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Design of Data Center Network Architecture for Cloud Computing in Forestry Information

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Abstract:

Cloud Computing Oriented Data Center network architecture in forestry information is one of the key technologies of intelligent manufacturing data center. Data center network in forestry information is a new research hotspot driven by the actual needs of the industry under the condition of cloud computing. It has a very broad research prospect and is of great significance to the development of information technology. This paper summarizes the main research results of data center network, and summarizes the methods of constructing large-scale network. At the same time, this paper analyzes the server centric data center network and switch centric data center network, as well as the construction method of container based data center network, which is very popular at present. In order to solve the problem of whether the cloud computing carrying entity data center network structure is compatible with the cloud computing system, according to the characteristics of cloud computing data center and cloud computing data center network, this paper discusses the requirements of cloud computing technology for data center network and the corresponding key technologies step by step.

***Keywords**: Data center, forestry information, cloud computing bearer entity, network structure, intelligent manufacturing data center*

I. INTRODUCTION

With the rapid development of IT technology, data center has experienced the process from storage, processing, application to operation server in the process of developing from mainframe system to large data center in just 50 years, and has become the most important part of IT system [1-2]. The definition of data center in Wikipedia is: data center is a set of complex facilities, which includes not only computers, systems, communication networks and storage systems, but also environmental control, monitoring and security equipment. Data center is the

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product of industrialization and information integration, and the core of the information system of government and various industries. The most important function of traditional data center is to provide IT infrastructure and application server for enterprises or institutions. Its design and rigid IT architecture based on it resources make it face serious difficulties and challenges [3].

The structure of the data center network determines the selection criteria of the underlying hardware devices, the cooperation and interconnection between these devices, and the running quality of the upper application. The typical applications of data center, such as GFS, HDFS, BigTable, dynamo, Dryad, etc., are realized by parallel and distributed communication between a large number of servers through the data center network [4-5]. The connection mode of the network connecting servers, that is, the routing of communication data between servers, fault tolerance and congestion control, determines the performance of the upper application, including response time, throughput and so on. These performances determine the satisfaction of user experience and the maximum profit of network service operators.

Data center is the core of information system, and data center network is the key network of data center operation. In recent years, the research on key technologies and problems in data center network has never stopped in academia and industry, and has become a hot issue in the field of cloud computing infrastructure [6].

II. DATA CENTER NETWORK FOR CLOUD COMPUTING

2.1 Development and status of cloud computing

According to the definition of the National Standards and Technology Organization (NIST), cloud computing is a computing method in which users can access the shared computing resource pool (network, server, storage and service, etc.) quickly and anytime, anywhere on demand by using the Internet. Users use terminal equipment to access the Internet to access the "cloud" service, and the "cloud" here is equivalent to a power plant, which only provides computing resources instead of electricity. From this we can see that cloud computing has the following characteristics: (1) Access to cloud computing is based on the Internet. Today, when the Internet is so developed, the rise of cloud computing is also the demand for the development of IT technology. (2) Unified management of resources and information. Resource information is stored, managed and processed in the cloud computing data center, which is convenient for maintenance. (3) Providing information with service as the center, users only need to access cloud computing resources as needed, just like public services such as electricity. Ubiquitous access enables users to access cloud computing through the Internet anytime and anywhere by using various devices, such as PC, tablet and smart phone [7-9].

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Cloud computing is a revolution in science and technology industry. Since it was proposed in 2006, it has been based on IT industry with rapid development. World famous IT companies all take cloud computing as their core strategy. IT companies such as Google, Microsoft and IBM have successively launched their own cloud computing infrastructure and services, and achieved good results and social impact. Google has an exclusive cloud computing platform. This platform first served Google's most important search application, and now it has been extended to other applications. Its cloud computing infrastructure includes four relatively independent and closely linked systems: distributed file system (GFS), distributed computing model (MapReduce), distributed lock mechanism (chubyy) and distributed storage system (BigTable). At the same time, IBM also launched the "blue cloud" computing platform. The platform combines software and hardware, and uses Internet technology on the enterprise platform, which makes the data center use the computing environment similar to the Internet. The cloud computing platform proposed by Amazon is called elastic computing cloud. Amazon is also the first company to provide remote computing platform services. Amazon builds the elastic computing cloud on its own internal large-scale cluster computing platform, and users access and operate various application services on the cloud computing platform through the network interface of the elastic computing cloud.

The rapid development of cloud computing applications leads to the surge of traffic in the data center. As the hardware foundation of cloud computing and data center, the research and optimization of data center network has become one of the research hotspots in the data center [10]. Data center network is mainly divided into two levels: Data Center inter rack network and data center intra rack network. Inter rack network refers to the network connecting top of rack (TOR) switch. Top of rack switch is the electrical packet switch connecting servers in the edge layer of data center network, as shown in Figure 1.

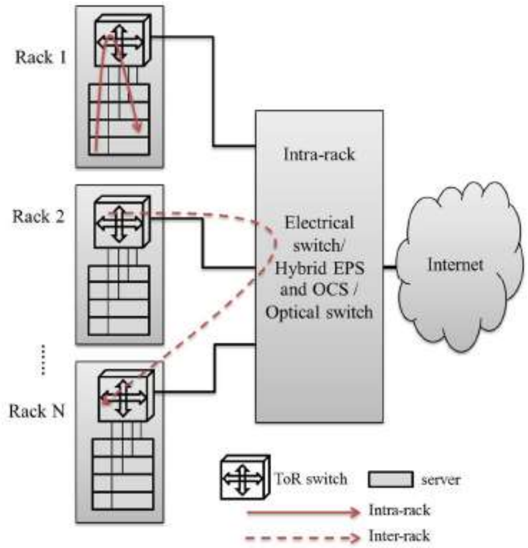

Fig 1: Data center network topology

2.2 Data center inter rack network

Most of the traditional electrical interconnection data center networks are constructed by commercial Ethernet electrical switches based on electrical packet switching. The traditional electrical interconnection data center network adopts a typical hierarchical tree structure, which is respectively composed of access layer top switch, convergence layer switch and core layer switch interconnection, as shown in Figure 2.

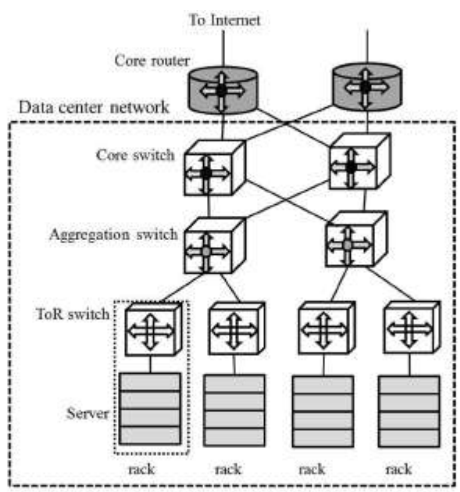

Fig 2: Traditional data center network hierarchy

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In the traditional data center network, the rack top switches are connected by 10Gbps links through convergence layer switches, and the core layer switches are connected by 10Gbps or 100Gbps links to convergence layer switches. The whole data center network is connected with the Internet through the core router. The network is simple, but there are many problems: (1) high energy consumption, because there are high energy consumption O/E and E/O converters in the switches at all levels, and the refrigeration equipment installed in the data center to ensure the normal operation of the network equipment is also high energy consumption equipment. (2) The links are complex, and the problem of single point failure inevitably exists. A large number of links also introduce the complexity of wiring and management, which limits the scalability of the network. (3) High delay. Data packets are forwarded from one server to the destination server through the access layer, convergence layer and core layer switches, and go through multiple store-and-forward processes, which leads to large delay. (4) The core switch at the top of the tree structure is easy to become a bandwidth bottleneck, and limits the scalability of the network. The access layer gathers the data traffic generated by the server to the convergence layer and then forwards it to the destination server through the core layer, which needs to forward a large number of traffic, which easily becomes the bandwidth bottleneck of the network.

Therefore, the traditional inter rack interconnection network can not be developed continuously to meet the performance requirements of high throughput, low delay and low energy consumption for emerging network applications, which has become the bottleneck of cloud computing data center development. Therefore, researchers at home and abroad have proposed an improved data center rack to frame electrical exchange network to overcome a series of problems.

III. NETWORK DESIGN OF OPTICAL INTERCONNECTION DATA CENTER

3.1 Introduction of key optical devices

Optical devices are the necessary devices to construct optical interconnection data center network. This section will introduce the physical mechanism and working principle of common optical devices used in the construction of optical interconnection data center network. The main optical devices used in modern optical network include: laser, optical detector, coupler, optical amplifier, optical switch, optical filter, multiplexer, demultiplexer, etc. But in the optical interconnection data center network, the functions of laser and optical detector are realized by optical transceivers. At the same time, due to the great difference between the data center network and the traditional telecommunication network, the network devices are also different. Therefore, this paper mainly introduces the main optical devices used in the optical interconnection data center network designed in this chapter, mainly including: optical

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transceiver, coupler, arrayed waveguide grating router.

Using the free spectral range (FSR) of AWGR and proper structural design, an n×n periodic AWGR supports K diffraction orders, that is, K groups of wavelengths are transmitted in the same routing transmission channel. Therefore, the small-scale AWGR of n×n can be equivalently extended to the AWGR of a large-scale port of kn×kn. Because the arrayed waveguide grating router AWGR composed of arrayed waveguide grating also has the characteristics of wavelength cycle routing, and AWGR can have multiple connection modes by selecting appropriate wavelength and free spectral range, it has been widely used in data center network to realize optical wavelength routing.

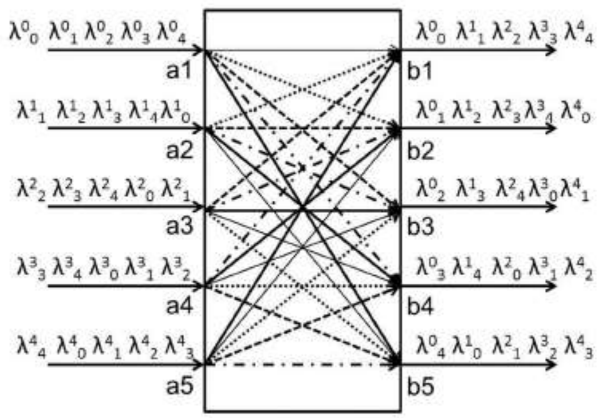

Fig 3: Schematic diagram of arrayed waveguide grating router

3.2 Design of inter rack optical interconnection network in data center

Software defined network (SDN) is a new open network architecture. Its predecessor was the ethane project in which Martin Casado, a Stanford doctoral student, participated. In the development of recent years, SDN has gradually formed a network structure with three layers of underlying physical hardware and virtual machine, software defined controller and top-level application. As shown in Figure 3.3, an example of software defined network structure is given. Various applications and advanced commands are located in the high-level application layer, the controller is located in the middle layer, and the data forwarding plane is located in the bottom layer. The middle layer controller communicates with the application layer through the North oriented application program interface (API), and communicates with the underlying data forwarding plane through the South oriented API. In software defined network, northbound API enables all kinds of applications and management systems to program the network. Due to the diversification of application layer applications, such as cloud computing system management and network virtualization solutions, no standardized northbound API interface has been released.

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Software defines that the optical interconnection network between data center racks is the network connecting the rack top switch. The traffic between servers in data center is usually dynamic and has burst. And the server in the same data center has frequent communication and large traffic due to its similarity or complementarity. The most suitable network for dealing with dynamic burst traffic is packet switching network, but it is a huge challenge to design the network based on optical packet switching without optical memory. Therefore, a new software definition optical interconnection network architecture between data center racks, which can provide high-speed packet switching capability, is proposed in this paper, namely Hybrid WDM routing and Ethernet (HWRE). The network structure is shown in Figure 4. Software defined Hybrid WDM routing and Ethernet architecture is characterized by the separation of network control plane and forwarding plane. The network data forwarding plane is composed of optical interconnection network and electrical switching network, that is, the top switch is composed of arrayed waveguide grating router awgr and Ethernet electrical packet switch. The optical network composed of arrayed waveguide grating router is responsible for transmitting long-term and large flow, while the Ethernet switching network is responsible for transmitting sudden small flow. Because 99% of the data streams in the data center are less than 100MB, 90% of the data streams are less than 1MB, and 90% of the data flows are concentrated in 1% of the data streams larger than 100MB, this traffic classification transmission can effectively improve the network utilization and efficiently complete the data flow scheduling.

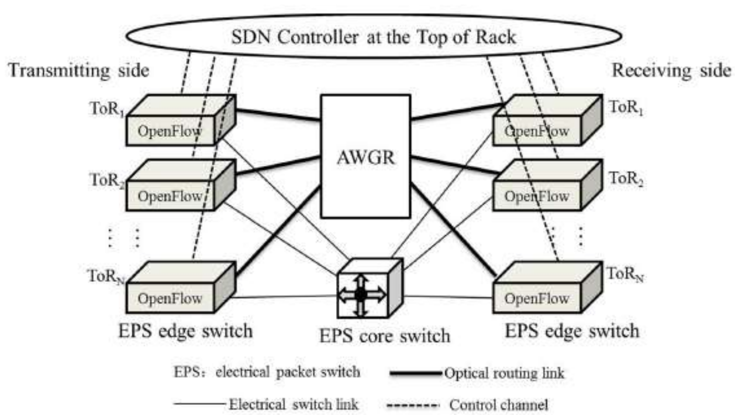

Fig 4: Data center inter-rack network HWRE

IV. PERFORMANCE ANALYSIS OF OPTICAL INTERCONNECTION DATA CENTER NETWORK

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4.1 Simulation results of inter rack network throughput and wavelength request blocking rate

The simulation results show that the network throughput and wavelength request blocking rate change with the network load. As shown in Fig. 5, the simulation results of wavelength request blocking rate of the three schemes under the parameter p = 0.5 (half of the number of fixed wavelength lasers and half of the number of wavelength tunable lasers) in scheme 2 are given. Figure 5 shows that the blocking rate of wavelength request increases with the increase of network load; With the increase of network load, the growth rate of wavelength request blocking rate of scheme 1 is the fastest, followed by scheme 2 hybrid fixed wavelength laser and wavelength tunable laser, and finally the growth rate of wavelength request blocking rate of scheme 3 multi wavelength light source is the slowest with the increase of network load. When the network load reaches 30%, the wavelength requests of scheme 1 start to block, while the blocking rate of scheme 2 and scheme 3 is zero. When the network load reaches 60%, the wavelength requests of scheme 2 and scheme 3 start to block, but the blocking rate of scheme 2 is higher. The main reason for this result is that the flexibility of all fixed wavelength laser in scheme 1 is poor, and there is wavelength waste. When the data on the rack block the wavelength request, it can not be tuned to other wavelengths for transmission. In scheme 2, a part of the wavelength tunable laser is used instead of a part of the fixed wavelength laser, which has certain flexibility, and can tune the blocked data of some wavelengths to other unoccupied wavelengths for transmission. Compared with scheme 1, the blocking rate is reduced. In scheme 3, the multi wavelength light source can generate a large number of precisely controllable wavelengths, and the data with wavelength request blocking can be tuned to other wavelengths for transmission, with the lowest blocking rate.

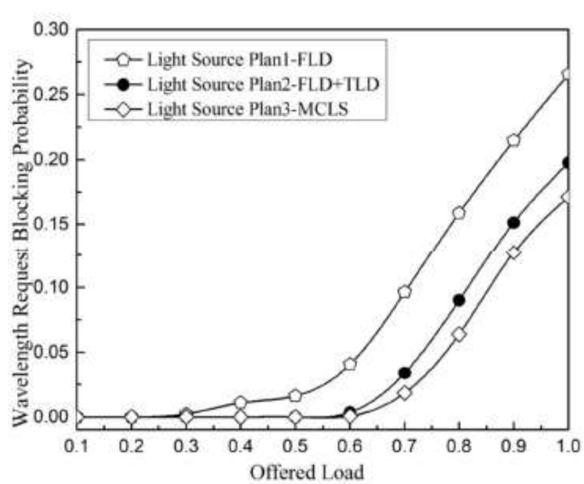

Fig 5: Comparison of wavelength request blocking rate of three light source schemes (P = 0.5)

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Scheme 2 is composed of hybrid fixed wavelength laser and wavelength tunable laser. The value of the ratio p of fixed wavelength laser represents the network flexibility between data center racks. The larger the value of P is, the less channels are available and the less flexible the network is. The smaller the value of P is, the more channels are available and the more flexible the network is. However, the cost of high network flexibility is the high cost and high energy consumption of the network. Therefore, while ensuring the network performance, properly adjusting the network flexibility, such as P = 0.3 or P = 0.5, can reduce the cost and energy consumption, and will not reduce the network performance.

4.2 Simulation results of in rack network throughput

The simulation results of network throughput with 20%, 50% and 80% traffic in the rack are shown in Figure 6. It can be seen from the figure that with the increase of network load, the network throughput in the rack also increases; When the network load reaches 0.8, the throughput reaches the maximum when the traffic in the rack accounts for 80%, and then the network is blocked; For the case of 20% and 50% of the flow in the rack, the throughput increases with the increase of the load, and there is no blocking.

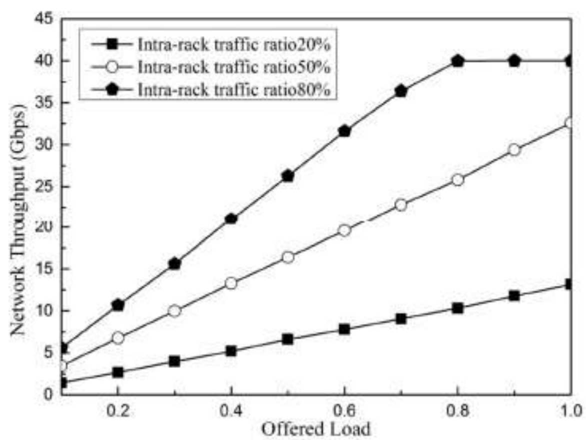

Fig 6: Network throughput of different traffic status in rack

Therefore, from the above results, it can be concluded that the optical interconnection rack in this paper can effectively realize data exchange in the campus data center and enterprise data center, and will not block. In the cloud computing data center, it will block only when it reaches high load (more than 0.8). The traditional top rack switch configuration of optical transceiver is 10Gbps, while the paper's in rack network configuration of optical transceiver is 40Gbps. The reason is that the network communication in the rack designed in this paper has only one

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wavelength, and the 10Gbps optical transceiver is difficult to meet the communication requirements of the network server in the rack.

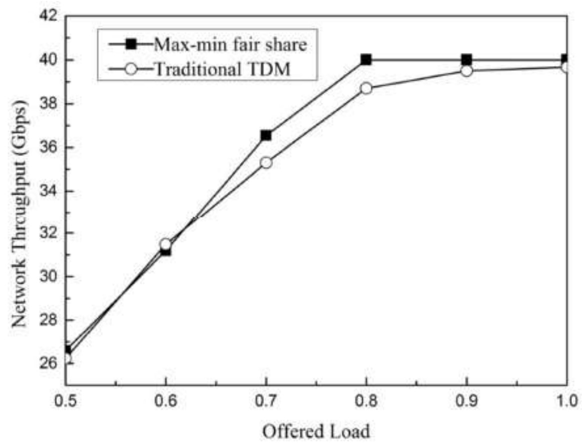

Fig 7: Comparison of network throughput between maximum minimum fairness time allocation and fixed time distribution

Figure 7 shows that the traffic in the rack accounts for 80%. At this time, when poirn is configured with 10Gbps optical transceiver, the network will be blocked when the load is 0.2, and the normal network communication cannot be guaranteed. When the 40Gbps optical transceiver is configured, the blocking starts when the load is 0.8. Therefore, it can be seen from the above results that the 40 Gbps optical transceiver of poirn in this paper can meet the communication requirements of servers in the rack.

V. CONCLUSION

Cloud computing uses the Internet to access the shared resource pool anytime, anywhere, on-demand and conveniently. Data center is the core platform and infrastructure for cloud computing to realize centralized processing, storage, transmission, exchange and management of information. Data center network is the network connecting large-scale servers to realize large-scale distributed computing. The existing data center network has the problems of high energy consumption, high delay, low capacity and complex control. In order to solve the problems existing in the data center network, this paper designs the data center network from the two levels of inter rack network and intra rack network.

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