Cloud Computing Technologies

Cloud computing, Load balancer, Virtualization, NoSQL database, Security

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Abstract

We developed a cloud computing platform which allows access by users, and collects and memorizes large volumes of data. The main enabling technologies are the NoSQL database, virtualization, load distribution, and security. This cloud computing platform realized scalability, security and redundancy. Such features are the initial design concepts for this development.

This platform provides access by cloud service applications. When our company decides to expand our business as a SaaS-type cloud computing service provider, the base system will be able to develop software to enable easy system access of applications.

1. Preface

With the current evolution of Internet, ICT technologies, and the improvement of better communication infrastructures, computer usage is changing from a user "on-premise" to an on-demand "cloud computing" through the Internet.

Meidensha Corporation ("MEIDEN") has been actively engaged in the service business that utilizes the Internet, including remote monitoring of photovoltaic and wind power systems, and an Application Service Provider (ASP). We have also been working on the business of cloud services. In the future, it will be necessary to offer more advanced services with high added values, and not simply provide Internet-based services. For this purpose, it became necessary to build a platform in order to produce new service innovations and allow secondary use of data more easily.

The main purpose of this development is to develop a platform for the collection and storage of large volumes of data in order to provide the afore-mentioned high values and develop a platform with (1) scalability, (2) redundancy (non-stop), and (3) security.

This paper introduces the SaaS type cloud computing platform in consideration of redundancy, security, and expandability.

2. Outlined of the Cloud Computing Platform

Fig. 1 shows an overall diagram of the cloud computing platform. The cloud computing platform is composed of the following elements.

2.1 User Side

This shows the section of cloud computing services access. It comes with desktop PCs, smart phones, PC tablets, etc.

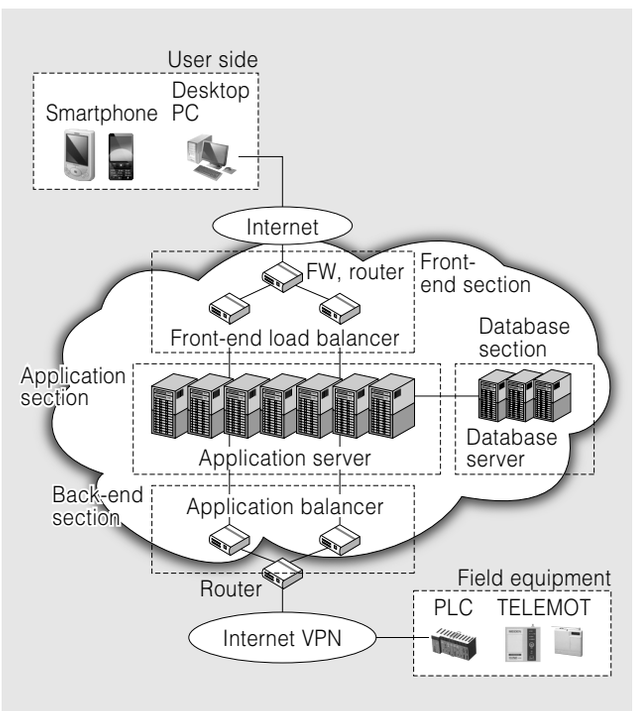

Fig. 1 Overall Diagram of the Cloud Computing Platform
It shows the configuration of internal units and the functional architecture in the cloud computing system.

2.2 Front-End Section

This is a front-end processing, a bridge to link the external client and the cloud-computing system. It consists of a firewall server, a load balancer, and a Web server.

2.3 Application Section

This section shows the part of the system where it accepts the transmission data of the access requests from clients and processes it according to the accepted

data. Applying the virtualization technology, there are many virtual machines for applications to provide a variety of services.

2.4 Database Section

The database adopts a MongoDB classified in the NoSQL database on the basis of document-oriented schema-less data. Since the data type is in BSON format, its compact data is compatible with JavaScript.

2.5 Back-End Section

This section shows the section relaying information between on-site equipment and the applications. To increase availability, a multiplexing system is adopted.

2.6 On-Site Device

An on-site device is connected to the cloud computing system through a wide-area Ethernet Virtual Private Network (VPN). The anticipated on-site device is a wireless telemetering unit TELEMOT, or one like it.

3. Features of Our Cloud Computing System

This system has been developed based on the design concepts of "scalability" (system can be expanded easily in data store area,) "redundancy (non-stop)" (system services will not be confined even while the system fault event), and "security" (safe access to the system, data exchange, and storage). The required techniques to attain the aforementioned goals are introduced below:

3.1 User Side

Most recently, technology users have access to many kinds of display devices such as desktop PCs, PC laptops, smart phones, and tablet PCs. As such, our cloud computing system focuses on Web browser-based services to provide service content independent of the type of device and different operating systems.

When using the HTML5, it can provide various Human Machine Interfaces (HMIs) such as multi-touch screen operation like pinch or flick in the browser.

In addition, under HTML5 it is easy to add and install functions like geography information, speech recognition, video playback, as well as others from the HTML5 software library. For this reason, it is possible to create various multimedia contents.

3.2 Front-End Section

Fig. 2 shows the functions of the front-end section. The firewall has a system to deny access from any unnecessary client access by limiting an access port by the white list method (which only allows the access by the preset items). Security is increased by using, coding communication and user authentication by using Hypertext Transfer Protocol over Secure socket layer (HTTPS).

For the load balancer, layer7 balancing (distribution of workloads across application layer) is carried out so that it can manage the URL or cookies. . The Front-End Section is designed to avoid a bottleneck of the system by off-loading the SSL processing with the

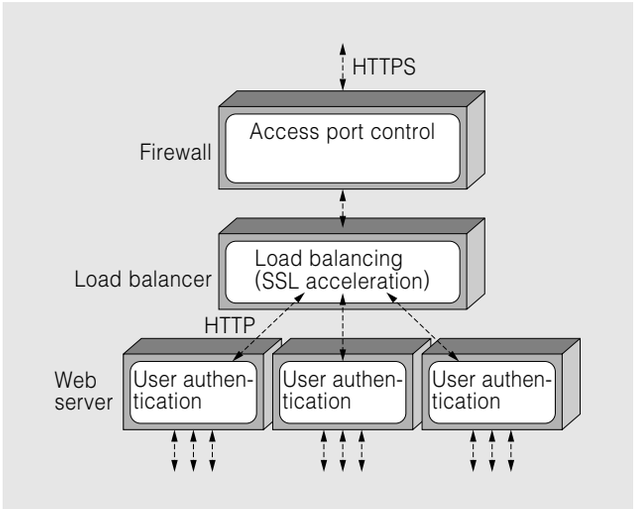

Fig. 2 Functions of the Front-End Section
Device allocation and configuration of the Front-end section are shown.

Web server. By the effect of SSL acceleration it is possible to code and compound data.

By the redundancy through multi-connect Internet, it is possible to continue offering services even though one network connection may break down.

For the Web server, instead of a multi-process type Apache or Tomcat, we adopted the Node.js which works under a single process. The Node.js has a high real-time response by desynchronizing I/O processing that becomes a major cause of process delay. Resources are effectively used even at a time when simultaneous connection requests from clients increase. Therefore, there is no C10K challenge (a problem of server failure due to too many processes and threads, even when there is no problem in hardware performance). In addition, the Node.js also has another feature: Server-side programming.

3.3 Application Section

Fig. 3 shows the functions of the application section. Using virtualization technologies, we may add or remove the device modules easily and quickly. This improves the scalability (redundancy) of the application processing performance.

As a distinctive feature of our cloud computing platform, the application section comes a with redundancy function. Generally, when virtualization technologies are used, it allows an install of an active/active or active/standby type of fail-over function (redundancy function) for the virtual machine. However, this is basically a function which becomes effective during a hardware fault or a heartbeat network error. Therefore, to establish a mission-critical (non-stop) system, it has to address all possible faults such as virtual machine faults and application faults. To solve these problems under our cloud computing platform architecture, we multiplex a virtual machine and make it assess a virtual machine fault by using the load balancer of the front-

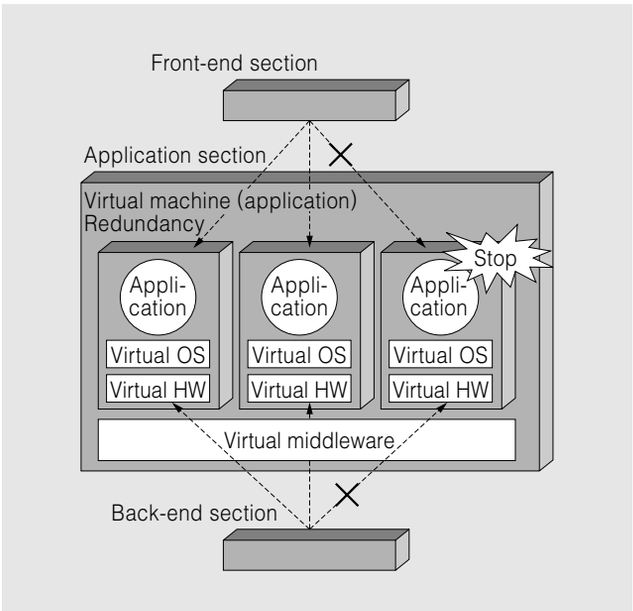

Fig. 3 Functions of the Application Section
Functional architecture of the application section and a redundancy image are shown.

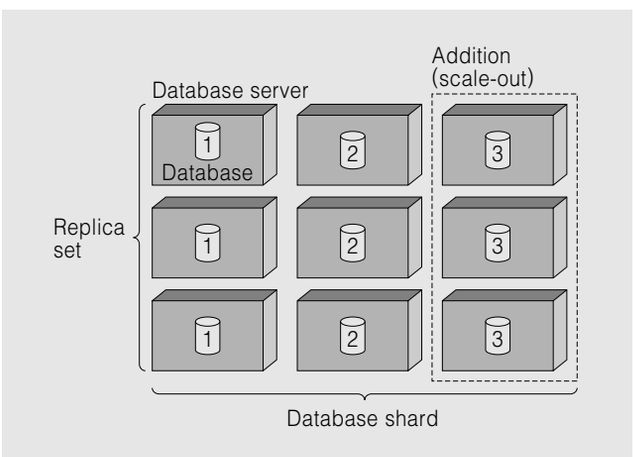

Fig. 4 Functions of the Database Section
An image of DB availability (replica set) and scalability (database shard) is shown.

end section and the application balancer of the back-end section. It can then distribute the workload into common virtual machines and applications.

3.4 Database Section

Fig. 4 shows the functions of the database section. The MongoDB has a concept of index, table, etc. It has many similar features as the RDBMS. Some typical functions are database shards and replica sets and these functions are used in this cloud computing platform. Each function is introduced below:

(1) Sharding

Sharding is a function to store data in such a manner that the database is distributed to multiple physical servers. Each application can gain access to the target data without regard to the distributed data positions. Thanks to the function of the database shard, it realizes the database scale-out and load distribution.

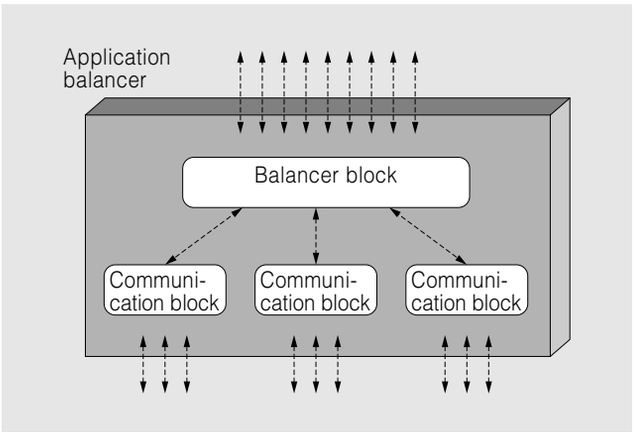

Fig. 5 Functions of the Back-End Section
Functional configuration of the back-end section and a data flow are shown.

Table 1 Each Section and its Key Units and Function List
It shows the key system units and related functions in a list in building our cloud computing platform.

Section	Key items	Functions
User side	・Desktop PC ・Smartphone ・Tablet PC	・HTML5-based browser screen display
Front-end section	・Firewall ・Load balancer ・Multi-homing unit ・Web server	・Connection port control ・Load balancing ・Multi-homing ・Coding communication ・Authentication
Application section	・Application server ・Virtual machine	・Virtual machine redundancy
Database section	・Database server	・Load dispersion by sharding ・Data backup by replica set and automatic fail-over
Back-end section	・Application balancer	・Data distribution and transfer by the define method such as round-robin, etc.

(2) Replica set

This is an automatic data backup function. It is possible to manage multiple faults by building the database system using three or more units. During the fault event, it can switch to another server as a master unit by using the automatic fail-over function whereby another server is able to automatically recover.

3.5 Back-End Section

Fig. 5 shows the functions of the back-end section. The back-end section is composed of the communication block directly communicating with the on-site equipment and the balancer block transferring the data to the application section.

The communication block can connect to a variety of on-site intelligent devices by installing programs to each on-site device.

The balancer block is used to transfer data from the communication block to the application section. For data distribution, a general round-robin is adopted. In addition, there is a function to transmit data to two or more destinations. The data distribution system is

designed to be scalable by plug-in. We can realize the balancing in response to application services depending on the load distribution and the fastest response requirements.

4. Postscript

This paper introduced our newly developed SaaS type of cloud computing platform with due consideration of redundancy, security, and scalability. Table 1 shows each section and its key units and function list.

Going forward, we will promote the business development of cloud computing services based on our cloud platform. Our first business focus will be the service of remote monitoring and surveillance systems.