

QoS Teaching Case Design of Campus Network

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Abstract: In view of the lack of real case problems in teaching computer network engineering in the major of network engineering in applied colleges and universities, the diversified characteristics of network application in park and the detailed classification and control requirements of data flow are studied and analyzed. Based on the virtual network environment of EVE-NG, a simulation network topology is built and DiffServ distinction is applied to network engineering. The business service model and the corresponding QoS technology, through data flow classification, marking, flow shaping and other technical applications, to build a QoS design teaching case for campus network-oriented, so as to let students experience the basic process of park network QoS design. More importantly, through the guidance of case content, the design ideas and methods of QoS in the park network can be effectively simulated, and students' QoS design and practical ability can be trained to provide reference for the real network engineering design.

1. Introduction

Network performance design is one of the main tasks of course teaching of computer network engineering for applied undergraduate network engineering. It is also the main symbol to measure the ability of network engineering program design for network engineering students. Its technical content mainly includes network bandwidth analysis and design, network traffic analysis and design, network QoS analysis and design, load balancing analysis and design, together four parts^[1]. The network QoS analysis and design highlights the comprehensive application of the basic technical principles of bandwidth management, flow classification and control and network load balancing, in order to ensure the quality of service for network services. With the expansion of the application of network services in the park, the network applications of the campus network are more diversified. In addition to the traditional web browsing data stream, Email data stream, FTP data stream, such as the campus network, such as the online video teaching, campus video monitoring, campus WiFi, P2P download, IP voice and other data streams. With the change of network application behavior, these data streams will seize each other bandwidth and seriously reduce the stability of network system and the availability of critical network services. Therefore, proper QoS design has become an important part of campus network design technology. However, in the specialized teaching of network engineering, which is lack of the corresponding teaching cases, so it is difficult to give a systematic and accurate technical framework.

On the basis of fully studying and understanding the teaching content and teaching goal of network performance design, in this paper it constructs a typical multi-service park network topology by using EVE-NG virtual network environment^[2]. According to the basic idea of DiffServ model QoS, QoS management strategy in the domain is formulated, and the corresponding strategies are configured in different locations in the domain, and the implementation of the corresponding strategies can be realized. Based on QoS control of park network, a teaching case of network QoS design for real network engineering can be formed. Through the simulation operation and dynamic display, it can not only make the presentation of classroom teaching more visualized, but also can provide a systematic, complete and accurate technical framework for the students to form the teaching and learning of teachers. The technology reference model and the application

scene of QoS technology can be formed for teacher's teaching as well as student's practical training.

2. Introduction of Main Technology of DiffServ Model

DiffServ model, also known as differentiated business model^[3], which is a multi service model that can meet different QoS requirements^[4]. Its basic technical principle is to divide the network into different DS domain (Differentiated Services Domain), redefine TOS field of IPv4 protocol and Traffic Class field of IPv6 protocol as DS field, and the router determines the forwarding behavior of the packet according to the value of DS field. In this way, different levels of quality of service can be defined by using different values of DS field. RFC2474 can define the first 6 bits of DS field as DSCP (Differentiated Service Code Point), which also specifies the corresponding encoding and PHB^[5].

DiffServ model places all the complexity in the boundary router of DS domain, which can make the internal router function of DS domain as simple as possible. QoS function of the border router mainly includes business classification, markup, flow regulation and flow shaping. After the data stream enters the internal router, the router will forward the packet according to DSCP of packet and the corresponding PHB. Flow supervision is to supervise the specific flow of inflow or outflow equipment. When the flow exceeds the preset value, the restrictions or penalties are taken to protect the network resources from damage^[6], which can be used in the access direction of the equipment interface. Flow shaping is the act of actively adjusting the rate of flow output. The purpose is to make the data flow outward at a relatively uniform speed, to better match the network resources available to the downstream devices, so as to avoid unnecessary message discarding and delay, which is usually applied to the interface output direction^[7].

DiffServ Model Defines Three Kinds of PHB, AF, BF, and EF. AF (Assured Forwarding), also known as "guaranteed forwarding" service level, which is defined by RFC2597^[8]. AF uses DSCP's 0~2 bits to divide the data stream into four levels, and provides the lowest number of bandwidth and cache space for each level; for each level of AF, using DSCP 3~5 bit to define "low", "middle", "high" priority. When the network occurs, the router first discards "the best". First level "higher packet discarding." With this priority, network managers can be more convenient to divide service levels for user services, manage and control the corresponding network bandwidth, flow and service charges. EF (Expedited Forwarding), also known as "fast forwarding" service level, which can be defined by RFC3246^[9], and the decimal value of corresponding DSCP is 46. It is specially designed for low packet loss rate, low delay, low jitter, so as to ensure end-to-end service of bandwidth, which is not queued or queued during the transmission process. BF (Best-Effort Forwarding) is the default PHB in DiffServ model, and the corresponding DSCP decimal value is 0, and the forwarding behavior can be defined as "try to forward" service level.

DiffServ model can provide a business aggregation function that allows a number of business flows to be aggregated into a small number of streams based on their DS values. The routers forward the aggregated streams to the same PHB, which can greatly simplify the forwarding mechanism of the router in the domain of DS^[10].

3. Topology Construction and Data Flow Simulation of Teaching Cases

As far as topology is concerned, the real campus network is generally designed as a multi-layer network with link redundancy and device redundancy, and the link and routing relationship are relatively complex. In order to highlight the QoS control problem and reduce the link redundancy relationship, when QoS teaching case topology is constructed, based on the basic requirements of DiffServ division service model, the campus network is used as DS domain to simplify the redundant design of the real campus network, and only the basic connectivity links are retained. The domain router KR1 can simulate the core routers of the campus network. R1, R2, R3, R4, etc. which can simulate the aggregation layer routing devices in different regions, ASA can simulate firewall, and the exit can connect Internet. VServer1 is a video server, which can provide multicast video for simulating online video teaching flow and campus surveillance video stream in daily

teaching. VServer2 is a live entertainment video server for simulating VOD data streams. OAServer is the server of the network business, which can simulate OA office system, educational administration system, financial management system, digital library, the teaching resource center, forum network, the enrollment and employment network, students' ideological and political work network, providing standard services such as the standard WWW, FTP and Email, etc. fa0/1 of R2 can simulate data flow of WiFi. According to the flow, fa1/0 of R3 can simulate IP voice data stream, PC1 and PC2 can simulate two network hosts respectively. When P2P application is operating, P2P data stream can be simulated.

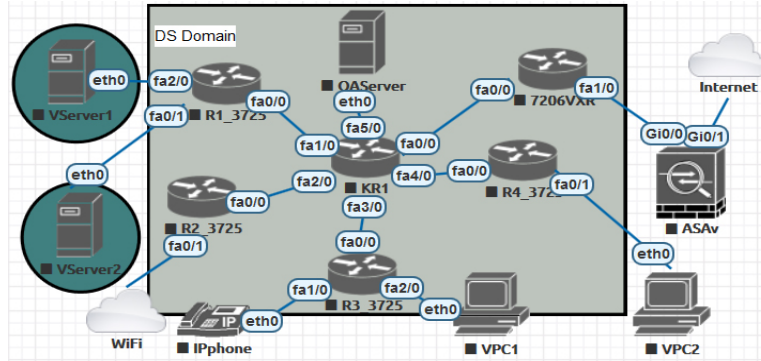


Fig.1 QoS Teaching Case Simulation Topology

4. Design Strategy in Teaching Cases

According to QoS demand of the campus network, video flow mainly includes two types: interactive video (such as video conference) and streaming video. The interactive video service requires more stringent bandwidth and delay, high bandwidth and low delay. It is suggested that DSCP label is AF41. The user can use the flow strategy to reduce the overload video stream level to AF42 or AF43^[11] according to its own requirements. The QoS requirement of streaming video is more relaxed than interactive video, because streaming video is insensitive to delay and is largely insensitive to jitter. However, in order to ensure the timely dissemination of organized online video teaching and video conferencing, it is suggested DSCP should be labeled as AF2, and it can be downgraded to AF22 or AF23, when overload occurs. IP voice is low packet loss rate, low delay, low jitter which can guarantee bandwidth end to end service. DSCP should be labeled as EF. For other non-critical data streams, it can reduce the priority and increase the possibility of packet loss to achieve the desired QoS effect, shown in table 1.

Table 1 Information Classification and Monitoring Strategy Information Table for Campus Network

Classification	Class name	Major business	Bandwidth ratio	Control requirement	DSCP	Exceed-action	PHB
Interactive video	Class 1	On-the-spot video teaching and video meeting	30%	Low packet loss rate, guarantee bandwidth	22	Marking AF43	AF41
Real time business	Class 2	IP voice, etc.	10%	Guarantee time delay and bandwidth office service	40	N/A	EF
Office business	Class 3	Streaming video, HTTP, FTP, etc.	20%	Medium packet loss rate, guarantee bandwidth	20	Marking AF23	AF22
Bulk data	Class 4	Entertainment video downloading on demand, etc.	20%	High packet loss rate, guaranteed bandwidth	18	Marking BF	AF13
Service with best effort	Class 5	Extra net access, P2P download, etc.	20%	Best-Effort Forwarding	0	Discard	BF

5. The Technical Realization of QoS in Teaching Cases

The configuration of QoS of DiffServ model is mainly used for MQC (Modular QoS Command), NBAR(Network-Based Application Recognition), CAR (Committed Access Rate), PDLM (Packet

Description Language Module), as well as the corresponding sequence technology and so on^[12]. In the edge part of park network, such as fa2/0, fa0/1 of R1, fa0/1 of R2, fa5/0 of KR1, as well as other data entries shown in Figure 1, by using using MQC and NBAR to perform data classification, data marking, etc. In the internal nodes of the campus network, the tagged data streams are forwarded according to DSCP and corresponding PHB. The exit nodes in the campus network boundary, such as exit fa0/0 of KR1, exit fa1/0 of 7206VXR in Figure 1, which can be classified according to QoS requirement of the next connected DS domain, then data classification, data marking, flow monitoring, and flow shaping can be done. As for data flow into this DS domain from DS domain, such as data inflow through fa1/0 interface of 7206VXR, the inflow port can be set to the "state of trust", which can automatically trust data categorization that has been done at the end, so as to avoid the repeated classification operations.

It should be noted that if port 6881-6890 is used to classify and define P2P data stream, as for the change port, P2P application will not be identified. Thus, this case uses the built-in bittorrent.pdlm module of NBAR to make the router identify P2P application through bittorrent protocol, so as to realize the traffic identification and supervision of port P2P application^[13]. Figure 2 is the corresponding code. This method can be applied to the classification recognition of other data streams. If NBAR does not have the corresponding built-in pdlm module, which can be downloaded to CISCO's official web search.

```

ip cef                                     //CEF support are needed
class-map match-all p2p_stream           //Define P2P Stream name
match protocol bittorrent                 //match bittorrent protocol
policy-map limit_p2p                      //define policy map name
class p2p_stream                          //load class of p2p_stream to policy map of limit_bt
police cir 180000 conform-action transmit exceed-action drop //limit the p2p stream
int fa2/0                                 //select the port of router
service-policy input limit_p2p            //limit p2p upload stream of PC1 or
service-policy output limit_p2p          //limit p2p download stream of PC1

```

Fig.2 Identifying Configuration Code of P2P Flow by Using bittorrent.pdlm Module

6. Conclusion

From the aspects of QoS technology introduction, network topology construction, data flow simulation, QoS strategy formulation, technology implementation and so on, it summarizes and implements a DiffServ model based on campus network QoS designing scheme, especially in the aspect of P2P data flow classification, which can not only use the port based on MQC classification method, but also can introduce PDLM based on PDLM. The network application recognition classification method can solve data flow identification problem of dynamic ports in P2P application by loading bittorrent.pdlm module files. Teaching practice can verify the practicability and effectiveness of this case.

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