

Review of New Data Center Network Structure

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Abstract—Nowadays, people's lives are increasingly inseparable from big data. The development of big data has a profound impact on human society. At the same time, the generation of massive data has promoted the transformation of data processing methods. In this development trend, cloud computing came into being. Cloud computing is to provide online cloud services to network users by building a large shared platform, so as to achieve on demand allocation of resources. Data centers are the core infrastructure of cloud computing. Therefore, the performance of the data center network determines the quality of service provided by cloud computing. However, traditional data center networks have long been unable to meet the needs of today's society for large data centers. This paper summarizes the new data center network structure proposed in recent years from the aspects of switch-centric, server-centric, wireless data center, wired and wireless combination, introduces its performance, fault tolerant routing efficiency and other advantages, and looks forward to the future development of data center network structure.

Keywords— Cloud computing, Network structure, Data center network (DCN)

I. INTRODUCTION

In the Internet era, due to the integration of information technology and human life, with the growth of massive data, data processing is developing towards a more professional, socialized and dynamic direction. In this case, cloud computing came into being. It is a kind of distributed computing, which enables users to access, calculate and store network resources on demand through the network[1-2].

- Virtualization technology. The most striking feature of cloud computing is that virtualization breaks the boundaries of time and space.
- Dynamic scalability. Cloud computing has powerful computing power. Adding cloud computing on the original basis can greatly improve the calculation speed, and ultimately achieve dynamic expansion virtualization to achieve the purpose of expanding applications.
- Deploy as needed. Users need powerful computing power to deploy resources to run different applications, and cloud computing platforms can quickly provision computing power and resources to meet user needs
- High flexibility. Cloud computing has a high degree of compatibility. It can not only be compatible with low-configuration machines and hardware products from different manufacturers, but also obtain higher-performance computing through peripheral devices.

- High reliability. If the server fails, it will not affect the normal operation of the calculation and application.
- High cost performance. Users no longer need to use those expensive, large storage host. You can choose cheap computers to form a cloud, reducing costs while taking into account good computing performance.

Data center just like a large data warehouse, which it can store large amounts of data for us to access, in order to meet the needs of people's daily processing. Today, the daily life of human beings is far from the data center this role. Every time we browse the Web, shop, or watch a video, the information is sent to our cell phones through the data center. In terms of the structure of the data center, It consists of different servers and network infrastructures. The server functions to collect data, and the network infrastructure enables services to be consumed, stored, or updated.

With the progress of the information age, the amount of social information grows exponentially. The storage, processing and forwarding of huge amount of information promote the rapid development of data center network. Traditional data center networks such as fat tree, snowflake structure, Bcube[10] and VL2[11] have been gradually eliminated. The new wired data center network structure and wireless data center network structure as well as the possible rapid development of wired and wireless data center structure is now required.

II. STRUCTURE

According to the proposed DCN topology, it can be divided into switch-centric DCN structure, server-centric DCN structure, wireless DCN structure and wired and wireless DCN structure. This article will introduce the new DCN structure from these four aspects.

A. Design of Data Center Network

1) Switch-centric data center

In the data center with switch as the core, the switch undertakes the network connection and routing forwarding of the whole data center, so the requirement for the switch is higher. As our data center expands, we need more switches to join us. Tree topology is a typical switch - centric data center structure. The typical topology is composed of three layer switches, which are access layer switch, convergence layer switch and core layer switch. Facts have proved that the tree structure has been unable to adapt to the development of the

current data. Common tree structures include Fat-tree[12], VL2[11], ElasticTree[13], and others.

2) Data center with server as the core

In the server-centered data center network, the server not only undertakes the task of data calculation and storage, but also participates in the data forwarding in the network together with the switch. A basic characteristic of this kind of network structure is that the server uses two or more network ports to participate in the interconnection of networks. Currently, the new server-centric data center network architecture includes MDCent[4], FleCube[5], Can-circle[6].

MDCent[4] is based on BCube[10] structure for inter-module server interconnection, and adopts generalized hypercube structure to serve as the basic topology structure. A large number of unused uplink ports in the module are used to build the interconnection structure between modules, and each module keeps a constant degree. Let the level of inter-module interconnection structure BCube be k , and the number of ports used by switches be n , then the number of inter-module switches is $(k+1)n^k$. Each MDCent $_{k-2}$ node in the MDCent $_{k-1}$ structure is replaced with MDCent $_{k-1}$, and the connection relationship between the original nodes is replaced with the corresponding relationship between the new node MDCent $_{k-1}$, then MDCent $_k$ can be obtained. The scale of MDCent structure is not limited by the uplink port within the module, and it is continuously expanded, with high bandwidth between adjacent modules. The bifurcated bandwidth is closely related to the degree of the module and has nothing to do with the network scale, but the diameters between modules are relatively large. As shown in Figure 1, schematic for the MDcent structure.

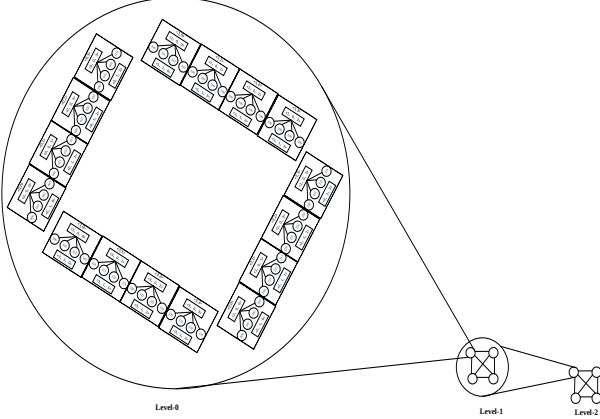


Figure 1. MDcent structure

FleCube[5] is an architecture for flexible connectivity on multi-port servers that do not use any switches. FleCube is constructed recursively by using complete graph based on multi-port partition of server. FleCube makes the data center network has the advantages of flexible scale, small diameter, large bisect wide width and small bottleneck. The topology of the Flecube network is defined recursively on the port grouping of multi-port servers. In this structure, the Flecube in the higher layer is composed of several Flecube in the lower layer which are completely interconnected. We use n to represent the number of ports on a multi-port server. We use n to represent the

number of ports on a multi-port server. Using $\{k_1, k_2, \dots, k_r\}$ to represent a group with length r of n ports of a server, the $k_i > 0$ ($i \in [1, r]$) represents the number of ports in group i . We use FleCube $_i$ to denote a Tier i Flecube network, f_i to denote the number of FleCube $_i$ networks contained in a FleCube $_i$, and SI to denote the number of servers contained in a FleCube $_i$. Flecube structure has good design flexibility and scale expansibility, which can meet the demand of large scale DCN for short path length and large split bandwidth. The complete interconnection of the lower layer network gives the FleCube network greater connectivity, and there are a lot of parallel paths between any two servers. In Fig. 2, there are 5 FleCube $_1$ s interconnected into a complete graph in the FleCube $_2$.

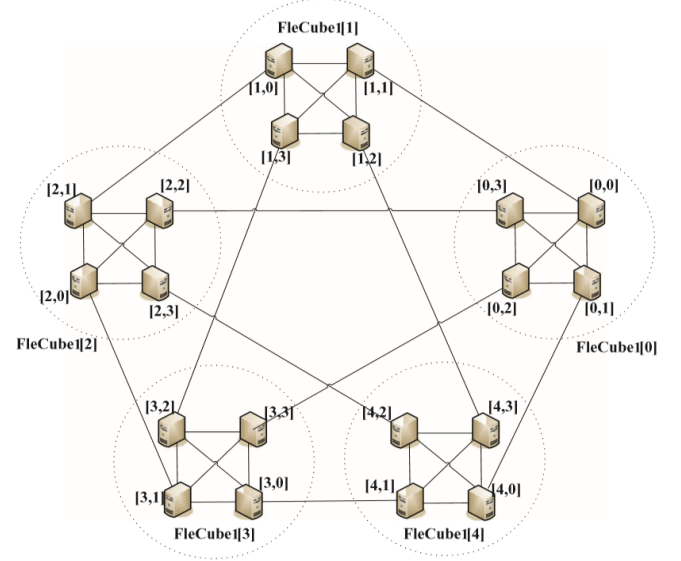


Figure 2. FleCube $_2$ on division $\{3, 1\}$ of 4-port server.

CAN-Circle [6] is a network topology based on direct interconnection of two - port servers. If there are N host nodes (personal host, server of data center and cloud host, etc.), they are connected to the transmission and communication media respectively, forming a circular basic unit structure. Several virtual machines are installed inside each host node. Bridging mode is used between the virtual machine and the host, so that the virtual machine and the host are in a peer position in the same network segment and can communicate directly with the external network. In order to make more efficient use of system resources and increase the efficiency of computing virtualization, multiple Docker containers can be installed under each virtual system. As shown in the figure 3, the CAN-Circle model composed of 6 nodes and its corresponding topological node relationship. As shown in Figure 3, can model and the corresponding diagram of CAN-Circle network structure.

3) Wireless data center network architecture

ExCCC-DCN[7] is a data center network designed based on ExCCC network. It inherits the features of ExCCC structure, such as low cost, low energy consumption, large data throughput and strong scalability. During the wireless transformation

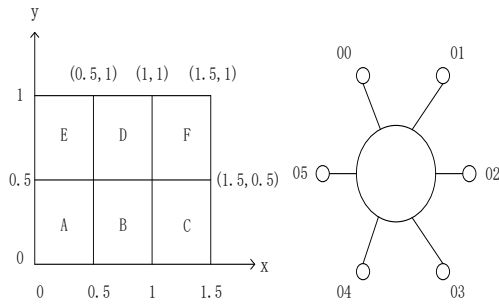


Figure 3. CAN model and the corresponding diagram of CAN-Circle network structure.

of EXCCC-DCN, it is considered to remove all the original switches and wired links in the network and only keep the top switch inside each rack to connect the server and the top antenna inside the rack. According to the structure of the Ex equal width will be divided into several equal network unit, and then at the top of the frame of each network units shall, in accordance with the 3D level beam informs technology set up three different height of the horn antenna used for sending and receiving 60GHz millimeter wave, and each antenna can according to need to adjust the angle in 3D space of communication. As shown in the figure 4 , the network unit of wireless ExCCC-DCN.

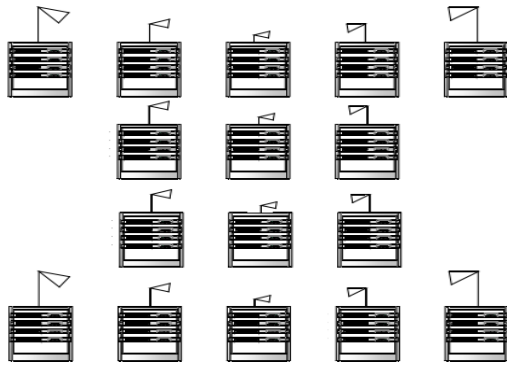


Figure 4. The network unit of wireless ExCCC-DCN

Comb[8] is a new wireless data center network topology. The topology, which is a large network and built by combining several basic network units. Because the complete network architecture is very similar to comb, so it is named Comb structure. The Comb model is a model of a multilayered honeycomb structure that consists of a single layer of celllike structure interlaced. Comb model is a model of a multilayered honeycomb structure that consists of a single layer of celllike structures interlaced. The structure increases the number of antennas on the wireless transceiver and deploys the structure on different planes. In this way, the occurrence of signal blocking can be greatly reduced, the routing path can be shortened, and the network connectivity can be increased. As shown in the figure 5 , 4*4 Cabinet array.

4) Wired wireless hybrid data center network architecture

Diamond[8] is a new hybrid wired and wireless network architecture that guarantees wireless high availability and efficiency, and provide a high performance data center network tra-

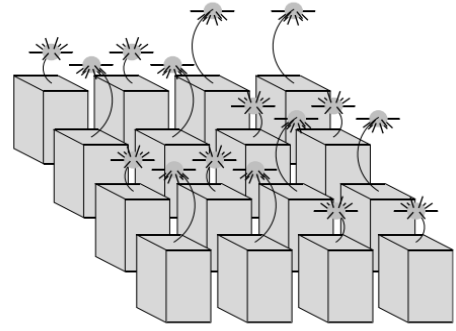


Figure 5. 4*4 Cabinet array

nsmission. Compared with the rack-top wireless deployment scheme in traditional wireless mechanism, this paper proposes to deploy additional wireless network card on the server instead of limiting wireless device to the rack-top. In order to avoid the interference between the dense wireless devices in the horizontal two dimensional plane a number of Ring Reflection Spaces (RSS) are proposed to make the wireless devices sparsely distributed in the whole three-dimensional Space. In each RSS, a novel multiple reflection technique is proposed to solve the blocking problem of establishing wireless links. Based on the above design, there will be no requirement or change to the space above the rack, which is more suitable for actual deployment. The topology design of Diamond aims at building large scale and parallel wireless transmission links with high performance. The wireless link and wired link in the network are separated from each other in terms of their respective transmission functions, so that they complement each other in transmission and realize complementary advantages. Firstly, a circular basic structure is constructed, which can realize efficient pure wireless transmission within the ring by using multiple reflection technology. Furthermore, a stable wired link is used to solve the transmission problem between different ring structures. As shown in the figure 6 , Diamond structure diagram.

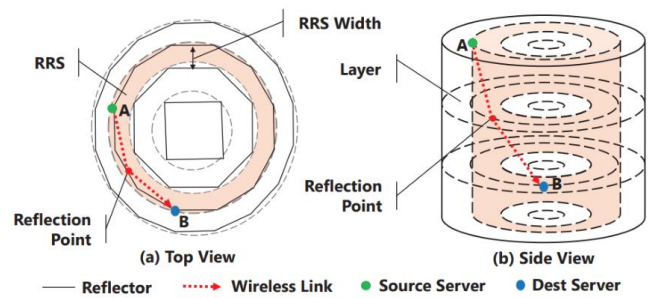


Figure 6. Diamond structure diagram

VBNet[9] is a hybrid DCN architecture based on VLC visible light technology. It use Bcube as a wired DCN, Bcube is a server-centric data center, and has extended it. By connecting all servers through VLC according to the interconnection rules, the seamless integration of wired and wireless hybrid VBNet is realized. By using VLC, the server is connected into a small-world structure to construct a more scalable topology. VLC reduces the average path length and

greatly improves network performance. As shown in the figure 7, VBNet hybrid network structure.

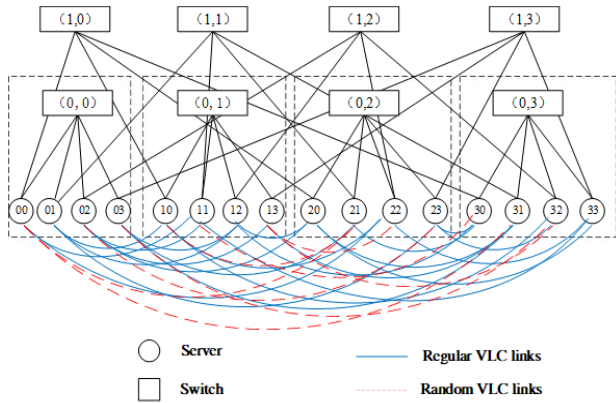


Figure 7. VBNet hybrid network structure

III. CONCLUSION

With the continuous development of social informatization, various services and applications under the cloud computing platform are migrated to the data center, and the requirements for the data center network structure will also be higher. The data center scale will be larger and larger, so the data center network structure will also continue to develop and progress[14]. In my opinion, the traditional wired data center is faced with such problems as difficult deployment and complicated wiring, and the wireless data center network and the combination of wired and wireless data center network will become the main research direction in the future.[15-16] However, at present, the signal transmission of wireless data center is realized by directional horn antenna, and the rotation delay of horn antenna is a part of the information transmission delay, as well as the signal occlusion and the distance limit of signal transmission. Solving these problems has become the key to the development of wireless data center network.

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