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Cloud Computing Design of Data Center Network Architecture of Forestry Information System

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Abstract:

The data center network architecture of cloud computing is one of the data core systems of industrial Internet and intelligent manufacturing. In recent years, the related technology based on the Internet platform has made gratifying scientific research achievements. On the basis of expounding the characteristics of forestry management and the advantages of cloud computing, this paper constructs a forestry information service platform based on cloud computing. This paper also discusses the mode of forestry information service in cloud computing environment. This technology has been widely used in various fields of society, and has brought a huge development breakthrough for the computer industry. This paper analyzes and summarizes the way of cloud computing technology at this stage, aiming to help the staff of the computer industry to build a more perfect data center. Cloud computing can give full play to its powerful data processing advantages in the design of data center network architecture. This paper introduces the design principles of data center network architecture for cloud computing. This paper analyzes the design focus, hoping to further highlight the advantages of cloud computing in the design of data center network architecture.

Keywords: *Forestry information system, cloud computing, data center, architecture, data fusion,intelligent manufacturing.*

I. INTRODUCTION

With the rapid development of cloud computing, data center, as the underlying support platform, is facing more and more challenges [1-2]. The traditional data center network has some problems, such as poor scalability, low utilization of network equipment, high energy consumption and so on. Some new data center architecture, to a certain extent, solves some of

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the problems existing in the traditional data center network, but also brings new problems such as cost, wiring complexity, control difficulty and so on [3]. Due to the gradual maturity of optical devices, the introduction of optical interconnection technology into the design of data center architecture can bring many advantages.

Due to the great performance advantages of optical interconnection technology, such as high communication bandwidth, low average network delay, low energy consumption, all-optical interconnection data center has become a hot development direction for cloud computing data center in the future. Therefore, another research focus of this paper is to design a new all-optical interconnection data center network architecture, which can make full use of the advantages brought by optical switching, and has flexible scalability, and can meet the performance requirements of the data center in the current cloud computing environment [4-5]. At the same time, according to the characteristics of the proposed network architecture, a corresponding multi-path routing algorithm is designed to use multiple parallel paths in the network to achieve the balance of traffic and improve the network throughput.

Due to the large number of cloud computing data center equipment, the construction of hardware test platform will bring greater cost. As a tool to test the network performance, the software simulation platform has the characteristics of low cost, high efficiency and good credibility, which can reflect the performance of the real network to a certain extent. Therefore, building the corresponding software simulation platform is also the focus of this paper.

II. DATA CENTER NETWORK TECHNOLOGY FOR CLOUD COMPUTING

2.1 Optical interconnection technology of cloud computing data center

With the development of semiconductor technology and silicon optical integration technology, the volume of optical devices is smaller and smaller, the heat dissipation is strengthened, and the energy consumption is reduced. The performance of optical switching module shows obvious advantages. The following introduces some optical devices commonly used in data center optical interconnection and the corresponding optical switching technology.

Optical splitter and combiner [6]: optical splitter is used to separate optical signal from one optical fiber to two or more optical fibers. The optical synthesizer synthesizes the signals from two or more optical fibers into one optical fiber. Both of them are passive components.

Optical coupler: an optical combiner is a passive device used to combine or separate optical signals. It can support multiple input sources and outputs. For example, a 2×2 optical combiner can separate the optical signal from one of the input sources into two parts and output them to two output terminals respectively.

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Semiconductor optical amplifier (SOA): SOA is a kind of optical amplifier based on silicon p-n junction. Light is stimulated and amplified as it passes through the active region. The switching time of SOA is very fast, which can reach nanosecond level, and the energy consumption is also small.

Arrayed Waveguide Grating (AW G) switching technology: The standard AWG is composed of input waveguide, array waveguide, two slab waveguides and output waveguide, which is also a passive device [7-8]. It can be used as a demultiplexer or multiplexer. Arrayed Waveguide Grating Router (AWGR), which is constructed with multiple AWGs, has cyclic wavelength routing characteristic, that is, for a specific input port, optical signals with a specific wavelength will reach a specific output port after transmission. For example, if an AWGR with N×N input wavelength number W enters the I input port, it will reach the output port [(w+N-i) mod N]+1 (where i,w=1,2,...,N), which determines that AWGR is a non-blocking and non-competing switching structure. AWGR has the advantages of fast switching speed, low insertion loss, low energy consumption and high wavelength selectivity. Moreover, its switching speed only depends on the speed of wavelength conversion, and the switching time is in nanosecond and sub-nanosecond level. Using AWGR as switching equipment to build a data center network can greatly improve the performance of the network and reduce the overall energy consumption of the data center.

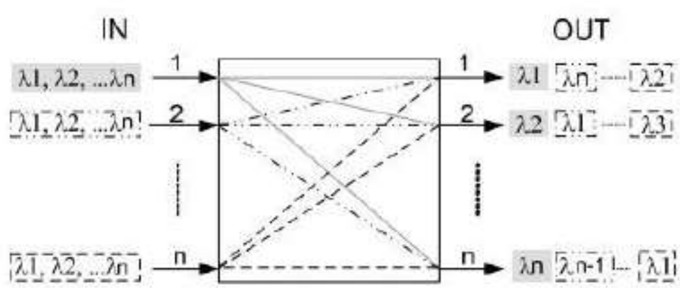

Fig 1: Schematic diagram of AWGR wavelength routing

2.2 Data center network architecture based on optical interconnection

(1) Optoelectronic hybrid data center architecture

Optoelectronic hybrid architecture includes both electrical switching network and optical switching equipment, which is compatible with the existing electrical interconnection architecture and takes advantage of the high bandwidth characteristics of optical switching technology. MEMS switch is generally used as the core switching equipment of optical network [9].

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In order to be compatible with the existing electrical interconnection network and cope with the high bandwidth communication request of the data center, researchers proposed C-through and Helios hybrid switching architecture. The main part of the C-through architecture is still the traditional tree structure. In order to increase the network bandwidth, an optical circuit switching network is added to each bottom shelf top switch, as shown in Figure 2. When high bandwidth requests appear in the data center network, routing is carried out through optical switching, so as to reduce the burden of the data center network. C-through uses a traffic management system to make decisions on bandwidth requests. Because the configuration time of MEMS switch is in millisecond level, some delay sensitive communication requests will be transmitted through traditional electrical network.

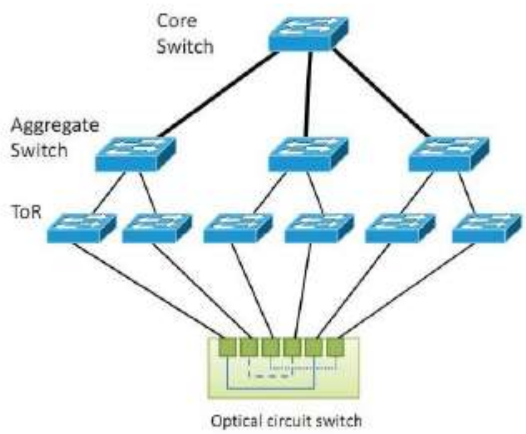

Fig 2: c-Through architecture

Helios architecture uses both electric packet switch and optical circuit switch to interconnect the pods of different server groups in the data center. Different from C-through, Helios uses optical circuit switch to replace some electric switches on the basis of the original network, and also uses wavelength division multiplexing technology [10]. The main advantage of Helios is that it is based on optical modules and optical transceivers widely used in optical communication network, so it can effectively reduce the construction cost and energy consumption of data center. At the same time, similar to C-through, Helios's optical switching network is based on MEMS switch, so its configuration time will reach several milliseconds, and service requests with high delay still need to be transmitted through the electric switching network.

(2) All optical interconnection data center network architecture

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Unlike mixed architectures such as Helios and c-Through, DOS is a centralized all-optical interconnection data center architecture. DOS architecture is mainly composed of a group of tag extractors and TWC, an AWGR, a control panel and a shared loop cache, as shown in Figure 3. When a node sends a packet to the switching architecture, the label extractor extracts the label of the packet and sends it to the controller. The label contains the destination address and packet length information. Then, the controller arbitrates the communication request, and the controller configures TWC to allocate the corresponding wavelength for the packets allowed to be sent so that the packets can reach the destination port after passing through AWGR. If the number of receivers corresponding to an output port is less than the number of nodes that need to send data to the port, conflicts will occur. Therefore, a shared SDRAM cache is used to temporarily store these conflicting packets. Simulation results show that DOS architecture can provide lower average network delay and higher throughput, and its average network delay is hardly affected by the number of servers accommodated in the network.

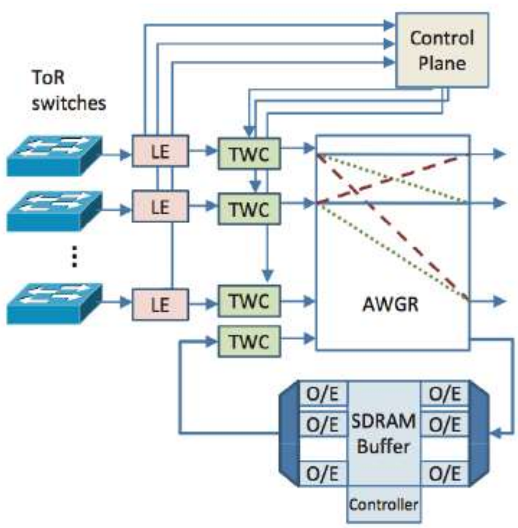

Fig 3: DOS architecture

III. DATA CENTER NETWORK ARCHITECTURE BASED ON PHOTOELECTRIC HYBRID

3.1 Topological structure of Cell-Tree

A concrete example of Cell-Tree(C) is shown in fig. 4. At first, an electric switch connects c servers to form the most basic cell structure. Then, the servers in C+ 1 cells are interconnected to form a cluster structure, and finally, C+1 such cluster structure forms the first layer of Cell-Tree. In the second layer of the Cell-Tree, C+1 AWGRs are used, and each awgr is connected to

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an electrical switch in each cluster of the first layer. In this way, all clusters are connected by C+ 1 AW GR. In the Cell-Tree, we modified the port connecting the electrical switch with AW GR, and added an electro-optical converter and an adjustable wavelength converter at the output port, which were used to convert electrical packets into optical signals and modulate them to specific wavelengths. After entering AWGR, optical signals can be directly forwarded to the corresponding output ports according to the wavelength routing characteristics of AWGR, thus reaching the cluster where the destination server is located.

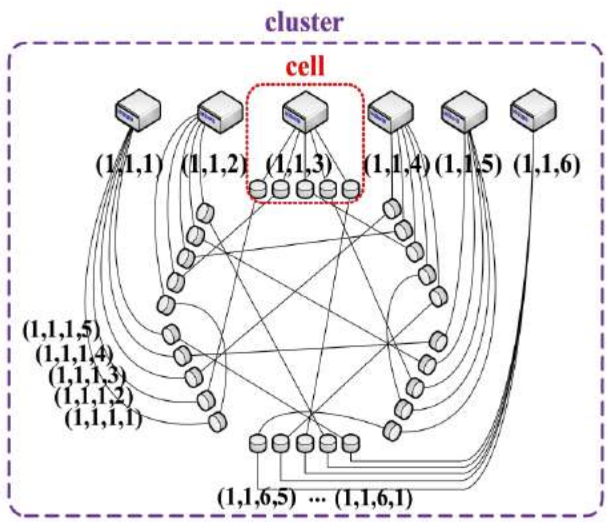

Fig 4: Schematic diagram of Cell-Tree(5) structure

3.2 Performance analysis of Cell-Tree

Network simulation has the characteristics of high efficiency, flexibility and low cost, because network simulation can easily and quickly model to realize the high simulation of the real environment, and can be modified at any time. For a variety of different schemes, network simulation can simulate the corresponding real scene. After simulation and comparison, the advantages and disadvantages of different networks can be analyzed.

After observing several cloud computing data centers, enterprise data centers and campus data centers, the researchers show that the distribution characteristics of communication traffic in different types of data centers are quite different. In the commercial cloud computing data centers running MapReduce and web services, nearly 75% of the traffic is local traffic (concentrated in the rack or cluster structure). In the enterprise data center and campus data center, at least 50% of the traffic is sent from the local server to the rack or cluster structure, that is to say, the local traffic and the traffic outside the rack each account for about half.

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According to the above analysis, we build the OPNET software network simulation platform based on cell tree topology. The simulation environment is set as follows: cell tree with C = 2 is used as the simulation object, and the bandwidth of the electric link is set as 10Gbps. Each WDM fiber between clusters contains three wavelength channels, and the bandwidth of each wavelength channel is set to 10Gbps. The generation time interval of each two packets follows a negative exponential distribution, and the packet length is 200 bytes and 1400 bytes respectively. In the uniform traffic mode, the destination address of each packet is a random value, and each server sends packets to other servers in the network with the same probability. In the local traffic mode, the servers send packets to the servers in the cluster with 50% and 75% probability respectively, and send packets to other servers with 50% and 25% probability respectively. Cell tree shortest path routing algorithm is used for routing selection.

IV. CLOUD COMPUTING DATA CENTER NETWORK ARCHITECTURE BASED ON ALL OPTICAL INTERCONNECTION

4.1 Topological structure of OIT

In recent years, with the development of cloud computing and various emerging online businesses, such as video streaming, online games, social networks, the network traffic shows an exponential growth trend. Most of these cloud computing or distributed computing services carried by data center are data intensive, and need frequent communication between servers. The requirement of interaction between servers brings higher requirements of communication bandwidth and network delay to the data center network. Although the technology of electrical switches / routers has been mature and easy to deploy, their performance growth rate is still behind that of optical interconnection technology.

Fig. 5 is a specific topological structure diagram of OIT(N, m). An OIT(N, m) structure contains N+ 1 clusters, each cluster consists of three layers, including N^2 server racks (each rack contains at most m servers) and 2N AWGR. Intra-cluster interconnection firstly uses the second layer AWGR to connect the adjacent server racks of the first layer, and then uses the third layer AWGR to connect the server racks of the first layer. Inter-cluster interconnection adopts the mode that the second layer AWGR is connected with the corresponding second layer AWGR, and the third layer AWGR is connected with the corresponding third layer AWGR to form a large-scale network. Specific topology construction rules are as follows. At first, we identify the devices in the network in the following ways: each server rack in the first layer of the cluster is represented by a triple (clusterid,layerid, rackid). Clusterid indicates the cluster number of the server rack, which increases from 1 to N+1 from left to right and from top to bottom. Layerid indicates the number of the layer where the equipment is located. Here, torackid is the number of the server rack, which increases from 1 to N^2 from left to right. The AWGR of the second

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layer is represented by triple (clusterid, layerid, awgrid). Clusterid indicates the number of the cluster where AWGR is located. similarly, it increases from 1 to N+1 in the order from left to right and from top to bottom. Layerid indicates the number of the layer where the device is located, which is set to 2 here. AWGRid is the number of awgr, which increases from 1 to n from left to right. The AWGR of the third layer is represented by triple (clusterid, layerid, awgrid). Clusterid indicates the number of the cluster where AWGR is located. similarly, it increases from 1 to N+1 in the order from left to right and from top to bottom. Layerid indicates the number of the layer where the device is located, which is set to 3 here. AWGRid is the number of awgr, which increases from 1 to N from left to right.

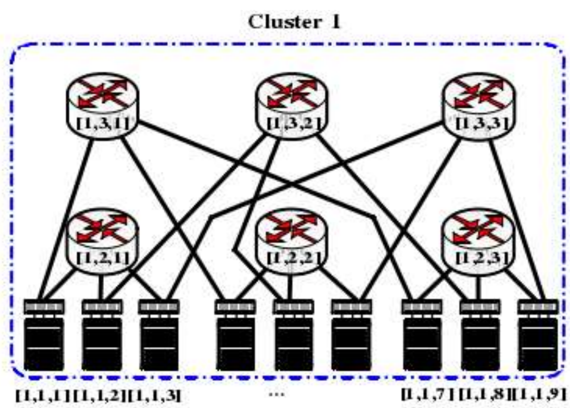

Fig 5: Schematic diagram of OIT(N, m) structure

4.2 Routing strategy of OIT

It can be seen from the topology of OTT that there can be multiple parallel links between different server racks. In order to make full use of the multipath characteristics between source nodes and destination nodes in OTT, we designed a multipath routing algorithm. For intra-cluster communication, for example, when server racks (1, 1, 1) communicate with server racks (1, 1, 8), packets can pass through AWGR(1, 3, 1), server racks (1, 1, 7), AWGR(1, 2, 3) and finally reach the destination server rack (1, 1, 8) It can also pass through AWGR(1, 2, 1), server racks (1, 1, 2), AWGR(1, 3,2), and finally reach the destination server rack (1, 1, 8). In the actual communication process, one of these two paths will be randomly selected. For inter-cluster communication, because the corresponding two-layer AWGR and three-layer AWGR between different clusters are connected by links, the server racks between different clusters also have multiple paths to meet the communication requirements. For example, server racks (1, 1, 1) communicate with server racks (4, 1, 1), and packets can pass through AWGR(1, 3, 1), server racks (1, 1, 7), AWGR (1, 2, 3), AWGR (4, 2, 1), and select the cluster of the second layer AWGR It is also possible to select the inter-cluster interconnection link of layer 3 AWGR through AWGR(1, 2, 1), server racks (1, 1, 3), AWGR(1, 3, 3) and AWGR(4, 3, 1), and finally reach the destination server rack ((4, 1, 1)), which will be randomly selected in the actual communication process

4.3 Theoretical analysis

With the development of cloud computing, the data center needs to support more and more business, and the scale of the data center is expanding. Therefore, it is required that the data center network has better scalability and can accommodate more server equipment. At the same time, the data center needs to provide higher throughput and lower average network delay to meet the business needs. The basic parameters of OIT are compared with some typical data center topologies, including the number of servers supported by the network, the network diameter (the maximum number of hops a packet passes from the source node to the destination node), the bisection width and the degree of server nodes. In which "b" represents the number of ports of switches in Bcube or Ficonn or DCell. "k" indicates the number of switch ports in fat tree. "d" indicates the number of layers in BCube or Ficonn or DCell. "s" indicates the total number of servers supported by the network.

Fat tree topology is a multi-root tree structure with high communication efficiency, which is improved from the traditional three-layer tree structure. Its split bandwidth increases with the expansion of network scale, and its fault-tolerant performance is good, so it can provide high-throughput transmission services for data centers, which is one of the mainstream topologies adopted by data centers at present.

BCube is a structure proposed by Microsoft Research Asia, which is mainly designed for modular data center container interconnection. It adopts commercial mini switches or routing equipment and multi-port servers, and has good scalability. BCube can provide a good guarantee for applications with high bandwidth requirements, and can provide high-speed services for various traffic modes. Moreover, for network failures, BCube can ensure that the overall performance of the network is not affected much.

Fat tree and BCube are commonly used structures with high scalability and good network performance in data centers. We compare OIT with them in terms of the number of servers supported. Compare the number of servers supported by fattree, BCube and OIT under the condition of using switches with the same number of ports. The horizontal axis is the number of ports of switches. The number of servers that a network can support is one of the important criteria to judge its scalability, and the network diameter is an important parameter to measure its network delay. Under the condition of using switches with the same number of ports, the network scale supported by OIT is close to that of the highly scalable modular data center network topology BCube (d=2), which is far greater than the number of servers supported by fat tree topology. The network diameter of OIT is maintained at a constant small value of 7, which is very close to the network diameter of fat tree 6. While the scalability of BCube is very good, and the number of servers supported by BCube increases rapidly with the increase of d, the network diameter of bcube will also increase at the speed of 2d with the increase of d. Based on the above, it can be seen that OIT maintains a low network diameter while maintaining high scalability, and achieves a good balance between these two parameters.

V. CONCLUSION

With the progress and development of communication, computing and storage technology, cloud computing, as a new computing model, has been widely used in only a few years. Cloud computing integrates physical resources such as communication, computing and storage, and provides them to users in a convenient and low-cost way. It enables users to live within their means and purchase effective and reliable resources on demand without having the corresponding underlying physical infrastructure. Cloud computing can flexibly adapt to a variety of business needs to ensure the quality of user service.

With the development of cloud computing business and application, data center is facing more and more challenges. The traditional data center network has some problems, such as poor scalability, low utilization of network equipment, high energy consumption and so on. Some new data center architecture, to a certain extent, solves some of the problems existing in the traditional data center network, but also brings new problems such as cost, wiring complexity, control difficulty and so on. Due to the gradual maturity of optical devices, the introduction of optical interconnection technology into the design of data center architecture can bring many advantages.

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