QoS Configuration

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Chapter 1 QoS Configuration

If you care to use your bandwidth sufficiently 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 aforehand 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. This designation can be embodied in different modes, such as, use IP priority status setting in IP data packet. 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), Weighted Fair Queuing (WFQ) and First-Come-First-Served (FCFS).

1. 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.

2. 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.

3. Weighted Fair Queuing

Weighted Fair Queuing (WFQ) classifies the packet according to the priority of the traffic. It sets the egress bandwidth based on the weight of each traffic. The bigger the weight, the greater the bandwidth. Thus, it guarantees the fairness of priority services and embodies the weight of different priority services.

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4. 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

### 1. 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.

2. 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**.

Average queue length
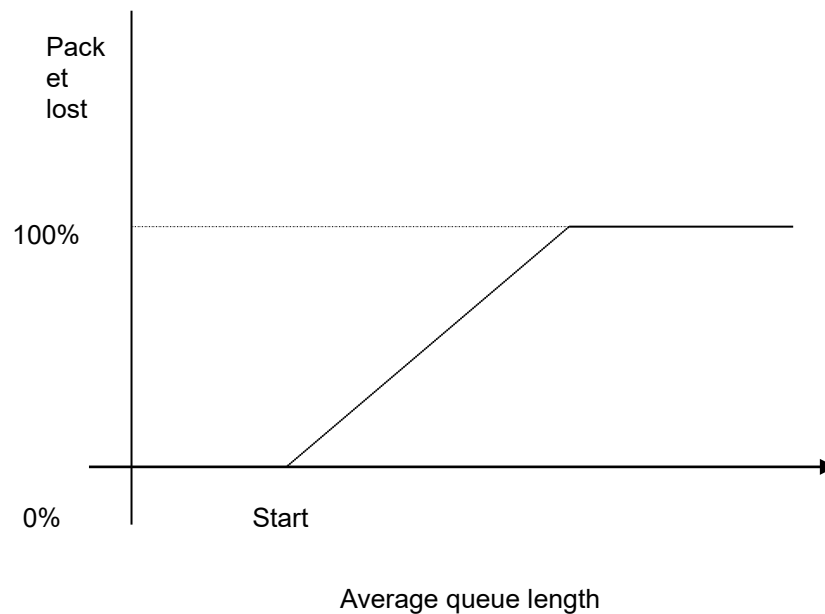
- When the queue length is less than **start**, packets will not be dropped.
- When the queue length is bigger than **start**, the incoming packets begin to be dropped randomly.The longer the queue is, the higher the dropping rate is.
- The rate for packet loss rises along with the increase of the queue 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 the Bandwidth of the cos Priority Queue

- Setting the Schedule Policy of the CoS Priority Queue

- Setting the Default cos Value of a Port

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- Setting the cos Priority Queue of a Port

- Setting the Bandwidth of the cos Priority Queue of a Port

- Setting the Schedule Policy of the cos Priority Queue f a Port

- Setting the CoS Priority Queue based on dscp

- 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

- Applying the QoS Policy on a global

- Configuring 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 management mode and run the following commands one by one to set CoS priority queue.

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.

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1.3.2 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 or wfq. 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 mode is set to WRR/WFQ. This command decides the bandwidth weight value of the CoS priority queue when the WRR/WFQ 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.

1.3.3 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 four 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.

- WRR (Weighted Round Robin) 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.

- WFQ (Weighted Fair Queuing) is an algorithm that brings each priority queue a certain bandwidth according to the priority of the flow.

- 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

Command	Purpose
	queue.
	sp means to use the SP schedule policy.
	wrr means to use the WRR schedule policy.
	wfq means to use the WFQ schedule policy.
	fcfs means to use the FCFS schedule policy.
exit	Goes back to the EXEC mode.
write	Saves the settings.

1.3.4 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 management 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.

1.3.5 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 management 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.

1.3.6 Setting the Bandwidth of a Port CoS Priority Queue

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

Enter the management mode and run the following commands one by one to set the CoS priority queue bandwidth of a port.

Command	Purpose
config	Enters the global configuration mode.
interface g0/1	Enters the to-be-configured port.
[**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 global configuration mode.
exit	Goes back to the EXEC mode.
write	Saves the settings.

1.3.7 Setting the Schedule Policy of a Port CoS Priority Queue

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

Enter the management mode and run the following commands one by one to set the CoS priority queue schedule policy of a port.

Command	Purpose
config	Enters the global configuration mode.
interface g0/1	Enters the to-be-configured port.
[**no**] **scheduler policy { sp	wrr|wfq }**	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. **wfq** means to use the WFQ schedule policy.

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	drr means to use the DRR schedule policy.
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.
write	Saves the settings.

1.3.8   Setting the CoS Priority Queue Based on DSCP

Based on the DSCP value, the COS queue is mapped again, the DSCP value is modified and the congestion bit is changed.

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

Command	Purpose
config	Enters the global configuration mode.
[no]dscp map *word* { cos *cos-value* } dscp	Word stands for the DSCP range table. Cos-value means to set the mapped priority CoS..
exit	Goes back to the global configuration mode.
exit	Goes back to the EXEC mode.

1.3.9   Establishing the QoS Policy Mapping

Flow classification means to identify a class of packets with certain attributes by applying a certain regulation and take designated actions towards to these packets.

Do as follows to set up a QoS policy.

Enter the management mode and then run the following commands to establish a new QoS policy mapping.

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.
exit	Exits from the global configuration mode.
exit	Goes back to the EXEC mode.

1.3.10 Setting the Description of the QoS Policy Mapping

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

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* |	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.

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mac *mac-access-list* } **no classify** { **cos** | **icos** | **vlan** | **ivlan** | **ethernet-type** | **precedence** | **dscp** | **tos** | **diffserv** | **ip** | **ipv6** | **mac** }	**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 Matchup 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 management 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* |**cos**	**max-band** stands for the occupied

cos | drop | dscp *dscp-value* | precedence *precedence-value* | forward | icos *icos* | ivlanID { add *addivlanid* | *ivlanid*}| monitor *session-value* | quequ *quequ-value* | redirect *interface-id* | stat-packet | stat-byte | vlanID { add *addvlanid* | *vlanid*} | copy-to-cpu}	maximum bandwidth: 1-163840. Unit: 64Kbps
	Configures policing.
	Cos: Configures the matching flow COS value; the valid range is 0 to 7.
	drop means to drop the matched packets.
	dscp-value: Sets the matched DSCP field to dscp-value 0~63.
no action {**bandwidth | cos | drop | dscp | precedence | forward | | icos | ivlanID | monitor | quequ | redirect | stat-packet | stat-byte | vlanID | copy-to-cpu**}	**precedence-value** stands for the priority field in tos of IP packet (5-7 of tos), which ranges from 0 to 7.
	Forward: Conducts no operations to the matched packets.
	Icos: Sets the matched COS field to cos-value 0-7.
	ivlanID used to replace or add the inner vlan ID, which ranges from 1 to 4094.
	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.
	Interface-id: 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.
	copy-to-cpu means to send message to CPU.
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 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 management 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 Applying the QoS Policy Globally

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

Command	Purpose
config	Enters the global configuration mode.
[**no**] **qos policy** *name* **ingress**	Applies the QoS policy globally.
	name stands for the name of QoS policy mapping.
	ingress means to exert an influence on the ingress.
exit	Goes back to the EXEC mode.

1.3.15 Configuring Trust Mode

When configuring the trust mode under the global configuration mode, there are three options: cos, dscp or untrust. The data will be mapped to the queue in the option chosen above. If choosing the option: untrust, the priority of the packet will be mapped to the queue by default.

Configuring the trust mode in EXEC mode as the following steps:

Command	Purpose
config	Enters the global configuration mode.
[**no**] **qos trust** { cos | dscp | untrust }	Configuring the trust mode in the global configuration mode. Untrust stand for not trust any modes.
exit	Goes back to the EXEC mode.

1.3.16   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 management mode to display the QoS policy mapping table.

Command	Purpose
show policy-map [*policy-map-name | interface | global*]	Displays all or some designated QoS policy maps. policy-map-name stands for the name of QoS mapping table. Interface stand for the QoS policy applied on a port. Global stand for the QoS policy for Global application.

1.4 QoS Configuration Example

1.4.1   Example for Applying the QoS Policy on a Port

The following example shows how to configure a QoS Policy that meet the IP access list 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 drop
interface g0/2
qos policy pmap ingress
```