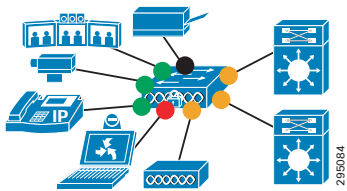


Roles in Campus Network

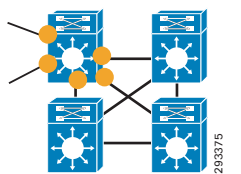
The Catalyst 9300 & 9400 Series switches are engineered to serve as access-layer switches in campus networks. As such, these switches may connect directly to a variety of endpoints and aggregation-layer switches, as shown in Figure 1.

Figure 1 Cisco Catalyst 9300 & 9400 Series Switches in a Campus Network



The Catalyst 9500 Series switches are engineered to serve as core or aggregation-layer switches in campus networks. As such, these switches may connect directly to other core, aggregation-layer, or access-layer switches, as shown in Figure 2.

Figure 2 Cisco Catalyst 9500 Series Switches in a Campus Network



● Trust DSCP
+ Egress Queuing

QoS Design Steps

There are two main steps to configure QoS on Cisco Catalyst 9000 Series switches:

1. Configure Ingress QoS Model(s):
 - Trust DSCP Model
 - Conditional Trust Model
 - Service Policy Models
2. Configure Egress Queuing
 - Queuing Models: 8Q3T, 1P7Q3T or 2P6Q3T

Step 1: Configure Ingress QoS Model(s)

The three most utilized ingress QoS models for campus networks are:

- Trust DSCP Model
- Conditional Trust Model
- Service Policy Models

Combinations of these ingress QoS models may be used at the same time.

Trust DSCP Model

Switch ports on the Catalyst 9000 Series default to a trusted state (shown as orange circles in Figures 1 and 2).

Conditional Trust Model

The Conditional Trust model configures the interface to dynamically accept markings from endpoints that have met a specific condition, such as a successful CDP negotiation (switch ports set to conditional trust are shown as green circles in Figure 1).

This model is suitable for switch ports connecting to:

- Cisco IP phones - **trust device cisco-phone**
- Cisco TelePresence Systems - **trust device cts**
- Cisco IP Video Surveillance cameras - **trust device ip-camera**
- Cisco Digital Media Players - **trust device media-player**

This model is also suitable for PCs and untrusted devices, since the ports connecting to such devices will remain in their default untrusted state (shown as black circles in Figure 1).

Service Policy Models

There may be cases where administrators require more detailed or granular policies on their ingress edges and as such they may construct MQC-based policies to implement classification, marking, and/or policing policies. These policies are constructed with:

- **class-maps** which identify the flows using packet markings, access-lists, NBAR2 classification, or other criteria

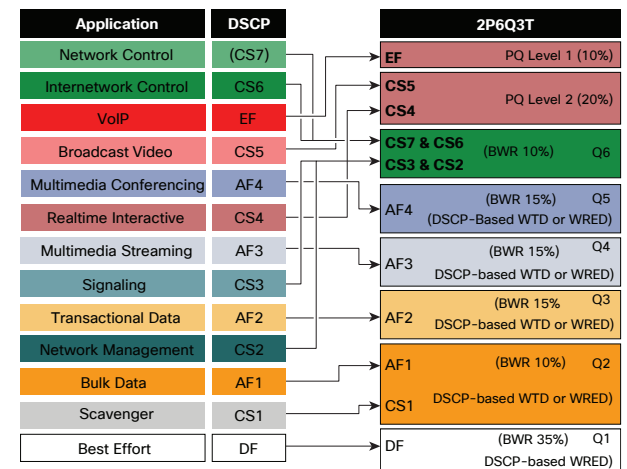
- **policy-maps** which specify policy actions to be taken on a class-by-class basis
- **service-policy** statements which apply a specific policy-map to an interface(s) and specify direction

On the Catalyst 9300 Series, service policies may be applied to switch ports (shown as red circles in Figure 1).

Step 2: Configure Egress Queuing for Switch Ports

Switch ports can be configured with an 8Q3T, 1P7Q3T, or 2P6Q3T egress queuing model. The only difference between the models is the number of priority queues configured via the **priority level 1** or **priority level 2** policy-map action commands.

Figure 3 Cisco Catalyst 9000 Series 2P6Q3T Egress Queuing Model



Both WRED and WTD are supported on Catalyst 9000 Series switches. WRED can be applied on up to four queues only. Additional queues can implement WTD if desired.

IOS XE 16.8.1 AVC / NBAR2 Policy Example

An example design for a Catalyst 9000 Series in the role of an access-layer switch in a campus network, using **match protocol attribute** commands and DSCP-based WRED is presented below.

Step 1: Configure Ingress QoS Model :**Trust DSCP Model:**

Switch Ports : <default>

Conditional Trust Model:

```
trust device cisco-phone or
trust device cts or
trust device ip-camera or
trust device media-player
```

Note: Yellow highlighted commands are interface specific; otherwise these are global.

Service Policy Models:

```
class-map match-all VOICE
  match protocol attribute traffic-class voip-telephony
  match protocol attribute business-relevance business-relevant
class-map match-all BROADCAST-VIDEO
  match protocol attribute traffic-class broadcast-video
  match protocol attribute business-relevance business-relevant
class-map match-all REAL-TIME-INTERACTIVE
  match protocol attribute traffic-class real-time-interactive
  match protocol attribute business-relevance business-relevant
class-map match-all MULTIMEDIA-CONFERENCING
  match protocol attribute traffic-class multimedia-conferencing
  match protocol attribute business-relevance business-relevant
class-map match-all MULTIMEDIA-STREAMING
  match protocol attribute traffic-class multimedia-streaming
  match protocol attribute business-relevance business-relevant
class-map match-all SIGNALING
  match protocol attribute traffic-class signaling
  match protocol attribute business-relevance business-relevant
class-map match-all NETWORK-CONTROL
  match protocol attribute traffic-class network-control
  match protocol attribute business-relevance business-relevant
class-map match-all NETWORK-MANAGEMENT
  match protocol attribute traffic-class ops-admin-mgmt
  match protocol attribute business-relevance business-relevant
class-map match-all TRANSACTIONAL-DATA
  match protocol attribute traffic-class transactional-data
  match protocol attribute business-relevance business-relevant
class-map match-all BULK-DATA
  match protocol attribute traffic-class bulk-data
  match protocol attribute business-relevance business-relevant
class-map match-all SCAVENGER
  match protocol attribute business-relevance business-irrelevant

policy-map NBAR-MARKING
  class VOICE
    set dscp ef
  class BROADCAST-VIDEO
    set dscp cs5
```

[Continued...]

```
class REAL-TIME-INTERACTIVE
  set dscp cs4
class MULTIMEDIA-CONFERENCING
  set dscp af41
class MULTIMEDIA-STREAMING
  set dscp af31
class SIGNALING
  set dscp cs3
class NETWORK-CONTROL
  set dscp cs6
class NETWORK-MANAGEMENT
  set dscp cs2
class TRANSACTIONAL-DATA
  set dscp af21
class BULK-DATA
  set dscp af11
class SCAVENGER
  set dscp cs1
class class-default
  set dscp default
```

Switch Port Application:

interface GigabitEthernet 1/0/1

service-policy input NBAR-MARKING

Step 2: Configure 8Q3T, 1P7Q3T or 2P6Q3T Egress Queuing on Switch Ports (2P6Q3T Example with WRED is shown) :

```
class-map match-any VOICE-PQ1
  match dscp ef
class-map match-any VIDEO-PQ2
  match dscp cs4
  match dscp cs5
class-map match-any CONTROL-MGMT-QUEUE
  match dscp cs7
  match dscp cs6
  match dscp cs3
  match dscp cs2
class-map match-any MULTIMEDIA-CONFERENCING-QUEUE
  match dscp af41
  match dscp af42
  match dscp af43
class-map match-any MULTIMEDIA-STREAMING-QUEUE
  match dscp af31
  match dscp af32
  match dscp af33
```

[Continued...]

```
class-map match-any TRANSACTIONAL-DATA-QUEUE
  match dscp af21
  match dscp af22
  match dscp af23
class-map match-any SCAVENGER-BULK-DATA-QUEUE
  match dscp af11
  match dscp af12
  match dscp af13
  match dscp cs1
```

policy-map 2P6Q3T-WRED

```
class VOICE-PQ1
  priority level 1
  police rate percent 10
class VIDEO-PQ2
  priority level 2
  police rate percent 20
class CONTROL-MGMT-QUEUE
  bandwidth remaining percent 10
  queue-buffers ratio 10
class MULTIMEDIA-CONFERENCING-QUEUE
  bandwidth remaining percent 15
  queue-buffers ratio 15
  queue-limit dscp af43 percent 80
  queue-limit dscp af42 percent 90
class MULTIMEDIA-STREAMING-QUEUE
  bandwidth remaining percent 15
  queue-buffers ratio 10
  queue-limit dscp af33 percent 80
  queue-limit dscp af32 percent 90
class TRANSACTIONAL-DATA-QUEUE
  bandwidth remaining percent 15
  queue-buffers ratio 10
  random-detect dscp-based
  random-detect dscp 18 percent 80 100
  random-detect dscp 20 percent 70 100
  random-detect dscp 22 percent 60 100
class SCAVENGER-BULK-DATA-QUEUE
  bandwidth remaining percent 10
  queue-buffers ratio 10
  random-detect dscp-based
  random-detect dscp 8 percent 60 100
  random-detect dscp 10 percent 80 100
  random-detect dscp 12 percent 70 100
  random-detect dscp 14 percent 60 100
class class-default
  bandwidth remaining percent 35
  queue-buffers ratio 25
  random-detect dscp-based
  random-detect dscp 0 percent 80 100
```

Switch Port Application:

interface GigabitEthernet 1/0/1

service-policy output 2P6Q3T-WRED