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The Research on Network Performance Measurement and Control Method Based on Virtual Network Environment

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Abstract: This article utilizes GNS3 network simulation technology and VirtualBOX virtual machine technology and is based on network topology which is actually needed to design in network performance test of network engineering. This method unites NTP network time protocol and Sike SLA protocol, synchronizes fiducial time of the equipments in virtual network, transfuses it with network flow of different business types, simulates the real network operation, and builds a virtual test environment of network performance. It simulates network jam using flow-limitation method and achieves control and test of network performance by deploying QoS strategy. The experimental result verifies the correctness and actual feasibility of this method. It can effectively solve many difficult problems of network performance test in practical network engineering and experimental teaching of network engineering.

Keywords GNS3; network performance; QoS; IP SLA; NTP

INTRODUCTION

Network performance test is the core content of network management and maintenance. It is also one of the teaching main contents of computer network design in college. It is helpful to increase scientificity of network design and it is the technical key of guaranteeing normal service of network. Common methods of network performance test include initiative test and passive test[1]. However, when facing actual network of business operation, it is difficult to conveniently test network performance and do technology training. Firstly, the actual network which operates business cannot be made QoS ability[2] test. Because artificially loaded network flow will surely influence the operating network business when testing. Secondly, the formulated network QoS control strategy is difficult to deploy and test in networks which are operating business. The strategy can verify correctness and operation effectiveness of configuration. Thirdly, the advanced QoS theory and complex QoS configuration command[3] make it difficult for webmasters to master them quickly. As for network teaching of colleges, the above two methods are lacking in usability owing to the limit of environment. Therefore, it is necessary to research a network performance test method which is simple, economical, flexible, and easy to use.

This article puts forward a network performance test method based on virtual network environment by the integrated application research of GNS3 network simulator, VirtualBOX virtual machine and SLA technology of Cisco company. The contents mainly include four aspects. Firstly, it is to build virtual network topology based on actual test need. Secondly, it is to synchronize fiducial time of the network equipments. Thirdly, it is to deploy IP SLA operation, transfuse flow of different types to the tested network, and test performance parameters of normal network operation. Fourthly, it is to deploy QoS control strategy according to control need of network QoS, test network performance again, and make comparing analysis. The advantage of this method is that it cannot be limited by actual network environment and equipment. And it is convenient, economical, flexible, and easy to use. It can be also trained to use repeatedly.

BUILDING VIRTUAL NETWORK TEST ENVIRONMENT

Figure 1 is a virtual tested network which has been built. One part is a virtual network topology which is similar to actual tested network topology. It is composed of five routers and one server. The five routers respectively simulate two border routers(C2691), two convergence routers(C3640), and one core router (C7200) in actual network. The used IOS versions are C2691-ADVENTERPRISEK9-M-Version12.4(25d),C3640-IK9O3S-M-Version 12.4(25d) and C7200-ADVIPSERVICESK9-M-Version 15.2(4)M1 respectively. The basic configurations of the virtual server include single CPU, PIIX3 chipset, internal storage of 256MB, network card PCnet-FAST III, operating system of Windows2008, configured Web service, Ftp service, DNS service etc.. It is mainly used for research and training of network performance test method. Another part is physical network(such as campus network) which is used for QoS test verification. It includes real connected mainframe and Cloud object in GNS3. In this case, the two parts can achieve two-way connectivity, which will form a basic test environment with virtuality and reality combination. And the environment can be used to learn, train, and verify network performance test method. It can be regarded as a practical teaching platform for students in network engineering major, beginners of network management etc. to learn QoS technology, train QoS configuration command, and observe, analyze, and understand QoS technical theory.

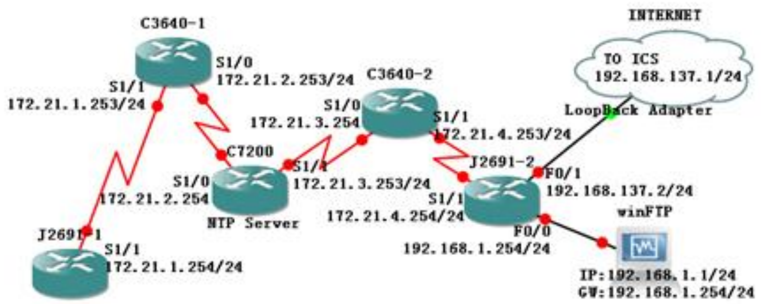

Figure 1 Logic structure of experimental environment for portable network

NTP AND SLA OPERATION CONFIGURATION

NTP Protocol and Configuration

NTP(Network Time Protocol) is used to calibrate real-time clocks of network equipments in network environment. It utilizes C/S model. NTP server offers time source which is accurate and reliable. NTP server synchronously calibrates real-time clock of NTP client through network. In order to avoid spiteful damage to NTP client, NTP uses mechanism of recognition and verification, checks whether the time-calibration information really comes from the declared server, detects returning route of data, and offers safe protection of network time calibration. This research chooses router C7200 as NTP Server from figure 1. In privilege mode, "clock set" command is used to set the time of NTP Server. Global configuration mode is turned into. Router C7200 is appointed to be NTP Server. It sets time zone and appoints IP address of NTP Server. In order to offer safety of time calibration, we also need to set and start NTP verification mechanism on NTP Server. NTP Client only needs to point out NTP Server when calibrating time and NTP verification information. What needs to be explained particularly is that every NTP Client is set with the same way. After the set is finished, real-time time of network equipments will synchronize with that of NTP Server through synchronization process of a span of time.

SLA Protocol and Configuration

IP SLA is a software module which is embedded in core of Cisco network equipment and used to monitor kinds of QoS indexes. It uses simulated "small packet" to transmit between the two network terminals and uses time labeling technology to calculate QoS parameters such as delay, vibration, responding time, round time, packet-loss rate, voice MOS value[7] etc.. And it supports many measurement types such as HTTP, FTP, DNS, DHCP, jitter, echo, Pathecho, pathjitter, tcpconnect, udpecho, voip, framerelay etc.. When it is measured in detail, it is requested to configure IP SLA to operate in source equipment, point out target equipment, monitoring protocol(monitoring type), UDP or TCP port number, and set parameters such as detection frequency, excessive time, and interval etc.. All the equipments in tested network had better use real-time clocks which are uniformly calibrated. That will improve accuracy of measuring data. If DNS, HTTP, FTP or DHCP is in operation, all the mainframes which accord with the conditions can be target equipments. If it is the operation used to test data port, IP SLA Responder command will be used on target equipments.

This research mainly configures operations such as HTTP, FTP, DNS, DHCP, jitter, echo, Pathecho, pathjitter, tcpconnect, udpecho, voip etc. in tested networks. It is convenient to transfuse network flow of different types into tested networks. Let us take VOIP jitter test as an example. This research tests the VOIP jitter generating from router J2691-1 to router J2691-2 in network of figure 1. VOIP voice connection equipments of target routers need to be pointed out. Therefore, we add a loopback connector in router J2691-2 and appoint IP address which is 1.1.1.1/24. That is used to simulate VOIP voice connection address. We utilize jitter operation type and respectively configure target address, target port, voice code, packet size, test frequency etc.. The detailed configurations are in the following:

```
Conf term
  Ip sla monitor 5
```

Type jitter dest-ipaddr 1.1.1.1 dest-port 14280 codec g711alaw advantage-factor 1
Request-data-size 200
Frequency 10
Exit
Ip sla monitor schedule 5 life forever start-time now

```
Modification time: 09:12:08.926 UTC Fri Jan 16 2015
Number of Octets Used by this Entry: 10648
Number of operations attempted: 25
Number of operations skipped: 0
Current seconds left in Life: Forever
Operational state of entry: Active
Last time this entry was reset: Never
Connection loss occurred: FALSE
Timeout occurred: FALSE
Over thresholds occurred: FALSE
Latest RTT (milliseconds): 59
Latest operation start time: 09:35:09.226 UTC Fri Jan 16 2015
Latest operation return code: OK
Voice Scores:
ICPIF Value: 1  MOS score: 4.34
RTT Values (milliseconds):
NumOfRTT: 1000  RTTAvg: 59      RTTMin: 41      RTTMax: 93
RTTSum: 59728   RTTSum2: 3581360
Packet Loss Values:
PacketLossSD: 0 PacketLossDS: 0
PacketOutOfSequence: 0  PacketMIA: 0    PacketLateArrival: 0
InternalError: 0        Busies: 0       PacketSkipped: 0
Jitter Values (milliseconds):
MinOfPositivesSD: 1     MaxOfPositivesSD: 23
NumOfPositivesSD: 282   SumOfPositivesSD: 1215  Sum2PositivesSD: 8561
MinOfNegativesSD: 1     MaxOfNegativesSD: 22
NumOfNegativesSD: 272   SumOfNegativesSD: 1236  Sum2NegativesSD: 9192
MinOfPositivesDS: 1     MaxOfPositivesDS: 23
NumOfPositivesDS: 368   SumOfPositivesDS: 1605  Sum2PositivesDS: 10803
MinOfNegativesDS: 1     MaxOfNegativesDS: 36
NumOfNegativesDS: 376   SumOfNegativesDS: 1601  Sum2NegativesDS: 10821
Jitter Avg: 3   JitterSD Avg: 3 JitterDS Avg: 4
Interarrival jitterout: 0       Interarrival jitterin: 0
One Way Values (milliseconds):
NumOfOW: 1000
OWMinSD: 13     OWMaxSD: 61     OWSumSD: 37062  OWSum2SD: 1382770
OWMinDS: 5      OWMaxDS: 56     OWSumDS: 22666  OWSum2DS: 526580
OWAvgSD: 37     OWAvgDS: 22
```

Figure 2 VOIP jitter test situation when network runs normally

PERFORMANCE PARAMETER COLLECTION

IP SLA operation test result is stored in MIB database of equipment. You had better use network management software such as NetQoSNetvoyant when making statistics analysis. You can visit test result data through SNMP protocol, make statistics analysis and report forms. If there is no corresponding network management software, single-time test result or several-time statistics test results of corresponding operations can be only showed through corresponding command lines under command mode. Figure 2 offers the statistics result of VOIP jitter test for the tested network when QoS control strategy is not configured. The number of test is 25.

JAM SIMULATION AND QOS STRATEGY FORMULATION

The above performance parameters were got when network ran normally. In order to measure network performance parameters when network jam exists, network jam phenomenon must exist. Because the simulated virtual network environment is used, we will need more payment for mainframe resource if we want to increase flow to cause network jam. There will be no method to make virtual environment run. Therefore, this research uses CAR speed-limit[8] method, which makes main links generate corresponding jam. In this instance, we simulate and test network performance parameters when network jam exists.

Controllable network performance is realized under corresponding QoS strategy control. Therefore, in order to get network performance which accords to business requirement, we must firstly make proper QoS control strategy according to operation need of network business. And then we configure and operate it in simulated network environment. In that case, we can verify effectiveness of the formulated QoS strategy and correctness of configuring operation. This example respectively tests important business guarantee using PQ, low-delay business guarantee using CBWFQ and LLQ, and QoS strategy which owns different bandwidth in other businesses. And it operates network performance test under control of corresponding QoS strategy. Taking measurement of HTTP performance parameters as example, we firstly configured kinds of SLA operations in access router J2691-1, simulated different flow of HTTP, DHCP, FTP, ICMP, TCP, UDP etc., and collected HTTP performance parameters when network ran normally. Then we used CAR technology to limit flow on up-going port of convergence router H3640-1. We made simulating operation for about ten minutes and that caused slight network jam. At this time, we collected HTTP performance parameters of the network jam. At last, we configured QoS control strategy which can guarantee HTTP business on up-going port of convergence router H3640-1. Then we collected HTTP parameters after QoS control strategy worked. It can be seen in table 1. After we used QoS control strategy which can guarantee HTTP business, the performance parameters of HTTP performed best.

Table 1 Comparison of HTTP performance parameters in circumstances of normal, jam, and configuring QoS strategy

Test parameters	Normal(MS)	Jam(MS)	Qos configuration(MS)
Latest RTT	316	816	191
Latest DNS RTT	84	204	0
Latest TCP Connection RTT	108	276	88
Latest HTTP Transaction RTT	124	336	103

CONCLUSION

This article puts forward a network performance test method in virtual network environment. This method builds tested network topology which accords with practical network engineering by network simulator. And this method configures QoS strategy and network performance test operation in the network topology. That will train the real network QoS configuration and performance test technology and greatly decrease the cost of network management and professional network talents training. This method uses network simulator to simulate real network. Therefore, mainframe which runs simulating software is requested with higher performance. Experimental test result will vary following the different performance of mainframe. And the result has deviation comparing with performance test result of real network. However, the conclusion is consistent.

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