# Technology for Safety and Security from Underwater to Outer Space and Cyberspace

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## GROWTH IN IMPORTANCE OF SAFETY AND SECURITY FOR SOCIAL INFRASTRUCTURE

OUR perceptions of safety and security were changed drastically by the September 11, 2001 terrorist attacks in the USA and the Great East Japan Earthquake that struck on March 11, 2011. In the case of the Great East Japan Earthquake, interruptions to essential services caused by damage to or loss of social infrastructure systems, such as electric power, gas, water, sewage, transportation, logistics, and communications, extended over a wide area, including places not directly affected by the disaster. In addition to reinforcing how essential these social infrastructure functions that people take for granted in normal times are to their way of life, this provided an opportunity to identify some of the vulnerabilities of this infrastructure.

This article describes what Hitachi is doing to ensure the safety and security of social infrastructure, and updates the latest situation with reference to the lessons learned from the Great East Japan Earthquake.

## EXPANSION OF SOCIAL INFRASTRUCTURE AND GROWTH IN POTENTIAL THREATS

Social infrastructure provides systems that are essential to our way of life. These include both industrial infrastructure, such as transportation, energy, finance, and communications, and lifestyle infrastructure, such as water, food, healthcare, and education. As in the past, these systems need to deliver reliable services and be kept in operation to underpin the public's way of life. Now, however, prompted by incidents such as terrorism or major earthquakes, major changes are taking place in the criteria by which the safety and security of social infrastructure are judged, resulting in these requirements becoming even more severe.

Fig. 1 shows the expansion of social infrastructure and growth in potential threats. Traditionally, social infrastructure has meant the equipment and other facilities used to support human activity. In recent years, however, the rapid emergence of the Internet and other networks has given the communication networks that carry information an essential role in social activity. Moreover, environmental conservation for the entire planet has become important now that problems such as global warming are becoming more severe, and it is no exaggeration to say that our destiny depends on the global environment.

Meanwhile, looking at the changing nature of the threats to social infrastructure, these consisted in the past of problems with system operation, such as dealing with accidents, faults, or human operational error. Now new threats have emerged, including deliberate attacks such as physical military strikes or cyber-attacks on information systems or information assets. Looking at the threats to the global environment, global warming caused by the emission of carbon dioxide ($CO_2$) has become a major issue along with natural disasters such as earthquakes and typhoons. Yet another threat to be concerned about is that of pandemics, in which an infectious disease impacts the population on a global scale.

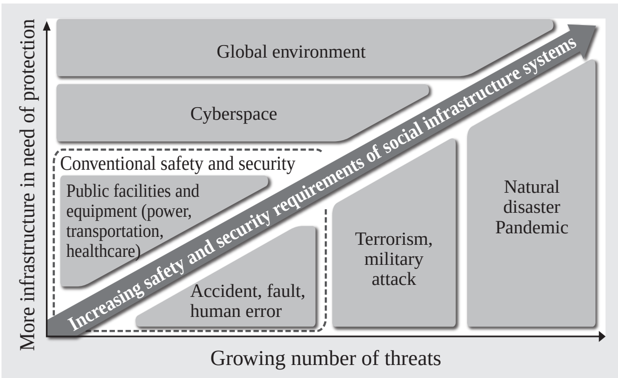


*Fig. 1—Expansion of Social Infrastructure and Growth in Potential Threats.*
*While more and more social infrastructure is in need of protection, the corresponding threats are becoming more diverse.*

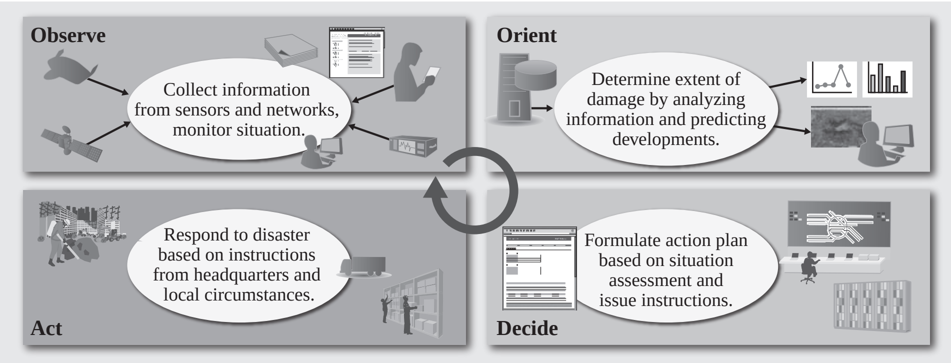


*Fig. 2—Crisis Management System Using OODA Loop.*
*The figure shows the basic concepts of crisis management incorporating the OODA loop methodology used in the defense sector.*

As this indicates, the background factors affecting social infrastructure are becoming more difficult, making the provision of safety and security solutions that can protect people's way of life an extremely important topic.

## THREAT RESPONSE STRATEGIES

With more and more social infrastructure in need of protection, as described above, considering all possible situations in advance and preparing countermeasures to each one is all but impossible. Given these circumstances, Hitachi is seeking to apply concepts from the defense sector to respond to crisis situations. Fig. 2 shows the basic concepts of crisis management.

The OODA loop(a) for rapid decision making and situation response is an effective concept to adopt in a crisis. The OODA loop consists of four phases: (1) Collect and monitor information (observation phase), (2) Analyze collected information to assess the situation (orientation phase), (3) Formulate an action plan based on the situation assessment and issue instructions (decision phase), and (4) Act based on instructions from headquarters and local circumstances (action phase). Repeatedly working through this cycle helps achieve rapid decision making and situation response. The OODA loop concept is suitable for use in disasters or other emergencies in which the situation is changing rapidly and there is a confused mix of different information.

Conducting training exercises beforehand and making use of the information they provide is also important. Use of the OODA loop concept is not limited only to emergencies. To be able to respond to situations that exceed expectations, regular training exercises need to be performed, and all of the lessons learned incorporated into actual practices. Using the OODA loop in exercises provides a reliable way to incorporate the results of these exercises into emergency scenario manuals or other materials used at times of emergency. Examples of results include checking command and control systems and improvised responses.

Scenarios and simulations are important aspects of this activity. To conduct a training exercise, the participants first need to be told a scenario based on the training objectives. The exercise then proceeds by running a simulation based on their response to this scenario and using this to generate a new scenario. Fig. 3 shows the concept behind training exercises.

(a) OODA loop
A decision making methodology proposed by U.S. Air Force Colonel John Boyd based on experience from the Korean War. OODA stands for "observe, orient, decide, and act," and it is a model for achieving fast and accurate decision making by repeatedly working through this cycle. The OODA loop is not only in widespread use throughout the US military, it has also been adopted as a decision making process in business.

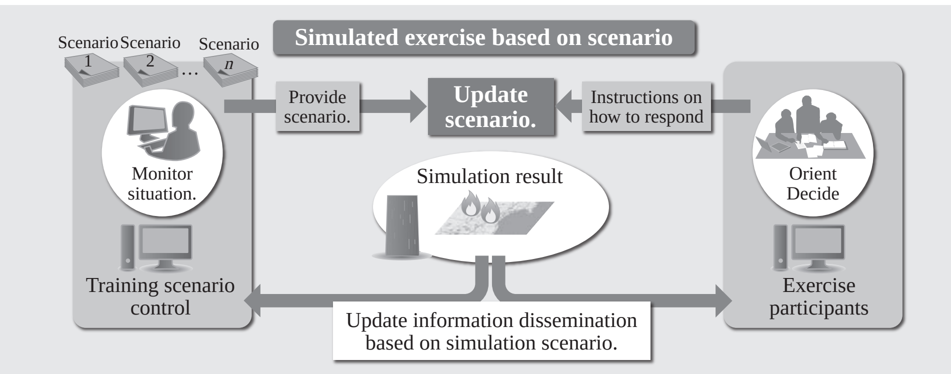


*Fig. 3—Concepts behind Training Exercises.*
*Training exercises involve providing the participants with a scenario based on the training objectives, running a simulation based on their response to this scenario, and using this to provide a new scenario.*

OODA loops also need to be established in cyberspace. The response to a cyber-attack can use the same concepts as the (real world) emergency situations or (virtual) training exercises described above. Simulation is particularly effective in cyberspace where staging exercises using the actual systems is difficult.

Incorporating the concepts described above makes it possible to respond flexibly to situations that could not be anticipated in advance, and that have been difficult to deal with in the past.

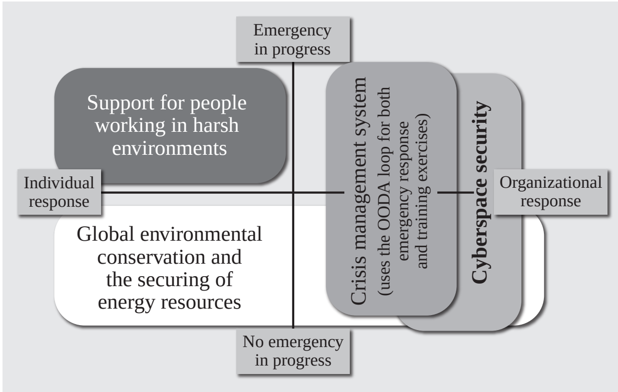


*Fig. 4—Technologies Covered in this Issue, and their Scope.*
*This issue contains articles on subjects that have been of growing importance in recent years, including crisis management systems, cyberspace security, global environmental conservation, the securing of energy resources, and support for activities in harsh environments.*

## HITACHI'S ACTIVITIES

Hitachi has for many years been developing, delivering, maintaining, and operating products and solutions for many different types of social infrastructure. This issue of Hitachi Review contains articles on subjects that has been of growing importance in recent years, including crisis management systems, cyberspace security, global environmental conservation, the securing of energy resources, and support for activities in harsh environments (see Fig. 4).

Crisis management systems and cyberspace security provide typical examples of the use of the OODA concept, both for training exercises and the actual response in an emergency. Global environmental conservation mainly concerns the use of the OODA concept to support data gathering (observation) and situation assessment (orientation) during times when there is no emergency. Support for work in harsh environments involves solutions that help with the "act" phase when dealing with emergency situations.

### Crisis Management Systems

In crisis situations that cause major damage over a widespread area, such as large disasters or terrorist attacks, there is a need to respond to a rapidly changing situation, with central government, public agencies, local government, and the general public working together to minimize the damage and accomplish the subsequent recovery and reconstruction. This requires preparing for disaster by fully implementing the OODA loop described above before the disaster strikes, and by establishing reliable means for data gathering and command and control during the disaster.

(1) Hitachi supplies a comprehensive disaster prevention management solution for dealing with large-scale disasters (see Fig. 5). This solution improves the awareness of personnel and tests command and control functions by conducting training exercises beforehand, and supplies information analysis functions that provide support during the disaster for data gathering and fast decision making by public agencies and local authorities (see p. 160).

(2) A nuclear incident response solution designed specifically for the nuclear power industry supplies enhanced security for nuclear power facilities and associated fields, applications that require especially strong incident response functions (see p. 168).

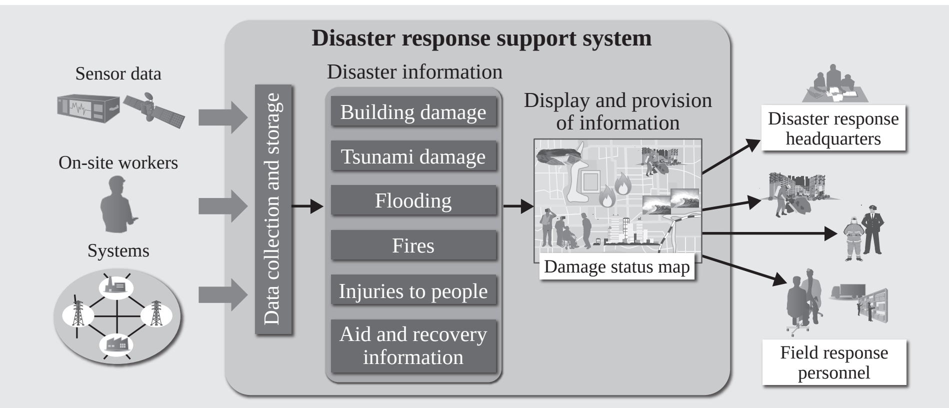


*Fig. 5—Example Disaster Prevention Management Solution.*
*This solution improves the readiness of personnel and tests command and control functions by conducting training exercises, and supplies information analysis functions that provide support during the disaster for data gathering and rapid decision making by public agencies and local government.*

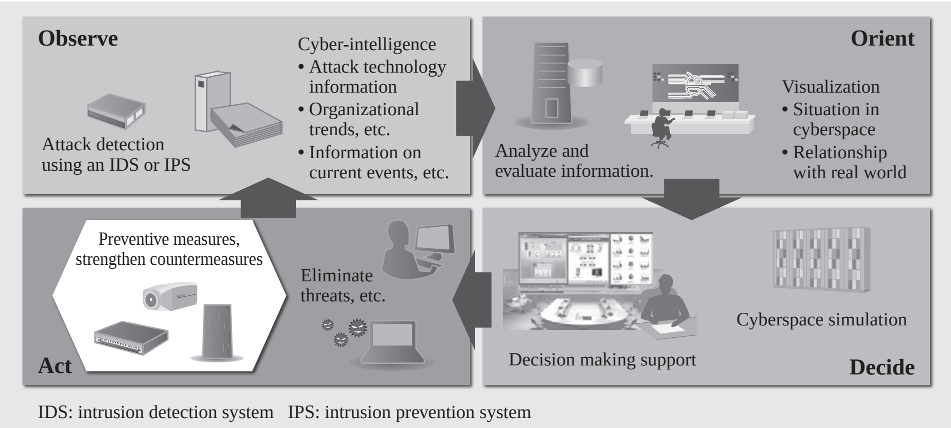


*Fig. 6—Example of Cyberspace Security.*
*The OODA loop is used as a basis for enhancing counter cyber-attack capabilities.*

This solution strengthens nuclear incident response functions for dealing with severe accidents, and implements the new recommendations stipulated by the International Atomic Energy Agency (IAEA).

(3) Hitachi supplies a wide-area communication system that coordinates the different communication systems used by government ministries and agencies during a major disaster to provide dynamic information sharing and interconnection between various communication systems (see p. 174).

## Cyberspace Security

It is no exaggeration to say that many types of social infrastructure could not function without information systems. This means there is a need to implement the OODA loop in cyberspace to prevent information leaks, cyber-attacks, and other threats.

(1) Hitachi supplies solutions for national security with functions for enhancing counter cyber-attack capabilities based on the OODA loop (see Fig. 6 and p. 180).

(2) A solution designed specifically for defending against information leaks helps keep information assets safe, particularly through the use of information encryption and strengthening measures for preventing the reverse engineering[(b)] of software (see p. 185).

## Global Environmental Conservation and Securing of Energy Resources

Securing reliable energy supplies is essential to industrial progress and a civilized lifestyle. On the other hand, indiscriminate exploitation of energy resources results in damage to the global environment and poses a threat to the long-term existence of humanity. Hitachi is taking on the challenge of combining global environmental conservation with a reliable supply of energy.

(1) The carbon-hydride energy storage system is intended for the long-term storage and transportation of hydrogen, a form of energy that is otherwise difficult to handle, by storing it in the form of methylcyclohexane (MCH), a stable liquid (see Fig. 7). The system can

(b) Reverse engineering
The analysis of hardware or software, or the observation and interpretation of its operation, to determine information such as its specifications, design, manufacturing methods, component parts, specific technologies, or source code.

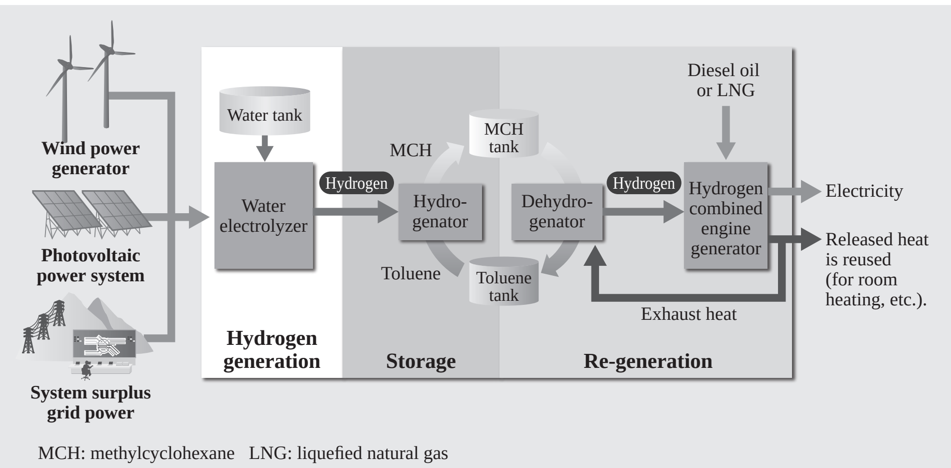


*Fig. 7—Overview of Carbon-hydride Energy Storage System.*
*Renewable energy is stored in the form of MCH and converted to electric power when needed.*

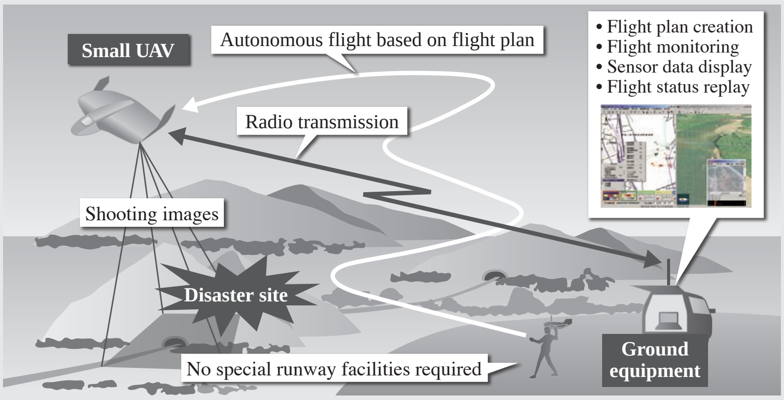


*Fig. 8—Example Unmanned Aerial Vehicle System.*
*UAVs are tools for automatic aerial data gathering that can be used with a small number of people and require only a short takeoff and landing distance.*

help achieve a stable supply of renewable forms of energy, such as wind power, that have a fluctuating output, and it can assist in situations where providing energy supplies is a challenge, including remote islands, Japan Ministry of Defense personnel on overseas missions, or places that have become isolated due to a disaster (see p. 192).
(2) Water resource cycle simulation assists with water resource management and countermeasures against flood damage. Hitachi's system includes functions for simulating the combined effects of both surface and ground water (something that was difficult in the past), and functions that provide an intuitive view of the simulation results. This helps solve the various problems associated with water. For example, it can facilitate faster decision making by allowing the current status of water resources or inundation damage to be determined and predictions made about the future (see p. 199).
(3) The satellite imagery solution enables quantitative evaluations to be made of conservation activities by using time-series data that extends into the past and was acquired through the use of satellite images for monitoring. It can support forest conservation by applying imagery analysis and interpretation techniques that Hitachi has built up over time to calculate carbon stock amounts. It can also contribute to the conservation of marine ecosystems through the analysis of ocean images (see p. 204).

## Support for Work in Harsh Environments

When an accident occurs, or in a disaster or other emergency, it is sometimes necessary to perform work in situations that are difficult for people to approach directly, such as contaminated land or places where hazardous materials are located. To deal with such situations, Hitachi supplies a range of equipment and systems that support data gathering and situation assessment during an emergency.
(1) Unmanned aerial vehicle (UAV) systems are tools for automatic aerial information gathering that can be used with a small number of people and require only short takeoff and landing distances. Hitachi can provide pilotless operation using autonomous flight control, realtime situation assessment via an aerial mesh network, automation of information analysis, and visualization enhancements (see Fig. 8 and p. 209).
(2) Hitachi is contributing to the security of maritime infrastructure in ways that include the construction of minesweepers that use sonar system technology[(c)] to remove mines so that vessels can travel in safety. Hitachi uses these technologies to supply underwater monitoring solutions for protecting important social infrastructure such as offshore airports and power plants or oil reserve facilities constructed on the shoreline (see Fig. 9 and p. 214).
(3) Japan's landscape is characterized by many rivers and ravines[(d)], and Hitachi supplies prefabricated supporting bridging systems for use in the event of breaks in the transportation infrastructure. The Japan Ministry of Defense uses Hitachi's prefabricated temporary floating bridges that are designed to float on a river and support vehicle traffic, and prefabricated temporary span bridges that can span rivers or ravines without requiring piers. In the Great East Japan Earthquake, a prefabricated temporary floating bridge helped with the recovery effort by ferrying

(c) Sonar system technology
Systems that use sound waves for purposes such as distance measurement and detecting the features of underwater organisms, objects, and topography. Some sonar systems emit their own sound waves and use the echoes to measure the distance and direction of objects. Others can detect and measure the sounds that objects emit themselves.
(d) Ravine
Used here to refer to any crevice or other gap in the earth's surface.

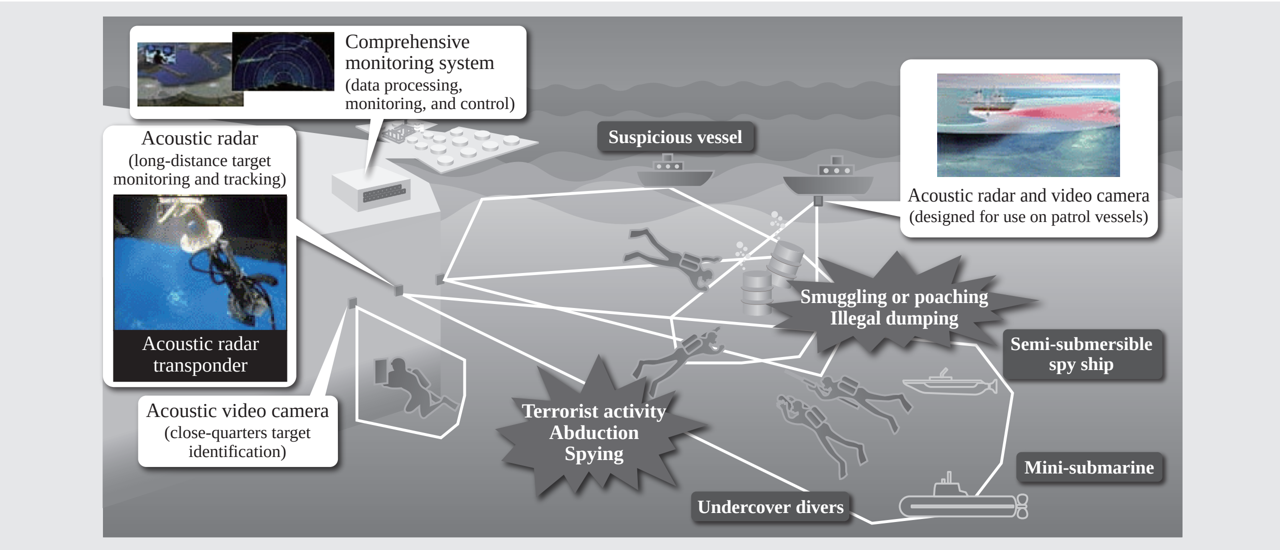


*Fig. 9—Underwater Monitoring Solution.*
*The solution uses sonar system technology to protect important social infrastructure built on the shoreline.*

construction machinery to an island that had become isolated due to a collapsed bridge (see p. 219).
(4) Hitachi is contributing to international peace by supplying demining equipment for clearing landmines left in the ground in overseas countries after civil wars or other conflicts. Hitachi is also developing a landmine clearance machine with a remote control function for clearing anti-tank mines (see p. 224).
(5) Hitachi supplied the electric propulsion system for the icebreaker Shirase that transports personnel and supplies to the Antarctic. The system supports the complex ship maneuvering required for icebreaking (see p. 231).
(6) A driverless tractor system used for the transportation of supplies in Antarctica supports the activities of personnel who are wintering over in that region's extremely cold climate (see p. 229).
(7) A radiation measurement device with a color-coded display that measures amounts of radiation over a wide range is helping improve the efficiency of decontamination work in the affected areas (see p. 233).

## WORK TOWARD A SAFER AND MORE SECURE SOCIETY

The need to prepare for the unexpected has grown in recent years, and society is seeking ways to achieve this and balance the costs. Hitachi draws on the technologies for safety and security it has built up over time to supply solutions that can deal in a scalable and flexible way with many different situations.

From underwater to outer space and cyberspace, Hitachi intends to utilize its accumulated technical capabilities to contribute to the building of safe and secure social infrastructure that can cope with the unexpected.

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