IoT Platform to Accelerate Data Utilization

● Yasunori Terasaki

The FUJITSU Cloud Service IoT Platform is one component supporting the Human Centric IoT (Internet of Things) at which Fujitsu is aiming. It is positioned as a platform as a service (PaaS) dedicated to IoT on the FUJITSU Digital Business Platform MetaArc. The Platform provides a function for collecting data from sensors and devices installed at customer sites and one for delivering instruction data to them. In addition, it can manage the data to be collected or delivered and control application programming interfaces (APIs) and accesses to make those data available from various applications. Introducing the Platform enables customers to continuously create new products and co-create products with various outside parties without anxiety. This paper presents the requirements for the Platform to achieve Human Centric IoT, outlines the product functions that embody it, and describes the enhancement plans.

1. Introduction

Fujitsu aims to achieve Human Centric IoT (Internet of Things) to promote innovation in business and public activities by connecting to the Internet not just physical machines and structures but also all sorts of "things" such as people, processes, and information.[1) To this end, Fujitsu has been providing its FUJITSU Digital Business Platform MetaArc (hereafter, MetaArc) incorporating advanced cloud, mobile, and big data technologies as a business platform for carrying out business and public activities.[2) It has also been providing since 2015 its FUJITSU Cloud Service IoT Platform (hereafter, IoT Platform) as a platform as a service (PaaS) above MetaArc specifically for using IoT data.[3) Fujitsu's IoT Platform constitutes an IoT-dedicated service with functions for performing data collection, delivery, and storage between the cloud and devices. It is a product that features support for many and varied sensors and devices, process optimization when collecting huge volumes of data, and safe usage of data.

2. Requirements for achieving Human Centric IoT

Achieving Fujitsu's goal of Human Centric IoT will require the connection of a wide variety of devices to detect in detail various types of changes in people, equipment, and the environment at target sites and to take action in response to those changes. It will also be necessary to coordinate processes appropriate to the formats of diverse types of generated data with various types of applications. There are thus three main requirements for achieving Human Centric IoT, as summarized below.

2.1 Requirement 1: Accommodation of diverse devices

To enable Human Centric IoT to be applied to a wide variety of locations and environments, a mechanism is needed to accommodate a wide range of devices, from existing ones to those expected to appear in the future. Specifically, this mechanism must be able to flexibly support the diverse data formats and communications protocols of these devices and enable applications to seamlessly access those devices despite such differences.

2.2 Requirement 2: System optimization as conditions change

Given that on-site conditions can change from moment to moment, detailed monitoring (such as when using a high-resolution camera in image-based monitoring) or simultaneous monitoring of multiple sites can generate a huge amount of data. If these data are then collected and processed in a uniform manner in the cloud, important data may end up being buried, preventing necessary actions from being taken at the right time. There is thus a need to assess cloud conditions and on-site conditions including platforms and applications and evaluate the importance of the collected data. It will also be necessary to optimize the system by dynamically changing the apportionment of data to be processed at the target site and in the cloud.

2.3 Requirement 3: Access control to data

Business applications are evolving from a vertically integrated, individually optimized configuration to a combination of reusable components. As a result, applications connected to platforms are likewise turning into a combination of reusable components. Consequently, when implementing a business process by combining components, access control to data will become essential since the purpose of collecting some types of data is to release that data to outside parties for processing. Additionally, given situations that presume the use of components in a closed environment, it will be necessary to provide a closed-connection environment on the application side as needed (**Figure 1**).

3. IoT Platform functions

This section introduces the main functions of IoT Platform (**Figure 2**).

1) APIs for devices/applications

For scalability and data accessibility, the platform uses a representational state transfer (REST) architecture so that it does not have to maintain the state of an access to an application programing interface (API). With this architecture, it is the user who creates a resource as a unit of data storage management on the IoT Platform and uses a Uniform Resource Identifier (URI) automatically assigned to that resource to access and manage the data.

IoT Platform also supports as standard Message Queuing Telemetry Transport (MQTT), a publish/subscribe[note 1)] type of protocol that is lighter than Hypertext Transfer Protocol (HTTP). This means that data can be transferred and received even in the case of low-spec devices by simply accessing an MQTT-using resource (called a "topic" in MQTT protocol specifications). Furthermore, since a publish/subscribe type of protocol features notification of resource updating, this feature can be used to notify a device or application of any updates in real time. It is also possible to incorporate linked operations in which resource update notification by MQTT is applied to a resource updated using HTTP, thereby enabling update notification irrespective of protocol.

Additionally, to facilitate the reading of data stored within a resource, IoT Platform provides a function for extracting only data that matches the search conditions described in a query. It also provides a function that can perform real-time event notification at the time of data writing by setting beforehand event detection conditions with respect to a resource and the action (mail notification, Web API calling, etc.) to be taken at the time of detection. The idea behind these functions is to improve the usability of applications when handling large volumes of data.

2) Database

To meet requirement 1 mentioned in Section 2, the MongoDB database is used in IoT Platform as it accommodates many and varied types of data from sensor devices. MongoDB features:

- a "schema-less" database independent of the stored data format,
- extensive data search functions despite the schema-less feature, and
- high write performance.

The user need not be conscious that the database is MongoDB—data can be written and read as needed via an API as long as the data is in JavaScript Object Notation (JSON) format.

3) Access management in units of resources

To meet requirement 3 mentioned in Section 2, IoT Platform was designed to provide for the specification of access codes that represent access rights for creating, reading, updating, and deleting resources created as needed by the user. An access code is provided for accessing a device or application resource, and access is allowed only if the rights specified by the code match the type of access attempted by the user.

Access codes themselves can be created as needed by the user. Multiple access codes may be

note 1) A messaging model in which senders of messages (publishing side) send their messages without indicating specific receivers (subscribing side).

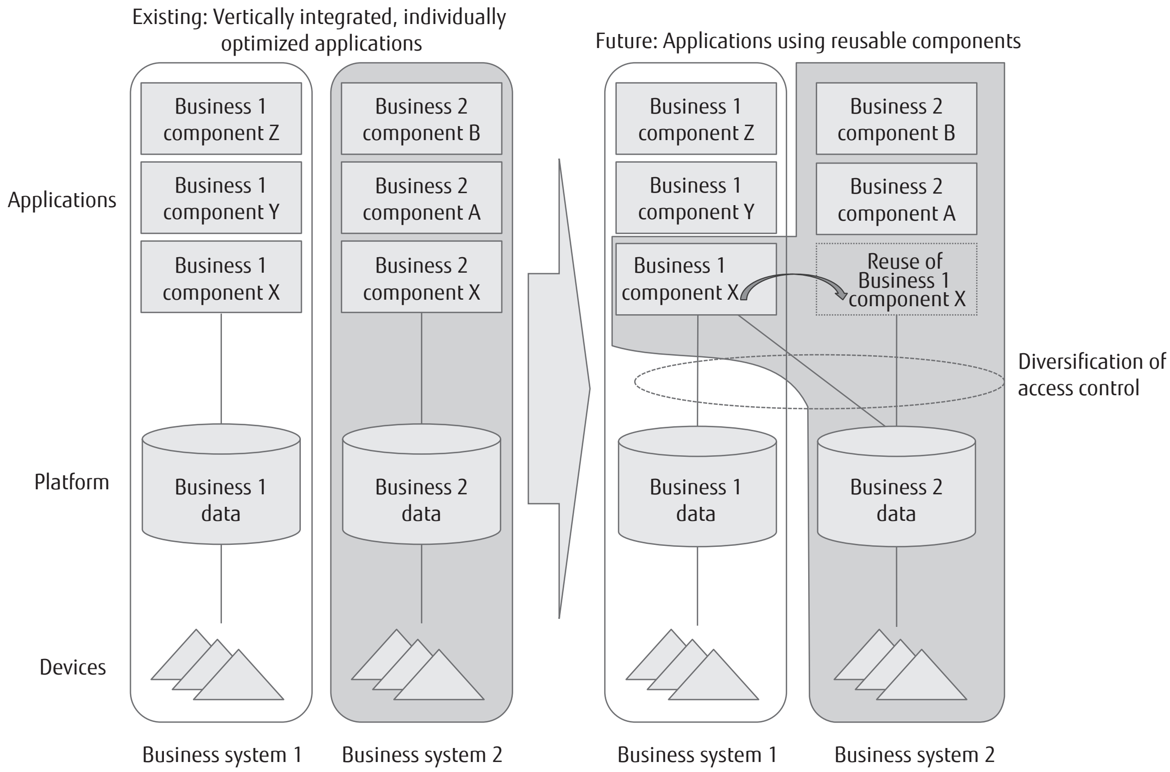

Figure 1
Shift to reusable components.

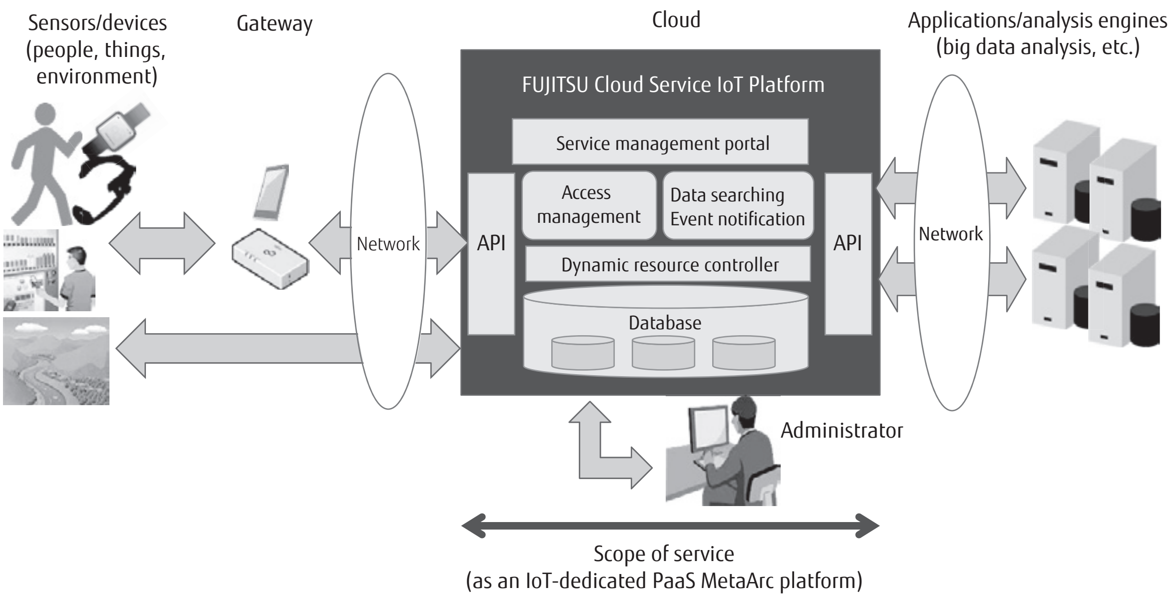

Figure 2
FUJITSU Cloud Service IoT Platform.

assigned to the same resource, and the same access code may be assigned to multiple resources. This makes it possible to analyze collected data in collaboration with a third party such as an outsourcing company by creating an access code that specifies the right to read for only the resources storing that data. Giving that access code to the third party controls access to that data (**Figure 3**).

4) Dynamic resource controller technology

To meet requirement 2 mentioned in Section 2, IoT Platform was designed to incorporate a dynamic resource controller developed by Fujitsu Laboratories as technology for optimizing a system through cooperative operations between the cloud and a data-generating site.[4)]

This technology makes it possible to control the entire system while monitoring the state of the site and cloud. With this technology, changes in event generation conditions at the site and in load conditions in the cloud can be used as a basis for changing the apportioning of data processing between the site and cloud or for changing the type of processing itself depending on the importance of that data.

For example, a high occurrence of events at multiple sites can result in excessive loads on the processing performed by applications in the cloud. Instructions can therefore be given so that some of the processing performed in the cloud is transferred to a server or gateway near those sites before the system enters such a state. Reducing cloud load in this way can help maintain system-wide performance. Once the frequency of event generation returns to normal, the off-loaded processing can be returned to the cloud. In the above ways, IoT Platform enables dynamic control of system optimization between in the field and in the cloud (**Figure 4**).

5) On-site gateway product

IoT Platform needs to support diverse devices and data formats, so a function is needed that can absorb those differences in the field and that can be viewed as an abstract function from the cloud. IoT Platform was thus designed to support gateways installed in the field. There is also a need for equipment (servers, gateways, etc.) that can perform data processing in the field to support the implementation of a dynamic resource controller. To meet these needs, a gateway product that can interface with IoT Platform must be installed in the field.

However, a diverse variety of devices may be in a site environment, so it is difficult for one company to provide gateway products for each environment. Fujitsu has thus formed a collaborative tie-up with Intel Corporation that will enable it to procure the IoT-oriented gateway products that Intel has begun to develop.[5)]

This collaborative effort is goes beyond simply forming a relationship for gateway procurement. It also aims to form a relationship that can serve to introduce Fujitsu's differentiated technologies such as its dynamic resource controller and various products included in IoT Platform to system integrators (SIers) on a global scale. Fujitsu and Intel are now studying what effects could be obtained by combining their products and technologies.

Gateway products have actually been provided as part of the FUJITSU Managed Infrastructure Service FENICS II M2M service,[6)] launched in 2010. Now, with the advent of the IoT era, connected devices are becoming highly diversified, and the need for greater processing performance in gateways has grown. The Intel gateway products that Fujitsu will procure will therefore comprise a high-level line-up of gateway products that can be provided as part of M2M (machine-to-machine) services.

6) Support of closed connection environments

IoT Platform—a shared-type, multi-tenant platform—provides an environment that can be openly accessed from the Internet. A closed environment can be provided to meet requirement 3 mentioned in Section 2 by linking closed connections with the customer's intranet or extranet[note 2)] with the FENICS network service.[7)] There is also a mechanism on the IoT Platform side to identify and control access from either an open or closed environment.

In this way, IoT Platform can be used to provide a closed environment that supports creation of an application in collaboration with a business partner.

7) Enhanced linking with outside analysis engines

IoT Platform does not currently support engines that analyze collected data. This is because analysis engines differ depending on the user's objective, which means that it is more effective for the user to link to a

note 2) A network system that interconnects a customer's intranets.

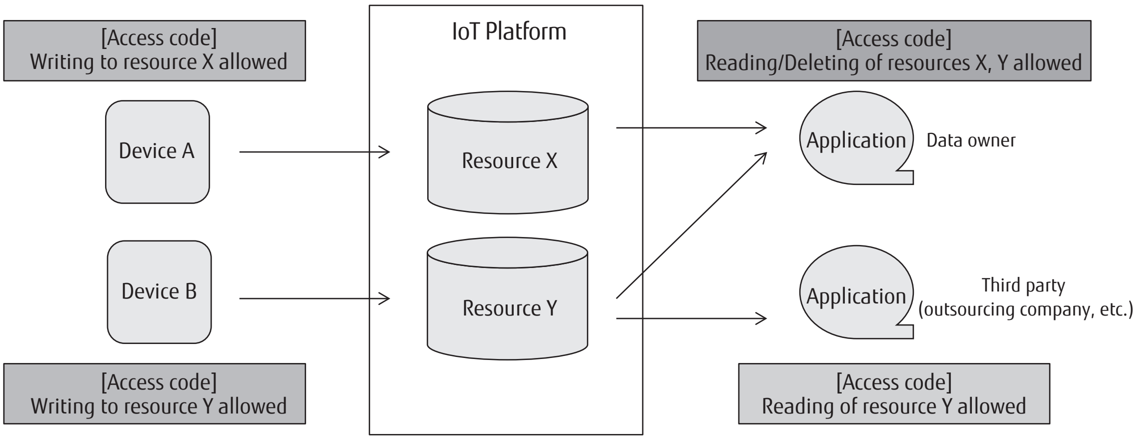

Figure 3
Use of access codes.

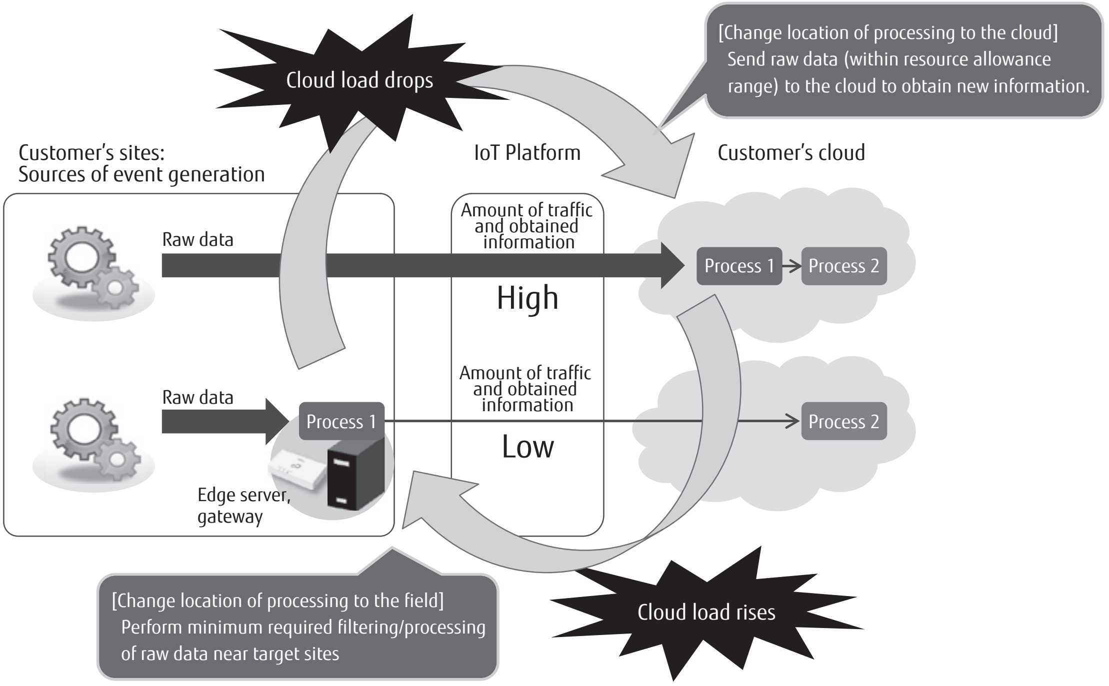

Figure 4
Dynamic control of resources.

third-party engine that is optimal for the task at hand. Since the data storage method used by IoT Platform is unsuitable for situations requiring real-time analysis and streaming processing, there is a strong need for relaying data without storage when linking with a third-party engine. A dispatch function has thus been added to IoT Platform that enables selection of either data storage or data relaying in units of resources. This enables flexible support of third-party analysis engines and application requirements of various types.

4. Effects of introduction

The effects of introducing IoT Platform can be summarized as follows.

1) IoT Platform provides a set of basic functions required for IoT applications in the form of a cloud service. Customers can therefore devote their energy to the development of IoT applications and

build a system in a relatively short time.

2) In addition to a monthly basic charge, customers pay only for what they use (e.g., amount of stored data, API usage, number of registered resources) in a metered system. However, this monthly basic charge includes a free-of-charge portion with respect to metered charges (for example, up to 5 GB of data storage is included in the basic charge), so IoT Platform can be introduced in a small-start manner from 50,000 yen (about 472 dollars at the rate of 106 yen per dollar) a month.
3) IoT Platform supports not only requirement 1 mentioned in Section 2 (which is a requirement of many other IoT-platform products), but also requirements 2 and 3, which take into account future developments in on-site environments and business systems. It can therefore be used with a sense of assurance over the long term while fostering ongoing innovation through co-creation with the customer.

5. Future enhancements

Fujitsu plans to enhance IoT Platform with a global rollout in mind with the aim of expanding the reach of its Human Centric IoT initiative. This global expansion of business is natural, but it is intertwined with rules and regulations in each country covering privacy and protection of personal information with respect to data collected through the IoT. It is therefore essential that a platform be launched in each country or region. Such a global rollout, however, would be difficult to achieve with just IoT Platform since it would also have to include back-end mechanisms such as delivery and support. For this reason, Fujitsu plans to roll out IoT Platform in conjunction with the global rollout of FUJITSU Cloud Service K5,[8] which is a constituent product of MetaArc that incorporates advanced cloud, mobile, and big data technologies.

Fujitsu will therefore promote the global rollout of IoT Platform by incorporating it in K5 as a PaaS while enhancing its affinity with the back-end mechanisms of K5.

6. Conclusion

This paper described the FUJITSU Cloud Service IoT Platform, a service that supports utilization of IoT data. As a key component in achieving Fujitsu's goal of Human Centric IoT, this product has made it possible to demonstrate with customers how the use of IoT can foster innovation while providing a foundation for achieving actual innovative results. Looking to the future, Fujitsu aims to provide even better products by enhancing the present product while incorporating new added value that we discover in joint trials with customers.

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Yasunori Terasaki
Fujitsu Ltd.
Mr. Terasaki is currently engaged in product planning and development for IoT platforms.