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Uses Quality of Services for Managing Network Traffic at Ghazni University

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Abstract **-** *To day, every network and internet service providers deploy Quality of services (QoS) in order to efficiently use its bandwidth and decrees packet delay, loss and jitter. An important current issue in the computer communication network is QoS and inter-domain traffic control in both types of networks (local area network and wide area network). Our objective is to use and implement Quality of services at Ghazni University to manage network traffic that extends over IP/IMPLS with bitter network performance, to achieve the expected result; first, we will have a case study and semi-structured interviews with IT and QoS professionals, second we will implement QoS based on collected data from case*

Keywords **-** *QoS; DiffServ; MPLS.*

I. INTRODUCTION

During the last decade, Quality of service (QoS) has become a hot topic for network operators because communication technology and the network have become an essential part of human's life, so they are trying more to improve their QoS in order to achieve more customer satisfaction, a study by (Prof. Augustine C. Odinma, PhD & Lawrence Oborkhale, 2011) shows that QoS has by itself become profit management tools for service providers to attain global efficiency, moreover the advancement of recent high-speed networking technology created opportunities for development network services especially delay-sensitive services such as voice over IP, multimedia, IP telephony technology considered by multiple QoS requirements. As (Muhammad Romdzi Habibah Hashim, 2012) also pointed out, the major concern for IP network providers is particular customers or organizations. There are many standards in order to attain the QoS in IP networks which are included MPLS network and differentiated services.

As (Hasen Ali, 2017) expressed in his research, computer and internet networks are designed to carry data using two very common (transmission control Protocol and User datagram protocol) transport layer protocols of the internet. This best-effort model of the internet protocol was designed to deliver and drop traffic equally over the network until the advent of voice over internet protocol and IP telephony; after that, the network should be able to deliver voice, video and data over a converged network instead of a dedicated network. The converged network allows for all types of network traffic to be delivered from the same network device and architecture; when it is carefully designed and implemented, the cost and complexity of network layers will be reduced and be able to save bandwidth and the equipment used in such network. With the converged network, the QoS should be configured in order to give different priority to network traffic based on their transport protocol uses.

II. QUALITY OF SERVICES (QOS)

According to (Donald Egbenyon, 2011), Quality of service (QOS) is not something to be configured in networking devices such as routers and switches, but it is the ability of networking devices to differentiate network traffic on different classes and give different priority for each class when there is congested in the network. Allow the network administrator to give some traffic more priority over others. as (Hasen Ali 2017) wrote, "comprises requirements on all the aspects of a connection – such as service response time, loss, signal-to-noise ratio, cross-talk, echo, interrupts, frequency response, loudness levels etc."

III. QUALITY OF SERVICE MODEL

The work of (Srihari Raghavan, 2014) shows that Quality of service (QoS) is used to make sure to guarantee the minimum bandwidth for identified traffic to control jitter latency and improve packet loss. QoS models art classified into three different (Best Effort, Integrated services and Differentiated services) models, but for end-to-end QoS on an IP network, the Internet Engineering Task Force defined two (Integrated Services and Differentiated Services) Models, and the best-effort model is the default model which has not QoS guarantee.

A. Best effort Model

This is the default model that comes with all networking devices and makes the best effort to transfer packets without any guarantees. The best effort model does not require any QoS configuration, so in case of congestion, any packet will be dropped because there is not any prioritization.

B. Integrated Services Model

As (Hasen Ali 2017) pointed out, This model provides high QoS for IP packets but requires special QoS to be made means, before the communication starts for every individual flow, it reserves network resources such as link capacity, queue memory, CPU of switching elements. Per-flow basis, this reservation is made by Resource Reservation Protocol (RSVP) protocol uses. RSVP itself is a signalling mechanism that is used by integrated services model to do its own function; when the session is established, then it has maintained by a router along the path, based on IETF recommendation, to prevent the soft state from time out in the router, RSVP protocols massaged should be sent every 30 seconds periodically along with the path session, and the session will be active till it is torn down or there no-refresh message received by the router along the path. With the implementation of this measure, packet delivery is guaranteed, but network scalability will be limited.

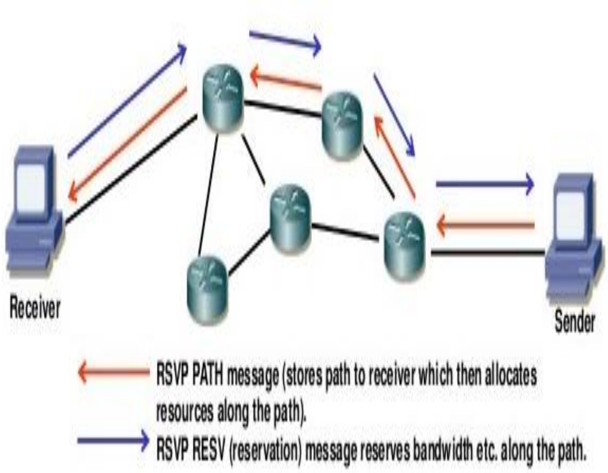

Fig. 1 RSVP Path massage and its reservation in the integrated service model

C. *Differentiated Services Model*

As (Prof. Augustine C. Odinma, 2012) pointed out, this model classifies and marks network traffic instead of resource reservation which is called the class of services (COS). DiffServ does not use any specific protocols to provide QoS, but it uses a specific architecture framework for carrying its own function. This model defines the Per-Hap behaviour of switching devices such as routers and switches for every traffic class. The packets are to be divided into different classes. The switching devices add and mark the Type of Service (TOS) byte in the IP header, which forms the aggregate behaviours. The traffic classification process will take place differently based on switching devices (Switches & Routers) characteristics. At switched environment (Layer2), the traffic is classified on class of service (COS) value.

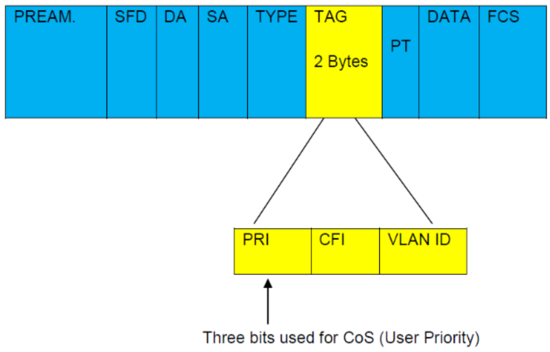

Fig. 2 Traffic classification tagging at the switched environment (Layer2) adapted from (Donald Egbenyon, 2011)

Based on figure1, switched environment (Layer2), the 802.1Q frame header carries the COS value in a 2-byte Tag control information field; the information field carries the COS value into three most important bits. That is called user priority bits in layer 2 802.1Q frame header. And the range of COS at layer 2 is from 0 for low priority to 7 for high priority.

At routed environment (Layer3), the traffic is classified on Differentiated Services Code Point (DSCP) value. DiffServ uses a 6-bit DSCP in the 8-bit differentiated services field in the IP header for packet classification purposes. The first six bits of the DS field are used to select a PHB forwarding and queuing method, and the remaining two bits are used for flow control.

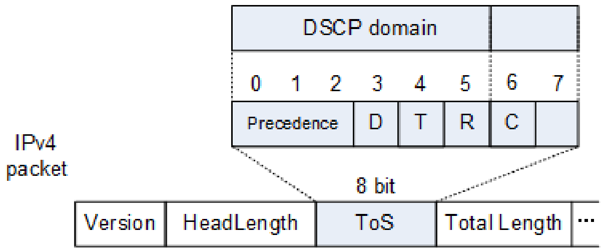

Fig. 3 DSCP 8bit differentiated service filed in IP header

DSCP is backwards-compatible with IP precedence. The value range of IP precedence from 0 to 7 while the value range of DSCP is from 0 to 63. From the above ranges, value 7 of IP precedence and upper from 48 value of DSCP are reserved for network use, DSCP values range from 0 to 48 used in network configuration while IP precedence values range from 0 to 7 used as well, any of DSCP values can be used to assign priority to traffic flow.

Class selector name	DSCP value	IP precedence Value	IP precedence name
Default/CS0	000000	000	Routine
CS1	001000	001	Priority
CS2	010000	101	Immediate
CS3	011000	011	Flash
CS4	100000	100	Flash Override
CS5	101000	101	Critic/Critical
CS6	110000	110	Internetwork Control
CS6	111000	111	Network Control

Fig. 4 DSCP Value Vs IP precedence value with their function

For voice carrier and fax traffic by IP phones, the COS value will be set to 5 or value 3 for voice signalling traffic, and the switch will reset the COS value to 0 for it is directly connected port to a computer, because the switch is configured not trust any traffic coming from it is directly connected port to the computer. But the edge switch maps the incoming COS value to a corresponding DSCP value within the IP packet based on the QoS policy.

Traffic Type	LAN	WAN
Voice bearer and Fax	COS = 5	DSCP = 46 (PHB = EF)
Voice control signalling	COS = 3	DSCP = 24 (PHB = CS3)
Citrix and other Business Critical	DSCP = 26	DSCP = 26 (PHB = AF31)
Video conferencing	COS = 4	DSCP = 34 (PHB = AF41)

Fig. 5 COS and DSCP based on different traffic types

If we look at the table1, we will see different traffics with different COS and DSCP marking systems. Voice bearer and fax are classified at the switch port are marked with COS 5 for layer 2 devices and DSCP 46 for layer3 devices, the business-critical application such as Citrix is marked as DSCP 26 value, and the remaining untrusted traffic DSCP value will set to 0.

IV. CONGESTION MANAGEMENT WITH QOS

The work of (Jitendra Joshi, Sonali Gupta, 2013) indicates these features allow us to manage the congestion by determining the order in which the packets are sent out an interface based on the priorities assigned to those packets, congestion management tools are applied to an interface that may experience the congestion whenever the packet is received faster than they can exit. The traffic classes will be stored into queues, and these queues will be served by various algorithms.

A. First in First Out algorithms (FIFO)

As *(Jitendra Joshi, Sonali Gupta, 2013)* pointed out, FIFO is one of the congestion management techniques for improving QoS at networking devices. In this technique, the packet waits in the device's buffer or queue until the device becomes ready to process them. The first received packet will be sent first from others based on it is own turn, but one problem of FIFO that faced with, if the buffer of the device becomes full of the packets, the incoming packets will be discorded automatically by the device. This was firstly used technique by networking device to improve QoS.

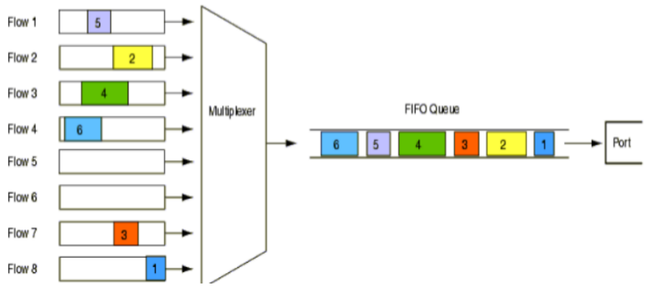

Fig. 6 FIFO Techniques for QoS improving adopted from (Jitendra Joshi, Sonali Gupta, 2013)

B. Priority Queueing Algorithm

Priority queueing technique ensures that important traffic gets the fastest handling at each point it is used. This technique can flexibly prioritize according to network protocol such as IP, IPX or Apple Talk. All traffic is generally divided into many categories such as high, medium, normal and low to queue network traffic for managing congestion, and the traffic will start sending from the highest priority.

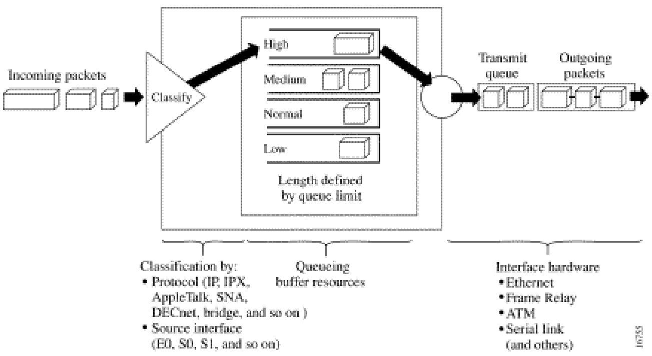

Fig. 7 Priority Queueing for QoS improvement adopted from (Jitendra Joshi, Sonali Gupta, 2013)

V. QOS WITH MPLS IP NETWORK

As (Redostina Gercheva, 2013) said, multi-protocol label switching is upgrading to work with IP routing protocols such as OSPF, BGP and IS-IS, and MPLS enable network traffic management from source to destination because the traffic moves independently. The path established by MPLS is called the label switched path (LSP). Each LSR (MPLS supported Routers) redirect packet is based on a packet header that contains the numerical value of the label.

The (Gull Hussain Sabri, 2009) pointed out based on the IP simplicity, it was deployed as layer 3 networking protocol, but the ATM is layer 2 (data link) protocols to offer end-to-end connectivity, and it faced with limitations at ISP WAN connection protocols. After this problem, the RFC 1483 the IP implemented over ATM to achieve multiprotocol encapsulation over ATM adaption layer 5 model OSI, with this implementation the IP mapping an ATM endpoint to be configured manually, or they implement layer2 Ethernet LAN emulation at edge router to connect networks, but this solution had its own limitation with the reliability and scalability at ISP side, so the only possible way was to make ATM switches intelligent enough to rout label switching technology with label distribution protocol with running IP protocols, and this solution was made possible through using MPLS technology.

The (Nasir Ahmad Jalali, 2016) discussed as well that MPLS is standard based on technology and deliver packets based on the label, these labels may correspond to IP destination network, and MPLS has been used for many years for industries network such as the RFC 3031 pointed out, how MPLS designed to combine or replace older Frame relay and ATM technologies for QoS. (IFTIKHAR.A & LATIF, F, 2010) also stressed that MPLS technology for internet traffic provides efficient prioritization, Quality of services and traffic engineering to increase the performance of internet applications such as voice and video used by services providers as well as enterprise networks. And there are many reasons such as network scalability, compatibility, IP QoS for using MPLS in the network.

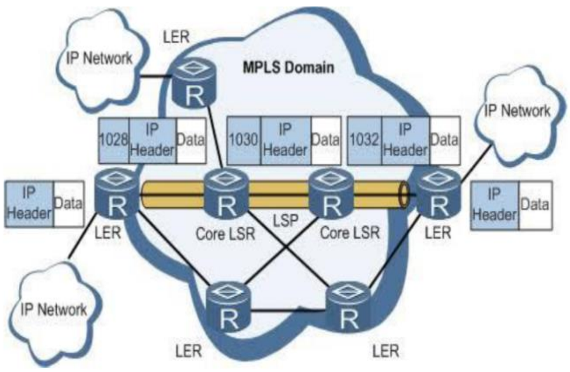

Fig. 8. MPLS Network architecture for traffic process adopted from (Romdzi. M, et,all, 2014)

According to (Romdzi. M, et,all, 2014) MPLS network is built from many different elements such as label switching router, label switching path (LSP), label distribution protocol (LDP) and MPLS node, as shown in the following figure.

- MPLS node: The sender and receiver of packets in the MPLS network is called the MPLS node. As (Romdzi M. et al., 2009) described, "MPLS nodes have two architectural planes that are the MPLS forwarding plane and the MPLS control plane.".
  - Forwarding Plan: as (Gurung S 2015) write, the forwarding plan sends data based on information that is contained by the label, and the MPLS label will be sent based on the Label Forwarding Information Base (LFIB), which is stored in the MPLS node. So for the forwarding plan, each MPLS node needs to store two types of tables:
  - Label Information base: this table stores all information about labels that are assigned by the MPLS node and mapping all label information received from the MPLS neighbour node
  - Label forwarding information Base: this table stores all sub information about the label to be forwarded.

VI. QUALITY OF SERVICE IMPLEMENTATION AT GHAZNI UNIVERSITY

As you know, information technology (IT) is one of the most important elements for the development of higher education system in all countries, and today information technology is growing at an undeniable rate both in international and national forums, fortunately in our country much investment has spent on this sector, and the work of standardization is underway. Fortunately, Ghazni University has had at least some facilities in this field since its establishment in 2009 at this university; as a result of the efforts of the university leadership in 1391, under the financial support of Silk Afghanistan, a number of tools have helped to this section, and well-equipped network system, video conferencing as well as a training lab. Based on Ghazni university requirements in 2017-2018, a world bank project was absorbed by the information technology management and leadership of Ghazni University, and the information technology department was transformed into an equipped information technology centre. Now, this centre (ICT centre) offers internet, telephone (VoIP) and online learning services to students, HEMIS system as well for conducting all students' affairs online through this system. As many different services offered by Ghazni University and this network are faced with many traffic loads and congestion, to work properly for delivering network traffic, we need to implement QoS at Ghazni University. QoS implementation can be a simple or complex task based on several factors (QoS features offered by networking devices), network traffic types and pattern in the network, level of control that need to be exercised over incoming and outgoing traffic.

A. QUALITY OF SERVICE (QOS) MODEL USED IN GHAZNI UNIVERSITY

There are many models for implementing QoS on the network; as I stated before in this paper, among those models, the best and most scalable model for implementing QoS in a network is the DiffServ model. As before, I explained many different characteristics and operations of the DiffServ model with its related diagrams in this paper. Ghazni University uses the DiffServ Model of QoS for managing network traffic and traffic congestion because this model is most scalable, and it is working properly with cisco devices (routers and switches) which are used at Ghazni university's IT department.

B. PREPARING TO IMPLEMENT QOS MODEL AT GHAZNI UNIVERSITY

Before implementing the QoS model, it is necessary to know about the business importance of all traffic in a network; there are a few steps to be taken for implementing QoS in Ghazni University's IT (GU-IT). First, the types of all traffic travelling in the network should be identified; second, they should be divided into different classes; third, the definition of QoS policies for each class. At Ghazni University, all types of traffic (text, voice and video), especially text and voice, are delivered, so here the traffic is divided into two classes (Voice and text), this for each class, the QoS policy such as setting minimal bandwidth guarantee, setting maximum bandwidth limit and assigning priority by using QoS will be defined.

C. IMPLEMENTATION AND CONFIGURATION QOS MODEL IN GHAZNI UNIVERSITY

First of all, we must have an overview of the logical network and the way packets flow from the different offices through the GU-IT LAN, and it is necessary to understand that at Ghazni University LAN topology, there are three regions, the network diagram is made up of different devices with different IOS models and software versions. The implementation of QoS in networks is related to the features offered by internetworking devices.

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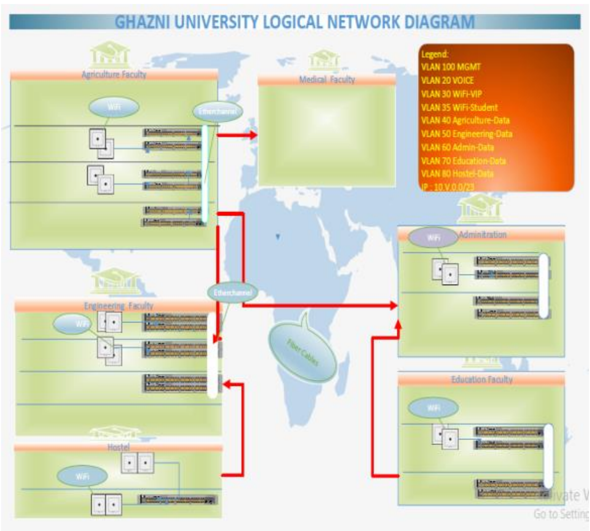


Fig. 9 Ghazni university's network logical diagram

In fig. 8, we see different regions connected to each other, the Agriculture region, Engineering region, administration region and education faculty region, and the agriculture region using an IP/MPLS for traffic management in both internal and external directions.

Based on the above network diagram for each region, there are many different cisco devices used for delivering data and voice traffic inside and outside the network; the brief information about equipment used for voice and data show in the following figures.

Table 1. Agriculture faculty building (Refer to section 2.1.4 for Building Layout)

Floor	Data Port	Voice Port	Access Point	Total Ports	Port 48 switch	Port 24 Switch	Port24 POE Switch
Basement	144	4	5	153	3	0	1
First	58	18	2	78	0	1	2
Second	43	0	2	45	0	1	1
Total	245	22	9	276	3	2	4

Table 2. Engineering faculty building (Refer to section 2.1.4 Building Layout)

Floor	Data Port	Voice Port	Access Point	Total Ports	Port 48 Switch	Port 24 Switch	Port24 POE Switch
Basement	19	1	2	22	0	0	1
First	46	16	2	64	0	1	2
Second	46	16	2	64	0	1	2
Total	111	33	6	150	0	2	5

Table 3. Administration Building (Refer to Section 2.1.4 Building Layout)

Floor	Data Port	Voice Port	Access Point	Total Ports	Port 48 switch	Port 24 Switch	Port24 POE Switch
Basement	16	0	2	18	0	0	1
First	32	0	2	34	0	1	1
Second	46	16	2	64	0	1	2
Total	94	16	6	116	0	2	4

Table 4. Education faculty building (Refer to section 2.1.4 Building Layout)

Floor	Data Port	Voice Port	Access Point	Total Ports	Port 48 switch	Port 24 Switch	Port 24 Switch
First	44	10	3	57	1	0	1
Second	33	5	3	41	0	1	1
Third	55	6	3	64	1	0	1
Forth	27	7	2	36	0	1	1
Total	159	28	11	198	2	2	4

Table 5. Boys dormitory building (Refer to section 2.1.4 Building Layout)

Floor	Data Port	Voice Port	Access Point	Total Ports	Port 48 switch	Port 24 Switch	Port 24 PoE Switch
First	6	4	4	14	0	0	1
Second	0	0	4	4	0	0	0
Third	0	0	4	4	0	0	1
Forth	0	0	4	4	0	0	0
Total	6	4	16	26	0	0	2

Briefly, we can say that Ghazni University has 615 data ports, 103 voice ports, 48 access points, total ports 766. Since there are different layer2 and layer3 cisco switches for connecting these ports in the network, these different switches are needed to design and configured differently whenever in some cases a particular configuration will fit into different switches, the reason of different configuration will be needed because every switch has different IOS models and these models are used for specific purposes. Each configuration starts with a class map, a policy map, Access list and then implement the policy to an interface. In Ghazni University, the routers are used in provider Edge, so they have already been configured by the service provider.

VII. CONCLUSION

Now it is necessary to show the QoS test for comparing the result gathered before and after implementation of QoS. Before implementing QoS configuration, a ping from one region of the switches (10.100.100.8) to another region's switch in the network. Following is the sample picture of the ping action.

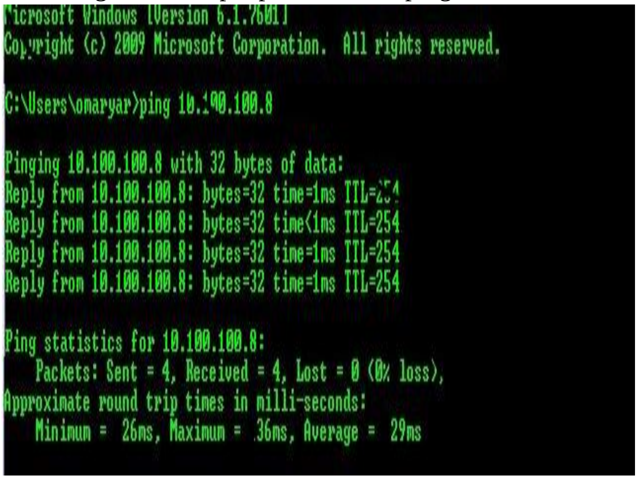
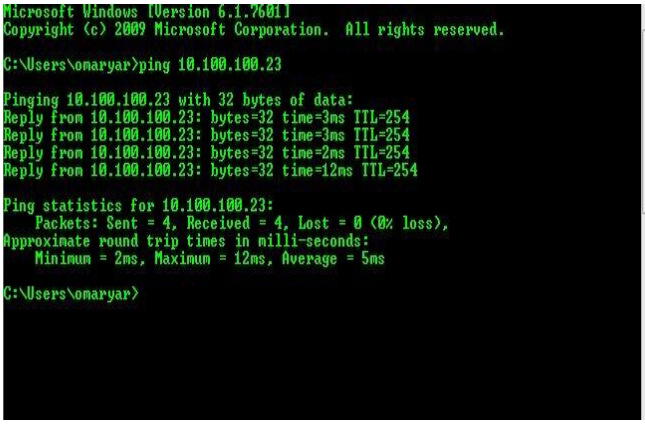


Fig. 10 Ping action without QoS implementation

After QoS implementation in the network, once again, we repeat ping test on switches, and we made a comparison



between both states of ping test, as shown in the following figure:

Fig. 11 Ping result with QoS implementation

To compare figure14 and 15, the difference between them will be seen obviously, in figure 14 (without QoS implementation), packet round trip is minimum 26ms, Maximum 36 ms, average 29 ms and success rate 100% as well, wherever figure 15 (with QoS implementation) the packet round trip decreased to minimum 2ms, maximum 12ms, average 5 ms and success rate is 100%. At last, we are concluded that the implementation of QoS in the network has positive effects on traffic priority, speed and management.

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