ISSUES 2

Service Collaboration that Integrates OT and IT

New Value Created by Connecting the Cyber World and the Physical World

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New digital technologies such as the IoT and AI have brought significant changes over recent years, not only to business, but also to industrial and infrastructure systems. Unfortunately, numerous obstacles remain in the way of achieving a wide-ranging digital transformation that transcends the boundaries between organizations and industries and enables new value to be produced by bringing the cyber and physical worlds together. Crucial to achieving this will be to work alongside and engage in collaborative creation with the cloud vendors who operate worldwide networks. For this article, *Hitachi Review* invited Tadashi Okazaki, a director and head of solutions architecture at the Japan subsidiary of Amazon Web Services, Inc., to meet with Masaaki Iwasaki, who manages research and development of the Lumada's Digital Innovation Platform at Hitachi, to discuss the progress of digital transformation, the work that is currently underway, and the outlook for the future.

Toward an Era where Internet Connection is Essential

Iwasaki: Hitachi is promoting digital transformation (DX) by applying the Internet of Things (IoT) technology and artificial intelligence (AI) technology, aiming to realize an innovative infrastructure system including many software and physical assets. However, Japanese manufacturers, who are major customers, have over-customized systems and applications to create their strengths. Therefore, there are many cases where implementation is difficult, such as the case when several process management systems at the manufacturing site are linked, or the case when the supply chain management system and the production management system are linked. Under such circumstances, how should DX generate innovation? AWS[*1] is developing pioneering

*1 AWS and the names of AWS products and services mentioned in the article are registered trademarks or trademarks of Amazon Web Services, Inc.

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Having previously filled management roles leading architecture teams at large system integrators and overseas-owned vendor companies, he now supervises the engineering teams for enterprises, Internet services and startups, and partners in his role as head of solution architecture at Amazon Web Services (AWS) in Japan. He is also engaged in the application of cloud and other advanced technologies, drawing on his background in consulting to bring a management as well as a technological perspective to this work.

initiatives that make full use of digital technologies such as IoT and AI. How do you view this situation?

Okazaki: For myself, I see the essence of DX as being the use of digital technologies to transform business and devise new business models. As for information technology (IT), while this tends to be thought of as something that applies to back office information systems, the future will likely see an acceleration of moves to encourage innovation by bringing IT into the realm of operational technology (OT).

As digital technology provided the basis from which digital natives like AWS got their start, all of our different divisions have their own teams for dealing with this technology and so DX is something we take for granted. At traditional companies, on the other hand, there are still areas where the conventional ways of doing things prevail. One example of the challenge this poses is the sense that faith in closed networks remains deep-rooted. Certainly, the belief in the past was that the only way to maintain absolute security was to keep networks closed off. This is not an attitude that can be changed easily. However, companies have to think about decisions that look to the future, including whether they will be able to keep their business growing if they continue to go about things in this way. As indicated by "Partnership for the goals," one of the 17 Sustainable Development Goals (SDGs), it is important for companies to work together if they are to overcome the challenges facing society. Hitachi's collaborative creation (co-creation) is one example and, along with a strategy for how you can grow your business by utilizing new technology, I believe it is absolutely vital that we contribute to society and envisage the new world on the basis of engaging and collaborating with multiple partners.

Iwasaki: That's right. The problems that currently beset the world cannot be resolved by one company working alone. Because of the involvement of politics and culture, technology alone does not provide comprehensive solutions and even reaching agreement among stakeholders can be difficult. Here at Hitachi we work with specialists in a range of fields on co-creation, a process that includes looking ahead to the world of the future, and this is something that requires that we bring together a diverse range of people at these and other forums to debate the best ways of putting digital technology to use.

However, Hitachi also had a strong internal network-oriented approach in the past, and although many in-house systems were connected via the internal network, there were various restrictions on communication with the Internet. Now that it is essential to connect with the outside world in order to realize collaborative creation with customers, we must move away from this internal network orientation. The research and development (R&D) department is accelerating the transition from an IT environment where computer resources are located on the internal network to a public cloud environment on the Internet. The difficulty for companies that manufacture high-quality products and market them globally, however, is that the migration of systems is no simple matter given the lengths to which these companies have gone to prevent problems arising in their production lines. While both Hitachi and our customers appreciate the merits of new technology, we are still at the stage of trying to figure out how best to overcome this obstacle.

Okazaki: At AWS, we see the cloud as being the best place to run most applications, and believe that there are considerable advantages for customers in doing so. Rather than urging a migration to the cloud in every case, however, we have instead adopted our "seven R" strategies for achieving this. These strategies include cases where our recommendation is to "retain" systems if migration would be difficult and would not bring many benefits, or to explicitly choose not to migrate applications and instead "retire" them as part of a restructuring. If a decision to migrate is made, we see it as being necessary to choose the extent of this migration based on where the customer wants to be, where they currently are, and their timeline. The options include "rehosting" systems without otherwise modifying them, "relocating" in a way that leaves the host unchanged as in a container or VMware Cloud*2 on AWS, "re-platforming" in a way that leaves the core application architecture unchanged, "repurchasing" by replacing solutions with new ones, or "re-architecturing" by rebuilding applications to use the latest technology.

In relation to the security issues mentioned earlier, there is a need to consider what sort of secure practices to adopt when connectivity is taken for granted as it is in a cloud environment. While the cloud is used for the machine learning models that are the basis for autonomous driving, for example, existing technologies are still used for vehicle control. While mobility as a service (MaaS) has attracted attention for its potential to provide solutions for many of the problems facing society, a world in which we can get off a train at a station to find a self-driving car waiting for us that we are able to drive away in simply by using a smartphone or other device to verify our identity will only be possible if the systems for the car, train, and smartphone all interconnect. Rather than replacing everything, what will be important will be to successfully combine existing technologies with those parts that we want to build anew, in such a way that the control that drives the vehicle does so while also connecting to the world of IT.

*2 VMware Cloud is a registered trademark or trademark of VMware, Inc. in the United States and other countries.

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Joined Hitachi, Ltd. in 1983 and started work at the Central Research Laboratory. In 1993, he transferred to the Systems Development Laboratory. He has held his current position since 2017. Having worked in the past on research and development in fields such as parallel inference machines, mainframes, the Computational Physics by Parallel Array Computer System (CP-PACS) (SR2201), data centers, and network-attached storage (NAS) and other system software, his research in recent years has focused on cloud technology. He earned a doctorate from Okayama University in 2008. He was director of the Information Processing Society of Japan (IPSJ) from 2015 to 2016, and is a member of the IPSJ, the Institute of Electronics, Information and Communication Engineers (IEIEC), and the IEEE Computer Society (IEEE CS).

Problems that Emerge when OT and IT are Combined

Iwasaki: While it depends on the complexity and size of the system, I believe that the "system-of-systems" concept has a key part to play. If an existing system is running without problems, it can be treated as a subsystem and incorporated into a new system. In the case of the DX of social infrastructure systems, however, this involves the introduction of new technology while keeping existing systems running. The problem is how to soften the impact when interconnecting new subsystems and existing legacy systems.

Moreover, I have gained a strong impression in recent times of how OT engineers are grappling with genuine concerns, reproducibility being one of these. In order to eliminate potential hazards, international standards in the OT domain require that systems should always generate

identical results for given identical input conditions. With deep learning, however, there is always the possibility that different results will be produced whenever additional learning takes place. They are now faced with the question of whether these standards need to be rewritten for a technology where perfect reproducibility cannot be guaranteed.

Another problem is the lifecycle of the products that we supply and that are operated by our customers. Frequent updates are common for open source software (OSS) and other areas of IT, with major updates sometimes happening on a near-annual basis. These have also at times resulted in a loss of functional compatibility. On the other hand, OT systems for social infrastructure such as industrial plants, power plants, and railways are designed to be used for a long period of time with the highest priority given to stable operation and accident prevention. The result is an ongoing dilemma about how to resolve the mismatch in lifecycles between this infrastructure and leading-edge information technologies such as OSS.

Okazaki: When bringing information technologies into the OT realm, it is important basically to adopt a "two-storied" approach of separating those areas that need to remain the same as before from those that do not. I expect that the approach to implementing MaaS that we talked about earlier will represent one solution. While information technologies are likely to spread into various different sectors in the future, it will be essential to consider how to achieve balance in their application.

In the past, latency (communication delay) has posed a major impediment to adoption of the cloud. To deal with this, AWS supplies technologies for running applications at the network edge (including AWS IoT Greengrass, AWS Outposts, and AWS Wavelength) and these enable factory line control applications where performance in the millisecond range is essential. For example, one German automotive manufacturer is able to maintain a real-time overview of operations and production at plants located around the world by using the AWS cloud platform to collect data on factory equipment and systems. As this example shows, things that were considered impossible in the past are now being done for real.

Elsewhere, Amazon announced its Prime Air concept of using drones to provide delivery services back in 2011 and this has now reached a stage where it is largely possible to put into practice. The drones incorporate a range of technologies such as image recognition and deep learning. If a location they would normally be able to navigate safely is found to be occupied by children or goods, for example, they are equipped with the recognition and control capabilities to avoid these obstacles. Likewise, accident-avoidance control in robots has now advanced to the point where it is close to being a practical proposition for a wide range of commercial applications. The Amazon Robotics distribution system that uses autonomous robots is currently being rolled out, while another example is the Amazon Scout, a six-wheeled robot that can drive on sidewalks and deliver goods directly to the customer's door that was trialed in the suburbs of Washington state in the USA during 2019.

In relation to machine learning models and the reliability of AI, including problems such as reproducibility and lifecycle, we are developing a service on the Amazon SageMaker Studio platform for machine learning services that makes the internal decision-making processes of these systems understandable.

Iwasaki: Hitachi, too, has started offering services for adopting and supporting AI that utilize explainable AI techniques. These let users understand the reason for predictions so that they can feel confident about their use, one example being a system we offer for optimizing the dispatch of ambulances.

Shift to Joint Service Development Arising out of Common Concerns

Okazaki: AWS offered a total of more than 175 services as of 2019, a major feature of which is that these are available as independent microservices. Each of these microservices focuses on a particular required function in a way that makes the different parts easy to adopt, the idea being to optimize these arrangements in the form of an ecosystem

in which other companies such as Hitachi can adopt these services with their own excellent technologies. Rather than competing over who has the best technology, our aim is to bring the best of each side together in a process of co-creation.

Iwasaki: We feel the same way. In the case of customers seeking to expand their operations globally and wanting to act quickly, and who may also be looking to work in languages other than Japanese, flexible access to proven technology in countries and regions around the world like that offered by AWS is extremely efficient and valuable. Would it be fair to say that the core services of AWS can be thought of as the general-purpose application of the technologies used to develop the functions required for Amazon's e-commerce system, reconfigured as separate microservices?

Okazaki: Yes, that's accurate. AWS began offering its services in 2006, having set out to find solutions to problems that have been faced by many existing companies, not just Amazon. As a consequence, 90 to 95% of the services and functions offered by AWS arose out of actual issues faced by customers. Many technologies have come about in the process of Amazon growing its own business. Examples include Amazon Personalize, a recommendation service that uses machine learning, and Amazon Kinesis Video Streams for processing large amounts of streaming data in real time.

Iwasaki: The functions available on Lumada[*3] include applications that our front-line divisions involved in the development of industry-specific applications have built for their own customers. As I observe the gradually increasing AWS service menu, I notice that new value is created each time you apply a newly developed technology to the real world and solve a problem that has emerged there. And I recognize your effort to generalize the technology so that it can be provided to customers in various other fields.

Okazaki: This is a situation where speed is of the essence. While the way our business works basically involves delving into the needs and issues faced by customers and making this available to the wider world, generally the opposite product-driven approach is pursued of offering up technologies and other products so that they can be put to use by those customers who are interested. When debating the relative merits of the customer-centric (service-centric) and product-centric (technology-centric) approaches, the point is often made that the customer-centric way of doing things is slower and makes innovation more difficult. However, we believe we can overcome this by working though the plan, do, check, act (PDCA) cycle quickly. This is the "two-way door[*4]" approach to decision-making that involves making decisions quickly with a readiness to backtrack in the event of a bad outcome and to get started early and try different things in order to build experience.

Iwasaki: As for Lumada, we are in the process of increasing the service menu of Lumada Solution Hub[*5], including the functions that we develop in-house and provide to our customers, as well as the introduction of missing functions from partners. Of course, this includes high-quality OSS. Hitachi's strength is its wide range of human resources who can propose which technology should be applied to the customer's system. Therefore, we do not have to stick to Hitachi original products and applications provided to customers.

Building Ecosystems as a Means of Delivering New Value

Iwasaki: While Lumada is generally able to run on the customer's choice of cloud platform, considerations such as security and authentication lead us to recommend platforms like AWS that offer global network capabilities. We also respect our customers' policies, for example, if they want to use AWS's unique and superior service, or conversely, if they want to use industry standard services.

*3 A platform for utilizing data and working with customers and other partners on the co-creation of value.

*4 Two-way door: This uses the analogy of a door through which one can both enter and leave to distinguish between irrevocable (one-way) decisions and the (two-way) process of trial and error, where the latter refers to trying different things with an emphasis on speed.

*5 A platform based on cloud infrastructure where Lumada solutions and application development environments are packaged and made available in a form that makes them easy to adopt.

Okazaki: Adding to that, I would say that the strength of AWS lies in the scope of functions we offer and that they can be used safely and with confidence, and also in the dramatic increase in the speed of interoperation that is possible between systems located in the cloud. For example, if partners engaged in co-creation with Hitachi choose to use our Virtual Private Cloud (VPC) environment, they will be able to utilize the Private Link function to provide fast and secure links between their respective systems. As well as enabling co-creation to proceed rapidly while dramatically accelerating the speed of management decisions, our ability to deliver value also comes about, I believe, from the fact that so many customers and other partners are already using AWS.

Iwasaki: We have recently seen an increase in the number of requests from customers wanting to develop systems that link different cloud platforms. Hitachi hopes to support the expansion of its customers' business in a collaboration between AWS and Hitachi while leveraging the respective strengths, such as providing integrated operation management by Lumada across multiple clouds.

Okazaki: I also believe in coexistence where each party retains its respective advantages. The "Amazon Flywheel," a drawing by company co-founder and CEO Jeff Bezos, expresses the philosophy shared by all company staff whereby the more customers and partners we have the greater the selection of products we can offer, and this in turn expands the size of our business. In regard to what we offer in the form of added value that accompanies the utilization of AWS services, we aim to come up with new technologies of value to our customers and we would very much like to do this with companies like Hitachi that are rich in expertise and knowledge.

Iwasaki: That is something I would like to see. In-depth knowledge of the OT world is steadily improving, even though not as fast as the digital world. In the 110 years since its founding, Hitachi has built up a track record of delivering physical products in various areas of social infrastructure. Lumada encompasses not only the digital world, but also the real physical world. And our objective is to supply digital innovation platforms that are designed to cope with both worlds. I look forward to further strengthening our partnership and working on co-creation, not just in technology and business, but also in areas like human resource development. Thank you for your time today.

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