Chapter 2
Main Components of Cloud Computing

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ABSTRACT

Cloud-era Information Technology (IT) contains three main themes: The information hub (cloud), network communications (pipes), and intelligent terminals. In this chapter, the developmental stages of these three main components of cloud computing are discussed, with emphasis on future development. The Internet of things is also examined, which is expected to thrive as a direct result of the development of cloud computing.

CLOUD ERA INFORMATION HUB

The information hub occupies the center position. Its fundamental tasks are to construct the cloud storage and computing systems, and complete the cloud era tasks of ultra-large scale and ultra-high complexity.

Originally referring to the main part of the human nervous system, the so-called hub or nerve center has the following major functions: stores and processes information, produces a variety of mental activities, and controls all aspects of the human behavior. In the personal computer (PC) and the internet age, a computer can be the information hub of a person or an enterprise that realizes information storage and computing functions. In the cloud computing era, cloud computing data centers are to replace personal computers, and become the new information hub that lowers costs and improves on the efficiency, in satisfying the human demands for massive information storage, computing and security.

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Microsoft's Senior Vice President Yaqin Zhang has pointed out: "Cloud computing is the engine and the nervous center for the next generation of the Internet, Internet of Things and mobile Internet." It is very true, that cloud computing is, in essence, the central nervous system of the cloud era. Presently, this fact has been mainly reflected in the cloud data centers. Various kinds of cloud terminals are connected through the various communication networks, to interact with the end users as well as the physical world. In this sense, the relationship between the "cloud" and the "terminals" may be compared with that of the spirit and matters, or the soul and bodies.

In the coming years, the world is to be populated with tens of billions of network-enabled devices, billions of network users, and countless cloud applications and services. It is not difficult to foresee that in this cloud era, there is not going to be a lack of devices and end users, nor applications and services. However, a smart "nerve center" that can resolve highly complex tasks is going to be in high demand. The development of cloud computing is not to be limited to commercial activities, nor is it going to be a simple update of the IT application model. Instead, the cloud computing development is likely to be a contest and competition, between the various cloud era nerve centers.

Computing System Based on the Conventional Architecture

Of human invention, a computer is a tool used mainly for the purpose of information processing. If other man-made tools are considered extensions of the human limbs, then a computer can be considered an extension of the human brain.

Although quite different from the modern day computers, the first computer has already possessed the basic components of a modern computer: the arithmetic unit, controller and memory. Modern computers are based on either the von Neumann architecture, first proposed in 1945 by von Neumann (Neumann, 1958), and also known as the Princeton architecture, or the Harvard architecture. The von Neumann computer architecture has the following basic components: a memory, a controller, an arithmetic unit, input and output devices. The computer systems designed to take advantage of this principle are collectively referred as the von Neumann machines. One other computer architecture is the Harvard architecture. Its basic characteristics are similar to the von Neumann architecture. The difference is that the storage of program instructions and data are separate. Most of the CPU processors are based on the von Neumann architecture: a representative example is the Intel (Intel) x86 microprocessor (Yang, 2011).

With the von Neumann architecture, one can achieve simplicity and low cost. However, when running at high speeds, simultaneous instruction and operand fetches are not possible with this architecture, thus a performance bottleneck exists for data transmission. On the other hand, the most representative examples that use the Harvard architecture bus technology are DSP and ARM. With the Harvard bus architecture, program space and data space are separate inside the chip, which allows simultaneous instruction and operand fetches, thus greatly increasing computing power. However the Harvard architecture is more complicated in that it requires high processing power and high-speed connections for its peripheral devices, and also it is unsuitable for external memory expansion. Modern processors have unified the two architectures with the help of CACHE storage.

For the PC, that is in essence designed based on the von Neumann or the Harvard architecture, their patterns of behavior can be called: "independent hardware and independent software to constitute a usable system," i.e., serial processing CPU hardware and onion-like layered software. The system functionality is limited to a single application software, and the system size is limited to a single piece of hardware.

Traditional hardware and software systems that are primarily designed for stand-alone ma-