FUJITSU Cloud Service K5 PaaS Digitalizes Enterprise Systems

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The modern enterprise is in need of a business transformation to keep up with the rapid evolution of cloud computing, the Internet of Things (IoT), mobile communications, and other digital technologies. The era has arrived in which a competitor may be a company in a completely different industry or a startup company (which was previously inconceivable). In such an era, growth is difficult to achieve by simply continuing one's traditional business, and predicting the future is nearly impossible. Change is required for growth. There is thus a need for enterprise systems that can forecast the future using information and communications technology (ICT), perform testing quickly and repeatedly, and react flexibly to change. To meet this need, Fujitsu launched the FUJITSU Cloud Service K5 Platform as a Service (PaaS) on April 1, 2016. It supports the development, execution, and operation of the business applications that lie at the core of an enterprise business. It combines years of system integration knowledge with open technologies and is aimed at improving the ability of business applications to respond to change. In particular, it enables enterprises to create new businesses by connecting a variety of service functions such as IoT and social media. This paper describes the features of K5 PaaS, the requirements for quickly and flexibly contributing to the digitalization of customers' businesses, and service functions for meeting those requirements.

1. Introduction

Advances in cloud technology and the development of high-speed networks have helped make corporate clouds an indispensable element of business activities in a manner similar to social infrastructures like electricity and water. Cloud usage formats of major interest include not only Infrastructure as a Service (IaaS), which accelerates the shift from ownership to use of infrastructure resources, but also Platform as a Service (PaaS), which provides a platform for developing and executing applications. According to IDC Japan, the use of PaaS is forecast to grow by 366% from 2014 to 2019.[1)]

Successful examples of how new business models can be created in the cloud include Airbnb, a service providing accommodations for travelers, and Uber, a ride-hailing service. Such groundbreaking services gain a first-mover advantage, so it is vitally important that a great idea somehow be quickly transformed into a practical service. For this reason, companies have come to concentrate their resources on application development and to look to PaaS for infrastructure and system operation.

A variety of cloud providers such as Microsoft and Google provide PaaS while adding and extending functions on an almost daily basis. There are also examples of usage scenarios that foster business innovation by combining technologies such as mobile communications, the Internet of Things (IoT), and artificial intelligence (AI) in the cloud. Nevertheless, most of these success stories are based on models for creating new business—there are few examples of transforming existing business. Fujitsu aims to transform systems that support existing business to improve productivity and integrate them with innovative services.

FUJITSU Cloud Service K5 PaaS (hereafter, K5 PaaS)[2)] can be used to develop and execute two types of applications having different attributes on an integrated platform. The first type of application is Systems of Record (SoR), which are centered on the conventional information records essential to the execution of business, and the second type is Systems of Engagement

(SoE), which connect a variety of services and thereby create new value.

In this paper, we introduce Fujitsu's approach to digitalizing corporate systems using K5 PaaS and describe the K5 PaaS service configuration and plans for enhancing the service.

2. Digitalization by K5 PaaS

This section describes Fujitsu's approach to using K5 PaaS to digitalize corporate systems.

Business enterprises have traditionally implemented a variety of in-house enhancements for their own existing systems. The idea was to gain a business advantage by applying original methods to proprietary systems. However, after implementing such enhancements over a long period of time, the system in question becomes a legacy system, which makes implementing changes to specifications time consuming and costly. In response to this problem, Fujitsu places importance on transforming systems through a process of modernization applied to applications, business rules, etc.

Specifically, Fujitsu defines three stages for transforming existing systems (**Figure 1**).

1) Migration

In the first stage, existing systems are migrated to new systems by changing their infrastructures, middleware, etc.

2) Modernization

Next, changes are made to the application architectures of the migrated systems, and functions such as the rule engine are placed in a loosely coupled[note 1)] state.

3) Digitalization

Finally, the modernized systems are linked with external services and innovative functions to create new systems.

The system functions provided by K5 PaaS at each of the above stages are summarized below.

1) PF ("mission-critical-business platform service") supporting migration
- Standardization of system/middleware configuration and standardization of design and settings in accordance with security level
- Parameter tuning of system middleware optimized by Fujitsu knowledge
- Provision of operating functions such as backup and disaster recovery[note 2)]

2) PF ("mission-critical-business platform service") enabling modernization
- Support for making applications of loosely coupled architecture
- Support for changing the applications of existing systems to applications capable of linking to other services
- Provision of functions such as session replication[note 3)] for scaling resources

3) CF ("cloud-native platform service") and application programming interface (API) management service supporting digitalization
- Merging with social media, IoT, and other SoE systems
- Creation of a new ecosystem with external systems

3. K5 PaaS service configuration

This section introduces the functions[3)] and technologies making up the services provided by K5 PaaS.

3.1 PF ("mission-critical-business platform service")

This service provides a platform for developing and executing Java applications, which are the most widely used in mission-critical business. With this service, all operations and tasks can be performed from a dashboard-type screen, which means the environment enables users to concentrate on application development. The following introduces the main PF functions.

1) Automatic deployment of operation-guaranteed system configuration

This function uses OpenStack HEAT functions of K5 IaaS to automatically configure the hardware, network, OS, open source software (OSS) such as Apache, Tomcat, and Zabbix, and operation settings needed to run an application. The parameters of the deployed OS and middleware are appropriately tuned from the viewpoints of security and performance to provide an operation-guaranteed system based on Fujitsu's proven system integration (SI) knowledge. There is no need

note 1) State in which connection between different applications is relatively loose so that independence of individual applications is strong.

note 2) Mechanism or system for quickly repairing and restoring a failed system.

note 3) Mechanism for replicating data stored within a session between different instances.

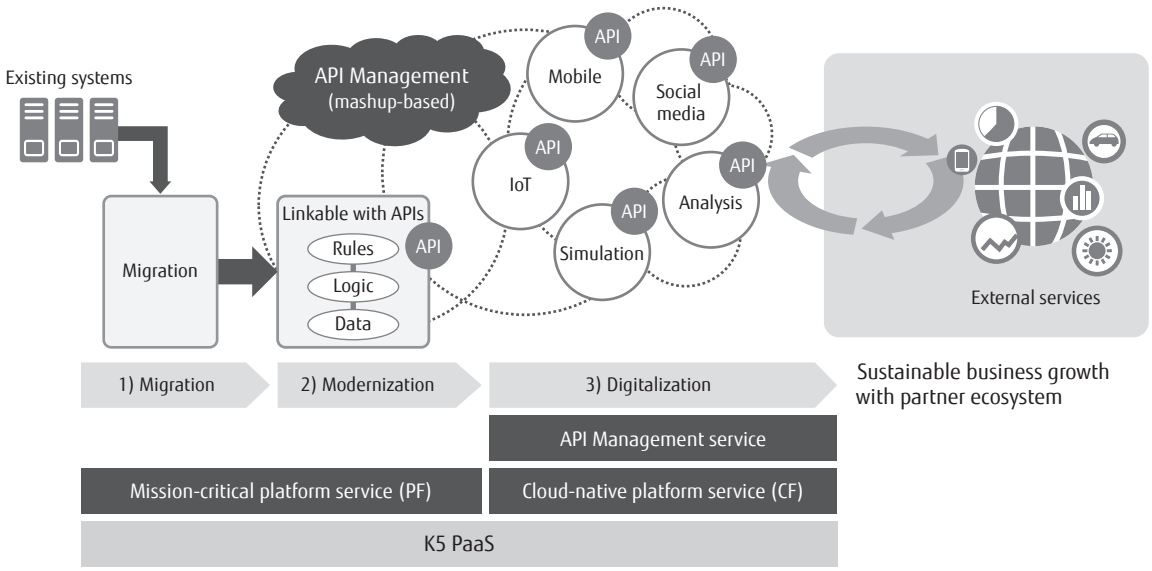


Figure 1
System transformation stages and K5 PaaS services.

for service users to be aware of security configurations and performance tuning. In addition, maintenance of the system infrastructure can be entrusted to PF on an ongoing basis.

Two commonly used system-configuration patterns can be deployed (**Figure 2**).

- Web—application (AP)—database (DB) (3 tier)
- AP—DB (2 tier)

2) Provision of application development/maintenance techniques

This function provides a standard framework of original techniques developed by Fujitsu (**Figure 3**). It supports the application development process by introducing application definitions in relation to program models, business rules, flow, etc. via the Eclipse[note 4)] plugin. This framework can define links between objects having some sort of relationship in terms of data items, business rules, etc. by using Fujitsu proprietary technologies and code analysis technologies that enable loose coupling of applications and improve maintainability. It can therefore improve the accuracy of searching for locations affected by a change in specifications. In short, using this framework for accurately isolating the range of impact of such changes can optimize the maintenance costs of a mission-critical system requiring long-term maintenance.

3) Provision of operation and management functions

PF provides an assortment of functions that are needed for operating a mission-critical business, such as those for system operation monitoring, log management, and maintenance support (applying patches).

Specifically, PF incorporates standard middleware functions as well as a backup function for saving log data in object storage[note 5)], a mail-based notification function advising of abnormal occurrences, and Layer 7 ping monitoring[note 6)] by issuing an original HTTP request[note 7)] to a server instance. These functions make it unnecessary to prepare anomaly monitoring and fault recovery utilities required for system operation.

Additionally, as the target is mission-critical-business services, PF also provides flexibility in expanding and contracting system scale through auto-scaling that capitalizes on cloud characteristics. (The plan is

note 4) An open source integrated development environment (IDE).

note 5) Storage equipment that treats data in units of objects.

note 6) Ping monitoring by issuing requests on Layer 7 (application layer) of OSI Reference Model.

note 7) A message sent from user's terminal to Web server requesting data in Hypertext Transfer Protocol (HTTP), a typical Internet communications protocol.

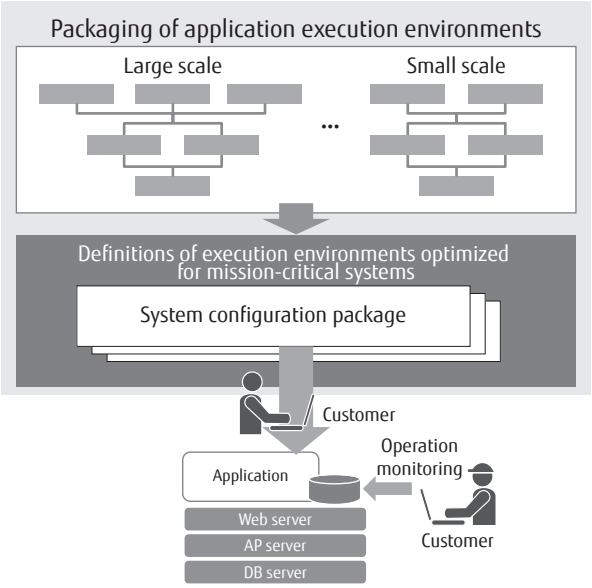


Figure 2
Automatic deployment of operation-guaranteed system configuration.

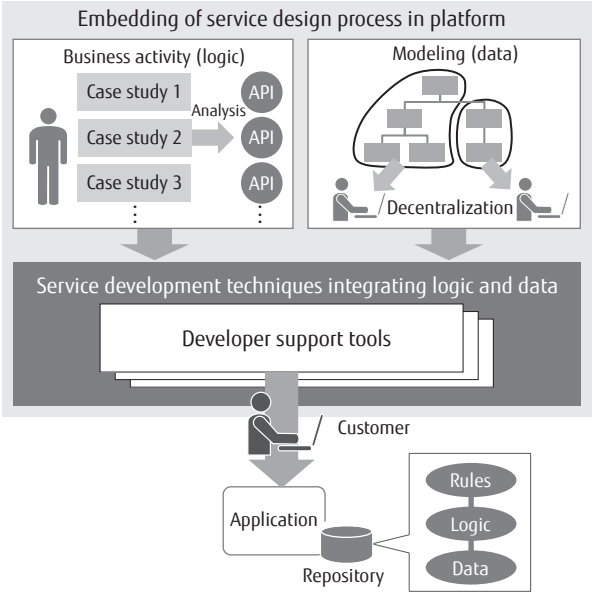


Figure 3
Application development/maintenance techniques.

to support this function in future enhancements of PF.)

3.2 CF ("cloud-native platform service")

This service provides an application development and execution environment based on Cloud Foundry, an open-source PaaS. Using a variety of development languages such as Ruby, Python, and Node.js, it enables the development of composite applications combining multiple services.

The main functions are introduced below.

1) Buildpack[note 8)] and Container

The CF service provides major runtime languages used in Web application development (e.g., Java, Ruby, Node.js, Python, nginx, PHP, Go) in the form of buildpacks (**Figure 4**).

Fujitsu was the first in the world to enable the use of the GlassFish open-source application server conforming to the Java Enterprise Edition (Java EE) standard as a Java buildpack on CF. This makes it possible to use the same applications as those used with the FUJITSU Software Interstage Application Server, which also uses GlassFish.

CF uses a Container as an application execution environment. An application deployed by the user is dynamically joined with a buildpack through a staging process and run in Container.

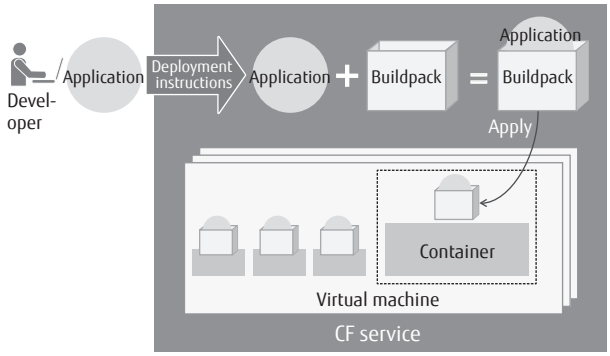


Figure 4
Buildpack and Container.

2) Service catalog toward development of composite applications

Services that can be used in application development and operation on CF are provided as a catalog. Combining these services to develop composite-type applications enables application development and deployment in a relatively short period.

For example, a new service has been developed on FUJITSU Cloud Service MobileSUITE, a development and execution platform for mobile services, using

note 8) A mechanism for preparing runtime execution framework for operation on CF.

the relational database service (RDS) and Log as a Service (LaaS) (log collection/monitoring service) on CF (**Figure 5**). In this way, the time needed for constructing an application infrastructure can be shortened from six days, as needed in the past, to ten minutes, reflecting a significant shortening of the development and deployment periods for services.

3) Contributions to Cloud Foundry community

Cloud Foundry is being developed by a community centered about the Cloud Foundry Foundation[4] consisting of more than 60 member companies and organizations including Fujitsu.

As an active participant in the community, Fujitsu has dispatched project managers for the Command Line Interface (CLI) project and developers for application auto scaling, a Cloud Foundry incubator project. Fujitsu has also provided the most correction programs among Japanese vendors.

3.3 API Management

API Management (**Figure 6**) is a PaaS based on Apigee Edge, an API management service from Apigee Corporation in the United States. In addition to linking with K5 services, API Management also supports API development and publication of applications in an on-premise environment.

These days, a variety of APIs can be used on the Internet. These include not only open data and APIs offered at no charge by companies and local governments but also APIs provided for a fee by companies for business purposes. API Management is an integrated platform that can manage and release Web-service

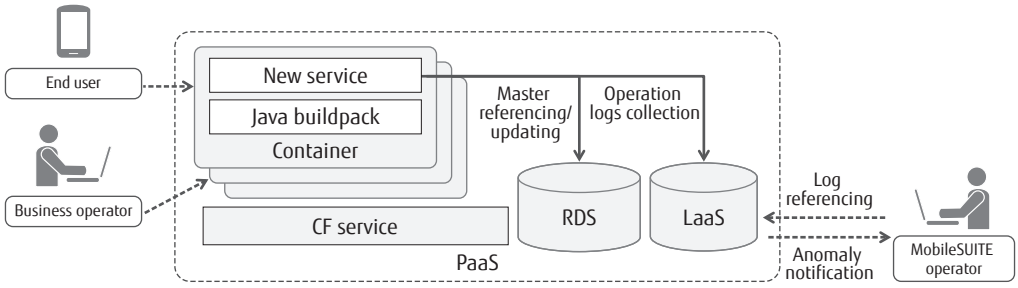


Figure 5
New service development and operation using RDS/LaaS services.

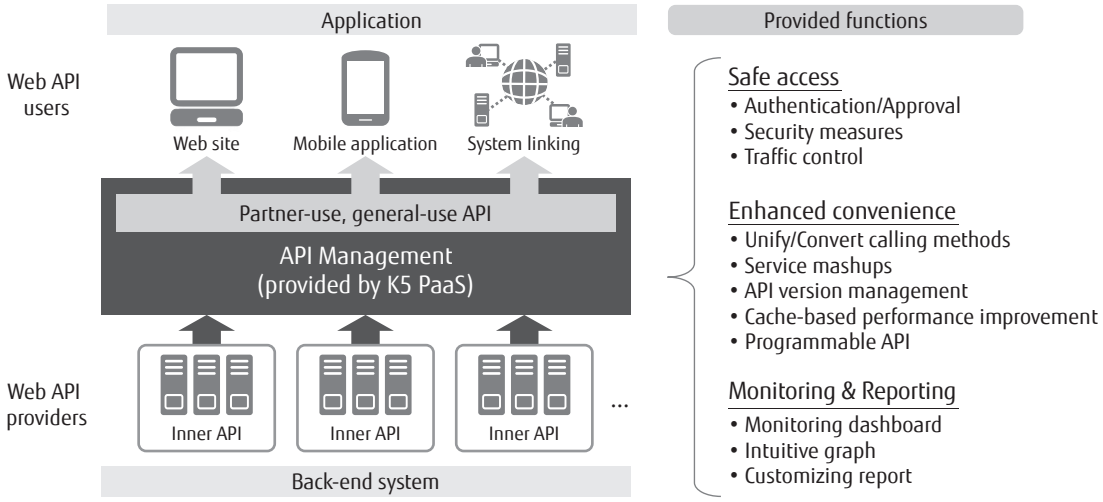


Figure 6
API Management functional configuration.

APIs using abundant functions in a middleware role. It can quickly publish a company's application APIs to the public and thereby contribute to the digital use of corporate systems.

To begin with, API Management provides management functions that take into account security for inner APIs provided by back-end applications. It also has functions for developing front-end applications using publically released APIs (outer APIs). API Management enables business API providers to quickly publish APIs for in-house and outside use and supports efficient application development by users.

1) From mobile first to API first

In parallel with the rapid spread of smartphones in recent years, "mobile first" has become a popular concept reflecting the trend toward optimizing not only Web content for mobile use but also public services and business mechanisms themselves.

Web API (RESTful API) is an example of technology supporting the mobile-first concept. Web API can be used to implement front-end applications on Web sites and mobile sites or as mobile applications and can handle the building of business applications. It is starting to be used for inter-firm linking in the IoT and B2B domains as well.

2) API Management for achieving API first

Today, mobile first is becoming a thing of the past as the "API first" concept gains in popularity. The four main features of API Management supporting API first are summarized below (**Figure 7**).

- Conversion to RESTful API by protocol/data-format conversion

API Management can convert the interface, data, etc. of an existing application into the RESTful interface, which is a well-known and user friendly format.

- Addition of authentication functions to API

Outer authentication such as OAuth can be added to APIs having no authentication functions.

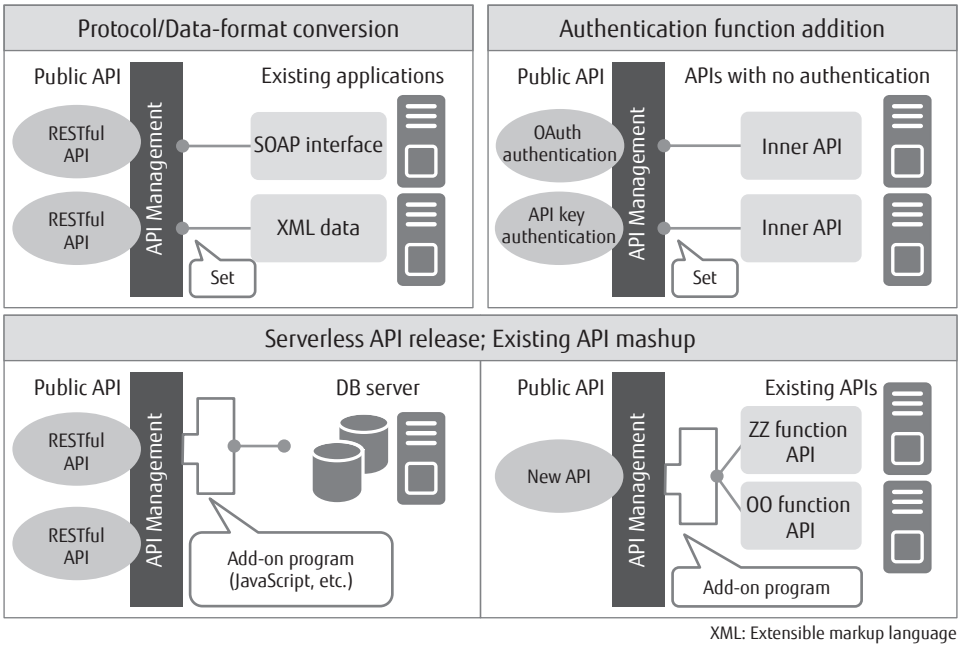
- Add-on program, serverless API development

Back-end API endpoints can be implemented by simply adding programs on the API management platform, so a back-end application server is not required.

- API mashup

An API mashup for calling multiple APIs as a single API can be achieved by simply adding a program.

These functions support fast and simple release of APIs.



XML: Extensible markup language

Figure 7
API Management linking configuration.

4. Toward a digital economy

As a cloud service, K5 PaaS is aimed at growing the customer's business and expanding the scale of the platform. To this end, there is a need for a "Mission-Critical Digital Cloud" achieved through the modernization of existing systems and a "Digital Economy Platform" for creating new markets (**Figure 8**). This can be achieved by using K5 PaaS as a service hub to connect a variety of functions and services through APIs as a single business.

To accelerate the growth of K5 PaaS into a service hub for business, an environment that enables the safe and secure use of diverse services on the Internet must be provided. In this regard, a platform that combines fast and low-cost processing with safety and security can be provided through the formation of a digital economy[note 9)], which can be achieved by converting Fujitsu's information resources into a service and linking up with other cloud providers. Specific types of support provided by K5 PaaS are summarized below.

1) Achievement of safety and security

Security technologies for protecting customer information are provided as a K5 service. These include Fujitsu's biometric authentication technologies (palm vein authentication, iris authentication, etc.), data concealment technologies, and technologies for safe and secure use of the Internet such as network tunneling and closed-network linking.

2) Provision of Fujitsu's information resources as a service

As individual services, support is provided for Docker open-source container management software used in Linux, for front-end processing, and so on. Fujitsu's Operational Data Management & Analytics (ODMA) platform for creating new value through the analysis of big data and its IoT platform implemented through systems integration are also provided as K5 services.

3) Linking to cloud services

It will be possible to link K5 services to other services such as the NIFTY Cloud mobile service provided by NIFTY, a Fujitsu Group company, as well as to business rule management systems (BRMSs) and Microsoft Azure, a cloud-computing platform.

note 9) Economic phenomena generated by ICT.

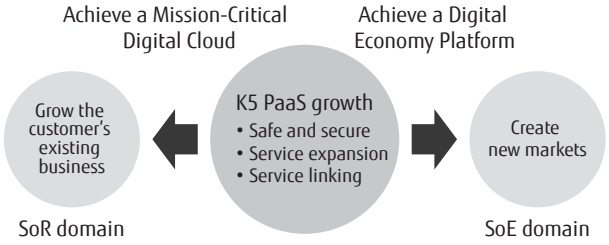


Figure 8
K5 PaaS growth and targets.

5. Conclusion

This paper described growth scenarios for customer systems as conceived by Fujitsu and Fujitsu's approach to achieving them using its K5 PaaS cloud service, which looks to expand from here on.

K5 PaaS does not simply provide service products. It also provides system integration to customers in an even faster way and at a reasonable cost compared to past methods. Fujitsu itself is currently using K5 PaaS for system modernization and for implementing innovative in-house services such as biometric authentication.

Cloud services are being introduced in many markets. Customers thus have a high degree of freedom in selecting which services to use, but this forces them to face the difficulty of combining such services in an optimal manner. K5 PaaS eliminates this difficulty by providing a standardized system platform, operating functions, and application development technologies as a service.

Going forward, Fujitsu intends to both extend and add services to K5 PaaS to ensure flexible and ongoing interaction with the evolving digital economy.

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