

Realization of Next-generation ICT Infrastructure with UniflDone Campus Cloud

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These days, the information and communications technology (ICT) environments in universities such as the spread of students' smartphone usage have been significantly changing. Diversification of users and usage scenes leads not only to a change in the existing learning environments, but also to a disorganized increase and upsurge in ICT services provided by universities. As a result, an urgent issue now is to have effective ICT operations. "FUJITSU Education Solution UniflDone Campus Cloud" is a private cloud solution tailored to universities' operational characteristics. In this solution, the Infrastructure as a Service (IaaS) function, which performs flexible dispensing of a server environment, and the Desktop as a Service (DaaS) function, which allows a desktop environment to be used whenever it is required, are integrated and managed. The functions required by universities are added and then the solution is provided as integrated cloud infrastructure. This paper presents the problems with conventional private cloud products and VDI products when they are used in ICT operations at universities, and describes the features of FUJITSU Educational Solution UniflDone Campus Cloud that can overcome them.

1. Introduction

The recent changes in the information and communications technology (ICT) environment in society including the popularization of smart devices, increase in network speeds and expansion of cloud services and Facebook and other SNSs are bringing rapid changes to ICT environments in universities. Styles of use in university ICT environments are being diversified to include, for example, learning and research using mobile devices and tablets in various places on campus, "bring your own device" (BYOD) use by instructors and students, and provision of 24-hour services to accommodate use from home. The "University Reform Action Plan"⁽¹⁾ announced by the Ministry of Education, Culture, Sports, Science and Technology in June 2012 requires support for self-directed learning by students in addition to the strengthening of university governance, which necessitates a departure from the conventional learning environment. Meanwhile, the increasingly diversified ICT services at universities have led to a disorganized increase and upsurge in servers and client computers on campus, which has made improving the

efficiency of ICT operations an urgent issue. In order to meet the rapid changes in ICT environments at universities, it is considered necessary to consolidate the ICT infrastructure scattered on campus and establish a system infrastructure environment capable of promptly responding to a variety of demands.

With this situation in the background, Fujitsu has made use of the existing virtualization technology to develop "FUJITSU Education Solution UniflDone Campus Cloud" (hereafter "Campus Cloud"), a private cloud solution for universities. It is intended to allow for integrated and flexible management and utilization of IT resources according to the university's operational characteristics. This paper describes issues with conventional methods, the configuration and features of Campus Cloud together with the operations realized, and the goals of Campus Cloud.

2. Issues with conventional techniques

Private cloud environments at universities can be roughly classified into two types: Infrastructure as a Service (IaaS) applications that dispense a server

environment from a resource pool as required and Desktop as a Service (DaaS) applications that allow users to remotely access a client environment when required. For operations of an on-campus private cloud, we refer to the private cloud function, the former, as “on-campus IaaS” and the desktop virtualization function, the latter, as “on-campus DaaS”, thereby clearly defining the functions according to the purpose of use.

Private cloud products and Virtual Desktop Infrastructure (VDI) products for corporations and general enterprises have existed for some time and are now positively utilized by enterprises. Meanwhile, it has been found that, in some cases of private clouds of universities, which were introduced earlier, simply introducing conventional products as mentioned above is not sufficient to suit their operations. In particular, desktop virtualization operations by means of conventional VDI products do not perfectly suit the operations for universities in terms of use for classes or self-study. One reason is that what general enterprises demand of virtual desktop operations significantly differs from the things desired by universities.

Enterprises’ reasons for introducing VDI products include reinforcement of security, strengthening of governance and improvement of efficiency of operations and management. However, for education and research systems of universities, immediacy, diversity, shareability and resource efficiency are more desired. From the perspective of resource efficiency, for example, operations at enterprises generally involve one person using one virtual desktop. This is because all employees need to continuously occupy PCs for use during working hours. That is, “number of employees = number of virtual desktops.” At universities, however, PCs are not continuously used by all students, but are used only during classes or self-study; hence “number of students > number of virtual desktops.” Accordingly, for cost reasons, a smaller number of virtual desktops than the actual number of students are used in operations in reality. This makes it necessary to have a system that can allow limited resources to be effectively used according to the operations of universities including classes. In terms of aspects other than the number of virtual PCs, the following are requirements for desktop virtualization at universities because of the difference in their operational characteristics compared with corporate use.

- 1) Ability to give the highest priority to classroom use
- 2) Provision of an environment offering anytime, anywhere availability
- 3) Ease of use
- 4) Ability to immediately change to the next user
- 5) Ability to offer diverse environments according to the purpose of use, such as a higher-specification environment for research purposes

Attempting to realize these with conventional VDI products alone makes it difficult for a user to fully enjoy the benefits of virtualization. For example, in order to ensure that students can use virtual desktops during their class, a one-to-one association between the classroom PCs and virtual desktops is necessary. This assures that the individual student can use a specific virtual desktop in the classroom at the time of the class, and the students can use them for certain. However, this association between a classroom and virtual desktops prohibits them from being used outside the classroom outside the class hours, resulting in restrictions to anytime, anywhere availability, which is the biggest benefit of desktop virtualization.

In an on-campus IaaS environment, there are some operational applications unique to universities such as limited-time loan of server resources and server construction exercises in classes. These are requirements that cannot be fulfilled by conventional private cloud products intended for general enterprises.

3. Basic configuration

In order to overcome the issues with conventional methods, we have used conventional VDI products and private cloud products as the basis to develop Campus Cloud as a private cloud solution for universities with the addition of functions in view of operations unique to universities.

The basic configuration includes VMware vSphere, which has a proven track record with regards to its stability, and it is used as the virtualization platform. As described earlier, Campus Cloud has the on-campus DaaS and IaaS functions separately provided and offers a Web interface common to students and instructors who use the solution (**Figure 1**). The on-campus DaaS function is realized by linking with VMware Horizon View and the on-campus IaaS function by linking with VMware vCloud Suite. Internally, VMware Horizon View

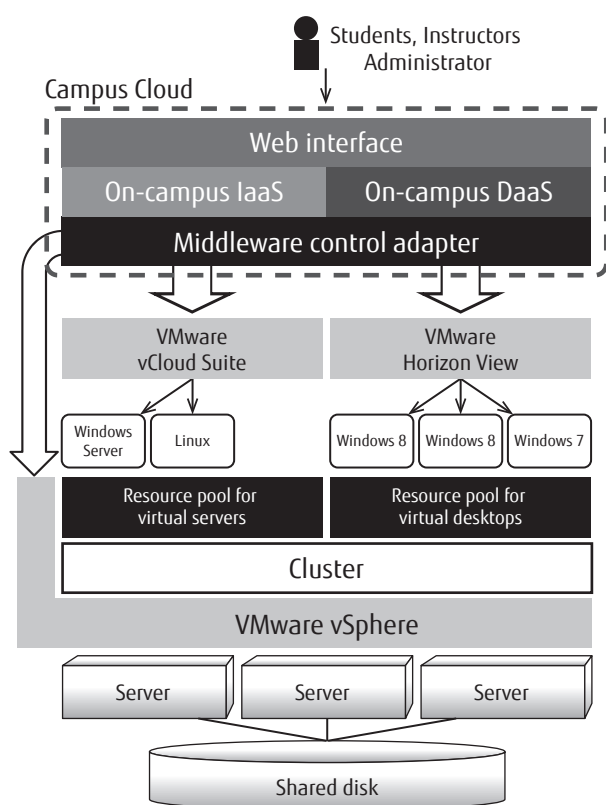


Figure 1
Basic configuration of Campus Cloud.

and VMware vCloud Suite are controlled from the middleware control adapter of Campus Cloud by using REST APIs, etc. Moreover, some of the operations originally performed by the system administrator are automated, thereby allowing on-demand use by end users. The three reasons why VMware products have been adopted as the middleware of this solution are:

- 1) Virtualization using VMware vSphere has already become widespread in various departments within universities.
- 2) Full-scale operational performance has started becoming possible as VDI products in the education and research field of universities in Japan.
- 3) Resource pools used by virtual desktops and virtual servers respectively can be created on the same hardware cluster and the user can flexibly switch between resource pools.

This solution has a module configuration with the processing dependent on and independent of the middleware separated as much as possible. This makes it possible to minimize the amount of development

required for future linking with other middleware, which is another feature.

4. Features and operations realized

4.1 Features of Campus Cloud

Here we explain three features of Campus Cloud.

One is the scheduling function, which incorporates the concept of “class,” an operation characteristic of universities. It can automatically switch between users who are allowed use the system, the virtual desktops to be used and virtual servers according to the class hours. It also includes a reservation function for efficiently using limited ICT resources. The second feature is the function to control resources including a limitation on sources of connection to virtual desktops and limitation on the types of template PCs available and simultaneous use. Third, there is a function to aid system management. For example, the system administrator can acquire connection source information on virtual desktops and check the status of occupancy of virtual desktops.

4.2 Operations realized

The following operations can be realized by introducing Campus Cloud.

- 1) Open use of virtual desktops outside class hours

By reserving a class in advance, virtual desktops can be kept for students only during the class hour. For users, one benefit is that they can be freely used outside the class hours, which allows them to use the virtual desktop environment from anywhere for the purpose of self-study without having to go to the classroom. There are other merits such as accessibility from various devices including tablets and availability of the same desktop environment as in the class for self-study at home. This operation makes the most of the benefits of conventional VDI products. Benefits for the administrator include an expected reduction of the total operation costs to approximately 75% of the conventional method, achieved by efficiently operating ICT resources in ways such as improving the desktop utilization rate, and a decrease in the number of expensive software licenses required.

- 2) Desktop switching for individual classes

In a class, a uniform environment must be prepared for every student taking it. One significant difference from existing image-delivery-based client

systems is that a physical terminal and a virtual desktop can be completely separated. Accordingly, flexible and diverse desktop environments independent of the model of the source physical terminal or type of its operating system (OS) can be offered to users. This also makes it possible to flexibly add classroom terminals after the start of operation (e.g., adding hardware over periods that span two fiscal years), which was difficult in the past. In addition, different template images for different classes can be instantly switched between during a recess. This can be realized by having virtual desktops on standby by the time a class starts, based on an advance class reservation.

3) Group exercise outside PC classroom

In the past, holding a class that uses PCs always required a PC classroom to be prepared in advance. However, incorporating the reservation function of Campus Cloud into operations allows universities to flexibly provide classes and group exercises through the use of special applications offered by the university, regardless of the place.

4) Use for server construction exercises in class

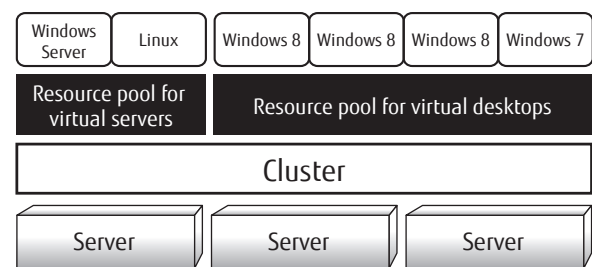
In information processing training at universities, exercises that require consoles or administrator rights such as server installation or construction exercises may be given in classes. In the past, servers needed to be physically prepared for each exercise or, even if they were virtually realized, a great deal of work was required for cumbersome preparations. Introducing Campus Cloud makes it possible to automatically allocate in advance the number of servers required for a class, and show the connection information and administrator password required for the installation exercise for each student on the Web browser beforehand. In this way, server construction exercises, which were difficult in terms of preparations and ensured use of devices, can be carried out relatively easily.

5) Optimization of ICT resources of university overall

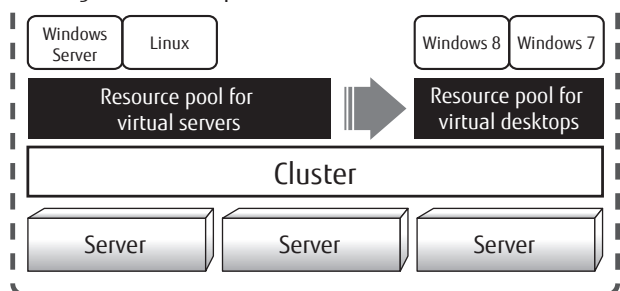
Compared with general enterprises, the rate at which universities carry out ICT operations greatly varies depending on the time of year or time period. Such on-demand use, or use on an as-needed basis, in ICT can generally be effectively handled by using the public cloud technology. In operations for universities, however, there are many unique requirements as described earlier and universities' own customizations, and hence general public clouds are unsuitable. In education and

research systems, for example, the utilization rate of desktops, in particular, tends to decrease over a relatively long period at times such as during the summer vacation. In the past, classrooms were often closed during long vacations and, as a result, hundreds or tens of hundreds of terminals, which are ICT resources, remained unused and redundant. In the Campus Cloud configuration, terminal resources are virtualized and integrated into the servers, which allows ICT resources to be flexibly used. That is, resource pools used for virtual desktops and virtual servers respectively can be located on the same hardware and same cluster in an integrated fashion and allocation can be flexibly changed (Figure 2). For example, the resources can be

■ At course opening



Change of resource pool



■ During long vacation

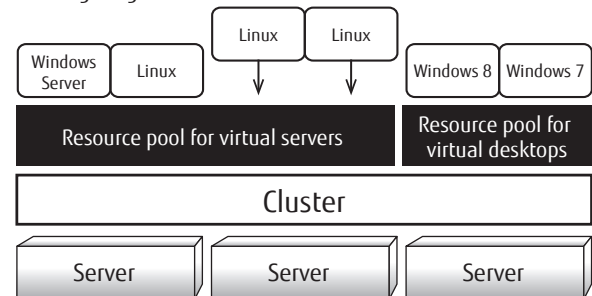


Figure 2
Flexible allocation of ICT resources.

applied to high-volume batch processing for large-scale computation servers during the summer vacation, when use of desktops significantly decreases, or use of virtual desktops for self-study can be limited before a Web course in order to apply the resources to the course server. In this way, the ICT resources of a university as a whole can be effectively utilized and optimized.

5. Goals of Campus Cloud

Campus Cloud is intended to provide a private cloud environment optimized for universities based on three concepts:

- 1) Optimization of on-campus ICT resources
- 2) Provision of learning environment that can be easily used anytime, anywhere
- 3) Realization of on-campus cloud environment that matches operations for universities

We believe that, from the perspective of university management, these can provide values including improved student satisfaction by enhancing student services, in addition to reduction of total cost of ownership. To the information processing department responsible for ICT operation and management, values such as a shift to planning work for providing better services by improving efficiency and simplifying operations can be offered.

In the future, it is thought that university education will undergo an educational reform with the focus

on learning outcome, and the time for active learning (self-study) will increase.

In that situation, with Campus Cloud we aim to offer an environment that allows students, who are end users, to learn by using their own familiar terminals or to study by themselves in comfortable places without having to go to the classroom, encourage students' self-directed learning and provide functions that contribute to "ensuring and improving the quality of education."

6. Conclusion

This paper has described a private cloud solution for universities that has been developed and offered by Fujitsu according to universities' operational characteristics. In the future, university ICT environments are expected to become further diversified. Therefore, it is necessary to have more efficient on-campus ICT management and flexibly deal with changes in the diversified environments. With this product, Fujitsu intends to extend functions in the future in order to offer a next-generation ICT environment.

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