Next-Generation Data Center Outsourcing Services

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In conventional data center outsourcing services, such as housing and hosting, information technology resources and human operators have to be secured individually for each client. This means that data centers are easily affected by constraints on physical hardware and human resources, resulting in problems such as long lead times and insufficient flexibility to accept short-term contracts. We have therefore been researching and developing a next-generation data center outsourcing service based on virtualization and autonomy techniques. With this service, we aim to provide our customers with faster, less expensive, and more flexible data center services. To illustrate our efforts toward the development of a next-generation data center outsourcing service, this paper introduces an on-demand hosting service and an organic storage service that we are now offering on a commercial basis.

1. Introduction

Conventional data center outsourcing services are centered on housing and hosting services. Housing services provide facilities such as rack space, electrical power and air conditioning; monitoring, reporting, and maintenance; and the like. Hosting services provide information technology (IT) resources such as servers and data storage equipment.

Since these services provide space and operations specialized to suit customers' requirements, they can be adapted to particular conditions, but on the other hand they are susceptible to constraints on the data center's physical hardware and human resources. Consequently, the services have problems such as long lead times and insufficient flexibility to accept short-term contracts. These problems can be resolved through the commoditization of various resources,[1)] but this approach still leaves concerns about security and availability. At Fujitsu, we have developed a safe and secure commoditized next-generation data center outsourcing service through the use of virtualization and autonomy technology. In this paper, we introduce this service by providing specific examples of services that are being provided to customers.

2. Overview of next-generation data center outsourcing service

The next-generation data center outsourcing service is based on the premise of commoditizing various resources among different customers. Since this involves standardizing various types of resources, it enables ones with the same specifications to be prepared in advance. This makes it possible to reduce lead times and offer shorter contract durations. Although commoditization also creates concerns about security and availability, it has become possible to provide safe and secure services by incorporating virtualization and autonomy technology. Below,

we describe the on-demand hosting service and organic storage service that we provide to our customers as next-generation data center outsourcing services.

2.1 On-demand hosting service

The on-demand hosting service provides system resources for implementing services such as software as a service (SaaS) and Cloud computing (servers, storage, and network resources) from a shared resource pool (**Figure 1**).[2] The technical characteristics of this service are described below.

2.1.1 Resource pool control and resource virtualization

To implement a resource pool, we must virtually manage each layer of resources and dynamically allocate resources to the systems provided to customers. We must also set up a reliable isolated environment between the allocated systems that is theoretically secure (i.e., prohibits other systems from seeing or connecting to them).

In the on-demand hosting service, a virtual network is configured in multiple stages with server resources connected in a physically flat configuration, thereby letting us provide each customer with tailor-made hierarchical systems as specialized resources. Even stand-alone systems that have already been allocated can be monitored and controlled from the pool management side, leading to the construction of independent management networks that are theoretically blocked from the front. This results in a resource pool management system that can be centrally managed.

2.1.2 Automated service delivery process

By dynamically allocating systems that have been standardized for each service from the pooled shared resources, we can add and remove resources flexibly according to demand fluctuations and service provision lead time

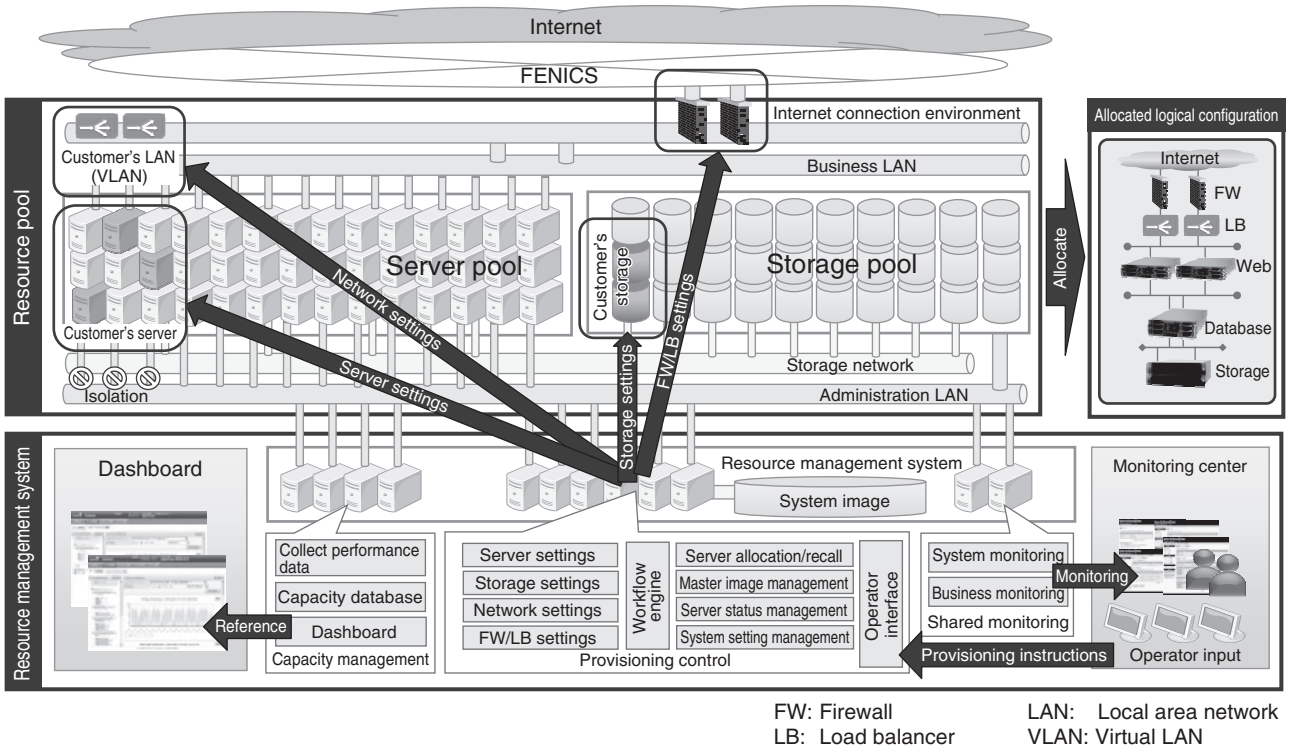

Figure 1
On-demand hosting service.

reductions. In the on-demand hosting service, the service delivery process is standardized and provisioning is automated[note 1)] by the resource pool management system. In this way, the necessary resources are provided promptly to support the customer's timely business entry and development.

2.1.3 Resource status visualization

In the operating phase of services such as SaaS and Cloud computing, it is important to accurately ascertain the resource status and manage the service capacity as factors on which to base decisions regarding investment in service environments and the continuous maintenance of service levels. In on-demand hosting services, dashboard functions are provided for service status visualization. In the dashboard, it is possible to ascertain a server's operational state by checking the load information of server resources while they are being used. The dashboard also supports the drafting of capacity plans based on statistical information for time spans measured in years, months, weeks, or days.

An on-demand hosting service that benefits from these virtualization, automation, and visualization capabilities lets us provide a service that allows IT resources to be used flexibly and at a speed that matches the speed of business developments.

2.2 Organic storage service

The organic storage service is a data center outsourcing service. This service provides shared data storage at Fujitsu's data centers (at Tatebayashi, Akashi, and Tokyo) that can be used by multiple customers. Customers can use these storage facilities for file servers and backup storage, for example, by accessing them over the network from their offices (**Figure 2**).

For shared data storage, this system uses *organic storage technology*, which is a virtual storage technology developed by Fujitsu Laboratories that offers high security and reliability with long-term storage that exceeds the equipment lifetime. It has the following features.

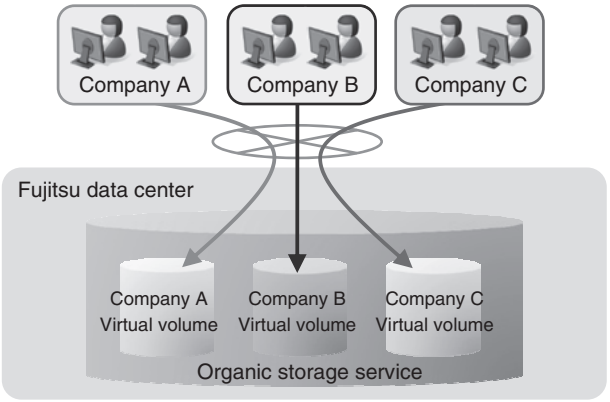

Figure 2
Overview of organic storage service.

1) High security

Shared data storage protects confidential data by using virtual volumes to achieve theoretical separation between customers. This separation is made even safer by applying a technique developed by Fujitsu that is based on public key infrastructure technology.

2) Reliability

Data in the shared data storage is copied and distributed redundantly across multiple hard disks so that if one disk breaks down, the data can still be recovered from one or more other disks. This makes the likelihood of data loss very small.

3) Long-term storage beyond equipment lifetime

In general, IT equipment has a life expectancy of about five years. For the long-term storage of data over periods of decades, data has had to be transferred from old storage equipment to new storage equipment every five years. Even transferring relatively small amounts of data of the order of terabytes can take many hours or even days to accomplish, which can have a significant

note 1) Automatic provisioning: technology for rapidly constructing the environment needed for a service.

effect on the client's business. Our service uses "metabolic" functions that can replace worn-out shared storage equipment without any service interruption.

3. Application examples

This section introduces three examples in which the abovementioned on-demand hosting and organic storage services were applied to the businesses shown in **Table 1**.

3.1 Application to core business systems: Cloud service for SAP systems

The on-demand hosting services are used for a Cloud service for SAP[3] systems.

A growing number of customers intend to migrate their SAP software and hardware to an on-demand hosting service instead of replacing the hardware and upgrading the SAP software. These days, with the decline in sales caused by the economic downturn, many customers are decreasing the volume of their business. Even in core systems such as SAP, the system scale is varied according to the business volume, so there is a growing need for system resources to be optimized in order to reduce running costs.

The customers in this example have a business model in which the business volume and system load are linearly tied to the sales volume. It has therefore become important to optimize the IT resources by rapidly increasing the system scale at prosperous times and reducing it when the economic situation worsens. We have therefore proposed a Cloud service for SAP systems in order to reduce the total system cost by providing infrastructure resources and middleware resources on demand according to the application-centric concept, which means that the resources needed to run software applications are provided by outsourcers as a data center outsourcing service so that customers can concentrate their efforts on the development, introduction, and operation of software.

Running SAP software requires not only infrastructure resources such as servers with operating systems, storage, and networks, but also middleware resources such as transaction monitors and databases. The Cloud service for SAP systems aims to provide the various resources needed to run such SAP software as services (**Figure 3**).

3.1.1. On-demand allocation of infrastructure resources

When system resources (including hardware and operating system resources) are provided in a conventional hosting and housing system, they are basically sized on the premise that they will operate with the same configuration over a long period of time. Consequently, system designers

Table 1
Business applications of next-generation data center outsourcing services.

Business field	Examples
Core businesses	• Construction/transportation: manufacturing, sales, distribution, customer relationship management, electronic data interchange, etc. • Finance/social infrastructure: accounting, customer management, etc. • Public sector/medicine: citizen registration, tax, electronic medical charts, etc.
New businesses	• Shopping malls • Video game sites • Ringtones, movie download sites • SaaS, etc
Common businesses	• Human resources, payroll, attendance records, accounting • Email, groupware, file servers • Identity-management, integrated certification • Public Websites • E-learning, etc.

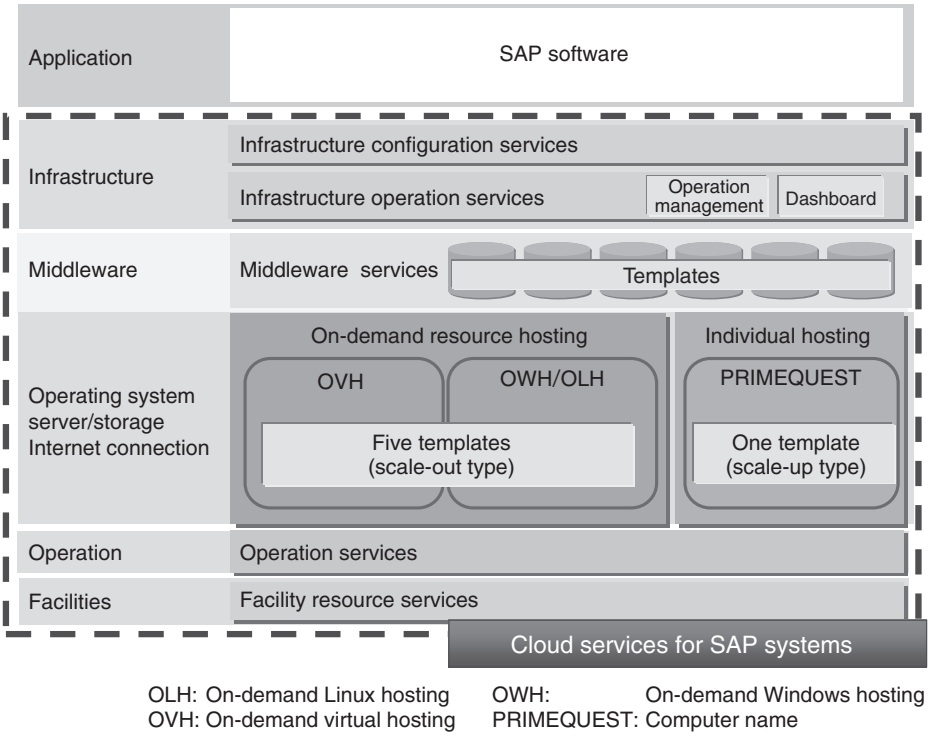

Figure 3
Concept of cloud services for SAP systems.

have no choice but to include safety margins when designing the system configuration, and systems are often overspecified on the basis of the peak load. Moreover, since an SAP system requires a development and verification environment, those environments must be kept throughout the system's life cycle even though they are used only temporarily. We therefore took the approach of producing templates of on-demand hosting services and infrastructure components so that resources can be provided on demand to match the life cycle of SAP systems.

An SAP system can be broadly divided into a front-end Web/Application server and a back-end database server. We made a dedicated template for SAP systems that enables Web/Application servers to be scaled out for on-demand hosting services. Using Fujitsu's previous SAP system provision experience, we analyzed the configuration and requirements of these systems, including the effects of redundancy in the central processing unit, memory, and disk capacity, the pros and cons of virtualization, and the storage connections. By modeling the common elements, we were able to distill these requirements into five SAP system templates of differing scales. Specifically, by selecting and combining templates that match the scale of our customers' businesses, we can provide optimal SAP system infrastructure resources rapidly.

Systems such as database servers that are required to be scalable are incompatible with on-demand hosting services. Therefore, we decided to work on an individual hosting service as an example of a conventional data center outsourcing service.

By choosing to use a hybrid configuration combining on-demand hosting services with individual hosting services, we implemented on-demand functionality through the allocation of SAP system infrastructure resources.

3.1.2 On-demand allocation of middleware resources

The on-demand provision of middleware involves issues such as licensing middleware resources and reducing the time taken to construct middleware environments. To avoid middleware resource licensing issues, we chose to use our own software.

SAP system operation requires middleware resources in addition to the abovementioned infrastructure resources. Licenses for middleware resources are normally purchased by the customer. In this case, since long-term use is presumed, short-term use is not cost effective. We conducted trials in which customers could license Fujitsu's middleware (Interstage, Systemwalker, etc.) on a monthly basis, limited to SAP Cloud services, meaning that they only had to pay for what they used and the software could be removed when it was no longer required.

Next, we used Fujitsu's infrastructure construction/operation service to reduce the middleware environment construction time. The infrastructure construction/operation service provides support from construction through to operation of system infrastructures outsourced at Fujitsu data centers. The infrastructure construction/operation service is used to create templates by identifying patterns in the middleware resources used in SAP. These templates include database software needed to run SAP programs, and operation management software needed to operate the service. By providing them separately for each template, we were able to reduce the lead time for middleware resource provision from the usual 2–3 weeks to five working days.

In this way, we have made it possible to provide an environment where development and verification environments can be promptly provided when they are required, and relinquished once the system is up and running.

By allocating infrastructure resources and middleware resources on demand, it has become possible to adjust the use of resources to suit the SAP system life cycle. The adjustment of resources is illustrated in **Figure 4**. This service made it possible for the customers introduced

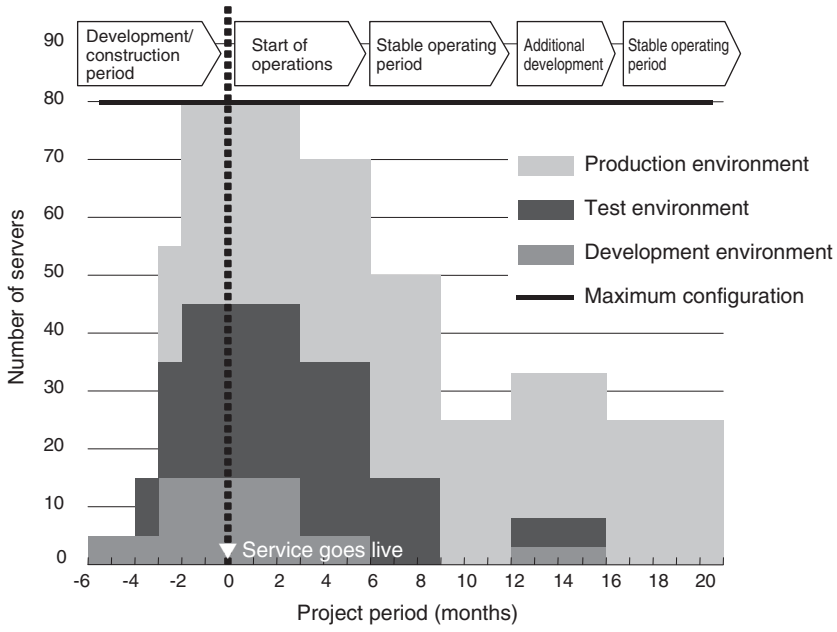

Figure 4
Evolution of SAP system resource requirements.

in this example to reduce their IT resources by approximately 60% compared with their normal requirements.

In this section, we introduced a method for reducing the total cost of SAP systems through on-demand provision of the diverse resources necessary for running SAP software based on the application-centric concept. This method should work not only with SAP systems but also with other packaged software and individual software applications and is expected to lead to the development of more general-purpose services.

3.2 Application to new business system: Cloud services for online games

Here, we introduce an example where on-demand hosting services were applied to online games. The game industry ranks alongside the automobile industry as one of Japan's main exporters, and even in the domestic market it remains robust during economic downturns. In particular, online games place large demands on IT systems, and Fujitsu has concluded that on-demand hosing services would contribute to the business of customers in this field. By engaging in discussions with a number of online game providers, we established the following hypotheses related to the needs of the online game industry.

1) Divergence of designed and actual access loads

An online game service is a business-to-customer (B2C) service where the players have direct access to IT systems such as game servers via the Internet. There is a large peak in access rate when new content is provided, such as when a new game becomes operational or new content is added to an existing title. Thus, IT resources for online game systems are sized according to the expected access peak conditions. However, since these services are made available to the general public via the Internet, unexpectedly high access rates often occur. If a game becomes unplayable just after new content is provided as a result of game server access overload, most players are likely to abandon the game altogether, with the result that the game provider loses potential users. The reduced player numbers that result from these lost opportunities are likely to continue until the server loads falls enough to make the game playable again (i.e., with the system performance limits) [1) in **Figure 5**].

2) Large access fluctuations

Due to the inherent nature of games, the

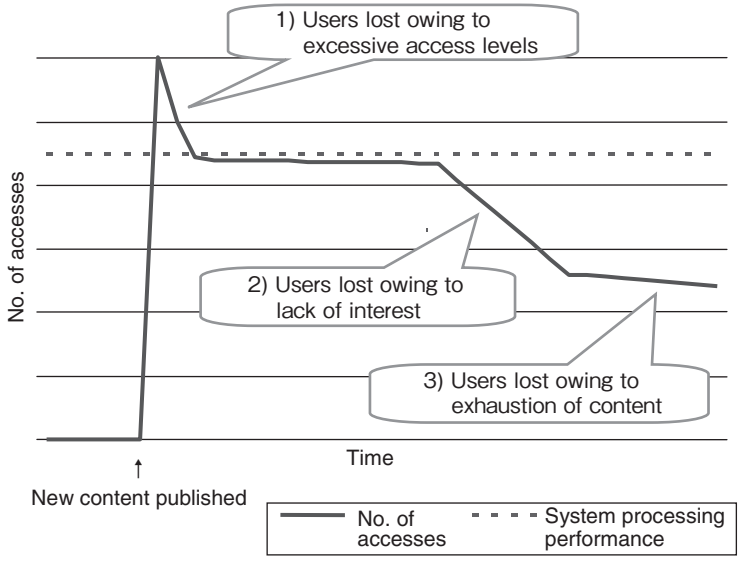

Figure 5
Changes in traffic levels for online video game.

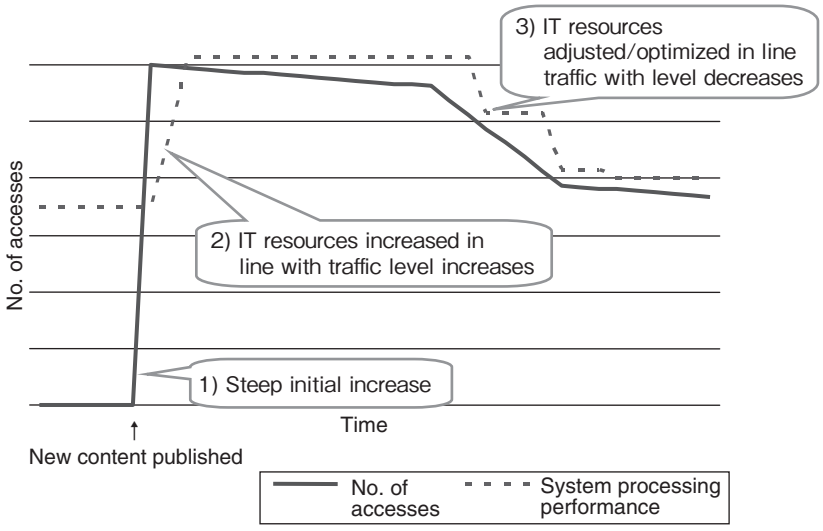

Figure 6
Adjustment of on-demand IT resources in line with traffic changes.

number of players decreases as they lose interest in the content. At Fujitsu, we envisaged two cases in which the number of players might decrease through loss of interest. The first is where players who are not particularly interested in the content lose interest quickly. This case is envisaged as a pronounced drop in the number of players a few weeks after the content is initially provided (peak access time) [2) in Figure 5]. The second is where players lose interest in the content after playing the game for a long time. This case is thought to be represented by a gradual decline [3) in Figure 5]. Since the revenue from an online game service is proportional to the number of players, it is important to control costs by adjusting IT resources in line with fluctuations in the number of players.

It should be possible to address these issues by using an on-demand hosting service. The adjustment of on-demand IT resources in line with fluctuations in the number of accesses is described below with reference to the example shown in **Figure 6**.

When new content is first published, the number of accesses increases sharply [1) in Figure 6]. When the initially provided IT resources are overwhelmed, further resources are added to strengthen the processing performance [2) in Figure 6]. Once the number of accesses has peaked, it gradually declines. As it does so, the IT resources are also gradually reduced to optimize costs while maintaining the required level of performance [3) in Figure 6].

To perform these operations in an on-demand hosting service, we used virtualization technology to produce templates for online games. Virtualization enabled us to reduce the time needed for adding IT resources (from five working days to one). Moreover, by running approximately eight virtual servers on one physical server, we were able to greatly reduce the cost of providing a single virtual server (to approximately one fifth).

In standard services, we cannot allow a reduction in IT resources for a year after any change has been made. However, to match the speed of changes that occur in the online game industry, we customized the specifications to allow resource reduction on a monthly basis.

The above measures enabled customers to achieve stable operation of their IT resources under peak access conditions, while minimizing user loss. It was also possible to control these IT resources in line with fluctuations in the number

of people accessing the games, thereby optimizing the revenue from these games.

Although this study is related to the application of services on the theme of online games, the same issues seem to arise in other B2C online services (e.g., movie/music distribution and social network services), so this model has the potential for development across a broad range of fields.

3.3 Application to common services: Using organic storage services for file servers

With regard to the application of organic storage services to the operation of a file server service, we introduce the example of company X here.

Company X has built multiple branches throughout Japan. In the past, it operated file servers installed separately at branch offices, but this arrangement caused a number of operational problems for their system administration department:

1) Coping with shortfalls in capacity: having to purchase new disks and add disks to the system and enhance the system capacity
2) Replacing old equipment: having to purchase new file servers and migrate data from old file servers
3) Dealing with faults: having to investigate faults and make maintenance arrangements with vendors and take on-site measures depending on the type of fault
4) Security: having to periodically install operating system updates and perform virus scans and virus pattern updates
5) Backup/restoration: having to make routine backups and restore data in response to user requests

To address these issues, Fujitsu proposed the use of an organic storage file server service. Company X agreed to install this service because it realized that this service offers the following merits (**Figure 7**).

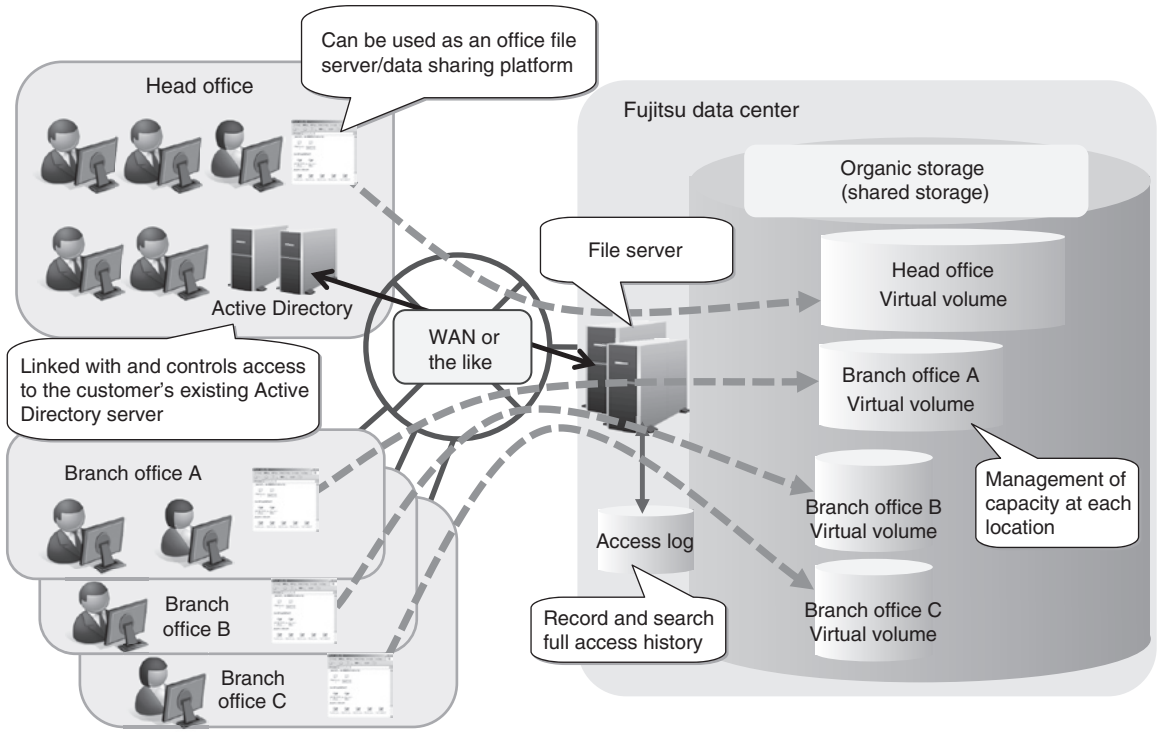

Figure 7
Overview of file server service.

1) Everything is provided as a service

Our service provides a complete package, including not only the hardware and software necessary for operating the file servers, but also monitoring, operation, and maintenance services and center facilities. This releases the customer from the burden of having to purchase, maintain, and replace hardware and software.

2) On-demand addition of capacity

Starting from the minimum contract capacity (1 terabyte), it is possible to increase the disk capacity on demand in 100-GB units to match the current usage. This makes it possible to optimize the file server costs.

3) Redundant configuration with round-the-clock monitoring and fault recovery

The file servers and shared storage have a fully redundant configuration. They are monitored 24 hours a day, 365 days a year so that any faults that occur can be dealt with swiftly and business can be restored without delay.

4) Replacement-free design

When the abovementioned metabolic functions of organic storage are used, there are no additional costs for replacing storage equipment after its life expectancy has expired (normally every five years). Accordingly, the long-term file server operating costs are lower than for a system constructed and operated by the customer.

5) Comprehensive security measures

For each group registered in the customer's Active Directory, it is possible to control access to folders in the virtual volume (write, read, and access permissions). Moreover, when files are accessed, virus scans are performed in real time. If a virus is detected, it is automatically destroyed or quarantined.

6) Snapshots

Regular snapshots are generated once a day, so that if the service user inadvertently deletes or overwrites a file or folder, it can easily be recovered.

After the introduction of this service, we received the following feedback from company X.

- When we needed more storage space, we were able to increase the system capacity simply by contacting Fujitsu.
- We were released from the need to perform sporadic restore operations.
- We no longer have to manage equipment lifetimes or plan and implement the replacement of old equipment.
- When a fault occurs, Fujitsu not only contacts us to report the problem but also performs maintenance and recovery, so we don't need to do anything.
- Large Excel spreadsheets and PowerPoint presentations take longer to load than they used to.

The longer file load times (last feedback item) occurred as a result of the changeover from a 100-Mb/s local area network (LAN) to a 100-Mb/s wide area network (WAN). A characteristic of the SMB protocol[note 2)] used to access the file server is that the access performance decreases when access is via a WAN, which has higher latency than for LAN access[note 3)] even if the network bandwidth is the same. This characteristic was explained to the IT systems department of company X at the system proposal stage and simulated in Fujitsu's test environment before system introduction to evaluate the range of acceptable response times. Nevertheless, the slowdown was criticized by users. In the future, it should be possible to overcome this drawback of SMB now that SMB2.0[note 4), 4)] has been released.

4. Future prospects

In the future, we will promote our next-generation data center outsourcing services to a wider range of businesses and business fields.

note 2) SMB: Server Message Block. A protocol developed by Microsoft. Also known as Common Internet File System (CIFS).

note 3) Latency is 1 ms or less for a LAN and from 10 ms to several tens of milliseconds (depending on distance) for a WAN.

note 4) Compatible with Windows Server 2008 or Windows Vista and more recent versions of Windows.

In particular, we hope to play an active role in the market for new business systems where we can make the most of the system's characteristics in terms of speed, cost and flexibility. When customers set up new businesses, our system should be able to help them get started very quickly with a low level of risk and with minimal investment.

From October 2010, we are providing the "On-demand Virtual System Service", which is the foundation of Fujitsu's Cloud computing services, in Japan. Using Fujitsu's own advanced virtualization technology, we will enable customers to use the IT resources necessary for their businesses at the lowest cost.

For further details of our "On-demand Virtual System Service," please see the articles "Service-Oriented Platforms" and "Data Center Services for the Cloud Era" in this Special Issue.

5. Conclusion

Fujitsu is committed to the development of next-generation data center outsourcing services and will continue working to strengthen its conventional data center outsourcing services. As described in Section 3.1, we will respond to customers' needs that cannot be met with next-generation data center outsourcing services alone (such as scaling up the central processing unit performance). In the future, we will develop and provide hybrid data center outsourcing services that combine next-generation and conventional services in order to provide our customers with the best of both worlds.

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