Cloud Computing Based on Service-Oriented Platform

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A new concept for using information and communications technology (ICT) called Cloud computing has recently arrived. This paper describes how Fujitsu approaches Cloud computing and intends to implement it in Japan as a first step toward globalization.

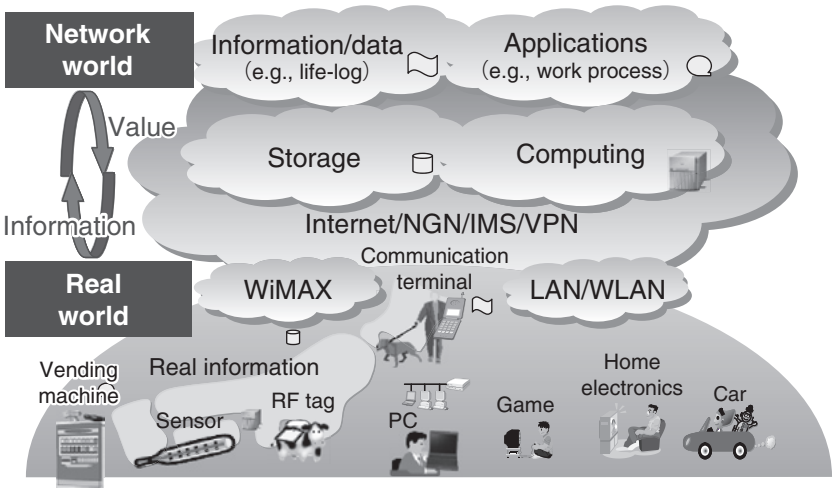
1. Introduction

Cloud computing is a recent concept for using information and communications technology (ICT), in which ICT resources, such as servers and storage devices, existing in the Cloud (Internet) are used via a network. It offers the following advantages to customers: They do not need to prepare servers or other hardware; they can use it whenever they want using only the required resources; they can access virtually unlimited computing power; they can easily interconnect systems; and they do not need to own facilities, which leads to green computing. The emergence of the Cloud computing concept can be attributed to three factors.

1) The rising cost of ICT operation. The costs of operating and powering servers and other equipment have been increasing and are expected to make up more than 60% of total ICT investment. Customers desire drastic change in this regard.
2) Technical innovation. ICT performance has made remarkable progress in the last 15 years. In particular, the cost performance of network technology has improved by about 20 000 times. This has taken the stress out of using ICT resources via a network.
3) The need to reduce CO_2 emissions and handle other environmental problems and to adapt to an increasingly severe business environment.

Against this background, the concept of Cloud computing has been attracting attention throughout the world. We can expect ICT usage in society to increase and a huge amount of information to be accumulated in conjunction with data from sensors and other devices. The hope is that this massive amount of information can be used to good effect in corporate and social activities, in the form of collective intelligence or "long tail" applications, and that new value can be created. Cloud computing, which provides users with efficient and virtually unlimited computing power, can process this huge volume of information "in the cloud" (on the other side of the network) and provide it as services to the real world (**Figure 1**).

However, this does not mean that all computing is destined to become Cloud computing. At present, the mainstream is internal deployment, or ownership, of ICT systems. In the years to come, we can expect to see an increase in the use of Cloud computing for software as a service (SaaS). However, the core



IMS: Internet protocol multimedia subsystem
LAN: Local area network
NGN: Next Generation Network
PC: Personal computer
RF: Radio frequency
VPN: Virtual private network
WiMAX: Worldwide Interoperability for Microwave Access
WLAN: Wireless local area network

Figure 1
Real world and network world.

business systems in particular will remain as internal, company-owned systems. Nevertheless, we can expect that Cloud technologies, including virtualization, automation, and conversion to green techniques, will be adapted for all ICT systems.

In this way, a transition will be made from "total facility ownership" to "widespread utilization of ICT", taking the form of services provided in alignment with needs and current conditions. This new environment will drive business innovation.

2. Approaches to Cloud computing

The application of Cloud computing to corporate ICT can be broadly divided into two forms.

1) Use of Cloud services offered by service providers (public Cloud). In this form, the user does not own any ICT system assets, which relieves him of the burdens of investment risk and operation and management costs. Services provided via the public Cloud, however, target public users, so the content and service levels are consequently limited. Other problems include resources possibly being shared among users and data storage locations being invisible to the user.

2) Construction of an enterprise system as a Cloud (enterprise Cloud). In this form, the company introduces products using server-, storage-, and network-virtualization technology, dynamic resource provisioning technology, and integrated operation and management technology in its data center. ICT capabilities are then provided as services to company departments and affiliated companies. In this form, the company must install equipment on its premises and own it as assets, but it can use those assets in a flexible, dynamic, and efficient manner and reduce operation and management costs compared with traditional ICT systems. Another advantage of this approach is that

resource locations, such as data storage locations, are visible and controllable.

As described above, we can expect the use of ICT capabilities as services to increase from now on (public Cloud), but we can also expect the core business system to remain as an on-premise, company-owned system. This means that the public and enterprise Clouds can take on mutually complementary roles: each Cloud will be applied where and when needed from the viewpoints of cost, flexibility, and compliance. To make this possible, corporate ICT should be migrated to the Cloud-ready architecture according to the following scenario.

1) Clarify (visualize) the business systems that the company owns and select systems to be migrated to the Cloud-ready architecture. In general, front-end business systems and development systems are more likely to benefit from the features of Cloud computing than mission-critical systems.
2) Standardize the implementation of those selected business systems. For example, the x86 architecture could be chosen for servers, Linux or Windows for the operating system, and a certain type of middleware for application servers and databases. Existing systems should be ported to the standardized implementation as needed.
3) Construct a "Cloud platform" within the enterprise data center, based on virtual machines and other virtualization technologies, and then consolidate and integrate standardized business systems in this Cloud (establishment of an enterprise Cloud).
4) Since business systems on the enterprise Cloud have been standardized, they have high compatibility with the public Cloud. This provides flexibility in the migration of on-premise systems to public Cloud services. For example, it allows business systems in an enterprise Cloud to be used jointly with public Cloud services as needed (for example, in the temporary use of public-Cloud resources during times of peak load). It also enables a whole business system to be migrated smoothly to the public Cloud once a decision to do so has been made.
5) When a new business system is being developed, construction on the public Cloud services should be considered as the first choice. If that proves to be difficult, the system can be constructed on the enterprise Cloud on the basis of the standardized implementation.

3. Fujitsu's Cloud platform

Fujitsu plans to assist customers in utilizing ICT for their business in the Cloud era in two ways: by providing public-Cloud services and by providing ICT platform products and services for establishing an enterprise Cloud. The main value that Fujitsu provides for a business-oriented Cloud is the "trusted Cloud". Whether it is a public Cloud or an enterprise Cloud, a company's business platform must meet the requirements specific to corporate ICT, such as guaranteed security, visualization of service levels from a business viewpoint, and highly loaded batch processing. The aim of the trusted Cloud is to satisfy these requirements and provide a Cloud that is appropriate as a business platform while retaining most of the Cloud's advantages, such as the ability to use only the required resources when they are needed, virtually unlimited computing power, and easy service coordination.

The use of public-Cloud services is expected to expand over the long term. The platform that Fujitsu is developing to provide such services is called the Service-Oriented Platform (SOP). SOP is an entirely virtualized and fully Internet protocol (IP)-based platform that consists of a large number of servers, storage systems, and networks in Fujitsu's data centers. It is developed on the basis of server, storage, software, and network technologies that Fujitsu has accumulated over the years. Furthermore,

it includes operations and management technologies and know-how accumulated from the actual experience of service operations, such as hosting using data centers.

4. Concepts

In Japan, Fujitsu is developing SOP on the basis of five concepts: application-centric, hands-on, end-to-end security, green, and open.

4.1 Application-centric

One objective of SOP is to provide the application-program developer with convenient services to streamline program development. Fujitsu will provide as services much of the development process, except for the application logic itself, which is the developer's main concern (**Figure 2**).

Developing a business application system includes much work in addition to application logic development. This work may include the procurement, installation, configuration, and operation of servers, storage, and networks as well as the provision of database servers and user-authentication mechanisms. Providing those portions of the development process outside the application logic as services is expected to ease the work load of the application-program developer.

At the same time, the application-centric approach can help raise the scalability and reliability of the developed system. For example, having everybody use the same database services supported by Fujitsu's IT system management technologies and skills allows the Cloud-computing characteristic of "everybody uses the same thing" to coexist with diversity in business application systems.

4.2 Hands-on

It is difficult to give a fixed figure for the performance metrics of virtual servers because it can be affected by the performance of the physical server, the operating conditions of other host-sharing virtual servers, and the conditions of shared networks and shared storage. Thus, if it becomes necessary to indicate a performance value beforehand, it must invariably be accompanied by the words "best effort". Such circumstances make it difficult for the business application system developer to carry out performance design.

Fujitsu's approach to this problem is to provide a dashboard for visualizing performance metrics and a scale-out function for improving the performance of business application systems. The dashboard enables the user to monitor system performance (response and throughput) in real time and the scale-out function lets the user add more servers whenever performance is substandard. Fujitsu calls this the hands-on concept. It exploits the Cloud-computing feature of quick procurement of ICT resources at optimal cost. This approach can eliminate the

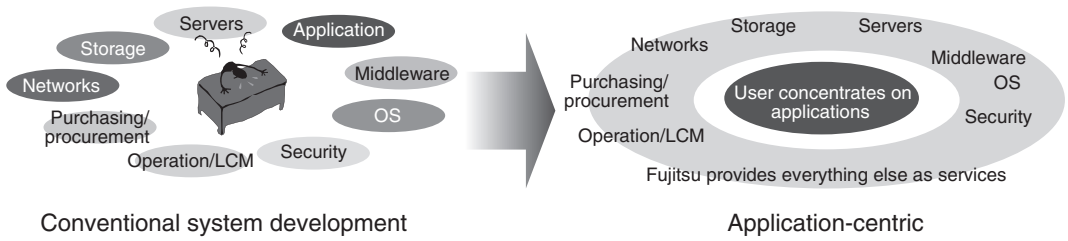


Figure 2
Application-centric.

risk of preparing too many ICT resources caused by inflating the safety margin in performance design. It can also prevent inconsistencies between the ways in which users and service providers perceive the service level by sharing the same performance indexes (**Figure 3**).

4.3 End-to-end security

Security is a great concern for users who are considering the use of Cloud computing. Fujitsu aims to alleviate this concern by providing end-to-end security covering the network, servers, storage system, and connections with external services (**Figure 4**).

First, with regard to connections between SOP and user internal systems, or the Internet, Fujitsu possesses network protection, terminal authentication, and other technologies cultivated through running the proven FENICS services.[1)]

Next, for security on the interconnect network within SOP, the operating system of the physical server is equipped with a mechanism for establishing a clear separation between the interconnect networks of application systems, which may share the same physical resources.

Moreover, with regard to data, the storage system encrypts the stored data to prevent data leaks even if hard-disk equipment is removed from the premises by maintenance personnel or thieves.

Finally, since links to external services (such as the Google Maps service) are inevitable in Cloud computing, even greater security risks of information leakage could arise. Fujitsu is

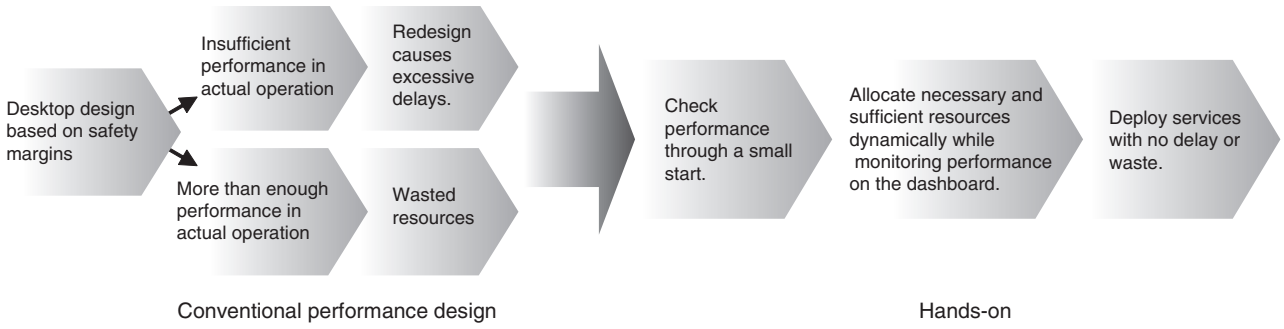


Figure 3
Hands-on.

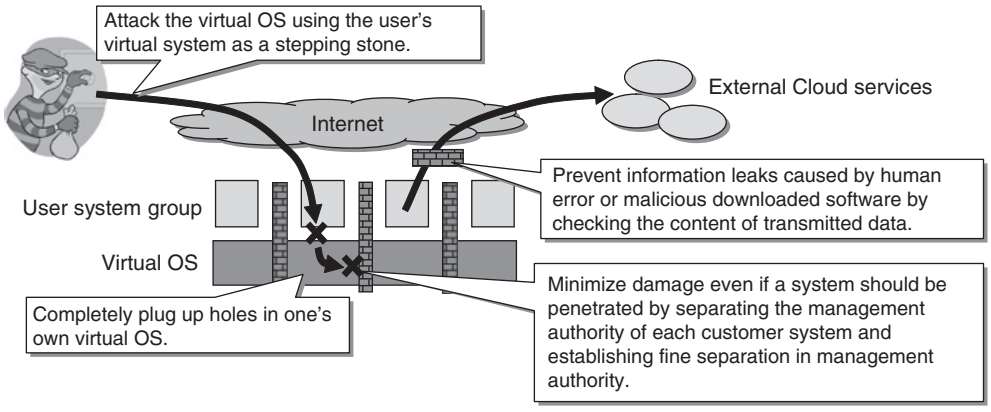


Figure 4
End-to-end security.

developing functions to control these risks.

4.4 Green

The power consumed by ICT resources currently represents only a few percent of the total power consumption of businesses, but this figure is expected to increase considerably in the future. Fujitsu feels that it has a responsibility to reduce CO_2 emissions by optimizing social activities through the use of ICT while simultaneously reducing the power consumed by ICT itself.

In SOP, Fujitsu aims to reduce the power consumed per unit processing capacity by raising the resource utilization rate. The utilization rate of server equipment can be raised by consolidating multiple virtual servers on a single physical server. The average utilization rate of server equipment is said to be below 20%. If this figure can be increased, say, to 80%, the power consumed per unit processing capacity will fall to one quarter of its usual value. However, while consolidating many virtual servers on one physical server can enhance the environmentally friendly characteristics of a system, it also creates the risk of performance degradation. Here, SOP's hands-on function can be used to achieve both sufficient performance and green characteristics at the same time by monitoring the performance of virtual servers and optimizing the mapping pattern of virtual servers to the physical servers.

Likewise, for storage, the utilization rate can be improved by using the thin-provisioning method in which no hard-disk resources are allocated to unused areas.

4.5 Open

Finally, Fujitsu is pursuing openness in SOP development. Because Cloud computing is expected to penetrate all facets of human life and to function as a social platform, it is not desirable for only a few companies to monopolize and control the platform technology supporting Cloud computing. If we consider the overwhelming success of the Linux open source project, it would be desirable to promote the development of the Cloud computing platform as an open project. Such an open development method would eliminate user concern about being locked into a specific platform while also promoting competition among platform providers on the upper technology level, such as operations knowledge. It should also be possible to resolve security-related issues quickly by having many parties involved in the review process.

To put these ideas into practice, the platform portion of SOP is being developed on an open-source basis. Fujitsu plans to release the other portions that are still under development on the same basis.

5. Conclusion

The scope of Cloud computing is wide. There is the public Cloud, in which the user utilizes ICT resources over the Internet, and the enterprise Cloud, where a company purchases services or products as a platform for Cloud computing and then operates those assets in the company's own data center as an extension of the existing enterprise system. In Japan, Fujitsu is developing a Service-Oriented Platform as a next-generation global platform based on the "trusted Cloud" concept and is looking to start commercial services for a public Cloud in fiscal year 2010. Fujitsu also plans to apply these Cloud technologies to enterprise systems and to construct enterprise Clouds for customers, with the ultimate aim of expanding its support of customer business operations.

Reference

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