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Оглавление

1. QOS CONFIGURATION

If you care to use your bandwidth and your network resources efficiently, you must pay attention to QoS configuration.

1.1. QoS Overview

1.1.1. QoS Concept

In general, the switch works in best-effort served mode in which the switch treats all flows equally and tries its best to deliver all flows. Thus if congestion occurs all flows have the same chance to be discarded. However in a real network different flows have different significances, and the QoS function of the switch can provide different services to different flows based on their own significances, in which the important flows will receive a better service.

As to classify the importance of flows, there are two main ways on the current network:

- The tag in the 802.1Q frame header has two bytes and 3 bits are used to present the priority of the packet. There are 8 priorities, among which 0 means the lowest priority and 7 means the highest priority.
- The DSCP field in IP header of the IP packet uses the bottom 6 bits in the TOS domain of the IP header.

In real network application the edge switch distributes different priorities to different flows based on their significance and then different services will be provided to different flows based on their priorities, which is the way to realize the terminal-to-terminal QoS.

Additionally, you can also configure a switch in a network, enabling the switch to process those packets with specific attributes (according to the MAC layer or the L3 information of packets) specially. This kind of behaviors are called as the one-leap behaviors.

The QoS function of the switch optimizes the usage of limited network bandwidth so that the entire performance of the network is greatly improved.

1.1.2. Terminal-To-Terminal QoS Model

The service model describes a group of terminal-to-terminal QoS abilities, that is, the abilities for a network to transmit specific network communication services from one terminal to another terminal. The QoS software supports two kinds of service models: Best-Effort service and Differentiated service.

1. Best-effort service

The best-effort service is a singular service model. In this service model, an application can send any amount of data at any necessary time without application of permits or network notification. As to the best-effort service, if allowed, the network can transmit data without any guarantee of reliability, delay or throughput. The QoS of the switch on which the best-effort service is realized is in nature this kind of service, that is, first come and first served (FCFS).

2. Differentiated service

As to the differentiated service, if a special service is to be transmitted in a network, each packet should be specified with a corresponding QoS tag. The switch uses this QoS rule to conduct classification and complete the intelligent queuing. The QoS of the switch provides Strict Priority (SP), Weighted Round Robin (WRR), Deficit Round Robin (DRR) and First-Come-First-Served (FCFS).

1.1.3. Queue Algorithm of QoS

Each queue algorithm is the important basis to realize QoS. The QoS of the switch provides the following algorithms: Strict Priority (SP), Weighted Round Robin (WRR), Deficit Round Robin (DRR) and First-Come-First-Served (FCFS).

3. Strict priority

This algorithm means to first provide service to the flow with the highest priority and after the highest-priority flow comes the service for the next-to-highest flow. This algorithm provides a comparatively good service to those flows with relatively high priority, but its shortage is also explicit that the flows with low priority cannot get service and wait to die.

4. Weighted round robin

Weighted Round Robin (WRR) is an effective solution to the defect of Strict Priority (SP), in which the low-priority queues always die out. WRR is an algorithm that brings each priority queue a certain bandwidth and provides service to each priority queue according to the order from high priority to low priority. After the queue with highest priority has used up all its bandwidth, the system automatically provides service to those queues with next highest priority.

5. Weighted Fair Queuing

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6. First come first served

The First-Come-First-Served queue algorithm, which is shortened as FCFS, provides service to those packets according to their sequence of arriving at a switch, and the packet that first arrives at the switch will be served first.
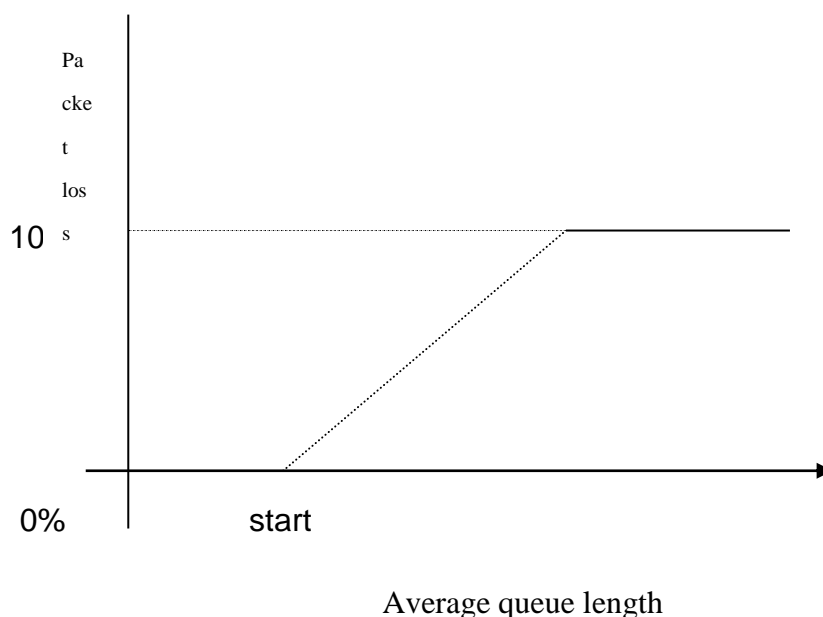
1.1.4. Weighted Random Early Detection

Congestion avoidance and traditional packet loss mechanism

Excessive congestion may inflict damage on network resources, so network congestion should be resolved through some measures. Congestion avoidance is a sort of flow control method of positively dropping packets and regulating network flows to solve network overload via network resource monitoring. The traditional way of resolving network congestion is to drop all incoming packets when the queue length reaches its threshold. But for TCP packets, heavy packet loss may cause TCP timeout and lead to slow TCP startup and congestion avoidance, which is called as TCP global synchronization.

WRED

The WRED algorithm is adopted to prevent TCP global synchronization. WRED helps users to set the queue threshold. When the queue length is less than the configured threshold, the packets will not be dropped; otherwise, the packets will be dropped randomly. Because WRED drops packets randomly, it is avoided for multiple TCP connections to slow down the transmission speed at the same time, which is the reason why TCP global synchronization is avoided. WRED enables other TCP connections to maintain a relatively high transmission speed when the packets of a certain TCP connection begin to be dropped and their transmission speed is slowed down. No matter what time it is, there are always some TCP connections to transmit packets with a high speed, which ensures effective bandwidth usability.

WRED cooperation is conducted when packets enter the outgoing queue and are checked for their size and packets in different ranges get different treatments. The key parameters include **Start**, **Slop** and **Drop priority**.

When the queue length is less than **start**, packets will not be dropped.

When the queue length is bigger than **start**, the incoming packets begin to be dropped randomly.The longer the queue is, the higher the dropping rate is.

The rate for packet loss rises along with the increase of the queue length.

1.2. QoS Configuration Task List

In general, ONU will try its best to deliver each packet and when congestion occurs all packets have the same chance to be discarded. However, in reality different packets have different importance and the comparatively important packets should get the comparatively good service. QoS is a mechanism to provide different priority services to packets with different importance, in which the network can have its better performance and be used efficiently.

This chapter presents how to set QoS on ONU.

The following are QoS configuration tasks:

- Setting the Global CoS Priority Queue
- Setting Global Cos to Local Priority Mapping
- Setting the Bandwidth of the CoS Priority Queue
- Setting the Schedule Policy of the CoS Priority Queue
- Setting the Default CoS Value of a Port
- Setting the CoS Priority Queue of a Port
- Setting the CoS Priority Queue of a Port

- [Establishing the QoS Policy Mapping](#)
- [Setting the Description of the QoS Policy Mapping](#)
- [Setting the Matchup Data Flow of the QoS Policy Mapping](#)
- [Setting the Actions of the Matchup Data Flow of the QoS Policy Mapping](#)
- Applying the QoS Policy on a Port
- Configuring the Trust Mode
- [Displaying the QoS Policy Mapping Table](#)

1.3. QoS Configuration Tasks

1.3.1. Setting the Global CoS Priority Queue

The task to set the QoS priority queue is to map 8 CoS values, which are defined by IEEE802.1p, to the priority queues in a switch. This series of switch has 8 priority queues. According to different queues, the switch will take different schedule policies to realize QoS.

If a CoS priority queue is set in global mode, the mapping of CoS priority queue on all ports will be affected. When priority queues are set on a L2 port, the priority queues can only work on this L2 port.

Enter the following privileged mode and run the following commands one by one to set DSCP mapping.

Command	Purpose
config	Enters the global configuration mode.
[no] cos map *quid cos1..cosn*	Sets the CoS priority queue. **quid** stands for the ID of a CoS priority queue. **cos1…cosn** stands for the IEEE802.1p-defined CoS value.
exit	Goes back to the EXEC mode.
write	Saves the settings.

1.3.2. Setting Global Cos to Local Priority Mapping

The command is used to set map inner CoS priority to the congestion bit.

Enter the following privileged mode and configure global CoS to local priority mapping.

Command	Purpose
config	Enters the global configuration mode.
[no] cos map-local-priority *cos-value1* {cos *cos-value2* | cng *cng-bit* }	Sets the local priority mapping of cos. *cos-value1* is cos value defined IEEE802.1p, 0-7. *cos-value2* is remapping inner priority cos, 0-7. *cng-bit* is congestion bit of cos mapping.
exit	Exit from management configuration mode.
write	Saving the configuration.

1.3.3. Setting the Bandwidth of the CoS Priority Queue

The bandwidth of priority queue means the bandwidth distribution ratio of each priority queue, which is set when the schedule policy of the CoS priority queue is set to WRR/DRR. This series of switches has 8 priority queues in total.

If this command is run, the bandwidth of all priority queues on all interfaces are affected. This command validates only when the queue schedule policy is set to WRR or DRR. This command decides the bandwidth weight of the CoS priority queue when the WRR/DRR schedule policy is used.

Run the following commands one by one to set the bandwidth of the CoS priority queue.

Command	Purpose
config	Enters the global configuration mode.
[no] scheduler weight bandwidth *weight1...weightn*	Sets the bandwidth of the CoS priority queue**..** **weight1…weightn** stand for the weights of 8 CoS priority queues of WRR/DRR.

exit	Goes back to the EXEC mode.
write	Saves the settings.

1.3.4. Setting the Schedule Policy of the CoS Priority Queue

A switch has many output queues on each of its port. This series of switches has 8 priority queues. The output queues can adopt the following three schedule modes:

- SP (Sheer Priority): In this algorithm, only when the high-priority queue is null can the packets in the low-priority queue be forwarded, and if there are packets in the high-priority queue these packets will be unconditionally forwarded.
- In this mode, the bandwidth of each queue is distributed with a certain weight and then bandwidth distribution is conducted according to the weight of each queue. The bandwidth in this mode takes byte as its unit.
- The First-Come-First-Served queue algorithm, which is shortened as FCFS, provides service to those packets according to their sequence of arriving at a switch, and the packet that first arrives at the switch will be served first.

Enter the following configuration mode and set the schedule policy of CoS priority queue.

Command	Purpose
config	Enters the global configuration mode.
[no] scheduler policy { sp | wrr|wfq|fcfs }	Sets the schedule policy of the CoS priority queue. **sp** means to use the SP schedule policy. **Wrr** means to use the WRR schedule policy. **Fcfs** to use the FCFS schedule policy. **drr** means to use the DRR schedule policy.
exit	Goes back to the EXEC mode.
write	Saves the settings.

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1.3.5. Configuring the Minimum and Maximum Bandwidths of CoS Priority Queue

The minimum and maximum bandwidths of CoS priority queue can be modified through configuration. All the flows with a bandwidth less than the configured minimum bandwidth shall not be dropped, but the flows with a bandwidth bigger than the configured maximum bandwidth shall all be dropped.

Enter the privileged mode.

Command	Purpose
config	Enters the global configuration mode.
interface g0/1	Enters the to-be-configured port.
[no] cos bandwidth *quid min-bandwidth max-bandwidth*	**quid** stands for the priority queue. **min-bandwidth** means the minimum bandwidth. **max-bandwidth** means the maximum bandwidth.
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.
write	Saves the settings.

1.3.6. Setting the Default CoS Value of a Port

If the port of a switch receives a data frame without tag, the switch will add a default CoS priority to it. Setting the default CoS value of a port is to set the untagged default CoS value, which is received by the port, to a designated value.

Enter the privilege mode and run the following commands to set the default CoS value of a port:

Command	Purpose

config	Enters the global configuration mode.
interface g0/1	Enters the to-be-configured port.
[no] cos default *cos*	Sets the CoS value of the received untagged frames. **cos** stands for the corresponding CoS value.
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.
write	Saves the settings.

1.3.7. Setting the CoS Priority Queue of a Port

When a priority queue is set on a L2 port, the priority queue will be used by the L2 port; otherwise, you should conduct the configuration of a global CoS priority queue.

Enter the privilege mode and run the following commands to set the default CoS value of a port:

Command	Purpose
config	Enters the global configuration mode.
interface g0/1	Enters the to-be-configured port.
[no] cos map *quid cos1..cosn*	Sets the CoS priority queue. quid stands for the ID of a CoS priority queue. cos1…cosn stands for the IEEE802.1p-defined CoS value.
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.

1.3.8. Setting Cos Priority Queue Based on dscp

The command is used to remap cos queue based on dscp value, modify dscp and the congestion bit.

Enters the privileged mode and configures CoS of the port.

Command	Purpose
config	Enters the global configuration mode.
[no]dscp map *word* {dscp *dscp-value* | cos *cos-value* | cng *cng-bit* }	Word configures dscp range table. Dscp-value Configures re-mapped dscp value. Cos-value Configures priority cos of mapping. Cog-bit Configures congestion bit of mapping.
exit	Exit from the global configuration mode.
exit	Exit from the management configuration mode.

1.3.9. Setting QoS Policy Mapping

QoS policy mapping refers to use a certain rule (based on MAC layer or IP header information) to identify packets with certain characteristics and adopt a certain action.

Do as follows to set a QoS policy.

Enters the privileged mode and configures CoS policy mapping.

Command	Purpose
config	Enters the global configuration mode.
[no]policy-map *name*	Enters QoS policy table configuration mode. name The name of policy
exit	Exit from the global

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	configuration mode.
exit	Exit from the management mode.

1.3.10.   Setting the Description of the QoS Policy Mapping

Enter the privileged mode and run the following commands to set the description of a QoS policy mapping. This settings will replace the previous settings.

Command	Purpose
config	Enters the global configuration mode.
[no]policy-map *name*	Enters the configuration mode of the QoS policy map. name stands for the name of the policy.
description description-text	Sets the description of the QoS policy. description-text stands for the text to describe the policy.
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.

1.3.11.   Setting the Matchup Data Flow of the QoS Policy Mapping

The classification rule of the QoS data flow means the filtration rule configured by the administrator according to management requirements. It can be simple, for example, flows with different priorities can be identified by the ToS field of the IP packet's header, or complicated, for example, the packets can be classified according to the related information about the comprehensive link layer, the network layer and the transmission layer, such as the MAC address, the source address of IP, the destination address or the port ID of the application. In general, the classification standard is limited in the header of an encapsulated packet. It is rare to use the content of a packet as the classification standard.

Enter the policy configuration mode, set the match-up data flow of policy and replace the previous settings with this data flow according to the following steps:

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Command	Purpose
config	Enters the global configuration mode.
[no]policy-map name	Enters the configuration mode of the QoS policy map. name stands for the name of the policy.
description description-text	Sets the description of the QoS policy. description-text stands for the text to describe the policy.
classify {any | cos *cos* | icos *icos* | vlan *vlanid* | ivlan *ivlanid* | ethernet-type *ethernet-type* | precedence *precedence-value* | dscp *dscp-value* | tos *tos-value* | diffserv *diffserv-value* | ip *ip-access-list* | ipv6 *ipv6-access-list* | mac *mac-access-list* } no classify { cos | icos | vlan | ivlan | ethernet-type | precedence | dscp | tos | diffserv | ip | ipv6 | mac }	Matches up with any packet. Configures the matched COS value which ranges between 0 and 7. icos stands for the matched inner COS value which ranges between 0 and 7. vlanid stands for the matched VLAN, which ranges from 1 to 4094. ivlanid stands for the matched inner VLAN, which ranges from 1 to 4094. ethernet-type stands for the matched packet type, which is between 0x0600 and 0xFFFF. precedence-value stands for the priority field in tos of IP packet, which ranges from 0 to 7. dscp-value stands for the dscp field in tos of IP packet, which ranges from 0 to 63.

	tos-value stands for latency, throughput, reliability and cost fields in tos of IP packet, which ranges from 0 to 15. diffserv-value stands for the entire tos field. Ip-access-list stands for the name of the matched IP access list. The name has 1 to 20 characters. Ipv6-access-list stands for the name of the matched IPv6 access list. The name has 1 to 20 characters. Configures the name of the matched MAC access list. The name has 1 to -20 characters.
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.

1.3.12. Setting the Actions of the Match-up Data Flow of the QoS Policy Mapping

The actions to define the data flow mean to take corresponding actions to a data flow with compliance of the filtration rule, which include bandwidth limit, drop, update, etc.

Enter the privileged mode and run the following commands to set the action of a policy, matching up the data flow. The action will replace the previous settings.

Command	Purpose
config	Enters the global configuration mode.
[no]policy-map *name*	Enters the configuration mode

	of the QoS policy map. name stands for the name of the policy.
action{bandwidth *max-band* | {cir *commit-band* {bc *commit-burst-size* {be *peak-burst-size* | pir *pir-band* } } | [conform {forward | dscp *dscp-value*} | exceed {forward | drop | dscp *dscp-value* | discardable {green | yellow | red}} | violate {forward | drop | dscp *dscp-value* | discardable {green | yellow | red}}]} | cos *cos* | drop | dscp *dscp-value* | precedence *precedence-value* | forward | icos *icos* | ivlan {add *ivlanid* | del *ivlanid* | *ivlanid*} | cpicos | mac *mac-addr* | monitor *session-value* | queue *queue-value* | redirect *interface-id* | stat-packet | stat-byte | vlanID { add *vlanid* | *vlanid* }} no action {bandwidth | cir | cos | drop | dscp | precedence | forward | icos | ivlan | cpicos | mac | monitor | queue | redirect | stat-packet | stat-byte | vlanID}	max-band stands for the occupied maximum bandwidth. Sets the policing: cir commit-band stands for the certified bandwidth. bc commit-burst-size stands for the size of burst packet, which ranges from 4 to 4096Kb. be peak-burst-size stands for the size of peak burst, which ranges from 4 to 4096Kb. pir pir-band stands for the peak bandwidth, which ranges from 1 to 163840. conform {forward | dscp dscp-value} stands for a bandwidth guarantee action, among which forward means not to conduct any action and dscp means to change the dscp value. drop means to drop the matched packets. Sets the matched DSCP field to *dscp-value* 0~63. precedence-value stands for the priority field of tos in ip packet.0-7. Conducts no operations to the matched packets. Sets the matched COS field to

	cos-value 0-7. ivlanid is used to replace, add or delete the inner VLAN ID. cpicos means to replace the outer cos with inner cos. mac-addr is used to set the destination MAC address. session-value is used to set mirroring, which ranges from 1 to 4. queue-value is used to set the mapping queue, which ranges from 1 to 8. Redirects the egress port of the matched flow. stat-packet stands for the number of packets under statistics. stat-byte means the number of bytes under statistics. vlanID is used to replace or add the outer vlan ID, which ranges from 1 to 4094.
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.

1.3.13. Applying the QoS Policy on a Port

The QoS policy can be applied to a port; multiple QoS policies can be applied to the same port and the same QoS policy can also be applied to multiple ports. On the same port, the priorities of the policies which are earlier applied than those of the policies which are later applied. If a packet is set to have two policies and the actions are contradicted, the actions of the firstly matched policies. After a QoS policy is

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applied on a port, the switch adds a policy to this port by default to block other data flows, which are not allowed to pass through. When all policies on a port are deleted, the switch will automatically remove the default blockage policy from a port.

Enter the following privileged mode and run the following commands to apply the QoS policy.

Command	Purpose
config	Enters the global configuration mode.
interface g0/1	Enters the to-be-configured port.
[no] qos policy *name* { ingress|egress}	Applies the QoS policy on a port. name stands for the name of QoS policy mapping. *ingress* means to exert an influence on the ingress. *egress* means to exert an influence on the egress.
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.

1.3.14. Configuring the Trust Mode

In the global configuration mode, trust of cos, dscp or untrust can be configured. When the data maps to the queue, the trusted mode chosen by the global will be mapped to the queue. If the configured trust mode is untrust, the default priority of the packet will be mapped to the queue.

Enters the management mode and do as the following steps:

Command	Purpose
config	Enters the global configuration mode.
[no] qos trust { cos | dscp | untrust }	Configures the trust mode in the global configuration mode.

	untrust refers to untrust of any mode.
exit	Exit to the management configuration mode.

1.3.15. Displaying the QoS Policy Mapping Table

You can run the **show** command to display all or some designated QoS policy maps.

Run the following command in privileged mode to display the QoS policy mapping table.

Command	Purpose
show policy-map [*policy-map-name*]	Displays all or some designated QoS policy maps. policy-map-name stands for the name of QoS mapping table.

1.4. QoS Configuration Example

1.4.1. Example for Applying the QoS Policy on a Port

The following example shows how to set packet's cos to 2 on port g0/2:

```
ip access-list extended ipacl

permit ip 192.168.20.2 255.255.255.255 192.168.20.210 255.255.255.255

!

policy-map pmap

classify ip ipacl

action cos 2

!

interface g0/2

qos policy pmap ingress

!
```