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Leveraging Data for the Delivery of a Super Smart Society

Smart City Interoperability — Fed4IoT Japan-Europe Joint Research —

Secure Components in the IoT Ecosystem Era — Toward a trusted smart society —

Using Advanced Technology and Data in Yokohama for Co-creation based on Open Data

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About ITU-AJ

The ITU Association of Japan (ITU-AJ) was founded on September 1, 1971, to coordinate Japanese activities in the telecommunication and broadcasting sectors with international activities. Today, the principle activities of the ITU-AJ are to cooperate in various activities of international organizations such as the ITU and to disseminate information about them. The Association also aims to help developing countries by supporting technical assistance, as well as by taking part in general international cooperation, mainly through the Asia-Pacific Telecommunity (APT), so as to contribute to the advance of the telecommunications and broadcasting throughout the world.

Smart City Interoperability

— *Fed4IoT Japan-Europe Joint Research* —

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1. Introduction

With the development of ICT technology, all types of object can now be connected to networks. As implementation of 5th Generation mobile communications network technology (5G) approaches, machine-to-machine (M2M) communication is gaining prominence as one of its applications, connecting computers, sensors, actuators and other devices. One target in this area is called massive machine-type communication (mMTC). mMTC will be used to implement IoT systems, connecting large numbers of devices and computers to the network, and controlling them cooperatively.

IoT systems are anticipated for a wide range of applications, including Smart Cities, involving initiatives to optimize municipal functions and improve convenience. According to an interim summary report from the Ministry of Land, Infrastructure, Transport and Tourism titled, "Toward implementation of Smart Cities"[1], Smart Cities are defined as, "A city or region that utilizes ICT and other new technologies to manage (plan, organize, manage, operate, etc.) various issues it is faced with and to perform overall optimization in a sustainable fashion." Smart City initiatives started to develop in around 2010 throughout the world, with practical R&D and demonstrations. Until recently, these initiatives were applied and operated to solve problems in a particular field. Examples are Smart Grids, which optimize supply and demand in the electricity distribution system, and efforts to optimize transportation system operation.

Following IoT systems in separate fields, R&D toward the next level of Smart Cities now requires these individual IoT systems to be linked together, to optimize and increase efficiencies in the city as a whole. There are already many initiatives to link IoT systems throughout the world. However, it is not a simple matter to link IoT systems from different fields and provide services that span different application fields because these IoT systems were built as separate systems and use different internal representations, terminology and data models. Linking of IoT systems has not yet progressed beyond tests and demonstrations, and implementations with a business model and capable of sustained operation are still in the future.

Existing IoT systems have been integrated vertically as separate systems, and built for an individual IoT service. It is difficult to utilize IoT devices that are already installed for other purposes. To develop and operate any new IoT service from the ground up requires installing IoT devices at the low level, connecting them to the network, establishing the IoT platform and developing the service. The high start-up costs are hurdles that must be overcome to execute a new IoT service and to promote Smart Cities and IoT services.

To deal with these two issues—linking IoT systems and the high startup costs—we are running a joint Japan-Europe Research project under the Ministry of Internal Affairs and Communications, Strategic Information and Communications R&D Promotion Programme (SCOPE), called "Federating IoT and cloud infrastructures to provide scalable and interoperable Smart Cities applications, by introducing novel IoT virtualization technologies (Fed4IoT)"[2]. This article introduces initiatives of the Fed4IoT joint Japan-Europe research project toward realizing Smart City interoperability.

2. Fed4IoT Development Plan/Policy

The aim of Fed4IoT is to build a virtual IoT-cloud platform that will provide interoperability among separate IoT systems (the IoT service domain), using various existing IoT platforms, including oneM2M[3], FIWARE[4], and ETSI-MEC for 5G[5]. Fed4IoT performs sharing on the following three levels, to link IoT service domains and reduce start-up costs (Figure 1).

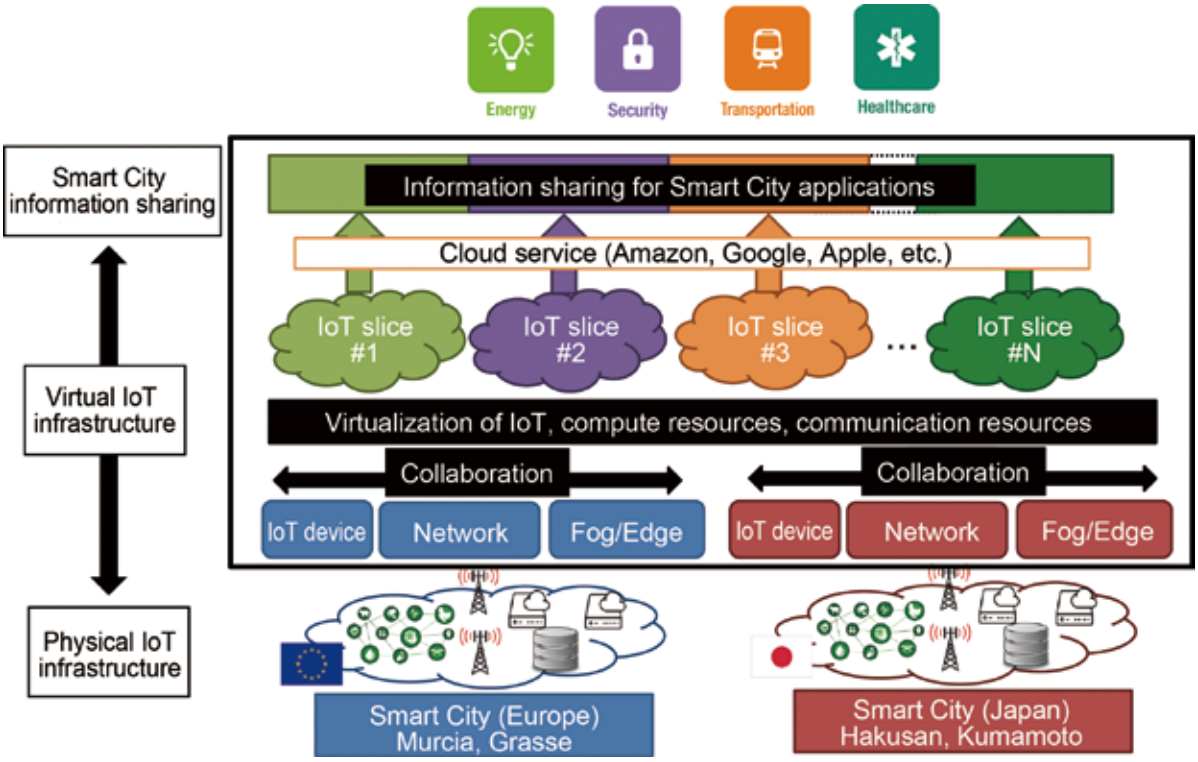
- Data Level
- Platform Level
- Device Level

For interoperability in the IoT service domain, one issue is that different terminology and data models are used to represent IoT data in each IoT service domain. For interoperability, individual IoT services must first share the terminology and data models as metadata. This will enable the Fed4IoT collaboration platform to convert data from individual IoT service domains to its own internal representation, referring to this metadata. The administrator for each IoT service domain is responsible for managing the data handled by the service for that domain. The administrator controls publication of the IoT service domain information to the platform when the domain is linked to the Fed4IoT collaboration platform. Access control information related to publication of this information must also be shared as metadata.

Sharing at the platform level involves connecting each IoT service domain, and an adapter is needed to connect each IoT domain to the Fed4IoT collaboration platform. These adaptors will be described below where device level sharing is described.

Two methods for communication between the multiple IoT service domains and the Fed4IoT collaboration platform are being considered. The first is publish/subscribe communication, and the second is content-centric or information-centric

Figure 1: Overview of Fed4IoT R&D issues



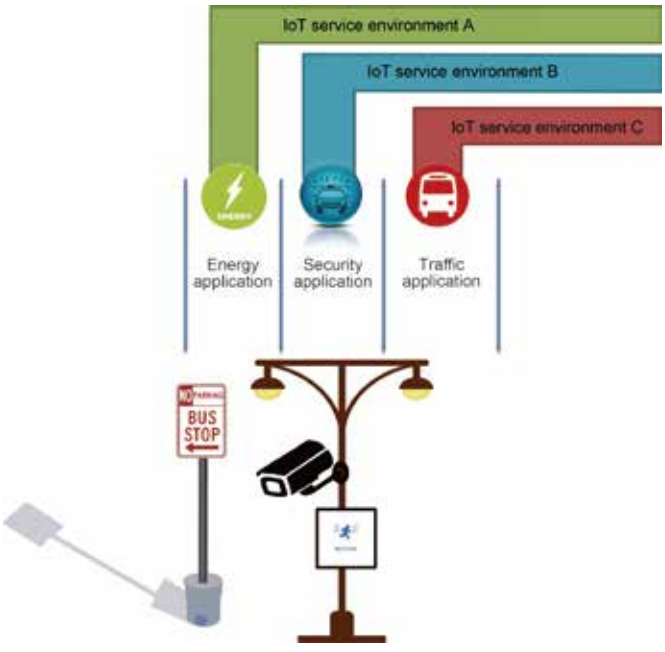
networking (ICN). Both communication methods use abstract identifiers, such as keywords or content names, and are suitable for implementing communication specifying various IoT devices and services.

Data from IoT devices is stored in a repository, such as the Data Management & Repository, which is a Common Service Function of oneM2M, or the Context Broker of FIWARE. Most IoT devices are normally in a sleep state to conserve power. They wake up to collect data, send it to a repository, and then return to a sleep state. This is referred to as "push" communication from the IoT device. IoT applications such as fault detection are required to respond immediately to data from the IoT device. A publish-subscribe model must be used to send and receive data to implement this sort of coordination. On the other hand, it would be wasteful to constantly send values read from the IoT device for applications that require low latency. Request/response form of communication, as with ICN, is appropriate.

IoT devices are supplied by various vendors, and each operates in an IoT service domain. The various IoT devices in each IoT service domain can be used and shared through the unified Fed4IoT collaboration platform. In doing so, IoT devices in each IoT service domain are presented to IoT applications on the Fed4IoT collaboration platform as virtual IoT devices through the repositories of each IoT service domain, rather than present them directly as physical devices. By going through this virtual IoT device software layer, access can be synchronized and data can be distributed among the various IoT applications sharing an IoT device. The software structure implementing virtual IoT devices is also able to perform adapter functions for connecting the various IoT service domains to the Fed4IoT collaboration platform.

IoT device sharing through virtualization is useful in cases such as the one shown in Figure 2. In the figure, the electric company has installed smart light bulbs and person sensors in street lights to control the illumination according to the presence of people, and these are connected to the cloud. A security company has also installed surveillance cameras on the lamp posts to monitor people in the street, and these are also connected to the cloud. The bus company could then use the surveillance camera to monitor the wait times and the number of people waiting at the bus stop next to the lamp post, in order to optimize bus

Figure 2: IoT device sharing

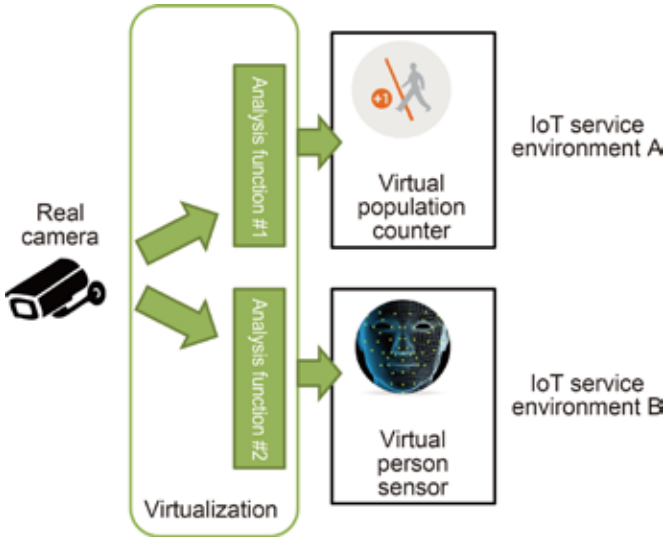


operations. This sharing of devices could help reduce the start-up and operating costs of providing various services.

It is also possible to configure multiple virtual IoT devices with different functions from a single real IoT device (Figure 3). In this figure, virtual IoT devices with different functions, person-counter and person-detector, are derived from a single surveillance camera.

To promote sharing of IoT devices through virtualization, the Fed4IoT project considers it important to make these multiple IoT service environments (the run-time environment for IoT applications) independent of each other, without interference among them.

Figure 3: Providing multiple functions with virtual IoT device



3. System architecture

A conceptual diagram of the Fed4IoT virtual IoT-cloud collaboration platform, called "VirIoT," is shown in Figure 4. Various IoT service domains are shown on the left side of the figure. These IoT service domains are built according to oneM2M or FIWARE standards. They contain repositories that store IoT data, and provide external access to some of this data.

IoT data from various IoT service domains along with open data and other data sources comprise the "Root Data Domain," and this Root Data Domain forms the data set for VirIoT operation. The "Virtual Things" are virtual IoT devices, which are implemented by "ThingVisor" software.

VirIoT provides virtual IoT systems called "Virtual Silos" to IoT service providers, or "tenants." A Virtual Silo is an environment provided to a specific tenant, providing an independent execution environment, which does not interfere with any other Virtual Silos, for an IoT application. A tenant can use a virtual IoT device, a Virtual Thing, by selecting the ThingVisor that implements the Virtual Thing and adding it to their own Virtual Silo.

Each Virtual Silo also has a repository for managing IoT data to be used within the Virtual Silo, similar to the linked IoT service domains, and the data in this repository can be opened to and shared with other Virtual Silos. Virtual Silos can also be connected with real IoT devices.

In the example in Figure 4, tenant Bob wants to build an irrigation system at his home. Bob has experience using FIWARE's Orion broker (repository), so he creates a virtual silo incorporating Orion broker. He connects his own temperature sensors and sprinkler devices to the Virtual Silo he has created, and since he does not have a humidity sensor, he creates a virtual

Figure 4: Fed4IoT virtual IoT platform: VirIoT

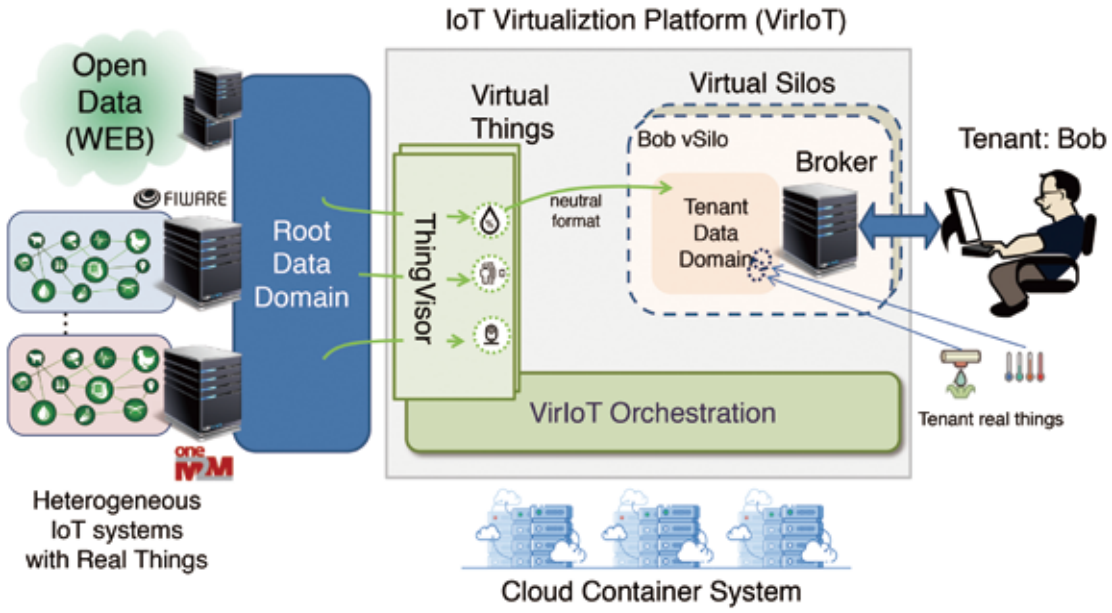
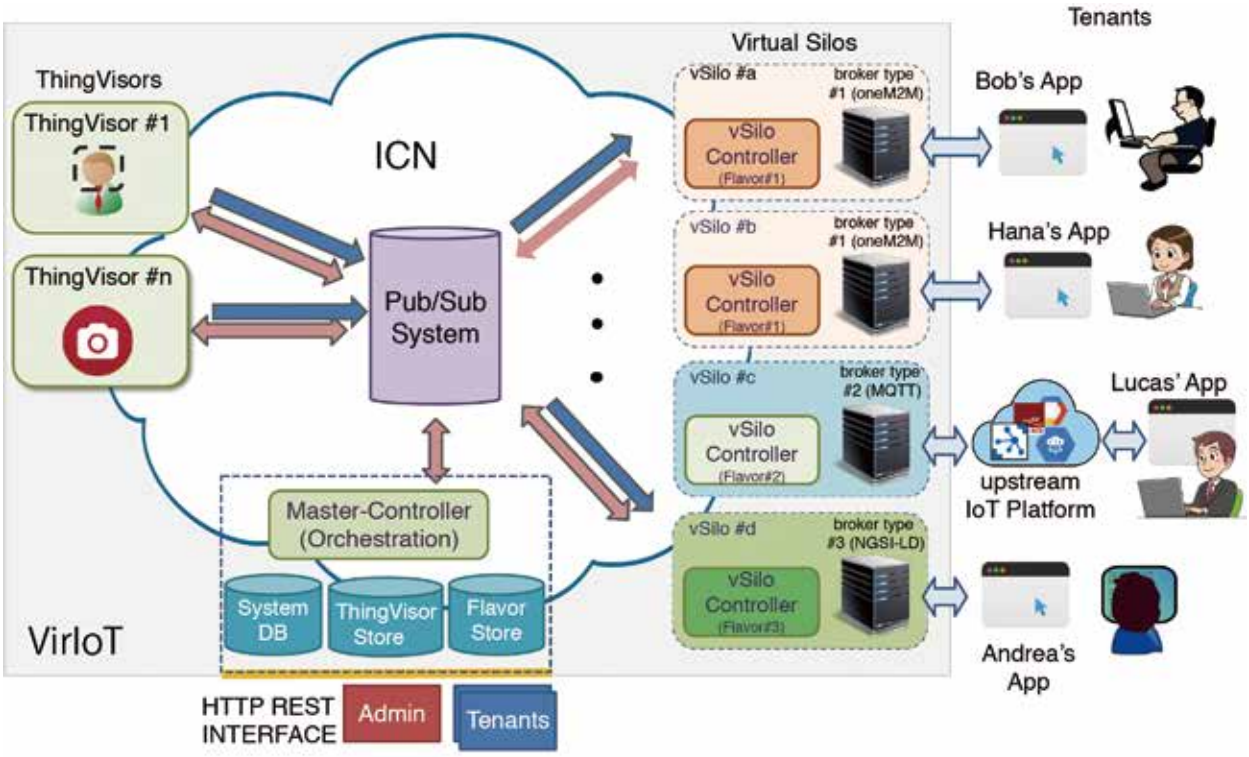


Figure 5: Fed4IoT system architecture



one by borrowing one from another IoT sensor domain. This enables him to build an IoT application to irrigate automatically.

The Fed4IoT architecture is shown in Figure 5. It uses a micro-service design method, and components, including ThingVisor and VirtualSilo, are independent subsystems with their own network interfaces. This architecture enables IoT service developers to develop their components independently. These independent components are currently being created as Linux containers. By making each Virtual Silo an independent Linux container, Virtual Silos realize IoT application execution environments that cannot interfere with each other.

As mentioned earlier, the communication environment within VirIoT provides communication using both publisher/subscriber model and content-centric networking. In particular, implementations using the content-centric networking can use service function chaining to link ThingVisors. Thus, the environment is designed to enable tenants to easily build the IoT service they desire by linking various service functions that have been prepared earlier as ThingVisors. We hope to promote development and spread of IoT services by providing an environment that makes IoT services easy to develop. For example, in smart home environments, many different IoT devices are installed in each home. How these are controlled can be expected to differ depending on the environment they are in, and home owners will want to create their own IoT services. As such, a simple environment for building IoT service is an essential function of an IoT system.

4. Conclusion

In this article, we have discussed how it is necessary to link IoT systems built for separate fields in order to implement overall optimization in Smart Cities. We have also introduced Fed4IoT, a joint research project between Japan and Europe that is working to enable such linking. There is much R&D being done to link IoT systems, and we expect that user-friendly IoT systems supporting highly efficient services will be implemented in the near future.

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Secure Components in the IoT Ecosystem Era

— *Toward a trusted smart society* —

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1. Introduction

The IoT environment has been developing remarkably recently. AI, Big Data and Cloud infrastructure technologies are being used to link and utilize data in many fields, moving toward realization of a smart society.

However, in this environment, reports of incidents due to vulnerabilities in IoT devices are on the rise, and it is becoming increasingly important to study how the authenticity and trustworthiness of data and devices can be ensured.

Secure components are an approach to resolving such issues that is attracting attention and has been applied mainly for conventional strong consumer authentication.

This article discusses the current state and future of secure component technology that is being used to provide a trusted environment for the emerging super smart society, with reference to IoT and the developing IoT ecosystem.

2. Secure Components

So what are secure components? Secure components are secure elements (SE), such as the now-widespread smart cards and smartphone SIM cards, which are very resistant to external attack (tamper-resistant). They have features such as: 1) A secure store that can manage secret and confidential information such as security keys; 2) Security features such as authentication, digital signatures and encryption; and 3) Remote application management.

In recent years, secure components such as embedded SIMs (eSIM) and integrated SIMs (iSIM) have entered the market. eSIMs allow the issuer to be changed remotely, after they are issued, and have started to be used in applications such as connected cars. iSIMs, which are bundled in Systems-on-a-Chip (SoC), strengthening the security of device hardware have appeared. In addition to this expansion in types of SE, secure components are also advancing rapidly, with appearance of new secure execution environments, called Trusted Execution Environments (TEE). These are different from ordinary operating systems and they are much anticipated for use in a wide range of wearable and other IoT devices[1].

In particular, IoT network environments involve a wide range of elements—edge devices, gateways, edges servers and cloud—and discussion has begun regarding how secure components will be integrated, linked and/or isolated with conventional tamper resistant module technologies, such as Trusted Platform Modules (TPMs) Hardware Security Modules (HSMs) used with traditional PCs/servers and secure micro-processing/controller units (MPUs/MCUs).

3. IoT Device Certification and Authentication

The question arises, why are secure components important in the IoT era?

In connected IoT environments a range of edge devices are widely deployed, distributed and connected, and threats and verified results are increasing. These often involve falsification of sensor data, but due to cyber-physical integration, they also include cyber attacks entering via low-end IoT devices to gain illicit control of physical devices that have life-threatening implications (such as medical devices or automobiles). As a cyber-attack countermeasure, the Japanese government has also started a survey of IoT devices through the NOTICE Program in February, 2019.

In the future, as the number of incidents increases and the scope of their effects expand, hopes will increasingly be placed on secure components[1] that support device attestation and secure-boot functions, to provide a basis for trust in strong authentication and device legitimacy, similar to how use of smart cards have spread to provide strong authentication of people.

IoT devices are also often installed over long periods of time in locations where maintenance is difficult so it is important to have flexibly and be able to update and add security functions in tamper resistant chips remotely, as has been pointed out by the GlobalPlatform[1] international standardization organization. Such updates will be used to counter compromises to these functions, for example. It could be argued that the most important feature of secure components is the ability to load, add or modify various functions after installation, using a remote environment in this way.

4. Development of an ecosystem—The importance of secure ID component management

Another important trend in the connectivity environment is development into an ecosystem.

With advances such as 5G and LPWA in the connectivity environment, we are entering an era in which all kinds of objects will be able to connect dynamically.

For people, objects and systems to be able to register and connect dynamically throughout the network in this environment, it is desirable to be able to check their credibility (security) and reliability (safety and trustworthiness).

Within this ecosystem, a connectivity environment will be formed with products deployed from various manufacturers, and spanning national boundaries. Recently, discussion of product supply chain and device life cycle issues is occurring more often,

but in the future, our approaches to securing and evaluating the security and trust of overall systems, together with secure components, will also become more important.

As this ecosystem emerges, automobiles, homes, buildings, and other Systems of Systems (SoS) composed of various elements, will increase in complexity and scope. The key to this problem will be in how we assure and authenticate the IDs of each of these systems as well as the components that comprise them (identifiers, but also the legitimacy of various attributes of the actual components).

As such, it will be extremely important how the set of ID components in these extremely complex configurations are composed and structured, in what units and with what interrelations, how they are managed and authenticated using secure components, tamper resistant modules and secure MPUs/MCUs, and how their authenticity and trustworthiness is guaranteed.

In other words, important issues in the future will include organizing the relationships among IDs and other secure components (other tamper resistant modules, secure MPUs/MCUs, etc.), which are the basis for trusting people, objects, systems, SoS and their components; the mechanisms for evaluating and assuring the security and trust in these relations; and the security-by-design.

5. Trusted smart society

In addition to the promising fields of IoT and IoT security, discussion is now also beginning in the promising field of secure component applications and use cases.

Studying in detail, the issue of managing the ID component set and the secure components that we have discussed, including guarantee (attestation) of real object/entity configurations, will ultimately lead to realization of a super smart society and trusted smart cities that support it. This society will be able to safely and securely link data from many fields and types of business.

Another important key in achieving this will be to study social trust in these composition elements at various levels in society[2].

6. Conclusion

Serious study of standardization related to IoT, security and secure components, has just begun.

International organizations including GlobalPlatform, GSMA[3], and OneM2M[4], are collaborating to set these standards.

In February 2019, the ETSI released technical specifications in a consumer IoT oriented cyber security document, including descriptions of managing security services using eUICC/TEE[5]. Similarly, the NIST in the USA, ENISA in Europe, and the IPA and IoT Promotion Consortium in Japan are also referring to tamper resistant modules and secure components in cyber security and IoT related guidelines.

In the future, we look forward to stronger links between GlobalPlatform and other organizations related to tamper resistant chips, such as the Trusted Computing Group (TCG), which is standardizing TPM, and expanding cooperation among organizations involved in tamper resistant chips and IoT. We also anticipate collaboration with and assistance from organizations involved in smart-city technologies, such as ITU-T SG20, in the future.

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Using Advanced Technology and Data in Yokohama for Co-creation based on Open Data

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1. Introduction

Yokohama is Japan's largest municipality, with 3.75 million inhabitants. To address the city's mounting social and regional issues, we are promoting city-wide co-creation (public/private partnership) measures to create diverse solutions through cooperation and collaboration through interaction between the government and various private-sector entities including citizens, businesses, NPOs, universities and research institutes.

The analysis of data underlying social phenomena is indispensable for identifying issues and examining and implementing solutions. Due to the accelerating pace of developments in information and communication technology in recent years, there are now various types of data that can be used. The city of Yokohama recognizes the importance of using advanced technologies and data-gathering together with open data as a platform for promoting co-creation. In this article, we present an overview of the current state of co-creation through such efforts.

2. Recent efforts to establish data utilization environments

With new business innovations, it is possible to use data to solve various issues of a super-aging society with a declining population, and to promote data-driven reforms in a wide range of fields such as administration, agriculture, medical care, tourism, finance and education. In December 2016, a new statute called the Basic Law for the Promotion of Public-Private Data Utilization was implemented in order to expand the distribution of data that supports these initiatives, and to promote the development and utilization of AI and IoT related technologies. This law provided Yokohama with the opportunity to establish its own system of byelaws, and in March 2017, the city's municipal government enacted the first basic byelaw on the use of public and private data in Yokohama. In April 2017, the Yokohama Open Innovation Promotion Headquarters led by the deputy mayor (chief information officer) was established to perform inter-departmental promotion of the city's advanced technology/data utilization and open innovation initiatives. Following the enactment of this law, a municipal public/private data utilization promotion plan was put in place according to the obligations imposed by Article 9, Paragraph 3, and in May 2018, Yokohama became the first government-designated city to implement its own public/private data utilization promotion plan. To develop human resources that can support data utilization, Yokohama City University opened the Tokyo metropolitan area's first department of data science in April 2018. Yokohama is also currently preparing to open a graduate school to train the advanced data scientists that will be needed by society.

3. A co-creation helpdesk to promote dialog with the public

As a mechanism for the promotion of co-creation, Yokohama City has established a one-stop helpdesk to handle co-creation proposals. Since this service was launched in June 2008, we have received about 900 proposals, of which about 400 have been put into practice. Some examples of data utilization projects realized through the co-creation helpdesk are described below.

3.1 Working with I-Net Corp. to develop a parent-oriented information portal

After two years of collaborative research with I-Net Corp. (one of Yokohama's major ICT companies), a website containing information on childcare facilities and businesses catering to working parents was established in June 2017. Although the city of Yokohama had previously been providing childcare information on its own website, this information had not been released as open data and was lacking with regard to qualities such as searchability.

I-Net put forward the idea of a joint study with the city authorities with the aim of leveraging I-Net's expertise in system development and making the city's information resources available as open data to enable the construction of a web-based system that provides useful support to female employees around the time of their maternity leave. This study was centered on the Women's Committee, which reports directly to the mayor, and involved conducting research and discussions with relevant city departments on how to implement open data provision, the nature of this data, its content, and how it should be disseminated. A user-friendly website was developed to cater to the needs of young female employees. After it went online, it received a favorable reception from users who particularly liked being able to compare multiple childcare facilities closest to a particular train station, and to gather facility-specific information such as the size of bags that children are expected to bring with them. This collaborative study also led to the release of open data related to childcare in Yokohama, including the location of childcare facilities/offices, the services they offer, and their free capacity. In March 2019, with the publication of the Yokohama City Open Data Catalog site, an API was implemented to cater for strong demand for this data from private users. This joint research clearly demonstrates the benefits of open data usage in Yokohama, and has also served as

■ **Figure 1: Home page of the support website for working mothers**
https://kosodate.inet.co.jp/

a popular example of how open data can provide benefits in other fields.

3.2 NTT, Yokohama City University, and a comprehensive cooperation agreement for a super smart society

In July 2018, Nippon Telegraph and Telephone Corporation (NTT), Yokohama City University and the city of Yokohama signed a comprehensive cooperation agreement on the use of public/private data to implement a super smart society, and began various actions aimed at the realization of Society 5.0. Our common goal is to create new solutions from the best mix of NTT's advanced information-related technology, the specialist knowledge accumulated by the Yokohama City University, and the official data held by Yokohama's local government. Specifically, we are promoting efforts to perform accurate data-based measurements of the effects of the Yokohama Walking Point (YWP) business initiative for the promotion of public health, we are developing an AI chatbot-based app to help people separate their garbage correctly, and we are constructing an information exchange support system for residents in certain areas using the same chatbot.

In verifying the effectiveness of YWP businesses, we are using anonymized electronic receipt data and specific medical consultation data to perform investigations such as a comparison of medical expenses and lifestyle-related diseases between participants and non-participants and between people who walk different numbers of steps per day, and a cluster analysis of medical expense reduction effects for participants. We will also continue to pursue initiatives in various fields, including analyzing the effectiveness of tourism investment based on inbound tourist flow data, and using a sports data analysis system to promote regular exercise to residents. Our aim is to realize a super smart society that is both convenient and lively.

■ **Figure 2: Garbage separation assistance app**
https://www.city.yokohama.lg.jp/kurashi/sumai-kurashi/gomi-recycle/gomi/

3.3 Care-Tech Open Lab Yokohama: a civic research pact for open innovation in nursing care

Japan's ageing society is driving a rapid increase in the demand for nursing care. The whole country is now tackling the issue of how to build systems that can improve the quality of nursing care services while ensuring that they can be provided effectively and efficiently. In March 2019, the city of Yokohama joined four local companies involved with nursing care and ICT in a research pact aimed at solving problems through open innovation in the field of nursing care. The members of this pact (called "Care Tech Open Lab Yokohama") are Tsukui Corporation, a major Yokohama-based nursing care company, J-Ark Co., Ltd., which specializes in services that support independent living and the prevention

Table: Overview of Yokohama's main living labs

Name	Main theme	Implemented by
Idogaya Living Lab (Minamu-ku)	○ Stimulating the local area by making use of unoccupied properties ○ Reforming work styles	Taiyo Jyuken KK etc.
Minamaki Lab (Asahi-ku)	○ Regional branding ○ City planning	Sotetsu Building Management Co., Ltd.
Wise Living Lab (Aoba-ku)	○ Suburban town planning for the next generation	Tokyu Corporation
Totsuka Living Lab (Totsuka-ku)	○ Innovation in nursing care services ○ Area management	(NPO) Comachi Plus etc.

of dementia and care dependence, Fujisoft Inc., a comprehensive ICT company, and Welmo Inc., a nationwide social IT venture in the fields of nursing care and disability.

A characteristic of this pact is that it is an open innovation initiative, which is open to anyone, not just the original members. For the time being, we plan to reduce the burden on care managers by providing updated detailed information on nursing care facilities and offices, develop software that uses AI to support the creation of care plans and daycare plans, and promote various events and social demonstrations such as "Digital Hackathon in Yokohama" in order to cultivate innovative talent in the nursing care industry. This research will cover topics including efficient methods for data collection and analysis, and the development of technology to facilitate the mutual cooperative use of data stored by different entities. It will also promote city-wide measures such as "living labs" that facilitate interaction with the public.

4. Development of various interactive forums and platforms

In addition to the co-creation helpdesk, Yokohama also offers a variety of interactive venues including a co-creation forum, a co-creation lab, and a living lab, as well as a platform for use by industry, government and academia.

4.1 Deployment of living labs in multiple locations

A living lab is a community-based forum where people can solve problems by interacting with organizations such as businesses and universities with a variety of insights regarding issues of local importance. To raise the awareness of lab participants regarding the current state of affairs and issues, it is expected that the labs will freely share ideas and find new solutions while using public and private data to promote visualization of the current situation.

Yokohama not only has locally-based communities and NPOs such as neighborhood associations, self-government associations, welfare commissioners and child welfare volunteers, but is also actively supporting living labs where members from a wide cross-section of residents and businesses can gather and interact. This allows issues to be tackled on a wider front, and our basic policy is to provide logistical support to living labs that are primarily operated by local communities.

There are currently over 15 living labs operating in Yokohama. These are mainly operated by local resident groups, locally-based small and medium-sized enterprises, and railway companies seeking to increase the value of properties adjacent to railway lines, but they always keep residents involved so they can share issues and discuss solutions with people who know the local area well.

4.2 The Graduate School of Project Design and Yokohama City: Studying a new business project for regional revitalization

In the 2019 business year, Yokohama launched a new business project for regional revitalization in partnership with the Graduate School of Project Design (Minato-ku, Tokyo). This ambitious program aims to formulate new business concepts that contribute to regional revitalization by combining the expertise of researchers from private companies with the knowledge accumulated by graduate schools and the city of Yokohama.

By treating specific areas as fields, businesses in diverse industries and with diverse business conditions are engaged in delivering commercial success in their own fields while aiming to solve social issues and regional issues. As part of this initiative, co-creation promotion staff from Yokohama are involved as visiting professors, allowing them to provide solutions and related data for the city's current situation and to share problems by interacting with others. In this way, we are taking on the challenge of creating solutions together.

Based on the opportunities for co-creation presented by our co-creation link with the Graduate School of Project Design, we have also published a series of articles on our basic concepts of co-creation in Yokohama in three editions of the monthly "Business Concepts" journal (May–July 2019). Japanese readers are encouraged to take a look:
https://www.projectdesign.jp/201907/keyfactors/006593.php/

4.3 Construction and deployment of diverse platforms

In Yokohama, organizations such as the Yokohama SDGs Design Center, which addresses environmental, economic and social issues associated with sustainable development goals (SDGs), I-TOP Yokohama, which engages in business creation using IoT and other technologies, and LIP Yokohama, which aims

to create innovation in the fields of medicine and healthcare, are creating and publishing a platform for use by industry, government and academia for the purpose of problem-solving and innovation using the diverse knowledge and resources of the public sector, including cutting-edge technology and data in diverse forms for different objectives and fields.

5. Other initiatives related to co-creation

5.1 Promoting social demonstrations before introducing social impact bonds

A social impact bond (SIB) is a new type of public-private partnership scheme that originated in the UK in 2010. In recent years, SIBs have appeared in the government's basic policies on economic and financial management and reforms. The government's plans for the 2019 business year also mention the "promotion of studies on public contracts and dissemination policies for the mobilization of private sector funding, such as performance-linked incentives". In cases where a private company raises funds by itself to implement a public project and then meets preset achievement targets, the government will reimburse the company's costs. In Japan, this sort of mechanism was pioneered in schemes that included an SIB in Kobe city for the prevention of severe problems such as diabetic kidney disease, and in an SIB in Hachioji, Tokyo for the improvement of colorectal cancer screening and detailed medical examination rates.

Yokohama also aims to introduce a result-linked business that aims to solve problems through early preventive intervention. From the 2016 business year, children who face problems such as a difficult home environment have been offered support for learning, living (meals) and a place to stay. This has continued to the present day, and from the 2018 business year, we have also implemented a remote healthcare consultation project for new mothers who are experiencing post-natal anxiety. Both of these projects have been confirmed to deliver measurable results in social demonstration projects.

An important consideration of SIBs is how to accurately measure their social impact and evaluate their effects. Data analysis and utilization are essential elements in this regard.

In the former project, volunteers such as university students provide learning support (Figure 3) at a community salon operated by a social welfare corporation. In addition to measuring the changes before and after intervention by twice-yearly questionnaire style interviews of children and carers, the results of the Yokohama academic achievement and learning survey (conducted at all schools in the city) are also collected by personal disclosure and are used for social impact evaluation.

In the latter project, a remote pediatric healthcare consultation service provided by Kids Public Co. (Figure 4) is used to analyze questionnaire and medical receipt data obtained before and after intervention. In this way, it is possible to measure the reduction of anxiety and the suppression of non-essential consultation behavior.

Figure 3: Learning support for schoolchildren

In an SIB, data can be accurately collected and analyzed, and by sharing the results of this analysis with service providers, fund providers, third-party evaluators and government departments, it becomes possible to objectively evaluate the achievements of business outcomes. This idea of evaluating administrative services in terms of their social impact is likely to become increasingly important in the future, so Yokohama will continue to conduct social demonstrations for the introduction of SIBs.

5.2 Yokohama behavioral insights and design team (YBiT)

In February 2019, volunteer staff members from a range of different departments gathered to take part in an innovation workshop on the theme of worker behavior patterns by incorporating behavioral design concepts and methods into government agencies. The Yokohama behavioral insights and design team (YBiT) was established in order to provide feedback

Figure 4: Chatting with an online pediatric consultant
Users can spend up to ten minutes at a time talking to a pediatrician about their child's condition by text messaging, voice calls or video calls.

on the results to Yokohama's citizens.

Behavioral design is the science of designing environments that make people more likely to choose a desired course of action so as to achieve certain policy targets without any significant financial burden. For example, people will tend to choose the healthier option of climbing the stairs instead of using the elevator if the staircase is decorated with interesting pictures. The government is also showing an interest in this field, and has drawn up a number of broad policies and growth strategies based on behavioral design. Furthermore, the Ministry of the Environment and the Ministry of Economy, Trade and Industry have set up behavioral design promotion teams and are working with local governments.

Through the Yokohama Smart City Project, which was set up after the Great East Japan Earthquake of 2011, Yokohama has gained experience in promoting the transition to new electricity tariffs that use behavioral design to reduce peak power consumption levels. Based on this accumulated know-how, YBiT is working on the creation of advanced examples by launching projects in Yokohama with specific targets, such as combating global warming, encouraging people to have health checkups for specific conditions, improving emergency evacuation in procedures in the event of a disaster, and conducting public awareness surveys by the ward office. In May 2019, we introduced Yokohama's initiatives at a government-sponsored international symposium on behavioral design. We are collaborating not only with domestic experts but also with a British behavioral design team. It is important that these measures are adopted throughout Japan. YBiT is holding regular monthly meetings as well as workshops when requested by various government bureaus and ward offices, and these have been attended by many people from the government, other local administrative bodies, and private businesses.

The analysis and utilization of data are indispensable for realizing behavioral design, and we hope that it will also help with the promotion of EBPM (evidence-based policy making) in Yokohama.

6. Conclusion

As mentioned above, the city of Yokohama is actively working on co-creation as a means of promoting open innovation. We believe that by promoting the digital transformation of government and society, we can move towards our goal of realizing Smart City Yokohama — a "Society 5.0" city that is both convenient and prosperous. We are also certain that this process can contribute to the achievement of sustainable development goals (SDGs) in other cities around the world.

In February this year, the International Conference on Sustainable Brands 2020 was held in Yokohama. This event was attended by people from all over the world. Businesses and other types of organization were able to deploy activities and projects using prescribed SDGs or live cycle brands, thereby raising the awareness of society as a whole and realizing a sustainable society and economy.

To solve issues that are increasingly complex and diverse, it is essential to further promote dialogue and cooperation among a wide variety of entities. We hope you will continue to watch the co-creation efforts being made in Yokohama.

Cover Art

This picture is a scene from the Kabuki play, Sekai no hana Oguri gaiden (Worldly Flowers, an Oguri Anecdote) played in April 1851.
The play is a based on folk tale of a historic figure, Oguri Mitsushige.

Utagawa Toyokuni III
(1786~1865)

Collection of the Art Research Center (ARC)
Ritsumeikan University
Object number: arcUP2847

= A Serial Introduction Part 3 = Winners of ITU-AJ Encouragement Awards 2019

In May every year, The ITU Association of Japan (ITU-AJ) proudly presents ITU-AJ Encouragement Awards to people who have made outstanding contributions in the field of international standardization and have helped in the ongoing development of ICT.
These Awards are also an embodiment of our sincere desire to encourage further contributions from these individuals in the future.
If you happen to run into these winners at another meeting in the future, please say hello to them.
But first, as part of the introductory series of Award Winners, allow us to introduce some of those remarkable winners.

Kazuki Takeda
NTT DOCOMO, INC *Member of the above organization, when notified of receiving the award.
https://www.nttdocomo.co.jp/english/
Fields of activity: 3GPP RAN standardization

5G standardization in 3GPP

I am deeply pleased and honored to receive the ITU-AJ Encouragement Award, and would express my thanks to the selection committee and to all those who offered their support and encouragement.

3GPP RAN WG1 (RAN1) is responsible for specifying physical layer designs of 5G wireless access. More specifically, our task was to specify rules for converting upper layer data to wireless signals that can be carried over radio frequencies.

3GPP RAN1 meetings bring together hundreds of wireless experts and engineers from around the world for week-long sessions held 6 to 8 times a year. In addition to representing my own company, I was also responsible for moderating the discussions on the agenda. This requires technical expertise, a clear understanding of the designs, and the ability to prioritize and make decisions.

I certainly could not have succeeded in this important role on my own, but had dependable allies I could rely upon including my boss, colleagues, and associates. Allow me to express my thanks again for your support.

Masaru Mitani
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Fields of activity: ITU-R SG6, Broadcasting Service

Advancement of broadcasting services through ITU-R standardization activities

Thank you very much for this prestigious award. I would like to express my appreciation to the ITU-AJ and to all those who helped and encouraged me along the way.

Here I will highlight three key assignments enabling me to contribute to ITU-R SG6 block meetings, which deal with broadcast services.

First, I contributed to the promotion and dissemination of 4K/8K technology. Japan has been a global leader in 4K/8K technology R&D, and was first to roll out 8K satellite broadcasting services. I played an active role in bringing 8K-related information and knowledge into the ITU, and worked to promote and disseminate 8K technology by introducing 8K to broadcasters from around the world at SG6 related meetings.

Second is my involvement with Japan's terrestrial broadcasting system, ISDB-T (Integrated Services Digital Broadcasting-Terrestrial). ISDB-T has been adopted by other countries in South America and Asia, and when relevant ITU-R Recommendations and Reports were revised and the adopting countries asked for the updated technical information, I provided what they needed and supported them.

Third is sharing studies between broadcasting and other services. I helped organize data for sharing studies from the broadcasters' perspective to assess efficient frequency band usage, and incorporated such information in relevant ITU-R Reports. This also contributed to sharing studies in the WRC-19 agenda.

A new study period began in 2020, and ITU-R SG6 block meetings already have many themes on the agenda including advanced digital terrestrial TV broadcasting, AR/VR, advanced sound systems, Integrated Broadcast-Broadband system, and more. As ever, we are committed to further develop broadcasting technology to enhance the experience and pleasure of viewers.

Takuya Miyasaka
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Fields of activity: IETF

Standardization supporting network slicing in IETF

I am deeply honored to receive the ITU-AJ Encouragement Award, and would like to express my appreciation to the many operators and manufacturers from Japan and other countries that have supported these activities.

5G network slicing is a key feature of the 5G architecture for it enables much greater flexibility by allowing the creation of multiple virtual networks that provide quality of service (QoS) for different scenarios, or use cases, atop a shared physical infrastructure. My standardization work for the IETF involves

implementing network slicing in the transport network for 5G services.

This capability is required because 5G base stations are connected to core equipment via the transport network, so the transport network must also be capable of allocating optimized resources with QoS tailored for different use cases.

I am currently involved in IETF standardization of network slicing in the transportation network, and as a network operator contributed to use cases and technical requirements for the ACTN (Abstraction and Control of TE Networks) hierarchical network control framework. I also helped implement the API (Application Programming Interface) that provides external users with ACTN control requests. Utilizing this API, 5G core equipment can request transport network slicing, which provides users with end-to-end QoS network slicing.

Leveraging these technologies will open the way to a high-quality 5G communication environment by incorporating network slicing in the transport network for 5G services.

Masahide Murakami

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Fields of activity: IMS, VoLTE roaming, and NNI

Standardization of VoLTE roaming and II-NNI

I am greatly honored to receive this Encouragement Award from the ITU Association of Japan. I am also grateful for the opportunity to participate in the standardization and development of Voice over LTE (VoLTE) roaming methods and Inter-IMS Network-to-Network interfaces (II-NNI).

VoLTE roaming is a method for users to connect to Voice services over LTE while traveling outside their serving area. There are two main methods for realizing roaming: S8 Home Routing (S8HR) and Local Breakout (LBO). I participated in the standardization of S8HR starting in 2015. Unlike conventional data roaming services (e.g. Internet access), voice services require low latency and higher QoS characteristics. My colleagues and I were able to make numerous contributions to the GSMA, making it is possible to guarantee the quality needed for voice.

II-NNI are used to interconnect different IMS networks. When a user places a voice call, the originating network needs to decide which network to connect to. This can be done through ENUM processes defined in GSMA NG.105. This document was created in 2017 and I was able to make contributions including defining the key issues that need to be solved, adding solutions to current problems, and defining requirements for the ENUM process itself. Without these contributions it would have been difficult to specify the destination user/operator, and making calls over the II-NNI would have been difficult.

Of course there are many more aspects that need to be discussed and decided in the GSMA (e.g. 5G, roaming issues, etc). I will continue to participate in standardization activities, so that a wider variety of services can be provided through the core network.

Naoto Yoshida

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Fields of activity: International cooperation in ICT development

Contributing to ICT development through international cooperation

It is an honor to receive the ITU-AJ Encouragement Award, and I would take this opportunity to thank the ITU-AJ and all those who offered their guidance and encouragement.

My first involvement in international cooperation came through participation in JICA's Japan Overseas Cooperation Volunteers. I had only been working for NTT East for two years, but applied because I wanted to contribute to people in developing countries. I was sent to León, the second largest city in Nicaragua, as a system engineer at city hall. My instructions were to provide technical guidance and transfer technology to construct a network in city hall, while at the same time upgrading the local IT technology and streamlining operations. Mindful that our Nicaraguan counterparts had to take the lead, I assumed a modest role of supporting technology transfer continuity, encouraging self-help, and allocating tasks based on strengths and weaknesses among the local engineers.

Back in Japan after that project was finished, I was given an opportunity to organize a computer course at the JICA Okinawa International Center. The purpose of the course was to teach foreign trainees how to set up e-government systems in their own countries, and I was involved in everything from designing and managing the course to instructing the trainees and supporting them after they went back to their home countries. Through constant contact with trainees in the IT program who were from different countries, I developed strong bonds with many of them, and I certainly learned as much from them as they learned from me.

Contributing to the modernization of ICT in developing countries was truly an invaluable experience for me, and bolstered my own self-confidence. Leveraging this experience will not only support ongoing international cooperation, it will forge long-lasting business ties that provide mutual benefit and harmony to both our company and developing countries around the world. Never forgetting our original motive for setting up this program, we will continue to offer cooperation to developing nations in upgrading and enhancing their ICT infrastructures.

通巻百二十六号

The ITU Association of Japan

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