Introduction of Internet of Things Suite "ClariSense" Design Guides

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1. Introduction

IoT systems are increasingly being used to help achieve the digital transformation (DX) in various fields. The IoT systems business will continue to expand: as shown in Fig. 1, the market in Japan is expected to be worth 10.2 trillion yen by 2025 (1). This paper describes our design guides currently under development.

2. Initiatives for the IoT System

2.1 Organizing the components of the IoT system

Figure 2 shows the basic components of the IoT system.

(1) Data collection and accumulation system function

Collects and accumulates the data generated and held by devices and passes it to applications.

(2) Control system function

Controls devices by event triggers of applications and the data collection and accumulation system function.

(3) Operational function

Provides operation and management, including authentication for connected devices, authentication management for users, administrators and other systems, and management of settings for each functional element.

(4) Application

Performs analysis and processing based on data; control instructions based on the processing; data provision and screen display to users, administrators and other systems; and reception of control instructions.

(5) Wide area network

Refers to the Internet or an intranet used within an organization. Based on the Internet Protocol (IP) network, the protocol is selected according to the communication frequency and data size.

(6) Edge device

Converts the data transmitted from a device into a protocol suitable for the server and network for a certain period of time or at the timing when data acquisition from the device is completed. Performs data encryption and encapsulation processing according to requirements.

(7) Device

Digitizes various physical and chemical characteristics (temperature, humidity, pH, etc.) inside and around the device using sensors, performs protocol conversion according to the network used for transmission, and transmits the data from the communication module to other components.

2.2 Initiatives in each business field

In order to solve diverse social issues, we provide solutions using IoT systems in fields related to "Life," "Industry," "Infrastructure" and "Mobility."

2.2.1 Life

Since 2019, we have provided the global IoT common platform "Linova" for collecting and managing data of our IoT home appliances via the Internet (2). In 2020, we released the home appliance integration application "MyMU" to provide customers with a way of integrally controlling multiple home appliances managed by Linova.

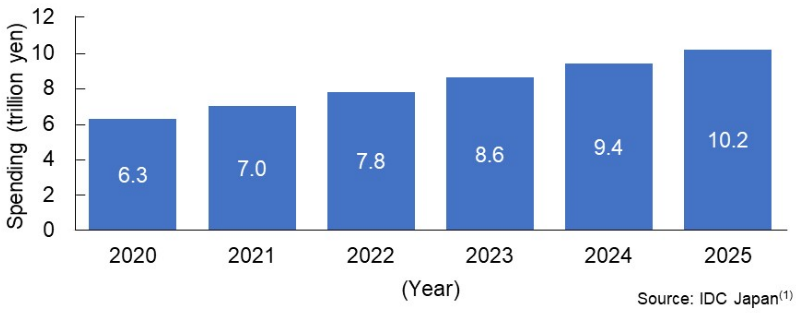


Fig. 1 Trends in spending on IoT in Japan 2020–2025

*Information Technology R&D Center

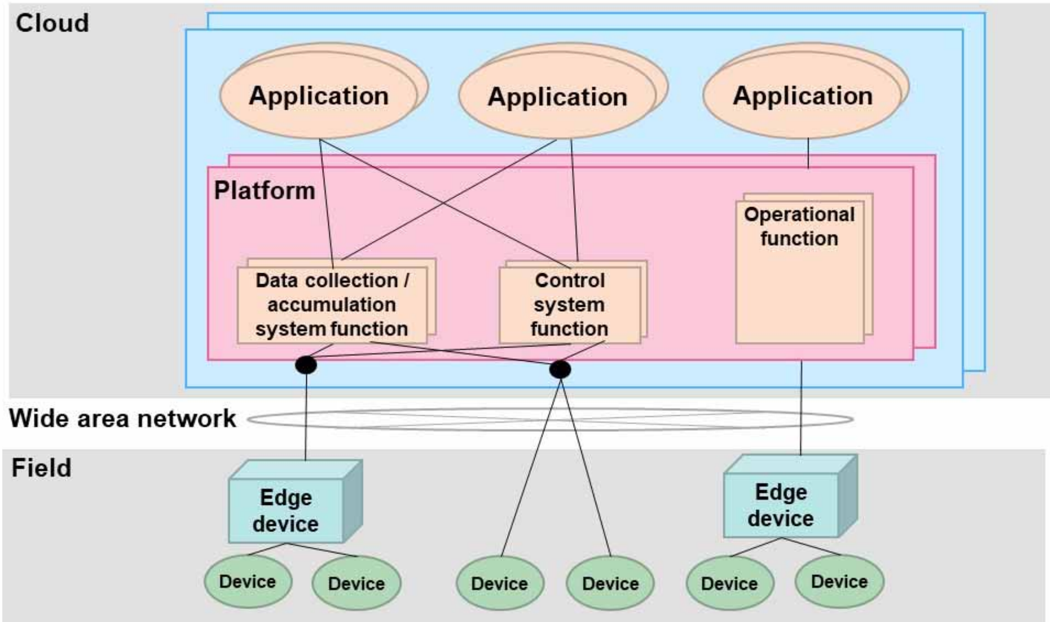


Fig. 2 Components of an IoT system

2.2.2 Industry

Since 2003, we have provided the FA-IT integrated solution “e-F@ctory” for production sites (3). We are also involved in the activities of the Edgecross *1 Consortium. This Consortium aims to create new added value beyond the boundaries of companies and industries by creating an open platform that will connect among different types of equipment and communication standards in the area of edge computing and facilitate the collection and use of data.

2.2.3 Infrastructure

Since 2017, we have provided “INFOPRISM” as an IoT platform for improving the efficiency of operation and maintenance of social and electric power infrastructure equipment (4). INFOPRISM is applied to equipment maintenance systems such as generators, integrated monitoring systems such as public facilities, and systems for optimizing equipment operation such as water supply and sewerage systems. Since 2020, we have provided “Ville-feuille” as an IoT platform that collects and accumulates operating data and sensing data of building equipment and processes data using technologies such as AI and big data analysis (5).

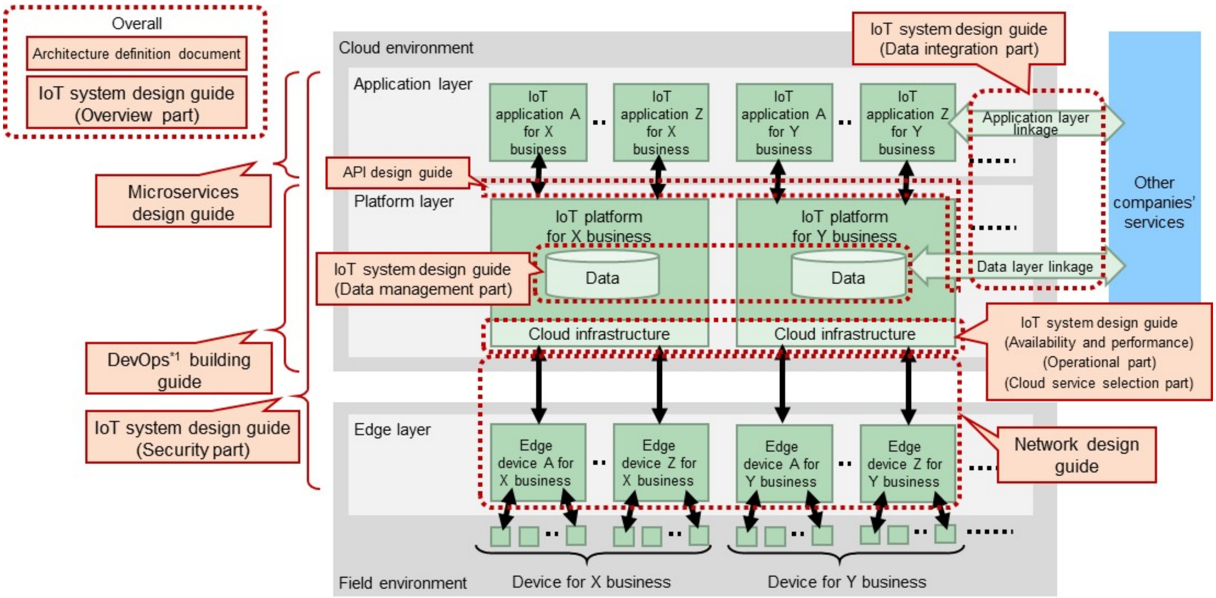
2.2.4 Mobility

Since 2019, we have provided “Railway LMS on INFOPRISM” as an IoT platform that collects and analyzes various information on railway vehicles in real time. In addition, since 2020, using in-building dynamic maps, we have built a service on Ville-feuille for collaborating with and controlling various types of personal mobility such as service robots for cleaning, security, delivery and guidance and next-generation electric wheelchairs, as well as building facilities such as elevators and access control systems.

3. Design Guides in ClariSense

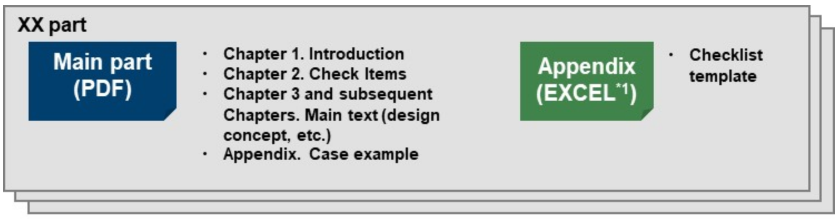
As described in Section 2, ClariSense organizes the knowledge and technical assets related to security, networks, etc. for IoT systems in each business field as design guides and solution libraries, and we are promoting its sharing and use within the Mitsubishi Electric Group (6) to improve the efficiency of IoT system design and realize new IoT system solutions across business fields. This section describes the structure of the ClariSense design guides and the contents of each guide. Figure 3 shows the correspondence relationship between the IoT system components.

[1] Edgecross is a registered trademark of the Edgecross Consortium.



[1] A coined word meaning joint development by development personnel and operation personnel.

Fig. 3 Correspondence between architectural layers of IoT systems and design guides



PDF: Portable Document Format
[1] Excel is a registered trademark of Microsoft Corp.

Fig. 4 IoT system design guide structure

3.1 IoT architecture definition document

This document focuses on the functional elements of the IoT system and the concept of the API, and provides a basis for common understanding and discussions among stakeholders with different backgrounds related to construction of the IoT systems that Mitsubishi Electric is promoting.

Regarding the architecture of IoT systems, various organizations have defined reference architectures. ClariSense refers to the Industrial Internet Reference Architecture (IIRA), which is a reference architecture for the Industrial IoT (IIoT) developed by the Industry IoT Consortium (IIC). Mitsubishi Electric is also involved in the development of the IIRA; the latest version, v1.9, was developed in June 2019.

3.2 IoT system design guides

This is a collection of guides that organize how to select a managed service on the cloud to balance functionality and cost according to the development purpose, service level management and monitoring design during operation after service development. The IoT system design guides consist of seven separate volumes, and as shown in Fig. 4, each volume consists of a main part and an appendix. The main part explains the items to be checked when designing an IoT system, the concept, and examples of in-house system configurations as case studies.

(1) Overview part: Summarizes the ClariSense design guides, explains the guide system, and lists location examples.
(2) Data management part: Introduces the selection of services according to the requirements in consideration of the data format, usage method, etc., and the items necessary for data management.
(3) Data integration part: Summarizes the items to be confirmed in order to select technologies and products to be used for data integration, and explains examples of useful metadata for finding and using data to be linked.
(4) Security part: Describes how to design a typical security function that is expected to be implemented in an IoT system. It also includes separate volumes for each cloud vendor (Security volume - AWS *2-, Security volume - Azure *3-).
(5) Availability and performance part: Summarizes the viewpoints that should be considered for the availability and performance required as non-functional requirements for cloud services used to build IoT systems.
(6) Operation part: Related to operation design such as distributed tracing in IT service design.
(7) Cloud service selection part: Summarizes how to perform service selection according to the requirements for cloud services (especially Platform as a Service (PaaS)).

3.3 Microservices design guide

Microservices are software architectures that manage and operate multiple small, individually developed services by linking them. Microservices are an effective means of flexibly adapting to business changes and improving service reusability, but in order to properly implement them, it is necessary to fully understand the design considerations. This guide organizes the matters that various microservices solve, how to divide services when designing them, and the engineering methods used to develop them. This guide summarizes considerations for two development patterns, new system development and migration development from monolithic systems, and describes microservice design methods, agile development processes, and best practices for development.

3.4 API design guide

This guide summarizes the concept of Web API for exchanging data in a loosely coupled manner that takes into account security, ID linkage, etc., mainly in the application layer linkage and platform layer linkage, assuming external system linkage. The guide summarizes notes on endpoint naming conventions and response formats as API design, configuration examples for public cloud services such as Azure and AWS as implementation, and usage management and version control methods as operations.

3.5 Network design guide

This guide summarizes the protocol conversion and data conversion required when collecting data on a field network via a wide area network (IP network). The guide consists of a general part that summarizes common basic design methods that are not dependent on business fields, and individual parts that describe examples of protocol conversion and data conversion for each use case.

3.6 DevOps building guide

This guide shows the concepts and examples of system environment design required to practice DevOps, and consists of separate volumes for introduction, AWS practice, and Azure practice. The guide summarizes the version control method, branch method, and Continuous Integration/Continuous Delivery (CI/CD) pipeline design method, as well as the concept of monitoring in operations and the concept of feeding back the results of monitoring to development.

4. Extending the ClariSense Design Guides

4.1 Expansion of design guide content

The conventional approach to drawing an overall picture and filling in the missing pieces leads to the creation of guides that have no need for rapidly evolving IoT systems, and also accelerates the obsolescence of content. We will constantly monitor internal and external needs and conduct flexible management such as selecting the content to be included.

4.2 Sharing design guides

Currently, we are distributing the created design guides in-house, but in order to quickly identify needs, we are planning to link them with the content management system used in-house. This will provide direct feedback to authors and accelerate the accumulation of knowledge by allowing users to create design guides directly via web browsers.

[2] AWS is a registered trademark of Amazon Technologies, Inc.
[3] Azure is a registered trademark of Microsoft Corp.

5. Conclusion

This paper described our approach to the ClariSense design guides, which are shared within the Mitsubishi Electric Group by centrally organizing the knowledge obtained by combining our strengths in core components with our extensive field knowledge and IoT system construction know-how. We will continue to use the design guides to quickly create flexible and highly scalable IoT solutions.

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