# Facilitation of System Implementation and Operation to Encourage Public Sector Use of Cloud

The Japanese government has adopted a "cloud-by-default principle" that makes cloud services the first choice for public sector information systems. However, this policy still leaves open the question of which of the many different forms of cloud services to adopt based on considerations such as cost or data protection, with options including SaaS, PaaS, and IaaS as well as the choice of public or private clouds. This creates a need for the flexibility to deliver solutions in ways that suit customer's requirements, such as being able to offer SaaS or to build and deliver systems using IaaS or PaaS. To achieve this, Hitachi has developed technologies that enable use of a common set of tools for implementing and operating solutions in a variety of different formats, combining these as a package for use across all public sector digital solution projects.

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## 1. Introduction

The Japanese government is promoting its Society 5.0 vision of a "super-smart society" achieved by systems where there is an advanced level of integration between cyberspace and physical space(1). Use of new technologies such as artificial intelligence (AI) and the Internet of Things (IoT) will be key to achieving this vision.

In order to provide government services suitable for Society 5.0, the public sector is working on digital government initiatives that seek to re-design these services in ways that include the comprehensive use of digital technology. One such initiative is the "cloud-by-default principle" that makes cloud services the first choice for public sector information systems(2).

Hitachi supplies its platform, Lumada, for open collaborative creation (co-creation) based on its objective of creating a sustainable society through its Social Innovation Business. By the timely delivery of Lumada-based solutions for social innovation, Hitachi is seeking not only to provide customers with enhanced business value, but also to enhance social and environmental value through improvements to public services, thereby helping bring about Society 5.0(3).

The following two sections describe how cloud services are currently being used in the public sector and the requirements and technical challenges for the implementation and operation of cloud-based public-sector systems. This is followed by a description of how the facilitation of system implementation and operation is achieved and how this will be leveraged for future business development.

## 2. Current Use of Cloud Services in Public Sector

### 2. 1 Changes in How Cloud-based Systems are Delivered

As noted, the cloud-by-default principle makes cloud services the first choice to consider for public sector solutions. However, this policy still leaves open the question of which of the many different forms of cloud service to adopt based on considerations such as cost or data protection, with options including software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS) as well as the choice of public, private, or hybrid clouds.

There are two main ways in which cloud systems are delivered. The first is delivery as a package whereby Hitachi acts as a system integrator and implements the system on the customer's premises or by utilizing IaaS or PaaS. The second way is delivery as a service whereby Hitachi builds and operates the system and makes it available to the customer as a SaaS. Delivery as a package has predominated in the public sector in the past, with core business systems that handle confidential data being developed individually to run on the customer's premises. However, because the benefits of solutions that utilize technologies such as AI or analytics can vary from user to user, there is rising demand for "starting small," meaning initially introducing such solutions on a trial basis. Security requirements are also becoming more diverse, such as allowing some data to be stored on a public cloud. These factors have led to increasing use of delivery as a service.

### 2. 2 Examples of Solutions Delivered in Different Forms

A materials development solution using materials informatics (MI)[4] is one example from Hitachi's public sector business of a solution delivered in a variety of forms. Materials development is a field experiencing an intensification of global competition with a need to find ways of developing materials ahead of competitors through the timely analysis of large amounts of simulation data and testing results for the three-dimensional structures and other properties of new materials. MI is a set of techniques for the rapid analysis of data like this that relates to new materials.

As materials development involves investment in research by publicly funded research institutions and private-sector businesses, there is demand for ways of keeping data on analyzed materials in-house. To satisfy this requirement, Hitachi's MI solution is available both as a package and as a service (see **Figure 1**).

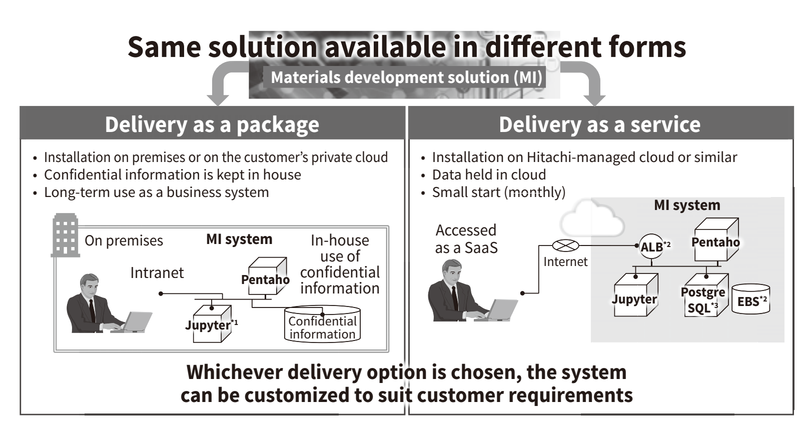
Delivery as a package means the materials development system is installed on the customer's premises or on their private cloud. Delivery as a service means it is made available as a SaaS on a monthly contract. Whichever delivery option is chosen, the functions can be customized as needed to suit a variety of customer requirements. By using the techniques for system implementation and operation described later in this article, it is possible to combine flexible customization with rapid solution rollout based on a choice of different delivery formats[5].

## 3. Requirements and Challenges for Delivering Cloud-based Systems

While solutions like that for MI that provide the flexibility to adapt to different requirements are suitable for a wide range of customers, ways also need to be found to reduce the cost of developing, implementing, and operating these solutions. This section describes the technical requirements for enabling the rapid rollout of solutions in a variety of formats while also allowing for flexible customization of the system configuration for customers with diverse needs.

• Requirements and challenges 1: Fast and flexible system development

Customizing the delivery format and system configuration for every user increases system development costs. What is needed to satisfy customer requirements is a way of combining fast and flexible system development with cost




MI: materials informatics SaaS: software as a service ALB: Application Load Balancer EBS: Elastic Block Store
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*3 PostgreSQL is a registered trademark or trademark of PostgreSQL Community Association of Canada in Canada and other countries.

**Figure 1 — Delivery of Materials Development Solution**

Depending on where the customer wants the system to be implemented, Hitachi's materials development solution is available both as a package (installed on premises) and as a service (a SaaS accessed via the web). Despite it being the same solution, the customization of individual systems is needed to satisfy delivery format and other customer-specific requirements.

reduction. This in turn requires packaging of the system's functions in a form that allows them to run on the customer's premises or on a variety of different clouds (multi-cloud environment), and also ways to improve system development efficiency by encouraging their sharing and re-use among developers.

• Requirements and challenges 2: Facilitation of multi-cloud system implementation

Achieving flexible system delivery in a multi-cloud environment requires a way to simplify the task of tuning the large number of implementation-specific system parameters. The challenge, however, is to automate this configuration process in a way that takes account of the complex interdependencies between these parameters.

• Requirements and challenges 3: Reduction in marginal cost of system monitoring

When systems are run in a multi-cloud environment, special allowances need to be made for the different monitoring practices and standard software used in each case. This in turn creates a need for the cross-platform standardization of system monitoring. The challenge, however, is to come up with standard ways of performing tasks such as managing monitoring data, setting alerts, and isolating faults that can cope with the different system monitoring practices used on each platform.

## 4. Facilitation of Cloud-based System Implementation and Operation

This section describes how cloud-based system implementation and operation can be facilitated to overcome the challenges identified above. **Figure 2** shows an overview of how this is done.

The following describes the available functions in terms of the above-mentioned challenges.

• Function 1: Use of Docker*1 and Kubernetes*2 to modularize system functions and make them available in a shared repository

This involves using Docker containers (a form of virtualization) and Kubernetes (the de facto standard for container orchestration) to split up middleware, PaaS, and other individual functions into separate packages. As Kubernetes supports multiple cloud environments, functional components can be used the same way, regardless of the platform. The individual function packages are managed in a shared repository where they are available to other developers, enabling re-use across different solutions or systems.

This packaging can also be nested such that systems developed by combining these functional components can themselves be made available as packages for sharing and re-use by other developers. Developers can deliver new systems by re-using existing system configurations, only customizing the functional components to the extent needed to satisfy user requirements.

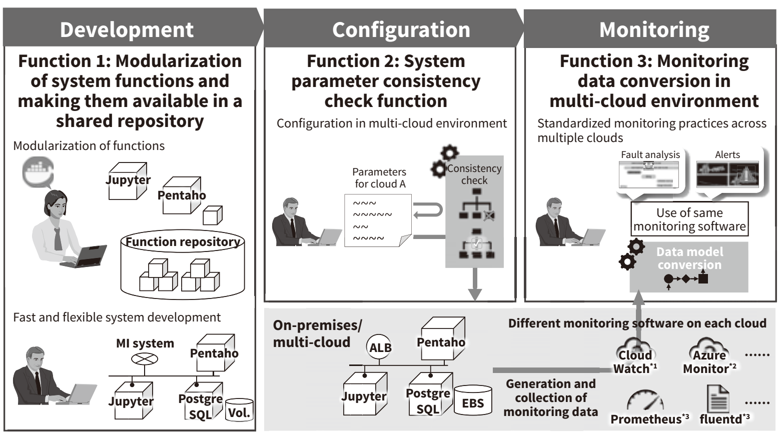
• Function 2: System parameter consistency check function

This provides automatic checking of the implementation-specific parameters that need to be tuned during system configuration to ensure consistency between interdependent parameters. These may include parameters that relate to the execution of functional components or their performance.

The former, execution-related parameters, include cases when certain functional components are dependent on the

*1 Docker is a registered trademark or trademark of Docker, Inc. in the United States and other countries.

*2 Kubernetes is a registered trademark or trademark of The Linux Foundation in the United States and other countries.




Vol.: volume

*1 Amazon CloudWatch is a registered trademark or trademark of Amazon Web Services, Inc. in the United States and other countries.

*2 Azure Monitor is a registered trademark or trademark of Microsoft Corporation in the United States and other countries.

*3 Prometheus and fluentd are registered trademarks or trademarks of The Linux Foundation in the United States and other countries.

**Figure 2 — Overview of Facilitation of Cloud-based System Implementation and Operation**

Function 1 uses de facto standard technologies for function modularization and sharing. Function 2 simplifies the task of setting parameters that vary between system platforms. Function 3 uses monitoring data model conversion to enable the same software to be used for monitoring across multiple clouds.

virtual network, storage, or other features of the runtime environment, when the virtual resources or services required for functional component execution need to be defined explicitly for the cloud being used, or when the location of the container image needs to be specified. Performance-related parameters include the resource allocations for containers or the middleware running in containers that need to be adjusted in step with system performance ratings. For parameters like these, this function identifies interdependencies with other parameters and checks against constraints. This simplifies the configuration associated with system implementation when customizing for a multi-cloud environment.

• Function 3: Monitoring data conversion in a multi-cloud environment

This collects the data generated by the different monitoring software used on each platform in real time and converts the data model. The converted monitoring data is then used in the standardized cross-platform monitoring software.

As this function needs to be used across a wide range of solutions and applications, the systems it is able to monitor include not only containers used as functional components, but also PaaS that run on many different clouds. Because it collects and converts monitoring data regardless of the type of cloud or other platform being monitored, the function automatically detects functional components that run as part of the system configuration across different clouds and applies the appropriate model conversion rules for the type of data collected. This enables the same system monitoring practices to be used in all cases.

## 5. Conclusions

This article has described ways of facilitating system implementation and operation to encourage use of the cloud in the public sector where greater use of cloud services is anticipated. This enables the systems needed to implement particular solutions to be customized as required by different users and delivered rapidly and at low cost on different platforms in different forms.

Hitachi is anticipating growth in hybrid cloud solution businesses, this being one of the areas where the practices described in this article will likely be deployed in the future. In the public sector, maintaining data security is an important consideration for many customers, with the current trend being toward placing greater restrictions on the handling of personal information. Accordingly, Hitachi hopes to help add value to customer businesses through the operation of its solution businesses that effectively and securely integrate information such as confidential data held by users with advanced digital technologies supplied as cloud services. The intention is to actively pursue the development and delivery of solutions like this that make use of the practices described in this article.

Lumada is being used for solution development and re-use in the public sector. The practices described in this article pre-emptively resolve the issues that arise when supplying cloud-based solutions on Lumada and, by incorporating these functions into Lumada, Hitachi plans to look into expanding their use to other businesses in the future.

### References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