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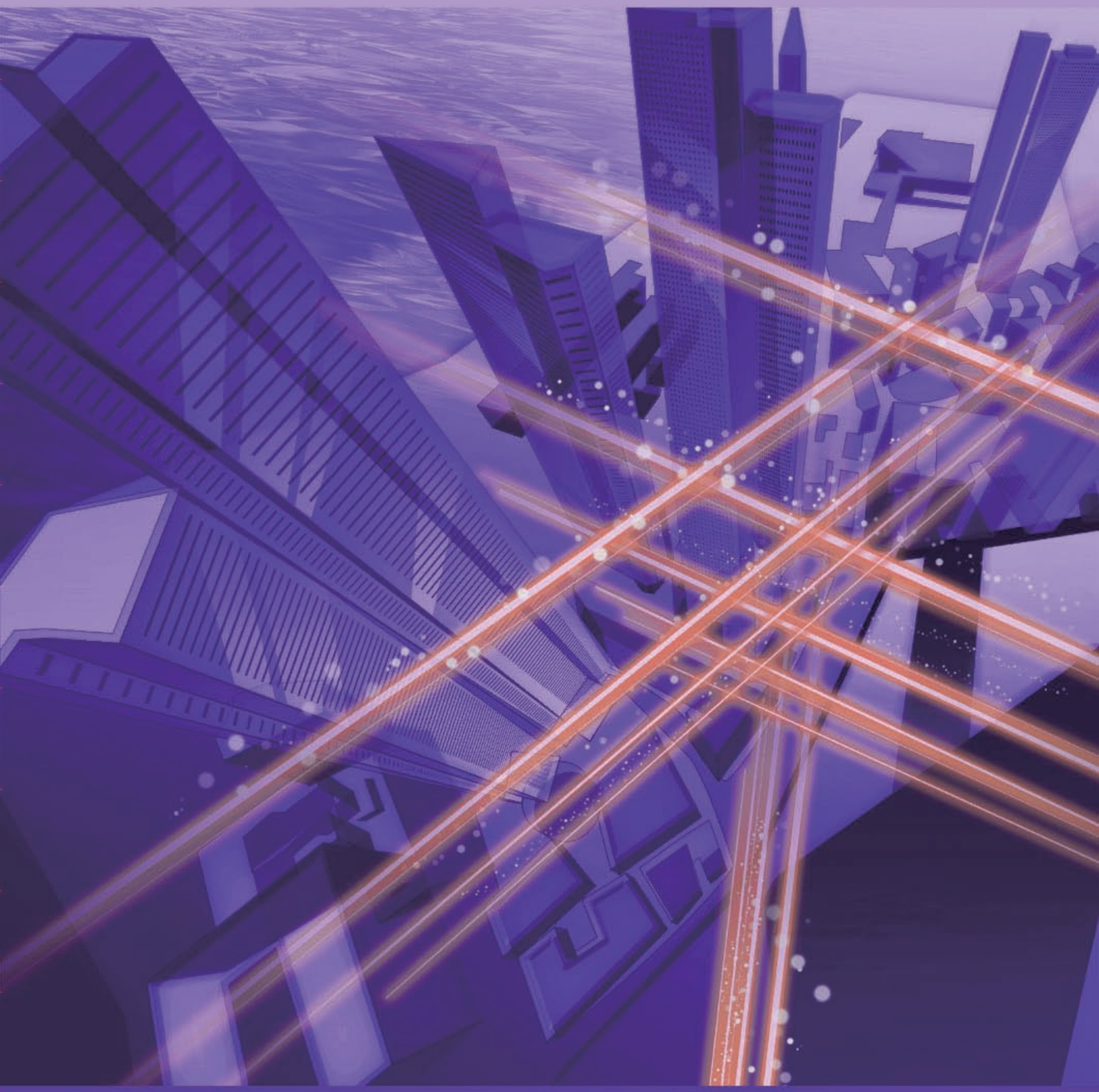

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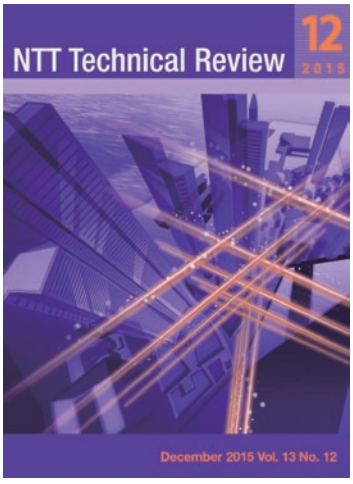

Practical Field Information about Telecommunication Technologies

Wireless LAN Tester Conformable to IEEE802.11ac

New NTT Colleagues

We welcome our newcomers to the NTT Group

External Awards/Papers Published in Technical Journals and Conference Proceedings

External Awards/Papers Published in Technical Journals and Conference Proceedings

NTT EAST at a Major Turning Point in Business Structure—All Employees Working as One to Reform the Business Model toward Sustainable Management

Hiroshi Nakagawa
Senior Executive Vice President, NTT EAST

Overview

The growth of FLET'S HIKARI—NTT's optical access broadband service and flagship product—shows signs of slowing down as the demand for high-speed Internet eases and competition with optical access services of other companies intensifies. Under these conditions, NTT EAST is reexamining its business structure and reforming its business model to steer the company toward sustainable management while growing its business-user market. We asked Hiroshi Nakagawa, Senior Executive Vice President of NTT EAST, to tell us about the aims and rollout of the Hikari Collaboration Model and specific initiatives such as the new marketing method called ICT Concierge.

Keywords: optical access, FLET'S HIKARI, Hikari Collaboration

Opening up the future through employee efforts—turning to profit-oriented management and reforming the business structure

—Mr. Nakagawa, please tell us about the business environment surrounding NTT EAST.

NTT EAST is now at a major turning point. Since fiscal year 2014, we have been making changes to our business structure and tackling various tasks in reforming our business model. The history of the company up to now has been a history of expanding FLET'S HIKARI. As you know, NTT EAST is a company that carries on the work of the former Nippon Telegraph and Telephone Public Corporation, which means that the foundation of its business is the traditional growth-in-numbers model. In line with this business model, we began the full-scale provision of our B FLET'S optical access broadband service in 2001. Since then, we have expanded the service coverage area and deployed splitter equipment in condominium buildings, and we have steadily increased our number of subscribers while improving the usage environment for optical broadband services. As a result of implementing these measures, we have grown our optical access business to a level that surpassed 10 million subscribers in 2015. I attribute this success to the personal efforts of the employees of the NTT EAST Group, our subcontractors responsible for sales and access-line installation, and our research

team that works tirelessly to develop compact equipment and efficient installation methods.

However, the growth in the number of subscribers has slowed as the demand for high-speed Internet eases, thereby reducing the number of new lines. Service terminations have also increased as some customers switch to other companies' services.

This ease in the demand for high-speed Internet can be attributed to a change in Internet terminals, that is, from connecting to a fixed network with a personal computer to using mobile broadband via a smartphone, tablet, or other smart device. In younger age groups dominated by students, it is not unusual for users to have no personal computer, so the presence of fixed broadband services is on the wane. At the same time, severe competition with the optical access services of other companies continues as ever, with the result that our annual operating revenue is on a downward trend.

We have been striving to make up for this drop in operating revenue by curtailing operating costs. In fiscal year 2014, we reduced expenses by more than 1 trillion yen over fiscal year 2000 and managed to maintain a profit. However, given the costs of discount services and sales promotions, the profit ratio of network services themselves remained low with no fundamental improvements in this area.

We therefore gathered up the courage to steer the company in another direction. In short, we abandoned the model of growing only in terms of numbers. We are working, for example, to reform the mechanism of paying high commissions to agencies and representatives and to revise the billing system such as by terminating the Omoikkiri Wari discount plan. This is a radical departure from our past marketing method, so there has been some puzzlement and even backlash from the front lines of our sales force. I have therefore had talks with our staff members who have direct contact with our customers in an effort to obtain their understanding. Thanks to everyone's hard work, we achieved an operating profit of 109.8 billion yen in fiscal year 2014, the highest record since the company's founding.

To hear what our employees at the front lines have to say, the President, Senior Executive Vice President, and Executive Vice Presidents make time to visit the various NTT EAST regions two or three times a year to talk with employees. This means hearing some very strong opinions, but it also provides a great opportunity to convey each other's honest feelings. There are many things that are true in theory that do not hold in the field, and it is vitally important that we have a firm grasp of the real situation.

—NTT EAST is transforming itself in a big way and exploring new frontiers. What is the company's medium-term management strategy for facing these challenges?

The growth-in-numbers era is over. From here on, all employees will be asked to understand shifts in the business environment, the status of operations, etc., and to orient themselves along a new vector, that is, to change direction. In short, we have to steer ourselves toward sustainable management that emphasizes profit and efficiency.

There are three main elements to this strategy. The first one is "profit-oriented management." In addition to network services such as FLET'S HIKARI, which is becoming a commodity, we are aiming for an early launch of high-value-added services expected to have a high profit ratio such as datacenters and cloud services.

The second element is "business structure reform." I would like to shift our consumer-oriented business structure to one centered on business users and the Hikari Collaboration Model (wholesale fiber access service). Our corporate customers are doing business on a variety of scales, and some have expressed the need to use the Internet to enhance and expand their business. However, I don't believe these needs are being adequately met, so for these customers, we are introducing aggressive reforms including the development of new services and systems and the appropriate allocation of human resources.

Finally, the third element involves making a "contribution to NTT's consolidated profits." NTT EAST is not confined to the business of one company. For example, we also provide base station circuits for

NTT DOCOMO's LTE (Long Term Evolution)-Advanced system, and we undertake facility maintenance for NTT Group companies that benefit from our many maintenance bases. In this way, I would like to promote initiatives that contribute to expanding the NTT Group's profits.

Serving as a catalyst to roll out services closely linked to the community and people's lives

—The Hikari Collaboration service was launched in February 2015. Can you give us a progress report?

Thanks to all concerned, the number of contracts has been increasing steadily, and as of July of this year, that number topped 1 million. Moreover, the number of service providers using the Hikari Collaboration service including initially targeted businesses such as mobile operators, home-electronics mass retailers, and Internet service providers came to more than 150 companies as of September.

Hikari Collaboration is a mechanism for providing NTT EAST FLET'S HIKARI services to businesses that, in turn, provide those services to end users combined with their own commercial products. With this mechanism, we can cultivate user layers that we could not reach in the past, and because it features composite services intertwined with a company's products, we expect end users to make longer use of such optical services.

There have been some misgivings about this mechanism since it prevents us from having any direct involvement with end users. However, I feel that we can eliminate such apprehension by building a solid, trustworthy relationship with these companies in order to achieve a Win-Win-Win relationship among three parties that includes end users.

Let me be more specific. The companies using Hikari Collaboration serve as a business partner of NTT EAST, and FLET'S HIKARI serves as a catalyst for making the services provided by those companies even better for their customers. In other words, we are developing a business in which NTT EAST and its business partners work together on providing services to end users. For example, companies in fields such as caregiving or security provide services that are seen by their end users as indispensable to their lives. End users should then continue to use them unless they become unnecessary or out of date; to put it another way, end users are not likely to quit using FLET'S HIKARI. In addition, a company using FLET'S HIKARI can differentiate its services from those of other companies in the same industry. At the risk of exaggerating the effects of Hikari Collaboration, I believe it can foster innovation in all sorts of industries.

Going forward, NTT EAST will support the business endeavors of the companies participating in Hikari Collaboration while providing them with know-how that we have accumulated such as knowledge of optical fiber services and methods of consulting with end users.

This is a new B2B2C (business-to-business-to-consumer) approach, which means that our business sense will be tested as well. I am confident, however, that both young employees with a flexible way of thinking and veteran employees who have achieved much up to now in the B2C (business-to-consumer) business will do their part diligently.

—How will you approach expansion of the business user market?

I would like to intensify our contribution to the vitalization of local economies. Our strengths in this regard are the branch offices that we have in each region and the close relationships that we have formed with local governments. I would like to leverage these strengths to promote projects in education, medical care, and other areas.

Since the businesses of our corporate customers are of various scales, we will need to prepare strategies tailored to businesses of various sizes instead of one comprehensive approach. Up to now, our standard business style has been to talk to customers as the need arose on their end and to then proceed with measures to meet their requests. However, from this spring, we began to change this approach by proactively visiting customers on our end and asking if they have any problems or requests. We have named this new marketing method "ICT Concierge."

There are as many types of needs as there are types of customers. Since we also call on customers that have no particular information and communication technology (ICT) needs, receiving a response from them can be difficult. Thus, it's not simply a matter of visiting customers and getting quick results. For this reason, I instruct our employees to make frequent visits to our customers, assess their responses after each visit, and adjust our activities with an eye to the future. All in all, I would like to have our customers entrust us with the task of ICT management that they have been burdened with up to now.

The dedication to routine and patient effort produces great results—passing on the corporate DNA of NTT EAST

—Do you have a few words for NTT EAST employees who are working together to get through this period of great reform?

We began our reform by making contact with our customers and going out to visit them, and this is an approach different from the past and requires effort and patience. I understand that changing what we are already comfortable and familiar with can cause much anxiety. It is difficult to make such a switch, especially after having achieved positive results with our past approach. Now that we are advancing all together at NTT EAST in a new direction, I would like to ask everyone to understand the ideas that we in top management are promoting and to tell people not to be discouraged if they cannot achieve good results right away.

Additionally, I would like everyone to remember that, while we are a leading ICT enterprise providing ultrahigh-speed broadband services, we are also a company doing what might be called routine or unexciting work such as erecting utility poles and connecting cables. In the aftermath of the Great East Japan Earthquake, this is the type of work that we faithfully

did around the clock to restore services to our customers. It is this spirit, this corporate DNA, that we should pass on. There's hardly any other company that can say "Don't worry, leave it to us!" Being someone that customers depend on and doing work that is essential to the daily lives of people can be a source of much happiness and satisfaction. The fact that the Hikari Collaboration service launched only in February of this year is already achieving results is something that many people didn't think could be done. So to everyone, I say "Be confident in yourselves!"

—Mr. Nakagawa, can you leave us with a message for NTT researchers?

My father was a researcher at Nippon Telegraph and Telephone Public Corporation. At that time, he served in various positions such as head of the Ibaraki branch of Electrical Communications Laboratories, and he was involved in the development of optical fiber manufacturing technology. He would often join other young NTT researchers living in corporate housing for evening drinks and lively discussions after work. Just the other day, I was delighted to receive a replica of the plaque commemorating the recognition of NTT's optical fiber research and development as an IEEE Milestone* [1]. This was especially moving for me as I would never have imagined that I would someday be managing the very

* IEEE Milestone: The IEEE Milestone was established by the Institute of Electrical and Electronics Engineers (IEEE) in 1983 as a way of honoring significant historic achievements of innovative technologies in the field of electrical and electronic engineering, information and communication. The technology must be at least 25 years old, and its achievement must have a high global reputation.

work that my father began.

As seen from the business side, there is definitely a need for the prompt development of "sellable" and "profitable" technology. However, when I think that it's been about 40 years since the basic research began in my father's generation was first commercialized, I can feel the endurance of that research. My father would often say, "A researcher finds a theme on one's own. If that theme can be found, the research is half done." Finding one's research theme is no doubt difficult, so I would like to ask researchers to look for their themes and undertake their research carefully and patiently to achieve great results.

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Interviewee profile

■ Career highlights

Hiroshi Nakagawa joined Nippon Telegraph and Telephone Public Corporation (now NTT) in 1978. After serving as NTT EAST Executive Manager of the General Affairs and Personnel Department, Executive Manager of the Corporate Strategy Planning Department, and Executive Manager of the Accounts and Finance Department, and Executive Vice President, he assumed the office of Senior Executive Vice President and Senior Executive Manager of Consumer Business Headquarters in 2012 and took up his present position in June 2015. He concurrently serves as President of NTT East Properties and President of NTT Vietnam.

Cybersecurity R&D to Counter Global Threats

Takeshi Nakatsuru, Yoshiaki Nakajima, Jun Miyoshi, and Katsumi Takahashi

Abstract

New cybersecurity threats are continuing to expand on a global scale, and Japan is expected to become the target of cyber-attacks in the run up to 2020. In these Feature Articles, we discuss the key points of resisting global cybersecurity threats and introduce our research and development strategy for dealing with them.

Keywords: security, global, R&D strategy

1. Introduction

The NTT Group has aggressively expanded into the global business sector to establish global cloud services as a cornerstone of our business. To this end, we are establishing stronger systems to offer to the world by responding to the needs of our customers who are developing diverse information and communication technology (ICT) services on a global scale. In the global business arena, ICT is an essential component that is used by a wide range of businesses in diverse fields. Incidents of cyber-attacks on these businesses can cause serious damage such as service interruptions or information leaks. In recent years, many cases of cyber-attacks directly aimed at exploiting business secrets or financial assets have been reported, and the financial impact of these attacks is also increasing.

NTT Group's managed security service provider companies are expanding their services in order to address these issues in the global business arena. Cyber-attacks on global businesses raise various concerns, including the risk of theft of business secrets through industrial espionage and the disruption of key infrastructures such as electricity, gas, and communications.

Broadly speaking, there are three points that global businesses must follow to protect themselves from the latest security threats and new threats accompanying the latest technological developments. We describe them here and explain our efforts to address them in section 2.

1.1 Technology and security operations are both important when responding to targeted attacks

The NTT Group's Global Threat Intelligence Report (GTIR) analyzed common factors in businesses that had suffered losses and found that although unknown threats that instigate targeted attacks against businesses and other organizations do exist, most attacks exploit known vulnerabilities that are sometimes several years old. To deal with these incidents, it is essential not only to use advanced techniques such as attack detection, but also to implement operations to pre-empt attacks by taking steps such as establishing patch management processes and incident response procedures, and by training people how to deal with attacks.

1.2 Making use of threat intelligence is essential to reduce the cost of security operations

Cyber-attacks are becoming more organized, with corporate spies and even state agencies among the perpetrators in some cases. In these cyber-attacks, there are clear profits to be made by the attackers, who may also have considerable financial resources at their disposal. When running a global business, it is

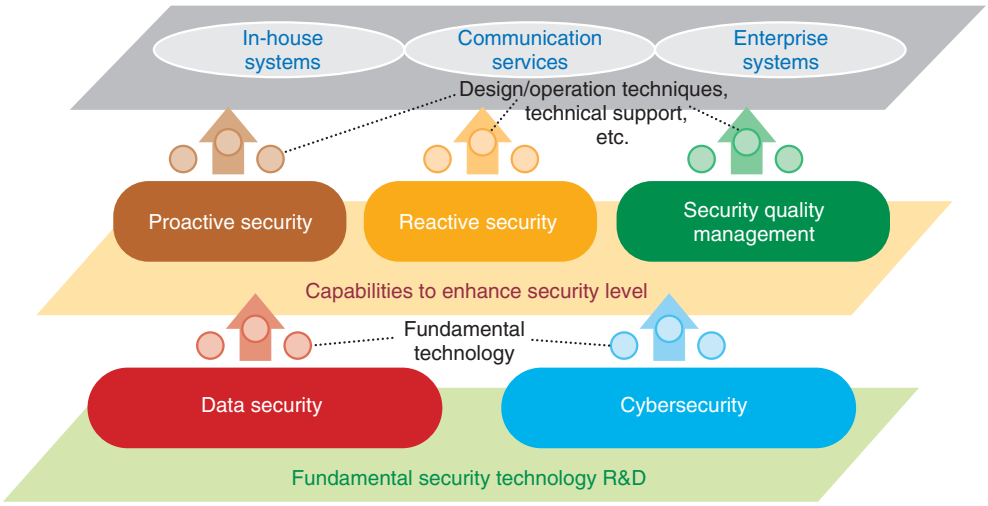

Fig. 1. R&D efforts focusing on security measures.

difficult to put a cost on security alone, so it is necessary to apply measures efficiently. It is also important to make use of threat intelligence such as that on new types of vulnerabilities and the places from where attacks are originating, which makes it possible to balance the cost of security measures by pre-emptively blocking access from attack sites and to increase the efficiency of business operations.

1.3 Integration of the real world and cyberspace is essential when applying security measures in the IoT era

As technology advances, we are fast approaching the Internet of Things (IoT) era, where all sorts of things will be connected to the Internet. In some respects, this era has already started. For example, the use of IoT has been discussed for applications such as self-driving automobiles and the optimal distribution of electric power. In this sort of world, cyber-attacks are considered as a possible cause when there is an incident such as a widespread power outage in one area. In dealing with such cases, it is first necessary to clarify the relationships between incidents that occur in the real world (physical accidents) and those that occur in cyberspace. To respond to these incidents, it is essential to implement a response that takes both real-world and cyberspace factors into consideration.

2. R&D efforts to respond to global cybersecurity threats

At NTT Secure Platform Laboratories, we are engaged in research and development (R&D) in order to implement security measures to keep up with changes in the latest threats and the latest technologies (**Fig. 1**).

Regarding the first point mentioned in section 1, we are not only studying fundamental security technology aimed at creating the world's most advanced systems, but we are also studying how fundamental security technologies can be used to provide enhanced security for in-house systems, communication services, and enterprise systems. We are working to enhance the level of security by not only researching and developing ways of dealing with incidents before and after they have occurred, but also investigating security designs that can be easily operated.

Regarding the second point, we have launched initiatives for sharing threat intelligence with global Group companies including NTT Innovation Institute, Inc. (NTT I^3), which was founded in 2013 as a North American base for R&D.

Regarding the third point, we are researching and developing integrated risk management solutions that combine the know-how of NTT Secure Platform Laboratories on disaster response systems, and the know-how of NTT-CERT* in handling incidents in

* NTT-CERT: NTT Computer Security Incident Response and Readiness Coordination Team

response to cyber-attacks.

In these Feature Articles, we first present some case studies of cybersecurity threats in the global arena [1], and then we discuss two of our activities associated with threat intelligence [2, 3]. Finally, we introduce our efforts aimed at integrated risk management [4].

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Takeshi Nakatsuru
Senior Research Engineer, Planning Section, NTT Secure Platform Laboratories.

He received a B.S and M.S. in computer science and system engineering from Yamaguchi University in 1998 and 2000. In 2000, he joined NTT Information Sharing Platform Laboratories, where he worked on R&D of VOIP (voice over Internet protocol), location awareness systems, and NGN (Next Generation Network) subscriber session control servers. In 2008, he joined NTT WEST and developed high speed (200M and 1G) optic network services for consumers. He joined the R&D planning section in 2012 and was involved in launching NTT I^3 as the North American R&D base.

Yoshiaki Nakajima
Senior Research Engineer, Supervisor, Planning Section, NTT Secure Platform Laboratories.

He received a B.S. in information science and an M.S. in mathematical and computing science from Tokyo Institute of Technology in 1995 and 1997. He joined NTT Information and Communication Systems Laboratories in 1997, where he worked on R&D of information security. From 2009 to 2013, he was with the Security Strategy Section of the Technology Planning Department. He has been involved in R&D of information and communication platforms, security platforms, and other areas.

Jun Miyoshi
Senior Research Engineer, Planning Section, NTT Secure Platform Laboratories.

He received a B.E. and M.E. in system engineering from Kyoto University in 1993 and 1995. Since joining NTT Telecommunication Networks Laboratories in 1995, he has been researching and developing IP networking technologies. From 2006 to 2011, he was engaged in developing FLET'S Hikari networks at NTT and NTT WEST. He has been involved in security R&D management since 2011. He is a member of the Institute of Electronics, Information and Communication Engineers.

Katsumi Takahashi
Executive Research Scientist, Senior Manager of Planning Section, NTT Secure Platform Laboratories.

He received a B.S. in mathematics from Tokyo Institute of Technology and a Ph.D. in information science and technology from the University of Tokyo in 1988 and 2006. He joined NTT in 1988 and has studied information retrieval, data mining, location information processing, information security sociology, privacy preserving techniques, and cryptographic techniques. He has developed several commercial systems including i-Townpage, Mobile Info Search, and privango.

Trends in Global Security Threats

Yosuke Aragane, Kenji Ogura, Hitoshi Endoh, and Kenji Takahashi

Abstract

In this article, to illustrate the trends in global security threats, we examine two ingenious cyber-attacks that were recently reported, and we discuss the countermeasures to the attacks. We also introduce the Global Threat Intelligence Report, an NTT Group initiative related to global security threats. We believe that sharing this sort of information about security threats will help to raise awareness of cyber-security and lead to more secure systems.

Keywords: threat information, cyber-attack, global security

1. Introduction

In recent years, massive cyber-attacks have occurred that have inflicted damage on a scale that is difficult to assess. Examples include the JPMorgan Chase & Co. (a major American financial services firm) data breach targeting its customer information, the devastating cyber-attack on Sony Pictures that included the destruction of corporate systems and the publication of stolen corporate information, a large-scale data breach of government employee information from the United States Office of Personnel Management, and the leakage of information from Japan Pension Service. These cyber-attacks are often not reported in great detail from the viewpoint of ensuring security.

However, people can strengthen the security of their own systems by using cases such as these to understand the deceptive tactics used by attackers and the measures that can be used to defeat them. Consequently, sharing information about security threats will become increasingly important in the future.

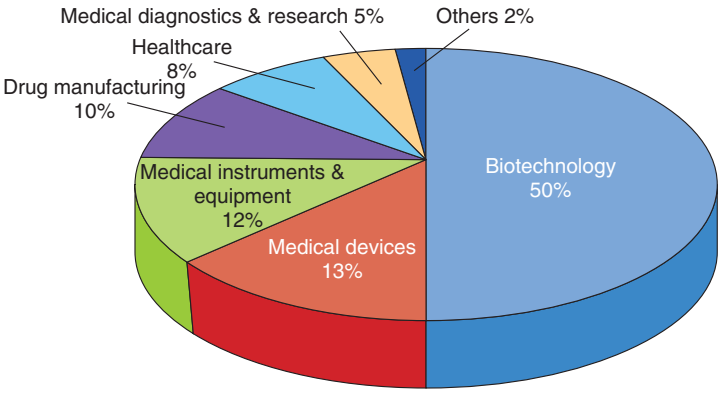
In this article, we report on some sophisticated cyber-attacks reported recently, and we explain the NTT Group's Global Threat Intelligence Report (GTIR) initiative that aims to accelerate the sharing of information.

2. FIN4: Secretly stealing confidential information

FireEye, Inc., a U.S. based network security company, analyzed certain incidents in its clients' networks as well as data it obtained separately through their products and detected a group that is focused on secretly stealing confidential company information that could affect the stock prices of publicly traded companies. FireEye named the group FIN4.

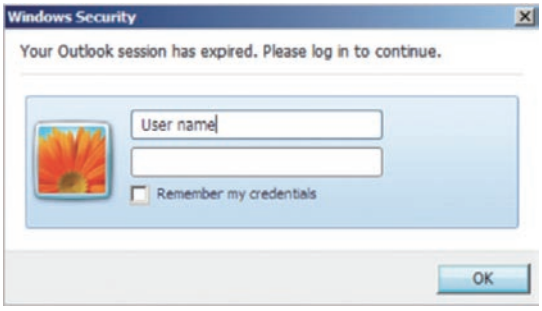
The members of this group have not been identified, so the purpose of their attacks is still unclear. However, FireEye believes that FIN4 is exploiting this insider information in order to profit on the stock market. It is very difficult to ascertain the actual damage because there have not been any apparent losses at the companies targeted in this type of cyber-attack.

FIN4's activities have been observed since mid-2013, and FireEye has discovered about 100 targets consisting of publicly traded healthcare and pharmaceutical companies (68%), firms advising public companies on matters concerning security, legal issues, and mergers & acquisitions (M&A) (20%), and other publicly traded companies (12%). For healthcare and pharmaceutical companies, information on the authorization of drugs or the development and clinical testing of new drugs can have a major impact on the share prices. Also, M&A consultants are privy to M&A information before it is made



Source: http://www2.fireeye.com/fin4.html

Fig. 1. Breakdown of the healthcare and pharmaceutical industry sectors targeted by FIN4.



Source: http://www2.fireeye.com/fin4.html

Fig. 2. Fake dialogue box used to steal login credentials.

public. A breakdown of the healthcare and pharmaceutical industry sectors targeted by FIN4 is shown in **Fig. 1**.

When FIN4 targets a particular company, it starts out by targeting other companies that do business with it. It then uses the email accounts of these other companies to send emails to the target company containing information on transactions that are currently in progress. These emails are addressed to people dealing with confidential information of the target company such as management executives, company attorneys, and researchers. They include attached Office[*1] documents that are exchanged in actual transactions but that have embedded macros that display a fake Outlook[*1] login prompt when the files are opened [1] (**Fig. 2**) and then send the login information to FIN4's server. For environments where macros are disabled, the email message includes a link to a fake Outlook Web App (OWA) login page from where the login information can be stolen. Using this stolen Outlook authentication information, FIN4 accesses the email accounts of people who work with the target company's insider information and obtains confidential information by intercepting and reading their email.

FIN4 also creates settings that automatically delete emails containing terms such as *hacking*, *phishing*, and *malware* from the target's Outlook account. As a result, the targeted individual is not able to see warning emails with messages such as "Is your company being targeted?" from external correspondents.

The U.S. Securities and Exchange Commission (SEC) was reported to have requested detailed reports on at least eight companies targeted by FIN4 [2], but as of the end of June 2015, they had not yet released

*1 Office and Outlook are registered trademarks of Microsoft Corporation in the United States and other countries.

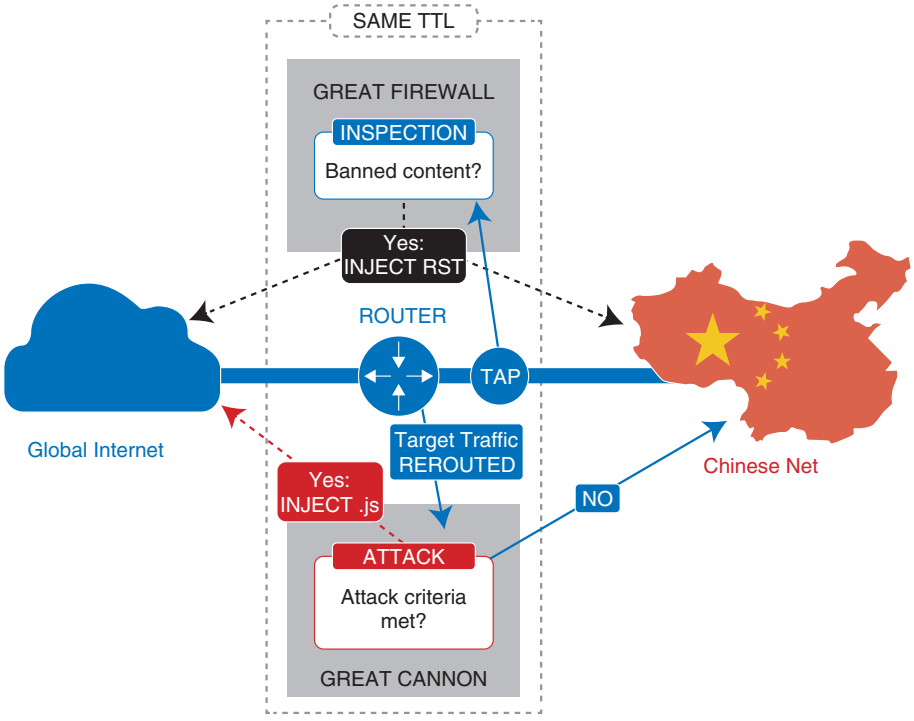


Fig. 3. Schematic model of GFW and GC.

a public statement on the issue.

Steps that can be taken to avoid becoming one of FIN4's victims include disabling macros in Microsoft Office and enabling two-factor authentication for OWA. Also, since FIN4 uses Tor[*2] to conceal the traffic that sends login information to its server, another effective measure is to monitor the internal network logs to check for communication with known Tor nodes.

3. The Great Cannon of China

A study by the Citizen Lab at the University of Toronto has shown that the Great Firewall (GFW)[*3] of China is now partnered with an attack system, which it calls the Great Cannon (GC). In March 2015, GreatFire.org and GitHub[*4] became the first observed victims of massive DDoS (distributed denial of service) attacks from GC. In the following, we describe the GC and GFW mechanisms on which they are based, as well as a GC attack.

3.1 GFW mechanism

The GFW is shown in the upper part of **Fig. 3** [3]. All Internet traffic in and out of China passes through the GFW. The traffic is intercepted at the element labeled TAP, and content that is subject to restrictions or blockades is identified at the element labeled INSPECTION. When such content has been identified, the INJECT RST part transmits RST (reset) packets, which are used when blocking communication or denying access, to the source and destination servers. A load-balancing mechanism is used in the GFW so that it can process multiple communication streams in parallel. In this way, the GFW continuously monitors network traffic in order to block access to content that the Chinese authorities regard as undesirable.

*2 Tor: Software that anonymizes the paths of network connections without encrypting the content of the traffic carried by them.

*3 GFW: A large-scale censorship system used by Chinese authorities to restrict and cut off Internet connections into and out of China.

*4 GitHub: A web service provided by GitHub, Inc. as a platform for sharing software development projects. Its basic functionality is available for free, and extended features can be used for a fee.

3.2 GC mechanism

In the GC, the Target Traffic REROUTED component in Fig. 3 reroutes the corresponding traffic, and the ATTACK component identifies whether or not it is to be used in an attack. If so, an attack code is sent to the access source; otherwise it connects to the requested destination server. On receiving an attack code, the access source becomes a temporary agent that supports a GC attack. Just as with the GFW, all Internet traffic in and out of China passes through the GC, so it is possible to launch a large-scale attack even when only a tiny fraction of traffic is used by the GC. The GC takes over this traffic, which makes it capable of launching man-in-the-middle (MITM) attacks. The GC is compatible with high-bandwidth communications, so it collects only IP addresses of the access sources. It also has a mechanism for caching previous traffic so that it can eliminate unnecessary work when the same process is performed repeatedly on the same traffic. Citizen Lab's test results suggest that up to 16,000 access source IP addresses can be stored in this way.

According to Citizen Lab, the results of sending traffic configured to respectively operate the GC and GFW, and the results of analyzing the responses to this traffic suggest that the GC and GFW do not share attack facilities but have their own systems. However, there are similarities in the way they rewrite data packets, so they appear to share parts of the same program code and are thought to be very closely related. The GC and GFW have similar load balancer functions and are thought to distribute traffic based on the IP addresses of access sources.

A Citizen Lab survey of communication paths set up to activate the GFW and GC indicated that both are on the same destination network, so it seems that the GC and GFW are installed right next to each other [3]. In one test environment, the destination network was China Telecom, and in another test environment the destination network was China Unicom. The research done by security blogger Robert Graham suggests that the GC exists in the infrastructure of China Unicom.

3.3 Attacks on GreatFire.org and GitHub

From March 14 to March 25, 2015, a large-scale DDoS attack was carried out against GreatFire.org, which was hit with 2.6 billion requests per hour (2500 times the usual rate). GreatFile.org provides functions that use the Amazon CloudFront CDN (content delivery network) service to bypass the GFW and allow blocked sites to be viewed. Note that the Cyberspace Administration of China has already identified GreatFire.org as a foreign anti-Chinese organization.

From March 25 to April 7, 2015, GitHub was also hit by a large-scale DDoS attack, causing the site's response times to increase several times over [4]. GreatFire.org has two GitHub repositories that provide technology to users wishing to circumvent Chinese censorship. The attack on GitHub appears to have been carried out with the aim of forcing the removal of these repositories from GitHub.

The GC attacked GreatFire.org and GitHub by intercepting and redirecting traffic destined for Baidu Analytics and Baidu Advertising, which are parts of the Baidu common platform. However, not all the traffic to these sites was used in the attack. According to Citizen Lab's observations, the majority of traffic (about 98.25%) passed through to Baidu unaffected, while the remainder (about 1.75%) was used in the attack [3]. The web requests used in the attack included page views of sites containing advertising from Baidu, so the visitors to these sites were unwittingly taking part in the attacks on GreatFire.org and GitHub.

3.4 Who built the GC?

Citizen Lab considers that the GC could not have been built or used without the approval of the Chinese government, since its attacks are too overt to have been conducted without government permission. It also stated that although it is not clear why the GC was built, it may have resulted from the conflict between the activities of GreatFire.org and the Chinese Communist Party's ideology [3]. These destructive acts may be designed not only to block access to content that the party finds undesirable but also to set an example for other organizations engaged in similar activities.

3.5 Predictions

Since the GC is evidently capable of launching attacks based on the source of Internet traffic, it is assumed to have latent capabilities for other forms of cyber-attack besides DDoS, even though they have not yet been observed. For example, it could be easily reconfigured to send malware to specific individuals that access servers in China without using encryption. Also, since the GC is a complete MITM, it could even replace attachments of an unencrypted email with malware.

It is very difficult for organizations and individual users to defend themselves against attacks by the GC. However, due to the way in which the GC works,

these attacks only work on unencrypted traffic, and will not work on traffic encrypted using the protocol HTTPS (Hypertext Transfer Protocol Secure) or the like. The GC can therefore be rendered less effective by promoting the encryption of traffic and content by many organizations and users.

4. GTIR

The 2015 edition of GTIR [5] was produced by NTT Innovation Institute, Inc. (NTT I^3) with the cooperation of NTT Group companies (NTT Com Security, Dimension Data, Solutionary, NTT Secure Platform Laboratories, and NTT DATA). It contains detailed descriptions of the following important trends based on the analysis of about 6 billion attack events observed by the NTT Group during 2014.

- The financial industry continues to represent the number one targeted sector, accounting for 18% of all detected attacks. Attacks against business and professional services increased from 9% to 15%.
- Basic controls are still not implemented in all cases; 74% of organizations do not have formal incident response plans.
- Incident responses involving malware threats increased 9% compared to 2013, from 43% to 52%.
- During 2014, 76% of identified vulnerabilities throughout all systems in the enterprise were more than 2 years old, and almost 9% of them were over 10 years old.
- Over 80% of vulnerabilities in 2014 exploit kits were published in 2013 and 2014.
- There was an increase in Adobe Flash*5 exploit usage in exploit kits from 2012 to 2014.
- Of the attacks on NTT's customers worldwide, 56% originated from IP addresses in the US. The attackers are not necessarily in the US but are taking advantage of the rich cloud services available there.
- DDoS amplification attacks using User Datagram Protocol accounted for 63% of all DDoS attacks observed by NTT Group.

5. Future prospects

The NTT Computer Security Incident Response and Readiness Coordination Team (NTT-CERT) at NTT Secure Platform Laboratories is working to improve security throughout the NTT Group and the information network society. NTT-CERT provides consultation services on information security and also delivers security-related information.

We will continue with our ongoing incident response support for NTT Group companies. We also plan to continue providing security information with the aim of expanding the global scale of our activities.

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*5 Adobe and Flash are registered trademarks or trademarks of Adobe Systems Incorporated in the United States and other countries.

Yosuke Aragane
Senior Research Engineer, Supervisor, NTT-CERT, Security Risk Management Project, NTT Secure Platform Laboratories.

He received his M.S. and Ph.D. from Tokyo Institute of Technology in 1997 and 2005. He joined NTT Multimedia Network Laboratories in 1997, where he worked on intelligent transportation systems. Since 2003, he has been with NTT Information Sharing Platform Laboratories and NTT Secure Platform Laboratories focusing on cybersecurity research. His current research interests include security operation optimization, security intelligence sharing, and human factor influences on the information security. He is a member of the Institute of Electrical and Electronic Engineers (IEEE), the Association for Computing Machinery (ACM), the Information Processing Society of Japan (IPSJ), and the Institute of Electronics, Information and Communication Engineers (IEICE).

Kenji Ogura
Senior Research Engineer, Security Risk Management Project, NTT Secure Platform Laboratories.

He received a B.E. and M.E. in electrical engineering from Keio University, Kanagawa, in 1988 and 1990. He joined NTT LSI Laboratories in 1990, where he researched and developed CAD (computer aided design) systems for LSI (large-scale integrated circuit) design. Since joining NTT Secure Platform Laboratories in 2014, he has been working on security information analysis at NTT-CERT. He is a member of IPSJ.

Hitoshi Endoh
Research Engineer, Security Risk Management Project, NTT Secure Platform Laboratories.

He received an M.A. in arts and sciences from the University of Tokyo in 1997. He joined NTT Cyber Space Laboratories (now, NTT Media Intelligence Laboratories) in 1997. During 2000-2012, he was a member of the Cyber Security Department at NTT EAST Corporation, where he developed information system security guidelines and a security vision with medium and long term action plans. Since joining NTT Secure Platform Laboratories in 2012, he has been working on computer security incident response team (CSIRT) activities at NTT-CERT. He is currently working on information sharing projects with other CSIRT teams and cyber threat analysis.

Kenji Takahashi
VP, Product Management, Security, NTT Innovation Institute, Inc.

He received his B.S., M.S., and Ph.D. in computer science from Tokyo Institute of Technology. He has over 28 years of international experience in the information and communication industry. He has led many projects at NTT R&D in Japan, including those related to cloud computing, software engineering, digital identity management, collaboration environments, and ubiquitous computing. He was previously President and CEO of NTT Multimedia Communication Laboratories, Inc. (NTT MCL) in Silicon Valley, where he successfully launched and led open source, open standard based cloud, and software-defined networking projects. He was a visiting scientist at the College of Computing at Georgia Institute of Technology and a member of the Discovery Park Advisory Council at Purdue University. He received the Kiyasu Special Industrial Achievement Award from IPSJ for his pioneering work on federated identity management. He is a member of IEICE, IPSJ, IEEE Computer Society, and ACM.

Security Intelligence for Malware Countermeasures to Support NTT Group's Security Business

Takeo Hariu, Keiichi Yokoyama, Mitsuhiro Hatada, Takeshi Yada, Takeshi Yagi, Mitsuaki Akiyama, Tomonori Ikuse, Yuta Takata, Daiki Chiba, and Yasuyuki Tanaka

Abstract

Cyber-attacks caused by malware (malicious software) are becoming a serious social problem in many parts of the world. In this article, we introduce the security intelligence technology behind our WideAngle global integrated security service.

Keywords: malware, security intelligence, WideAngle

1. Introduction

Cyber-attacks have been causing a number of social problems in recent years. In particular, malware infections inflict severe damage and can cause leakage of information at a national level. An example of a malware attack on a personal computer (PC) is shown in **Fig. 1**. When a PC with vulnerabilities in its web browser or plugins visits a portal or relay site that has been created by an attacker to automatically forward content, it is automatically transferred to an attack site containing attack codes that cause the browser to become infected by downloading malware. A PC that has been infected with malware by accessing a series of malicious sites in this way will exchange information with a command site created by the attackers for purposes such as information theft.

At NTT's laboratories, we have been researching and developing technology to detect infection activity, collect malware, and analyze the infection pathways and malware behavior [1]. By continuously collecting and analyzing attacks, we have created techniques for efficiently and accurately characterizing the latest malware infections. Recently, however, it has become difficult to create services that lead to effective countermeasures using a single technology alone due to the increasing complexity of attacks and the emergence of malware attacks with a very short cycle.

From empirical knowledge obtained in previous research and development (R&D) and from observing attacks, we realized the importance of the security intelligence and its effect on malicious activity. The security intelligence includes the destinations of traffic related to malware infections, which are obtained through cross-sectional analysis of traffic data and attacks occurring up to and beyond the point of malware infection. Therefore, we began conducting R&D on world-leading intelligence creation techniques [2]. Furthermore, in partnership with NTT Communications, which is a world leader in the global security business, we expanded our security intelligence efforts into the WideAngle managed security service [3].

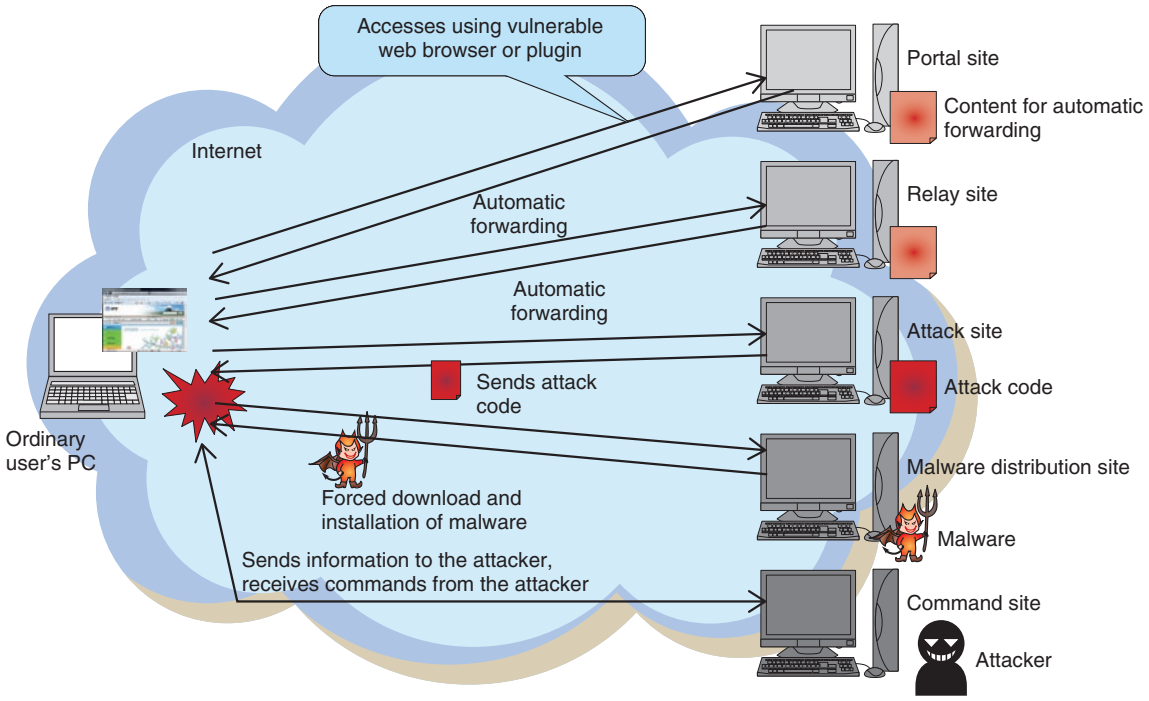


Fig. 1. Malware infection attack.

2. NTT security intelligence

In general, security intelligence refers to information used to defend against cyber-attacks. For example, this includes the originating Internet protocol (IP) addresses of DDoS (distributed denial of service) attacks or spam emails, or the IP addresses of botnet C&C (command & control) servers or collection sites for stolen data, and the Uniform Resource Locators (URLs) of phishing sites and fake websites.

A wide variety of cyber-attacks originate from PCs and servers that have been compromised by attackers via malware infection. Therefore, to fundamentally solve the problem of cyber-attacks, it is absolutely essential to have security intelligence for deploying malware infection countermeasures. Also, to develop security intelligence into a business, it is important to have clear documented information on which to base malignancy decisions, as well as information on how it is used.

At NTT's laboratories, security intelligence includes information such as the destination IP addresses and URLs of traffic at the time of malware infection and the destination of traffic from the infected victim, as shown in **Fig. 2**.

Each item of information is associated with evidence identified using proprietary techniques such as decoy systems (*honeypots*) and dynamic malware analysis systems. These techniques are applied in parallel to identify the URLs of malware sites that cannot be collected by other companies. Furthermore, the URLs of these malware sites are analyzed to identify unknown malware site URLs.

2.1 Honeypots

Malware is collected by using decoy systems called honeypots to accept attacks. By analyzing the communication with honeypots, we can gather evidence about the vulnerabilities that are being used by attackers to spread their malware, and to identify information that is effective for preventing infection.

We are conducting R&D on honeypots that keep up with the trends in malware infection activity. We are currently researching and developing web server honeypots to attract attacks that exploit vulnerabilities in web applications, and *honeyclients* to attract attacks that exploit vulnerabilities in web browsers and plugins. Here, we introduce a honeyclient that performs a key role in intelligence creation.

In general, honeypots are classified into two categories: low-interaction honeypots that securely gather the minimum amount of information by simulating a

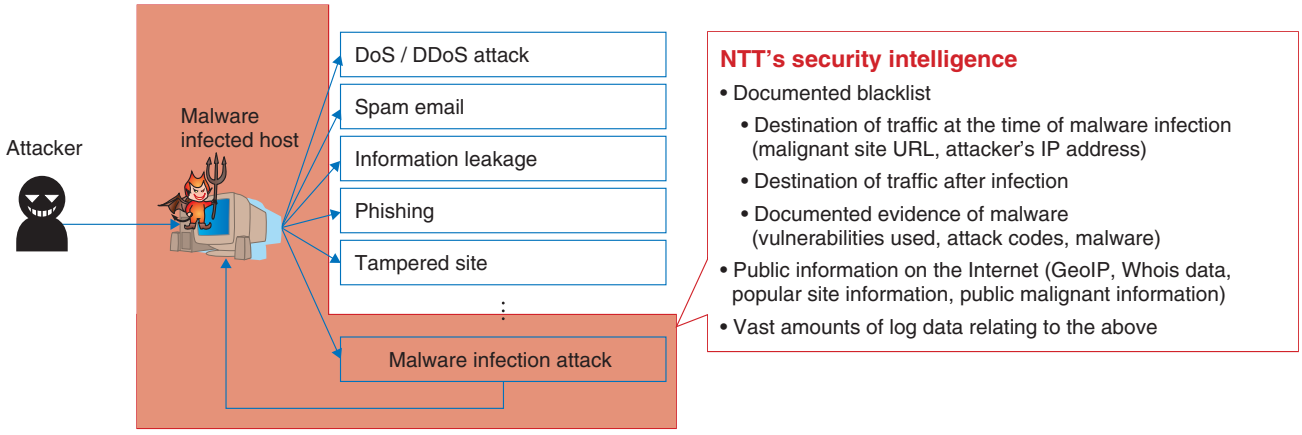


Fig. 2. NTT's security intelligence.

vulnerable system, and high-interaction honeypots that collect a lot more information by using an actual vulnerable system. Although high-interaction honeypots are said to run the risk of being infected with malware, we have managed to develop a secure high-interaction honeyclient. Also, low-interaction honeypots are said to be only capable of collecting limited information, but we have managed to develop one with improved information-gathering capabilities. With a honeyclient, it is possible to detect malware infections and identify the URLs of malware sites that infect visitors with malware. Then malware infections can be prevented by prohibiting access to such URLs.

2.2 Dynamic analysis of malware

Malware collected by honeypots is analyzed to shed light on its latent threats by investigating its functions in detail. Furthermore, by analyzing the traffic generated by malware infections to discover information such as the servers they communicate with when obtaining additional malware and the command servers set up by the attackers, it is possible to identify information that is effective for suppressing the damaging effects of malware.

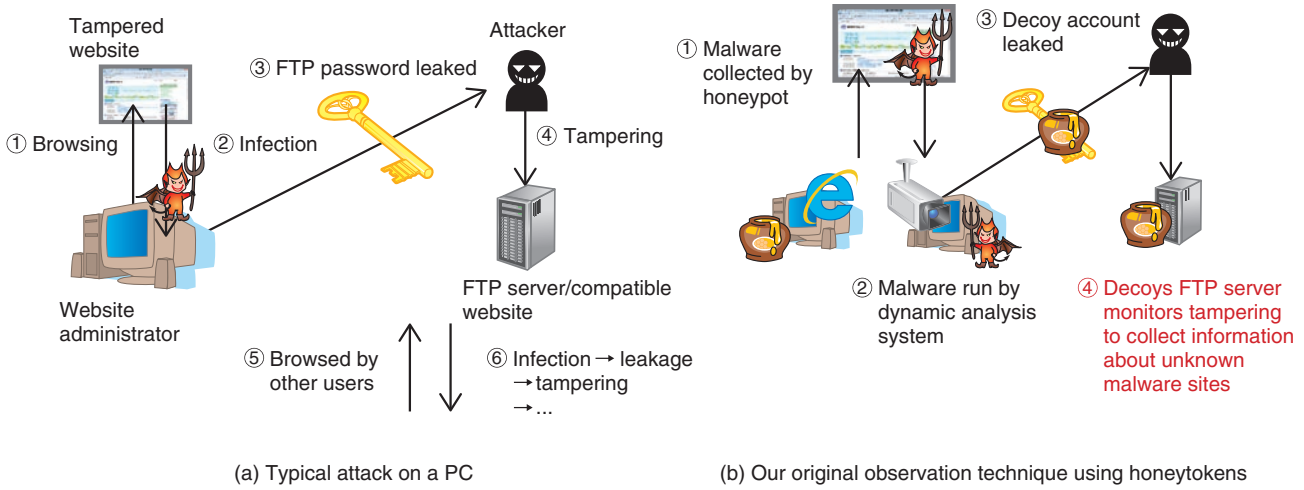
Malware analysis includes dynamic analysis, which clarifies the behavior of malware by actually running it, and static analysis, which deciphers the malware's program code. Dynamic analysis is introduced here.

Dynamic analysis can be performed either in a closed environment, where the malware is operated in complete isolation, or in an open environment, where the malware can connect to the Internet. In both types of environment, a debugger can be used to closely monitor the malware's behavior. Furthermore, taint analysis techniques can be used to track the flow of data handled within a system and identify servers prepared by the attackers to send data causing malicious behavior. For example, PCs that have been infected with malware can be discovered by identifying the PCs that access the command server or destination server when acquiring additional malware.

2.3 Honeytokens

During the dynamic analysis of malware collected by a honeypot, it is possible to allow the attacker to tamper with a controlled decoy website by deploying false information for the website administrator's account in the analysis environment. This makes it possible to collect the latest attack information.

As mentioned previously, the greatest threat of malware infection in recent years has been caused by users unknowingly visiting malware sites. Parts of the malware deployed in these attacks have functions that collect and send out various kinds of account information. Therefore, when a website administrator's account information is recorded on an infected PC, this information is leaked to the attacker so the website can be manipulated by the attacker, as shown in **Fig. 3(a)**. A honeytoken shows nothing but decoy information. Since the content of a website is often managed via a File Transfer Protocol (FTP) server, fake FTP account information is prepared as a honeytoken. The attacker uses the honeytoken information to log in to a separate fake FTP server and tampers with its content. Checking the falsified content in the honeypot makes it possible to collect security intelligence about the latest attacks initiated by the attacker



(a) Typical attack on a PC (b) Our original observation technique using honeytokens

Fig. 3. Honeytokens.

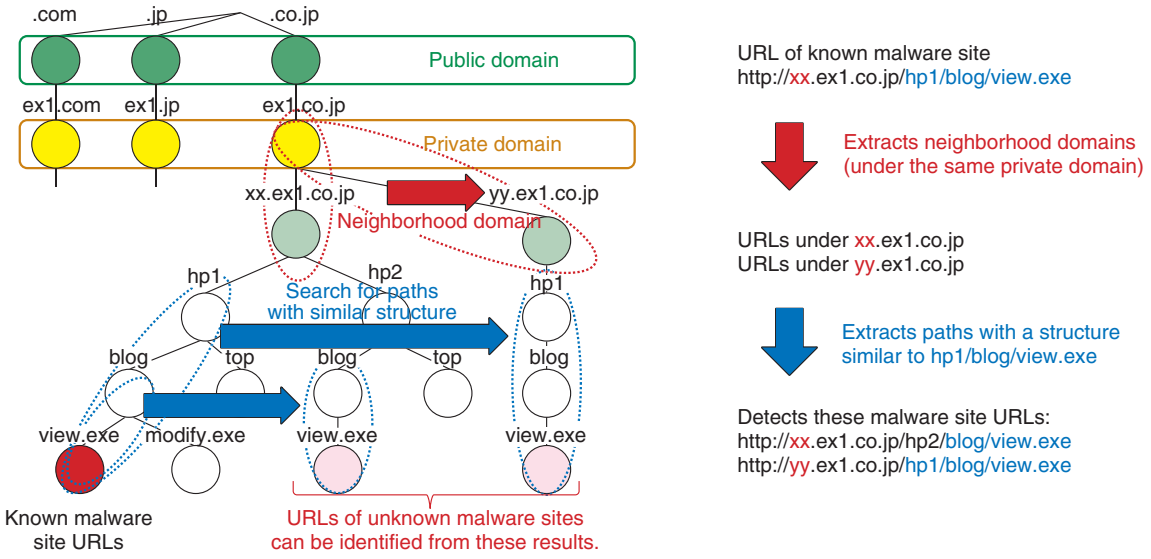


Fig. 4. Neighborhood search of malware sites.

(**Fig. 3(b)**).

A paper summarizing this technique [4] was the first Japanese-authored paper in ten years to be accepted at one of the highest-level international conferences and was highly rated all over the world.

2.4 Searching the neighborhood of malware sites

To avoid defenses set up based on security intelligence, attackers construct numerous malignant sites. Since they are reluctant or unable to spend much money on each site, they adopt configurations that enable new malware sites to be set up without incurring much additional cost. In anticipation of this trend, we identify malware sites by searching for web spaces that are highly likely to have been created by attackers.

This search technique is shown in **Fig. 4**. We first extract URLs with the same path structures as existing malware site URLs in URL groups that exist in the same private domains as the URLs of known malware sites, and then we investigate these URLs using

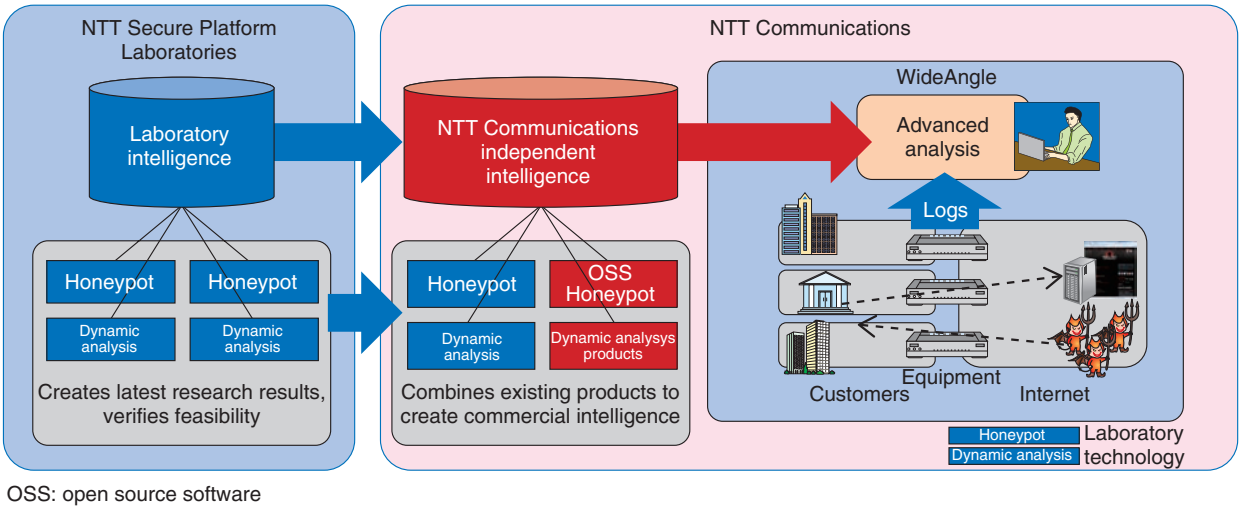


Fig. 5. Global business development.

honeypots. An attacker who manages a known malignant site URL will be able to generate such URLs without incurring any cost burden, so with this search technique it is possible to discover malignant URLs prepared by attackers that are intended to avoid security intelligence. This technique was summarized in a paper that achieved global recognition [5] and received the best paper award at a major international conference.

3. Global business development of security intelligence

The honeypot and analysis techniques and the security intelligence services created at NTT's laboratories are being put to use in the services offered by NTT Communications. By implementing a combination of laboratory techniques, security intelligence, and existing products, NTT Communications is creating its own independent security intelligence, as shown in **Fig. 5**.

In business applications, we envisage that security intelligence could be deployed in services such as log auditing, user access filtering, or monitoring user websites. We have been using security intelligence in NTT Communications' managed security services for log auditing since February 2013. In this service, security intelligence is used to detect security risks by employing advanced correlation analysis and to automatically assess threat levels. In this way, correlation analysis is done automatically on vast amounts of security information such as communication log files collected using ICT (information and communication technology) equipment, enabling an advanced and rapid response to any detected threats.

Our managed security services are currently marketed under the WideAngle brand name, and they provide globally seamless comprehensive security countermeasures to users by conducting advanced security monitoring all day, every day based on a security provider system that includes over 900 specialists in 14 countries worldwide.

4. Future prospects

In the future, we plan to work on making our global business more competitive and on developing our security business while prototyping NTT's leading-edge security technology.

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Takeo Hariu
Senior Research Engineer, Supervisor, Cyber Security Project, NTT Secure Platform Laboratories.
He received his M.S. in electro-communications from the University of Electro-Communications, Tokyo, in 1991. Since joining NTT in 1991, he has been engaged in network security R&D. He is a member of the Institute of Electronics, Information and Communication Engineers (IEICE) and the Institute of Electrical Engineers of Japan (IEEJ).

Keiichi Yokoyama
Senior Manager, Security Operation Center, NTT Com Security Corporation.
He joined NTT in 1997 and worked on the development of security services for the OCN Internet service. He has led various Ministry of Internal Affairs and Communications projects involving NTT R&D technology, including the Cyber Clean Center project from 2006 to 2010 and the Reputation Database Project from 2009 to 2011. He has been with NTT Com Security since 2012.

Mitsuhiro Hatada
Senior Manager, Technology Development/ NTT Com-SIRT, NTT Communications Corporation.
He received his B.E. and M.E. in computer science and engineering from Waseda University, Tokyo, in 2001 and 2003. He joined NTT Communications in 2003 and has been engaged in R&D of computer and network security. He is a member of the Information Processing Society of Japan (IPSJ) and IEICE.

Takeshi Yada
Senior Research Engineer, Supervisor, Cyber Security Project, NTT Secure Platform Laboratories.
He received an M.S. in engineering from Tokyo Institute of Technology in 1991. Since joining NTT in 1991, he has been conducting R&D on network architecture, measurement, and inference for network traffic, and network management. His current research interests include network security. He is a member of IEICE, the Operations Research Society of Japan, and the Japan Statistical Society.

Takeshi Yagi
Senior Research Engineer, Cyber Security Project, NTT Secure Platform Laboratories.
He received a B.E. in electrical and electronic engineering and an M.E. in science and technology from Chiba University in 2000 and 2002. He also received a Ph.D. in information science and technology from Osaka University in 2013. Since joining NTT in 2002, he has been engaged in research and design of network architecture and traffic engineering. His current research interests include network security, especially honeypots and security-data analysis based on machine learning. He is a member of IEICE, the Institute of Electrical and Electronics Engineers (IEEE) and IEEJ.

Mitsuaki Akiyama
Research Engineer, Cyber Security Project, NTT Secure Platform Laboratories.
He received his M.E. and Ph.D. in information science from Nara Institute of Science and Technology in 2007 and 2013. Since joining NTT in 2007, he has been involved in R&D of network security, especially honeypots and malware analysis.

Tomonori Ikuse
Researcher, Cyber Security Project, NTT Secure Platform Laboratories.
He received an M.E. in information science from Nara Institute of Science and Technology in 2012. Since joining NTT in 2012, he has been engaged in network security R&D. He is a member of IEICE.

Yuta Takata
Researcher, Cyber Security Project, NTT Secure Platform Laboratories.
He received his B.E. and M.E. in computer science and engineering from Waseda University, Tokyo, in 2011 and 2013. He is currently a Ph.D. student in the Department of Computer Science and Communications Engineering, Waseda University. Since joining NTT in 2013, he has been engaged in R&D of network security, especially honeyclients and malicious code analysis.

Daiki Chiba
Researcher, Cyber Security Project, NTT Secure Platform Laboratories.

He received his B.E. and M.E. in computer science and engineering from Waseda University, Tokyo, in 2011 and 2013. He is currently a Ph.D. student in the Department of Computer Science and Communications Engineering, Waseda University. Since joining NTT in 2013, he has been conducting research on cybersecurity through data analysis.

Yasuyuki Tanaka
Manager, Technology Development/NTT Communications Corporation.

He received a B.E. in physics from Rikkyo University, Tokyo, in 1995 and an M.E. in informatics from the Institute of Information Security, Kanagawa, in 2015. He joined NTT in 1995 and has been engaged in R&D of computer and network security. He is a member of IPSJ.

Security Orchestration with a Global Threat Intelligence Platform

Takaaki Koyama, Bo Hu, Yukio Nagafuchi, Eitaro Shioji, and Kenji Takahashi

Abstract

The NTT Innovation Institute, Inc. has developed a system for collecting and distributing information on the threats posed by cyber-attacks: the Global Threat Intelligence Platform (GTIP). By connecting with NTT Secure Platform Laboratories' security orchestration technologies, GTIP makes it possible to run advanced cyber defenses based on threat data. In this article, we demonstrate how we jointly built and connected these technologies and discuss their future global deployment.

Keywords: GTIP, security orchestration, network security

1. Introduction

Cyber-attacks against companies and public organizations have continued to evolve in recent years. Security appliances have been used to detect, filter, and otherwise protect against these attacks—primarily with the help of virus definition files and signature updates. However, attackers have been able to employ new techniques to hack into networks while avoiding detection. As a result, data leaks, tampering, and other damage incurred via the Internet continue to be a problem. To deal with this, we may need security operations that take a more unconventional approach. In this article, we introduce these new types of cyber-attacks and the initiatives to deal with them at NTT's laboratories and NTT Innovation Institute, Inc. (NTT I^3); we also present our jointly developed cooperative system along with plans for its global deployment.

2. New types of cyber-attacks and countermeasures

Attackers use spear phishing emails, watering hole attacks, and other strategies to get their targets to download malicious programs on the Internet. Once installed on a victim's computer, these programs accept remote commands to leak data, upgrade themselves, set up command-and-control (C&C) servers, and cause other damage. Because this series of operations is conducted over the Internet and even newer malicious programs continue to be created, we believe that the following three-step process is an effective way to respond to these threats.

(1) Actively collect external threat intelligence to prevent damage

Threat intelligence includes blacklists of Internet protocol (IP) addresses and Uniform Resource Locators (URLs) as well as the behavior of the latest malicious programs discovered on the Internet; this information is helpful in preventing both infiltration and subsequent actions by attackers.

(2) Automatically configure security operations to respond quickly

By promptly configuring the appropriate countermeasures as new malicious programs emerge, we can mitigate their effects.

(3) Choose appropriate appliances and countermeasures using diverse threat intelligence

There are a variety of security appliances installed within private companies' intranets as well as at the connection points between these intranets and the Internet. By configuring the appropriate appliances and countermeasures, we can stop attackers' Internet-based actions.

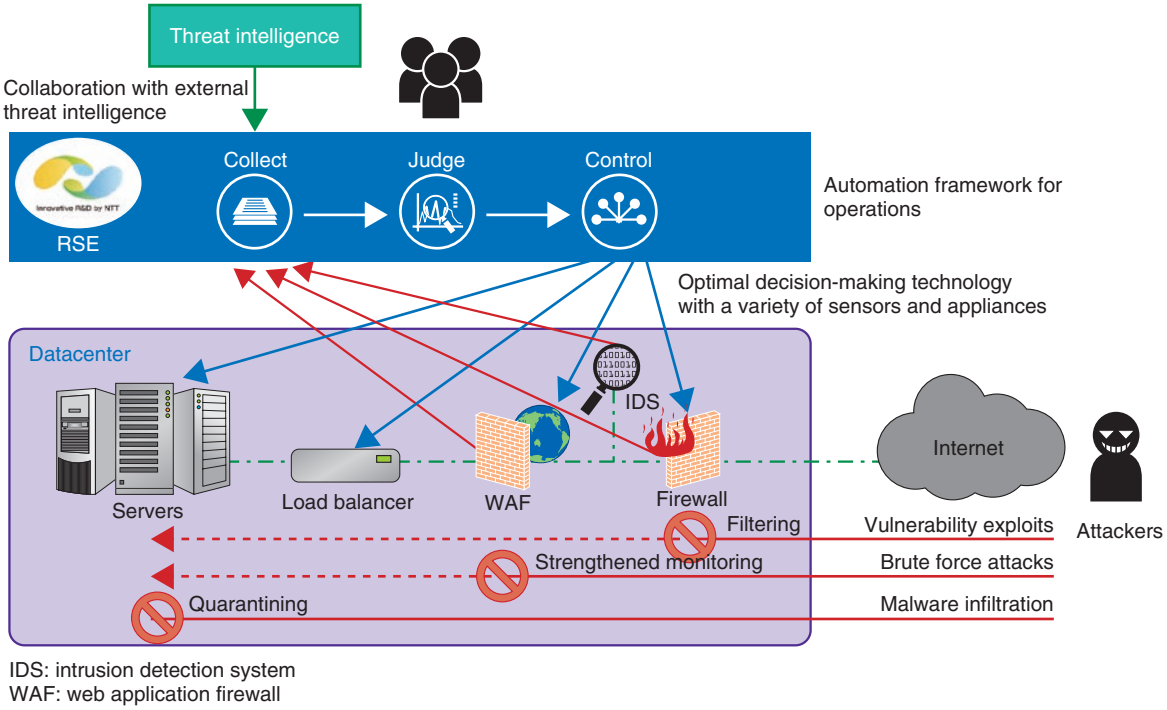

Fig. 1. Resilient Security Engine (RSE).

3. Initiatives at NTT Secure Platform Laboratories

At NTT Secure Platform Laboratories, we have researched and developed security orchestration technologies to automatically respond to cyber-attacks [1]. In the interest of establishing methods of coping with new and even more sophisticated cyber-attacks in the future, we are also currently carrying out research and development (R&D) efforts focused on a Resilient Security Engine (RSE), which implements three technical components (**Fig. 1**).

3.1 Proactive defense technologies incorporating threat intelligence

We actively collect external threat intelligence to protect users from Internet-based cyber-attacks. We specifically collaborate with a threat intelligence platform that collects cyber-attack data from around the world, blacklisting IP addresses and URLs associated with attackers to prevent attacks and their subsequent damage before they can occur. For example, when suspicious behavior is detected, we receive information about the source of the attack from the threat intelligence platform; this allows us to make more accurate decisions.

NTT Secure Platform Laboratories is moving forward by connecting the RSE system and the threat intelligence platform developed by NTT I^3. By using an automation framework for operations (as explained in the next section) along with a variety of sensors and appliances, our technology is able to choose optimal countermeasures; we can thus expect attacks and threats to be handled promptly and appropriately.

3.2 Automation framework for security operations

When an incident occurs, the datacenter's security operators determine what course of action to take after they confirm the type of attack from logs that are used to detect attacks and threats. The security operators must then find and send commands to the appropriate hardware or software solution (e.g., the firewall) dictated by the network structure. The aforementioned process of collecting data on attacks and threats is currently consolidated under a Security Information and Event Management (SIEM)*1 system;

*1 SIEM: A system that collects log data from servers, network devices, and other security-related equipment. When a malfunction, attack, or other unusual event is detected, the system notifies its administrators with information on and steps to resolve the situation based on the collected log data.

dedicated tools provide a simplified interface to the firewall's controls. However, operators must manually respond to incidents using multiple administrative systems and control tools with an understanding of security policies and network structures. As a result, these operations are problematic both in terms of the time and effort they require.

For these reasons, we are proposing an automation framework that will promptly carry out security operations—from data collection to decision making to response. Our proposed framework does not simply define a single program to link multiple administrative systems and control tools with one another; it is also intended to allow users to choose from different methods of responding to the same types of attacks (e.g., malware infections) for a desired level of security. Responses can include strengthened monitoring, filtering, and quarantining; for example, users should be able to filter network traffic or completely isolate a device from the network. Furthermore, our proposal is intended to implement general-purpose operations that can make use of different types of equipment (e.g., physical switches or virtual switches in a hypervisor) according to the user's information and communications technology (ICT) environment for the same attack response (e.g., network filtering).

3.3 Optimal decision-making technology with a variety of security sensors and appliances

One effective strategy for dealing with multi-vector attacks is a layered area defense using several varieties of security sensors and appliances distributed across a user's ICT environment. However, intrusion detection systems (IDSs)[*2] and web application firewalls (WAFs)[*3]—as well as other similar sensors and appliances—have been designed to run independently; they do not give sufficient consideration to sharing data and working together with other devices. Although some vendors offer value-added solutions to connect their own products, attempts to create synergy by improving detection and control capabilities with products from multiple vendors have not taken off; this has led us to believe that the effectiveness of linking products together is limited.

For these reasons, we have been researching and developing technology that collects information on threats from a wide variety of sensors, determines what types of attacks or threats it encounters as well as the best way to deal with them, and finally, makes use of the most suitable network devices to respond to them. This technology can combine data from multiple sensors to determine when attacks or threats are present and how to deal with them appropriately; it can also manage an attack or threat situation by defining relationships between the sensors' data. Using configuration data for the appliances distributed across a network, the technology can even select a location close to the root cause of an attack from several candidates and direct its response there.

4. Initiatives at NTT I^3

This section introduces the Global Threat Intelligence Platform (GTIP) being developed by NTT I^3. GTIP is a comprehensive platform for collecting, analyzing, and distributing actionable intelligence (data) on cyber-threats from around the world. We intend to use this platform within the NTT Group to contribute to improving the quality of the entire group's security services.

GTIP has three major features: data collection, which involves gathering diverse threat data from both inside and outside the NTT Group; data analysis, which involves employing advanced analytics based on proprietary technology; and data sharing, which provides flexible input and output interfaces. By combining these features, we can counteract the complex and wide-ranging threats that in recent years have become difficult to defend against through conventional methods (**Fig. 2**).

4.1 Data collection

GTIP collects data provided by proprietary commercial web crawlers, large numbers of community vendors, the NTT Group's security professionals (e.g., managed security services providers), and threat sensors (e.g., honeypots) installed around the world. We plan to continue adding more data sources, such as those obtained from network traffic.

4.2 Data analysis

Using the advanced program analysis technology (also known as taint analysis[*4] technology) developed by NTT I^3 in collaboration with NTT Secure

*2 IDS: A system that monitors the packets sent over a network and notifies its administrators when any indication of unauthorized access occurs.

*3 WAF: A firewall that can detect and protect against unauthorized breaches from external networks (e.g., the Internet) using data exchanged with web applications.

*4 Taint analysis: An analysis technique that tags important data at runtime and then closely follows data flows so it can detect when data have been exfiltrated.

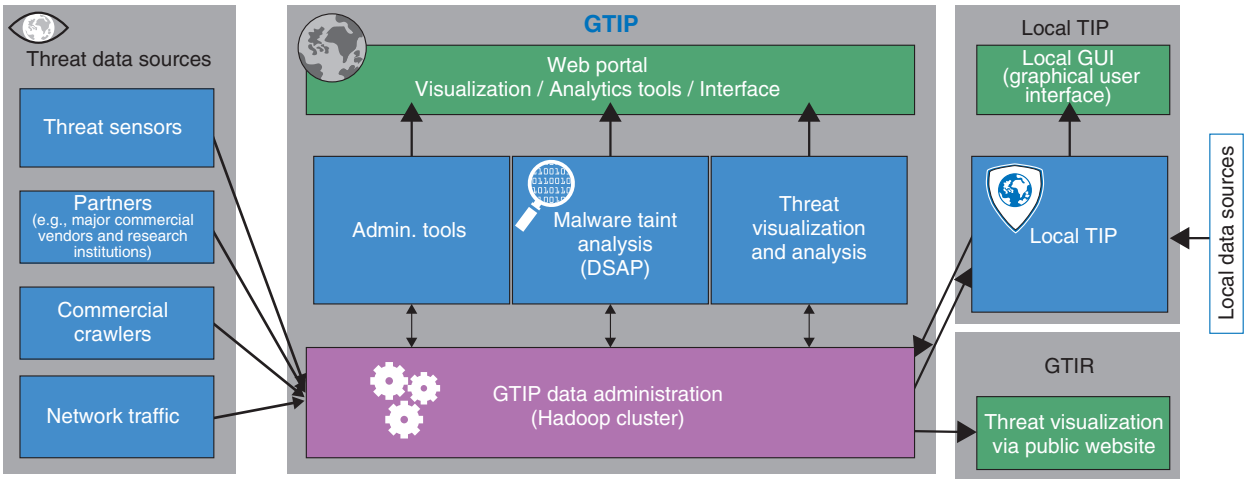

Fig. 2. GTIP.

Platform Laboratories, we can create a list of malicious servers with which malware communicates. By also calculating reputations and analyzing correlations in the data, we can produce easily actionable intelligence supported by detailed evidence and maliciousness ratings.

4.3 Data sharing

GTIP stores the enormous amount of data it collects and analyzes in a Hadoop cluster that restricts access according to permissions configured for individual types of data. GTIP provides a web portal, an Apache Thrift application programming interface, and other user-facing interfaces to support many different service patterns and requirements. GTIP also provides a client-side local TIP that synchronizes GTIP data with users' local environments, and we have taken it upon ourselves to supply information through a public website: the Global Threat Intelligence Report (GTIR) [2].

One of GTIP's use cases is increasing our ability to detect and defend against attacks by supplying shared intelligence as input to firewalls, IDSs, and other network security devices. However, it is not easy to integrate these disparate components because different user environments have different security policies for making decisions and different interfaces for controlling devices. We expect RSE connections to serve as an intermediate layer for alleviating these obstacles.

5. System for connecting GTIP with RSE and future global deployment

NTT Secure Platform Laboratories and NTT I^3 currently conduct periodic information exchanges. At the beginning of 2015, we found that the collaboration between RSE and GTIP had allowed us to strengthen our cyber defenses even further; RSE was reinforced with threat intelligence for defending against more advanced cyber-attacks, and GTIP benefited from simpler integrations with user environments. As a result, during the first quarter of 2015 we jointly developed a proof of concept for connecting RSE and GTIP.

Although we can think of many different configurations for connecting the systems together, we implemented automatic defenses in our demonstration based on GTIP data (**Fig. 3**).

As can be seen in the figure, GTIP first detects an attack (1) and then notifies RSE with data relevant to the attack (2). Finally, RSE determines a response based on the attack data and configures the appropriate network devices to block the attack (3). Automating this series of actions allows us to proactively defend ourselves. Through this experiment, we proved that we could successfully connect RSE and GTIP together and could thus expect to make further progress on implementing and enhancing the combined system. Our next step will be to demonstrate that this solution works in actual user environments during our GTIP beta trial in the second half of 2015. We expect to continue discovering issues (some related to operational logistics) and considering ways

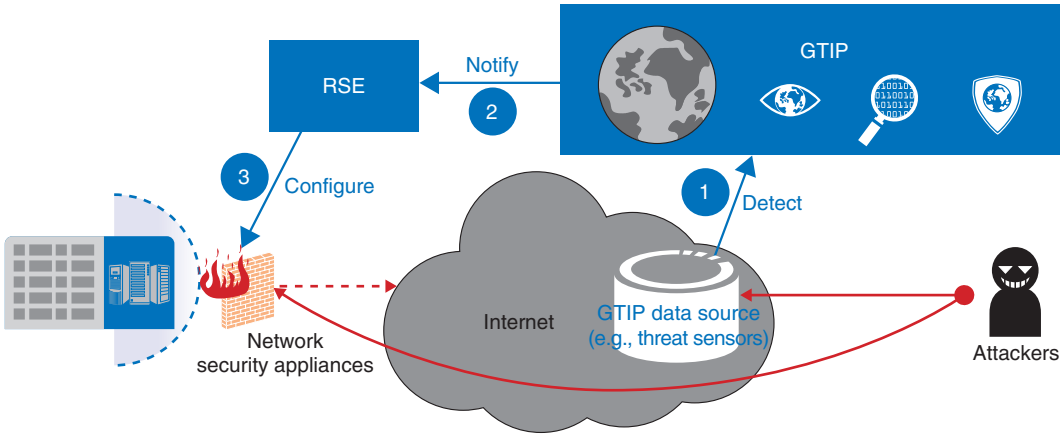

Fig. 3. System for connecting GTIP and RSE.

to resolve these issues in the future.

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Takaaki Koyama
Senior Research Engineer, Network Security Project, NTT Secure Platform Laboratories.
He received a B.A. and M.M.G. in media and governance from Keio University, Kanagawa, in 1994 and 1996. He joined NTT Software Laboratories in 1996 and began studying software CALS (client access license). Since 1999, he has been developing network equipment and studying GMN-CL, a kind of IP-virtual private network technology. His research interests also extend to enterprise cloud network systems and security orchestration systems. He is a member of the Information Processing Society of Japan (IPSJ).

Bo Hu
Researcher, NTT Secure Platform Laboratories.
He received an M.S. in wireless network engineering from Osaka University in 2010 and joined NTT the same year. He has mainly been engaged in researching network security technology and inter-cloud technology and has developed security orchestration architecture and inter-cloud protocols. He has also worked on cloud computing standardization activities in the Telecommunication Standardization Sector of International Telecommunication Union, and other standardization organizations. He received the Telecommunication Technology Committee standardization performance award and has contributed to Institute of Electrical and Electronics Engineers (IEEE)/Institute of Electrical, Information and Communication Engineers (IEICE) international academic conferences as a member of the Technical Program Committee or Organizing Committee.

Yukio Nagafuchi
Senior Research Engineer, Network Security Project, NTT Secure Platform Laboratories.
He received his B.S. and M.S. in science and engineering from Saga University in 1996 and 1998. He joined NTT in 1998 and has been engaged in the design and development of network systems, VoIP (voice over IP) network systems, and virtual network systems. His current interests include traffic and security issues in computer networks. He is a member of IEICE and IPSJ.

Eitaro Shioji
Software Engineer, Security, NTT Innovation Institute, Inc.
He received a B.E. in computer science and an M.E. in communications and integrated systems from Tokyo Institute of Technology in 2008 and 2010. He joined NTT in 2010 and has been conducting research on network security. Since joining NTT I^3 in 2013, he has been developing a threat intelligence platform. His current and past research interests include vulnerability exploitation and mitigation, mobile security, malware analysis, and secure network coding. He is a member of IEICE and received the Information and Communication System Security Research Award from IEICE in 2013.

Kenji Takahashi
VP, Product Management, Security, NTT Innovation Institute, Inc.
He received his B.S., M.S., and Ph.D. in computer science from Tokyo Institute of Technology. He has over 28 years of international experience in the information and communication industry. He has led many projects at NTT R&D in Japan, including those related to cloud computing, software engineering, digital identity management, collaboration environments, and ubiquitous computing. He was previously President and CEO of NTT Multimedia Communication Laboratories, Inc. (NTT MCL) in Silicon Valley, where he successfully launched and led open source, open standard based cloud, and software-defined networking projects. He was a visiting scientist at the College of Computing at Georgia Institute of Technology and a member of the Discovery Park Advisory Council at Purdue University. He received the Kiyasu Special Industrial Achievement Award from IPSJ for his pioneering work on federated identity management. He is a member of IEICE, IPSJ, IEEE Computer Society, and Association for Computing Machinery.

Efforts to Achieve a Joint Risk Management Support System

Tomohiro Kokogawa, Naoko Kosaka, Akira Koyama, Fumiaki Ichinose, Fumiyuki Tanemo, and Yuji Maeda

Abstract

At NTT Secure Platform Laboratories, we are developing technology to support joint risk management and incident response based on unified chain of command and control in order to respond to the expanding global threat of cyber-attacks and physical emergencies such as natural disasters and accidents. This article introduces our efforts aimed at implementing a risk management/incident response management support system that can be applied in the event of risks of any kind.

Keywords: risk management, incident response, WebEOC

1. Introduction

Throughout the world, great losses are suffered due to the frequent occurrence of large-scale natural disasters, accidents, and terrorist incidences. It is necessary to achieve cooperation between organizations and governments, and consequently, there is a growing movement to standardize incident response measures. Thus, in autumn 2011, the ISO[*1] 22320 international standard was established to define the requirements for incident response [1]. In 2013, this was also adopted as a Japanese standard (JIS[*2] Q 22320), and it is thought that it will form the basis for future standardization in Japan's domestic incident response measures, which have so far been implemented in a non-unified way by various local governments and institutions. To respond to the threat of natural disasters such as floods, volcanic eruptions, and major earthquakes, it is important that government, businesses, and people work together to implement disaster risk reduction and mitigation measures.

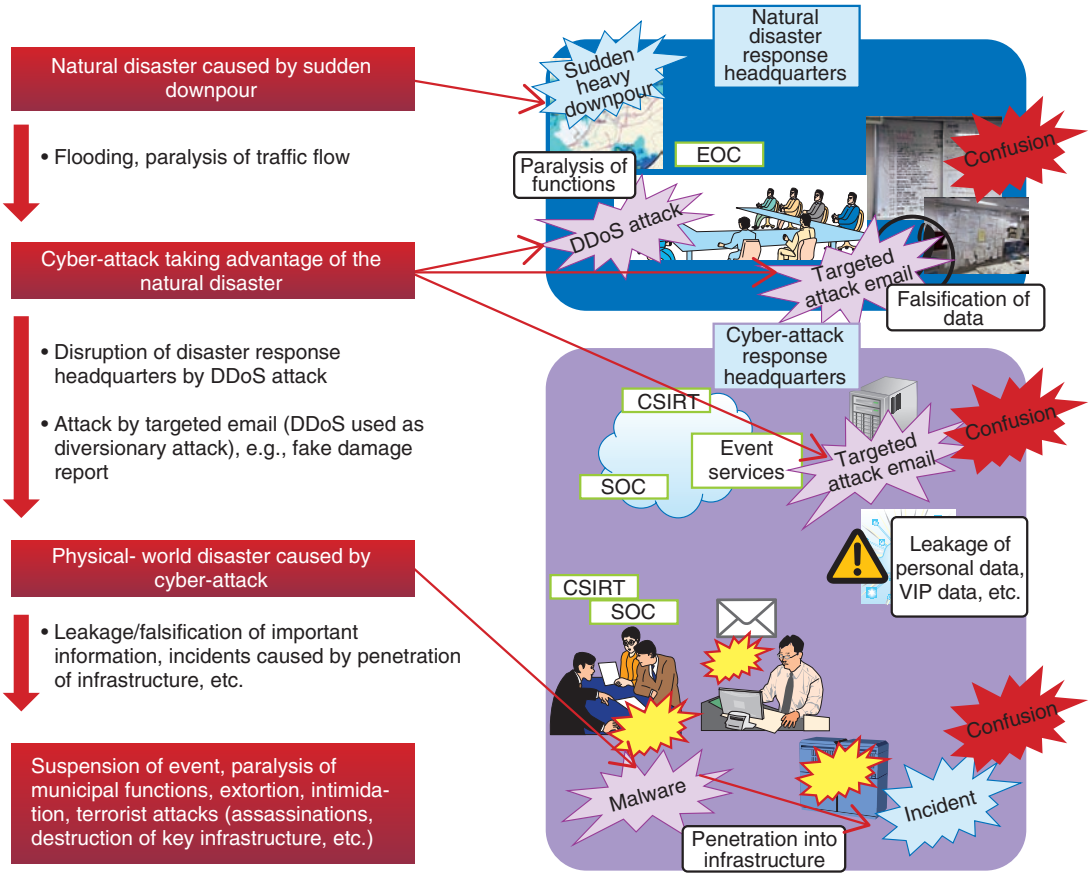
With the arrival of the Internet of Things (IoT), in which more and more objects are being connected to the Internet, and the cyber-physical integrated society, where cyberspace and the physical world are integrated in an advanced fashion, the Japanese government is working on the implementation of a new cybersecurity strategy [2]. In particular, during large-scale international events such as the Olympic and Paralympic Games, there is an urgent need for countermeasures to the increased threat of global terrorist cyber-attacks that involve both physical-world and cyberspace elements.

In the past, various organizations have responded to different types of emergencies such as natural disasters, terrorism, and cyber-attacks, but in the future it will be necessary to develop risk management and incident response mechanisms that have a broader outlook and draw no distinction between physical-world and cyberspace incidents. In this article, we discuss the concept of joint risk management as the way forward for risk management and incident response measures, and we introduce our research and development (R&D) efforts aimed at realizing systems to support this concept.

2. Preparing for complex crises

Thus far, different types of emergencies have been handled by different organizations. For example, cyber-attacks are handled by security operation centers, natural disasters and accidents are dealt with by emergency operation centers, and pandemics are

*1 ISO: International Organization for Standardization
*2 JIS: Japanese Industrial Standards



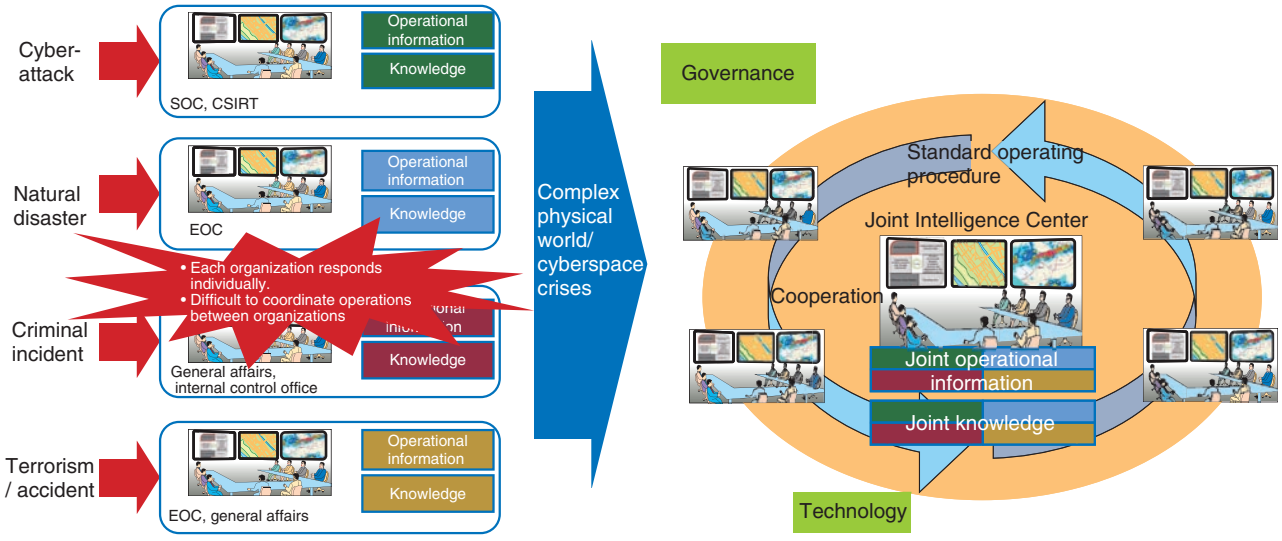
EOC: emergency operation center
CSIRT: computer security incident response team
DDoS: distribute denial of service
SOC: security operation center
VIP: very important person

Fig. 1. Example of physical world/cyberspace complex crises.

dealt with by general affairs departments. However, with the arrival of the IoT and the increasing sophistication of cyber-attack techniques, we can expect to see an increased incidence of complex crises such as cyber-attacks launched on top of natural disasters, or cyber-attacks causing other physical-world incidents. For example, an attacker might take advantage of a sudden unexpected downpour (natural disaster) during an event such as the Olympic and Paralympic Games in order to launch a cyber-attack on the organizations responding to this disaster. This might be carried out by crafting malware designed to attack infrastructure organizations and sending it in a targeted email supposedly connected with the disaster response efforts, thereby damaging the infrastructure facilities and creating further confusion (**Fig. 1**). Even though these individual events should be dealt with by the corresponding organizations and departments, the occurrence of this sort of complex crisis could cause responders to lose focus by making it impossible to grasp the overall incident situation, resulting in suspension of the event and huge human and financial losses.

3. Joint risk management concept

The occurrence of complex crises involving cyber-attacks coupled with physical-world events such as disasters and accidents is expected to increase in the future, so it is important to deal with this sort of incident with a joint response that takes a bird's-eye view of the entire situation beyond the boundaries between



(a) Conventional incident response

(b) Incident response by joint risk management

Fig. 2. Joint risk management concept.

separate organizations.

An illustration of the joint risk management concept is shown in **Fig. 2**. By joining and centralizing the handling of operational information (information for the implementation of response measures) and knowledge (external information that adds value to disaster response efforts) that was previously handled by separate organizations, it is possible to achieve efficient cooperation between these organizations. Furthermore, incorporating the conventional response organizations into a joint intelligence center makes it possible to carry out operations under a unified command.

To turn this joint risk management concept into reality, it is essential to consider the following viewpoints:

(1) To achieve unified command through cooperation between multiple organizations, we need to establish management processes to coordinate activities between organizations and implement effective decision-making and response measures based on a standardized management flow.

(2) To share information efficiently between organizations, we need to establish a standard operating procedure (SOP) for field activities and implement field operations using unified tools.

(3) To implement a common operational picture (COP) of the situation across multiple organizations, it is necessary to present operational information and knowledge in an integrated manner.

4. Plan, Do, See system concept

At NTT's laboratories, we have already developed an emergency management support system to increase the efficiency of responding to incidents, especially natural disasters [3]. This system implements management functions conforming to the ISO 22320 international standard based on crisis management software that runs on the web (WebEOC).

The operational information needed for incident response is broadly divided into fixed-format (collected using information-gathering forms) and free-format (free description) types, and is presented as an overview from three views (Plan, Do, and See) to support an efficient incident response.

In implementing joint risk management, we should build on the functions achieved with this system in order to strengthen the cooperation between organizations by expanding their scope to encompass risks of all kinds (including cyber-attacks). This system concept is illustrated in **Fig. 3**.

(1) Plan (What should we do now?)

To support overall management, an Operational Planning "P" (an international standard incident response process) is developed with a checklist (SOP)

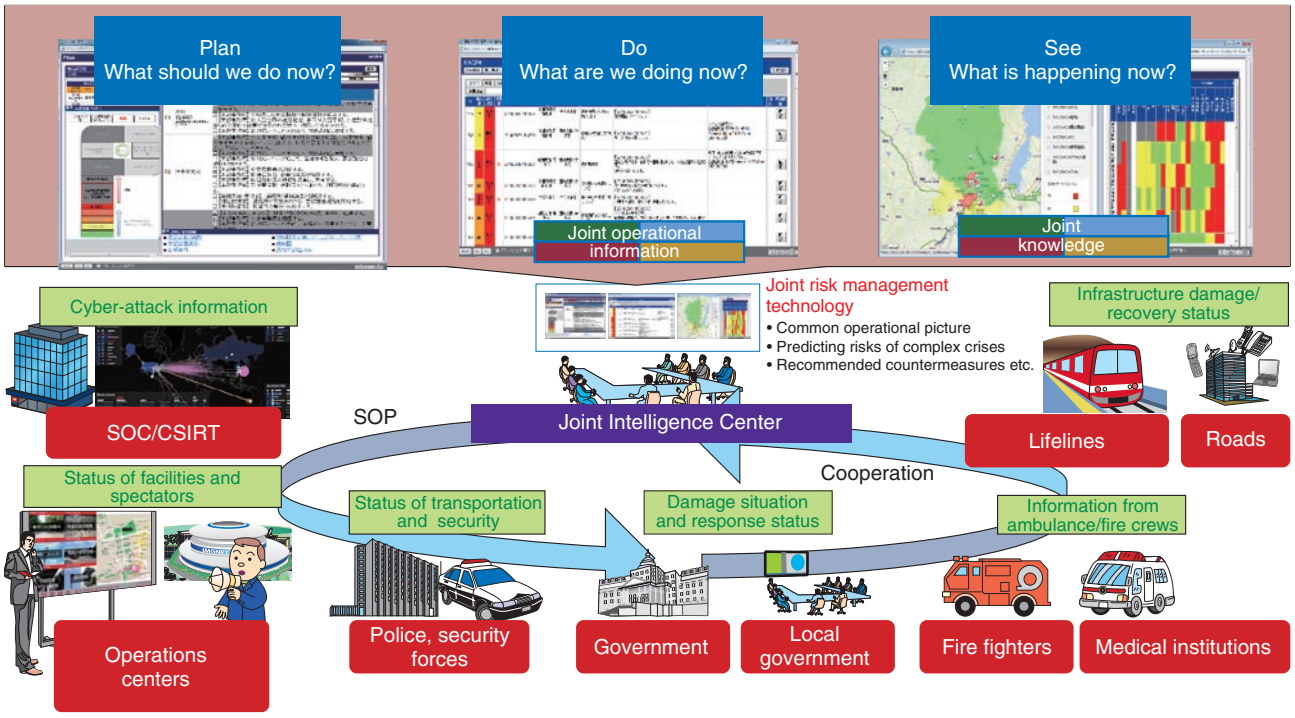


Fig. 3. Example of joint risk management support system.

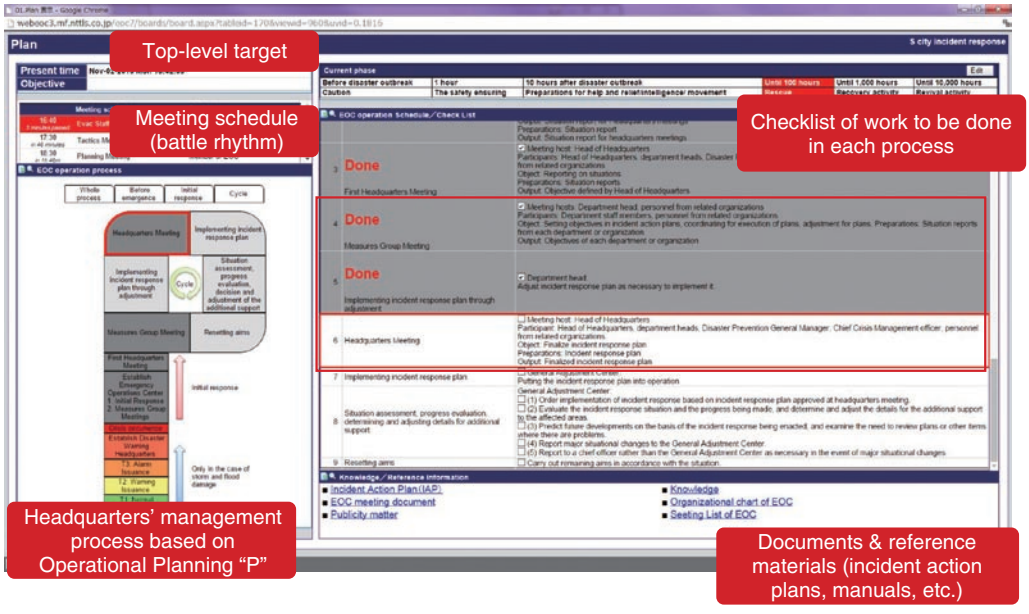


Fig. 4. Composition of the "Plan" screen.

for each phase (**Fig. 4**). This process must be organized so that policies and planning decisions can be made in a unified manner by all related organizations, regardless of the type of incident.

(2) Do (What are we doing now?)

By introducing unified management of free-format

information that was previously conveyed by phones (oral communication), white boards, and the like in field operations, we can provide status checks and displays based on an operational flow defined as an SOP so that the state of progress can be rapidly ascertained. The way in which this information is used is thought to differ according to the characteristics of the incident. For example, in the case of a natural disaster, a huge amount of work is created at the time of the incident, so it is important to support viewpoints that prevent leakage of shared information. In the case of cyber-attacks, however, small-scale events have to be dealt with on a daily basis, so it is thought to be necessary to support objectives such as increasing the efficiency of progress management and optimizing the control of access to shared information.

(3) See (What is happening now?)

An overall view of the damage situation and response status is facilitated by presenting information in the form of maps and dashboards. When complex crises occur, there will be a need for information presentation methods that can provide a joint overview of the current situation to the organizations responding to each incident.

5. Future prospects

At NTT's laboratories, in addition to advancing our R&D aimed at achieving joint risk management by solving the above issues, we aim to enable the NTT Group to provide total risk management and incident response solutions that facilitate efficient cooperation between organizations by allowing existing NTT Group products to cooperate with the products of other vendors that conform to a wide variety of standard specifications. We will also make use of this technology and other incident response know-how cultivated by the NTT Group in order to contribute to the realization of a society resilient to disasters.

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Tomohiro Kokogawa

Senior Research Engineer, Security Risk Management Project, NTT Secure Platform Laboratories.

He received a B.E. and M.E. in engineering science from Osaka University in 1991 and 1993, and a Ph.D. in engineering from Wakayama University in 2013. Since joining NTT Telecommunication Networks Laboratories in 1993, he has been researching and developing information sharing systems and public service systems. He received the IPSJ SIGGN Best Presentation Award in 2012. He is a member of the Institute of Electrical and Electronics Engineers (IEEE) and the Information Processing Society of Japan (IPSJ).

Naoko Kosaka

Research Engineer, Security Risk Management Project, NTT Secure Platform Laboratories.

She received a B.E., M.E., and Ph.D. in engineering from Tokyo Institute of Technology in 1995, 1997, and 2004. She joined NTT Human Interface Laboratories in 1997 and engaged in researching and developing image processing methods for 3D maps and satellite images. She is now involved in researching and developing emergency management support systems. She is a member of the Institute of Electronics, Information and Communication Engineers (IEICE) and the Japan Society for Disaster Information Studies.

Akira Koyama

Research Engineer, Security Risk Management Project, NTT Secure Platform Laboratories.

He received a B.E. and M.E. in applied chemistry from Hokkaido University in 1998 and 2000. Since joining NTT-EAST Tokyo branch office in 2000, he has been integrating the disaster risk reduction system to customers' emergency operation centers.

Fumiaki Ichinose

Senior Research Engineer, Security Risk Management Project, NTT Secure Platform Laboratories.

He received a B.E. and M.E. in applied physics from Osaka University in 1994 and 1996. Since joining NTT Kansai branch office in 1996, he has been integrating the disaster risk reduction system to customers' emergency operation centers. He is a member of the Institute of Social Safety Science.

Fumiyuki Tanemo

Senior Research Engineer, Supervisor, Security Risk Management Project, NTT Secure Platform Laboratories.

He received a B.E. and M.E. in engineering from Nagoya University in 1991 and 1993. He joined NTT Information Processing Laboratories in 1993, where he researched and developed object-oriented databases and information security management tools. He is now engaged in researching and developing emergency management support systems. He is a member of IEEE Computer Society and IPSJ.

Yuji Maeda

Vice President, Senior Manager, Security Risk Management Project, NTT Secure Platform Laboratories.

He received a Ph.D. in systems information science from Future University Hakodate, Hokkaido, in 2013. He joined NTT Telecommunication Networks Laboratories in 1991. He is currently managing projects related to general emergency management such as those concerning natural disaster response and cybersecurity involving NTT-CERT. He received the Scholarship Encouragement Award from IEICE in 1998. He is a senior member of IEICE and a member of IEEE and the Japanese Telemedicine and Telecare Association.

Service Design for Creating Attractive Services, and Trends in Design Thinking

Takehiko Ohno, Yasuhisa Kato, and Yoko Asano

Abstract

Terms such as service design and design thinking are receiving a lot of attention as methodologies for producing attractive services, and the NTT Group is tackling this issue from various perspectives. This article introduces these initiatives, first discussing what design is, then describing how service design and design thinking fit within current design trends. Finally, it introduces three key concepts on which NTT Service Evolution Laboratories places particular focus: human-centered design, user experience design, and participatory design

Keywords: service design, design thinking, user experience design

1. Introduction

The concept of design is attracting attention in various fields. Upon hearing the word *design*, one tends to think of something stylish or cool, but that is only part of it. *Design* derives from the Latin word *designare*, meaning to express (de-) a sign or symbol (sign), or to encode a person's acts. In other words, design is the process of producing a concrete form creatively expressing people's productive activities. There are many ways to define design, but we have adopted the following definition (**Fig. 1**).

Design is a process of adapting products and systems so that resources meet human needs and wants and solving problems by working creatively and iteratively within various societal, economic, and other constraints.

In other words, in most of our productive activities, we are actually carrying out design. However, there are various constraints in implementing excellent products and services, and the solution for them is not unique. It is also extremely difficult to achieve an excellent solution in just one try. For these reasons, it is very important to iterate design, creating something and repeating the process, in order to gradually reach a concrete solution. The object of design usually begins with some necessities in daily life, develops into a product or service, and then expands through society, involving cities, the environment, and energy. Of course, information and communication technology (ICT) is also a product of design. Terminals, applications, and also networks, clouds, security, and other aspects have points of contact with people, so design can be said to apply to them too (**Fig. 2**). The NTT Group is addressing this broad domain. These Feature Articles introduce design initiatives to produce excellent ICT services within the NTT Group. This article discusses design trends as an introduction to this topic.

2. From modern design to service design

Formerly, design was closely tied to complex social systems such as those related to class or occupation. Where one lived, what one wore, what one used every day, and other factors were determined by the class to which one belonged. These ties were broken by modern revolutions such as the French Revolution, the Industrial Revolution, and the Meiji Restoration. Then, starting in the latter half of the 19th century, new designs signifying new social systems, life styles, and living environments began to appear.

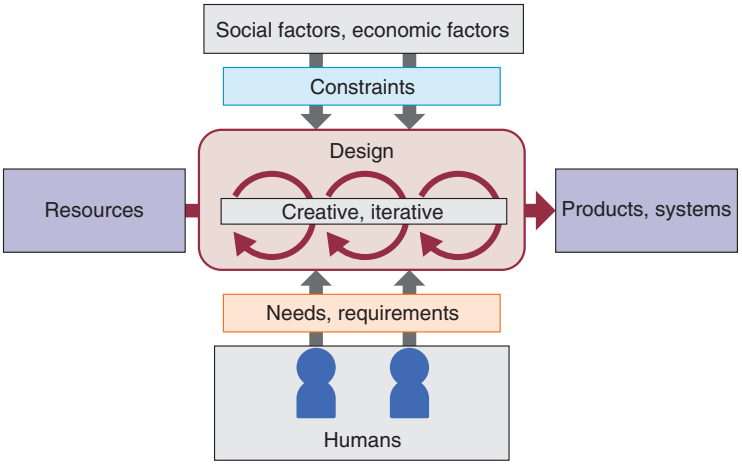


Fig. 1. What is design?

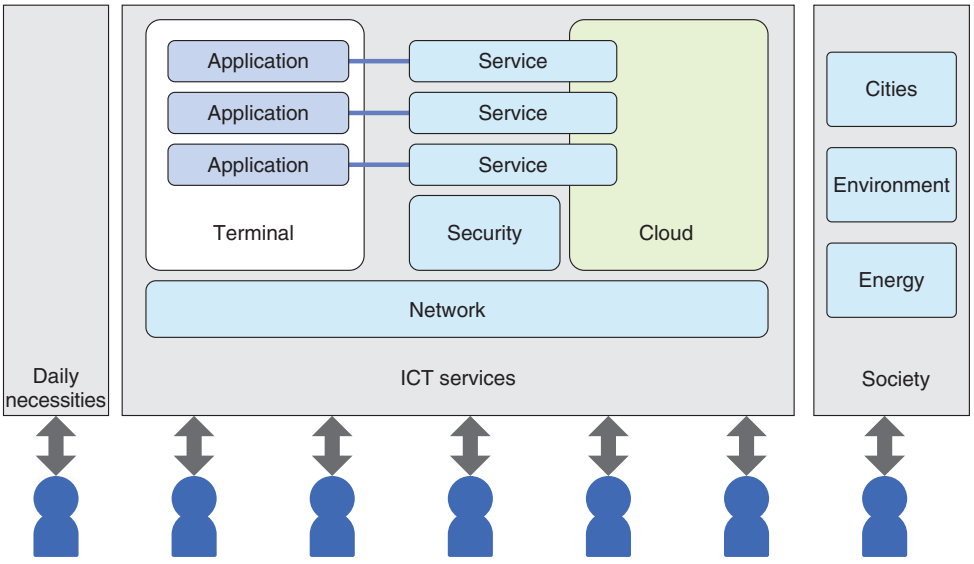


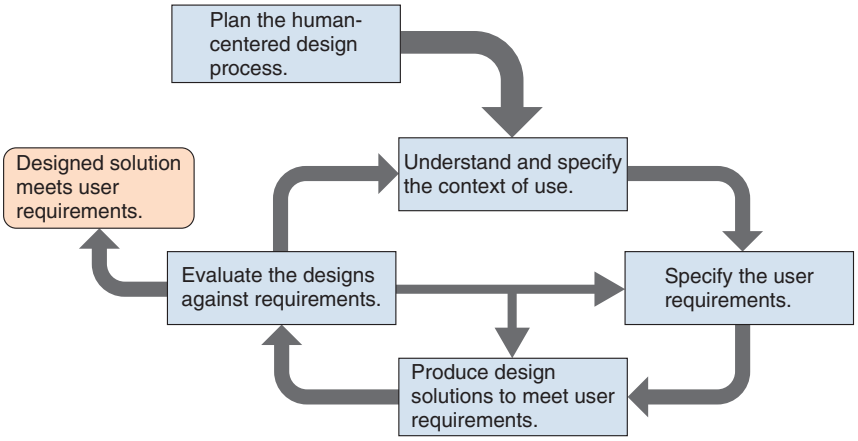
Fig. 2. Major design domains.

These are in the category referred to as modern design [1].

The new social systems are closely connected to market economies. Initially, manufacturing was basically handcrafted, but soon, the age of mass production began, bringing homogeneous, low-cost products. This enabled enterprises to use design to generate large profits. For example, design took a significant role in the field of automobiles. Henry Ford produced the Model T—a low-priced, highly reliable automobile—in 1908, generating explosive sales, and General Motors attempted to segment the market with different models in the 1920s. In the 1980s, design began to have a close connection with ICT. Apple* is a typical example. As everyone knows, the Apple II, Macintosh, and later the iPhone and iPad have all had a significant impact on people's lives.

In the 21st century, enterprises generated quite a lot of profit through the design of products, but there was

* Apple, Apple II, Macintosh, iPhone, and iPad are trademarks or registered trademarks of Apple Inc.



ISO: International Organization for Standardization

Fig. 3. Human-centered design process (from ISO 9241-210:2010).

also much discussion in relation to design through problem solving, innovation, and even management strategy. In addition to products, services also came to be considered as something to be designed. *Design thinking* and *service design* are methodologies that arose in this context. Design thinking is a methodology that uses the basic approach of a designer to develop services, in other words, thinking deeply about the people using the product or service, clarifying the various constraints, and then using an iterative, trial-and-error process to arrive at the best solution. It is a human-centered, iterative method used to create services. As such, it emphasizes prototyping, and services take form while repeatedly being verified. The U.S. design firm IDEO has recently been attracting a lot of attention with its proposal of design as a methodology for innovation. Service design is almost the same approach [2], but this is more common in Europe and is used more broadly than just in private enterprise, for example, in public services as well.

These methodologies focus not only on products and services produced through design, but also on design processes and methodologies. Attention is paid to any new strengths arising from design, which are then incorporated into innovative products and services as part of the process within the enterprise.

Design has also greatly exceeded the economic activity of private enterprises and has become an essential means of finding solutions to urgent issues in society and the environment around the world [3]. As such, efforts are producing excellent, breakthrough solutions that demonstrate a deep understanding of the needs and desires of the relevant people and that satisfy the various constraints involved. In Japan, design has not necessarily been applied in finding solutions to such problems, but initiatives are gradually beginning to spread. The importance of design and the range of applications should continue to expand in Japan in the future.

3. Different design concepts

Here, we introduce three concepts we emphasize when designing ICT services: human-centered design, user experience design, and participatory design.

3.1 Human-centered design

Human-centered design is a methodology for designing convenient, usable systems, which focuses on the people that will use the service and their needs, and uses knowledge of human engineering and usability [4]. Here, system users are not limited to those directly operating the system but include other stakeholders surrounding it such as managers and owners deciding whether to purchase the system. Designers first gain an understanding of the users of the service and clarify the user characteristics, the conditions under which the service will be used, and the desires of users in those scenarios. Then, ideas on how to satisfy those desires are generated and evaluated as to whether the user desires are really satisfied. It is difficult to achieve an excellent service that truly satisfies the desires of users in one try, so this process is repeated (**Fig. 3**). Often, thinking about services

begins with a technology or a function, but a major strength of human-centered design is that it always maintains a focus on the people that will use the service. Both design thinking and service design are based on the concept of human-centered design.

3.2 User experience design

User experience (UX) design is a methodology for designing attractive services that appeal to users, and it has attracted a great deal of attention in recent years. UX encompasses the behaviors taken by users when using the service, the feelings produced in doing so, and the experiences and memories left afterward. These experiences and memories are formed during the entire process: before, during, and after use. There are various opportunities at points of contact between the user and the service for adding advertising, support, or other features to the service itself. Various usage scenarios can also be considered. They must be considered in an integrated rather than fragmented way when designing the service so that all contact between the user and the service leaves a positive impression on the user.

Deep knowledge of the users is needed to accomplish this. To understand the users, they are interviewed and observed in order to clarify their everyday activities, interests, and values and the environments in which they use the service so that a service integrating all of them can be created. It is important to create a service that has a user interface with a consistent appearance that is carefully and discretely configured, and it is also vital to determine how the users feel when operating the service to ensure that they feel comfortable and content. This requires extra work, but many leading enterprises have adopted it as a way to create attractive services.

3.3 Participatory design

Participatory design is the idea of involving the various end users and other stakeholders directly in the design from the initial stages. It has spread around the world from its beginning in Northern Europe. It has recently attracted much attention as a new approach to designing ICT systems, and in particular, applications, infrastructure, and the environments for those using the systems and the environments for people engaged in work using ICT systems. For example, when developing a service, it is helpful to hold workshops with users in the initial stages of service development in order to draw out any latent issues and ideas from users themselves. There are two main points that led to the idea of doing this.

The first is an ethical factor, the idea that users who will be using the product or service have a right to participate in the design. For example, it is considered important for workers who will be working in a particular environment to be able to participate in its design. This idea was introduced into information systems workplaces in the 1970s in Northern Europe and arose from concerns that efficiency was the only thing that mattered, and the value of work and humanitarian concerns were being ignored.

The second point is related to efficiency. The service is used by users, and ultimately, they are the ones that best know themselves. The objective is to more effectively understand users' needs, evaluate usability, and design services by having them participate from the initial stages of the design process. This idea is also emphasized in human-centered design.

These concepts and methodologies are effective for creating attractive and competitive services and also in handling societal issues for which solutions are difficult to find.

4. Service design initiatives within the NTT Group

These Feature Articles introduce various initiatives in service design within the NTT Group. In "Concept Tailor: A Tool for Iteratively Designing Service Concepts Using Storyboards" [5], we introduce the Concept Tailor tool developed by NTT Service Evolution Laboratories. This tool supports the process of obtaining user evaluations of and refining a service concept iteratively. Concept Tailor makes iterative design easier, which is important for human-centered design. Note that this laboratory is also engaged in various other research and design initiatives related to service design [6].

In "Evaluation Methods for Service Design" [7], we introduce user evaluation methods for service design in use at NTT Advanced Technologies, including both concepts and practical methods. User evaluation is essential in deciding what is good or bad about a service and for drawing out issues that need to be addressed. The article explains what evaluation methods must be used in line with the objectives at various stages of design.

"Methodology for Creating Attractive Services" [8] introduces various service-design methodologies that NTT IT Corporation is working on and discusses points that must be considered throughout the process of creating and evaluating ideas based on user understanding.

"Training Initiatives for UX Designers" [9] introduces the results of work done by NTT Communications in organizing the skill set, mind set, and design processes for training UX designers. Excellent UX designers are needed to produce excellent services. This initiative is a first step.

Finally, "Initiatives Related to the Creation of New NTT DATA Services" [10] introduces initiatives at NTT DATA to create new services together with corporate customers, centered on and related to service prototyping, which is based on design thinking. Here, design is based on realizing ideas through prototyping and verifying whether they really are good from the customer's perspective. It is a very important initiative.

5. Future prospects

All of the methodologies discussed—design thinking and service design—and the concepts overviewed—human-centered design, UX design, and participatory design—appeared in the context of modern design efforts in Europe and the United States. However, they do not include views, methodologies, or values from Japan. They are closely related to Western culture and so may not necessarily work well in Japan as-is. Japan boasts a wonderful culture and values, including a hospitality culture as exemplified by the tea ceremony and folk crafts that find the beauty in simple everyday things, as well as an acceptance of diversity as shown by the syncretization of Shinto with Buddhism, and an emphasis on quality as represented in the manufacturing industry. We believe that to compete globally in service design, it will be important to think of new design methodologies and concepts based on such Japanese values. NTT Service Evolution Laboratories will continue to research and develop service design, establish new design methodologies and values in collaboration with others within and outside the NTT Group, and work to create excellent ICT services.

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Takehiko Ohno
Director, Heart Touching ICT Design Department, NTT IT Corporation.

He received a B.Sc. and M.Sc. from Tokyo Institute of Technology in 1992 and 1994. He joined NTT Basic Research Laboratories in 1994 and studied cognitive science and human-computer interaction. He has been researching human-computer interaction, human-centered system design, service design, design thinking, user experience design, usability, gaze tracking technology and its applications, cognitive modeling, and computer-mediated communication. He moved from NTT Service Evolution Laboratories to NTT-IT in September 2015. He is a member of the Association for Computing Machinery, the Information Processing Society of Japan (IPSJ), the Human Interface Society, and the Institute of Electronics, Information and Communication Engineers (IEICE).

Yasuhisa Kato
Senior Research Engineer, Supervisor, Universal UX Design Project, NTT Service Evolution Laboratories.

He received a B.E. and M.E. in applied systems science from Kyoto University in 1988 and 1990. He joined NTT Information Processing Laboratories in 1990. He also received an M.A. in education from Stanford University and his Ph.D. from Kumamoto University. He has been engaged in research and development of voice processing systems, educational systems, and search systems. He is a director of the Japanese Society for Information and Systems in Education, e-Learning Consortium Japan, and the Japan Evaluation Institution for Education and Learning. He is a member of the Japan Society for Educational Technology, the Japanese Society for Artificial Intelligence, and IPSJ.

Yoko Asano
Executive Research Engineer, Project Director, Universal UX Design Project, NTT Service Evolution Laboratories.

She received a B.E. in administration engineering from Keio University, Kanagawa, in 1988 and joined NTT Human Interface Laboratories the same year. She moved to NTT Cyber Solutions Laboratories (now NTT Service Evolution Laboratories) in 2001. Since then, she has been conducting research on human interfaces. She is a member of the Human Interface Society, the Japan Ergonomics Society, and IEICE.

Concept Tailor: A Tool for Iteratively Designing Service Concepts Using Storyboards

Koki Kusano and Takehiko Ohno

Abstract

To develop services that are attractive to users, it is important to refine the service design iteratively by obtaining evaluations of the service from users from the earliest stages. NTT Service Evolution Laboratories has developed Concept Tailor, which supports iterative design and applies a rule that divides service concepts into four stages. This article introduces the process of realizing a service concept using this tool.

Keywords: service design, prototyping, storyboards

1. Introduction

As information and communication technology (ICT) has progressed, numerous ICT services have been created, enabling users to select and use the services they prefer. To be selected by users, services must have not only good functionality and performance but also an attractive design. Here, *design* refers to more than just the physical design; it includes the whole process of using the service and the entire experience until the result is achieved.

To realize an attractive design, it is important to follow an iterative process from the initial stages throughout the entire development process, which involves making repeated improvements while continuously receiving user evaluations [1]. In particular, in the initial stages of service design, it is effective to verify the hypotheses through prototyping, including whether the assumed user need really exists, and whether users will empathize with the conceived scenarios of the service.

However, real projects have time and budget constraints, and it is not always possible to allocate enough time to prototyping [2]. Of course, various methods have been proposed for performing each iterative task efficiently [3], but skill is needed to master and use them together. The amount of work required to reference and use the knowledge gained from each technique is also an issue. As a result, the design process takes time, and it is difficult to verify the hypotheses through user evaluation, reducing the effectiveness of iterations. This issue is particularly noticeable with people who are not expert in iterative design techniques.

2. Concept Tailor: supporting effective iterative design

In consideration of the issues described above, we have developed Concept Tailor, a tool for supporting iterative design from the initial design stages. The tool supports an iterative process for implementing service concepts, as shown in **Fig. 1**. The general iterative design process consists of repeated actions of clarifying the service concept hypothesis, creating a *story* (prototype), and getting user evaluations. Concept Tailor introduces a new rule that divides the hypothesis into four stages that link each of these steps smoothly. Specifically, it provides templates for a four-stage draft hypothesis, creation of storyboards linked to the hypothesis, and guides for user interviews called *hearings*. These three templates support the processes for each task and can be used to manage, reference, and use the information gained from

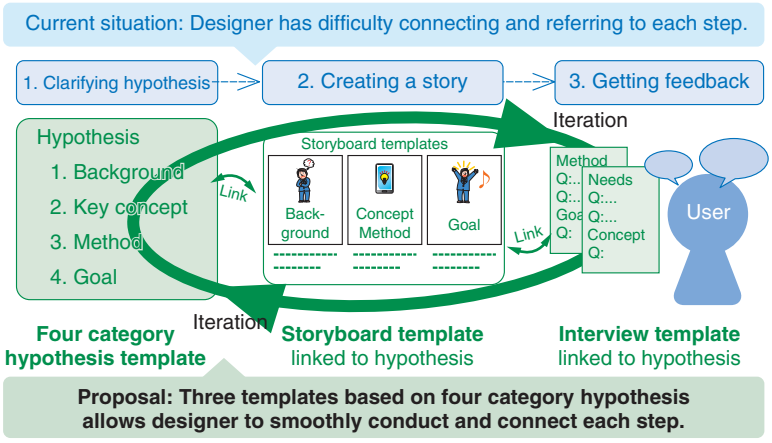

Fig. 1. Design process supported by Concept Tailor.

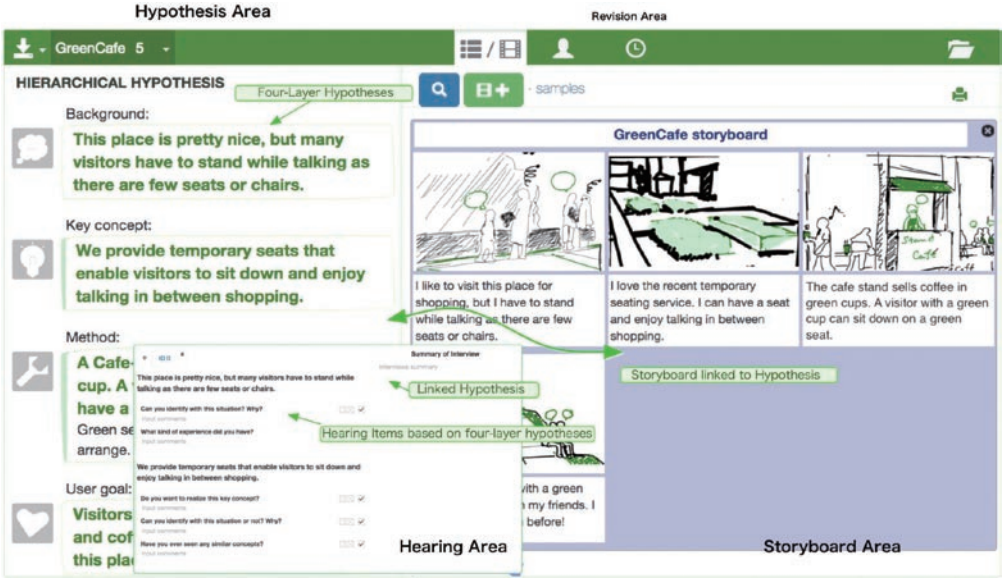

Fig. 2. Using Concept Tailor.

each process. Thus, even non-experts can perform iterative design effectively within a limited amount of time.

The tool's three templates support the three design processes of (1) clarifying the service concept hypothesis, (2) creating storyboards to verify the hypothesis, and (3) analyzing results of user evaluations in the form of hearings using the storyboards. It also implements interactions that smoothly link each of the processes. The tool is particularly effective to use when the service designer or planner conceives an idea for a new service.

3. Four areas for tailoring concepts

The tool is organized into four areas: the Hypothesis, Storyboard, Hearing, and Revision areas (**Fig. 2**). The areas are linked together, and the tool makes it possible to manage, reference, and use information among them. The roles of each area are described in more detail below.

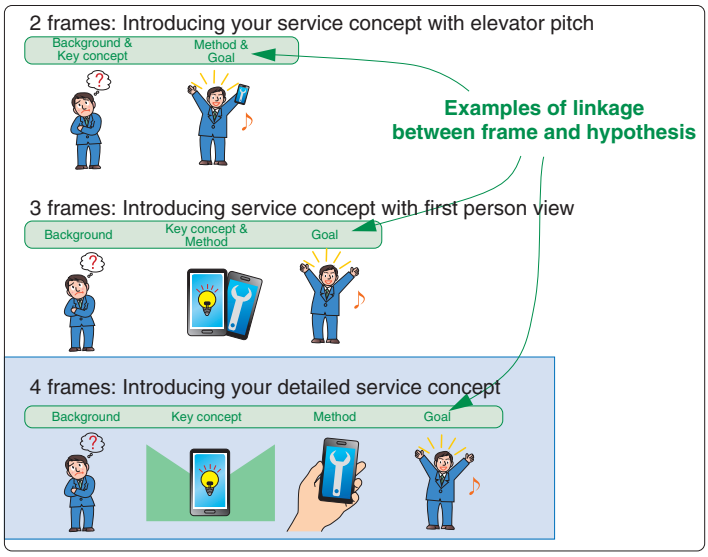

Fig. 3. Various storyboard templates.

3.1 Hypothesis area

When iterating a design, if the user evaluation is simply "Good" or "Bad," it is not possible to decide what improvements should be made in the next iteration. Therefore, it is important to evaluate the hypothesis in different stages, such as whether it matches service use cases for the target users, whether it fits the service concept, or whether users desire to use the device. The tool makes it easier to clarify the hypothesis by dividing it into four stages with respect to the service concept: the background, key concepts, methods, and goals.

Each stage of the hypothesis is described below.

(1) Background: Describes the issues or needs of the target users of the service.
(2) Key concept: Describes the concepts of how the service to be provided will address the issues in the background hypothesis.
(3) Method: Describes specifically what methods will be implemented for the key concepts.
(4) User goal: Describes the ideal state of users whose needs have been satisfied by the service.

3.2 Storyboard area

In the service concept hearings, it is important that users imagine specific situations when using the service. Sharing stories is effective for this. Seeing and hearing stories makes it easier to imagine specific conditions when using the service.

The tool supports creation of storyboards by providing templates such as those shown in **Fig. 3**. Each frame of the template is associated with the four-stage hypothesis. Also, when a template is selected, the hypotheses described for each stage are automatically imported into the text of the corresponding frame. This enables the designer to quickly understand the correspondence between frames and hypotheses. Photos from a smartphone or other camera can also be sent to the tool so that frames of the storyboard can be created quickly.

3.3 Hearing area

In hearings, it is important to obtain user evaluations for each stage of the hypothesis and lessons that can be used in the next iteration. When doing so, information beyond just "Good" or "Bad" assessments must be obtained, for example, reasons for the evaluation, the basis for it, and specific details of the experience. This information is used to decide whether each hypothesis is supported or not and can be used to study what improvements need to be made in the next design iteration.

However, the information obtained in a hearing with users can vary greatly based on how users understood the questions (hearing items). For this reason, skill is needed to obtain and analyze each hypothesis appropriately and to use it in the next design iteration. Thus, in the hearing area, the user can simply select a hearing template. Hearing items are generated automatically by associating them with the hypotheses

described in the hypothesis area. Hypotheses are divided into four stages, so hearing items matching the stages of the hypothesis can be generated automatically.

When a hearing template is loaded, hearing topics and entry forms for responses to each topic are displayed, as shown at the lower left in Fig. 2, so even people with little experience can take part in hearings with confidence.

Finally, the hearing area provides an entry form for summarizing the results of the hearing. This improves efficiency when reviewing particular hearings later.

3.4 Revision area

With rapid iterations, the lessons learned and decisions made in the past can fade, and it can become difficult to perform effective iterations. Therefore, it is important to make it easy to reference that information and study how to proceed with the design. The revision area retains a record of each iteration and provides a function to reference it in one click.

Specifically, in addition to supporting the three processes of clarifying hypotheses, creating storyboards for hearings, and analyzing the results of hearings, it preserves this information for each revision so that continuous, effective iterations can be performed. Revision management simply stores what hypotheses were established, what stories were conceived for them, and what hearing results were obtained for each iteration. Thus, what was learned and what was decided as a result can be seen at a glance for each revision. In other words, any decisions made in past iterations can be reviewed quickly.

4. Future prospects

We recently implemented a prototype of this tool and began trial use in a collaborative study conducted with the Graduate School of System Design and Management at Keio University and in collaborative projects with NTT Group companies that are creating new services and improving existing services. It has so far been found to be effective in supporting iterative design for people with little design experience. In the future, we will continue to apply prototypes of this tool in various cases, repeatedly improving it to make it more practical. We will also continue to gather knowledge through these cases and use it to research new ways to extend functionality and techniques.

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Koki Kusano
Researcher, NTT Service Evolution Laboratories.
He received his M.E. in engineering from the University of Electro-Communications, Tokyo, in 2010. Since joining NTT in 2010, he has been working in the research areas of human computer interaction for service design and user experience design.

Takehiko Ohno
Director, Heart Touching ICT Design Department, NTT IT Corporation.
He received a B.Sc. and M.Sc. from Tokyo Institute of Technology in 1992 and 1994. He joined NTT Basic Research Laboratories in 1994 and studied cognitive science and human-computer interaction. He has been researching human-computer interaction, human-centered system design, service design, design thinking, user experience design, usability, gaze tracking technology and its applications, cognitive modeling, and computer-mediated communication. He moved from NTT Service Evolution Laboratories to NTT-IT in September 2015. He is a member of the Association for Computing Machinery, the Information Processing Society of Japan, the Human Interface Society, and the Institute of Electronics, Information and Communication Engineers.

Evaluation Methods for Service Design

Xinlei Chen

Abstract

Service design is not a direct path but requires repeated creation and improvement in order to make progress. Suitable evaluation methods can be used to assess the results of each step (concept plan, mock-up, prototype, etc.) to avoid moving in the wrong direction. This article introduces ideas and evaluation methods used in service design.

Keywords: human-centered design, evaluation methods, prototyping

1. Introduction

The idea of human-centered design[*1] is the basic concept in service design. Everything begins with gaining an understanding of users and having empathy with them and proceeds in steps—defining the problem, finding a solution, developing a concept plan, producing mock-ups, and creating prototypes—until a solution is finally produced and the design is realized. However, this process is by no means linear and involves repetitions of creation, improvement, and selection. As such, decisions have to be made every day (concept A or concept B, design 1 or design 2, etc.). Correct decisions are necessary in order to proceed in the right direction, and the correct basis must be obtained to make them. One important way to obtain the correct basis is by conducting evaluations. Evaluation of service design has the following characteristics in contrast to conventional evaluation of existing services.

(1) Diversification of what is evaluated

In evaluating existing services, the service is usually evaluated in its completed form. However, during the service design process, most evaluations are done on intermediate results such as a concept plan, rough mock-up, or prototype. When such results are evaluated, it is important to carefully study how the service is shown to users and what is actually being evaluated in order to obtain correct results.

(2) Novelty of what is evaluated

To understand whether a service will be effective or acceptable, it can be compared with existing services. However, for very novel services, there is often no existing service to compare it with. In such cases, other effective evaluation methods must be studied.

(3) Repetitiveness of evaluation

Until now, evaluations were basically done before improvements were made (when problems were found in an existing service), or when a prototype or service was completed (checking the effect of improvements). Since service design is iterative, it is more effective to do evaluations at each step and to feed the results back into the next step.

(4) Acceleration of feedback

The amount of time that can be spent on each step in service design is limited, so evaluations must be done quickly. In some cases, there is insufficient time to gather enough participants. Therefore, a way to obtain evaluation results in a shorter time period is needed.

NTT Advanced Technology has been providing consulting services supporting research and development and improvement of products and systems based on human-centered design for over 20 years.

*1 Human-centered design: A development approach for making systems more user-friendly and usable. A detailed definition is given in ISO 9241-210.

Table 1. List of evaluation methods.

Design phase	To be evaluated	Evaluation objectives	Evaluation methods
(1) Understanding users	–	–	–
(2) Defining issues	–	–	
(3) Studying solutions	- Scenarios - Storyboards - Concept videos	- Checks concept validity	- Interviews - Surveys
(4) Designing	(Rough prototypes) - Sketches - Wireframes - Mock-ups - Paper prototypes	- Checks function acceptability - Verifies information architecture (navigation, categories, layout, labeling, etc.) - Verifies usability (effectiveness, efficiency)	- Interviews - Expert reviews - User testing - Card sorting - Simple evaluations
	(Advanced prototypes) - Advanced visual mock-ups - Interactive prototypes	- Checks service acceptability - Verifies information architecture (hierarchical visual structure etc.) - Verifies usability (effectiveness, efficiency, satisfaction) - Checks price acceptability	- Interviews - Expert reviews - User testing - Simple evaluations
(5) Development	- Real prototypes	- Checks effectiveness of use in real or simulated environments - Checks usability in real or simulated environments	- Field testing - Performance measures

During that time, we have accumulated know-how regarding characteristics of user behavior, various interface design patterns, and evaluation methods such as surveys. In collaboration with people from the Universal User Experience (UX) project at NTT Service Evolution Laboratories, we have applied this knowledge to service design and have developed simple evaluation methods that can be performed efficiently and effectively.

2. Evaluation methods

It is important to select evaluation methods suited to the type of results and evaluation objectives for each stage of service design. A list of evaluation methods is given in **Table 1**. The details of evaluation in each of the phases are described below.

2.1 Solution study phase

The main evaluation objective in this phase is to verify the solution concept. The various concept plans being studied are expressed in easy-to-understand text (scenarios), illustrations (storyboards), and video (concept videos). These are used to explain the solution to users, ask their opinions directly, and verify which concept plan evokes the best response. It is desirable to hear opinions from as many users as possible, but actual costs (time, money, etc.) are usually limited, so methods that integrate less expensive web surveys can also be used.

2.2 Design phase

(1) Rough prototype

In this phase, rough prototypes are created, from sketches of the idea to wireframes, mock-ups, and paper prototypes. The main functions and screen framework of the service can be seen, so the following areas should be verifiable before performing graphical and interaction design.

1) Function acceptability: Evaluate whether the main functions to achieve the user's objectives are included, and whether these functions seem attractive. An effective evaluation method is to have users experience the prototype and then conduct interviews with them.
2) Information architecture suitability: Evaluate the comprehensibility of the overall screen layout, navigation, categories, labels, and other aspects. Expert review by a specialist in human-centered design and user testing are often used. Card sorting is also useful for evaluating the appropriateness of categories.
3) Usability: Evaluate whether objectives are achieved (effect), whether there are wasteful procedures, and whether objectives can be achieved by the shortest possible path (efficiency). There are indices for usability satisfaction (whether users feel any discomfort), but evaluating it at this stage is not recommended because prototypes at this stage are visually incomplete, and this could introduce some subjective bias. Expert reviews and user testing are

common methods to evaluate usability, and the *Wizard of Oz* method is often used for user testing, where in place of a computer or smartphone, a human operator runs the prototype according to user operations. If time is limited, a simple evaluation can be done in three days (not including recruiting of participants), combining expert reviews and user testing with two participants.

(2) Advanced prototype

During this phase, design of overall screen graphics (style, color scheme, icons, etc.) and detailed animations (smartphone screen window swipes and motions, etc.) are prototyped. Thus, visual and subjective acceptability can be evaluated.

1) Service acceptability: Check the overall attractiveness of the service, including appearance, and disposition toward using it. Detailed views can be gained in interviews with users and through questions about the conditions and environment after they have experienced the prototypes.
2) Information architecture suitability: Evaluate visual aspects that could not be evaluated with the rough prototype (e.g., how color and font size in headings make the text structure easier to understand). An expert review by a specialist and user testing can be used for evaluation.
3) Usability: Evaluate whether user interface (UI) elements on the screen are recognizable in terms of effectiveness and efficiency (e.g., whether it is clear that a given element is clickable as a button). Evaluations such as expert reviews and user testing or a simple evaluation combining them can be used here as well.
4) Price acceptability: Pricing is usually evaluated through interviews, but effective answers cannot be obtained by simply asking "How much do you think you would pay to use this?" This is because users tend not to give high prices, and users have differing standards, so responses tend to vary greatly. From our experience, we obtain the most useful responses when we ask interested users, "We plan to charge around xxx yen. Do you think you would want to use it?"

2.3 Development phase

In this phase, real equipment can be used in the evaluation based on real data. Effective field testing can be conducted with real target users in a real environment. The effectiveness of the overall service can be judged by having users actually experience it, observing changes in behavior before and afterwards, determining conditions through journaling, and understanding users' views through interviews. These methods can be used even if there is no existing service with which to compare, and significant evaluation data can be obtained. If quantitative data are needed, user behavior not obtainable from service logs can be understood from performance measurements. Examples of specific measurements are as follows.

- Effect: Achievement rate (task completion rate)
- Efficiency: Work time or numbers of errors, help requests, steps, etc.
- Satisfaction: Subjective evaluation of difficulty, comprehensibility, ease of training, consistency, and other factors

3. Points for improving evaluation quality

(1) Thorough preparation

Preparation before evaluation may be the most important step. Before planning an evaluation, the following should be reconfirmed within the design team and summarized in a document.

- Applicable service: Product name, features, main functions, related tasks, enterprise strategy, development state, user environment
- Relevant users: User class, basic attributes and characteristics, skill characteristics, usage objectives

(2) Appropriate restraint

What can and must be evaluated during each design phase is fixed. It is important not to rush ahead, and to carefully follow the plan. Missing things that need to be evaluated can be a problem, but it is even more dangerous to obtain reference data for things that cannot be evaluated. This is because there is a danger that referring to inaccurate data can have more influence on decisions than expected. If relevant evaluation results cannot be obtained, it is better not to do the evaluation.

(3) Gathering suitable participants

It is important to gather participants that are similar to the anticipated users, but it is even more important to gather users that will be interested in the service. Users with different motivations will not only have different levels of acceptance of and satisfaction with the service, but they will also have different levels of acceptance regarding usability. Those that are interested, even if their literacy is low, will not consider small difficulties troublesome, and they will learn quickly. Suitable conditions and questions (if recruiting

through the web) must be set when recruiting participants to understand the motivations of participants accurately beforehand.

4. Future prospects

Recently, the number of our projects has been increasing, and they range from requests for evaluation only to requests for total support from prototyping through to evaluation. A feature of NTT Advanced Technology is that we have teams for both development (web, mobile, IoT (Internet of Things), etc.) and UX design. They communicate easily, so they can move quickly from rough prototyping to producing real prototypes. We will continue to utilize this strength to meet the demands of customers and to provide higher quality development and evaluation, and we will use our entire capacity to support service design for our customers.

Xinlei Chen
UX Consultant, NTT Advanced Technology.
She received an M.E. from the Department of Information Management Science at the Graduate School of Information Systems, the University of Electro-Communications, Tokyo, in 2002. She joined NTT Advanced Technology in 2002 and has been working as a UX consultant. She is also a Certified Human Centered Design Professional.

Methodology for Creating Attractive Services

Momoko Nakatani, Kenta Amano, Hikari Fukuoka, Nana Hamaguchi, and Chinatsu Saito

Abstract

NTT IT Corporation provides consulting services to help companies create services that will appeal to their customers. In this article, we introduce some of the methodologies employed by the ICT Design department to design services that capture people's interest. We also discuss points that need to be considered with respect to user interviews and our interpretations of them as well as the generation and evaluation of ideas.

Keywords: service design, human-centered design, user experience

1. Introduction

An important issue for many companies is the creation of services that appeal to users. Human-centered design and user experience (UX) design represent ways of thinking that are known to be effective in this regard. Under these approaches, a service's users are carefully studied, ideas are brainstormed based on the users' needs, prototypes are rapidly developed, and then the prototypes are repeatedly evaluated and improved. There are many systematized service development methodologies such as this one. However, to actually implement a service that will impress and appeal to people, it is not sufficient to simply apply a methodology as-is. Methods must be appropriately selected and customized—and their designs polished—according to each user's circumstances, reactions, and goals at any particular moment.

The employees in NTT's laboratories have accumulated many years of practical expertise along with experience researching and developing these types of methodologies. The ICT Design department of NTT IT Corporation (NTT-IT) specializes in providing consulting services that apply these methodologies and expertise. This is all connected to the creation of information and communication technology (ICT) services that appeal to people by using the appropriate methodology for any given context. In this article, we introduce several methodologies that have been put into practice by NTT-IT.

2. Understanding the target user

We conduct ethnographic investigations to gain a deeper understanding of the target users. In these investigations, we visit the users, collect data, and analyze on-site user behavior (eg., at home, at work); we also conduct interviews to reveal aspects of the unconscious mind. Although these investigations are said to be an easy way to understand users, we need to interpret and analyze minute details in our data to avoid being deceived by superficial remarks. For example, we use the Modified Grounded Theory Approach (M-GTA), in which everything the subject says is labeled and structured in detail. We used this same approach in the past to create a mental model (called NARUTO) of the users of ICT services, as shown in **Fig. 1**. The base of this model shows a negative psychological feedback loop in which limited use of the ICT services causes learning to stagnate; this prevents users from feeling confident, which in turn reduces their interest in the services and therefore limits their use of the service.

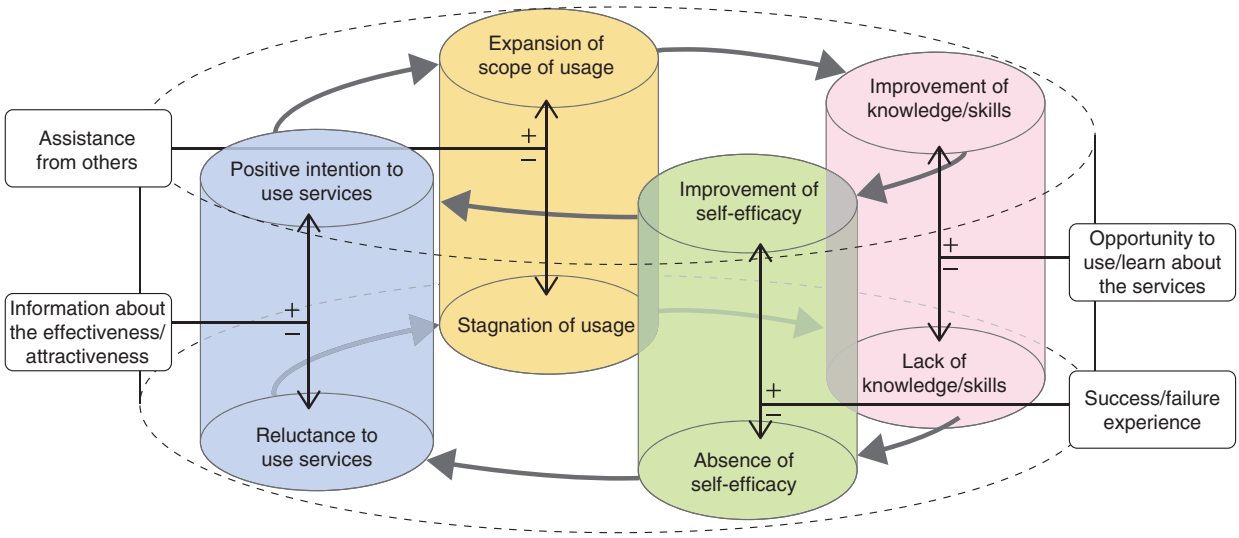


Fig. 1. NARUTO mental model for users of ICT services.

There are four elements that break the negative cycle and hold the key to encouraging positive feedback loops toward the top of the model: assistance from others, opportunity to use/learn about the services, successful experiences, and information about the effectiveness/attractiveness. If we can find the essential causes influencing people's actions and thoughts in this way, we can also apply this knowledge when developing services. When we actually designed support services based on this model and provided them to Internet-averse senior citizens, we observed some examples of surprisingly positive change.

It takes a long time to build a model like this from scratch. As a result, there are also many cases in which we proceed to brainstorm ideas and search for solutions without spending much time on conducting investigations and analysis; for example, we may make use of existing models and user data that we have already collected. By emphasizing the process of evaluating designs we have created in cases like these, we can understand the users' needs through the entire service development process and thus refine our services.

3. Coming up with ideas

Appealing services are not uniquely guided by users' needs. We occasionally need innovative ideas in order to take mental leaps forward. The ICT design game and cross-boundary methodology are effective techniques for coming up with ideas that start with the users' needs.

3.1 ICT design game

The ICT design game is an application of Scandinavian spatial design methods to ICT services. The game is a type of forced association technique that pushes ideas for services in a particular direction, forcing business areas and technology to be associated with the needs of a service's users (as identified through user investigations). For example, consider the price sensitivity of people who would like to exercise more but cannot justify the expense of joining a gym because they do not believe they would continue exercising for very long. By associating this need with medical insurance (a business area), we can come up with ideas such as a service that reduces the price of insurance as people get healthier through exercise.

The ICT design game assumes that several people will brainstorm ideas together and is also characterized by the inclusion of techniques for bringing out each participant's creativity. Specifically, the game introduces a variety of rules; for example, each person speaks in order, building upon the idea proposed by the previous speaker.

The rules are intended to leverage the diversity present among several participants. Left to think alone, individuals often follow familiar trains of thought and thus have a tendency to get stuck on solutions that represent local optimums. By providing

mechanisms that allow people to apply and share their own cognitive strengths, we combine a variety of perspectives to increase the probability of coming up with good solutions. Even people who are not used to contributing ideas can participate in this method and we have found that this method can produce a wider variety of concrete ideas than unstructured brainstorming.

3.2 Cross-boundary methodology

NTT-IT has developed the cross-boundary methodology to push the boundaries of diversity even further. Specifically, by choosing people with a variety of backgrounds and values to come up with ideas, we are creating diversity amongst the group's members themselves. For example, if we wanted to create a new service to help people enjoy traveling and commuting, we would hold a session in which a variety of people could exchange ideas—from train fanatics to night club workers who regularly use taxis to celebrities who must exercise caution when moving about in public.

We have often noticed that project members who develop a service have strong feelings about the project. Although these feelings can drive the project forward, they sometimes result in strong assumptions that make it difficult to get past preconceived notions. We can think outside the box and increase the probability of coming up with innovative ideas by inviting people whose cultures and value systems significantly differ from those of the project members.

4. Evaluating service ideas

Once a service's design has solidified to some extent, we enter the next phase of our methodology: quickly visualizing our ideas so that we can evaluate and improve upon them. To get users to ultimately accept our service, we need to determine which part of the service appeals to them and verify that they are not encountering any obstacles that prevent them from using it; it is important to then steadily improve the service as necessary. Therefore, NTT-IT is particularly focused on the evaluation step.

Although evaluation methods that collect feedback directly from the actual (target) users through interviews appear quite simple at first glance, it is actually rather difficult to correctly intuit users' opinions and make improvements based on them. This is because even if we present the same service to the same user on different occasions, that person's reactions will vary based on how questions are asked, how the person is feeling, and many other possible factors. For example, during a past interview to evaluate the design of an event recommendation service—specifically, whether people would like to use it—we received the following response from a (male) interviewee.

"Sounds good to me. I've become more and more reluctant to look for [events], so—for example—if I have a chance, I could look at my choices and say 'I guess I'll try hiking today.'"

However, when we conducted the same interview with the same person five months later, we received the following negative response.

"This app is hard to use, the things I have to tap are really small, my eyes get tired […] and it's just a bit of a pain, you know?"

As this anecdote shows, it is dangerous to evaluate a service at the planning stage by simply taking what users say at face value; figuring out how to interpret these responses is important. Specifically, we focus our attention on listening to what users are evaluating negatively—and why—to find hints for areas of improvement. In the first of the two sample responses given above, the user was focusing on the concept behind the service itself; in the second sample response, on the other hand, the user was focusing on actual interactions with the service. In other words, if reactions to the concept behind the service itself are positive, it is possible that people will actually use the service. However, given that assumption, we need to simplify and remove any friction that may exist in user interactions.

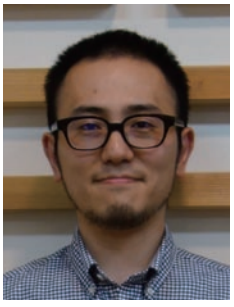
To accurately collect user feedback in the ICT Design department, we developed a three-step receptivity evaluation method and are finding ways to improve the process of asking questions itself. Under this method, we ask questions to identify people's needs and to clarify how they will use the service before we ask for any opinions on the concept behind the service. We cannot understand why we have received a negative reaction to a service's concept until we have first determined whether anyone needed that service in the first place and whether that service was suited to the context in which it would be used. Through this process of improving how we ask questions and collecting accurate evaluation results, we can get many useful hints for improving services.

5. Future work

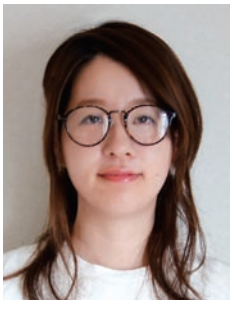
In this article, we introduced some of our methodologies for creating attractive services. There are

various other techniques and expertise applicable to designing services that appeal to users; by ascertaining users' circumstances and reactions along with market conditions and company strategies, we can perfect our designs through repeated trial and error. The ICT Design department comprises a multidisciplinary team of experienced UX designers and engineers as well as researchers knowledgeable of human characteristics. The department is supported by the combination of each person's domain knowledge with a variety of techniques for applying that knowledge. We plan to continue to develop and deploy services that both appeal to and are enjoyed by as many people as possible.

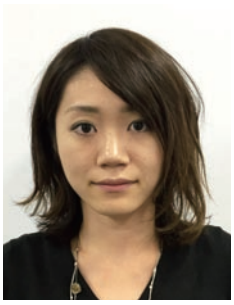
Momoko Nakatani
Senior Researcher/Senior UX Strategist, Heart Touching ICT Design Department, NTT IT Corporation.
She received her M.E. and Ph.D. in engineering from Waseda University, Tokyo, in 2003 and 2013. She joined NTT Service Evolution Laboratories in 2003. She has been researching human computer interaction, human-centered design, manual design, human modeling, usability, and qualitative studies. She moved to NTT-IT to develop the UX business in 2014 and works as a UX consultant. She is a member of the Association for Computing Machinery (ACM), and the Human Interface Society.



Kenta Amano
Researcher/Engineer, Heart Touching ICT Design Department, NTT IT Corporation.
He received a B.E. from Shibaura Institute of Technology, Tokyo, in 2002 and an M.E. from Japan Advanced Institute of Science and Technology, Kanazawa, in 2004. He has been working at NTT-IT since 2004 and specializes in Japanese text processing. He was selected as a starting member of the UX business in 2014 and is now working as a UX consultant.



Hikari Fukuoka
Design Consultant/Catalyst, Heart Touching ICT Design Department, NTT IT Corporation.
She received a Bachelor of Human Sciences from Waseda University, Tokyo, in 2004, and an Industrial Design degree from Musashino Art University, Tokyo, in 2007. She specializes in UX design, UI design, usability design, graphic design, movie creation, and design education. She joined NTT-IT in 2015 as a design consultant/catalyst focusing on design and human factors.



Nana Hamaguchi
UX Designer/Researcher, Heart Touching ICT Design Department, NTT IT Corporation.
She received her B.E. and M.E. from Osaka University in 2009 and 2011. She worked at NTT Service Evolution Laboratories from 2011 to 2015. Her research focuses on service design based on ethnography. She is now working at NTT-IT as a UX designer.

Chinatsu Saito
Researcher, Heart Touching ICT Design Department, NTT IT Corporation.
She received her B.E. and M.E. from Tamagawa University, Tokyo, in 2011 and 2013. She has been with NTT-IT since 2013 and has been a consultant in the field of human-centered design since 2014.

Training Initiatives for UX Designers

Jiji Kim, Hana Tsuchiya, Kazunori Yamada, Yoshie Sagata, Nobuhiro Kiyama, and Kazuo Yoshimi

Abstract

AT NTT Communications, we are actively training user experience (UX) designers. The first step in this process involves examining the existing skills of UX designers within the company. Another key step is applying the CHEF model we developed for organizing the design processes, skillsets, and mindsets required for UX design work within the company. In this article, we present the results of these initiatives and our plans for future work.

Keywords: UX design, human resources, human-centered design

1. Introduction

In recent years, the diversification of customer needs and the environmental changes surrounding companies have been accompanied by a need for companies to shift from simply providing products and features (goods-dominant logic) to providing services and experiences (service-dominant logic). In light of these changes, it has become important to understand each customer's context (e.g., environment and emotional state) and then to think about both how to provide value to that customer and what type of value the customer will perceive from the service. Furthermore, it has become important for service providers to design optimal user experiences by empathizing with, analyzing, and understanding their users rather than relying on their own theories alone.

Our Strategic UX Design Unit in NTT Communications' Technical Development Department was established in October 2011 with the goal of incorporating user experience (UX) design into business activities, improving existing projects, and accelerating the creation of projects that will become new profit centers, all while increasing the number of UX designers throughout the company.

We are primarily engaged in three types of activities: supporting UX improvements in the services we provide (application), actively learning how to become exceptional UX designers (training), and presenting what we have learned through study and practice within our company while also promoting the importance of UX designers internally (osmosis).

2. Background

The UX designer training initiatives introduced in this article are rooted in an awareness of two problems. The first problem is that to achieve business results in the short term, practical activities become the center of attention, and human resource development (e.g., the systemization and assessment of UX design-related skills as well as the examination of training guidelines among members) cannot be tended to. As a result, new members cannot be trained effectively.

The second problem is that, institutionally, there are no designer positions at NTT Communications. This makes it difficult to improve UX design skills and accumulate expertise.

3. Overview of activities

Knowing all this, we set out to bring visibility to UX design skills and techniques and to build guidelines for training UX designers. Our first step was to define the design process that would guide UX designers—along with the requisite skillset and mindset—from what we learned by conducting

Fig. 1. Constructing the design process matrix.

research in various areas so that we could determine what kind of UX designers were needed at NTT Communications. We then specified how UX designer positions differed from other types of positions (e.g., management, engineering, and service planning) and also established the UX designer levels needed for different roles and locations in the company's organizational structure.

4. CHEF model

We established the CHEF model to describe the skillset, mindset, and design processes required of UX designers.

Why call the model *CHEF*? First, we gained a deeper understanding of the act of design by collecting existing design processes, with an emphasis on desk research. We thought of design as the creation of new ideas from observing the natural state of things—without being prejudiced by existing concepts and viewpoints—and then, based on what was discovered through observation, perceiving the subject anew. To debate the guiding principles for UX design, we then created a two-dimensional matrix with contrasting concepts at each edge: Radical vs. Emotional and Progressive vs. Traditional. Using this matrix, we discussed the areas of activity that are considered to be necessary for UX designers. Through brainstorming sessions based on our image of the words that correspond to each of these areas, we created and named 24 new UX design processes, which we applied to the matrix (**Fig. 1**).

After filling in the matrix, we discussed and voted on each of the ideas to arrive at the idea for the CHEF model, which uses *creative cuisine* as a metaphor for UX design.

We wanted to stress that design processes should be incorporated into a company's business processes and also that business results should be linked to the outcomes of UX design. To further raise awareness of this, we emphasized *Tasting* (inspection, prototyping) and *Feedback* (evaluation, reporting) as parts of our model. We ultimately split our design process into five steps: Ingredients (Insight), Recipe (Ideation), Cooking (Implementation), Tasting (Test), and Review (Feedback), as shown in **Fig. 2**. In the Ingredients (Insight) step, we collect *ingredients* and gain a deep understanding of each one. This is the process of deeply understanding customers, their environment, and their circumstances to come up with new insights. In the Recipe (Ideation) step, we define problems and come up with ideas based on the insights we obtained so we can create new *recipes* inspired by our ingredients. In the Cooking (Implementation) step, we quickly give our ideas shape as a chef would in the kitchen. In the Tasting (Test) step, we examine the implementation of our ideas and collect feedback to determine whether our ideas *taste* the same as we expected them to and whether people are happy to *eat* them. Finally, in the Review (Feedback) step, we organize our feedback so we can use it for our next challenge. Note that we intend for these steps (processes) to be repeated over and over to improve the accuracy of their results; they are not complete after they have been followed only once.

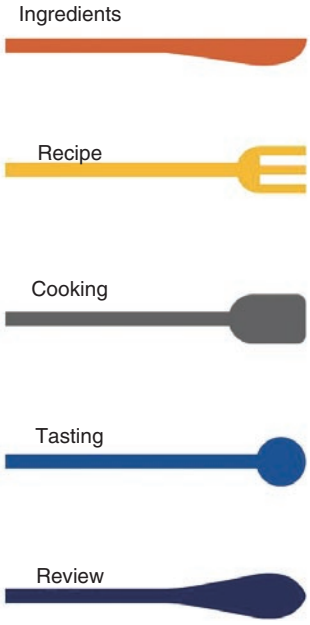


Fig. 2. CHEF model.

Table 1. UX designer levels.

Levels	Definitions
Junior	A designer who precisely understands all of the processes, tools, and skills related to UX design and handles the actual work.
Senior	A designer who has sufficient general UX design experience to be qualified to manage projects. Senior designers also plan the actual work and mentor junior designers.
Lead	A designer who makes decisions and takes responsibility for the design process. Lead designers are responsible for assigning and hiring team members and serve as mentors to junior and senior designers. Lead designers may also have received design-related awards outside the company.

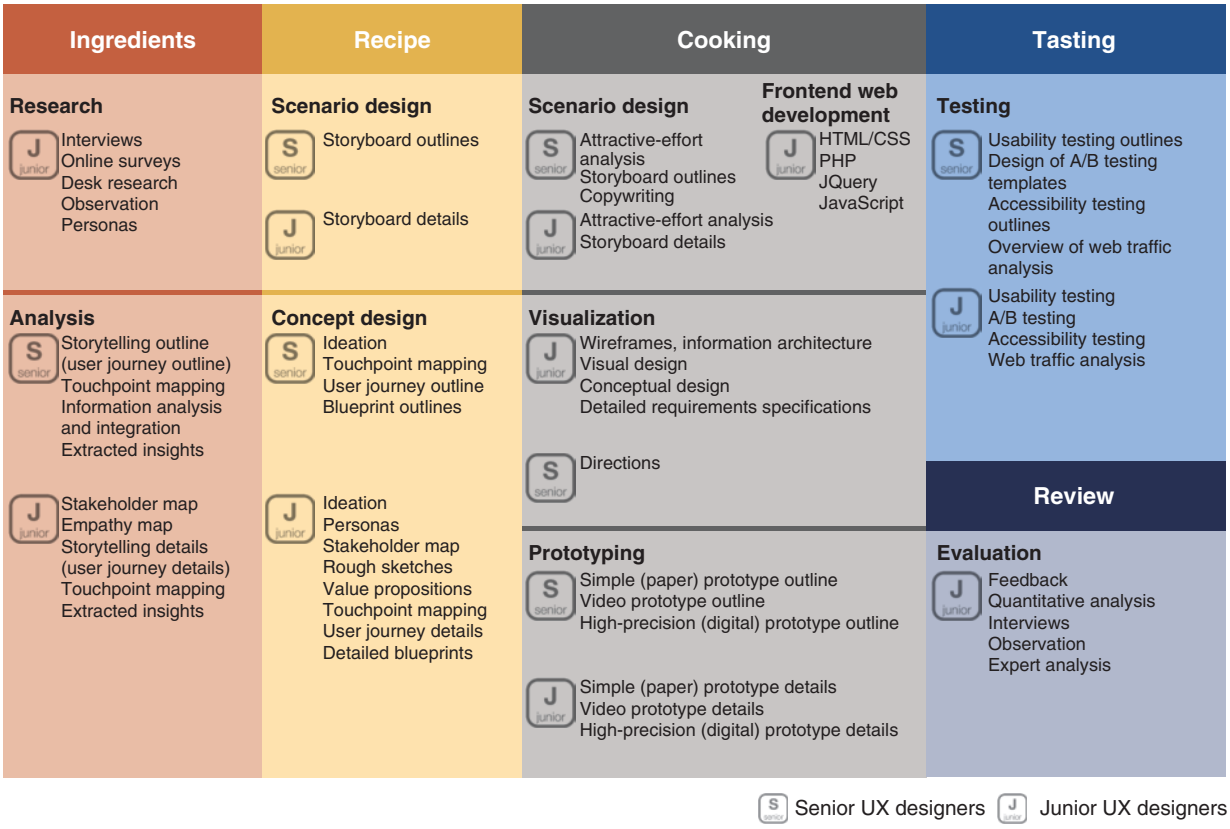
5. UX designer levels

Before establishing detailed skillsets and mindsets, we defined three levels of designers—Junior, Senior, and Lead—to support structured learning, the transmission of knowledge, and business applications within our company (as indicated in **Table 1**). The levels are determined by UX design proficiency, project experience, and external assessment; we expect each of these factors to be used as a guideline while considering a combination of team composition and mentoring, which forms the basis for training.

6. Skillsets

Next, we organized the skillsets (ability to understand the essence of a variety of methods and appropriately use them) used in each step of our design process, based on current experience (methods employed and results obtained in a project) and knowledge of known methods gleaned through desk research (**Fig. 3**).

We assume that several UX designers will work together as a team, with the senior designers deciding and presenting the direction of the project while the junior designers are tasked with handling more specific details.



CSS: cascading style sheets
HTML: hypertext markup language
PHP: PHP Hypertext Preprocessor

Fig. 3. Skillsets.

Furthermore, NTT Communications does not handle all development in-house; for the most part, systems are implemented in collaboration with designers and developers at partner companies. As a result, the Cooking step of the design process defines the implementation skills sufficient to create prototypes as well as the direction and detailed requirements specification skillsets for working with technical companies.

7. Mindset

We classified mindsets for UX designers in addition to skillsets (**Fig. 4**). In summarizing these mindsets, we found that a characteristic job of internal UX designers is to cut across the structure of an organization and build consensus while empathizing with and understanding customers. We were conscious of explicitly making this a smooth process. As with skillsets, we gave UX designers complementary roles: the senior designers are responsible for the team's accomplishments, and the junior designers are in charge of more detailed work.

We largely categorized mindsets into three types: the foundational mindset, the core mindset, and the collaborative mindset.

The foundational mindset is indicative of a person who is actively interested in business and technical matters and also takes a high-level view to plan ways to integrate those with other fields—all with respect to design issues.

With the core mindset, we emphasized that designers should be curious about new things and continue challenging themselves to produce unconventional creations in order to support design activities, using their empathy with others as a guide. The core mindset also clearly indicates taking responsibility for time, which is an important constraint for businesses.

Finally, we use the collaborative mindset to clearly indicate an aptitude for creating new things while communicating with people from other fields, other

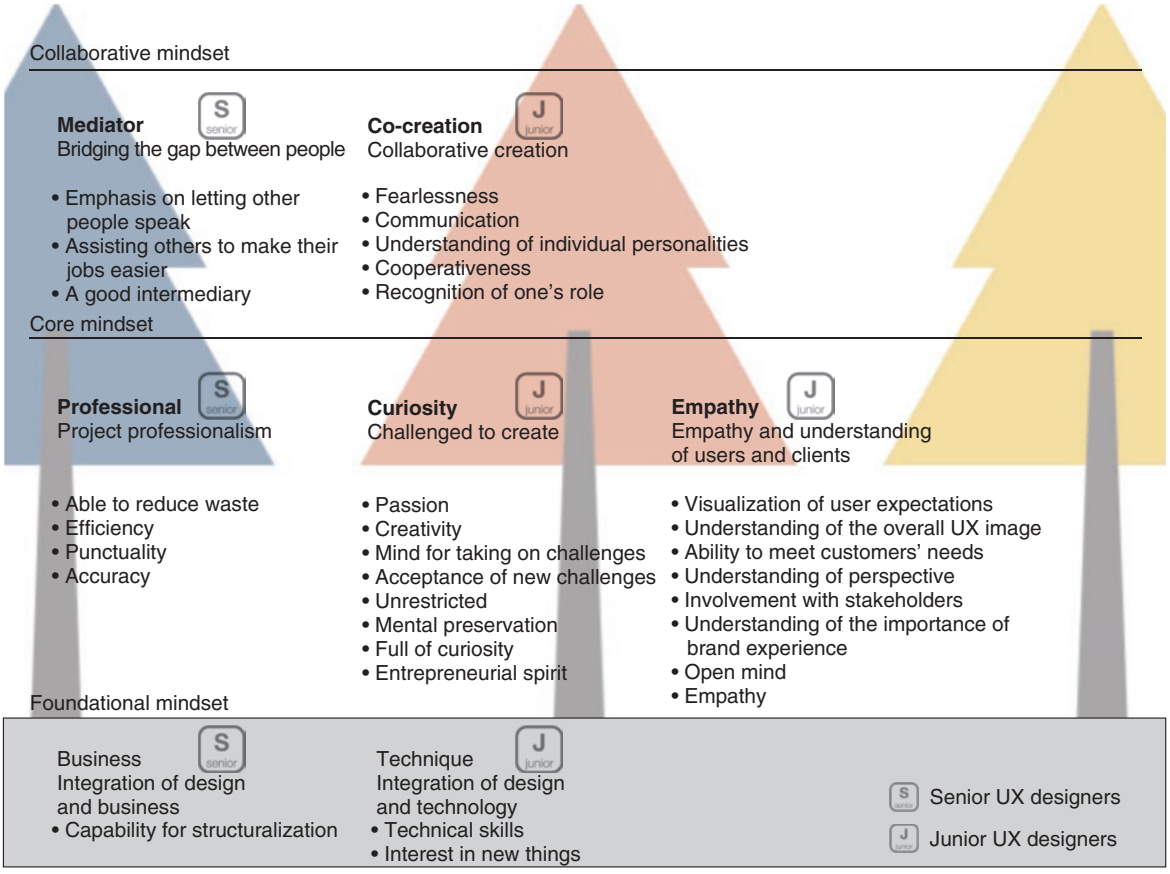


Fig. 4. Mindsets.

departments, and other companies.

These mindsets are illustrated in Fig. 4 using a tree metaphor. The foundational mindset is akin to the soil on which the core UX designer mindset is cultivated like the trunk of a tree, while the collaborative mindset for working effectively with people both inside and outside a company continues to grow and gain attention until it sprouts branches full of leaves.

8. Future work

Through this initiative, we were able to compile the design processes, skillsets, mindsets, and designer hierarchy required by NTT Communications into the CHEF model. We hope to use this as a base from which to train UX designers who will improve our services. We are also investigating the possibility of adding human-centered design, UX design, and other related topics to external certifications (which employees are encouraged to obtain) as well as training programs for the entire company to strengthen their UX designer skillsets.

Furthermore, we would like to publish the skillsets, mindsets, and design processes established here on websites and in other information sources both inside and outside the company.

Jiji Kim
UX Designer, Manager, Technology Development Division, NTT Communications Corporation.
He received a Master of Design from the Kyushu Institute of Design (merged into Kyushu University in 2003), Fukuoka, in 2005. He joined NTT Communications in 2005 and has been engaged in researching and practicing UX design and human-centered design for various NTT Communications products. He has been a Certified Human Centered Design Professional (HCD-Net) since 2013.

Hana Tsuchiya
Manager, Technology Development Division, NTT Communications Corporation.
She received a Master of Media and Governance from Keio University, Kanagawa, in 1997. She joined NTT in 1997 and has been engaged in research and development of web-based services.

Kazunori Yamada
UX Designer, Technology Development Division, NTT Communications Corporation.
He received an M.E. from Keio University, Kanagawa, in 2007. He joined NTT Communications in 2014 and has been engaged in researching and practicing UX design and human-centered design for various NTT Communications products.

Yoshie Sagata
Usability Testing Specialist, Workshop Designer, Technology Development Division, NTT Communications Corporation.
She received a Master of Information Science from University of Tsukuba, Ibaraki, in 1994. She joined NTT Communications in 2013 and has been conducting usability testing on several web services and products of NTT Communications. She has been a Certified Human Centered Design Professional (HCD-Net) since 2014.

Nobuhiro Kiyama
Manager, Technology Development Division, NTT Communications Corporation.
He completed the Master Program of Innovation for Design and Engineering from the Advanced Institute of Industrial Technology, Tokyo, in 2015. Since joining NTT Communications, he has been researching and practicing UX design and human-centered design for various NTT Communications products. He has been a Certified Human Centered Design Professional (HCD-Net) since 2015.

Kazuo Yoshimi
Senior Manager, Technology Development Division, NTT Communications Corporation.
He received a B.E. in electrical and electronic engineering from Sophia University, Tokyo, in 1989. He joined NTT Communications in 1989 and has been working on improving the UX of various businesses.

Initiatives Related to the Creation of New NTT DATA Services

Kyoichi Kadoya

Abstract

At NTT DATA, we do not limit ourselves to developing systems in response to RFPs (requests for proposals); we endeavor to create and commercialize innovative new services together with both client and partner companies in short periods of time. However, thinking about this work and proceeding with it involve a very different approach than that used in system development projects, and therefore, several departments within the company have been moving forward with a variety of initiatives to facilitate the process. This article introduces the initiatives related to the creation of new services at NTT DATA.

Keywords: service design, prototyping, co-creation

1. Introduction

Smartphones, big data, and other recent technological innovations have brought enormous changes to our lives. The providers of these services—NTT DATA's customers—need to accurately ascertain their end users' needs and efficiently provide services.

Under these circumstances, information technology (IT) vendors such as us need to not only obtain and implement RFPs (requests for proposals); we also need to co-create businesses and services themselves with our customers and then engage in open innovation through the adoption of existing solutions and technology and the rapid implementation thereof. We need to make these service initiatives part of the value provided by NTT DATA.

2. Internal company initiatives related to developing new businesses and services

Initiatives for developing new services have been deployed in a variety of departments at NTT DATA. Six of these initiatives are introduced here (**Fig. 1**):

1) Vision-oriented methods: One of the frameworks for organizing thoughts related to new business development
2) Human-centered design process: A process for honing in on users' subconscious needs to implement experiences that can satisfy them
3) Service prototyping: A technique that gives a diverse team a common language for developing new services
4) Co-creation workshops: A technique for producing ideas for new services during short workshops
5) INFORIUM Toyosu Innovation Center: A venue for the co-creation of new services with clients
6) Open Innovation Forum—From the Toyosu Port: A venue for new services emerging through open innovation

2.1 Vision-oriented methods

NTT DATA maintains two types of methods for developing new services. The first is the vision-oriented method (**Fig. 2**), which involves searching for business opportunities by breaking large problems into smaller ones. This method adopts a future-oriented approach and techniques for thinking freely; as a result, mental barriers can be torn down in order to create fresh business proposals that have not been seen before. Also, the goals to be achieved (the *vision*) and the business opportunities for those goals (the *actions*) are each split into two levels. This makes it easy to come up with expansive business plans and is particularly suitable for creating businesses that

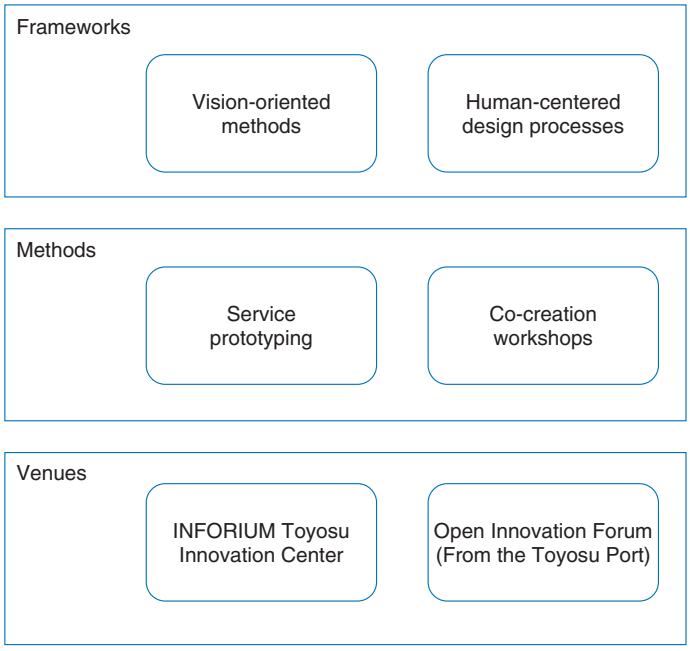


Fig. 1. Six initiatives.

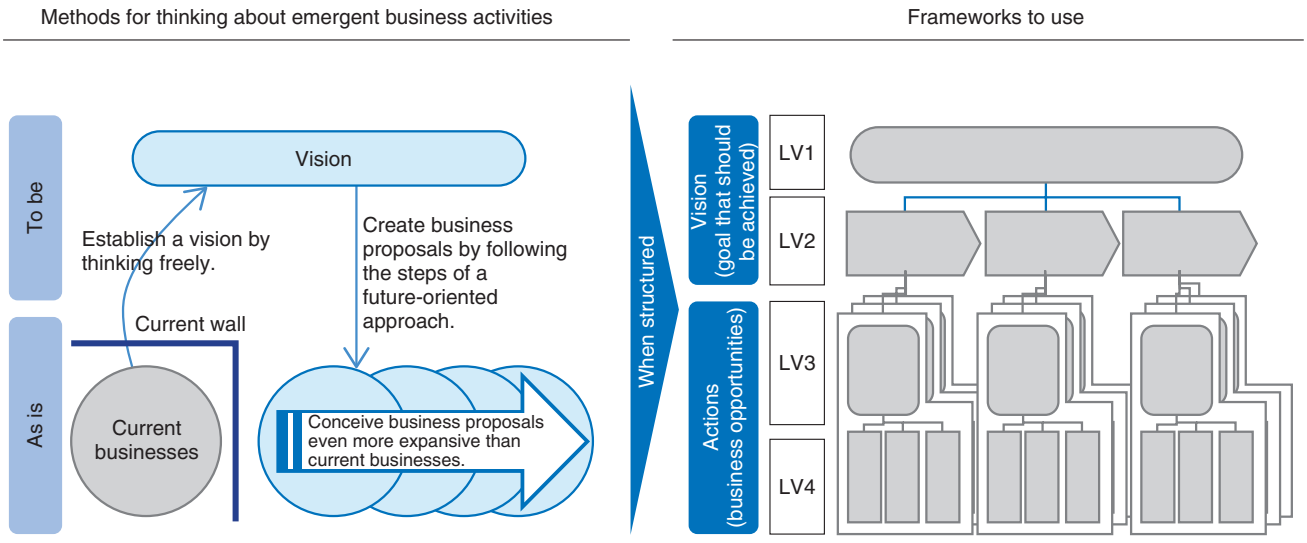


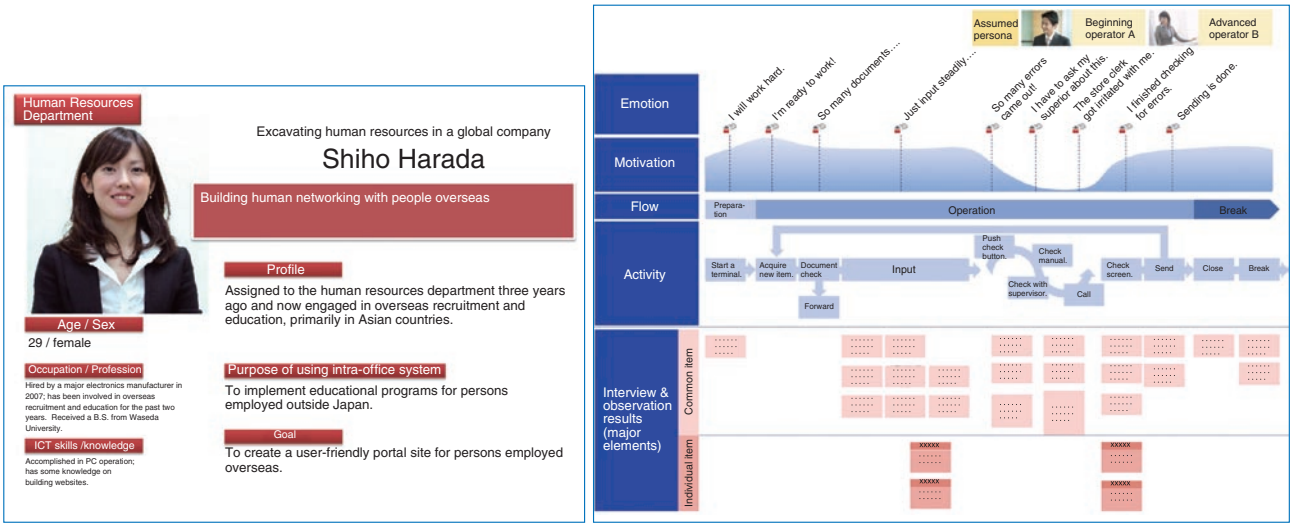
Fig. 2. Vision-oriented method.

address societal problems and also for creating infrastructure services.

The second method for developing new services is the user-oriented method. This is based on a human-centered design process, as described below.

2.2 Human-centered design process

With the diversification of smartphones, tablets, and other consumer devices, we need to be conscious of the many different kinds of end users, including the elderly and technical neophytes. In 2000, NTT DATA established a dedicated IT accessibility team. Starting in 2009, usability considerations were also taken into



(a) Persona example. (b) Journey map

Fig. 3. Example of user modeling in human-centered design process.

account, user interface policies were created to support proposals, screen design documents were reviewed, usability evaluations were conducted, and other similar efforts were implemented. These were later expanded to cover user experience design as well, which involved focusing on users' actual subconscious needs to provide experiences that can satisfy them through systems. User studies, user modeling, for example, personas (**Fig. 3(a)**) and journey maps (**Fig. 3(b)**), prototype construction, and evaluation processes are conducted to place people (users) front and center.

2.3 Service prototyping

A wide variety of people are involved in developing new services, from client and partner companies to NTT DATA's development and marketing teams. As the scale of a project grows, so too does its complexity. In other words, project members and teams with differing backgrounds share an image of the user experience and the concept for new services, causing different opinions and arguments to compete with each other. It is not uncommon for project members with different positions and roles to think that they are saying the same thing to each other when in actuality the things they imagine differ. A common language is therefore necessary to express concepts, user experiences, and other abstract ideas as concretely as possible.

For this reason, the Technical Development Department's Service Innovation Center has proposed the service prototyping method, in which services are expressed in four stages: concept, scenarios, architecture, and touchpoints. Together, these are called a prototype and are defined as part of the common language for service development projects.

(1) Concept

The concept for a new service—especially in the early stages of considering it—is very abstract and difficult to explain to others. We define a concept prototype to express a service's essential value proposition in concrete terms (**Fig. 4**).

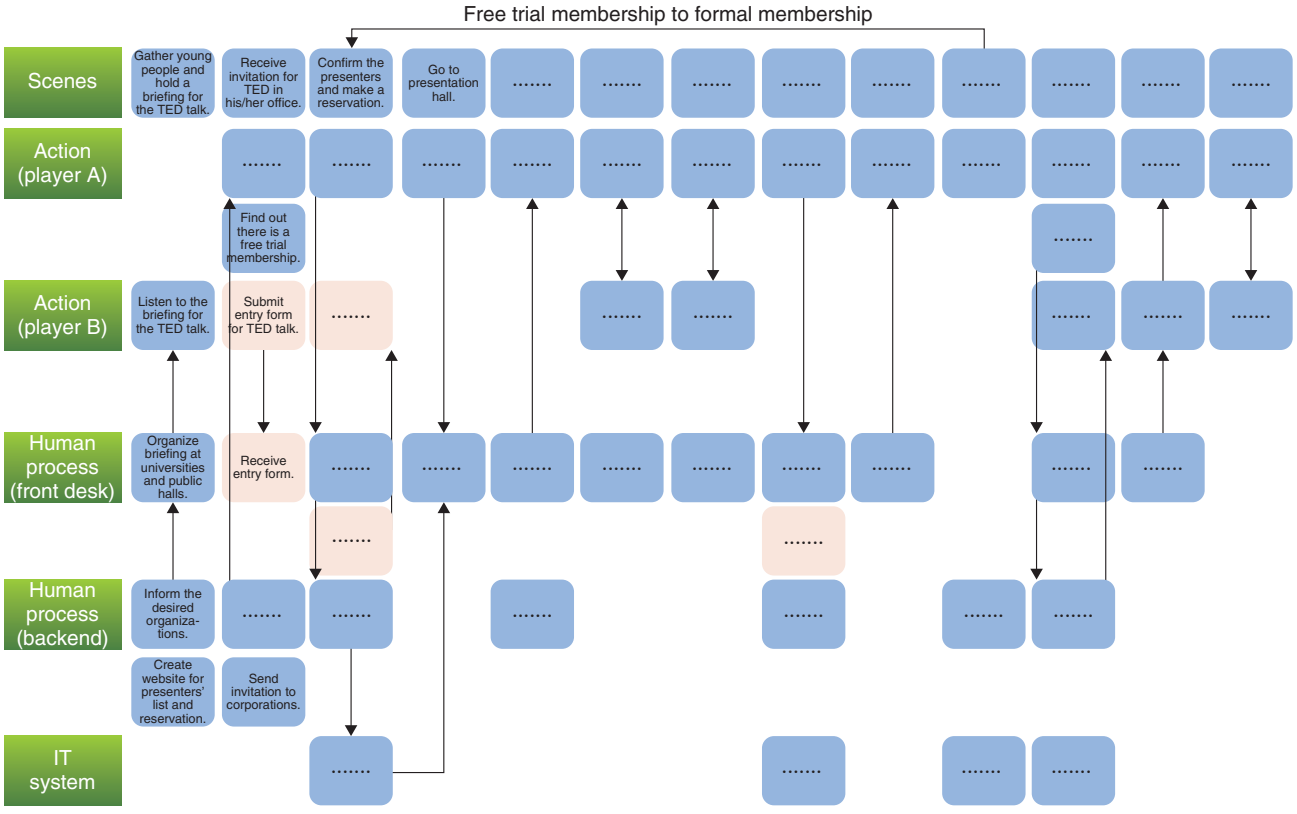
(2) Scenarios

What experiences will end users have as a result of a new service? What latent needs will the service satisfy? How will the service provider communicate with the end users? These questions, along with other user actions and user experience flows, are often represented via four-panel comics and other prototypes called user scenarios.

(3) Architecture

Architecture prototypes are extremely important because newly devised services need to be implemented as IT systems and human processes. We define the flow of the end user experience as well as the technological and non-technological features implementing it; we also provide detailed definitions of a wide variety of workflows, touchpoints, and the way in which features are structured, covering a wide variety of situations from the initial use to continued

Fig. 4. Concept prototypes.



*TED is a registered trademark of TED Conferences LLC.

Fig. 5. Service architecture prototypes.

use of the service (**Fig. 5**).

2.4 Co-creation workshops

We promote ideas related to our clients' industries

Fig. 6. INFORIUM Toyosu Innovation Center and co-creation workshops.

and the future of their businesses to discover clues relevant to new services. When members of the business and research and development departments at both our and our clients' companies gather together, they investigate the essential issues that arise from their discussions to think through the clients' values and paint an image of the future. A single person only has a limited capacity for coming up with ideas, but a diverse group of people can motivate each other to produce new ideas more easily. The Technical Development Department runs two types of workshops (**Fig. 6**) that are inspired by future trends in our information society and the technology that supports it that have been pointed out in the NTT DATA Technology Foresight report.

The first workshop focuses on expressing ideas and employs forced creative thinking techniques. Scenes of a service in use are combined with technology to come up with new ideas that answer the question of what would happen if the latest technology was used for existing work and services. The second workshop involves examining medium- and long-term policies and paints a picture of what our company should be like 10 years hence. By predicting how trends in technology and our information society will change the world 10 years in the future, we speculate on how the industry and our own business will be affected. We also examine what our future course should be, including what actions we will need to take to get over these expected changes and continue growing. All of our workshops entail a combination of individual and group work.

2.5 INFORIUM Toyosu Innovation Center

The venue for the co-creation workshops is also important. It is difficult to effectively disseminate ideas in an ordinary conference room. At the INFORIUM, which is run by the Public Relations Department, visitors can at any time readily see creative content concerning the future as well as demonstrations of the latest technology that is connected to the future painted by NTT DATA Technology Foresight. There is also an open area where visitors can watch a video of NTT DATA's vision for the future, an exhibition area where visitors can actually try out the latest technology that NTT DATA has been working on, and a workshop area that functions as a space for encouraging co-creation with clients via co-creation workshops and individual informational seminars for NTT DATA Technology Foresight, which is organized by the Technical Development Department.

2.6 Open Innovation Forum: From the Toyosu Port

This open innovation forum is an attempt to create an emergent business lab for open innovation. Because it takes a long time for a company to commercialize an idea if it develops new services entirely in-house, the goal of the open innovation forum is to implement innovative new services in a short period of time by combining new technologies and adding ideas from outside companies as well. We combine our core services and solutions with those of startups that have new technologies and services in order to provide new value to client companies. This forum is named *From the Toyosu Port* and was started in September 2014; regular meetings are held once a month [1] (**Fig. 7**).

In accordance with the theme of each meeting, several startup companies give presentations and conduct panel discussions with members of our relevant business departments. These meetings are held in

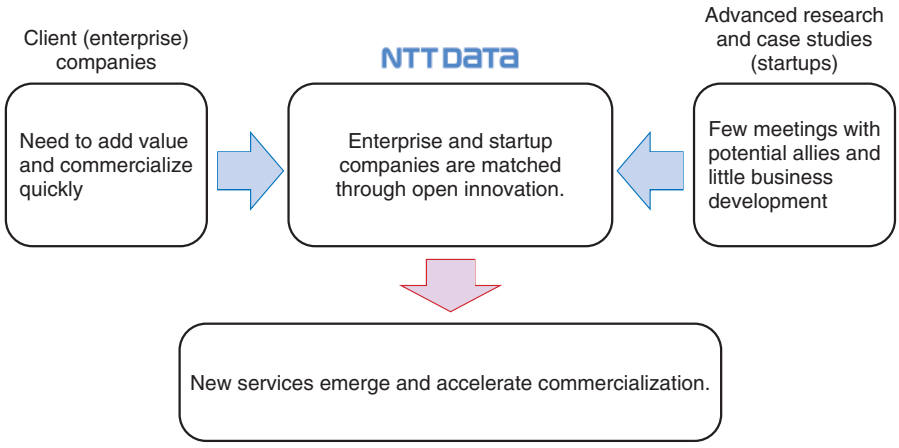


Fig. 7. Goals of the Open Innovation Forum "From the Toyosu Port."

front of our own group members and people from our client companies. Social gatherings also serve as an opportunity to exchange business cards, have active discussions, and participate in networking devoted to the development of new services; this is all linked to businesses being matched with each other. Recently, we have gone one step further by holding open innovation business contests [2] and developing our initiatives involving support services called digital corporate accelerator programs to support our clients' open innovation efforts.

3. Future work

NTT DATA is promoting several initiatives across multiple departments for emergent new services. We hope that exchanging the actual results of these activities will lead to the establishment of standard methods for service design at NTT DATA in the future as we strive to make service designers as common as software engineers.

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Kyoichi Kadoya
Manager, Open Innovation Business Development Office, Innovation Promotion Department, NTT DATA Corporation.

He received a B.E. in system engineering from Musashi Institute of Technology (now Tokyo City University) in 1988. Since joining NTT in 1988, his responsibilities have ranged from developing optical character recognition (OCR) technology and devices to planning electronic commerce services. He held a management position in technology development and has also been involved in user experience and behavior observation, design thinking based on requirement development activities, and research and development of IT-ROI (return on investment) maximization.

Recent Activities Involving OpenStack Swift

Kota Tsuyuzaki and Masahiro Shiraishi

Abstract

OpenStack Swift is popular open source software used to build very large-scale storage systems. OpenStack Swift was originally released by Rackspace, and it has been developed with community effort over the last five years by developers from all over the world. The OpenStack Swift community recently introduced some major features such as global cluster management and erasure code capability. NTT has also contributed to the OpenStack Swift community. In addition, NTT developed a proprietary secret sharing engine called Super High-speed Secret Sharing, which achieves data encryption that is compatible with erasure code. In this article, we introduce these developments and discuss NTT's activities in the Swift community.

Keywords: OpenStack Swift, distributed storage system, object storage

1. Introduction

OpenStack Swift (hereinafter referred to as either Swift or OpenStack Swift) [1] is one of the most common types of open source software (OSS) used to build very large-scale storage systems with Hypertext Transfer Protocol (HTTP) based application programming interfaces (APIs). OpenStack Swift was originally released by Rackspace [2], and developers all over the world have been collaborating on it for five years with great community effort. OpenStack Swift is now used in production in various ways. For example, Rackspace and HP [3] are using OpenStack Swift for their own public cloud storage services. Additionally, NTT DOCOMO is using OpenStack Swift [4] as a 7-petabyte private storage system for its cloud mail backup system.

Swift's key features for production use cases have three main characteristics.

(1) HTTP based APIs

Swift supports HTTP based APIs using HTTP verbs such as PUT, GET, and DELETE for uploading/downloading and deleting data. This way of using the cloud storage system is an easy way to share data among cloud systems because developers do not have to worry about the actual data location, and they can retrieve their own data whenever they want. Furthermore, the HTTP based APIs are quite useful for handling binary large objects because in recent commonly used Internet technologies, clients such as web browsers and smartphones transfer content via HTTP on the Internet.

(2) High reliability

Swift has the capability to ensure that data are stored with high reliability and to prevent significant data loss caused by various events (e.g., disk failure). To prevent the data loss, Swift has a consistency engine called an object-replicator that works to find a lack of data redundancy (three replicas in default) and consistency. Then it copies valid data if some replicas are lost or mismatched in the cluster.

Swift also has the capability to store each replica in as unique a failure domain as possible. For example, Swift never allows more than one replica to be placed on the same disk to prevent a failure of one device resulting in reduced data redundancy. These mechanisms ensure that Swift has high reliability and high durability.

(3) Scale out

An important item to consider when deploying a large system is scalability. Swift can scale with no single point of failure. A typical example of a Swift

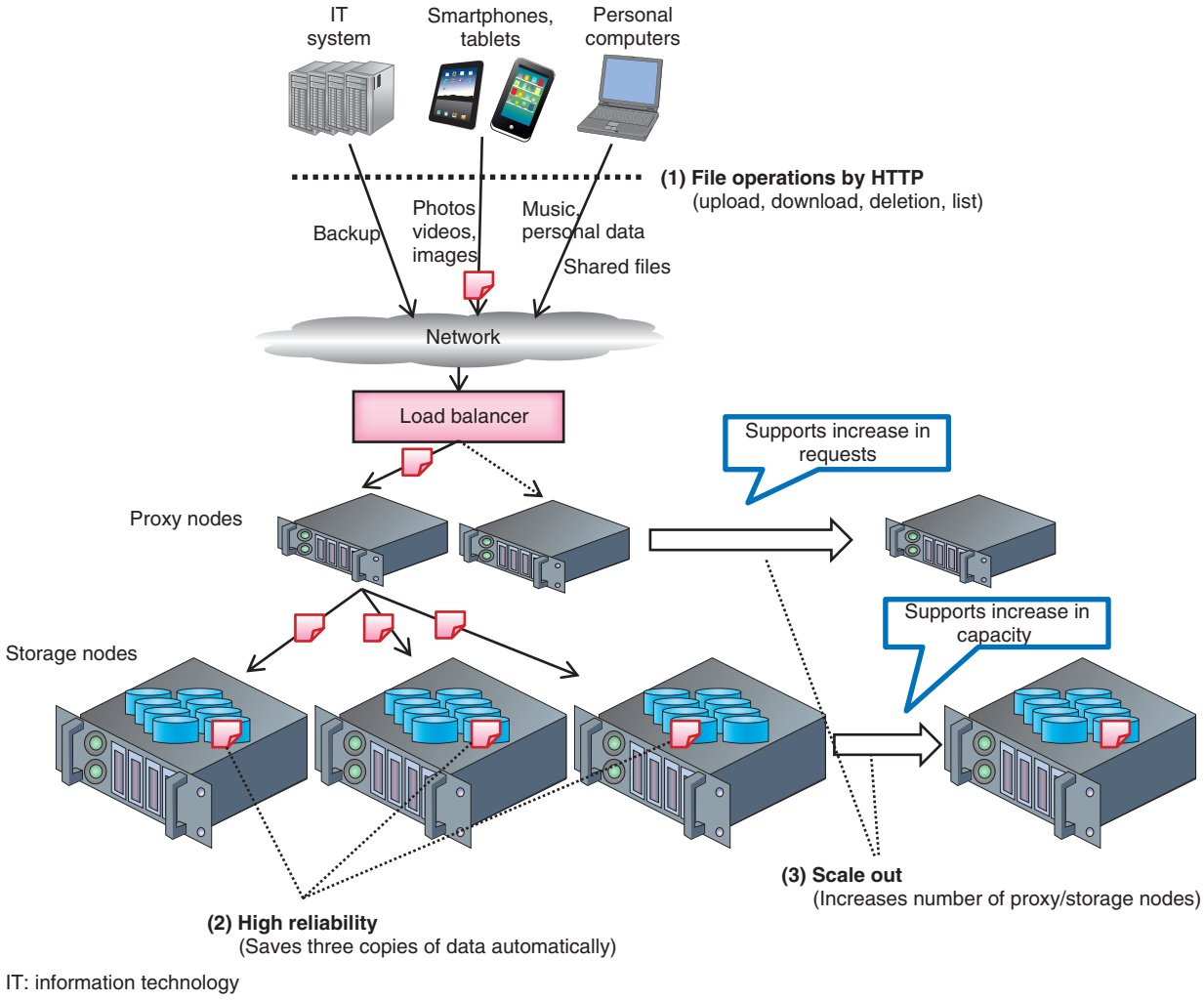


Fig. 1. Example of OpenStack Swift cluster configuration.

cluster configuration is shown in **Fig. 1**. In this example, the system has proxy nodes that receive requests from clients and storage nodes that actually store data. This makes for a highly extendible cluster architecture since proxy nodes can be added if the number of requests becomes excessive, while storage nodes can be added if storage capacity becomes insufficient.

In addition to these characteristics, the Swift community has been working on building some major features, and some of them were achieved in recent releases. In this article, we introduce two of these features: global cluster management and erasure code capability. We also describe the secret sharing engine and how it is used with Swift. This secret sharing engine makes it possible to store data with encryption; it was developed by NTT to be compatible with OpenStack Swift erasure code capability.

2. Global cluster management

Some companies may want to deploy OpenStack Swift in more than one datacenter to prevent a large data loss caused by a disaster such as an earthquake, fire, or tsunami. Our customers must also consider their requirements for disaster recovery. However, geographically distributed clusters sometimes have physical issues with network latency. In the worst case, the network latency will degrade the input/output performance of the storage system.

The Swift community has been working to improve

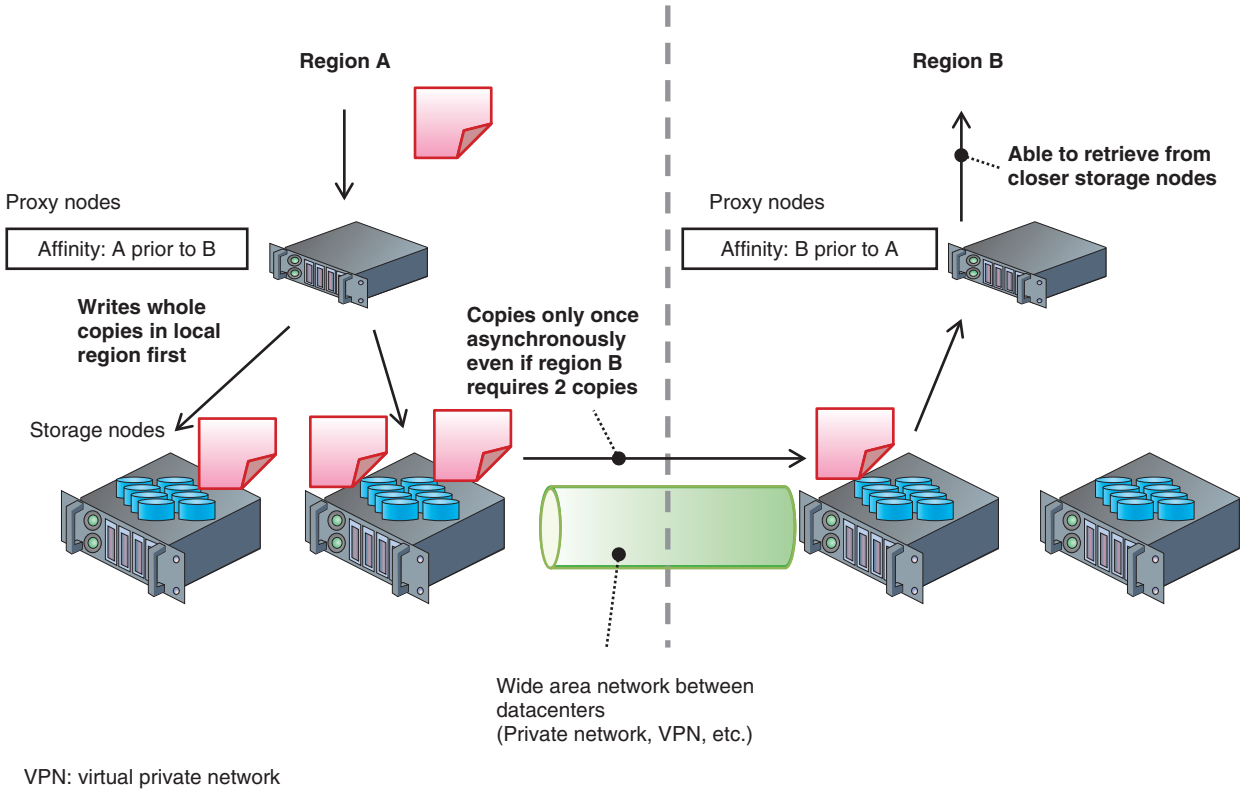


Fig. 2. Global cluster.

the inner architecture in order to reduce the effect of network latency. This is the feature known as a global cluster.

Swift employs the concepts of *region* and *affinity* to achieve the global cluster. A region is a domain that defines which datacenters the actual hard drives belong to. Affinity is an attribute that defines the priority among regions seen by the proxy-server.

By defining these two factors, Swift can access regions that are as local as possible. In an uploading sequence, Swift will write all of the replicas into unique devices in the closest region, and the replicator will then copy the replicas asynchronously to nodes in another region. In a downloading sequence, Swift will read the object from nodes in the closest region first. If all nodes are offline in the region, Swift will try to retrieve the object from another region.

For example, when we define two regions A and B and define B prior to A by its affinity at the proxy-server in region B, Swift will try to get the object from the devices in region B prior to region A, as shown in **Fig. 2**. As described in section 1, Swift stores three copies of replicated data in devices in domains (regions, zones, Internet protocol addresses, and devices) that are as unique as possible so that the global cluster mechanism efficiently retrieves data from the device in the closest unique domain.

Furthermore, Swift now has the ability to reduce the number of data transfers among regions by copying the replica only once between regions. This feature was developed mainly by NTT with the Swift community.

3. Erasure code capability

Since the first major release of OpenStack Swift, Swift has employed the replicated model to protect stored objects with high availability and durability. However, nowadays we need a scheme that is more efficient than the replicated model in order to reduce the amount of hardware (especially the number of hard disks) and the associated costs. Erasure code is a way to reduce the volume of hardware by creating parity fragments, which refers to smaller amounts of redundant data than the replicated model. This scheme uses redundant arrays of inexpensive disks

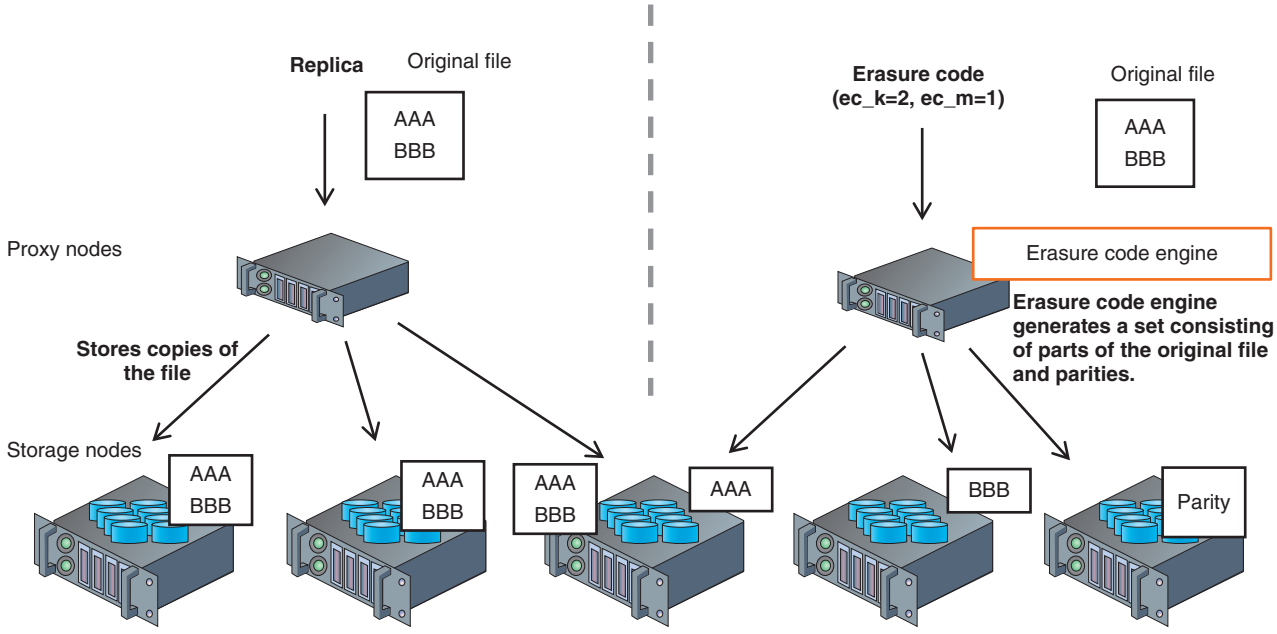


Fig. 3. Example of Swift erasure code for a PUT request.

(RAID).

In an erasure code scheme as shown in **Fig. 3**, Swift slices the original data into "ec_k" data fragments that consist of an aggregation of split original data. Swift also creates "ec_m" parity fragments, which are mathematically redundant data of the data fragments. In the erasure code scheme, it is possible to rebuild the original data from any "ec_k" fragments among all the fragments.

For example, we use ec_k=2 and ec_m=1 parameters for Swift erasure code; Swift will create two data fragments and one parity fragment and store a total of three fragments in three unique devices. When a user requests Swift to retrieve original data, Swift responds by rebuilding the original data from any two of the stored fragments.

For the erasure code feature, the Swift community added a new consistency engine called object-reconstructor. It works almost the same as the object-replicator to maintain high durability of data redundancy, but the difference is that it enables the reconstruction of a unique fragment (not a copy) for the node.

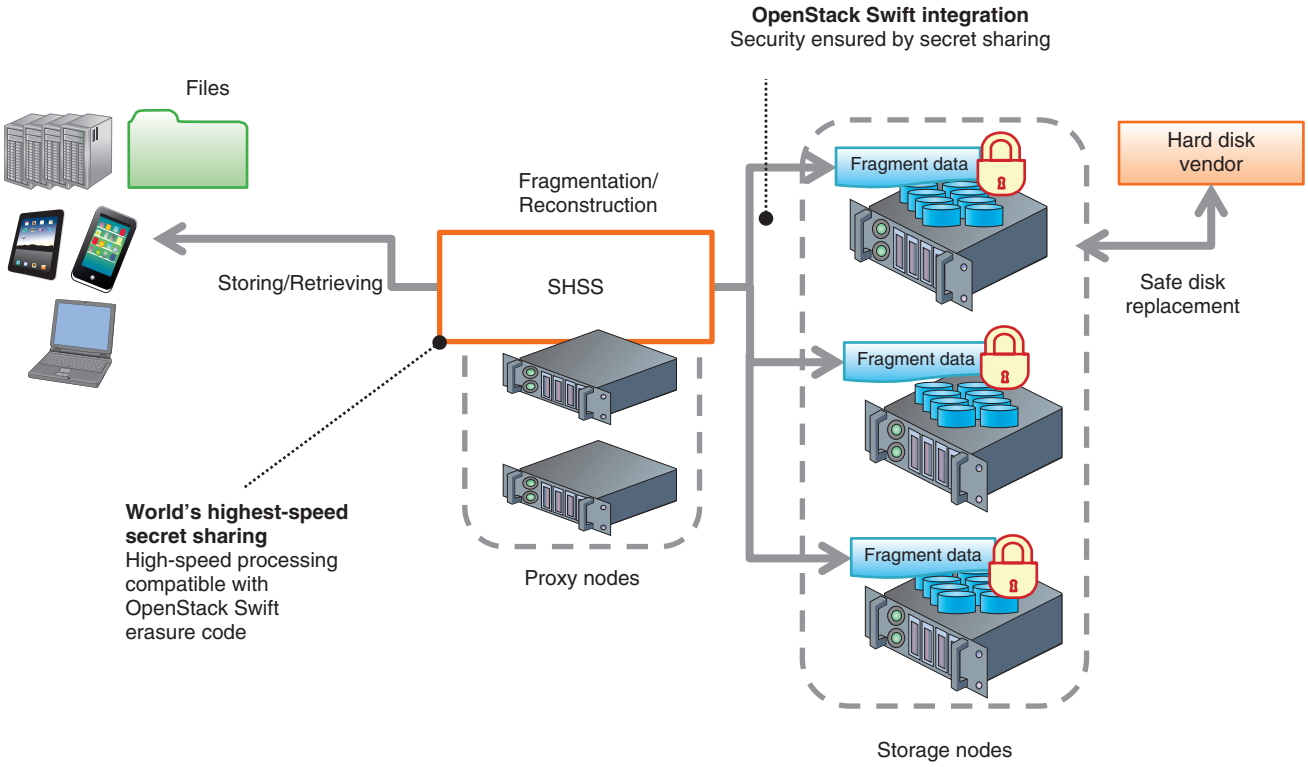
The major players in the Swift community have been making an effort to implement this feature for approximately a year and a half, and it was finally published as a beta version in the most recent OpenStack release. We are hoping that Swift erasure code will be ready to release as a production-ready version with the code name Liberty in the next release.

4. Secret sharing

Solutions for security, data durability, and increasing data volume are more important than ever in the information technology business market, since the amount of highly confidential information will continue to grow. To manage confidential data, NTT developed a proprietary secret sharing engine called Super High-speed Secret Sharing (SHSS) [5] as a pluggable backend for the OpenStack Swift erasure code, and it is expected to be used in secure storage products as the amount of confidential data increases.

The SHSS engine enables OpenStack Swift to encrypt fragments and to reconstruct the plain data from the encrypted fragments (**Fig. 4**). The reconstruction requires a number of fragments, and OpenStack Swift stores the fragments to unique disks in the same way as erasure code. This mechanism prevents the system from reconstructing original data from insufficient fragments, and it reduces the risk of information leakage when broken physical drives are replaced by hard drive vendors.

In addition, the main advantage of SHSS is that it has the world's fastest fragmentation and reconstruction performance, which allows OpenStack Swift to



* SHSS is configured in Swift as the only available erasure code engine that achieves security.

Fig. 4. Swift secret sharing.

quickly store/retrieve files. Previously, secret sharing processing for fragmentation and reconstruction was much slower than erasure code's encoding and decoding; therefore, it was difficult to apply secret sharing to storage systems. To improve the performance, NTT developed a new high-performance 64-bit processing technique that is faster than the 8-bit process used in previous mechanisms. This makes it possible to increase the processing speed so that SHSS can fragmentize and reconstruct data at about 20 Gbit/s in the case of 24 total fragments, with 20 fragments used for reconstruction.

5. Future work

For three years, NTT has been working to develop the Swift features as described in this article. In the future, we will primarily focus on developing two new features for Swift.

One is a combination of global cluster and erasure code. As explained, they both have substantial advantages. However, erasure code cannot currently be applied for global cluster use cases because the lower data redundancy (in particular, < two times data redundancy) leads to the possibility of data loss if a region goes completely offline. In addition, we noticed from parity calculation constraints that a large number of parity fragments (i.e., ec_m) for increasing data redundancy reduced the PUT/GET performance in our experiment. To achieve the benefits of both global cluster and erasure code, we are now attempting to develop a new scheme called global EC (erasure code) cluster, with the Swift community.

The other concept we are trying to develop is storage tiering. Automated tiering has recently become a popular feature in storage system products. It makes it possible to connect two or more storage tiers together that are basically different in performance and cost. With tiering, we can use actual hardware more efficiently according to the user's own data access pattern. Swift currently supports the static deployment of certain kinds of storage definitions called storage policies, but we are now researching a

way to dynamically place each object among the storage policies in the Swift cluster to achieve greater efficiency.

6. Conclusion

Working with Swift software and the Swift community has improved our software development and enabled us to focus on which areas we should develop as part of the OSS community. The Swift production development cycles and community activities provide many opportunities for developers to contribute, and the Swift community has recently finished developing notable features such as global cluster and erasure code. We believe that working together with the OSS community is a great way to improve our products. To further speed up our research and development, we will continue to work closely with the OSS community.

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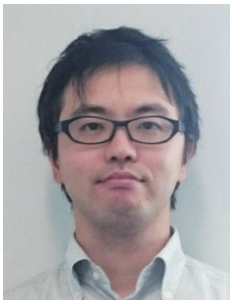


Kota Tsuyuzaki

Software Engineer, NTT Software Innovation Center.

He received an M.E. in information engineering from Waseda University, Tokyo, in 2010. Since joining NTT in 2010, he has been engaged in developing distributed storage systems. He has been working on OpenStack Swift for approximately three years and has been a member of the Swift Core Team since June 2015.

Masahiro Shiraishi

Senior Research Engineer, Supervisor, NTT Software Innovation Center.

He received an M.E. in mathematics from Kagoshima University in 1991. He joined NTT in 1991 and studied and developed operating system platforms. He is currently studying distributed storage systems.

Improving Inter-system Cooperation and User Convenience in Confirming Personal Safety during Disasters

Naoto Hoshikawa, Toru Inaba, Kentaro Kichiyoshi, and Masatsugu Ohnishi

Abstract

The need for effective ways to check on the safety of persons in times of disaster has been increasing in recent years. Personal safety information in times of disaster has been handled separately for different types of user terminals, different media (voice, text, etc.), and different networks. NTT Network Service Systems Laboratories has been developing a system that integrates those separate services to work cooperatively and to provide a unified service for simple and certain communication and confirmation of personal safety. Here, we describe the Personal Safety Confirmation System and the functions it provides.

Keywords: safety confirmation, service providers, disaster response

1. Introduction

The major earthquake disaster that occurred in eastern Japan on March 11, 2011 greatly damaged the telecommunication infrastructure, and a number of lessons on maintaining communication during a disaster were subsequently learned. As a result, a Japanese Ministry of Internal Affairs and Communications (MIC) study group was formed to study ways of ensuring communication during major disasters and other emergencies. This study group investigated how best to deal with network congestion during an emergency, how to maintain communication when a base station or relay station is damaged, what should be done with future network infrastructure considering experience from past disasters, how the Internet can be used in the future, and other such issues related to ensuring communication in emergency situations [1].

In terms of confirming personal safety, those studies found that during the aftermath of the 2011 disaster, only a limited number of people in the disaster area were easily able to use the Internet, particularly social media, and they were thus unable to communicate what was needed in the disaster area in a timely and accurate fashion. That resulted in a mismatch of what was provided and what was needed. Consequently, it is now necessary to work towards eliminating information disparities and raise information and communication technology (ICT) literacy, and to develop terminals and services that have high usability for the elderly and others.

2. Efforts by the NTT Group

In response to the social needs described above, we have been working on a Personal Safety Confirmation System for all NTT Group companies. The objective with this system is to be able to easily confirm the personal safety of others during a disaster, regardless of network, terminal, or type of media. We are moving forward with this work guided by the following principles and objectives:

1) Achieving the capability to respond to increases in mobile network traffic or other such changes in network conditions

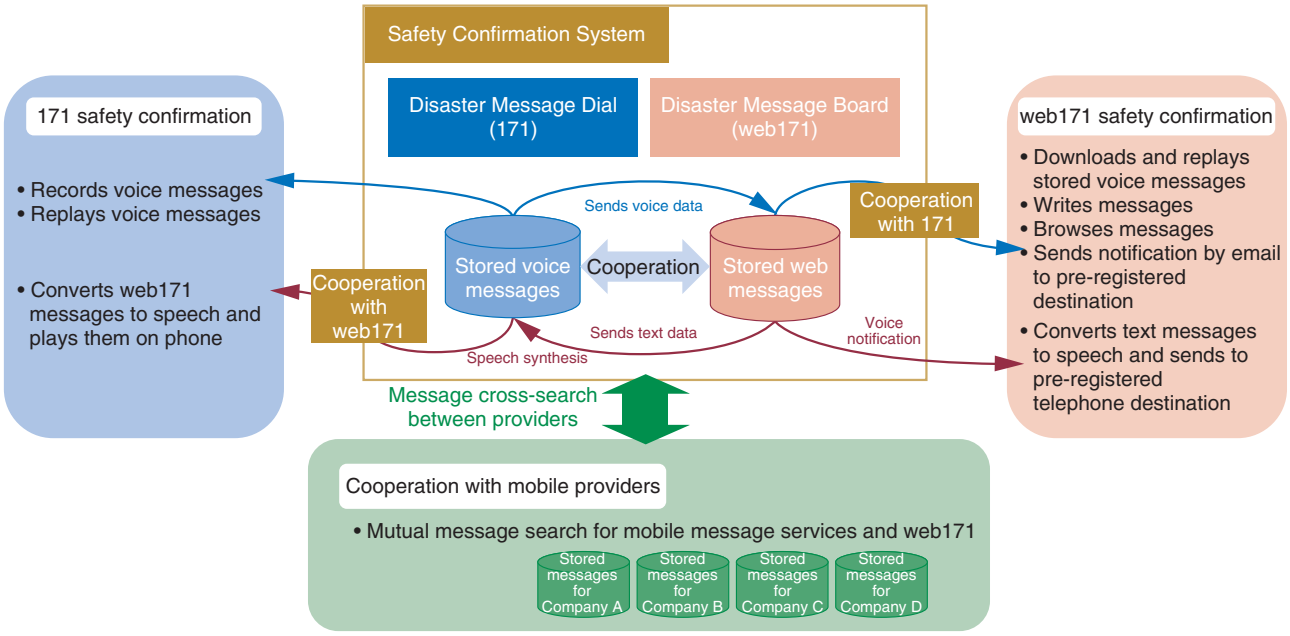


Fig. 1. Overview of 171 and web171 services.

2) Achieving cooperation between multiple personal safety information systems (fixed-line and mobile networks, voice and web services)
3) Providing services that do not require a high level of user ICT literacy
4) Achieving higher usability and convenience in registering and checking information

Here, we explain the functions for message registration, replay, browsing, and search, which are the basic functions of the Personal Safety Confirmation System, and we describe the implementation of functions for inter-system cooperation.

3. Service overview

The Personal Safety Confirmation System is based on the Disaster Message Dial (171) and Disaster Message Board (web171) services provided by NTT EAST and NTT WEST. An overview of the system is presented in **Fig. 1**.

Disaster Message Dial (171) is a dial-up service that enables users in areas affected by a disaster to register messages over a telephone line when it is difficult to place a telephone call. The registered messages can be accessed via the Internet or over the phone. The Disaster Message Board (web171) service makes it possible to register and browse registered messages via the Internet. Interworking between the 171 and web171 services enables mutual confirmation of messages. A service for sending email and telephone notifications to pre-registered destinations is also provided. Additionally, cooperation with various mobile providers enables mutual message search functions with the systems they provide.

4. System overview

The operating states and definitions of this system are explained in **Table 1**. Voice functions are provided by the 171 service, and web functions are provided by the web171 service. Message registration, replay, and browsing services are suspended during normal times when no disaster has occurred, although user information can be registered, updated, and deleted using the web functions. When the system changes to the operating state because a disaster has occurred, message registration, replay, and browsing are enabled.

An overview of the system and its functions are presented in **Fig. 2**. The system comprises application functions, platform functions, reference functions, and common functions.

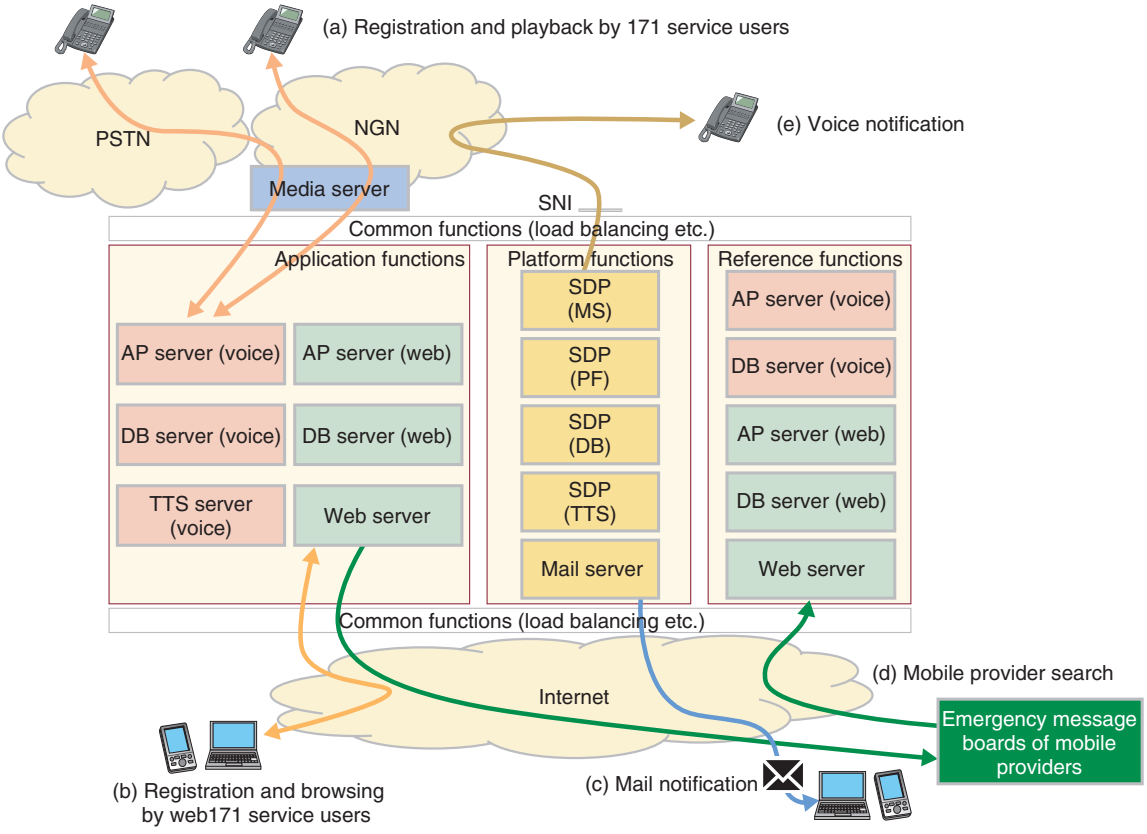
(1) Application functions

Two functions are possible: voice functions and web functions.

The voice functions implement registration and replay by 171 users ((a) in Fig. 2). When there is a

Table 1. Operating states of the Personal Safety Confirmation System.

Operating states	Definition	Functions	Operations for user access
Suspended	Normal times/situations (when no disaster has occurred.)	Voice functions	Messages cannot be registered or played back.
		Web functions	Messages cannot be registered or browsed. Only user information registration, updating, and deletion are possible.
Operating	The 171 and web171 services are being provided because a disaster has occurred or because it is the trial day set by NTT to allow users to experience how the services work.	Voice functions	Message registration and replay are enabled.
		Web functions	Message registration and browsing and user information registration, updating, and deletion are enabled.



PSTN: public switched telephone network
SNI: application server-network interface

Fig. 2. Functions and system overview.

user request for message registration in the Next Generation Network (NGN), the media servers perform call termination and conversion of voice message content to voice files, the application servers (voice) send and receive the voice files, and the database servers (voice) perform database management. When there is a user request for a message replay, the voice message that corresponds to the specified phone number is played back.

The web functions implement registration and

browsing by web171 users ((b) in Fig. 2). When the web server receives a request, the application servers (web) process the text data and the database servers (web) manage the database. When there is a user request to browse messages, the text message that corresponds to the specified phone number is displayed.

(2) Platform functions

The service delivery platform (SDP)[*1] includes five servers that have different roles. Upon a user request for message registration or replay, the SDP (PF (platform)) server receives requests from the application server (web) for media conversion, call origination, or another function, and provides additional services. The SDP (DB (database)) server performs database management, the SDP (TTS (text to speech)) converts text to voice files, the SDP (MS (media server)) plays the voice file on the user terminal, and the mail server sends and receives email ((c) and (e) in Fig. 2).

(3) Reference functions

These functions store data on the content of the various application function servers and handle message search requests from mobile providers ((d) in Fig. 2).

(4) Common functions

These functions comprise load balancers, which distribute the load of communication over equipment that has a redundant configuration and other such network devices.

4.1 Message information media (speech and text) distribution and notification functions

Cross-checking of message data between the 171 and web171 services is possible. For example, the content registered as a voice message in the 171 service can be downloaded from web171 to a terminal as a voice file ((a) to (b) in Fig. 2). Also, the content of web171 text messages can be converted to speech for playback by the 171 service ((b) to (a) in Fig. 2). A function for sending notifications by email or phone, even if the user does not access the system to check for messages, has also been implemented ((c) and (e) in Fig. 2).

4.2 Cooperation with mobile providers for text message browsing

The web functions also work in cooperation with mobile providers. The improvement described here makes it possible for a web171 user to check for messages registered in the system of a mobile provider ((d) in Fig. 2). If there are messages that correspond to the search keywords, links to the message board of the mobile provider are displayed. When a search request from a mobile provider is received, a message search is performed using the phone number as the search key.

This system implements the functions described above to realize interworking across media and cooperation with mobile provider systems to provide users with a unified way to check messages, which previously had to be done independently for each system.

5. Advantages of the system

5.1 System reliability

(1) Handling a heavy concentration of search requests from mobile providers

One problem with achieving cooperation among providers is handling large numbers of search requests (**Fig. 3**). In implementing this function, there was concern that search requests from mobile providers, which have many more users than fixed-line phones, may overwhelm the processing of message registration and access by users of the 171 and web171 services. We therefore divided the functions into a) application functions for registration and searching of safety confirmation information and b) reference functions for information referencing and access between providers. Disruption can thus be controlled, even when numerous search requests from multiple mobile providers are received. This separation of functions also enables flexibility in handling the addition of mobile providers and changes in service number ranges.

(2) Site switchover

The process of switching from an active site to a standby site and switching back when a major disaster has occurred is shown in **Fig. 4**. When the service is operating, the system settings, user information, and other data are stored in one of two types of databases according to the frequency of updating. Data that are updated with high frequency are synchronized between sites as needed; data that are updated with low frequency are synchronized periodically. As a result, site switchover can be done quickly. Also, a technique for incremental synchronization of the data stored in standby systems for switchback and data updates makes it possible to bring systems online faster, allowing active site assignment according to the disaster situation.

*1 SDP: A general term for functions and equipment for interworking with web application functions.

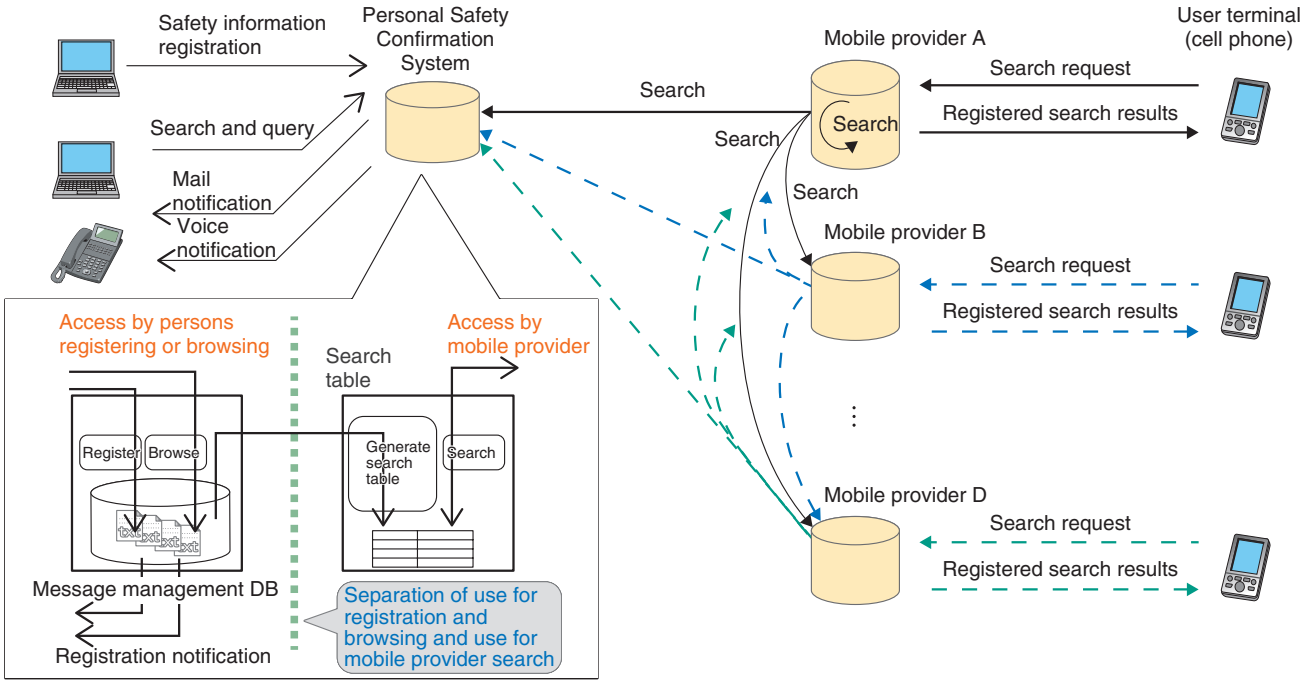


Fig. 3. Response to concentrated search requests from mobile providers.

5.2 User convenience

(1) The web171 message registration notification to fixed-line phone users

When providing a service that does not require a high level of user ICT literacy, it is important to consider fixed-line phone users. Data from the major earthquake disaster that occurred in eastern Japan in March of 2011 showed that only 36% of the people who used the disaster voice messaging service[*2] had been able to confirm the personal safety of friends or loved ones [2]. A comparison of the 171 and web171 services indicates that the number of voice messages registered with the 171 service is smaller than that for the web171 service. Furthermore, the proportion of users that register personal safety information via cell phone or Internet services is expected to increase, so in addition to functions enabling the use of different types of media, we implemented functions for converting the text data registered with web171 to speech data by the TTS server and sending voice notifications to fixed-line users. The voice notifications enable users to receive the notifications regardless of whether the original message was in text or voice form.

(2) High-usability user interface

During times of emergency, having the ability to surely and easily perform the operations needed to use the service and having a display that is easy to read are important. The use of the 171 service to replay messages in the order in which they were sent, regardless of media type, was taken into account in the interworking between the 171 and web171 services, which was implemented for the first time in the development reported here. For the web171 service, we separated the listing of target messages from the opportunities for exchanging message content between systems so that the target messages could be displayed quickly even if there was a large number of registered messages. Furthermore, we reduced the number of display screen transitions by 60% to achieve a more user-friendly interface.

6. Future development

Because the Personal Safety Confirmation System is connected to the Internet, it is crucial to ensure it is safe from cyber-threats. To further strengthen security, we are implementing a data analysis function for early detection of repeated access attempts and other such indications of cyber-threats. Additionally, we

*2 Disaster voice messaging service: A dial-up service that was developed after the major earthquake that occurred in the Hanshin-Awaji region in 1995. Service began on March 31, 1998 as the Disaster Message Dial (171).

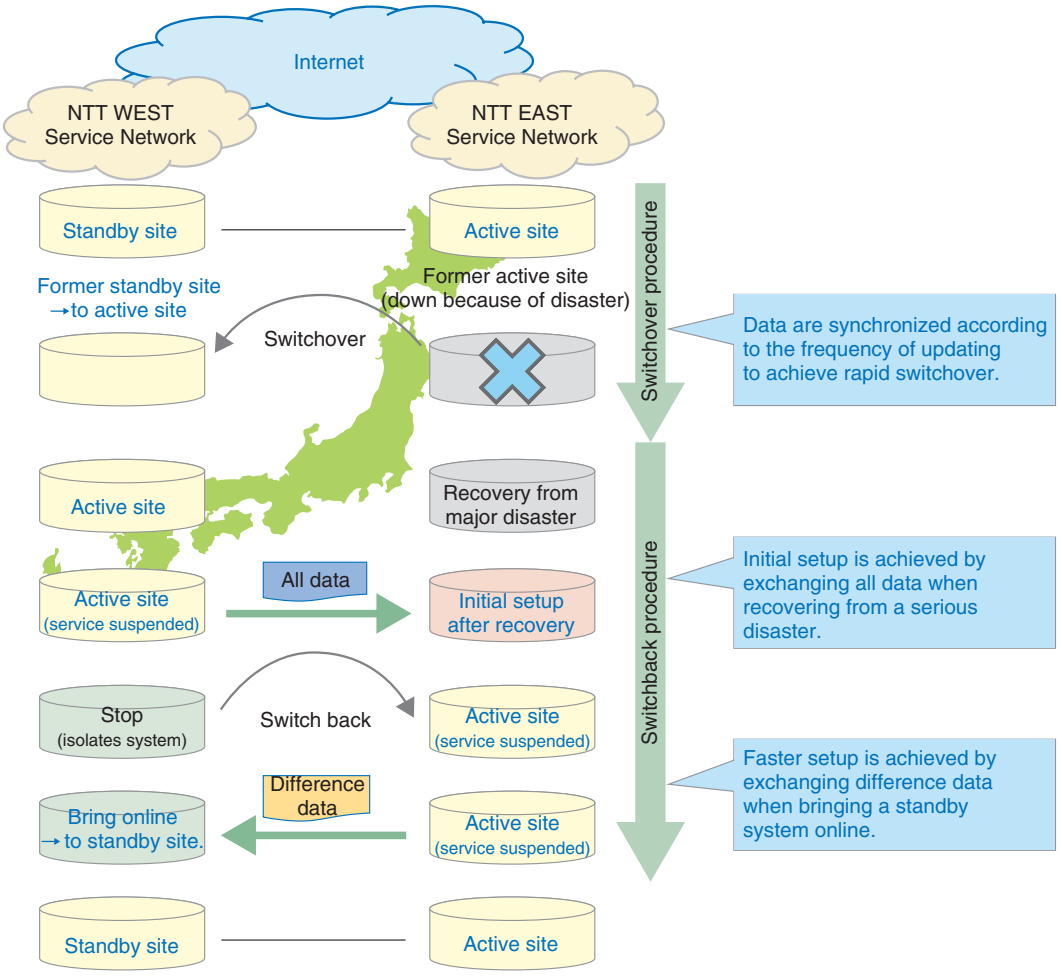


Fig. 4. Site switchover and switchback during a major disaster.

are investigating the distribution of data among other providers as well as interworking with the web171 service, and we plan to further improve the convenience for users.

The Personal Safety Confirmation System must be easy to use and provide accurate confirmation of personal safety during an emergency, so we will continue working to make it even more convenient for users while dealing with changes in network circumstances.

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Naoto Hoshikawa
Research Engineer, Network Service Platform Project, NTT Network Service Systems Laboratories.

He received a B.E. in engineering from Chiba University in 2004, and an M.E. and Ph.D. in information science from Nagoya University in 2006 and 2012. He joined NTT EAST in 2010 and began studying SDPs. He developed the website Safety Confirmation System (Disaster Message Board web171) using SDP. He has also been engaged in research and development (R&D) of the telephone and website Safety Confirmation System at NTT Network Service Systems Laboratories. He is a member of the Institute of Electronics, Information and Communication Engineers (IEICE).

Toru Inaba
Senior Research Engineer, Network Service Platform Project, NTT Network Service Systems Laboratories.

He received a B.E. in mechanical engineering from Kogakuin University, Tokyo, in 1991. He joined NTT in 1991 and engaged in development of telephone exchange machines, media servers, a unified messaging system, and a SIP server in PSTN/IP networks. He has also been involved in R&D of the telephone and website Safety Confirmation System.

Kentaro Kichiyoshi
Senior Research Engineer, Network Service Platform Project, NTT Network Service Systems Laboratories.

He received a B.E. in information science from Kyoto University in 1996 and an M.E. from Nara Institute of Science and Technology in 1999. He joined NTT in 1999 and engaged in the study, development, and maintenance of commercial network services. He has also been involved in R&D of the telephone and website Safety Confirmation System.

Masatsugu Ohnishi
Research Engineer, Network Service Platform Project, NTT Network Service Systems Laboratories.

He received his B.E. in earth and planetary systems science from Hiroshima University in 2000. He joined NTT COMWARE in 2000 and engaged in the study, development, and maintenance of the NGN service. He is also involved in R&D of the telephone and website Safety Confirmation System at NTT Network Service Systems Laboratories.

Standardization Efforts in IP Number Portability Specifications

Toshio Norimatsu, Kenjiro Arai, and Tsuyoshi Jocha

Abstract

In the near future, the inter-connections between communications carrier networks that use E.164 numbers are expected to migrate to Internet protocol (IP) technology rather than connecting them through the existing public switched telephone network (PSTN). For the migration, IP networks must support number portability functionalities in order to continue the current service, although such functionalities are currently supported only in the PSTN. We describe in this article the domestic number portability specification published in August 2015 as well as the NTT initiatives in this area.

Keywords: number portability, IP interconnection, standardization

1. Introduction

Number portability is a service that enables users to change their contract communications carrier without changing their telephone number [1]. Number portability for fixed telephone numbers is called local number portability (LNP), and that for mobile numbers is called mobile number portability (MNP). In Japan, the Ministry of Internal Affairs and Communications (MIC) allocates telephone numbers to communications carriers. The carrier to which the number is allocated can be identified based on the first five digits (except the first '0') of a telephone number [2]. Conventionally, an originating carrier network forwards a call to a terminating carrier network based on the telephone number being called since the originating network can identify the terminating network from the called telephone number. However, with number portability, the originating carrier network cannot determine the terminating carrier network by inspecting the called telephone number; therefore, carrier networks need to obtain information in order to route a call to the terminating carrier network.

2. Solutions to number portability

The International Telecommunication Union, Telecommunication Standardization Sector (ITU-T) E.164 supplement 2 specifies four solutions to number portability:

- All Call Query (ACQ)
- Query on Release (QoR)
- Call Dropback (CD)
- Onward Routing (OR)

The following database solutions for maintaining number portability data are also specified.

- The data of all communications carriers are collected in a common database (common database solution).
- Each communications carrier deploys a database for collecting the data of all communications carriers (individual database solution (all data collection)).
- Each communications carrier deploys a database for collecting only its own data (individual database solution (own data collection)).

2.1 Method of implementing number portability in current telephone networks (PSTN)

In a public switched telephone network (PSTN), the destination carrier network of a call destined to a number portability user is resolved using one of the following methods (see **Fig. 1**):

1) CD solution: an originating carrier network routes the call to a donor carrier network based on the telephone number, and the donor network

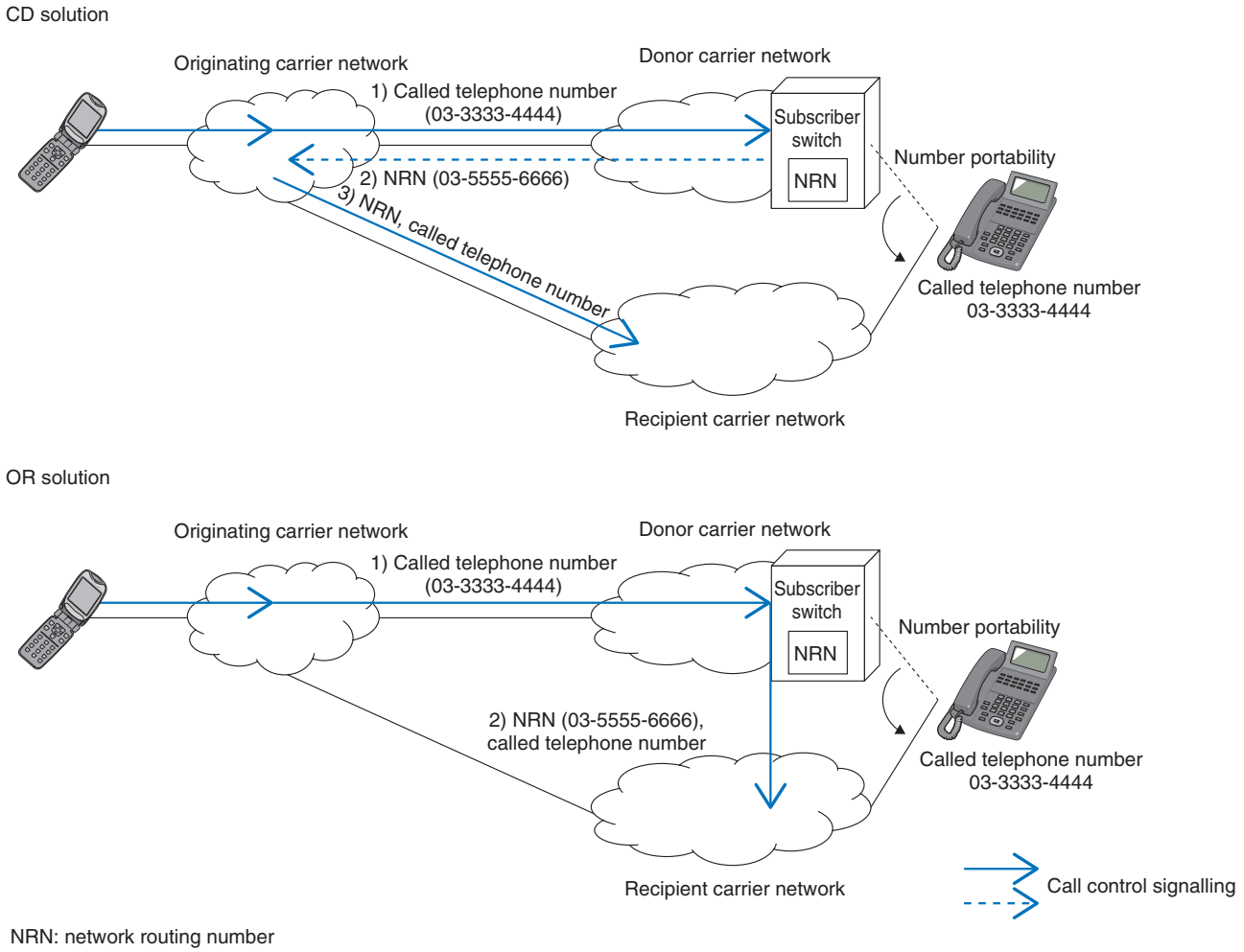

Fig. 1. PSTN number portability implementation method.

provides the routing information to the originating network. Then the originating carrier network reroutes the call to the recipient carrier network.

2) OR solution: an originating carrier network routes the call to a donor carrier network based on the telephone number, and the donor network routes the call to the recipient carrier network using the routing information in the donor carrier network.

In routing the call to the recipient carrier network, a network routing number (NRN) is used to identify the donor carrier network. Fixed carrier networks store NRNs in the subscriber circuit switches, and mobile carrier networks store them in the home subscriber server or home location register. Also, a connection request from the originating carrier network contains an indication that the originating carrier network requested the call to be routed by using either the CD or OR solution. The recipient carrier network determines the routing action based on the information.

2.2 Domestic standardization of IP number portability

The Mutual Understanding Meeting on PSTN Migration is a forum hosted by NTT EAST and NTT WEST that has been held regularly since 2010. In this meeting, representatives of domestic communications carriers discuss a variety of PSTN-migration-related requirements, including number portability. As a result of these meetings, it was agreed to adopt the ACQ solution as an Internet protocol (IP) number portability solution for the following reasons

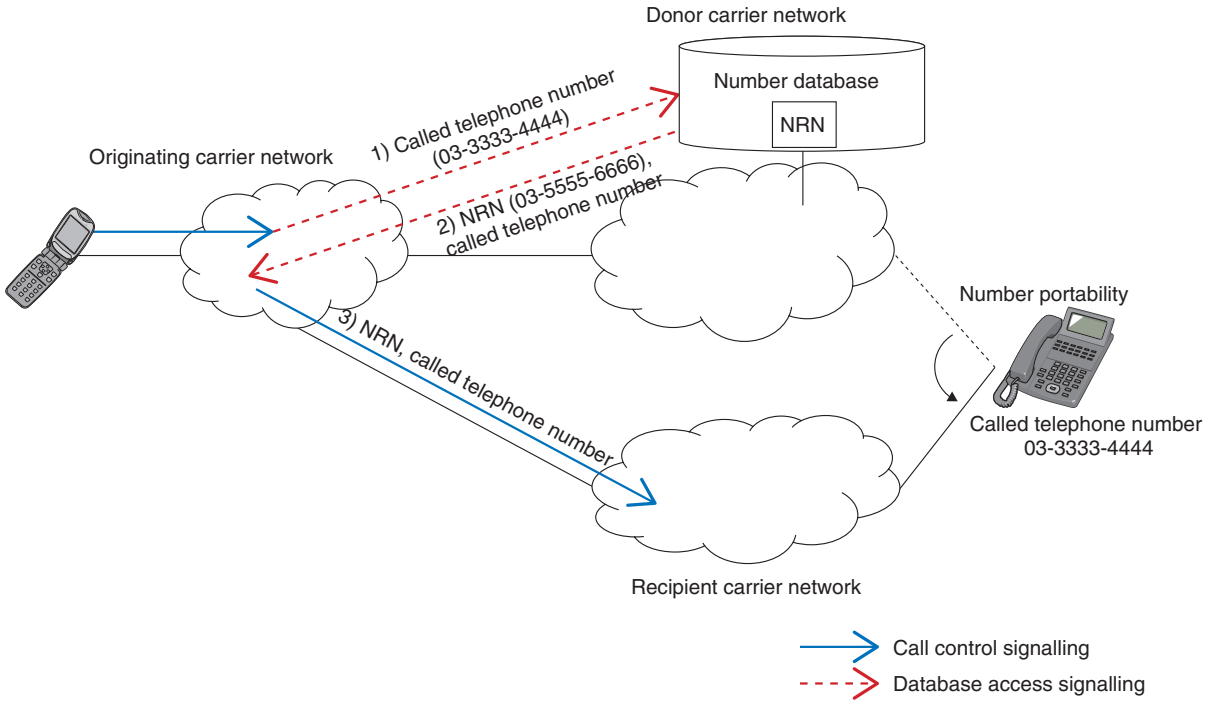

Fig. 2. IP number portability implementation methodology.

(**Fig. 2**):

- Because calls are not forwarded to the donor carrier network, codecs and services such as messaging are not affected by the services or capabilities supported by the donor carrier network. Calls can be connected to the recipient carrier network even when call control servers of the donor carrier networks are out of order.
- Many countries have adopted this solution in their PSTNs.

An individual database solution (own data collection) was selected for ease of deployment and security of data management.

Based on this conclusion, a liaison statement that requests domestic standardization of IP number portability in order to implement the agreed-upon basic policies was created at the mutual understanding meeting and sent to the Telecommunication Technology Committee (TTC).

For number portability standardization, it is necessary to standardize the system architecture and function deployment, as well as the signalling that is implementable on that architecture. To achieve this, the Number Portability Joint Ad Hoc Study Group was established as a joint ad hoc group of the Numbering Plan Working Group (responsible for E.164 numbers*) and the Signalling Working Group (responsible for signalling).

3. NTT initiatives for TTC standardization

Our group in NTT Network Service Systems Laboratories is working on some initiatives for standardizing the interface between communications carriers, which is called the network-to-network interface (NNI), to enable future IP interconnection between carriers (**Fig. 3**).

We studied signalling requirements related to number portability database queries, and to enable fixed and mobile carriers to be commonly used, we adopted the carrier E.164 number mapping (ENUM) applied in the Third Generation Partnership Project (3GPP) specifications and guidelines of the GSM (Global System for Mobile communications) Association (GSMA), and thoroughly took the initiative in making a draft of TTC standards related to domain name system (DNS) messages exchanged between ENUM servers and Session Initiation Protocol (SIP) servers as well as SIP server routing requirements using

* E.164 number: A telephone number format specified in ITU-T E.164.

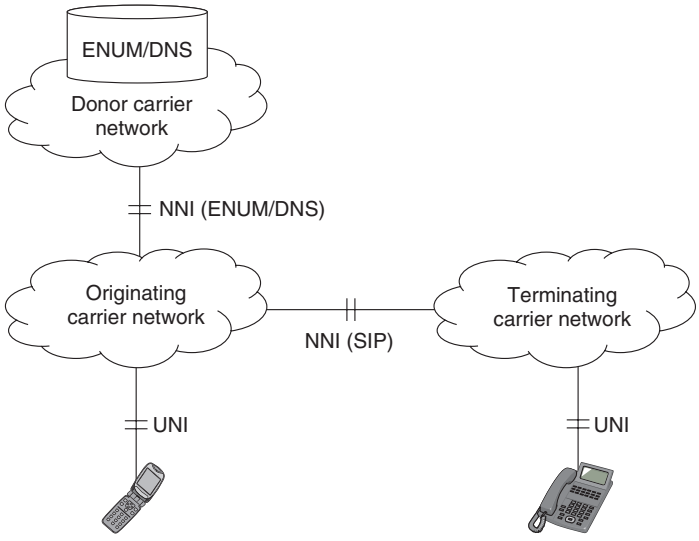

Fig. 3. Interconnection model of carrier networks.

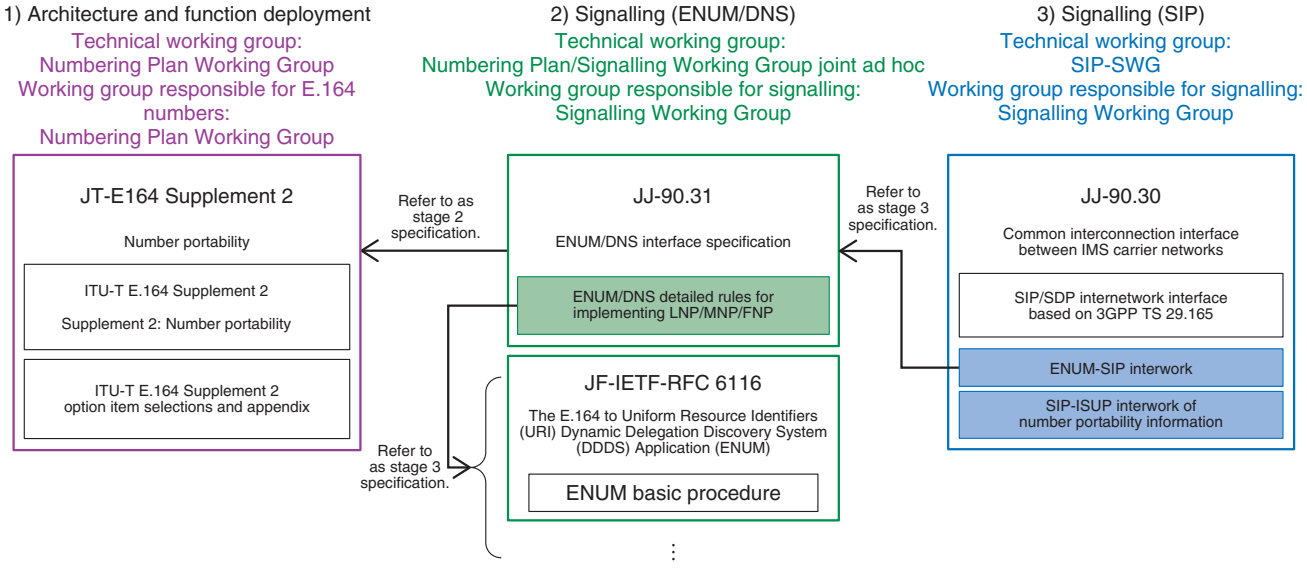

Fig. 4. Configuration of number portability specification documents.

ENUM. The TTC conducted technical studies, and the specifications were published in August 2015 as JJ-90.31. The specification documents for number portability are indicated in **Fig. 4**.

Furthermore, with respect to the basic SIP/Session Description Protocol (SDP) NNI specifications, except those concerning number portability, we proposed the IP interconnection specification to TTC, and TTC published it in May 2015 as JJ-90.30 [3]. This specification conforms to 3GPP specifications.

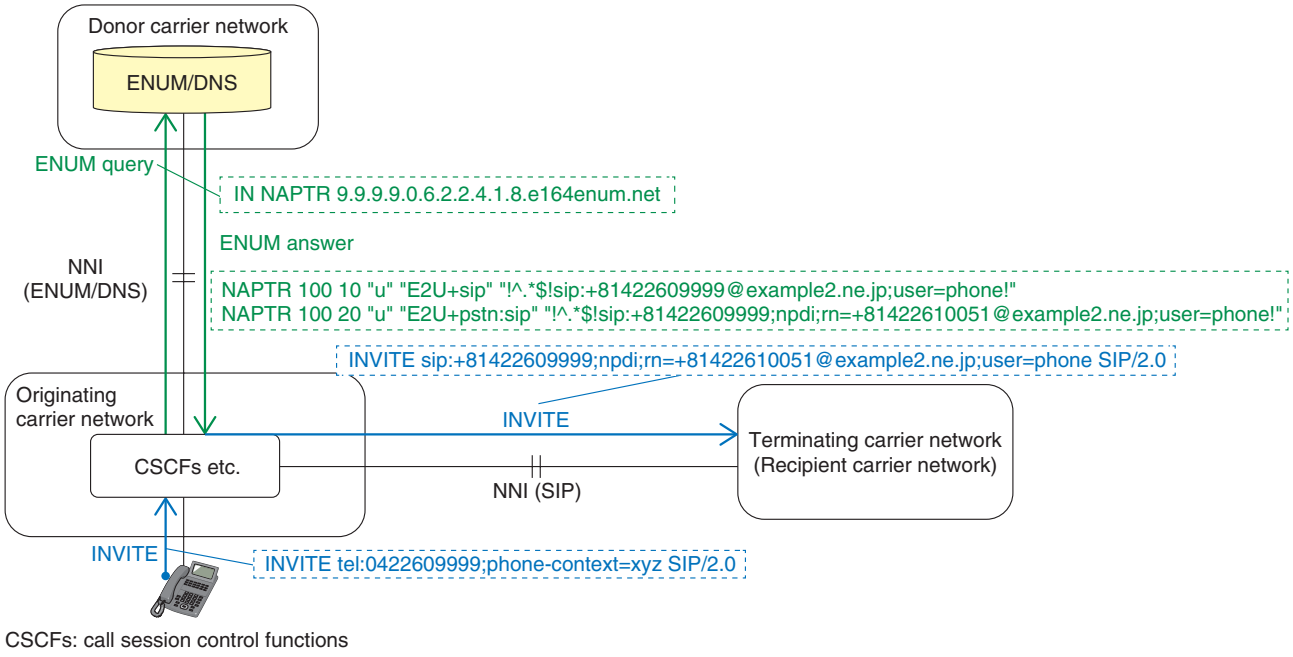

Fig. 5. Example call flow of number portability.

4. Overview of number portability technical specifications

JJ-90.31 specifies basic signalling requirements for retrieving Uniform Resource Identifiers (URIs) corresponding to the telephone numbers over the NNI between different communications carrier networks. Protocols and procedures are also specified in JJ-90.31. Furthermore, JJ-90.31 conforms to ENUM/DNS Request for Comments (RFCs) (e.g., RFC 1034, RFC 1035, RFC 6116) and GSMA ENUM/DNS guidelines [4], with operating conditions related to migration from current telephone networks added.

The ENUM is a mechanism by which an application can retrieve one or more applications corresponding to a telephone number in the URI format through the querying DNS using the telephone number as a search key. The source of an ENUM query uses a URI in Naming Authority Pointer (NAPTR) records in order to connect to the application. The TTC standard includes the following clarifications in regard to the corresponding international standards:

- A priority value described in NAPTR records is specified, and supplementary rules on option parameters used in URIs are added.
- Supplementary rules to ENUM/DNS procedures (iterative and recursive queries) are added.
- Sequence and message examples are added.

For example, as an ENUM/DNS procedure clarification, the answer condition for an absent number (a telephone number that is not in use) is clarified. For conformance to international standards and PSTN function deployment, JJ-90.31 specifies that ENUM/DNS answers a query by sending a NAPTR record(s) corresponding to the absent number as routing information to the donor carrier network, which is connected to the originating carrier network. Then the donor carrier network determines whether it is an absent number in the SIP layer.

Taking into account the coexistence period of the PSTN and IP networks, we needed to consider the case in which the originating and donor carrier networks are IP-interconnected, but the originating and recipient carrier networks are interconnected via the PSTN. To address this coexistence period, JJ-90.31 specifies that multiple NAPTR records can be conveyed in the answer of an ENUM query to allow ENUM/DNS to include in the answer the URI information including the NRN, which is needed for the PSTN in connecting to the recipient carrier network (**Fig. 5**).

5. Future prospects

Preparation of TTC standard JJ-90.30, which specifies NNI basic SIP/SDP signalling requirements, and TTC standard JJ-90.31, which specifies the ENUM/DNS interface needed in SIP routing including number portability, have been completed, and the bilateral IP interconnection between communications carriers has shifted to the implementation phase towards commercial service. With the objective of realizing commercialization, we plan to work on achieving timely and continuous standardization in tandem with the discussion at the Mutual Understanding Meeting on PSTN Migration, while covering carrier demands.

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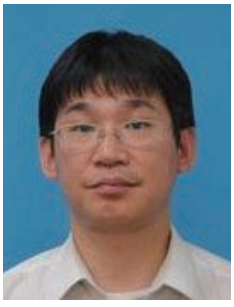
Toshio Norimatsu
Research Engineer, NTT Network Service Systems Laboratories.
He received a B.S. in information sciences from Tokyo Institute of Technology in 1992. He is currently researching interconnection between IP multimedia subsystem (IMS) networks.

Kenjiro Arai
Researcher, NTT Network Service Systems Laboratories.
He received an M.S. in information sciences from Tohoku University, Miyagi, in 2007. In the same year, he joined NTT Network Service Systems Laboratories. He is currently researching interconnection between IMS networks.



Tsuyoshi Jocha
Researcher, NTT Network Service Systems Laboratories.
He received an M.S. in basic science from the University of Tokyo in 1996. In the same year, he joined NTT Network Service Systems Laboratories. He is currently researching interconnection between IMS networks.

Wireless LAN Tester Conformable to IEEE802.11ac

Abstract

This article describes the development and introduction of a wireless LAN (local area network) tester conformable to the IEEE802.11ac standard. This is the thirty-second article in a bimonthly series on practical field information on 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, NTT EAST.

Keywords: wireless LAN tester, IEEE802.11ac, access point

1. Introduction

The proliferation of mobile terminals equipped with wireless local area network (LAN) functions has led to the installation of wireless LAN access points (APs) both indoors and outdoors and to the creation of Internet connection environments in diverse places.

In addition, the new IEEE*802.11ac wireless networking standard was approved in January 2014 with a maximum theoretical bit rate of 6.9 Gbit/s. In line with these trends, NTT EAST has been increasing the provision of telecommunication services using wireless LAN. For example, it has made its fifth-generation home gateway conformable to IEEE802.11ac and begun providing FLET'S HIKARI optical broadband services capable of gigabit-level communications.

However, installing Internet connection environments using wireless LAN can lead to communication problems due to radio wave interference and other factors. In fact, communications by wireless LAN can be lost in homes and retail establishments due to the effects of radio waves emitted from a variety of wireless devices. It is desirable that such problems be solved at an early stage, and for this reason, we developed a wireless LAN tester that can visualize signal and communication conditions in the radio interval and expanded its on-site use [1].

In this article, we introduce our development of a wireless LAN tester conformable to the new IEEE802.11ac standard.

2. Wireless LAN tester functions

The main inspection requests and failure causes in relation to on-site use of wireless LAN are shown in **Fig. 1** together with corresponding functions deemed necessary for the wireless LAN tester. Here, the main causes of communication failures are interference from extraneous noise and inter-channel wireless LAN interference. In addition to finding solutions for communication problems, there is also a need to inspect AP placement and the electromagnetic environment prior to AP installation. To meet these needs, we have equipped the wireless LAN tester with the following functions.

Function 1: AP detection

- Detect APs conformable to IEEE802.11a/b/g/n/ac and display a list of APs.
- Select any AP and display channel number, transmission method, and other details of that AP.

Function 2: Received signal strength (RSS) measurement

- Continuously measure the RSS of all detected APs.
- Display temporal fluctuation of RSS for any AP.

* IEEE: Institute of Electrical and Electronics Engineers

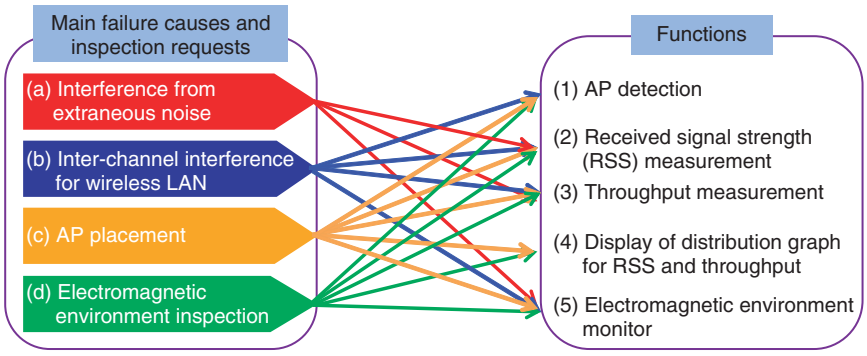


Fig. 1. Main inspection requests in relation to wireless LAN and functions.

Function 3: Throughput measurement
- Connect to any AP and continuously measure its throughput in the radio interval.
- Display temporal fluctuation of measured throughput.

Function 4: Display of distribution graph
- Display a distribution graph of RSS and throughput for any AP.

Function 5: Electromagnetic environment monitor
- Display RSS of all detected APs by channel.
- Display noise affecting wireless LAN communications by channel.

Function 6: Interference analysis
- Quantify possibility of throughput degradation due to inter-channel interference by channel.
- Display channels having low possibility of inter-channel interference as recommended channels.

Function 7: Pass/fail judgment
- Set targets (RSS and throughput) and automatically make a pass/fail judgment on measured values.

Function 8: Report preparation
- Output reports on measurements and judgment results.

Our wireless LAN tester equipped with the above functions consists of a personal computer (PC), dedicated wireless LAN adapter, and dedicated software. In addition, a USB (universal serial bus)-type spectrum analyzer can be used to measure noise affecting wireless LAN communications.

3. Conformity with IEEE802.11ac

3.1 AP detection

A wireless LAN AP periodically transmits a beacon signal to notify the surrounding area of its existence. This signal includes information that is needed for a terminal to connect to the wireless LAN network such as the channel number and security information. The AP detection function can detect and analyze this beacon signal and display detailed information on that AP. The function can also display a list of all detected APs classified by channel or service set identifier (SSID) and can be used to check for available channels and the interference with other APs.

A screenshot of the AP detection function is shown in **Fig. 2**. Detailed information on an AP selected from the left of the screen is displayed on the upper right of the screen. It can be confirmed that the target AP conforms to IEEE802.11ac.

The IEEE802.11ac standard achieves high-speed communications through a channel-bonding function that binds multiple channels. The AP details in Fig. 2 indicate that communication that binds four channels (for a total bandwidth of 80 MHz) is possible enabling a maximum bit rate of 1.3 Gbit/s.

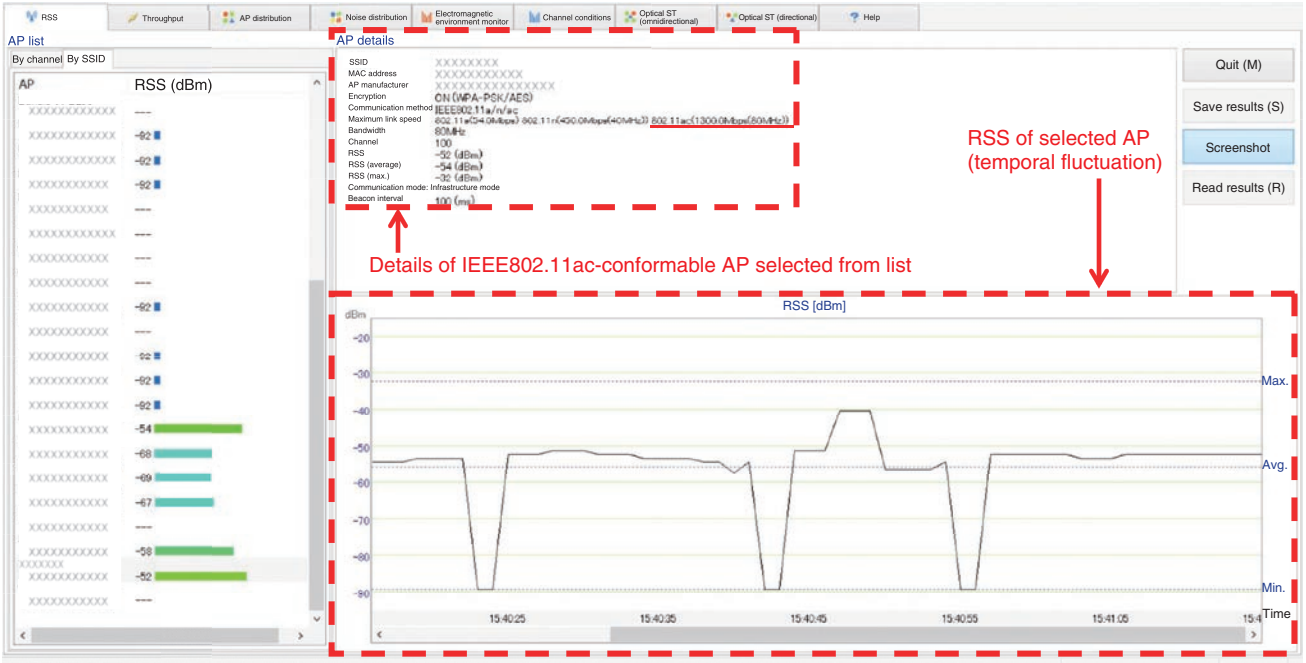
3.2 RSS measurement

The function can display the signal strength of APs in real time. A screen shot of this function is shown in the lower part of Fig. 2. The function can be used to examine the temporal fluctuation of RSS and to check the RSS of wireless LAN signals at any position.

3.3 Throughput measurement

This function continuously transmits User Datagram Protocol packets generated by dedicated software on the wireless LAN tester to the wireless LAN adapter and measures throughput on the radio interval between the AP and the tester. This requires a connection with the AP targeted for measurement and a password to make that connection.

A screenshot of throughput measurement for an IEEE802.11ac-conformable AP is shown in **Fig. 3**.



MAC: media access control
ST: station

Fig. 2. Screenshot of AP detection function.

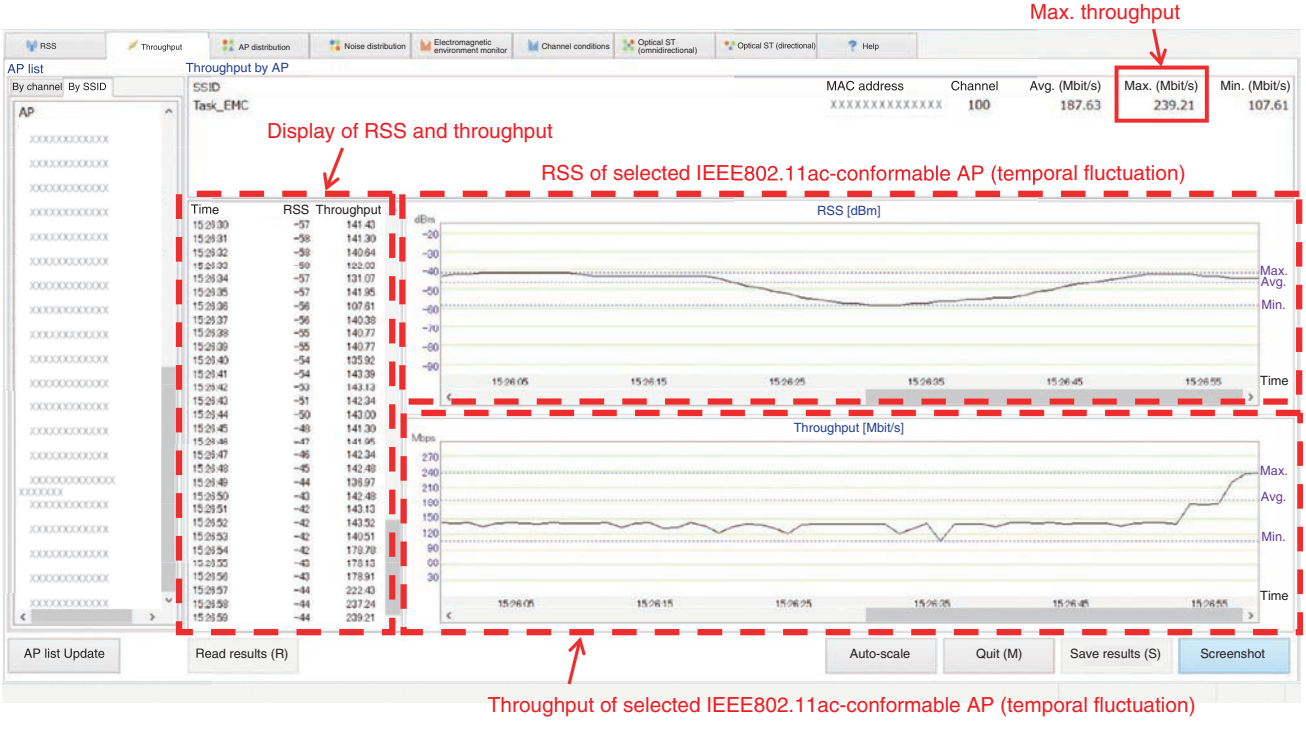


Fig. 3. Screenshot of throughput measurement function.

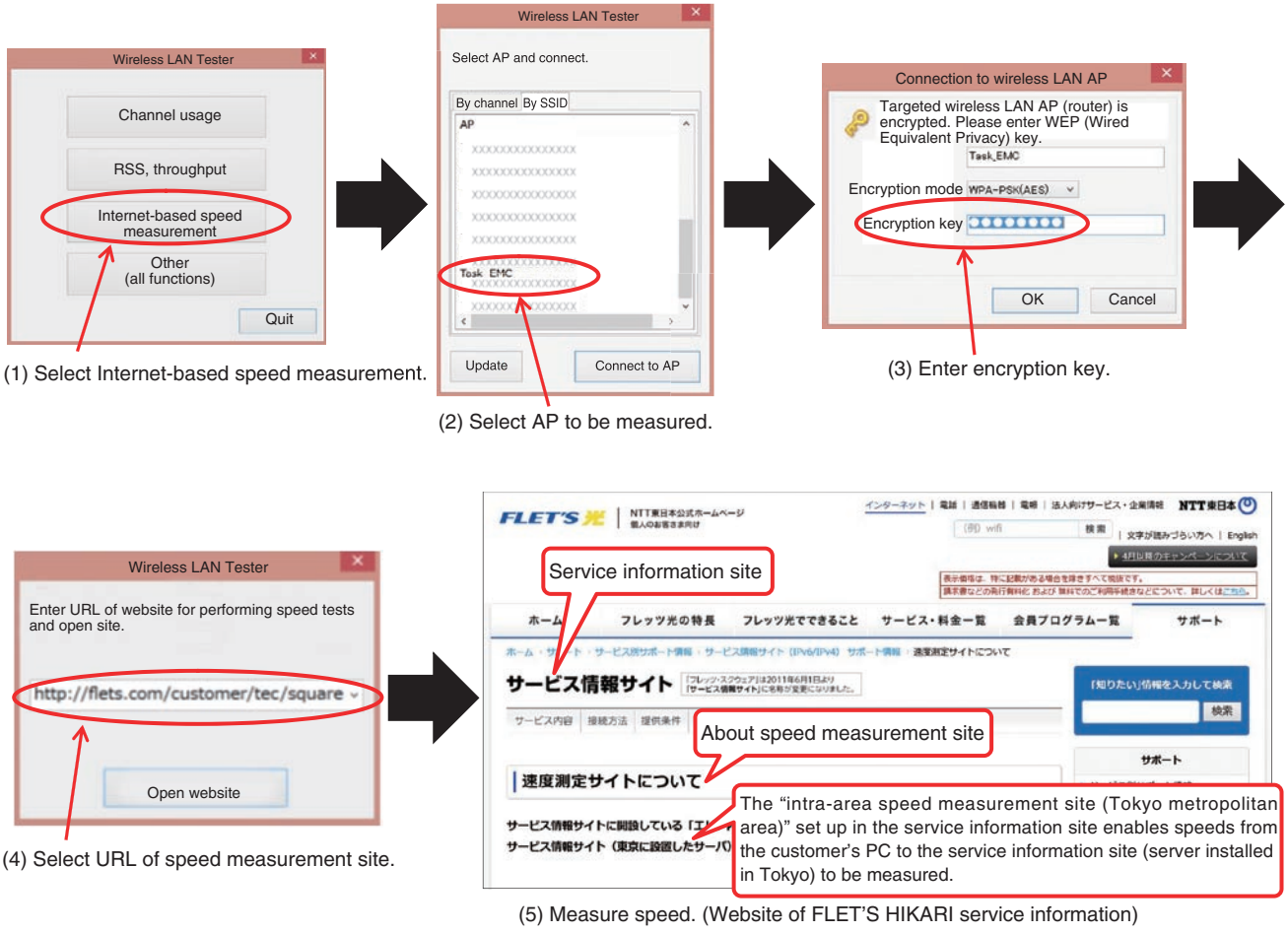


Fig. 4. Screenshots of Internet-based speed measurement.

These results show that a maximum throughput of 239 Mbit/s was measured. Displaying the measurement results for RSS and throughput on one screen in this way enables the user to examine the correspondence between these two characteristics. Furthermore, in an environment enabling an Internet connection, throughput can be measured by connecting to a website for measuring speed as shown in **Fig. 4**.

3.4 Electromagnetic environment monitor

This function can be used to examine the level of noise affecting wireless LAN communications on each channel. It can also be used to confirm the channels set for a wireless LAN AP and associated bandwidth and RSS. A screenshot of the electromagnetic environment monitor is shown in **Fig. 5**. It can be confirmed that a noise level is extremely high in channels 4–6 in the 2.4-GHz band, while it is extremely low in the 5-GHz band. In addition, while the channel set for this AP in the 5-GHz band is channel 100, communications using four channels becomes possible through the channel bonding function.

4. Application

We describe here AP placement as an application of the wireless LAN tester. We tested the signals transmitted from an AP installed outside an apartment room for achieving shared use of wireless LAN in that apartment. We used the distribution graph function of the wireless LAN tester. The results are shown in **Fig. 6**. The AP was set to channel 100 in the 5-GHz band. These results show that the RSS and throughput were greater than –67 dBm and 53 Mbit/s, respectively, which indicates that wireless LAN communications were possible in all rooms within the apartment. Thus, the wireless LAN tester was effective for

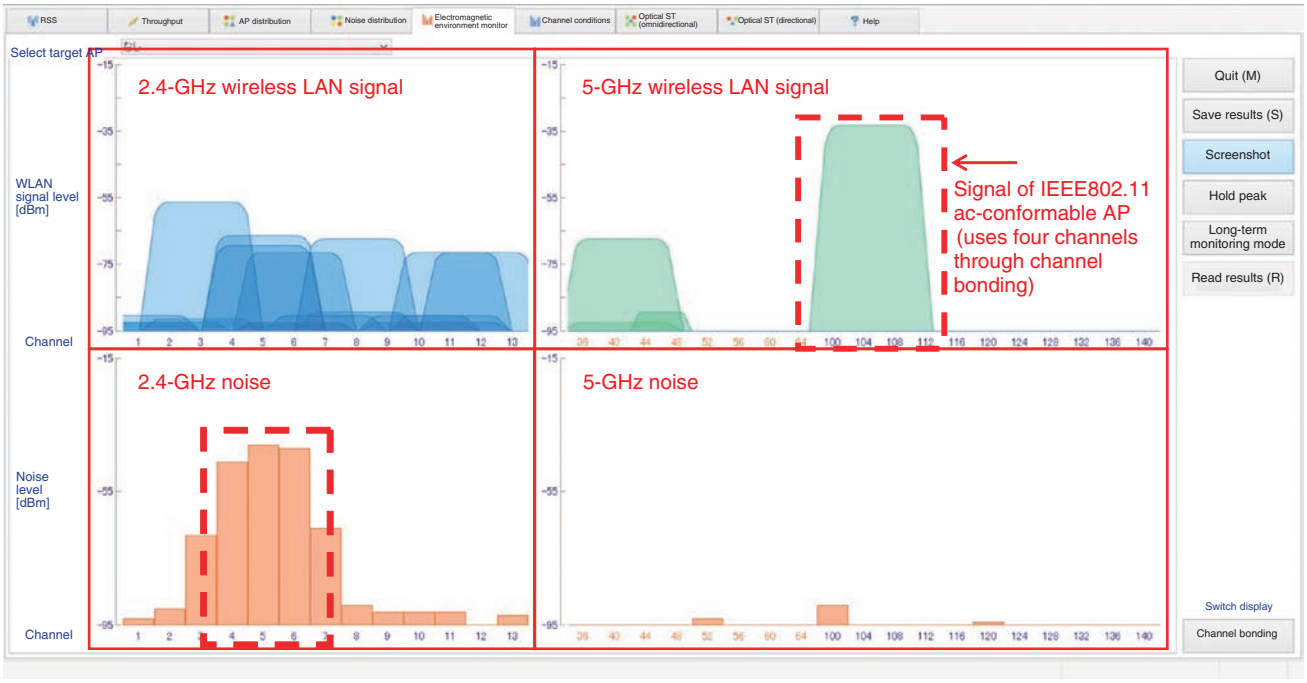
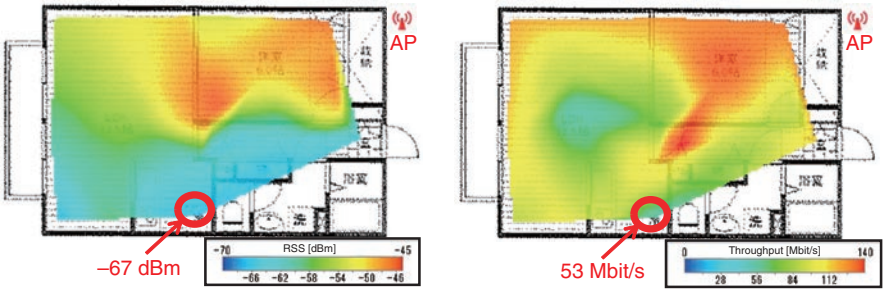


Fig. 5. Screenshot of electromagnetic environment monitor.



(a) RSS (b) Throughput

Fig. 6. RSS and throughput measurement results.

visually confirming the signals transmitted from an AP.

5. Conclusion

In this article, we introduced the functions of an IEEE802.11ac-conformable wireless LAN tester and described an application including a distribution graph for RSS and throughput.

We made this wireless LAN tester conformable to IEEE802.11ac with respect to the functions of AP detection, RSS measurement, throughput measurement, and electromagnetic environment monitoring. We also devised a display format that shows the measurement results of RSS and throughput on one screen to speed up troubleshooting of the causes of failures. We plan to improve and expand the functions of this tester and to make it conformable to any new wireless LAN standards.

The EMC Engineering Group of the Technical Assistance and Support Center is committed to achieving prompt resolution of failures related to wireless LAN and to contribute to the smooth provision of communication services. To this end, it is

actively engaged in technology dissemination activities through technical support, development, and technical seminars.

Reference

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New NTT Colleagues
—We welcome our newcomers to the NTT Group

This is a corner of the NTT Technical Review where we introduce our new affiliate companies.

PT. Cyber CSF
Largest datacenter service provider in Indonesia; established in 2012; headquartered in Jakarta

Founded in 2012, PT. Cyber CSF (renamed PT. NTT Indonesia Nexcenter), is Indonesia's largest datacenter service provider. It operates a high-quality facility equipped for 24 MVA of power and 2800 racks in 7700 square meters of space in the heart of Jakarta (**Photo 1**). The Indonesian ICT (information and communication technology) market is expected to average about 10% annual growth through 2017, exceeding growth in most other Southeast Asian countries. Datacenter outsourcing in Indonesia is expected to expand beyond 2016, triggered by new laws and regulations, as well as administrative guidance by the central bank, Bank Indonesia, regarding datacenter quality and the use of such services by financial companies.

In October 2015, NTT Communications Corporation announced that it had wholly acquired PT. Cyber CSF and renamed the company PT. NTT Indonesia Nexcenter. The acquisition further strengthens NTT Communications' Nexcenter™ datacenter capabilities in the Asia-Pacific region, where it serves major local and

Photo 1. External view of datacenter in Jakarta.

multinational customers, especially in the fields of finance, information technology, and manufacturing.

Contact:
Public Relations Department
NTT Communications Corporation
http://www.ntt.com/aboutus_e/news/data/20151007_2.html

External Awards

METI-KANSAI Director-General's Award

Winner: Kenta Niwa, Hisashi Uematsu, and Kazunori Kobayashi, NTT Media Intelligence Laboratories
Date: March 27, 2015
Organization: The Kansai Bureau of Economy, Trade and Industry (METI-KANSAI)

For their demonstration of the zoom microphone system, which can pick up target sounds from a distance, at The Lab. in Grand Front Osaka.

IIEEJ Research Encouragement Award

Winner: Shuhei Tarashima, NTT Media Intelligence Laboratories
Date: June 28, 2015
Organization: The Institute of Image Electronics Engineers of Japan (IIEEJ)

For "Fast Web Image Object Cosegmentation with Region Matching."
Published as: S. Tarashima, G. Irie, H. Arai, and Y. Taniguchi, "Fast Web Image Object Cosegmentation with Region Matching," Proc. of Media Computing Conference 2014 (the 42nd Annual Conference of the Institute of Image Electronics Engineers of Japan), R4-2, Tokyo, Japan, Jun. 2014.

IPSJ Yamashita SIG Research Award

Winner: Takeshi Yamamuro, NTT Software Innovation Center
Date: August 3, 2015
Organization: The Information Processing Society of Japan (IPSJ)

For "LZE++: Fast Random Access for Shared Dictionary Compression."
Published as: T. Yamamuro, M. Onizuka, and T. Honjo, "LZE++: Fast Random Access for Shared Dictionary Compression," Proc. of DEIM2015 (the 7th Forum on Data Engineering and Information Management), G3-3, Fukushima, Japan, Mar. 2015 (in Japanese).

Analytical Sciences Hot Article Award

Winner: Yuko Ueno, Kazuaki Furukawa, Andrew Tin, and Hiroki Hibino, NTT Basic Research Laboratories
Date: September 10, 2015
Organization: The Japan Society for Analytical Chemistry

For "On-chip FRET Graphene Oxide Aptasensor: Quantitative Evaluation of Enhanced Sensitivity by Aptamer with a Double-stranded DNA Spacer."

We propose a molecular design for a biomolecular probe to realize an on-chip graphene oxide (GO) aptasensor with enhanced sensitivity. Here, GO works as an excellent acceptor for fluorescence resonance energy transfer. We inserted rigid double-stranded DNA as a spacer between the GO surface and the aptamer sequence to extend the distance between a fluorescence dye and the GO surface during molecular recognition. We examined the dependence of the sensitivity on the length of the spacer quantitatively by using a 2×2 linear-array aptasensor. We used the modified aptamer with 10 and 30 base pair (bp) double-stranded DNA spacers. The signal with a 30-bp spacer was about twice as strong as that with a 10-bp spacer for both thrombin and prostate specific antigen detection. The improvement in the sensitivity was supported by a model calculation that estimated the effect of spacer length on fluorescence recovery efficiency.
Published as: Y. Ueno, K. Furukawa, A. Tin, and H. Hibino, "On-chip FRET Graphene Oxide Aptasensor: Quantitative Evaluation of Enhanced Sensitivity by Aptamer with a Double-stranded DNA Spacer," Analytical Sciences, Vol. 31, No. 9, pp. 875–879, 2015.

Young Scientist Presentation Award

Winner: Kota Okazaki, NTT Nanophotonics Center/NTT Device Technology Laboratories
Date: September 13, 2015
Organization: The Japan Society of Applied Physics (JSAP)

For "A Low-loss SiON Optical Waveguide Fabricated by ECR-PE CVD with SiD_4 Gas."
Published as: K. Okazaki, H. Nishi, T. Tsuchizawa, T. Yamamoto, and K. Yamada, " A Low-loss SiON Optical Waveguide Fabricated by ECR-PE CVD with SiD_4 Gas," Proc. of the 62nd JSAP Spring Meeting 2015, 11p-A16-2, Kanagawa, Japan, Mar. 2015 (in Japanese).

JSAP Young Scientist Award

Winner: Daiki Hatanaka, NTT Basic Research Laboratories
Date: September 13, 2015
Organization: The Japan Society of Applied Physics (JSAP)

For "Mechanical Random Access Memory in a Phonon Circuit."

A phonon waveguide (WG) constructed via a one-dimensional array of mechanical resonators is used to access a localized mechanical resonator. This resonator plays the role of a memory node in which binary information can be written, stored, and read via the mobile mechanical excitations in the phonon WG. The phonon WG-localized resonator architecture demonstrates the viability of mechanical circuits for information processing applications.
Published as: D. Hatanaka, I. Mahboob, K. Onomitsu, and H. Yamaguchi, "Mechanical Random Access Memory in a Phonon Circuit," Appl. Phys. Express, Vol. 7, No. 12, p. 125201, 2014.

Encouragement Award (Industrial Science and Technology Policy and Environment Bureau Director-General's Award) in FY2015 Industrial Standardization Awards

Winner: Takashi Matsui, NTT Access Network Service Systems Laboratories
Date: October 5, 2015
Organization: Ministry of Economy, Trade and Industry

For his supportive role in international standardization activities for IEC (International Electrotechnical Commission) Technical Committee 86 (fibre optics) and the expectation to make further contributions in the future.

Papers Published in Technical Journals and Conference Proceedings

Visual Attention Driven by Auditory Cues: Selecting Visual Features in Synchronization with Attracting Auditory Events

J. Nakajima, A. Kimura, A. Sugimoto, and K. Kashino

Proc. of MMM 2015 (the 21st Anniversary International Conference on MultiMedia Modeling), pp. 74–86, Sydney, Australia, January 2015.

This paper proposes a novel computational model of human visual attention driven by auditory cues. Founded on the Bayesian surprise model that is considered to be promising in the literature, our model uses surprising auditory events to serve as a clue for selecting synchronized visual features and then emphasizes the selected features to form the final surprise map. Our approach to audio-visual integration focuses on using effective visual features alone—but not all available features—for simulating visual attention with the help of auditory information. Experiments using several video clips show that our proposed model can better simulate eye movements of human subjects than other existing models even though our model uses a smaller number of visual features.

Virtual Network Embedding across Multiple Domains with Secure Multi-party Computation

T. Mano, T. Inoue, K. Mizutani, and O. Akashi

IEICE Transactions on Communications, Vol. E98-B, No. 3, pp. 437–448, March 2015.

Network virtualization is a promising technology that can increase flexibility, diversity, and manageability of networks. The concept of building optimal virtual networks across multiple domains is getting much attention, but existing studies are based on the unrealistic assumption that providers' private information can be disclosed; as is well known, providers never actually do that. In this paper, we propose a new method that solves this multi-domain problem without revealing the providers' private information. Our method uses an advanced secure computation technique called multi-party computation (MPC). Although MPC enables existing unsecured methods to optimize virtual networks securely, it requires a very long time to finish the optimization due to the MPC's complex distributed protocols. Our method, in contrast, is designed to involve only a small number of MPC operations to find the optimal solution, and it allows providers to execute a large part of the optimization process.

Analysis of Process Assignment in Multi-tier Mobile Cloud Computing and Application to Edge Accelerated Web Browsing

N. Takahashi, H. Tanaka, and R. Kawamura

Proc. of IEEE Mobile Cloud 2015 (the 3rd IEEE International Conference on Mobile Cloud Computing, Services, and Engineering), pp. 233–234, San Francisco, USA, March/April 2015.

This paper discusses multi-tier mobile cloud computing architecture, where small IT (information technology) servers in the users' proximity are utilized to execute part of the application processing. The partitioning method changes the distribution of processing loads and traffic and affects the processing delay or battery usage. The problem is that it is unclear which partitioning method brings a better result. This paper introduces an abstract model of application execution in a multi-tier mobile cloud, discusses performance metrics, and examines various trade-offs. A prototype named Edge Accelerated Web Browsing is also presented.

Geometric Interpretation of Fisher's Linear Discriminant Analysis through Communication Theory

J. Fujiki, M. Tanaka, H. Sakano, and A. Kimura

Proc. of MVA 2015 (the 14th IAPR International Conference on Machine Vision Applications), pp. 333–336, Tokyo, Japan, May 2015.

This paper provides a geometrical aspect of Fisher's linear discriminant analysis (FLDA), which has been widely used owing to its simple formulation and low computational costs. Our approach is based on a new framework of pattern recognition that can be modeled by communicating class information. This model is quite different from a commonly used framework of pattern recognition as a mapping from the set of patterns to the set of classes. In the new framework, patterns can be regarded as class information with redundant encoding. We show that the geometry of two-class FLDA can be described via a communication theory of noisy channels.

Path Accommodation Design and Reconfiguration for Different Reliability Classes in Virtualized Multi-layer Transport Network

A. Kadohata, T. Tanaka, A. Watanabe, A. Hirano, H. Hasegawa, and K. Sato

Proc. of OECC 2015 (the 20th OptoElectronics and Communications Conference), Shanghai, China, June/July 2015.

We propose differenced accommodation design and reconfiguration in virtualized multi-layer transport networks. Numerical evaluation shows that when the number of classes allowing reconfiguration is dominant, the number of transponders is reduced up to 12%.

Mode Dependent Loss Equaliser and Impact of MDL on PDM-16QAM Few-mode Fibre Transmission

T. Mizuno, H. Takara, K. Shibahara, Y. Miyamoto, M. Oguma, H. Ono, Y. Abe, T. Matsui, S. Matsuo, K. Saitoh, and Y. Kimura

Proc. of the 41st European Conference on Optical Communication (ECOC 2015), Valencia, Spain, September/October 2015.

We experimentally evaluate the relationship between mode dependent loss (MDL) and Q penalty for few-mode fibre transmission. We employ a low-MDL recirculating loop and free-space optics type MDL equaliser and transmit 3-mode signals with PDM (polarization-division multiplexed)-16QAM(quadrature amplitude modulation).

Dense Space Division Multiplexing Long Haul Transport System Using Multi-core / Multi-mode Fibre

T. Mizuno, H. Takara, A. Sano, and Y. Miyamoto

Proc. of ECOC 2015, Valencia, Spain, September/October 2015.

We review recent dense space division multiplexing (DSDM) transmission technologies for multi-core/multi-mode fibre and discuss issues toward future DSDM long haul transport systems.

Pre-adjustment Rerouting for Wavelength Defragmentation in Optical Transparent WDM Networks

A. Kadohata, A. Watanabe, A. Hirano, H. Hasegawa, and K. Sato

IEICE Transactions on Communications, Vol. E98-B, No. 10, pp. 2014–2021, October 2015.

We propose a new extension to reconfiguration algorithms used to address wavelength defragmentation to enhance the path accommodation efficiency in optical transparent wavelength division multiplexing networks. The proposed algorithm suppresses the number of fibers employed to search for a reconfigurable wavelength channel by combining routes between the target path and the existing path in a reconfigured wavelength channel. This paper targets three main phases in reconfiguration: i) the reconfiguration trigger; ii) redesign of the wavelength path; and iii) migrating the wavelength paths. The proposed and conventional algorithms are analyzed from the viewpoints of the number of fibers, the accommodation rate, and the number of migrating sequences. Numerical evaluations show that the number of fibers is suppressed by 9%, and that the accommodation efficiency is increased by approximately 5–8% compared to when reconfiguration is not performed.

Acoustic Event Detection in Speech Overlapping Scenarios Based on High Resolution Spectral Input and Deep Learning

M. Espi, M. Fujimoto, and T. Nakatani

IEICE Transactions on Information and Systems, Vol. E98-D, No. 10, pp. 1799–1807, October 2015.

Acoustic event detection techniques are typically based on derived features that reduce resolution and detail when we are targeting other kinds of events. We propose a method that learns features in an unsupervised manner from high resolution spectrogram patches, and integrates within the deep neural network framework to detect and classify acoustic events.

Adaptive Post-filtering Method Controlled by Pitch Frequency for CELP-based Speech Coding

H. Chiba, Y. Kamamoto, T. Moriya, N. Harada, S. Miyabe, T. Yamada, and S. Makino

IEICE Transactions on Information and Systems (Japanese Edition), Vol. J98-D, No. 10, pp. 1301–1311, October 2015.

Most speech codecs utilize a post-filter that emphasize pitch structures to enhance perceptual quality at the decoder. Particularly, the bass post-filter used in ITU-T G.718 performs a pitch enhancement technique for a lower fixed frequency band. This paper describes a new post-filtering method which adaptively controls the frequency band and the gain of the post-filter frame-by-frame depending on the pitch frequency of the decoded signal to improve the quality. We have confirmed the enhancement of the speech quality with the developed method through objective and subjective evaluations. This devised technology can be easily applied to most of CELP-based speech codecs.

Comparison of the Photodegradation Behavior of LDPE Using Accelerated Weathering Instruments

T. Miwa, Y. Takeshita, Y. Akage, M. Watanabe, M. Takaya, and T. Sawada

Corrosion Engineering, Vol. 64, No. 4, pp. 99–106, October 2015.

Samples of low-density polyethylene (LDPE) were photodegraded using accelerated weathering instruments and outdoor exposure. The physical properties and chemical structures of the photodegraded samples were studied through a tensile test, gel chromatography, and infrared spectroscopy. The molecular weight distribution of a sample photodegraded by using a fluorescent ultraviolet lamp at a high black panel temperature (80°C) was more similar to that of an outdoor-degraded sample than that of other artificially samples photodegraded by using a xenon lamp at the standard black panel temperature (63°C). It is estimated that accelerated weathering tests at a high sample temperature can accelerate cross-linking more than chain scission, consequently recreating molecule-enlargement in a similar way to the outdoor-degraded sample.

Optical DP-high Order-QAM Transmission System for High-speed Short Links Utilizing Copropagating Twin Local Lights

H. Kawakami, T. Kobayashi, and Y. Miyamoto

Proc. of the 21st Asia-Pacific Conference on Communications (APCC2015), pp. 94–97, Kyoto, Japan, October 2015.

A novel optical high order quadrature amplitude modulation (QAM) transmission system for high-speed short links is described. Dual-polarization (DP) QAM and twin local lights are generated from one light source in the system, and these light waves are simultaneously transmitted via standard single-mode fiber. The receiver can be constructed simply because it does not require a coherent light source under wavelength control. The system enables a 3.1-Gbaud DP-16-QAM signal to be successfully demodulated after 80-km transmission without using an optical dispersion compensator. It also achieves high tolerance against phase noise in the signal light source.

High Capacity Dense SDM Transmission Using Multi-core Few-mode Fiber

T. Mizuno, H. Takara, A. Sano, and Y. Miyamoto

Proc. of the 2015 IEEE Photonics Conference, Virginia, USA, pp. 259–260, October 2015.

We review recent progress in space division multiplexed (SDM) transmission, and our proposal and the first demonstration of dense space division multiplexing (DSDM) towards ultra-high capacity optical transport systems.

Comparison of Subscriber Assignment Methods on Scalable Distributed Pub/Sub Systems

R. Banno, T. Kawano, S. Takeuchi, M. Takemoto, and M. Matsuo

Proc. of APCC2015, pp. 632–636, Kyoto, Japan, October 2015.

Scalable messaging methods for IoT services are needed to accommodate a vast number of devices. Skip Graph based, topic based pub/sub (SG-TPS), which utilizes multiple brokers composing a structured overlay network, is a promising candidate. In SG-TPS, the distribution delay time is widely influenced by the way subscribers are assigned to each broker. There are two possible approaches:

intensive assignment, by which subscribers having the same topic are accommodated on the same broker, and extensive assignment, by which the subscribers are accommodated on different brokers as far as possible. In this paper, we formulate the difference in the distribution delay time between these two approaches and discuss optimization of subscriber assignment.

Identifying Attractive News Headlines for Social Media

S. Kourogi, A. Kimura, H. Fujishiro, and H. Nishikawa

Proc. of CIKM 2015 (the 24th ACM International Conference on Information and Knowledge Management), Melbourne, Australia, pp. 1859–1862, October 2015.

This paper provides a novel solution to this problem by identifying attractive headlines as a gateway to news articles. We performed one of the first investigations of news headlines on a major viral medium. Using our investigation as a basis, we also propose a learning-to-rank method that suggests promising news headlines. Our experiments with 2000 news articles demonstrate that our proposed method can accurately identify attractive news headlines from the candidates and reveals several promising factors in making news articles go viral.

Linewidth-tolerant Dual Polarization QAM Transmission System Using Twin Local Lights

H. Kawakami, T. Kobayashi, and Y. Miyamoto

IEEE Photonics Technology Letters, Vol. 27, No. 22, pp. 2375–2378, November 2015.

A novel digital coherent transmission system based on dual polarization quadrature amplitude modulation (DP-QAM) is proposed. In this system, a DP-QAM signal and twin local lights are generated from one continuous wave (CW) light source and transmitted simultaneously. Because optical phase noise is canceled in the proposed receiver, linewidth tolerance is improved without using a coherent light source in the receiver. The proposed scheme successfully demodulates a 3.125-GBd DP-quadrature phase shift keying (i.e., DP-4-QAM) signal. After 50-km transmission, no degradation in bit error rate was observed even at the linewidth of 45 MHz.
