

NFV 523-WBT vRouter Quality of Service

# NFV 523-WBT AT&T Vyatta 5600 vRouter Quality of Service

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Welcome to the AT&T vRouter Dynamic Multipoint VPN course.

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Before we begin the course, please take a moment to read our legal disclaimer.

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## Course Objectives

### After completing this course, you will be able to

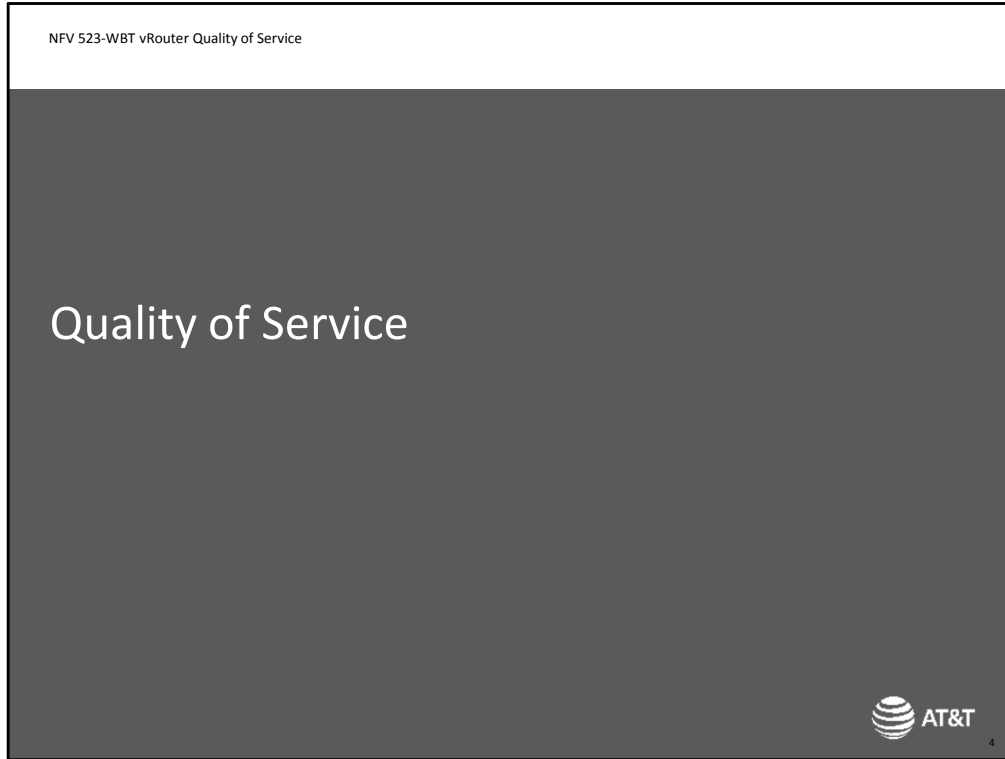
- Describe Quality of Service (QoS)
- Explain AT&T Vyatta vRouter 5600 QoS
- Describe the AT&T Vyatta vRouter 5600 default QoS queuing mechanism
- Configure a QoS policy
- Verify QoS operations

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After completing this course, you will be able to:

- Describe Quality of Service (QoS)
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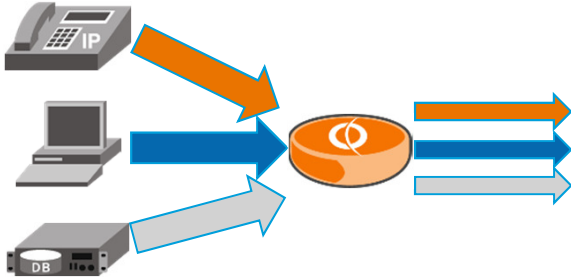
We'll begin with a discussion of the Quality of Service features and options available on the 5600 vRouter.

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## Quality of Service (QoS)

**QoS provides guarantees to services:**

- Reduces latency by limiting buffering
- Controls bandwidth to contracted service levels
- Prioritizes traffic based on application
- Limits certain traffic to help with Denial Of Service



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Quality of Service (or QoS) allows you to determine how you want the vRouter to handle data when you have more traffic than a link can support. QoS features are typically implemented to protect time-critical data such as voice over IP or streaming media transmissions, which cannot tolerate lost data or transmission delay. QoS is also used to provided guarantees to services by reducing latency by limiting buffering, controlling bandwidth to contracted service levels, prioritizing traffic based on application, and limiting certain traffic to help with Denial Of Service.

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## Why Use QoS?


### Without QoS:

- Traffic is first in, first out (FIFO)
- Traffic is directly forwarded to hardware
- All packets are equal
- Bandwidth is limited only by hardware
- Goal: maximum performance

### With QoS

- Traffic is categorized
- Different categories have different rules
- Bandwidth is controlled by software
- Goal: priority

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Let's take a look at how traffic is handled without QoS. Traffic is handled on a first in, first out basis. Traffic is directly forwarded to hardware and bandwidth is limited only by the hardware in the path. Without QoS all packets are treated equally. The goal in this scenario is maximum performance.

With QoS implemented, the traffic is categorized and these different categories have different rules assigned. With QoS, bandwidth is controlled by software. In this scenario the goal is to provide priority including dedicated bandwidth, controlled latency and jitter, and improved loss characteristics.

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## QoS Configuration - Policy

### QoS polices identify traffic flows and specify behavior to take

*Shaper* is currently the only type of policy implemented

```
set policy qos policy-name shaper burst | bandwidth |  
class | default | description | frame-overhead |  
profile | traffic-class | vlan
```

Must have a policy for default (no match) traffic

```
set policy qos policy-name shaper default default-name
```

### Interface configuration

Policies are applied outbound per interface

One policy per interface

Can have same policy on multiple interfaces

```
set interfaces dataplane dpxypyz qos-policy  
policy-name
```

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In the Vyatta vRouter 5600, QoS is configured in policies. Policies identify different traffic flows and the specific behavior to take on the traffic. Currently the only type of policy available for configuration is called shaper. QoS is currently only supported on data plane interfaces, not virtual or tunnel interfaces.

You must configure a default policy for any traffic that does not match the traffic specified in the shaper policy. If you do not configure a default policy, you will be given an error when you commit the QoS policy.

Once policies are configured they are applied outbound on a per interface basis. Though you can only have one policy per interface, you can assign the same policy to multiple interfaces.

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## QoS Configuration - Profiles

### Configure the shaper policy using profiles

Profiles describe different throughput groups

- For example, profiles can be configured per customer or per traffic type

```
set policy qos policy-name shaper profile profile-name burst  
| bandwidth | description | map | period | queue |  
traffic-class
```

Must have a profile for default policy (name of default profile)

```
set policy qos policy-name shaper profile default-name
```

Bandwidth settings configured per profile, expressed as:

- Number and suffix (i.e. 10Mbit, 1Mbps)
- If no bandwidth is specified the default is 100% (i.e. unlimited)

```
set policy qos policy-name shaper profile profile-name  
bandwidth value
```

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As a best practice you should configure the policy to use profiles to describe different throughput groups. For example, profiles can be configured per customer or per type of traffic. For example, you can configure profiles for premium traffic like VOIP, normal traffic, or guest traffic.

You must configure a profile for default traffic using the name of the default shaper created on the previous slide.

Configure bandwidth, burst, map, period, queue, and traffic-class settings under the profiles, for example, set the bandwidth per profile. If no bandwidth is specified, the default bandwidth is unlimited or 100%.



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## Queues

### The 5600 has 8 queues numbered 0-7

Each queue has a Traffic Class (strict-priority) from 0 (highest), to 3 (lowest)

Multiple queues in the same priority are serviced in weighted round-robin (WRR) mode

- WRR determines the proportion of bandwidth a queue receives

Each Traffic Class can be configured with its own bandwidth limit (fixed or percent)

### The default queue configuration at startup is 4 queues with strict-priority (0-3) sharing 100% bandwidth

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The Vyatta vRouter 5600 has 8 queues numbered zero through seven. Each queue has a strict-priority (or Traffic Class), priority 0 is the highest, and priority 3 is the lowest. If multiple queues have the same priority, they operate in weighted round-robin (WRR) mode. WRR mode determines the proportion of bandwidth a queue receives (1 to 100%). Each priority can be configured with its own fixed or percent of bandwidth limit. We will discuss the configuration of the bandwidth limit on the next slide. The default queue configuration on the 5600 is very basic, the vRouter initializes with 4 queues with strict-priority sharing 100% bandwidth.

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### Traffic Class

**Traffic Class describes the strict priority queue**

Can be configured per profile or per VLAN or per profile

**Traffic Class configuration nodes:**

Bandwidth can be expressed as:

- Number and suffix (i.e. 10Mbit, 1Mbps)
  - Number with no suffix is interpreted as kbits/sec
- Percent of line rate (i.e. 10%, 100%)


Burst size

- Consecutive bytes sent before re-evaluating the bandwidth (0 – 312500000)

Queue-limit

- Number of packets queued before dropping, must be greater than 0 (1 – 65535 bytes)

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Again, the traffic class describes the strict priority of the queue. This can be configured per VLAN or per profile. Each traffic class can be configured with a specific bandwidth, burst size and queue limit.

Configure a specific bandwidth using a number and suffix like 1Mbps. If no suffix is configured, the number is in Kilobits (kbit) per second.

The burst size is the consecutive bytes sent before re-evaluating the bandwidth. Burst size is configured as 0 through 312,500,000 bytes.

You can also configure a queue-limit. The queue-limit is the number of packets queued before dropping, the value must be greater than 0 bytes. The value can be configured as 1 to 65535 bytes.

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## Packet Prioritization

### Packets are assigned to a queue based on either:

Differentiated Services Code Point (DSCP) 0 – 63

- Differentiated Services (DS) field in the IP header indicates a 6-bit DSCP value for packet classification
- RFC 2474

Priority Code Point (PCP) 0 – 7

- IEEE 802.1Q 3-bit field indicating 802.1p class of service which maps to frame priority level
- 0 is the lowest level (background), 7 is the highest (network control)

### Default mapping is from DSCP (upper bits) to queue

This can be reconfigured using the `map` command per profile

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QoS mapping is based on priority for IPv4 or IPv6 traffic. Packets are mapped to queues based on either Differentiated Services Code Point (or DSCP) for IPv4 or IPv6 traffic, or IEEE 802.3 VLAN Priority Code Point (PCP) for tagged IPv4 traffic.

The default mapping is from DSCP to queue but this can be reconfigured per profile using the `map` command. We will discuss using the `map` command on the next slide.

For more information please review RFC 2474 for DSCP values, or the IEEE 802.1Q standard for PCP values.

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### Packet Prioritization Mapping

**map** command per profile maps packets to queue based on:

PCP value - IPv4 only, or

DSCP value - IPv4 and IPv6

- PCP mapping takes precedence over DSCP mapping

```
set policy qos policy-name shaper profile profile-name  
map dscp dscp-number to queue-number
```

```
set policy qos policy-name shaper profile profile-name  
map pcp pcp-number to queue-number
```

For more information on PCP and DSCP, please refer to the *AT&T Vyatta 5600 vRouter Software Documentation*

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To change the default mapping behavior you can use the `map` command per QoS profile. Use the `map dscp` command to change the association of a specific DSCP number to a specific queue. Likewise, use the `map pcp` command to change the association of a specific PCP value to a particular queue.

For more information on PCP and DSCP, please refer to the *AT&T Vyatta 5600 vRouter Software Documentation* on [www.AT&T.com](http://www.AT&T.com).

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### Random Early Detection (RED)

Random Early Detection (RED) as defined in RFC 2309 determines the likelihood of a packet dropped on the outgoing queue

Randomly drops packets when outbound interface shows signs of congestion

Packet drops signal the source to decrease transmission rate

RED is disabled by default

Can be enabled per Traffic Class

Unless RED is enabled, all traffic classes are drop-tail

- Drop-tail eliminates any class-based distinctions and processes all traffic on a strict first-in, first-out basis (FIFO)
- If outgoing traffic exceeds the volume of the queue, then excess traffic is dropped

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Random Early Detection, or RED, determines the likelihood of a packet to be dropped on an outgoing queue. RED will randomly drop packets when the outbound interface shows signs of congestion. These packet drops will then signal the source to decrease transmission rate. RED is disabled by default on the vRouter 5600, but it can be enabled per Traffic Class. When RED is disabled, all traffic classes are drop-tail. Drop-tail eliminates any class-based distinctions and processes all traffic on a strict first-in, first-out basis. If outgoing traffic exceeds the volume of the queue, then excess traffic is dropped. RED is defined in RFC 2309.

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## Bandwidth Configuration

### Bandwidth restrictions are supported at multiple levels of the CLI hierarchy (shaper, VLAN, Profile, and Traffic Class)

Bandwidth configured as percent, is the percent of bandwidth inherited from the parent node in the hierarchy

- This configuration is not allowed at *shaper* level of the hierarchy

Example: if the bandwidth for the shaper is 1Gbps, and the bandwidth for the profile is 50%, then the bandwidth for the profile is 500 Mbps

```
policy {
  qos testpolicy {
    shaper {
      bandwidth 1gbps
      profile testprofile {
        bandwidth 50%
      }
    }
  }
}
```

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As with many QoS configurations, bandwidth restrictions are supported at multiple levels of the CLI hierarchy. They can be applied at the shaper, VLAN, profile, and Traffic Class level. If bandwidth is configured as a percentage, this will be the percent of bandwidth inherited from the parent node in the hierarchy. For example, if the bandwidth for the shaper policy is 1Gbps, and the bandwidth for the profile under the policy is 50%, the bandwidth for the profile is 50% of 1Gbps, or 500 Mbps.

```
policy {
  qos testpolicy {
    shaper {
      bandwidth 1gbps
      profile testprofile {
        bandwidth 50%
      }
    }
  }
}
```

This does not pertain to the bandwidth configuration at the *shaper* level of hierarchy as it is the top of the hierarchy.

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### QoS Per VLAN

#### 5600 QoS can be configured per VLAN

Packets matching the VLAN tag are evaluated according to the QoS classification and scheduling policies for the VLAN

Untagged packets are evaluated according to non-VLAN QoS configuration

VLAN ID numbers range from 1 - 4094

```
set policy qos policy-name shaper vlan vlan-id
```

For more information on configuring QoS per VLAN, please refer to the *AT&T Vyatta 5600 vRouter Software Documentation*

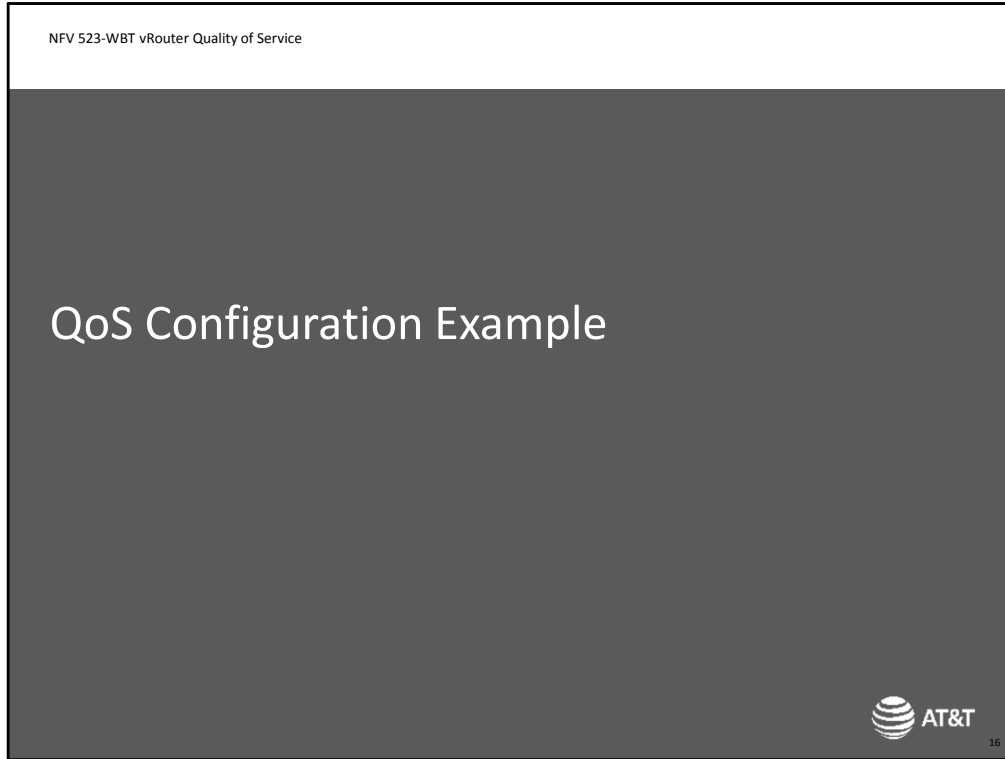
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We have been focusing on configuring QoS at the shaper profile level, but QoS can also be configured per VLAN. When configured per VLAN, packets matching the VLAN tag are evaluated according to the QoS classification and scheduling policies for the VLAN. Untagged packets are evaluated according to non-VLAN QoS configuration. Valid VLAN ID numbers range from 1 to 4094.

Use the `set policy qos policy-name shaper vlan vlan-id` command to configure QoS per VLAN.

For more information on configuring QoS per VLAN and other QoS options, please refer to the *AT&T Vyatta 5600 vRouter Software Documentation* on [www.AT&T.com](http://www.AT&T.com).



Let's put the information we just went over into a configuration example.



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### QoS Profile Scenario

#### Create a QoS policy with the following attributes

Limit bandwidth to 20 megabits per second (Mbps)

Define the maximum burst size to 50 bytes

#### Create a profile named *DSCP-Profile* to map DSCP value *af11* to queue 3

#### Create a default profile named *Default-Traffic*

Limit bandwidth to 10 megabits per second (Mbps)

#### Apply the policy to dataplane interface *dp0p1p1*

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In our example we will create a QoS policy with the following attributes:

- Limit bandwidth to 20 megabits per second (Mbps).
- Define the maximum burst size to 50 bytes.
- Create a profile named *DSCP-Profile* to map DSCP value *af11* to queue 3.
- Create a default profile named *Default-Traffic*.
- Apply the policy to data plane interface *dp0p1p1*.

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Configure Policy

**Configure QoS policy and shaper bandwidth**

```
set policy qos policy_name shaper bandwidth  
<number><suffix>
```

- Valid suffix values: mbit, mbps, gbit, kbps, gbps
- If no suffix defined, number is in kbits


**Configure shaper burst size in bytes (1 – 312500000)**

```
set policy qos policy_name shaper burst <value>
```

**Configure default QoS policy for no-match traffic**

```
set policy qos policy_name shaper default default_name
```

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Here we look at the commands used to configure the QoS policy. Each command uses the `set` command.

First configure the bandwidth at the shaper level of the hierarchy. Remember, if no suffix is defined, value is in kbits.

```
set policy qos policy_name shaper bandwidth <number><suffix>
```

Next, configure the shaper burst size in bytes (1 – 312500000)

```
set policy qos policy_name shaper burst <number>
```

Then, configure the default QoS policy for no-match traffic.

```
set policy qos policy_name shaper default default_name
```

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## Configure Profiles

### Configure a profile for DSCP mapping

```
edit policy qos policy_name shaper profile profile_name
```

Map DSCP value to queue 3

```
set map dscp dscp_value to queue_number
```

Define queue ID (0-7), and set traffic class (0-3)

```
set queue queue_number traffic-class TrafficClass_number
```


### Configure a profile for the default traffic

```
edit policy qos policy_name shaper profile default_name
```

Set the bandwidth for default traffic

```
set bandwidth <number><suffix>
```

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Here we show the commands to configure the profile for DSCP mapping. Note that we start with the `edit` command as all subsequent commands are set under the specified profile. We define the mapping of the DSCP value to the queue, define the queue ID with a value of 0 through 7, and the Traffic Class with a value of 0 through 3. We then configure a profile for the default traffic referencing the name of the default shaper configured on the previous slide, and set bandwidth for this profile.

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### Scenario Configuration

```
[edit]
vyatta@vyatta# set policy qos NewPolicy shaper bandwidth 20mbps
[edit]
vyatta@vyatta# set policy qos NewPolicy shaper burst 50
[edit]
vyatta@vyatta# set policy qos NewPolicy shaper default Default-Traffic
[edit]
vyatta@vyatta# edit policy qos NewPolicy shaper profile Default-Traffic
[edit policy qos NewPolicy shaper profile Default-Traffic]
vyatta@vyatta# set bandwidth 10mbps
[edit policy qos NewPolicy shaper profile Default-Traffic]
vyatta@vyatta# exit
[edit]
vyatta@vyatta# edit policy qos NewPolicy shaper profile DSCP-Profile
[edit policy qos NewPolicy shaper profile DSCP-Profile]
vyatta@vyatta# set map dscp af11 to 3
[edit policy qos NewPolicy shaper profile DSCP-Profile]
vyatta@vyatta# set queue 3 traffic-class 3
[edit policy qos NewPolicy shaper profile DSCP-Profile]
vyatta@vyatta# commit
[edit]
vyatta@vyatta# save
```

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<click> We begin by creating a policy shaper called *NewPolicy*, and create the bandwidth and burst values.

<click> Next, we create the shaper for default traffic called *Default-Traffic*.

<click> Then, we use the `edit` command to create the default profile,

<click> and set the bandwidth to 10mbps.

<click> We exit the default profile,

<click> and create a new profile for DSCP mapping called *DSCP-Profile* using the `edit` command.

<click> Now, we map DSCP value `af11` to queue 3, <click> and set the traffic class on queue 3 to 3,

<click> We are done with the QoS settings so we commit and save the configuration.


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Applying the Policy

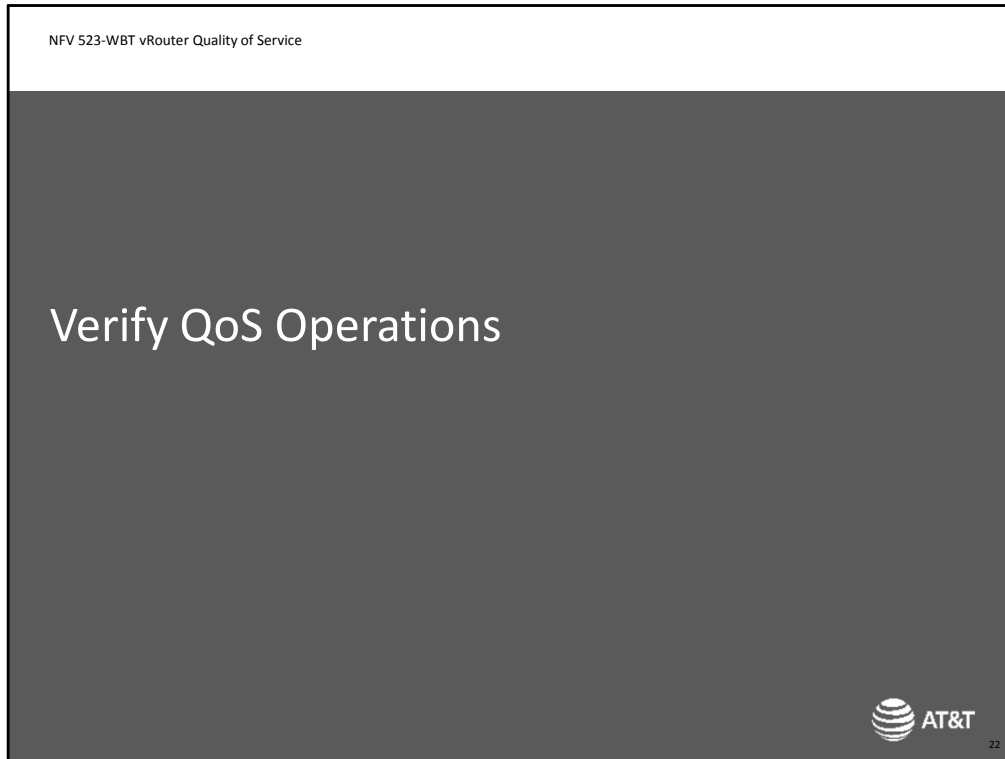
Apply the QoS policy to the interface

```
[edit]
vyatta@vyatta# set interfaces dataplane dp0p1p1 qos-policy NewPolicy
[edit]
vyatta@vyatta#
```

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Now that all policy configurations are saved, we apply the QoS policy named *NewPolicy* to the desired interface, in this case data plane interface 1.



Now that we have added a QoS policy to the vRouter, we can verify the operations.

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Display Outgoing Packet Actions

Use `show queuing dp0p1p1` to view outgoing packet actions


```
vyatta@vyatta:~$ show queuing dp0p1p1
```

Interface	Prio	Packets	Bytes	Tail-drop	RED-drop
dp0p1p1	0	0	0	0	0
	1	16476820	5480368	173195	0
	2	0	0	0	0
	3	2516476820	2805480368	1732333195	0

```
vyatta@vyatta:~$
```

For more details on QoS and 5600 vRouter QoS configuration, please refer to the [AT&T Vyatta 5600 vRouter Software Documentation](#)

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Use the `show queuing` command with the desired interface, in this case data plane interface 1. The output displays the interface, the Traffic Classes or priorities (0 through 3), and the number of packets that have been sent outbound on the interface and dropped. Also notice that RED has a value of zero, meaning it is disabled. Remember that RED is disabled by default.

This course only provides an overview of QoS on the 5600 vRouter, for more details please refer to the [AT&T Vyatta 5600 vRouter Software Documentation](#) on [www.AT&T.com](http://www.AT&T.com).

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### Summary

#### You should now be able to

- Describe Quality of Service (QoS)
- Explain AT&T Vyatta vRouter 5600 QoS
- Describe the AT&T Vyatta vRouter 5600 default QoS queuing mechanism
- Configure a QoS policy
- Verify QoS operations

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This concludes the AT&T Vyatta 5600 vRouter Quality of Service course.

You should now be able to:

- Describe Quality of Service (QoS)
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- Describe the AT&T Vyatta vRouter 5600 default QoS queuing mechanism
- Configure a QoS policy
- Verify QoS operations

We hope that this information has been useful, and that you will take additional AT&T University courses in the future.

Thank you.



# End of Course – Quality of Service

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