Technotalk

Symbiotic Autonomous Decentralized Platforms for Faster Fusion of Control and Information

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New uses for IT are leading to growing activity in initiatives aimed at innovation in manufacturing and other parts of the social infrastructure. Drawing on the strength of its experience in control systems for social infrastructure and other industries, Hitachi is also working on fusing these with information systems. The symbiotic autonomous decentralization concept is the key to creating new value through interoperation between different systems. Hitachi intends to pursue further advances in social infrastructure and industrial systems by expanding, into a wider range of industries, the platforms it offers that are based on this concept and built using associated technologies.

New Value through Coordination of Data across Different Systems

Hotta: There has been growing activity in initiatives aimed at innovation in manufacturing and other parts of the social infrastructure that take advantage of new trends in information technology (IT) such as the Internet of things (IoT). Hitachi has been working on control technology for social infrastructure and other industries for many years and also, in recent years, on the fusion of control and information with reference to these initiatives, during which time we have identified a number of challenges that need to be overcome.

Professor Tanaka, our guest today, specialized in such fields as artificial intelligence and distributed processing while at The University of Tokyo and is now President of the Institute of Information Security where he is currently engaged in research and teaching on security technology for information systems. Professor, I hope you will be able to give us the benefit of your experience by offering your views on this work by Hitachi.

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Graduated in electrical engineering from the Graduate School of Engineering, The University of Tokyo. Following appointments as head of the Graduate School of Information Science and Technology at The University of Tokyo and head and lecturer at the Graduate School of Information Security at the Institute of Information Security, he took up his current position in April 2012. His fields of expertise include computing architectures, parallel processing, artificial intelligence, distributed processing, and media processing. He is a professor emeritus at The University of Tokyo.

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Joined Hitachi, Ltd. in 1987. Having worked in the past on the design of monitoring and control systems for the water industry and at Beijing Hitachi Control Systems Co., Ltd., he took up his current position in 2014.

But before that, I would like to ask each of you to tell us about your own responsibilities.

Aragane: My Electrical Equipment Information & Control Systems Division deals mainly with two different industries. That is, we work on monitoring and control systems for water supply, sewage and other water-related systems, and for rolling mills and other processes in the steel industry. For the water supply and sewage sector, our main focus in Japan is on the maintenance and upgrading of existing facilities, and with the falling population, there is anticipated to be demand for the extension of systems to cover wider areas through business integration with neighboring local governments, and also joint operation of their maintenance services. Because the number of experienced technical staff will fall in the future, we are looking at ways to support management and operations that incorporate such technologies as the IoT.

Kobayashi: My Transportation Information & Control Systems Division handles traffic management systems for the Shinkansen and for major conventional railway services such as the system for the Autonomous decentralized Transport Operation control System (ATOS). While the railway industry in Japan, Hitachi included, is expanding its horizons offshore, domestically we are working with customers to look at ways of improving security. One of the challenges will be to strengthen both the cyber and physical security of railways in the Tokyo region, in particular, in the lead up to the international sports event in 2020. In the case of physical security, we are able to offer systems such as those for detecting dangerous items or suspicious individuals utilizing explosives detection, image recognition, and other such technologies.

Irie: I work at the Research & Development Group investigating new technology and business opportunity that utilize the IoT. The aims of the IoT can be broadly divided into the use of IT for the smart production of goods and services and for their wise use. By linking together systems that span both domains, Hitachi's aim is to achieve growth through the sharing of value across all the stakeholders involved with goods and services.

In railways, for example, because Hitachi is involved in the production of rolling stock as well as the control systems that support operations, we are launching an initiative to collect data on the operating conditions and movement of rolling stock with aims that include improving utilization and maintenance efficiency. In the future, we intend to expand this type of integration and use of data to a wide range of other industries, including energy, public services, and manufacturing. The key to achieving this is the symbiotic autonomous decentralization concept that is a further development of the autonomous decentralization concept on which the ATOS is based.

Tanaka: What does this concept involve?

Irie: The original autonomous decentralization concept was about building systems with excellent reliability and expandability by allowing subsystems to share information collected through realtime sensing of the equipment being controlled so that the individual subsystems are able to operate autonomously. The concept has been put into practice with control systems such as those used in the transportation and steel industries. The idea is to extend this to the system level, and rather than just optimizing on-site facilities and equipment, to achieve corporate-wide optimization and the optimization and creation of value across entire value chains, including other companies, through the sharing, analysis, and use of information all the way up to the management level. The aim is to use this concept as a basis for building platforms that share value by linking different systems together.

Tanaka: While I understand that, on a technical level, it

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Naohiko Irie, Dr. Eng.

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Joined Hitachi, Ltd. in 1990. Having worked at Hitachi's Central Research Laboratory in the past on research and development in such fields as mainframe, server, and system LSI architectures, he is currently engaged in the research and development on IoT products and platform.
Dr. Irie is a member of the Information Processing Society of Japan (IPSJ).

is not enough just to provide the links, what are the main considerations for combining symbiosis with autonomy.
Irie: To begin with, advanced sensing techniques for collecting the required data and big data techniques for handling large amounts of different types of data are essential. The integration and analysis of data across different systems is particularly important, for which purpose we use the proven Pentaho software. One of the other techniques we deploy for the analysis and use of big data is the Hitachi AI Technology/H artificial intelligence developed by Hitachi. Along with the incorporation of security techniques, the key points include coordinating these components to share and analyze information and provide precise feedback to the workplace.

We also aim to extend our platforms by building up operational know-how and other knowledge about specific sectors and then deploying this in different sectors.
Tanaka: It is important to start off with an expandable platform. However, do you find it difficult to get customers to understand the value of using such platforms?
Kato: That's right. At the Research & Development Group where I work we have developed the NEXPERIENCE / Cyber-Proof of Concept tool for simulating business value that can perform simple calculations of the profitability and benefits to society of social infrastructure projects. First of all, we support customers in taking on new challenges by using simulation as a basis for visualizing the benefits. The aim is to convey the value and other benefits that will overcome the challenges they face through a process of collaborative creation with the customer, using tools like this.

My own department also provides research and development support for the work of the operational divisions represented by you here today, and with regard to the symbiotic autonomous decentralization concept, we are working on research into determining concepts and architectures in the form of system technologies, translating these into implementations, and assessing them through actual system development.

Anticipated Uses for Artificial Intelligence Technology

Tanaka: Please tell me about the artificial intelligence technology you referred to earlier.
Kato: Hitachi AI Technology/H is used as a means of optimizing business and other activities. It works by identifying which items in large amounts of relevant data are correlated with desired outcomes, and automatically generating suggestions for improving the outcomes. This is more efficient that the existing process of manually testing hypotheses, with the advantage that it can consider a much larger number of parameters. We believe that artificial intelligence can demonstrate its usefulness in a symbiotic autonomous decentralized world where interoperation between systems and data occurs in ways that extend beyond past practices.
Irie: A feature of the technology is that, by analyzing big data that includes not only sales data, equipment operating conditions, and other such information, but also information on things like human behavior and communication that have been difficult to deal with in the past, it can find data correlations that would not occur to humans, such as identifying relationships between staff working practices and service quality. The technology has potential in a wide range of applications and we have started supplying business improvement services that use Hitachi AI Technology/H.
Hotta: I understand that artificial intelligence includes the use of deep learning techniques for things like

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Joined Hitachi, Ltd. in 1983. He is currently engaged in managing research into information and control systems and power electronics at the Hitachi Research Laboratory. Having previously headed Hitachi's Yokohama Research Laboratory, he took up his current position in 2013.
Dr. Hotta is a member of the IEEE, The Institute of Electrical Engineers of Japan (IEEJ), The Institute of Electronics, Information and Communication Engineers (IEICE), the IPSJ, and the Society of Project Management.

automatically identifying anomalies in surveillance camera video. We can expect the combination of artificial intelligence with cameras and other sensor technology to lead to further advances in the fusion of control and information.

Aragane: Given the labor shortages caused by a falling population, labor-saving practices for plant maintenance will be a long-term challenge for manufacturing and other parts of the social infrastructure, making this another area where we can expect to see the technology deployed.

How to Achieve the Safe Fusion of Control and Information

Tanaka: A major challenge that arises from the ongoing fusion of control and information is security. Whereas reliability can be achieved by practices such as system redundancy, for reasons of ensuring safety, there are cases in social infrastructure in particular when it is and when it is not permissible for services to shut down, and you can't just put a lid on whatever you want. I believe this to be particularly problematic in a symbiotic autonomous decentralized world.

Kato: That's right. The design concept used under the original autonomous decentralization systems concept was for nodes to improve resilience to faults by making their data available for mutual access so that they can perform autonomous diagnosis of other nodes and protect themselves if an anomaly is found. We are considering extending this same concept to security.

Furthermore, control systems tend to have a hierarchical design with defensive systems invariably provided for the most important components that connect directly to the equipment being controlled, such that the minimum level of safety can be maintained even in the event of a problem occurring at a higher level. I see the basis of symbiotic autonomous decentralized security as being the provision of demarcated interconnections by, for example, installing gateways between the information system level close to services and the control system level.

Aragane: Traditionally, control systems have been designed on the basis that protection is provided for those areas that need it not by software but physically using currents and so on. But even if the way in which signals are sent to the higher levels has changed, the idea of hierarchical protection will likely remain the same.

Irie: For the security of social infrastructure that is required to respond to threats and ensure the continuity of service supply, we have proposed the Hitachi system security concept. This is expressed in terms of "adaptivity," "responsivity," and "cooperativity." The concept defines three requirements for social infrastructure security. These are: to provide ongoing countermeasures to increasingly diverse threats by working through the plan, do, check, act (PDCA) cycle; to respond promptly to unanticipated attacks so as to minimize damage; and to prevent the spread of damage to other interdependent systems by coordinating across organizations and systems and maintaining a shared situational awareness. The concept has been proposed to the International Electrotechnical Commission (IEC) with the aim of having it adopted as a global standard.

Kobayashi: Combined with comprehensive control system safety and security, the use of information can deliver new value to both the operators and users of railway services, for example, by integrating the railway reservation, smartcard ticketing, and other systems with the traffic management system to enable realtime changes to departure times or to provide additional services based on actual user levels. Our aim is to use initiatives like this not only to provide greater convenience for users but also to increase value throughout the industry and society as a whole by enabling the world of control systems to take advantage of the possibilities of the information world.

Tanaka: It is highly significant that Hitachi has built up such a trusted brand in the field of control systems. I look forward to your delivering even greater benefits to your customers and other parts of society through the use of information systems with this brand as a foundation.

Hotta: Given that the past practice with social infrastructure systems has been to make improvements at the level of individual systems, there remains great potential for utilizing IT to optimize the infrastructure as a whole. Hitachi intends to continue enhancing its control system technology in order to contribute to Social Innovation. Thank you for your time today.