Research on DCN Traffic Scheduling Based on Private Cloud Platform

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Abstract. In the virtual switching of multi-tenant network under private cloud, the traffic load in peak period is too large to ensure the balance and bandwidth quality of service, while in the low period, the traffic load is too low to waste computing resources. Based on the current SDN, using Openflow to send traffic table to the data plane to realize dispatching and classifying the data flow according to the granularity of the data flow, and considering the factors such as QoS and resource utilization. This paper studies the hybrid scheduling strategy and priority based dynamic scheduling strategy to ensure the load balance and service quality in the peak period, in the low period, the utilization and throughput of computing resources are maintained.

Keywords: private cloud, DCN, traffic scheduling.

1. Preface
In recent years, with the rapid development of cloud computing, big data, the Internet of things and artificial intelligence, cloud computing as one of them is more and more widely recognized and welcomed by the people [1]. The infrastructure "data center" in cloud computing has also been focused by the industry [2]. The data center network (DCN) is the hub of building large-scale server cluster distributed computing, so the DCN has become a hot spot in this application. International and domestic network equipment manufacturers and cloud computing providers (Amazon, Ali, Tencent, Huawei) have built their own public cloud computing centers to provide flexible cloud computing services for all sectors of the society, and the data center network must be the focus of their attention [3]. However, the charging standards and methods of different resources in the public cloud make some small and medium-sized enterprises feel that they cannot meet their own needs very well, and they need to build their own pure hardware environment, so the private cloud also shows its advantages. But at the same time, the business in the private cloud will need to contact the public resources more or less, which makes the network of the private cloud also be concerned.

Many applications in an enterprise need a large number of servers running on their own private cloud for collaborative completion, and each physical machine in the server cluster also needs to communicate very frequently, so network performance becomes an important factor affecting enterprise applications in the data center [4]. For example, according to the statistics of technicians of a small e-commerce company, the number of visitors on the day of the 2018 "Shopping Festival" is about 200000 page view(pv), and the amount of data downloaded from each PV is about 60KB [5]. And according to the eight second law (when a user visits a website, if the waiting time for the page to open exceeds 8 seconds, more than 70% of the users will give up waiting), the response of the server to each visit cannot
exceed 8 seconds [6,7]. For this reason, if the communication delay between servers is greater than the
general meeting, it will have a great impact on the visited website, and then affect the purchase desire of
customers and transfer to visit other company sites. It has been calculated that every 100 millisecond
increase in communication delay will correspondingly reduce the business growth by 1%. In addition,
every half second increase in the response time of a single search in the user experience will reduce the
search volume by 20% [8].

It is recognized that the traffic scheduling method to ensure bandwidth generally has QoS
requirements for the minimum bandwidth between virtual machines, that is, sensitive application
requirements. When scheduling, we need to make the user application get better performance and
resource utilization in the low traffic period, while in the peak traffic period, we need to ensure that there
is the maximum delay to require QoS. In general, the sensitive flow is short flow (mouse flow), while the
long flow (elephant flow) of some nonsensitive flows accounts for more than half of the total flow.
Because of the TCP congestion control mechanism, the long flow occupies most of the space in the
bottleneck buffer pool, so the mixed scheduling is considered. The mixed scheduling also needs to
achieve the bandwidth QoS with the minimum bandwidth requirements without interference and impact
on the application, which is also the research content of this topic.

2. Related thoughts
Akyildiz et al [9] proposed SDN (Software Defined Network) mode, which is a new network architecture
based on network abstraction. It provides centralized management and programming interface for
distributed network by separating network control and data layer. Although it is convenient to optimize
the network performance by scheduling the information flow through the global network information
state of the SDN controller, the uneven distribution of non-uniform traffic in different path components
may lead to the decrease of network performance. Masoudi et al [10] proposed SDN analysis, which
enables users to define their own cost-effectiveness and application flexibility to meet the requirements
of application service system. However, due to the congestion of a small number of short traffic in the
peak period, most of the link interest rates are likely to be inadequate [11,12].

So at present, the private cloud still has the need and space to expand the traffic allocation, as well as
the need to provide network QoS while ensuring the computing and storage resources. It can be
predicted that in the future, service quality assurance and operation cost reduction for private cloud, and
resource efficiency will be the focus of consideration.

Build a virtual network model under multi-tenant, realize the seamless migration of virtual hosts of
tenants to the public cloud platform through point to point virtual link communication, so as to better
play the private cloud resources, connect data flow to the public cloud, and realize the two-layer
communication in the private cloud to the three-layer exchange. Generally, the traffic scheduling
method to ensure bandwidth has QoS requirements only for the minimum bandwidth between virtual
machines, that is, sensitive application requirements. When scheduling, it is necessary to achieve better
performance and resource utilization of user applications in the low traffic period, while in the peak
traffic period, it is necessary to ensure that there is a maximum delay requirement QoS [13,14]. In
general, the sensitive flow is short flow (mouse flow), while the long flow (elephant flow) of some
nonsensitive flows accounts for more than half of the total flow [15], and the long flow occupies most of
the space in the bottleneck buffer pool due to the TCP congestion control mechanism, so mixed
scheduling is considered. The hybrid scheduling also needs to achieve the bandwidth QoS with the
minimum bandwidth requirements without interference and impact on the application.

Various applications in the data center also have different requirements for the quality of network
performance, some of which require minimum low latency, some of which require minimum bandwidth,
some of which require dual requirements (i.e. the first two meet at the same time) [16]. In addition, the
data traffic generated by some applications is very explosive, so the prediction of traffic mode is not
fixed. When the applications in a specific period are competing for the network resources of the data
center, the problem of data flow scheduling is needed. For example, how to load the data traffic
3. Description of key ideas

In recent years, the academic and industrial circles pay more attention to the network traffic scheduling problem of data center. Throughout the relevant research of these traffic scheduling, either the scheduling method oriented to independent data flow or the scheduling method oriented to network flow group. For this reason, we also consider that scheduling technology can be described from two aspects:

3.1. Scheduling according to the load of the link

According to the burst of data center network traffic, it is easy to lead to extremely unbalanced load in the local link environment. If it cannot be adjusted in a short time, it will lead to link congestion. In the past, it was solved by increasing the link bandwidth and the network scale of data center, which is too single. According to the burst of data center network traffic, it is easy to lead to extremely unbalanced load in the local link environment. If it can't be adjusted in a short time, it will lead to link congestion. In the past, it was solved by increasing the link bandwidth and the network scale of the data center. This way is too simple to consider scheduling data traffic according to the load of the link, so as to avoid it; also consider splitting a complete link into multiple small flows, sharing these flows on a small granularity to avoid congestion. But at the same time, we need to consider the concurrent data flow generated by one task, which will cause the network traffic in the data center to increase abruptly on the second level granularity. When multiple tasks are running in parallel, we should pay attention to the delay and packet loss caused by the queuing phenomenon of the data flow transmitted in the network in the switch.

The current SDN technology has opened up new ideas in the field of Internet management, and also improved the flexibility of network technology in such aspects as load balancing, intrusion detection, etc. However, due to the congestion of a few short streams in concurrent requests, most of the links are not fully utilized, which leads to the blocking of data center network. As the processing speed of accessing computing resources and storage resources affects the application quality of service QoS, load balancing strategy can be considered to evenly divide the multi traffic paths, so that the network can process more data flows in a short time to cope with high concurrent traffic congestion. Using the forwarding rules of send in controller, we can consider to build a method based on the probability path selection of network flow and design a dynamic priority traffic scheduling strategy combining the specific characteristics of traffic, the current state of the link and the application requirements.

3.2. Optimization should also be considered from the application level

Considering that the traditional protocol cannot guarantee the transmission delay of a single data message, which results in the delay requirements of search and online real-time data applications in network applications and the differential scheduling of different business data flows, we can consider the research of independent data flow scheduling method for completion time optimization. At the same time, considering that big data analysis, machine learning and other applications will generate intermediate data on multiple nodes in the cluster, only when the intermediate data is collected can the entire distributed job be formed, which requires not only high network bandwidth support but also impact on other applications under the same flat network. We can reduce the average job completion time by considering the action level oriented logical aware scheduling strategy. In addition, it is noted that a job execution will generate multiple concurrent data streams. Therefore, from the application level, it is necessary to consider how to optimize the data stream to shorten the job completion time as much as possible, and at the same time, it is necessary to consider the dependency between each data stream.

The network deployment and management based on SDN architecture bring flexibility and creativity to network business, but the growing business requirements put forward higher requirements for the network equipment of open flow protocol. The validity and limitation of the traffic distribution storage space (referred to as "stream table space") can be optimized by cache mechanism, stream table structure
compression (or aggregation). In order to solve the problem of table space management, we need to expand the capacity of TCAM and increase the efficiency of linear query matching.

3.3. Several aspects to be noted

When we deploy the spatial optimization problem in the application, we also pay attention to the following aspects: (1) in the face of large-scale traffic, the performance requirements, large data volume, routability, scalability and other characteristics of the network restrict the development of SDN, and the optimization of the algorithm and the consideration of scheduling strategy also need to effectively reflect the needs of the actual business. (2) Considering the query efficiency and matching rate of flow table items, as well as the utilization rate of flow table space, as well as the control demand of fine-grained business flow, the flow table space should be optimized as much as possible, and the query efficiency and matching degree should be guaranteed at the same time. (3) Flow table rules ensure the storage of flow table space, and the storage security and table item consistency are related to the reliability of the whole network. The consideration of storage security in cache mechanism is also needed to deal with the allocation of management flow and resist network attacks.

4. Specific implementation

On the basis of previous scientific research, this project analyzes and deals with the key theories and technologies of the docker container cluster automatic arrangement system kubernetes (some referred to as k8s) based on the private cloud platform from the aspects of theoretical research, model building, key technologies, design algorithm and implementation system. The following technical schemes are adopted:

4.1. Take the application automation deployment system of k8s container arrangement system in the private cloud environment as the platform

In this project, the kubernetes cluster system platform is used as the cornerstone of cloud native application, relying on the physical environment constructed by 39 Huawei FusionServer1288HV5 servers, one ce8850-32cq-ei three-layer Huawei switch, two ce6880-24s4q2cq-ei three-layer switches, three groups of 42U server cabinets and several H3C switches. The k8s application platform is able to allocate and manage resources and corresponding application modes according to the project, and the application service management module is able to manage the application under the unified project. The application is standardized and rapidly deployed through the application management module of the platform, and the application is started, stopped, upgraded, rolled back or backed up in real time through the task management module, and the application is monitored and logged in real time Monitoring and troubleshooting.

4.2. Based on software defined network technology and traffic probability oriented scheduling strategy

In the private cloud environment, the link bandwidth utilization and throughput of data center network is the key part. Based on the software defined network architecture, the path is selected according to the traffic probability. According to the SDN controller, the network traffic is classified in advance. At the same time, the calculation of bandwidth usage of each data flow link under the comprehensive scheduling strategy is considered, while the reduction With less fragmentation, and aiming at the optimization of DCN traffic scheduling, we can achieve the goal of balancing progress and improving the link utilization, further develop the SDN network specification, separate the network control from the plane mode of data forwarding, improve the utilization rate of network resources and simplify the network management.

4.3. Use openflow protocol for reference to improve the storage mechanism of traffic table space

As a standard protocol of north south traffic communication commonly used in data center network, openflow provides a communication programming interface for the flat network under software defined network. It sends traffic meters to the data plane through openflow to realize routing and traffic...
scheduling functions. Combined with software and hardware aspects, it optimizes and compares the space of traffic meters, and improves the storage of traffic meters, capacity expansion, timeout management, accelerated matching and other mechanisms, research comprehensive scheduling strategies to achieve reasonable scheduling and ensure QoS, to achieve load balancing and quality of service in the peak period, and to maintain the utilization and throughput of computing resources in the low period.

5. Summary
Based on the research topic of DCN traffic scheduling in private cloud environment, this project explores the problem of network traffic scheduling in private data center at present, and studies the mixed scheduling strategy to ensure the load balance and service quality in the peak period, and maintain the utilization rate and throughput of computing resources in the low period.

At present, the application deployment of our university's digital campus is the virtual server deployment application in the central computer room of the Information Center (which is in the charge of the information department), which runs the public business within the university. Some of these businesses are allocated to each college for maintenance through the station group system, and the virtual resources are managed by the Information Center personnel in charge of the operation and maintenance, while the center personnel manage this some virtual resources also cost time and energy. The central computer room integrates the office and business of the whole school into the non-open source management platform of the central computer room server through the server virtualization technology. It can be considered to integrate into the research of this project to achieve the stages of data center automatic deployment and multi cloud deployment. In order to realize the automatic network deployment of cloud network linkage, we can consider the combination of software and hardware SDN, so the research of this project can also provide the interface and management realization for the digital campus integration private cloud service of our school, achieve the integration of server virtualization technology and cloud platform, and realize the integration and utilization of the whole school's computing and storage resources.

The research of this project not only has an important application value to the digital construction of our school, but also can be extended to the private cloud application of small and medium-sized enterprises. Through reasonable optimization of traffic communication between virtual machines, targeted scheduling of virtual machines can meet the purpose of reasonable resource utilization, better serve for small and medium-sized enterprises, and also build a win-win service for users to make full use of private cloud resources to promote the further development of cloud computing industry.

References