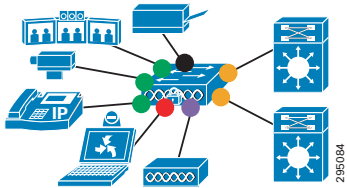


Role in Campus Network

The Catalyst 3650/3850 series switches are engineered to serve as a converged access switch in wired and wireless campus networks. As such, these switches may connect directly to a variety of endpoints and distribution-layer switches, as shown in Figure 1.

Figure 1 Cisco Catalyst 3650/3850 Switch in a Campus Network



QoS Design Steps

There are two main steps to configure QoS on Cisco Catalyst 3650/3850 series switches:

1. Configure Ingress QoS Model(s):
 - Trust DSCP Model
 - Conditional Trust Model (wired ports only)
 - Service Policy Models
2. Configure Egress Queuing
 - Wired Queuing Models: 1P7Q3T or 2P6Q3T
 - Wireless Queuing Model: 2P2Q+AFD

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

Wired ports on the Catalyst 3650/3850 default to a trusted state (shown as orange circles in Figure 1). Prior to IOS XE 3.3 SE wireless ports defaulted to an untrusted state. However, wireless ports could also be configured to be trusted by the global configuration command: **no qos wireless-default-untrust**.

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 or by access-lists or other criteria. As of IOS XE 16.3 NBAR2 classification on wired ports is also supported.
- **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

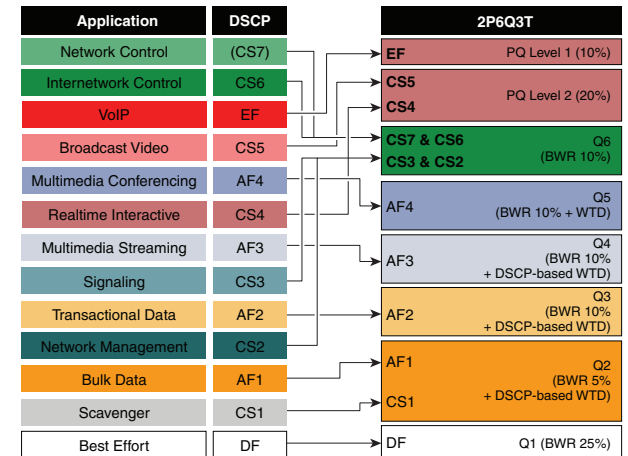
On the Catalyst 3650/3850, service policies may be applied to wired or wireless ports (shown as red circles in Figure 1) or to individual wireless clients (shown as purple circles in Figure 1).

Step 2a: Configure Egress Queuing for Wired Ports

Wired ports can be configured with a 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 2 Catalyst 3650/3850 2P6Q3T (Wired Port)

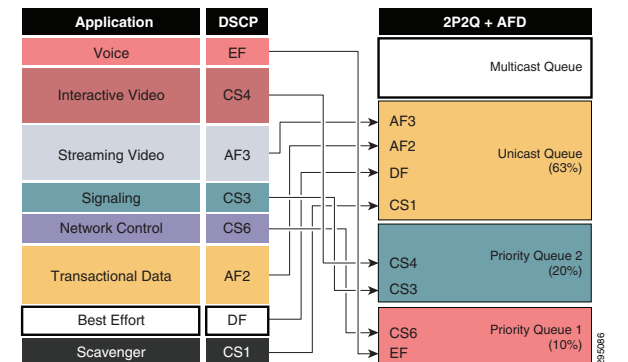
Egress Queuing Model



Step 2b: Configure Egress Queuing for Wireless Ports

The Catalyst 3650/3850 switch supports two levels of priority queueing on wireless ports, as well as one non-priority queue for unicast traffic and one non-priority queue for multicast traffic. The switch also supports a bandwidth control algorithm, Approximate Fair Drop (AFD), to provide fairness between radios, SSIDs, and even individual clients

Figure 3 Catalyst 3650/3850 2P2Q+AFD (Wireless Port) Egress Queuing Model



IOS XE 16.3 AVC / NBAR2 Policy Example

An example design for a Catalyst 3650/3850 series switch in the role of a converged access switch in a campus network are presented below.

Step 1: Configure Ingress QoS Model :

Trust DSCP Model:

Wired Ports : <default>

Wireless Ports: <default since IOS XE 3.3 SE>

Conditional Trust Model:

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

Service Policy Models(Wired):

```
class-map match-any VOICE
match protocol cisco-phone
match protocol cisco-jabber-audio
match protocol ms-lync-audio
match protocol citrix-audio
class-map match-any BROADCAST-VIDEO
match protocol cisco-ip-camera
class-map match-any REAL-TIME-INTERACTIVE
match protocol telepresence-media
class-map match-any CALL-SIGNALING
match protocol skinny
match protocol telepresence-control
class-map match-any TRANSACTIONAL-DATA
match protocol citrix
match protocol sap
class-map match-any BULK-DATA
match protocol attribute category email
match protocol attribute category file-sharing
match protocol attribute sub-category backup-systems
class-map match-any SCAVENGER
match protocol attribute category gaming
match protocol attribute application-group skype-group
```

```
policy-map NBAR-MARKING
class VOICE
set dscp ef
class BROADCAST-VIDEO
set dscp cs5
class REAL-TIME-INTERACTIVE
set dscp cs4
class CALL-SIGNALING
set dscp cs3
class TRANSACTIONAL-DATA
set dscp af21
class BULK-DATA
set dscp af11
class SCAVENGER
set dscp cs1
class class-default
set dscp default
```

Wired Port Application:

```
interface GigabitEthernet 1/0/1
```

```
service-policy input NBAR-MARKING
```

Wireless SSID Application:

```
wlan WLAN-1
```

```
service-policy input MARKER
```

Per-Wireless-Client Application:

```
wlan WLAN-1
```

```
service-policy client input MARKER
```

Step 2a: Configure 1P7Q3T or 2P6Q3T Egress Queuing on Wired Ports (2P6Q3T Example is shown) :

```
policy-map 2P6Q3T
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 10
queue-buffers ratio 10
queue-limit dscp af43 percent 80
queue-limit dscp af42 percent 90
queue-limit dscp af41 percent 100
```

```
class MULTIMEDIA-STREAMING-QUEUE
bandwidth remaining percent 10
queue-buffers ratio 10
queue-limit dscp af33 percent 80
queue-limit dscp af32 percent 90
queue-limit dscp af31 percent 100
class TRANSACTIONAL-DATA-QUEUE
bandwidth remaining percent 10
queue-buffers ratio 10
queue-limit dscp af23 percent 80
queue-limit dscp af22 percent 90
queue-limit dscp af21 percent 100
class SCAVENGER-BULK-DATA-QUEUE
bandwidth remaining percent 5
queue-buffers ratio 10
queue-limit dscp values af13 cs1 percent 80
queue-limit dscp values af12 percent 90
queue-limit dscp values af11 percent 100
class class-default
bandwidth remaining percent 25
queue-buffers ratio 25
```

Wired Port Application:

```
interface GigabitEthernet 1/0/1
```

```
service-policy output 2P6Q3T
```

Step 2b: Configure 2P2Q+AFD Egress Queuing on Wireless Ports :

```
policy-map port_child_policy
class non-client-nrt-class
bandwidth remaining ratio 7
class RT1
priority level 1
police rate percent 10
conform-action transmit
exceed-action drop
class RT2
priority level 2
police rate percent 20
conform-action transmit
exceed-action drop
class class-default
bandwidth remaining ratio 63
```

Note: This policy is applied automatically to all wireless ports and thus no explicit service-policy attachment statement is needed.

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