Design and deployment of an elastic network test-bed in IHEP data center based on SDN

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Abstract. High energy physics experiments produce huge amounts of raw data, while because of the sharing characteristics of the network resources, there is no guarantee of the available bandwidth for each experiment which may cause link congestion problems. On the other side, with the development of cloud computing technologies, IHEP have established a cloud platform based on OpenStack which can ensure the flexibility of the computing and storage resources, and more and more computing applications have been deployed on virtual machines established by OpenStack. However, under the traditional network architecture, network capability can’t be required elastically, which becomes the bottleneck of restricting the flexible application of cloud computing. In order to solve the above problems, we propose an elastic cloud data center network architecture based on SDN, and we also design a high performance controller cluster based on OpenDaylight. In the end, we present our current test results.

1. Introduction

In recent years, with the widespread application of cloud computing, OpenStack has become a mainstream IaaS platform. IHEP have established a cloud platform based on OpenStack which can ensure the flexibility of the computing and storage resources, and more and more computing applications have been moved to this platform. However, it can’t meet the demand of multi-tenant dynamic network: on one hand, the upper application can't perceive the current state of the network and can't control the same time, the tenant network is unable to realize the flexible expansion, neither the live migration of virtual machines can be achieved.

SDN provides a new method to solve these problems, while with a single controller, there will be single point failure, so there were some research works on the multi-controller solution such as ONIX\textsuperscript{[1]}, HyperFlow\textsuperscript{[2]} and etc. However these solutions only focus on the state consistency of the multi-controllers, and the relationship between controller and switch is static, which is incompatible with the dynamic characteristic of data center in IHEP.

We propose an elastic cloud data center network architecture based on SDN, and we also design a high performance controller cluster based on OpenDaylight(ODL) \textsuperscript{[3]}called HPOC.

2. Architecture
We integrated OpenStack with ODL, see in Figure 1. OpenStack manages compute nodes where the virtual machines are located, it also receives the network requirement of the tenants and delivers them to SDN controller, which will translate them to flow entry and set up them in the TOR switches.

![Elastic network Architecture](image)

Figure 1. Elastic network Architecture

To achieve the live migration of virtual machines in data center we apply VXLAN in this paper.

2.1. VXLAN

Virtual Extensible LAN (VXLAN) is a network virtualization technology that attempts to improve the scalability problems associated with large cloud computing deployments. It uses a VLAN-like encapsulation technique to encapsulate MAC-based OSI layer 2 Ethernet frames within layer 4 UDP packets, using 4789 as the default IANA-assigned destination UDP port number. VXLAN endpoints, which terminate VXLAN tunnels and may be both virtual or physical switch ports, are known as VXLAN tunnel endpoints (VTEPs). Figure 2 shows the VXLAN message format[4].

![VXLAN message format](image)

Figure 2. VXLAN message format
3. HPOC
To achieve the high performance network, we designed a distributed controller architecture which called HPOC shown in Figure 3. HPOC is developed based on the Beryllium-SR4 version of ODL. Controllers can be added or deleted depend on the current load of the controller and when the load between switch and controller is higher than a specified water level, the switch will be migrated to other controller. In this paper, we use a distributed data storage model to store the network information which including the switch status, network topology and controller’s load and etc.

4. Integration model
In order to integrate OpenStack with HPOC, we use the following Integration model shown as in Figure 4. In this paper, we use ML2Plugin[5] and networking_odl[6] in Neutron[7] component of OpenStack(version Mitaka )[8].
To implement this, we configure the following in the file of /etc/neutron/plugins/ml2/ml2_conf.ini in controller node of Openstack.

```
[ml2]
type_drivers = vlan
tenant_network_types = vlan
mechanism_drivers = openvswitch,opendaylight
[ml2_type_vlan]
network_vlan_ranges = vlan:MIN-VLAN-ID:MAX-VLAN-ID
[ml2_odl]
password = PASS
username = USER
url=http://<HPOC-IP>:8080/controller/nb/v2/neutron
```

We also add the following configurations in the file of /etc/neutron/neutron.conf

```
[default]
core_plugin = ml2
service_plugins = networking_odl,l3,l3_odl,OpenDaylightL3RouterPlugin
```
5. Test Results
When a tenant created network A and its subnet shown in Figure 5, the corresponding network information will also be shown in the controller side see in Figure 6.

Figure 4. OpenStack and HPOC Integration model

Figure 5. Create Network in OpenStack
Figure 6. Network information shown in HPOC. When created a virtual machine in OpenStack platform see in Figure 7, it will also be shown in the controller side see in Figure 8.

实例

Figure 7. Create Virtual Machine in OpenStack
We can also specify the network bandwidth of a single application see in Figure 9.

6. Conclusions

In this paper, we presented a elastic network architecture in IHEP data center based on SDN. In order to achieve this architecture, we designed a distributed SDN controller named HPOC, and integrated it with OpenStack. Based on the test results, elastic network architecture we proposed has achieved good results, and it is of great significance for the widespread use and promotion of cloud computing platform. We also plan to optimize the load balance module of the system to achieve better performance.
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