

O&M Service for Sustainable Social Infrastructure

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OVERVIEW: Hitachi is developing O&M services delivered through a cloud-based convergence of control and information technologies for operation and maintenance, together with their associated services. By using these O&M services, social infrastructure business operators can efficiently implement systems for operation and management on the cloud. By delivering O&M services throughout the world, Hitachi is helping create operation and maintenance systems that can keep up with the growth of social infrastructure in each country or region, and with changes in the associated business environment.

INTRODUCTION

GIVEN the growing cost of maintaining and updating infrastructure in developed economies and the increasing urbanization in emerging economies, there is a need for efficient operation and maintenance of energy, water, transportation, mining, cities, and other social infrastructure. A survey by the Ministry of Land, Infrastructure, Transport and Tourism⁽¹⁾ estimated that the cost of maintaining, managing, and updating infrastructure in Japan will reach approximately 65% of the infrastructure budget by 2030. This trend is not only visible in Japan, but applies across all developed economies that were among the first to develop their infrastructure. Also, because the proportion of people in middle-income or higher brackets (annual income of \$US3,000 or more) will reach approximately 70% of the global population by 2030 (compared to 40% in 2010), rapid progress is anticipated in the provision of social infrastructure in response to future urbanization and other trends in emerging economies. Meanwhile, the risk of shrinking workforces due to aging populations in developed economies in particular is making the efficient operation and maintenance of the social infrastructure into an important future social issue.

Against this background, Hitachi is developing operation and maintenance (O&M) services that are delivered through a cloud-based convergence of control and information technologies for operation and maintenance, together with their associated services. By using these O&M services, social infrastructure business operators can efficiently implement systems that collect and analyze detailed information about the equipment, facilities, and workers involved with operation and maintenance, apply it in the field for tasks such as preventive maintenance and operational

management, and use it to assist with business operation and management.

This article considers the issues facing the future operation and maintenance of social infrastructure, provides an overview of the operation and maintenance requirements and functions needed to implement O&M services and of the services that can satisfy these requirements and deliver the functions, and presents an example application from the railway industry.

OPERATION AND MAINTENANCE TASKS PERFORMED BY O&M SERVICE

Two features of O&M services provided by Hitachi are their high level of adaptability to business changes, and that these comprehensive services extend from equipment-level operation and maintenance up to business operations and management.

As social infrastructure provides the foundations for daily life and economic activity, its reliable, long-term provision is essential. Similarly, it must be able to respond flexibly to the various potential changes that may occur over the course of social infrastructure business operations, in areas such as the nature of the business, its governance, and the business environment.

Another feature of operating an O&M business for social infrastructure is that the various stages from equipment-level micro-management up to business operations and other macro-level management are coexistent and interdependent. This makes it important to perform the centralized collection and utilization of information with many different levels of granularity.

Given this background, the following sections describe the social changes that O&M services are likely to face and the functions they need to deliver.

Social Changes to which O&M Services Must Adapt

By considering the changing nature of operation and maintenance work, changes to its governance, and changes in the environment in which it operates, Hitachi has collated the changes likely to be faced by social infrastructure as it moves through the four phases of installation, growth, maturity, and decay or stability (see Fig. 1). In the case of a city, for example, the city grows as infrastructure is built to cope with its rising population. As the population peaks, the city enters its mature phase followed by a period of decay or stability. Operation and maintenance also goes through numerous changes over the course of this process.

Changing nature of operation and maintenance work

(1) Establishment and refining of operation and maintenance processes (1-a)

Along with the introduction and growth of the relevant business, the associated operation and maintenance processes are also established and refined. While this involves being able to proceed by trial and error, Hitachi's O&M services make it possible to change the nature of the operation and maintenance work and the processes (procedures) used, flexibly and based on the results of reviewing current practice.

(2) Increasing standardization of operation and maintenance processes (1-b)

As operation and maintenance processes are established along with the growth of business, the nature of the work and the processes used are increasingly standardized. Hitachi's O&M services are designed to facilitate standardization.

Changes in governance of operation and maintenance

(1) Entry of new operators (1-c)

As business grows, increasing numbers of new operators enter the market. Hitachi's O&M services are able to provide standard services to facilitate the entry of new operators and are able to make enhancements to suit the needs of individual companies.

(2) Increasing consolidation and reorganization of operators (1-d)

As business matures, operators increasingly consolidate or reorganize to reap economies of scale. Mechanisms are provided that allow this consolidation and reorganization to proceed efficiently, including ways of facilitating the integration of operation and maintenance work and processes.

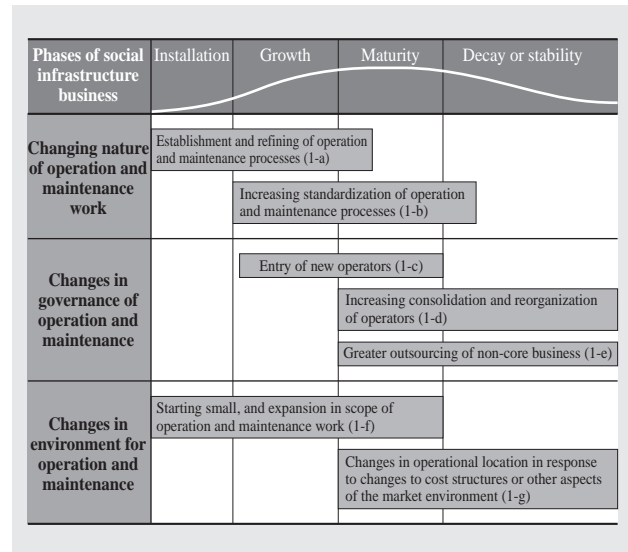


Fig. 1—Evolution of Social Infrastructure Business and Changes in Operation and Maintenance.

Business practices need to cope with a variety of changes as social infrastructure goes through the processes of installation, growth, maturity, and decay or stability.

(3) Greater outsourcing of non-core business (1-e)

As business matures, it becomes increasingly clear which areas are core business and which are non-core, with greater outsourcing to external suppliers. Mechanisms are provided to allow changes in which organizations are responsible for performing specific operation and maintenance tasks.

Changes in environment for operation and maintenance

(1) Starting small, and expansion in scope of operation and maintenance work (1-f)

When new business is introduced on a small scale, their operation and maintenance must also start from a similarly small base. Flexible system scalability is provided so that, as the scope of a business grows, its operation and maintenance can expand accordingly.

(2) Changes in operational location in response to changes to cost structures or other aspects of the market environment (1-g)

The location from which a business is performed may change in response to changes to cost structures or other aspects of the market environment. One example is how mining business moves as resources are depleted in one location and discovered in another. Another possibility is the use of remote monitoring and operation, for example, to shift operation and maintenance work to locations where labor costs are lower. Hitachi's O&M services provide the flexibility to shift to new locations.

Functions Delivered by O&M Services

The functions required for the operation and maintenance of social infrastructure extend from those associated with the maintenance and operation of the equipment through to the wide range of functions that support business operations and management.

Hitachi's O&M services provide integrated functions that include the collection of data, its use in analysis and planning, and the use of these analyses and plans as the basis for management and execution. This extends from the micro level of equipment operation and maintenance to the macro level of business operations and management (see Fig. 2).

The data collection functions required in the case of maintenance, for example, include the operational status of machinery and information about maintenance workers (2-a). Functions that use this collected data for maintenance planning or to detect potential breakdowns before they happen (2-d) are also required, as are functions for managing maintenance work in accordance with this planning and the results of analyses (2-g). Other support functions used for management include inventory management for spare parts and the provision of utilization and performance guarantees.

Similarly, the functions required for operation include monitoring of operations and work (2-b); operational plans and personnel assignments (2-e); and work management, automatic operation, raw materials management, and utilities management (2-h).

For business operations and management, functions need to be provided for assessing supply and demand and changes in markets (2-c); production planning (2-f); and the management of human resources, revenue, and investment (2-i). Hitachi's O&M services provide these functions in a consistent way in the form of common platforms.

OVERVIEW OF O&M SERVICE

This section provides an overview of O&M services that resolve the issues described above (see Fig. 3). The numbering in Fig. 3 indicates which aspects of the O&M services support which of the respective requirements and functions.

Hitachi's O&M services include both system and personnel services, providing operators with a total service for the outsourcing of personnel management, equipment management, facilities management, supply chain management, and operational management of operations and maintenance.

The system is implemented through the coordination of an O&M cloud with other systems. The O&M cloud has the primary role in supplying functions for the operation and maintenance of equipment, including plant (rolling stock and production lines, etc.), facilities (buildings, etc.), and mobile devices (worker management). It also supplies functions for business operations and management by providing coordination interfaces with business intelligence (BI) and other operational analysis systems, enterprise resource planning (ERP) and other operational management systems, and ordering and other in-house systems.

The O&M cloud consists of its hardware and other platforms, the shared platforms that provide common functions for the business operations and management of operation and maintenance, and applications for different end uses.

The O&M service platform has a distributed architecture comprising scalable services located at data centers in different countries. It also includes an integrated authentication framework so that it can adapt flexibly to changes in the organizations responsible for operating services. This allows the platform to adapt flexibly to changes in the scale (1-f) or geographical location (1-g) of operation and maintenance activities, and to the consolidation or

	Maintenance	Operation	Business operation and management
	Equipment-based ←		→ Entire business
Data collection	<ul style="list-style-type: none"> • Equipment status monitoring • Maintenance work monitoring (2-a)	<ul style="list-style-type: none"> • Operations monitoring • Operational work monitoring (2-b)	<ul style="list-style-type: none"> • Assess supply and demand. • Identify market changes. (2-c)
Analysis and planning	<ul style="list-style-type: none"> • Predictive diagnosis • Maintenance planning (2-d)	<ul style="list-style-type: none"> • Operational planning • Personnel assignment (2-e)	<ul style="list-style-type: none"> • Production planning (2-f)
Management and execution	<ul style="list-style-type: none"> • Maintenance work management • Maintenance inventory management • Maintenance inventory distribution • Utilization/performance guarantees (2-g)	<ul style="list-style-type: none"> • Operational work management • Automatic operation • Raw materials management • Utilities management (2-h)	<ul style="list-style-type: none"> • Human resource management • Revenue management • Investment management (2-i)

O&M: operation and maintenance

Fig. 2—Evolution of Social Infrastructure Business and Changes in Operation and Maintenance.

O&M services extend from equipment-based management to the entire business, and need to support everything from data collection to analysis and planning and the processes of management and execution.

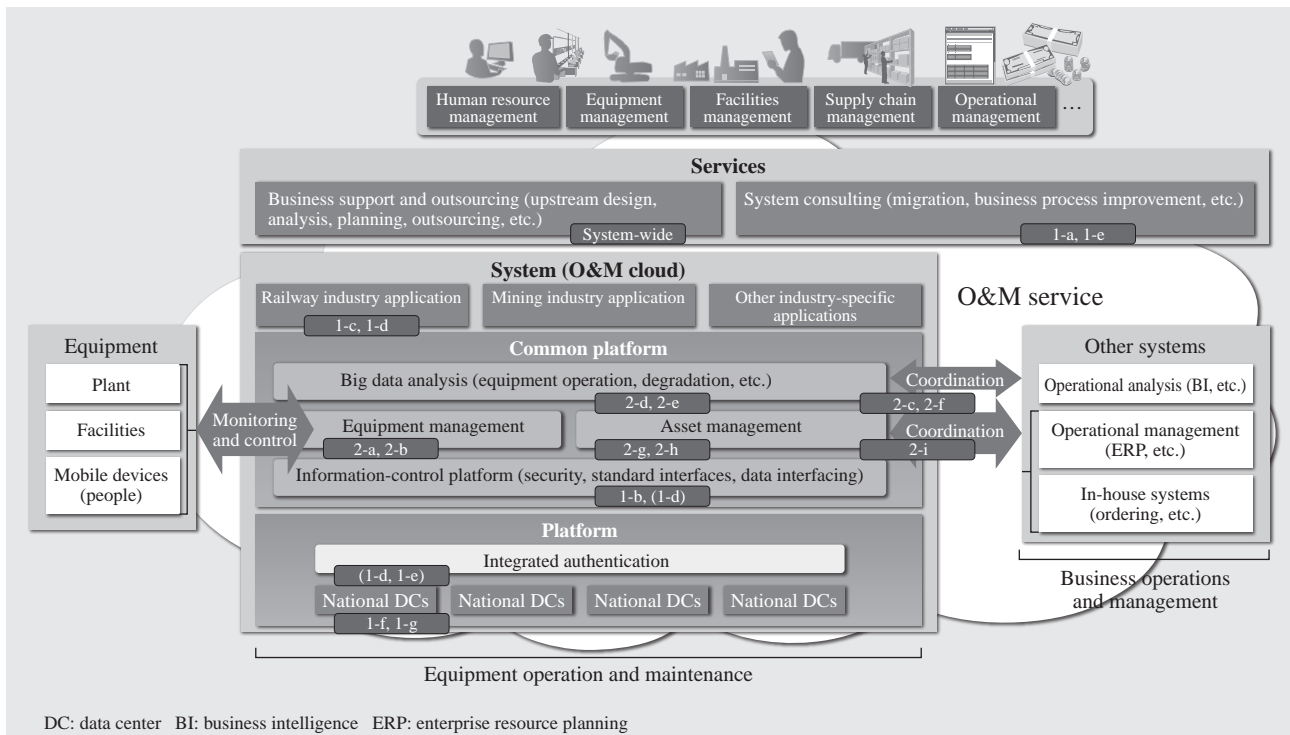


Fig. 3—Overview of O&M Service.

Hitachi's O&M services provide systems created through integration with the O&M cloud and other systems, and the business support, outsourcing, and system consulting services that use these systems.

reorganization of operators (1-d) or changes resulting from the outsourcing of some work (1-e).

The common platform consists of an information-control platform, equipment management, asset management, and big data analysis functions. The information-control platform provides standard interfaces for handling operation and maintenance data, data interfacing coordination (format standardization and conversion), and access control and other security functions. This minimizes the range of areas affected and the scope of system changes required when it is necessary to make improvements or comply with the standardization of operation and maintenance processes (1-b), or to integrate data following the consolidation or reorganization of operators (1-d).

The equipment management functions determine the location and other status information for equipment and facilities being managed and the workers involved, and issue control instructions [(2-a) and (2-b)]. Asset management includes collecting data about equipment management functions, presenting information about operation and maintenance work, and performing integrated management. It also includes the management of human resources, revenue, and investment based on actual operational data performed in coordination with operational management, and the

management of raw materials, spare parts, and product dispatch performed in coordination with ordering and other in-house systems [(2-g), (2-h), and (2-i)].

Big data analysis provides functions for analyzing equipment operation and deterioration based on equipment management information. These functions are used for tasks such as preventive maintenance and operational planning [(2-d) and (2-e)]. It also supplies operational information to operational analysis systems and uses this for tasks such as incorporating information about actual operation into production planning (2-f). In the other direction, it controls the operation of on-site equipment based on business operations and management data [(2-c) and (2-f)].

Implementing applications for specific end uses on this common platform reduces the required investment in systems when new operators enter the market or when operators consolidate or reorganize [(1-c) and (1-d)].

Meanwhile, human resource services supplied by the O&M service include upstream design for operation and maintenance and services that utilize the availability of the O&M cloud, including analysis and planning or business operation and support services such as outsourcing. Also, measures made possible by the provision of system consulting services, such

as migration away from existing on-premises systems or business process improvement, include flexible changes to operation and maintenance tasks (1-a) and the outsourcing of non-core processes (1-e).

By supplying these systems and services, O&M services supply a wide range of operation and maintenance services that extend from equipment management to business operations and management in a way that can respond flexibly to changes in the business environment.

EXAMPLE APPLICATION FOR ROLLING STOCK MAINTENANCE

This section describes an example O&M service for rolling stock maintenance in the railway industry (see Fig. 4).

The rolling stock maintenance system consists of on-train servers and an off-train management service. The on-train servers collect data from sensors on the rolling stock, and forward the information to the management service. The management service is implemented as an application on the common platform for O&M services. It collects the rolling stock information from the on-train servers in realtime and uses it for online monitoring and analysis.

This makes it possible to identify degradation or other changes in the operational status of equipment or parts in a timely manner. The system also uses

algorithms that have formalized the knowledge of experts in the form of mathematical and statistical calculations to perform comprehensive diagnostics and generate predictions. This helps prevent unexpected problems, allows parts inventory to be managed appropriately, and improves the efficiency of preventive maintenance and administration work.

CONCLUSIONS

This article has described Hitachi's O&M services for the operation and maintenance of social infrastructure businesses.

In addition to the rolling stock maintenance example described in this article, Hitachi intends to deploy its O&M services in a wide range of applications in the future, including the integrated management of energy for buildings or communities; the control of turbines, pumps, and other equipment at industrial plants; and operations management and remote control for vehicles used at mines.

By supplying O&M services, Hitachi intends to support social infrastructure operators in Japan and elsewhere so that they can respond flexibly to social changes and deliver medium- to long-term foundations for society. Through these activities, Hitachi believes it can contribute to the development of sustainable societies by seeking to be a "best solution partner" in the field of social infrastructure.

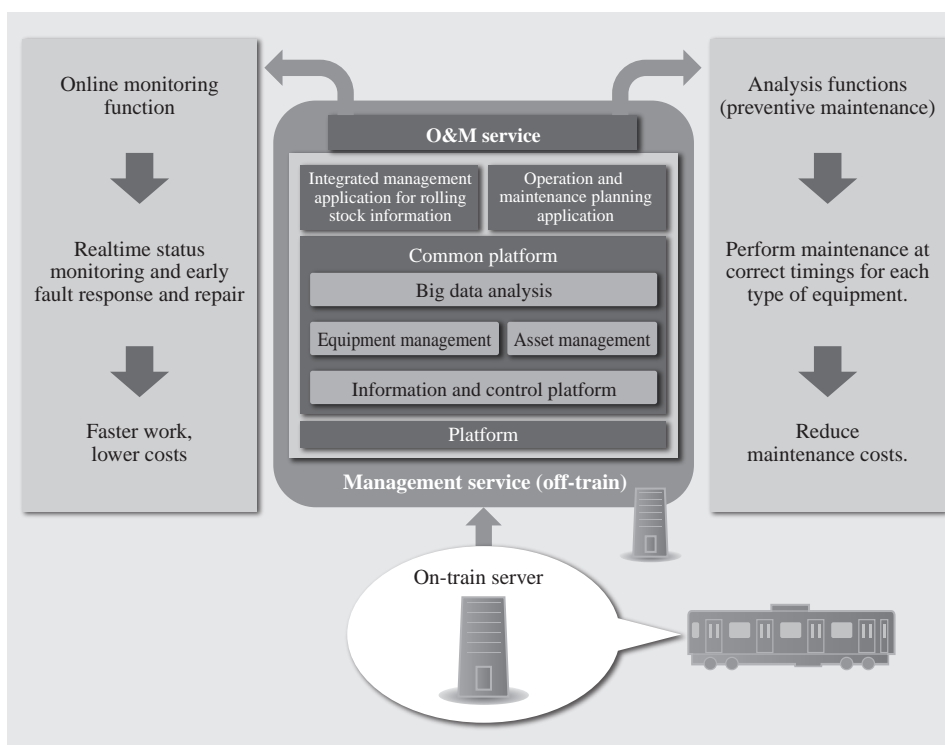


Fig. 4—Example O&M Service for Rolling Stock Maintenance. This O&M service for the maintenance of rolling stock uses online monitoring for the early detection of faults and analysis functions for preventive maintenance.

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