Future Directions in Cloud Computing and the Influence on Networks

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1. Preface

In 2005, Jeffery Dean and Sanjay Ghemawat presented a paper on MapReduce, a programming model for processing large data sets. In 2006, Amazon launched its Elastic Compute Cloud (EC2) service, and Eric Schmidt of Google first put forward the cloud computing concept. In 2009, some consulting companies projected that adopting cloud computing would be the best IT strategy. Today, it is generally recognized that cloud computing will be a service provision mode in the future. A lot of technologies’ service models are emerging to cater to the use of cloud computing and to propel its development. A key issue is how to transform cloud computing from concept to practice based on the basic network structure.

2. Future directions of cloud computing

Direction 1: Integrating resources, optimizing the information architecture, and migrating resources to cloud computing

In recent years, enterprises and governments have taken steps to integrate resources and optimize the information architecture. For example, IBM has combined more than 200 data centers into 12, and has used virtualized technology to reduce software license costs by 93%. This consolidation of its data centers and the optimization of its information architecture helped IBM earn US$4.1 billion in profits in 2011. Huawei is also optimizing its information architecture and promoting virtualization and desktop cloud technologies. Huawei has virtualized hundreds of the company’s servers, improving service reliability. In a Shanghai research center, Huawei has 10,000 cloud desktops in use. In Shenzhen, Beijing, and Xi’an, Huawei has also used cloud desktops on a large scale. The cloud desktops improve employees' work efficiency and reduce IT costs. Additionally, enterprises are migrating their information services to the cloud platform. For example, Amazon has been migrating its information services to a cloud platform since 2010. According to statistics collected by market research firm IDC, 80% of new commercial enterprise applications were deployed on cloud platforms in 2011 and 30% of enterprise IT budgets will be spent on cloud computing by 2014.

Influence: Resource integration and virtualization increase server density and use efficiency. Therefore, networks providing cloud computing must have high performance and port density.

Direction 2: Increasing service traffic volume

According to IDC, global information volume in 2011 reached 1.8ZB. By 2015, about 1.5 trillion terminals and 300 billion users around the world will access the Internet, and the IP traffic volume in global data centers will increase by 33% every year. The number of servers storing data will increase by a factor of 10 in the next 10 years, and the volume of data to be managed will increase by a factor of 50. By 2016, the data volume in global data centers will increase to 4.8ZB, which is three times the volume in 2012. This increase in information volume can be attributed to the
emergence of more smart terminals and the further development of Internet services – especially social, electronic business, and microblog websites. The information volume of enterprises continues to increase rapidly because enterprises are developing their own IT as well as the Internet of Things.

Most of this data is unstructured data, which means that enterprises have to strategize their resource allocation accordingly. Enterprises must develop cost-effective ways to maintain the data and find new ways to mine the data in order to extract useful information from it. For example, many banks use a cost-effective framework, such as the Hadoop architecture, to store and organize transaction data, business information, and other valuable information.

**Influence:** Faced with large amounts of useful data, enterprises are seeking cost-effective solutions with which to store, organize, and access this data. Hadoop may become a viable solution, but it requires high network bandwidth, a high degree of reliability, an appropriate cache size, and priority-based signal scheduling.

**Direction 3:** Upgrading GE servers to 10GE servers
In March 2012, Intel, which has a 70%–80% market share of X86 servers, launched the Romley platform that uses the E5 processor as the CPU. The Romley platform, developed for cloud computing, provides a complete solution that includes the processor, chipset, motherboard, and peripheral devices. This platform uses modular 10GE LOM with low power consumption. The main board provides 10GBase-T ports, so the platform ensures high connectivity and a high I/O rate while also providing high processing capabilities. Servers have started to enter the 10GE era. IDC predicts that the number of 10GE ports will start to surpass the number of GE ports between 2012 and 2014. As 10GE servers are developed and come into the market, the computing capability and performance of cloud computing data centers will improve.

**Influence:** The Romley platform supports the development of high-end 10GE servers from the second half of 2012 or early 2013. It is predicted that Romley will provide the most 10GE ports in the industry in 2012, and the 40GE market share will exceed US$20 billion.

**Direction 4:** Open cloud computing
Open cloud computing has two aspects: open source and open platform. The most famous open cloud computing platform is OpenStack. Due to its scalability, this platform has attracted attention from a lot of IT companies, such as HP, Intel, and Dell, and the OpenStack forum already has 2,100 registered members from 144 companies. Dell and HP have launched OpenStack solutions, and in 2012, OpenStack will be widely used in private and public cloud networks.

In addition to participating in open cloud projects, cloud platform vendors provide their own platforms to partners. For example, when Amazon launched the EC2 solution, the company also opened the API to third parties. Recently, Amazon partnered with Eucalyptus to set up cloud networks, opening the API to help Eucalyptus provide more EC2 services. Another example is Microsoft, which opened its virtualized platform, Hypervisor, to partners who can use the platform to develop virtual switch and value-added services.

**Influence:** Every cloud vendor understands the important role of open cloud computing. Vendors want to participate in the cloud computing industry chain, find an appropriate role, and be competitive in providing cloud computing solutions.
3. Influence of cloud computing directions on networks

As outlined above, cloud computing influences networks in various ways. The essential benefits of cloud computing are low cost and high efficiency, so it is important that the network not be a bottleneck for cloud computing services.

As shown in the following figures, cloud computing services require more connections on a central network.

Before resource integration  After resource integration  Virtualization and cloud computing

Influence and requirements:

1. Network performance is improved.
   With increases in server density (or more specifically, service provisioning density), a widespread use of 10GE servers, and an increase in the use of virtualized servers, I/O efficiency also improves. Thus, network connection performance improves significantly.

2. Network O&M needs to be simplified.
   As the size and density of cloud computing data centers increase and more servers are virtualized, the difference between the number of physical servers and virtual servers becomes larger and larger. When virtual networks become larger, all these physical servers and virtual switches must be managed.

3. An open network is required.
   With the evolution of cloud computing, the cloud computing network also needs to be changed, especially the network connections between servers and storage devices. Server virtualization leads to the emergence of virtual networks, and the integration of server I/O leads to the emergence of integrated networks. A cost-effective cloud computing solution must combine networks with servers and services.

Considerations in future cloud computing structure

Cloud computing solutions are defined by several attributes, including high performance, ease of management, and open standards. Many vendors have put forward their ideas and solutions to cater to the changes and future directions of cloud computing. Two general approaches have been proposed:

1. A network is considered as a device, which consists of a main control board and multiple line cards. The network provides high-performance load balancing and a centralized management system. However, this solution is difficult to implement due to technical limitations.

2. The traditional network forwarding structure is totally changed and the network is opened to upper-layer services.
   Both of these solutions have drawbacks and make networks complex.
In an ideal cloud computing structure, the network should act as a black box that ensures non-blocking forwarding and in which communicating devices all see the same network performance. The network must have the following features:

1. Self-healing: The network ensures connectivity without the assistance of external systems.
2. Plug-and-play: A device can operate immediately after being installed on the network.

This network is a platform providing physical links. Additionally, the network should be a platform featuring two types of scalability:

1. Scalable performance: 10GE, 40GE, and 100GE servers can access the network.
2. Scalable services: The entire network may need to be upgraded when the IPv4 network is migrated to IPv6, and the services need to be seamlessly migrated during FCoE network integration.

The network must be open so that it can be compatible with the devices of different vendors to provide cloud computing solutions.

During the development of cloud computing, enterprises should consider how to integrate resources and migrate services to the cloud computing platform. In addition, they must consider how to reduce costs and improve work efficiency. To support cloud computing development, the network must have high performance, scalability, manageability, and openness. The network should be a non-blocking black box that supports plug-and-play and is easy to scale. Such a network can meet cloud computing service requirements.