with realistic sensation, which is currently expensive, to be provided at an affordable price. The application of this engine with its unsurpassed performance is not limited to high-definition video communication. By combining

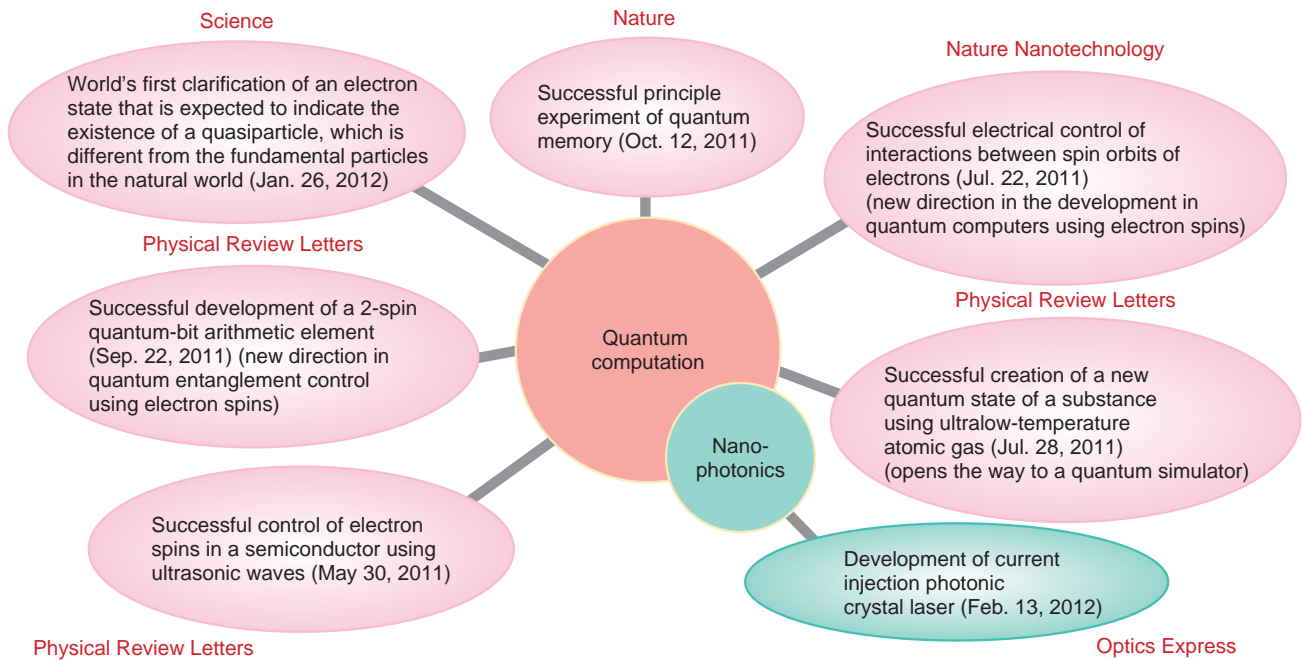


Fig. 12. Recent publications of leading-edge research.

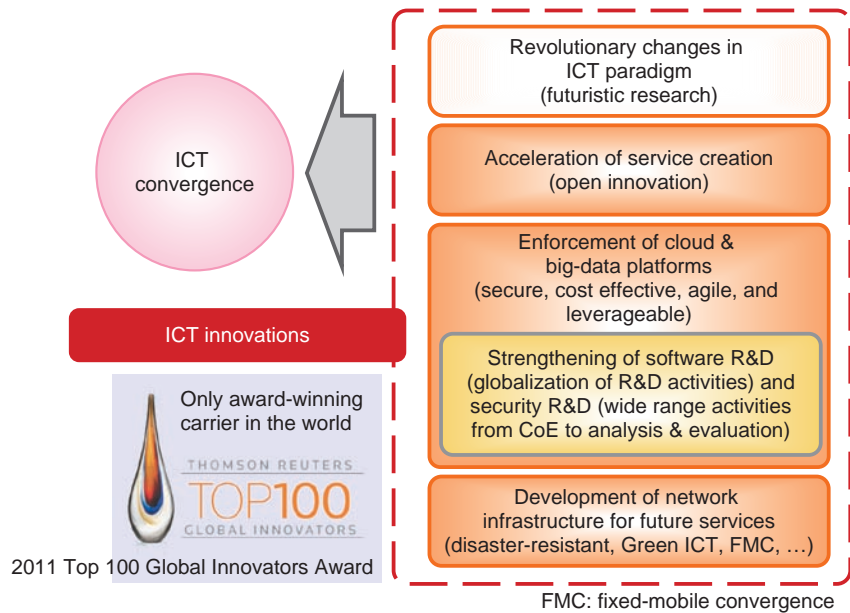


Fig. 13. Creating user values and new industries through ICT innovations.

its leading-edge R&D technologies with external technologies appropriately, NTT will provide services that are highly valuable to customers in a timely manner.

#### 4.2 Latest achievements in leading-edge research

NTT's R&D achievements in materials science over the last year are shown in Fig. 12. An experiment

related to the principle of quantum memory and an experiment indicating the existence of a *quasiparticle*, which is neither a boson nor a fermion, were published in Nature and Science, respectively, two world-renowned science journals. We have also succeeded in developing a current injection photonic crystal laser, which is another example indicating the extremely high level of activity we are maintaining in leading-edge research.

In the area of leading-edge telecommunication technology, we are pursuing the development of a digital signal processing large-scale integrated circuit (DSP-LSI), which allows high-capacity wavelength-division-multiplexing (WDM) transmission of 100 Gbit/s per wavelength in order to handle the ever-growing communications traffic, and the development of a photodiode for converting electromagnetic

radiation at visible light frequencies to terahertz frequencies, which can be used to detect the chemical composition of a dangerous gas or a drug. In particular, we are considering the application of optical device technology, which is NTT's forte, to fields not directly connected with telecommunications.

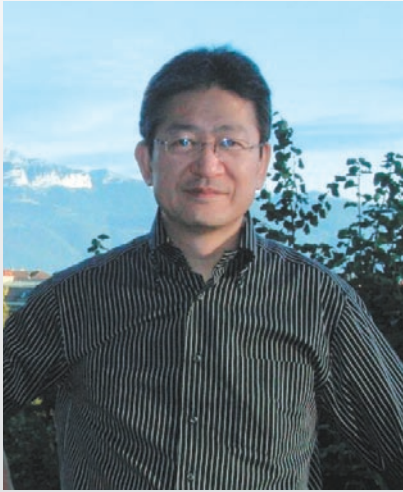
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## 5. Concluding remarks

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NTT was the world's sole telecommunications carrier to win the 2011 Top 100 Global Innovators Award from Thomson Reuters. As a carrier's R&D organization, striving to lead global innovation, the NTT R&D Laboratory Group will keep on opening up new possibilities while zealously guarding superiority in core telecommunications technology: the very technology on which a carrier stands (**Fig. 13**).

## Pursuing Your Interests Using Inspiration from the Outside World



***Hiroaki Gomi***  
***Distinguished Senior Researcher***  
***NTT Communication Science Laboratories***

Dr. Hiroaki Gomi, an NTT Distinguished Senior Researcher, is rare among technical researchers: He explores the mechanisms of information processing in the brain, an area normally associated with medical science and psychology. His achievements have attracted attention throughout the world, and his papers have appeared in numerous publications including the American academic journal *Science*. We asked him to tell us about his motivating force and the source of his ideas and how his research is currently progressing.

### Exploring the mechanisms of information processing in the brain to unravel everyday wonders

—Dr. Gomi, please tell us about your research.

In a few words, I am exploring the mechanisms of information processing in the brain. Only a small portion of information processing from sensory input to movement is performed consciously; most of it is performed unconsciously. This function is acquired through a development process that begins in childhood. It becomes increasingly diverse as you learn how to process information from sensory input to movement in everyday life according to your purpose. In our research, my colleagues and I seek to clarify the mechanisms of implicit, quick, and autonomous sensorimotor programming and control processes in human movement and the interaction between sensorimotor control and perception from a new perspective. To this end, we are focusing on top-down modification and prediction (forward estimation) and postdiction (retroactive estimation) processes that interact with information processing from visual and somatic sensations to the generation of

motor commands, and we are working to explain this interaction mechanism using a composite approach that includes psychophysics, electrophysiology, brain imaging, and computational modeling.

—That gives us a general idea of your research, but could you give us an even simpler description?

Please imagine for a moment that the brain contains embedded sensors associated with vision, touch, and muscles and that we wish to understand how information from those sensors is used to represent the outside world and move a person's hands, feet, mouth, and eyes (**Fig. 1**).

It might be better to experience such information processing instead of just talking about it (smiles), so let's move into the laboratory (**Fig. 2**). In this laboratory, we have constructed a mock-up of an escalator and covered it in black. When experimental subjects walked onto a black step, they felt nothing strange. On the other hand, after the black covering had been removed, they felt an odd sensation together with a swaying of their body in the forward direction as soon as they stepped onto a step that was now visually



recognized as being part of an escalator. Since there is no difference between the two structures, such as step height, we attribute this phenomenon to a difference in perception.

—*This odd sensation is just what you feel when stepping onto a stopped escalator, isn't it.*

That's right. No doubt many people have experienced this sensation. We are researching why it occurs.

Not everything about implicit brain processing has been explained, and I think this is why our view of

these strange happenings with a stopped escalator is attracting the interest of many people. Our interpretation differs from what has been said in the past about such phenomena.

Up to now, one frequently offered explanation of the mechanism behind such human behavior has been that the incline at the escalator's entrance causes the body's center of gravity to shift forward and become unstable. Another explanation has been that the continuous stripes on the escalator's steps create the illusion by a binocular mis correspondence. On the contrary, we have shown that this postural change originates from the brain's implicit information processing (motor programming) for the *moving* escalator even though its conscious perception is completely aware of the *stopped* escalator [1]. We are currently conducting further research on this finding.

### Inspiration came from an escalator in Barcelona

—*What drove you to begin this research?*

Some time ago, I visited the city of Barcelona in Spain to attend an academic conference. Perhaps because of the region's good weather, there was an outdoor escalator there, though it was clearly not moving. As soon as I stepped onto this stopped escalator, I felt a strange sensation that's hard to describe, and I felt a strong urge to understand its mechanism. I mentioned my interest in researching this sensation to my colleagues at the conference, but they did not show any enthusiasm.

This inspiration reminds me of a question that I posed when majoring in robotics at university. At that time, I thought "Why can't a robot perform actions

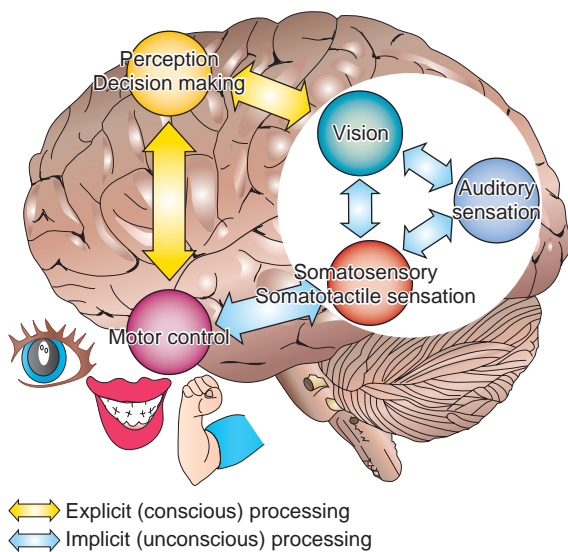


Fig. 1. Schematic representation of information processing in sensation, perception, and motor control.

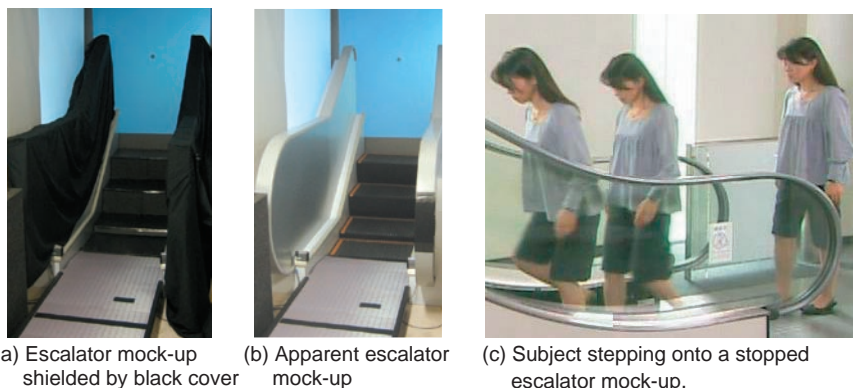


Fig. 2. Wonder of information processing in the brain.

that are very simple for a human to do?”

For my first assignment after entering NTT, I actually hoped to be placed in a department outside the field of robotics, but as it turned out, I was given a post related to robots that put me on a firm career path. This was quite lucky for me. I was also interested in information processing in the brain at that time, and I was able to participate in research exploring the mechanisms of human learning and movement as well as research in information processing related to human motor learning at the Advanced Telecommunications Research Institute International (ATR) in Kyoto.

I also had the opportunity to work with researchers at the National Institute of Advanced Industrial Science and Technology (AIST) (former name, Electrotechnical Laboratory (ETL)) on eye movement generated by surrounding visual motion and its physiological mechanism. During this research, I came to understand what kind of information about movements in the outside world is used to make the eyes move. Specialists in this field have been aware for some time of the connection between movement in the outside world and movement of the body, and I thought that maybe I could use this phenomenon of unconscious body movement and knowledge of its mechanism to clarify the mechanism behind the body’s forward sway on an escalator.

When first starting out on this research, I was focused on information processing in relation to motor learning and control, but from around 2000, I began to expand upon this and pursue the relationship between movement and visual information processing and perception.

### Taking great pride in rare but necessary research

*—Why is knowledge of sensorimotor mechanisms necessary in NTT laboratories?*

I am often asked this question. To be sure, such research is mostly pursued by people in the fields of medical science and psychology. In the past, people like my colleagues and I, who are first and foremost technical researchers, rarely became deeply involved in research on sensorimotor functions and mechanisms. Even today, we sometimes feel like heretics in NTT laboratories. Although it has been many years since I returned to NTT and began this research, I’m still being asked “Why?” However, a strong point of NTT laboratories is that you are given the opportunity to pursue a certain line of research provided that

you can provide a clear, logical reason why it is necessary.

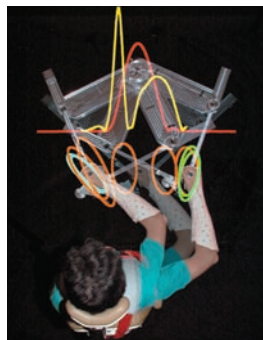
For example, among engineers attempting to improve communications technology, one way of thinking is that equipment and system functions should be enhanced and made more convenient, at least as a starting point. Of course, this is very important, but it is no less true that it is human beings that will be using such equipment and functions. Accordingly, could we not put more emphasis on communications technology by clarifying and understanding human sensory and cognition mechanisms? Could we not make communications technology even easier to use and more convenient by, so to speak, deceiving and altering human cognition? This aspect of communications is what we wish to explore. Though it is rare among research topics in communications, I believe that it is necessary. As members of NTT laboratories where a wide array of fields from fundamental technologies to applications are researched, we take great pride in undertaking the most fundamental of studies.

Moreover, there are many world-class experts in vision and hearing at NTT Communication Science Laboratories. Holding discussions with them and sharing results helps to bring a variety of questions and ideas to the surface. Putting myself into such an environment is stimulating and makes my research all the more satisfying.

*—Was there a moment when you first felt that your research was bearing fruit?*

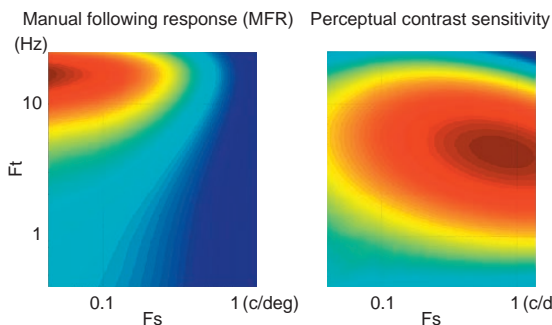
In research that aims for explanations, it is often difficult to get useful results that make people happy in a relatively short period of time. What can provide emotional support here is that research results can sometimes present and draw attention to new and interesting findings. It gave us great pleasure and a sense of accomplishment when our research on computation in the brain for moving the human arm was reported in the American journal *Science* [2] (**Fig. 3**) and our discovery of new characteristics of implicit visuomotor processing appeared on the covers of leading journals [3], [4] (**Fig. 4**).

However, a complete explanation is, in fact, difficult. While we may think that we understand, something may not hold true depending on conditions, so it’s best to take one step at a time. Taking, for example, the question of why your body sways forward when you step onto a stopped escalator, we were able to give a good explanation and to understand



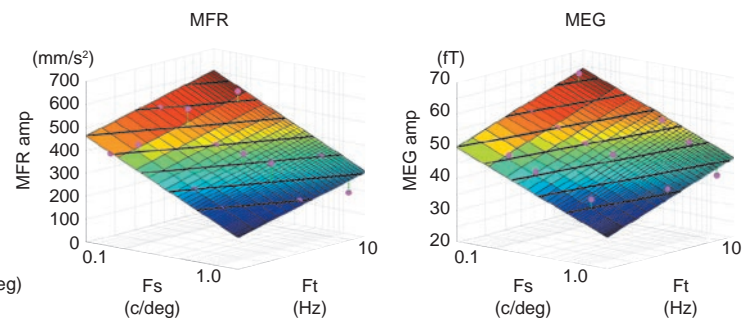
Arm stiffness ellipses measured in response to a time-series of perturbations during arm movement (blue: before movement; orange: during movement; green: after movement), tangential velocity of actual movement (red line), and estimated equilibrium-point velocity (yellow line). The measured arm stiffness was lower than previously predicted. This demonstrates that the brain must code complicated equilibrium-point movements according to the arm dynamics in order to achieve smooth arm movements. This finding argued against the hypothesis that the brain codes simple “equilibrium-point” control.

Fig. 3. Arm stiffness during movement and equilibrium-point velocity profiles.



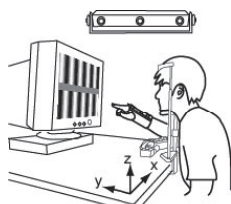
The differences in these characteristics indicate that the visual information processing differs in visuomotor control and visual perception.

(a) Comparison of spatiotemporal frequency tuning between manual response in reaction to visual motion and perceptual contrast sensitivity when viewing the same motion (Fs: spatial frequency; Ft: temporal frequency; c/deg: cycles per degree of visual angle on the retina).

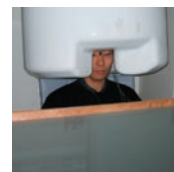


The similarity of these spatiotemporal frequency tunings suggests that the signal source of MFR is generated in the occipital lobe.

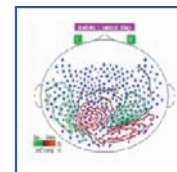
(c) Spatiotemporal frequency tuning of MFR and magnetoencephalography (MEG)



(b) Experimental setup



(d) Experimental setup for MEG measurement



(e) MEG brain mapping.

Fig. 4. Discrepancy in visual-motion analysis between manual response and perception.

that human movements that we are all familiar with can manifest themselves in a variety of situations. However, we are still researching why that forward sway is conveyed not as a mistake in body movement but as an odd sensation. We would like to understand what part of the brain is used for what kind of information processing.

**Pursue your interests insistently,  
but do not fear backing out**

*—Is the driving force behind your research a sense of mission as in contributing to society? Or are you interested in solving riddles?*

Pursuing my interests is a major force behind my

work. Basically, the reason for this is that a strong desire for knowledge makes me passionate about research more often than a sense of mission.

I often tell young researchers that there is no point in working on something that does not interest them—it can't go well in the end. The more one wonders about something that one does not understand or why something is happening in an area of interest, the more one's intellectual curiosity is tickled. This is beneficial for society while giving the researcher a sense of fulfillment.

Perhaps I myself have a persistent personality. It is not so easy for me to give up. I just keep thinking about a problem over and over again when I want to solve it. But sometimes, when I can no longer come up with new ideas or have lost my direction, I call a halt to the study. But this is not really giving up: when you move on to another topic, you sometimes think about the earlier problem later from a new perspective and see things that you could not see before.

*—From where do you receive your flashes of inspiration?*

I participate in academic societies in fields somewhat different from my area of specialization. We have often presented our research results to academic societies related to neuroscience and brain science from the viewpoint of information processing, but in the past, these were mainly societies specializing in motor control. Recently, however, we have been making presentations to societies that mainly target vision and cognition, which has been quite enjoyable.

Furthermore, when talking to foreign researchers, I can hear lots of opinions from a perspective completely different from that of Japanese researchers even if we are talking about a problem in the same area of research. Perhaps this is due to differences in background and fields of learning. In this way, I can see things that I had not noticed on my own and can be inspired as a result.

In addition, I make an effort to interact with researchers in different fields. Brilliant researchers, even those in different fields of study, will ask me straightforward questions, which are often quite important and worthy of considerable thought.

*—How is your research tied into the future?*

This is a matter of focusing on new discoveries and newly explained functions and showing the direction to applications. Uncovering applications from funda-

mental knowledge is often difficult, but what we would like to do is to build a foundation for paths leading to diagnostic techniques for deteriorating brain functions and brain disorders, training techniques for recovering and fortifying brain functions, and the creation of new human-machine interfaces, to give some examples.

Manipulating sensory information even just a little can produce some strange effects in cognition and movement. Such phenomena may be apparent to the person in question or go unnoticed. It's important that we deeply investigate those phenomena and clarify the information processing that enables the brain to interact with the outside world and show the direction for applying that processing.

To give some familiar examples, the present technology used in three-dimensional (3D) television is quite amazing, but watching such 3D images for an extended period of time can be tiring. Moreover, if you attach a similar 3D display mechanism to your head and move your hands or body in a virtual visual space, your movements will become awkward and you will tire and feel sickly even sooner. This is because difficulties arise in cerebral information processing, which we still have not explained sufficiently. If we can understand what kind of information processing is carried out in the brain and how to prevent such difficulties from occurring there, we should be able to contribute to the development of technology for achieving natural, easy-to-watch 3D television.

**A rebellious spirit is very welcome.  
Let the heated debates begin!**

*—Dr. Gomi, could you leave us with some advice for young researchers?*

Our laboratory is presently made up of about 30 young researchers in their 20s, 30s, and 40s. Young people tend to be quite flexible when facing new matters, and such an attitude is very gratifying. On the other hand, I sometimes feel that young researchers can be too quiet.

Perhaps the rebellious spirit that I look for in researchers is in conflict with what is normally required to receive praise as a good member of community. But in the world of research, I believe that a heretical stance is something that a researcher should be proud of.

The research process is more than just learning. I am always trying to figure out what I can take from

heated debates and how I can connect them to new experimental paradigms and new ideas. So, to young researchers, I say “Please, do not hesitate to debate. Engaging in lively and even heated discussions can lead to better research.”

### References

- [1] T. Fukui, T. Kimura, K. Kadota, S. Shimojo, and H. Gomi, “Odd Sensation Induced by Moving-phantom which Triggers Subconscious Motor Program,” *PLoS ONE*, Vol. 4, No. 6, e5782, 2009.
- [2] H. Gomi and M. Kawato, “Equilibrium-point Control Hypothesis Examined by Measured Arm-stiffness during Multi-joint Movement,” *Science*, Vol. 272, No. 5258, pp. 117–120, 1996.
- [3] H. Gomi, N. Abekawa, and S. Nishida, “Spatiotemporal Tuning of Rapid Interactions between Visual-motion Analysis and Reaching Movement,” *The Journal of Neuroscience*, Vol. 26, No. 20, pp. 5301–5308, 2006.
- [4] K. Amano, T. Kimura, S. Nishida, T. Takeda, and H. Gomi, “Close Similarity between Spatiotemporal Frequency Tunings of Human Cortical Responses and Involuntary Manual Following Responses to Visual Motion,” *J. Neurophysiol.*, Vol. 101, No. 2, pp. 888–897, 2009.

### Hiroaki Gomi

Distinguished Senior Researcher and Group Leader of Sensory and Motor Research Group at NTT Communication Science Laboratories.

He received the B.E., M.E., and Ph.D degrees in mechanical engineering from Waseda University, Tokyo, in 1986, 1988, and 1994, respectively. He was a researcher at Advanced Telecommunications Research Institute International (1989–1994), Adjunct Lecturer of Waseda University (1995–2001), and Adjunct Associate Professor (2000–2003) and Professor (2003–2004) of Tokyo Institute of Technology. He was also involved in CREST (1996–2003) and ERATO (2005–2010) projects of the Japan Science Technology Agency. His current research interests include computational and neural mechanisms of implicit human sensorimotor control and interactions among action, perception, and sensation. He is a member of the Society for Neuroscience, the Japan Neuroscience Society, the Japanese Neural Network Society, the Society of Instrument and Control Engineers, and the Institute of Electronics, Information and Communication Engineers.

## Electromagnetic Compatibility Standardization Activities in the Telecommunication Field at the IEC/CISPR Seoul Meeting

*Kimihiro Tajima<sup>†</sup>, Yoshiharu Akiyama, Norihito Hirasawa, and Fujio Amemiya*

### Abstract

This article summarizes recent electromagnetic compatibility (EMC) standardization activities in the telecommunication field at the 2011 IEC/CISPR Plenary Meeting held in Seoul, South Korea, from October 11 to October 21 and reports on the state of standardization deliberations relevant to NTT's telecommunication business. International EMC standards are an important issue for the NTT Group, as they define EMC requirements for the provision of safe and secure telecommunication services.

### 1. Introduction

The NTT Group maintains in-house technical requirements (NTT-TRs) that set out the electromagnetic compatibility (EMC) quality levels to be adhered to when developing or procuring telecommunication equipment and devices. NTT-TRs stipulate EMC requirements (acceptable limits and measurement methods) to ensure safe and secure telecommunication services in terms of emissions (of electromagnetic disturbances), immunity (to electromagnetic disturbances), and overvoltage tolerance capability (**Fig. 1**).

The acceptable EMC limits and measurement methods specified in NTT-TRs conform to international standards for information technology equipment (ITE) or telecommunication equipment set out by organizations such as IEC/CISPR (see section 2) and ITU-T SG5 (International Telecommunication Union, Telecommunication Standardization Sector, Study Group 5) so that enterprises in related industrial sectors in Japan and abroad can abide by the NTT-TRs.

### 2. Summary of CISPR Seoul Meeting

The Comité International Spécial des Perturbations Radioélectriques (CISPR)—also known as the International Special Committee on Radio Interference—is a special committee of the International Electrotechnical Commission (IEC). To ensure that there are consistent global standards, it issues international standards for the emission levels of unwanted electromagnetic disturbances from various devices (radio interference sources) as well as for the apparatus and methods used to measure such disturbances. The CISPR secretariat is located in Geneva, Switzerland.

The 2011 IEC/CISPR Plenary Meeting was held at the Palace Hotel in Seoul from October 11 to 21. The Steering Committee, the five subcommittees (Subcommittees A, B, F, H, and I), 14 Working Groups, and the IEC Subcommittee SC77C (High power transient phenomena) met in parallel with the Plenary Meeting. Japan sent 35 delegates representing the Ministry of Internal Affairs and Communications, the National Institute of Information and Communications Technology, NTT, universities, testing organizations, and industry groups (**Photos 1** and **2**). An organizational map of the EMC-related IEC

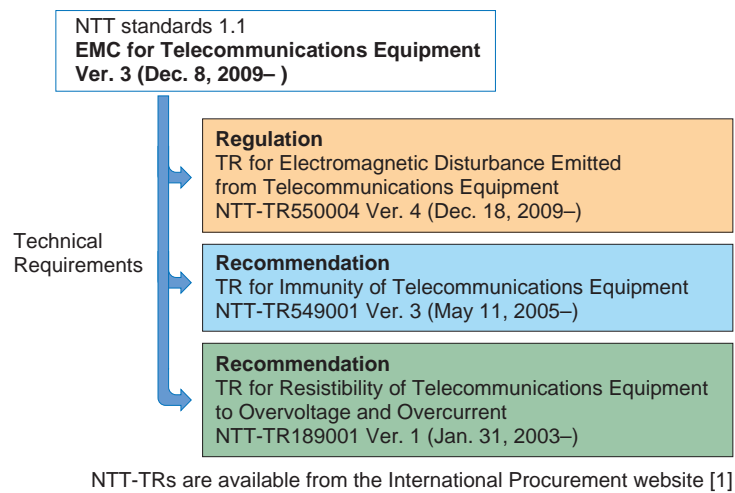


Fig. 1. NTT-TRs for EMC standards.



Photo 1. Meeting place: the Palace Hotel in Seoul.



Photo 2. Meeting.

committees is shown in **Fig. 2**.

### 3. Main topics at IEC/CISPR Seoul Meeting

#### 3.1 Smart grid standardization activities (creation of a WG)

Smart grids have been attracting increasing attention in recent years as a means of preserving the global environment and mitigating risks from major natural disasters. They provide coordinated systematic control over loads on decentralized energy sources, such as storage batteries and natural energy sources, to shift peak loads and reduce overall power consumption. To examine smart grids, the IEC decid-

ed to establish a Strategic Group on Smart Grid (SG3) at the Sao Paulo meeting in November 2008 and selected a convenor and 13 members at the February 2009 Seoul meeting. SG3 released a standardization roadmap in June 2010 and noted the need to work with TC77 and CISPR in the area of EMC.

In view of this background, it was agreed at the recent Seoul meeting to establish a smart grid WG under the CISPR Steering Committee. It was also decided to circulate a Document for Comments (DC) in November 2011 to the National Committees (NCs), SCs, and Technical Committees (TCs), such as TC77, with strong relations with CISPR to nominate members for the new WG. It was determined that

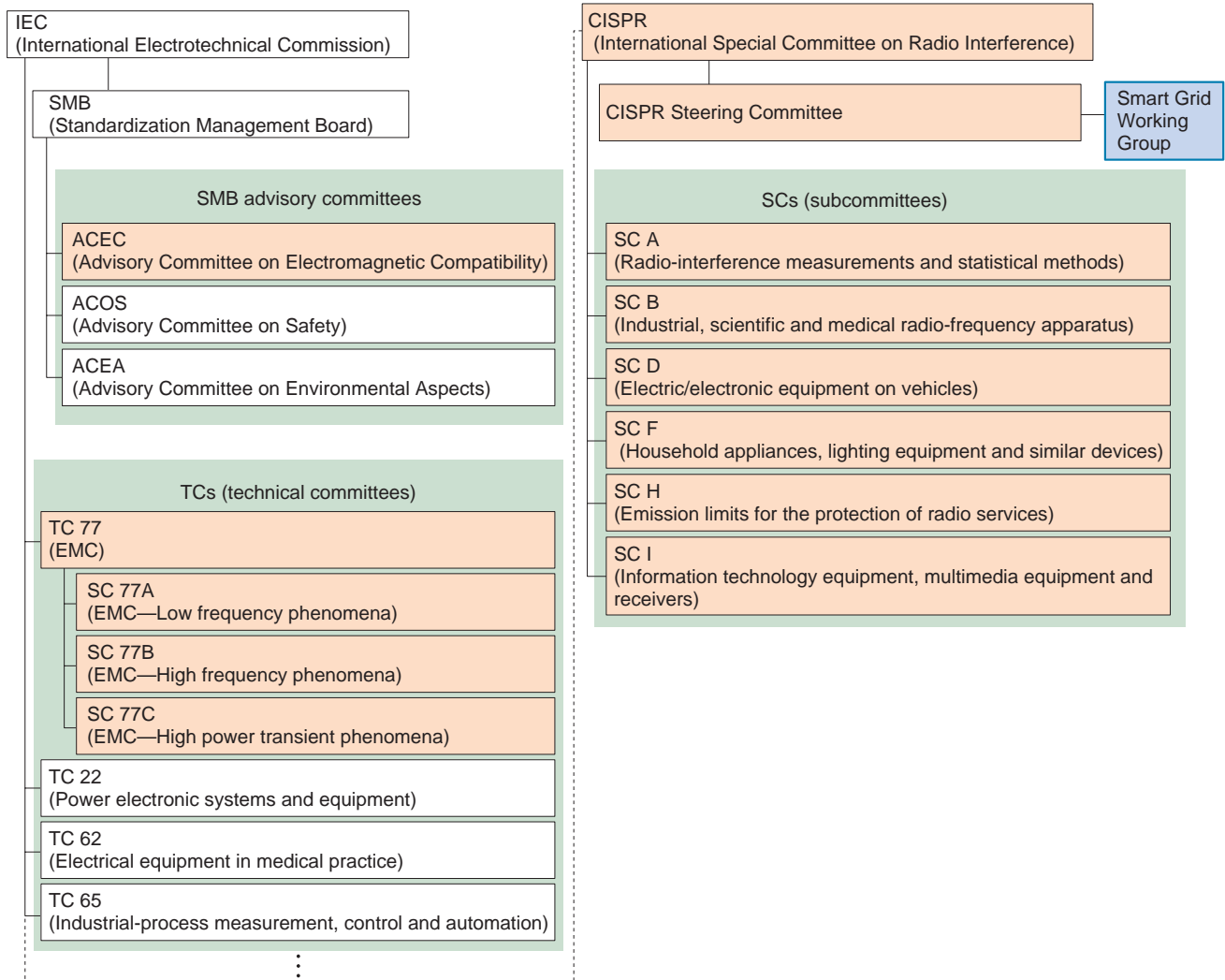


Fig. 2. EMC-related IEC committees (organizational maps of TC 77 and CISPR).

the WG will report on the progress of its activities to the Steering Committee, which meets by conference call every two months.

**3.2 Proposal to establish new acceptable limits and measurement methods for radiated emissions below 30 MHz**

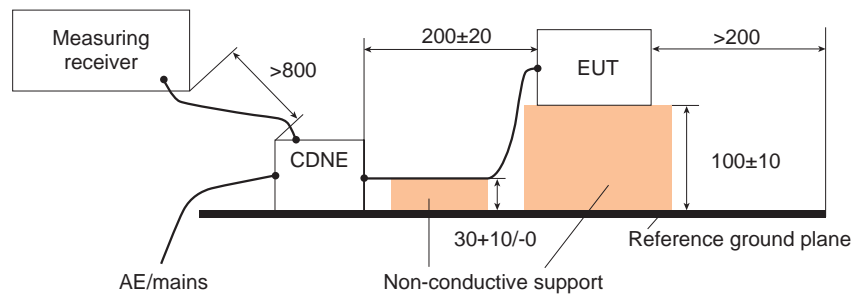
This proposal, tabled by Germany, was triggered by field data indicating that large-screen plasma TVs produced radiated emissions below 30 MHz and that these emissions were interfering with radio services. Current CISPR standards for measurement methods and acceptable limits for sub-30-MHz radiated emissions apply only to special devices, such as induction heating devices. This new proposal, therefore, called

for these regulations to be extended to cover all devices. As a majority was in general agreement with the need for measurements, it was decided that, as a first step, Subcommittee A would start to examine antenna calibration methods, test site validation methods, and other issues in line with Japan’s approach to the problem.

**3.3 Proposal to establish new EMC provisions for conducted emissions between 9 kHz and 150 kHz**

This proposal, tabled by Australia, recommends that acceptable levels of conducted emissions be examined in the range from 9 kHz to 150 kHz, which is not covered in current CISPR standards, in light of





NOTE: All dimensions are in mm.

EUT: equipment under test

Fig. 3. CDNE test setup (measures power-supply line radiated disturbances between 30 MHz and 300 MHz).

the introduction of smart meters using low-speed power line communications (PLC) with frequencies up to 450 kHz. In response to a questionnaire on the need to regulate such acceptable levels (CISPR/S/337/INF), Japan submitted the comment that there should be discussion about introducing emission measurements on the way to creating a standard since there have been cases of PLC impairing the performance of other devices and causing malfunctions. Countries submitted opinions both in agreement and opposition, but it was pointed out that there were procedural problems in how the questionnaire was circulated. Therefore, it was decided to resubmit the questionnaire to NCs and obtain comments. It was agreed that an action plan draft based on the obtained comments would be presented prior to the 2012 Plenary Meeting.

#### 4. Main issues and discussions

The NTT Group's in-house EMC regulations include EMC standards for telecommunication equipment (in-house standards), which specify the minimum EMC requirements and operational methods for telecommunication equipment that NTT uses to provide telecommunication services as well as for telecommunication equipment provided to customers. NTT-TRs consist of technical requirements taken from the in-house standards [2]. This section introduces the direction of discussions on standardization issues concerning these test methods, test apparatus, radiated emissions standards, and immunity standards.

##### 4.1 Subcommittee A

CISPR Subcommittee A is engaged in forming base

international standards for radio disturbance measurement apparatus and methods. Its main mission is preparing and revising the CISPR 16 series of standards that specify radio disturbance measurement apparatus and methods and are designated as base standards cited by all other CISPR standards.

##### (1) Proposal of a simple alternative method using coupling decoupling networks (CDNE method)

The proposal (measurement apparatus specifications, measurement methods, and uncertainties) on the coupling decoupling network for emission measurement (CDNE method) will move to a Committee Draft for Vote (CDV). Japan has expressed reservations about the basic correlation between the CDNE method and the ten-meter method, but it did not oppose the establishment of the CDNE method as a disturbance measurement method. Japan did submit technical comments on such matters as the CDNE specification and the rationale for the testing setup.

The CDNE method, as a measurement method, was originally intended for lighting equipment tests and does not require radiated disturbance measurements (between 30 MHz and 300 MHz) at 10 m (Fig. 3). Japan had been seeking an accurate specification for the CDNE method, because its inclusion in the CISPR 16 series, the base standards for measurement apparatus, raised the possibility of its use in tests of devices other than lighting equipment.

At the Seoul meeting, Japan was successful in getting incorporated into the text the importance of longitudinal conversion loss provisions for CDNE in tests of products dominated by differential-mode components and the issue [3], [4] of common-mode crosstalk.

Japan's proposal was based mainly on the results of actual measurements performed in NTT's R&D

laboratories, which have a wealth of experience and a long track record with conducted disturbance measurements on transmission lines. Because of this factual basis, neutral third-party countries approved Japan's suggestions.

(2) Validation of test sites for measurements of radiated disturbances below 30 MHz

With the growing momentum of the energy-conservation movement in recent years, inverters and other energy-saving electrical products have been adopted in increasing numbers and are now in widespread use. However, there are concerns that these devices will lead to greater electromagnetic interference at frequencies below 30 MHz. To date, disturbances in the sub-30-MHz frequency range for most products have been regulated by the disturbance voltage at the power supply terminals. But as the development and transformation of electrical and electronic devices have changed disturbance-emission mechanisms, there is a growing need to directly measure and regulate radiated disturbances to avoid electromagnetic interference. Consequently, there is a growing need for measurement methods and standards for sub-30-MHz radiated disturbance measurements.

SC-A/WG1 set up new *ad hoc* groups for "test site validation" and "measurement methods" with respect to sub-30-MHz radiated disturbance measurements. Dr. Akira Sugiura from Japan (NICT) was selected as the convenor of the test site validation *ad hoc* group. It was also decided to circulate a DC (CISPR/A/978/DC) after the Seoul meeting and ask for volunteers from countries for the following tasks related to sub-30-MHz radiated disturbance measurements.

1. Loop antenna calibration methods (A/WG1)
2. Standards on test sites for radiated disturbances below 30 MHz (A/WG1)
3. Test site validation methods (A/WG1)
4. Standards for measurements of radiated disturbances below 30 MHz (A/WG2)
5. Uncertainties assessment of radiated disturbances below 30 MHz (A/WG2)

#### 4.2 Subcommittee I

Subcommittee I is involved in creating international standards regarding EMC of ITE and multimedia devices. This subcommittee is preparing emissions standards (CISPR 13, 22, and 32) and immunity standards (CISPR 20, 24, and 35) for telecommunication equipment. It is working on two issues that have a direct bearing on NTT's business.

(1) Emission and immunity standards for multimedia equipment

This issue concerns the establishment of emission standards (CISPR 32) and immunity standards (CISPR 35) that target ITE and broadcast receivers. Since the functional barrier between them has disappeared, new standards that cover both categories are being drawn up. NTT's emissions TR and immunity TR are based on the existing CISPR 22 and CISPR 24 standards, but these TRs are expected to be replaced once CISPR 32 and CISPR 35 come into effect. The establishment of new standards that will govern NTT's required EMC performance in the future is therefore a highly relevant issue for NTT's business.

A vote was held on the Final Draft International Standard (FDIS) for CISPR 32 (the vote deadline was Dec. 9, 2011), and as a result the FDIS was approved. It was also decided to start debate quickly on the five pending Committee Drafts for Comments (CDs) with the aim of issuing them as an amendment 1 of CISPR 32 Edition 1.

Japan has steered the debate on this standard and has contributed multiple proposals. NTT has also contributed actively to the standardization process, particularly in the area of conducted disturbance measurement methods.

With respect to CISPR 35, the Seoul meeting concluded most of the debate on NC comments on the CD (I/380/CD) and it was agreed that the next step would be to prepare and vote on a CDV.

It was determined that the Subcommittee I WG4 management team will prepare the CDV draft based on the debate to date, confirm the CDV draft at the February 2012 WG4 meeting, and vote on it in time for the Subcommittee I meeting to be held in Bangkok in October 2012. The publication of this standard will speed up measurements and possibly have economic benefits, since where a device previously had to be measured under both CISPR 20 and CISPR 24, it can in future be measured under only CISPR 35.

(2) New ISN for measuring conducted disturbances at telecommunication ports

This issue involves the inclusion in CISPR standards of NTT's newly developed impedance stabilization network (ISN) for measuring conducted disturbances at telecommunication ports. This issue was also proposed at the 2010 Seattle meeting and this time it was accepted officially by Subcommittee I, which decided to propose the new type of ISN as a new measurement apparatus to Subcommittee A again.

A schematic diagram of the proposed ISN, which uses an asymmetrical transformer is shown in **Fig. 4** and examples of the improvement in voltage-

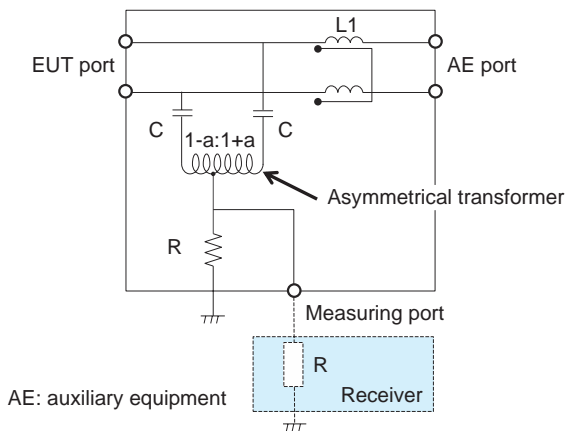


Fig. 4. Diagram of impedance stabilization network using an asymmetrical transformer.

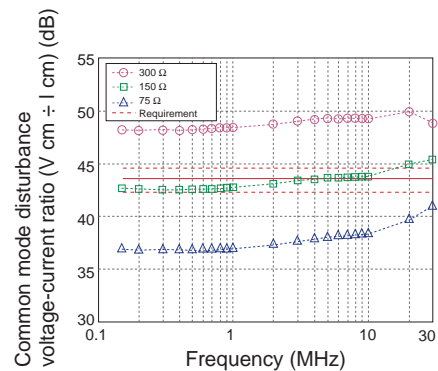
characteristic measurements of a transmission port when a telecommunication device's disturbance is measured with the proposed measurement apparatus are shown in Fig. 5 [5].

This example demonstrates that the proposed measurement apparatus can accurately measure common mode disturbance voltages independent of the common mode impedance of the device under test.

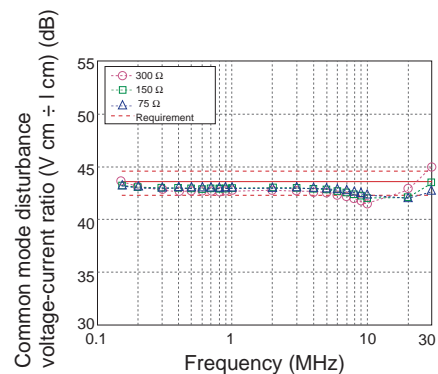
## 5. Concluding remarks

This article described the main topics discussed at the IEC/CISPR Seoul meeting and looked at the direction of those discussions. CISPR will continue to establish new standards and update existing standards to keep abreast of the many transformations in the electromagnetic environment, such as the convergence of telecommunication equipment and broadcasting equipment driven by broadband-service proliferation and the development of smart grids caused by the move to intelligent power control.

Through participation in international EMC standardization processes and active promotion of in-house regulations, the NTT Group is committed to maintaining a good electromagnetic environment and providing high-quality, highly reliable telecommunication services.



(a) Measurement results with a conventional ISN (measured voltage varies depending on the common mode impedance of the EUT)



(b) Measurement results with the proposed ISN

Fig. 5. Example of improved voltage characteristic measurements at telecommunication ports.

## References

- [1] NTT International Procurement website. <http://www.ntt.co.jp/ontime/eg/tr/tr.html>
- [2] K. Tajima, Y. Akiyama, and F. Amemiya, "Standardization Activities in IEC/CISPR for Communications Electromagnetic Compatibility (EMC)," NTT Technical Review, Vol. 8, No. 2, 2010. <https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201002gls.html>
- [3] CISPR/A/WG1 (Seoul/Amemiya, Tajima, Hirasawa, Akiyama) 11-01, Oct. 2011.
- [4] CISPR/A/WG2 (Seoul/Amemiya, Tajima) 11-01, Oct. 2011.
- [5] CISPR/I/WG3 (Hirasawa, Amemiya, Akiyama) 11-01, Oct. 2011.



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## Countermeasures to Lightning Damage in Home Gateways Supporting FTTH Services

### Abstract

This article introduces lightning damage countermeasures for home gateways supporting fiber-to-the-home (FTTH) services, which have been developed by NTT EAST. It is the tenth in a bimonthly series on the theme of practical field information about telecommunication technologies. This month's contribution is from the EMC Engineering Group, Technical Assistance and Support Center, Maintenance and Service Operations Department, Network Business Headquarters.

### 1. Introduction

The number of lightning-related failures of communication terminals such as home gateways (HGWs) was expected to decrease as metallic-circuit services are replaced by optical fiber-to-the-home (FTTH) services. However, it has become clear that the number of lightning-related failures of HGWs is not so different from that of integrated services digital network (ISDN) terminal adaptors and digital service units or asynchronous digital subscriber line (ADSL) modems using metallic circuits. We analyzed HGW failures and the manner in which customers use communication equipment. We found that the cause of lightning damage to HGWs was essentially unrelated to the transmission medium but closely related to lightning-induced current surges entering through the power-supply lines of equipment connected to the HGW's analog ports, local area network (LAN) ports, and other ports.

This article introduces specific countermeasures to lightning damage to HGWs for various HGW usage formats.

### 2. Countermeasures to HGW lightning damage

#### 2.1 One telephone unit

First, we describe a countermeasure when an HGW supporting Internet protocol (IP) telephony has one mains-powered analog terminal connected to it. If the power supplies of both the HGW and analog terminal are connected to different power outlets, a lightning surge current entering through the home's power distribution board could generate a potential difference between the two power outlets, which could cause damage to both the HGW and analog terminal.

A countermeasure to this problem is shown in **Fig. 1**. A lightning protection adaptor for analog port (Thundercut A-2 (**Photo 1**)) is installed between the power-supply line and analog port so that any lightning surge currents bypass the HGW via a surge protective device. It is recommended to install a lightning protection adaptor on both the HGW and analog-terminal sides. However, some business phones and fax machines incorporate lightning protection circuits and devices similar to lightning protection adaptors, so it may not be necessary to install an adaptor on the analog-terminal side.

Connecting both the HGW and analog terminal to the same power outlet can practically eliminate any potential difference between the two. Therefore, this configuration results in a low risk of lightning damage to the HGW and analog terminal. If both the HGW and analog terminal are installed in the same

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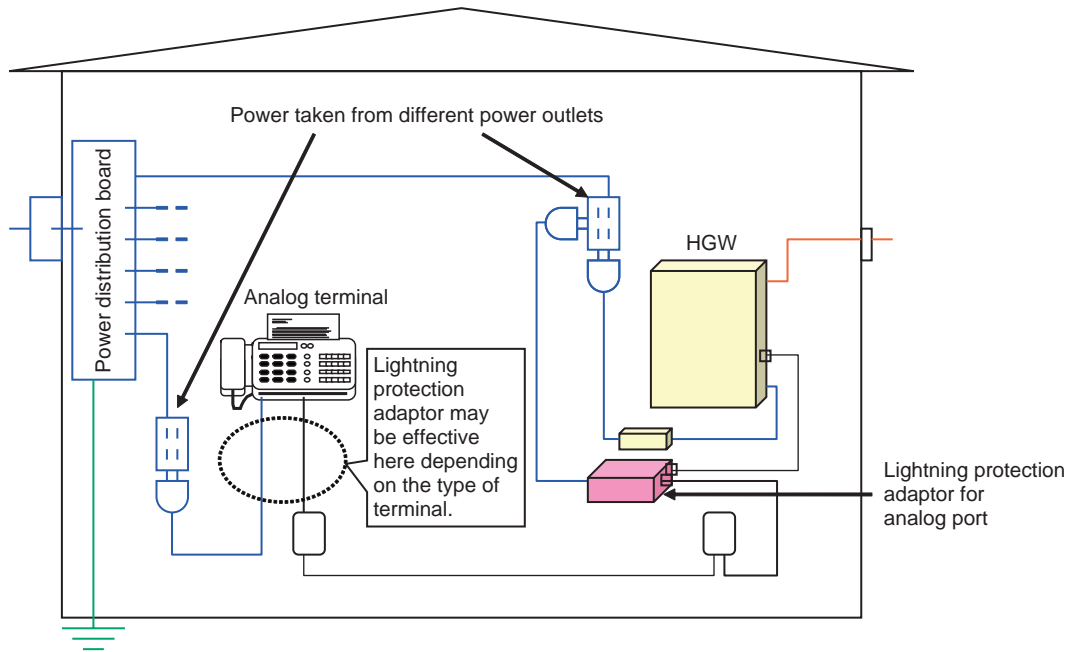


Fig. 1. Lightning damage countermeasure when the HGW has one analog terminal connected to it.



Photo 1. Lightning protection adaptor for analog port.

room, it is recommended that they be supplied power from the same power outlet if at all possible.

## 2.2 Multiple telephone units

Many HGWs that support IP telephony have multiple analog ports and, in many cases, the HGW has more than one analog terminal connected to it irrespective of the number of IP-telephone subscriber lines. If there are many HGW and analog-terminal connections, there is a high probability that at least one analog terminal will receive power from a different power outlet from the HGW, which opens up the possibility of lightning-related damage. Moreover,

among the equipment connected to the analog ports, a network control unit (NCU) for reading the gas meter, supporting a security system, etc. may be connected to an electrical earth that could act as a path for lightning backflow current [1]. In this case, the HGW should be connected to a power outlet separate from the NCU earth.

A countermeasure for this usage format is shown in Fig. 2. Since existing HGWs often provide two ports, an effective method for protecting the HGW from lightning is to use a lightning protection adaptor with two analog ports. Therefore, the HGW can be protected by installing a lightning protection adaptor, but a surge current can still flow toward the telephone units in the same manner as when only one unit is used. For this reason, adding lightning protection adaptors separately for the telephone units can also protect them from lightning damage.

## 2.3 One personal computer

The countermeasure to lightning damage when the HGW has one personal computer (PC) connected to it is basically similar to that for one analog terminal. Here too, lightning damage is more likely to occur if the PC is connected to a different power outlet from the HGW.

In this case, one countermeasure is to add a

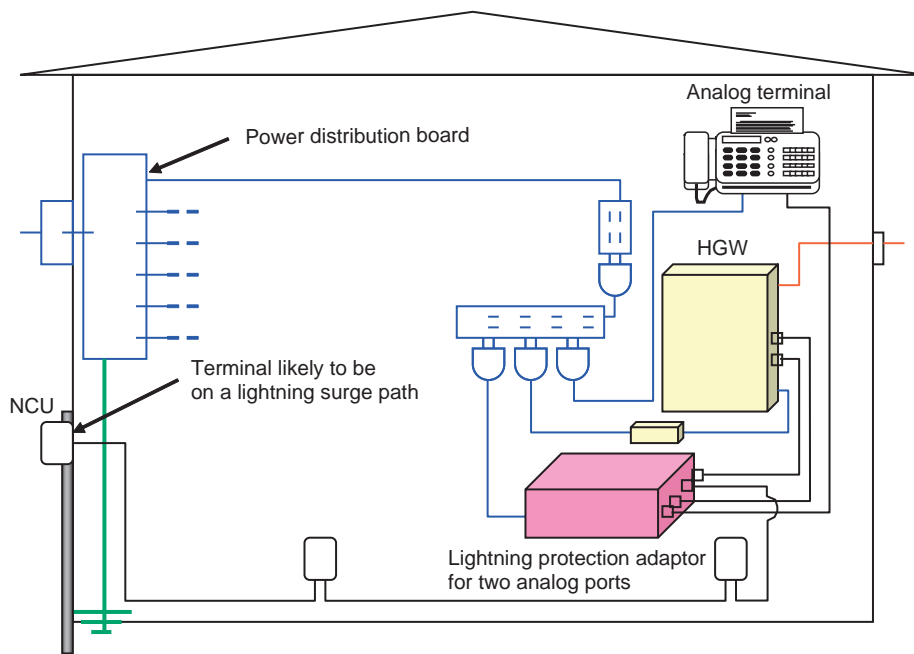


Fig. 2. Countermeasure to lightning damage when the HGW has two analog terminals connected to it.

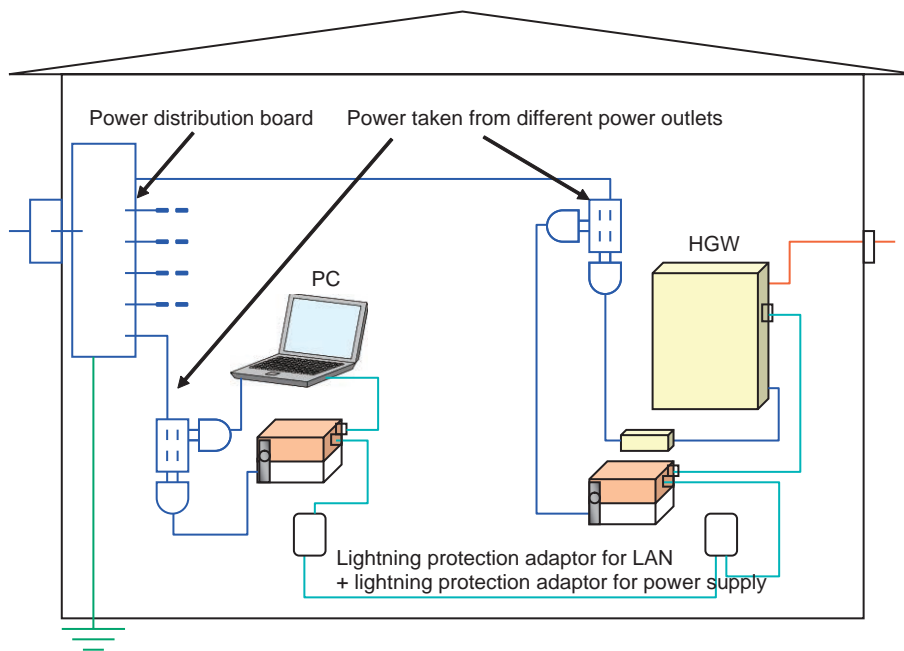


Fig. 3. Countermeasure to lightning damage when the HGW has one PC connected to it.

lightning protection adaptor for LAN in combination with a lightning protection adaptor for power supply, as shown in **Fig. 3**. An external view of this combined

adaptor is shown in **Photo 2** (lightning protection adaptor for LAN 100B-T and lightning protection adaptor for power supply PW). If the HGW's LAN

port is damaged by lightning, there is a high probability of the PC connected to that port being affected. It is therefore recommended that countermeasures to lightning damage be applied to both the HGW and PC.

In the case of a wireless LAN, there is no route between the HGW and PC for lightning surge current to take. However, there is a risk of lightning-related damage if the wireless router's power supply is connected to a different power outlet from the HGW.

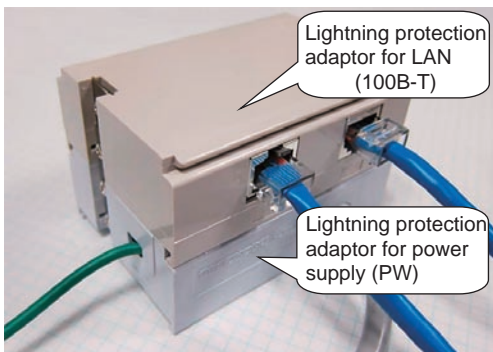


Photo 2. Lightning protection adaptor for LAN and lightning protection adaptor for power supply.

## 2.4 Multiple analog terminals and PCs

Here, we present a comprehensive countermeasure to lightning damage when the HGW has multiple analog terminals and PCs (or hubs) connected to it. In the example shown in **Fig. 4**, the HGW is connected to one telephone unit that incorporates a fax function, one NCU for reading the gas meter, and two PCs using Ethernet cables. In this case, if even one piece of equipment connected to one of the HGW's ports is using a different power outlet from the HGW, then lightning damage countermeasures must be applied to all of the HGW's ports. Moreover, since a PC does not have a surge-bypass circuit, if a PC is connected to the same power outlet as the HGW, then it is necessary to protect the HGW by using a lightning protection adaptor for the other ports.

The housings for the Thundercut A-2 and 100B-T adaptors can be integrated into one unit by a sliding mechanism. The ground terminals for both housings can also be linked via its coupling bar. Moreover, if there is felt to be a need to protect equipment on the other side of an adaptor, then it is recommended that a separate lightning protection adaptor be installed for that equipment.

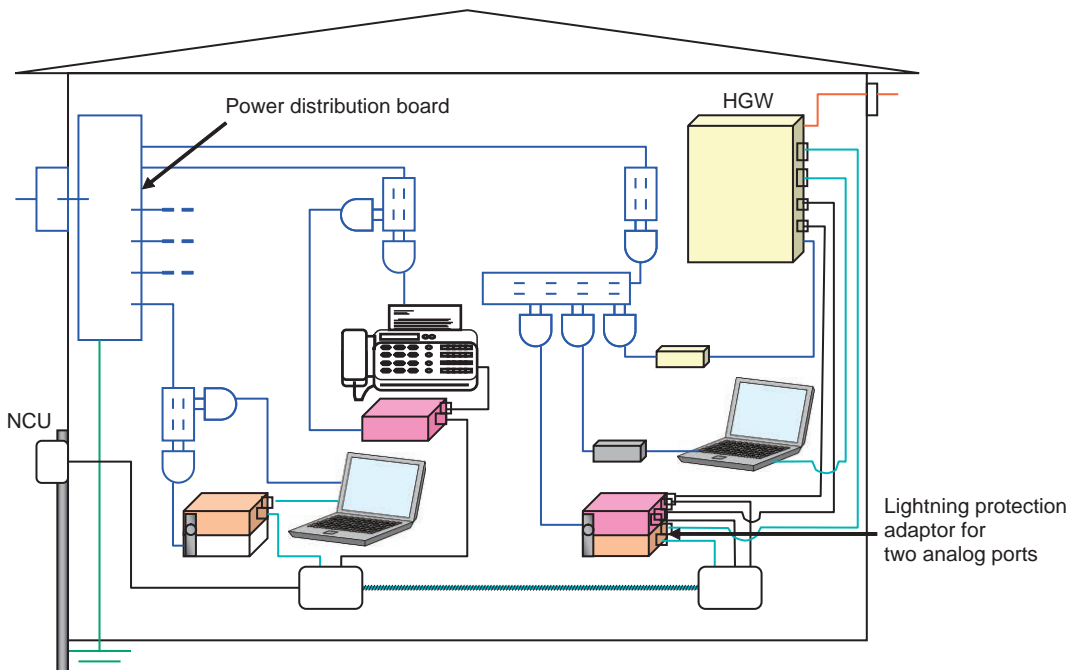


Fig. 4. Countermeasure to lightning damage when the HGW has multiple analog terminals and PCs connected to it.



### 3. Conclusion

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This article presented examples of countermeasures to lightning-related damage for a variety of customer usage formats using lightning protection adaptors developed by the Technical Assistance and Support Center. In the future, HGW interfaces are expected to become increasingly diverse. There are already ones with a coaxial port for broadband television, and the addition of USB (universal serial bus) ports is under study (USB-type ADSL modems already exist).

At present, there is not a complete lineup of anti-lightning products for all interfaces, so appropriate schemes for connecting the HGW and user equipment to power outlets and the introduction of wireless LANs will continue to be effective countermeasures to lightning damage. Nevertheless, the Technical Assistance and Support Center is constantly survey-

ing the surge resistance of commercially available user equipment and anti-lightning products and working to develop anti-lightning products for new HGW interfaces. To further reduce lightning-related failures in communication equipment, including HGWs, from here on, we plan to conduct on-site surveys and continue to develop anti-lightning products and lightning-protection measures while actively holding seminars on lightning countermeasures for on-site maintenance personnel in various regions of the country, updating websites about countermeasures to lightning damage, and so on.

### Reference

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- [1] "Countermeasures to Lightning Backflow Current in Telecommunication Cables," NTT Technical Review, Vol. 8, No. 10, 2010.  
<https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201010pf1.html>

# External Awards

## **FY 2011 Industrial Standardization Awards (Industrial Science and Technology Policy and Environment Bureau Director-General's Award)**

**Winner:** Hideaki Yamamoto, NTT Service Integration Laboratories

**Date:** Oct. 17, 2011

**Organization:** Ministry of Economy, Trade and Industry

For outstanding contributions to international standardization activities regarding ISO/IEC SC17/WG8 (Contactless smart card).

## **Celtic Excellence Gold Award 2012**

**Winners:** Servery Project (Hiroki Baba<sup>†1</sup> and Naoki Takaya<sup>†2</sup>)

<sup>†1</sup> NTT Service Integration Laboratories

<sup>†2</sup> NTT EAST

**Date:** Feb. 22, 2012

**Organization:** Celtic plus (Celtic Core Group)

The European research project SERVERY has been honored with the Celtic Excellence Gold Award 2012 for its excellent performance. NTT Service Integration Laboratories was involved in the project. [http://www.celtic-initiative.org/Publications/Press\\_releases/Celtic-Plus\\_Press-Release\\_2012-02-28.pdf](http://www.celtic-initiative.org/Publications/Press_releases/Celtic-Plus_Press-Release_2012-02-28.pdf)

# Papers Published in Technical Journals and Conference Proceedings

## **Generic Construction of Strongly Secure Timed-release Public-key Encryption**

A. Fujioka, Y. Okamoto, and T. Saito

Lecture Notes in Computer Science, Vol. 6812/2011, pp. 319–336.

This paper provides a sufficient condition to construct timed-release public-key encryption (TRPKE), where the constructed TRPKE scheme guarantees strong security against malicious time servers, proposed by Chow et al., and strong security against malicious receivers, defined by Cathalo et al., in the random oracle model if the component identity-based encryption (IBE) scheme is IND-ID-CPA secure, the component PKE scheme is IND-ID-CPA secure, and the PKE scheme satisfies negligible  $\gamma$ -uniformity for every public key. Chow et al. proposed a strongly secure TRPKE scheme, which is specific in the standard model. To the best of our knowledge, our proposed construction is the first generic one for TRPKE that guarantees strong security even in the random oracle model.

## **Learning Condensed Feature Representations from Large Unsupervised Data Sets for Supervised Learning**

J. Suzuki, H. Isozaki, and M. Nagata

Proc. of the 49th Annual Meeting of the Association for Computational Linguistics: short papers, pp. 636–641, Portland, Oregon, 2011.

This paper proposes a novel approach for effectively utilizing unsupervised data in addition to supervised data for supervised learning. We use unsupervised data to generate informative ‘condensed feature representations’ from the original feature set used in supervised natural language processing (NLP) systems. The main contri-

bution of our method is that it can offer dense and low-dimensional feature spaces for NLP tasks while maintaining the state-of-the-art performance provided by the recently developed high-performance semi-supervised learning technique. Our method matches the results of current state-of-the-art systems with very few features, i.e., F-score of 90.72 with 344 features for CoNLL-2003 named entity recognition data and unlabeled attachment score of 93.55 with 12,500 features for dependency parsing data derived from PTB-III.

## **Circulator-free Reflection-type Tunable Optical Dispersion Compensator Using Tandem Arrayed-waveguide Gratings**

Y. Ikuma, T. Mizuno, H. Takahashi, and H. Tsuda

Journal of Lightwave Technology, Vol. 29, No. 16, pp. 2447–2453, 2011.

A tunable optical dispersion compensator that uses cascaded arrayed-waveguide gratings and an integrated phase shifter is reported. It is a catoptric circuit but does not require a circulator. The dispersion is successfully controlled from +142 to +1148 ps/nm. Error-free transmission was confirmed after dispersion compensation in a transmission experiment using 43 Gbps CSRZ-DQPSK modulation.

## **Awareness of Central Luminance Edge is Crucial for the Craik-O’Brien-Cornsweet Effect**

A. Masuda, J. Watanabe, M. Terao, M. Watanabe, A. Yagi, and K. Maruya

Frontiers in Human Neuroscience, Vol. 5, No. 125, 2011.

The Craik-O’Brien-Cornsweet (COC) effect demonstrates that

perceived lightness depends not only on the retinal input at corresponding visual areas but also on distal retinal inputs. In the COC effect, the central edge of an opposing pair of luminance gradients (COC edge) makes adjoining regions with identical luminance appear to be different. To investigate the underlying mechanisms of the effect, we examined whether the subjective awareness of the COC edge is necessary for the effect to be generated. We manipulated the visibility of the COC edge using visual backward masking and continuous flash suppression while monitoring subjective reports regarding online percepts and after effects of adaptation. Psychophysical results showed that the online percept of the COC effect nearly vanishes in conditions where the COC edge is rendered invisible. On the other hand, the results of adaptation experiments showed that the COC edge is still processed at the early stage even under perceptual suppression. These results suggest that processing of the COC edge at the early stage is not sufficient to generate the COC effect and that subjective awareness of the COC edge is necessary.

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### Characterization of Strongly Secure Authenticated Key Exchanges without NAXOS Technique

A. Fujioka

Lecture Notes in Computer Science, Vol. 7038/2011, pp. 33–50.

This paper examines two-pass authenticated key exchange (AKE) protocols that do not use the NAXOS technique and that are secure under the gap Diffie-Hellman assumption in the random oracle model. Their internal structures are also discussed. We introduce an imaginary protocol, however insecure, to analyze the protocols and show the relations between these protocols from the viewpoint of how they overcome the insecurity of the introduced protocol. In addition, this paper provides ways to characterize the AKE protocols and defines two parameters: one consists of the number of static keys, the number of ephemeral keys, and the number of shared values, and the other is defined as the total sum of these numbers. When an AKE protocol is constructed on the basis of some kind of group, these two parameters indicate the number of elements in the group, i.e., they are related to the data sizes for storage and communication.

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### Multi-closure-interval Linear Prediction Analysis based on Phase Equalization

S. Hiroya, N. Miki, and T. Mochida

Proc. of APSIPA ASC 2011, Xi'an, China.

This paper presents a multi-closure-interval linear prediction (MCLP) analysis based on phase equalization in order to remove the effect of subglottal resonance in speech signals for estimating a vocal-tract spectrum. The validity of this method is evaluated by using a vocal-tract simulator that models vocal-tract losses and the subglottal system. Results show that the proposed method improves the estimation accuracy of a vocal-tract spectrum compared with the conventional MCLP method.

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### Stochastic Resonance Using a Steep-subthreshold-swing Transistor

K. Nishiguchi and A. Fujiwara

Proc. of the 24th International Microprocesses and Nanotechnology Conference, Kyoto, Japan, 2011.

We demonstrated stochastic resonance (SR) using nanoscale metal-oxide-semiconductor field-effect transistors (MOSFETs) with a small subthreshold swing. The MOSFET has a wire channel with triple gates and shows current characteristics, whose subthreshold

swing is much smaller than 60 mV/dec owing to a parasitic bipolar transistor. The strong nonlinearity and hysteresis of the MOSFET's current characteristics increase the effect of SR, which allows the MOSFET to output a signal similar to an input signal that is much smaller than the MOSFET's threshold voltage. Additionally, using these features, we demonstrated pattern cryptography as a new application of SR.

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### Distributed Minimum Error Rate Training of Statistical Machine Translation Using Particle Swarm Optimization

J. Suzuki, K. Duh, and M. Nagata

Proc. of the 5th International Joint Conference on Natural Language Processing, pp. 649–657, Chiang Mai, Thailand, 2011.

Direct optimization of a translation metric is an integral part of building state-of-the-art statistical machine translation (SMT) systems. Unfortunately, widely used translation metrics such as the LEU score are non-smooth, non-convex, and non-trivial to optimize. Thus, standard optimizers such as minimum error rate training can be extremely time-consuming, leading to a slow turnaround rate for SMT research and experimentation. We propose an alternative approach based on particle swarm optimization, which can easily exploit the fast growth of distributed computing to obtain solutions quickly. For example in our experiments on NIST 2008 Chinese-to-English data with 512 cores, we demonstrate a speed increase of up to 15 times and reduction in parameter tuning time from 10 hours to 40 minutes with no degradation in BLEU score.

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### Bound Exciton Photoluminescence from Ion-implanted Phosphorus in Thin Silicon Layers

H. Sumikura, K. Nishiguchi, Y. Ono, A. Fujiwara, and M. Notomi

Optics Express, Vol. 19, No. 25, pp. 25255–25262, 2011.

We report the observation of clear bound exciton (BE) emission from ion-implanted phosphorus. Shallow implantation and high-temperature annealing successfully introduce active donors into thin silicon layers. The BE emission at a wavelength of 1079 nm shows that some of the implanted donors are definitely activated and isolated from each other. However, photoluminescence and electron spin resonance studies find a cluster state of the activated donors. The BE emission is suppressed by this cluster state rather than by the nonradiative processes caused by ion implantation. Our results provide important information about ion implantation for doping quantum devices with phosphorus quantum bits.

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### Tunable Optical Dispersion Compensator with a High-resolution Arrayed-waveguide Grating

Y. Ikuma, T. Mizuno, H. Takahashi, and H. Tsuda

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A tunable optical dispersion compensator (TODC) that uses a high-resolution arrayed-waveguide grating and integrated resin lenses is reported. The dispersion tuning range is 1426 ps/nm, three times larger than that in our previous report for the same type of TODC. A transmission experiment using a 43-Gbps carrier-suppressed return-to-zero differential quadrature phase shift keying (CSRZ-DQPSK) signal is also reported.

### Effect of Hydrogen Entry into Steel

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Proc. of the ISSS-6: 6th International Symposium on Surface Science, 13PN-112, Tokyo, Japan, 2011.

Hydrogen embrittlement of steel is caused by the interaction between hydrogen and metal. We investigated this phenomenon by using an electrochemical technique and microscope observation. Since a hydrogen atom does not have extranuclear electrons, the behavior of hydrogen atoms is difficult to analyze. We therefore reduced a hydrogen molecule into protons, or hydrogen cations, at one surface of a steel plate sample and oxidized protons at the other surface of the plate. Reduction and oxidation were carried out by controlling the electrical potential. The measured current revealed the elementary reduction/oxidation process and entry properties of hydrogen on steel sample surface(s). We found that the polarization of a sample controls the entry of adsorbed hydrogen. Microscope observation showed that a critical concentration induces the growth of micro-cracks.

### SAW: Java Synchronization Selection of Lock or Software Transactional Memory

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Proc. of 2011 IEEE 17th International Conference on Parallel and Distributed Systems (ICPADS), pp. 104–111, Tainan, Taiwan, 2011.

To rewrite a sequential program into a concurrent one, the programmer has to enforce atomic execution of a sequence of accesses to shared memory to avoid unexpected inconsistency. There are two means of enforcing this atomicity: one is the use of lock-based synchronization and the other is the use of software transactional memory (STM). However, it is difficult to predict which one is more suitable for an application other without trying both mechanisms because their performance heavily depends on the application. We have developed a system named SAW that decouples the synchronization mechanism from the application logic of a Java program and enables the programmer to statically select a suitable synchronization mechanism: either lock or STM. We introduce annotation to specify critical sections and shared objects. In accordance with the annotated source program and the programmer's choice of a synchronization mechanism, SAW generates aspects representing the synchronization processing. By directly comparing the cost of rewriting using SAW and that using an individual synchronization mechanism, we show that SAW relieves the programmer's burden. Through several benchmarks, we demonstrate that SAW is an effective way of switching synchronization mechanisms according to the characteristics of each application.

### Proposal of Channel-grouping Wireless-transceiver Architecture for Suppressing Local-oscillator Phase Noise

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This paper proposes an architecture-level solution for suppressing the phase noise of local oscillators in wireless-transceiver large-scale integrated circuits (LSIs). Because a phase-locked loop (PLL) supplies only one local oscillator frequency for multiple channels, the PLL's large loop bandwidth can be used to suppress the phase noise. Simulation results show that a sixteen-channel grouping can suppress the phase noise by more than 24 dB in narrow-band wireless systems. Channel selection in receive mode can be ensured by a variable intermediate frequency (IF) complex band-pass filter. Local-leak and image signals in transmit mode can be suppressed by a quadrature up-conversion mixer and radio-frequency band-pass filter with a

high-IF configuration. A digital-to-analog converter, analog-to-digital converter, and digital LSI perform modulation and demodulation of the variable-IF signals.

### Growth and Device Properties of AlGaIn/GaN High-Electron Mobility Transistors on a Diamond Substrate

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Jpn. J. Appl. Phys., Vol. 51, No. 01AG09, 2012.

A crack-free c-plane AlGaIn/GaN heterostructure was grown on a diamond (111) substrate by using an AlN/GaN multi-buffer layer. We found that in the AlGaIn/GaN heterostructure, the GaN layer was coherently grown on the AlN/GaN multi-buffer layer. The a-lattice constant of strain-free GaN is longer than the average a-lattice constant of the AlN/GaN multi-buffer layer. Therefore, compressive strain is induced in the GaN layer of the AlGaIn/GaN heterostructure. The compressive strain compensates for the tensile strain induced by the diamond substrate, which makes the AlGaIn/GaN heterostructure free of cracks. AlGaIn/GaN high-electron mobility transistors (HEMTs) fabricated on diamond substrates show maximum drain current of 275 mA/mm, transconductance of 60 mS/mm, and clear pinch-off characteristics for a gate length of 6  $\mu\text{m}$ . The low thermal resistance of the AlGaIn/GaN HEMTs on diamond is demonstrated.

### Security of Sequential Multiple Encryption

A. Fujioka, Y. Okamoto, and T. Saito

IEICE Trans. on Fundamentals of Electronics, Communications and Computer Sciences, Vol. E95-A, No. 1, pp. 57–69, 2012.

This paper analyzes the security of sequential multiple encryptions based on asymmetric key encryptions and shows that a sequential construction of secure multiple encryptions exists. The sequential multiple encryption scheme can be proved to be indistinguishable against chosen ciphertext attacks for multiple encryptions (IND-ME-CCA), where the adversary can access the decryption oracle of the multiple encryption, even when all the underlying encryptions of the multiple encryption are indistinguishable against chosen plaintext attacks (IND-CPA). We provide an extended security notion of sequential multiple encryptions, in which the adversary is allowed to access decryption oracles of the underlying encryptions in addition to the multiple encryption, and we show that our constructed scheme satisfies the security notion when all the underlying encryptions are indistinguishable against chosen ciphertext attacks (IND-CCA).

### A Semitransparency-based Optical-flow Method with a Point Trajectory Model for Particle-like Video

H. Sakaino

IEEE Trans. on Image Processing, Vol. 21, No. 2, pp. 441–450, 2012.

This paper proposes a new semitransparency-based optical-flow model with a point trajectory model for particle-like video. Previous optical-flow models have used properties ranging from image brightness constancy to image brightness change models as constraints. However, two important issues remain unsolved. The first issue is how to track/match a semitransparent object when the displacement between video frames is very large. Such moving objects with different shapes and sizes in an outdoor scene move against a complicated background. Second, due to semitransparency, the image intensity between frames can also violate a previous image brightness-based optical-flow model. Thus, we propose a two-step optimization for the optical-flow estimation model for a moving semitransparent object,

i.e., particle. In the first step, a rough optical flow between particles is estimated by a new alpha constancy constraint that is based on an image generation model of semitransparency. In the second step, the optical flow of a particle with a continuous trajectory in a definite temporal interval based on a point trajectory model can be refined.

Many experiments using various falling-snow and foggy scenes with multiple moving vehicles show the significant improvement in the optical flow compared with a previous optical-flow model.

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