Technotalk

Accelerating Fusion of IT and Control to Deliver Innovation in Water Industry

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Thanks to a variety of technical innovations over time, the water infrastructure that forms an essential underpinning of society has achieved dependability along with safety and security. Outside Japan, there remain regions beset by water scarcity. In Japan, meanwhile, problems are emerging as a result of the changing social environment, which includes an aging population and declining birth rate. Hitachi supplies numerous products, systems, and services for the water industry that extend from watershed management to flood control, water supply and sewage, water recycling, and waste water treatment. By supplying solutions for the water industry based along these lines, Hitachi is helping overcome the challenges facing water infrastructure in Japan and elsewhere, including improving efficiency and reducing labor requirements for operation and maintenance, expanding the geographical coverage of services, and ensuring the security essential to IT.

Challenges for Social Infrastructure and Demands on Use of IT

Tachi: Information technology (IT) and control technology are used in a variety of ways by social infrastructure, including water infrastructure.

Consumers may not be aware of it when they see the taps and drains in their homes, but both water supply and sewage are made possible by the support of IT and control technologies, electrical equipment, and other such infrastructure.

Shin: There are very few countries in the world where it is safe to drink the water straight from the tap. While this is something we take for granted here in Japan, we should also bear in mind that underpinning this convenience is the role played by advanced control systems and information systems that have been built on the skills of experienced engineers and the efforts of water utilities and suppliers such as Hitachi.

Tadokoro: Having constructed this social infrastructure to such high standards, the challenge now facing Japan is how to maintain it into the future.

To ensure the continuity of social infrastructure, it is vital to work through the P-O-M cycle of planning, operation, and maintenance. While greater use is being made of IT in my own field of operations, there are still many aspects of maintenance that rely on work done by human beings. With the number of skilled staff set to fall in the future, there is a need to also use IT to perform maintenance more efficiently, and to collect and analyze the data associated with operation and maintenance (O&M) to optimize upgrade planning.

There is also a need to think about water and the environment in broader terms with a view to achieving efficient management of the circulation of water throughout a catchment. A key aspect of Hitachi's focus on its Social Innovation Business is the "symbiotic

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Following positions as tutor at the University of Tokyo in 1980, doctorate in engineering (University of Tokyo) in 1987, Associate Professor at the University of Tsukuba in 1988 and Associate Professor at the University of Tokyo, he took up his current appointment in 2006. Other roles have included President and Fellow of The Society of Instrument and Control Engineers (SICE), President of the Control System Security Center (CSSC), and chairman of the judging panel for the Japan Management Association Good Factory prizes.

autonomous decentralized" concept. This is a system concept for maintaining overall sustainability by having multiple systems that operate autonomously to fulfill their own respective functions also work together in mutual harmony and in an optimal way. Our long-term aim is to create a "symbiotic autonomous decentralized" infrastructure that encompasses not only water supply, sewage, and rivers and other environmental water, but also other social infrastructure.

Nakano: Greater use of IT, including open technologies, is essential for interlinking and coordinating social infrastructure. Also vital is the assessment of cybersecurity risks and the implementation of countermeasures, including for control systems. In this regard, of particular note over recent years has been the International Electrotechnical Commission (IEC) 62443 international standard for control system security. It stipulates the security programs required for compliance at each level, covering management and operation, systems, and components. In addition to participating in the standardization process, Hitachi has also developed the HISEC 04/R900E controllers that were among the first to obtain Embedded Device Security Assurance (EDSA) certification to minimize the risk of network-based cyber-threats.

In the case of critical systems, we also supply unidirectional routers that physically block access from the external network, and a system for identifying unauthorized personal computers (PCs) and forcibly excluding them to prevent security threats that issue from devices connected to the network without authorization. By taking these active steps to maintain security in control systems, we are helping to build social infrastructure that utilizes IT while also ensuring a secure environment.

Hitachi Solutions Contributing to Innovation in the Water Industry

Tachi: As you noted earlier, the water sector faces numerous challenges, including aging facilities and the retirement in large numbers of experienced workers here in Japan, and physical and economic water shortages evident when we look overseas. Hitachi is marketing its solutions for the water industry globally in order to help overcome these. Can you tell me about any specific initiatives of this nature involving IT and control technology?

Tadokoro: In my area, we are engaging in collaborative creation with customers to develop new control technologies that involve greater integration and coordination with IT. Examples aimed at dealing with the challenge of combining energy savings with efficiency and security of supply include the supply of a water distribution control system that performs realtime analysis of data from sensors in the distribution pipe network for optimal control of parameters such as distribution pump pressures, and a water operations planning system that predicts water demand based on factors such as the air temperature, weather, and day-of-week to formulate operational plans for water intake and pumping. In other words, to achieve sustainable progress, we are seeking to use new control technologies to contribute to the entire water supply and distribution network. In a practical manifestation of the "symbiotic autonomous decentralized" concept, we are seeking to commercialize demand response control to cut or shift peaks in the consumption of electric power without compromising the reliability of the water supply by harmonizing the operation of water and electric power infrastructure.

In the field of sewage treatment, we are participating in the Breakthrough by Dynamic Approach in Sewage High Technology (B-DASH) Project of the Ministry of

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Joined Hitachi, Ltd. in 1982. Having previously worked on the development and design of digital instrumentation and control systems and the design of water and sewage monitoring and control systems, he is currently engaged in the development and design of information and control systems for water and sewage and in overseas business activities.
Mr. Tadokoro is a member of The Institute of Electrical Engineers of Japan (IEEJ) and the SICE.

Land, Infrastructure, Transport and Tourism by trialing a water treatment control technique that uses IT-based predictive control to save electric power while maintaining the quality of the treated water.

In the case of pipe network maintenance, we are researching condition-based maintenance (CBM) techniques that utilize IT through our participation in the Rainbows Project, a joint research project on the reconstruction of water distribution networks run by the Japan Water Research Center.

Yokoi: In the Research & Development Group, we are focusing on research and development (R&D) work aimed at ensuring the safety and reliability of water. Two aspects of safety and reliability are "appropriate operation" and the "health of equipment." In terms of operation, we have been among the first to develop and supply water safety management systems that support the introduction and operation of Water Safety Plans in accordance with guidelines issued by agencies such as the World Health Organization (WHO) or Ministry of Health, Labour and Welfare.

In terms of equipment health, meanwhile, we have also developed abnormality prediction techniques that utilize adaptive resonance theory (ART) to categorize equipment condition and identify changes. Hitachi has already successfully applied ART in a condition monitoring system for thermal power plants that automatically identifies problems with plant operation.

We are currently using this technology to develop a system for detecting potential faults based on the operating history of pumps at water treatment, seawater desalination, and other such plants. If successfully implemented, the system will not only prevent shutdowns due to pump faults but also reduce maintenance costs without compromising the health of equipment by determining the best time to upgrade equipment.

Shin: When thinking about how to pass on technical skills, in addition to utilizing sensors and other IT to enable operation and maintenance to be conducted on the basis of data, we also recognize the importance of documenting practices in manuals. Future manuals will need to go beyond text to include the use of video to demonstrate operating procedures.

The use of three-dimensional (3D) mapping techniques for piping and other equipment at a plant also offers scope for improvements in maintenance efficiency.

Yokoi: To support safe and efficient maintenance and inspection at plants and other workplaces, Hitachi supplies a remote work instruction system that uses augmented reality (AR) and 3D data processing techniques. We are also working on the R&D of techniques for generating 3D map data from images with the aim of using these technologies to support O&M in water-related applications.

There is scope for the use of image processing techniques not only for monitoring but also in maintenance. In one example, we are helping pass on skills by developing a system for tablets that displays an inspection or operation procedure to the user when he/she points the camera at an AR marker indicating an inspection site.

Tadokoro: We also see potential for utilizing technologies such as sensing and the Internet of Things (IoT) and presenting information over a wider scope and in greater detail as a means of achieving the best possible O&M. In the case of sensing, we have developed a water leak management system that helps with the problems associated with water leaks in emerging economies by combining sensor data, asset information, and hydrological simulation techniques for piping networks to identify locations where the volume of water loss is high.

Tachi: To ensure the safety and reliability of water, work on the international standardization of things like abnormal event detection processes and crisis

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management of water and wastewater is being undertaken by agencies such as the International Organization for Standardization (ISO). Hitachi is participating along with Japanese agencies in technical committees that are working on the collation of guidelines for things like the procedures to follow in a crisis, how to detect water quality events, and decision-making processes. We aim to continue making a contribution internationally, including in the field of safety standards, by incorporating Japan's water and wastewater management techniques and knowledge of crisis management in response to natural disasters into our proposals.

Use of Social Infrastructure Security to Help Ensure the Safety and Security of Water

Tachi: As mentioned in an earlier discussion, security measures are essential to the achievement of more advanced social infrastructure. I would like to ask Professor Shin, who is President of the Control System Security Center (CSSC), to update us on what is happening in this field.

Shin: The CSSC is involved in R&D, training, awareness-raising, security certification, and other activities aimed at maintaining security and providing measures for dealing with cyber-threats against the control systems used for important social infrastructure, such as water, electric power, and gas.

As Dr. Nakano noted earlier, the IEC 62443 standard specifies security requirements for three separate layers, namely management and operation, technology and systems, and components and devices. Security certification is also dealt with in terms of these three layers. In the case of management and operation, the Japan Institute for Promotion of Digital Economy and Community (JIPDEC) provides a cybersecurity management system (CSMS) certification service for information security systems at organizations that deal with control systems. At CSSC, we launched the EDSA security certification program for embedded control system components in 2014 to cover components and devices, and we plan to commence a pilot certification service for technology and systems in 2015. This will make Japan the only country in the world with a comprehensive certification regime for control system security. Utilizing knowledge that you have shared in your role as a member of the CSSC, I look forward to Hitachi providing safety and security to the water industry throughout the world.

Nakano: In addition to ensuing that systems are robust, another factor vital to keeping important water infrastructure safe in this era of open systems is that the systems are capable of an accurate and timely response to threats and to other aspects of the ever-changing social environment.

To provide solutions that satisfy this requirement, Hitachi believes it is vital to incorporate "adaptivity," "responsivity," and "cooperativity" into the security measures for social infrastructure. "Adaptivity" means working through the plan, do, check, act (PDCA) cycle to make ongoing enhancements to preemptive countermeasures and defenses against ever-changing threats and other aspects of the social environment. "Responsivity" means accepting that security incidents such as attacks or disasters are inevitable and strengthening training exercises and incident response measures to minimize subsequent damage and to shorten the time it takes to recover. "Cooperativity" means strengthening countermeasures by standardizing situation assessments through the sharing of security information between organizations in order to establish defenses and minimize damage based on obtaining security-related information in a timely manner. Establishing security measures based on these three elements that cover both physical and cybersecurity and include both system management and operation will be essential to social infrastructure in the future.

Yokoi: In the case of techniques for physical security, Hitachi supplies technology for using finger veins to perform biometric authentication; systems able to coordinate multiple cameras and track suspicious individuals not only by their faces but also by the color of their clothes, the features of objects they are carrying, and the routes they follow; and explosive detection systems that incorporate mass spectrometers. A recent focus has been the development of security systems that do not compromise user convenience, such as by performing identification as they operate a touch panel or pass through a gate.

Tadokoro: For control security, we are increasing the level of security by adopting a philosophy of defense in depth that combines multiple layers of defense, including component-level countermeasures such as one-way routers that block unauthorized access, system-level design practices such as the use of white lists to only permit pre-approved access, and physical authentication systems.

Tachi: Because water is a part of the social infrastructure on which lives depend, particular consideration needs to be given not only to efficiency but also to safety and reliability. In addition to taking account of security, Hitachi is accelerating the fusion of IT and control technology and putting its comprehensive capabilities to work on helping overcome the challenges facing the water industry, both in Japan and elsewhere. Thank you for your time today.