

## The Case for QoS Mapping in the Wireless LAN

As internet traffic is increasingly sourced-from and destined-to wireless endpoints, it is crucial that Quality of Service be aligned between wired-and-wireless networks; however, this is not always the case by default. This is due to the fact that two independent standards bodies provide QoS guidance on wired and wireless networks: specifically, the IETF offers design recommendations for wired IP networks, while a separate and autonomous standards-body, the IEEE, administers the standards for wireless 802.11 networks. As such, custom QoS mappings are required between IETF Differentiated Services Code Point (DSCP) and IEEE 802.11 User Priority (UP) markings to reconcile the design recommendations offered by these two standards bodies, and, as such, to optimize wired-and-wireless interconnect QoS.

There are three general options for wired/wireless QoS mapping:

- (Downstream) DSCP-to-UP Mapping
- (Upstream) UP-to-DSCP Mapping
- (Upstream) DSCP-Trust

Note: In AireOS, these options are combined with QoS Profiles, which can limit the maximum marking values in use to/from a given WLAN.

### DSCP-to-UP Mapping

Downstream DSCP-to-UP mapping is shown in Figure 1. By default, 6-bit DSCP values are mapped to 3-bit 802.11e UP values by taking the three Most-Significant Bits (MSB) of the DSCP and copying these as UP values. For example, the IETF recommended marking for voice (DSCP EF/46-binary 101110) is mapped by default to UP 5 (binary 101); which, incidentally is an IEEE recommended marking for video (IEEE marks voice as UP 6).

Note: To partially compensate for IETF/IEEE marking misalignments, AireOS implements some non-default mappings, as specified in the QoS Translation Table at:

[http://www.cisco.com/c/en/us/td/docs/wireless/controller/8-1/configuration-guide/b\\_cg81/b\\_cg81\\_chapter\\_01010111.html](http://www.cisco.com/c/en/us/td/docs/wireless/controller/8-1/configuration-guide/b_cg81/b_cg81_chapter_01010111.html)

### Upstream DSCP-to-UP Mapping

Upstream UP-to-DSCP mapping is shown in Figure 2. Conversely, in the reverse direction, UP values are simply multiplied by 8 (in order to shift these three binary bits to the left) to generate a DSCP value. Continuing the example, the IEEE recommended marking for voice (UP 6-binary 110) would be mapped by default (i.e., multiplied by 8) to DSCP CS6/48 (binary 110000); which, incidentally is an IETF recommended marking for network control traffic (rather than EF/46, the IETF marking for voice).

### Upstream DSCP Trust

Upstream DSCP trust is shown in Figure 3. To prevent information from being lost in translation (which can happen when converting 6-bit markings to/from 3-bit markings), as well to prevent IEEE UP markings to generate misaligned IETF DSCP markings, Cisco wireless access points can also be configured to Trust DSCP. In this example, a voice packet marked EF can likewise have its CAPWAP outer DSCP set to match.

Figure 1: Default Downstream DSCP-to-UP Mapping

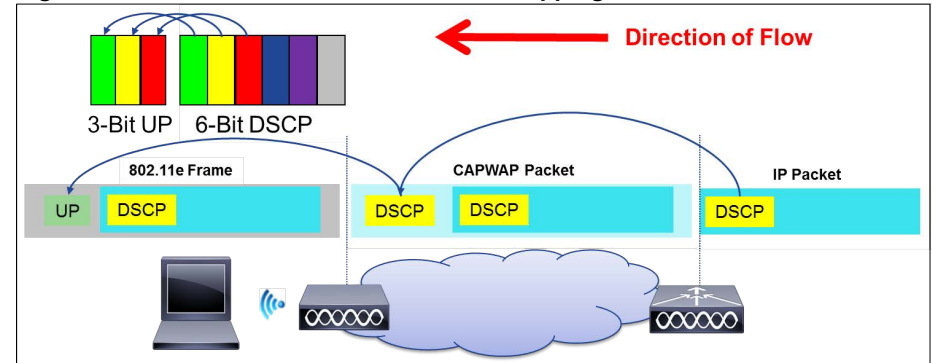


Figure 2: Default Upstream UP-to-DSCP Mapping

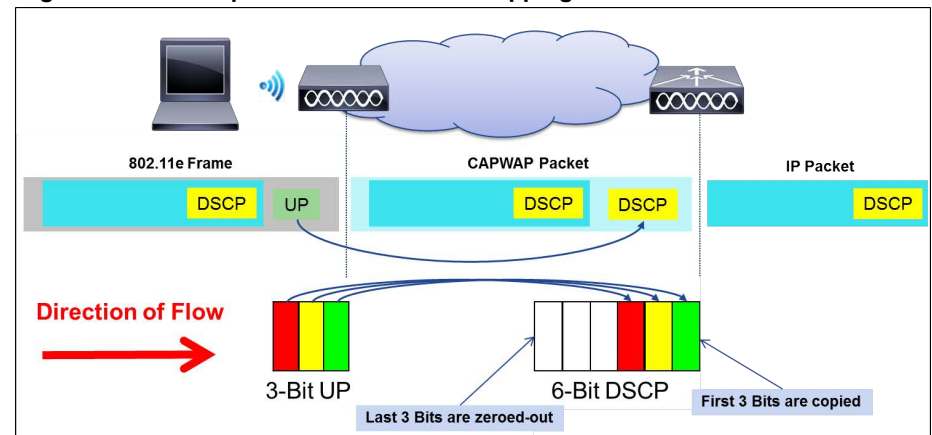
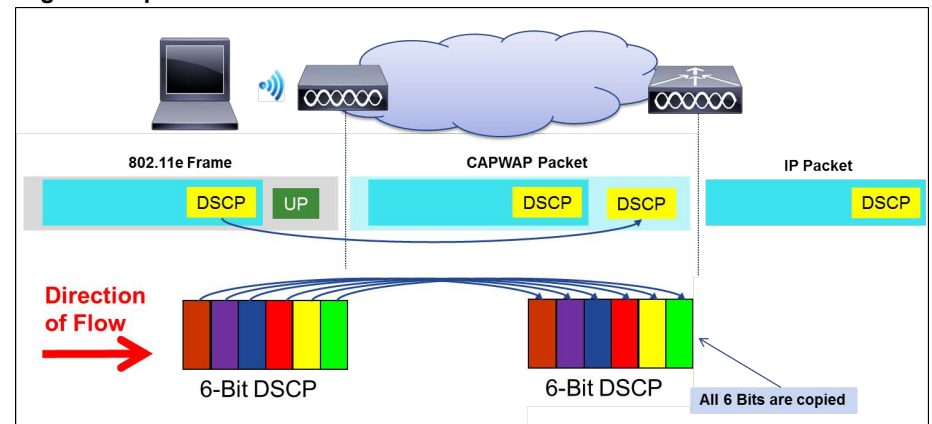


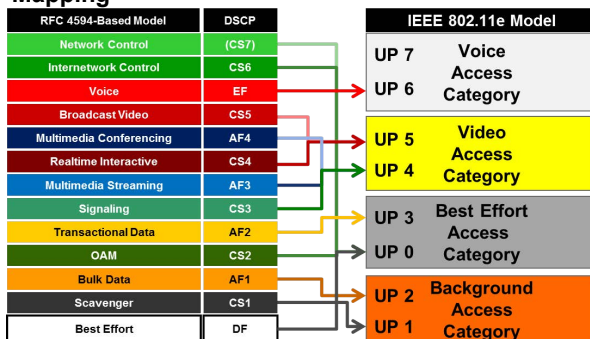
Figure 3: Upstream DSCP Trust



## Cisco DSCP<>UP QoS Mapping Recommendations

As previously mentioned, (Layer 2) IEEE and (Layer 3) IETF marking recommendations do not always align. For example, DSCP EF/46 is recommended by the IETF for use for voice, which would map by default to UP 5; but the IEEE designates UP 6 for voice. These discrepancies must be taken into account and reconciled in WLAN QoS designs, as shown in Figure 4 which presents Cisco's Recommended DSCP-to-UP Mappings.

**Figure 4: Cisco Recommended DSCP-to-UP Mapping**



Note: The details behind Cisco's recommendations for IETF/IEEE QoS Mapping are documented in the Internet Draft: <https://tools.ietf.org/html/draft-ietf-tsvwg-ieee-802-11-03>

In the upstream, Cisco recommends DSCP-trust, for the following reasons:

- This is a standards-based approach (per RFC 2474 and 2475)
- Most wireless device operating systems generate UP values by using the 3 MSB of the encapsulated 6-bit DSCP; then, at the access point, these 3-bit mappings are converted back into DSCP values; in such cases, information is lost in the transitions from 6-bit marking to 3-bit marking and then back to 6-bit marking; trusting the encapsulated DSCP prevents this loss of information
- A practical implementation benefit is also realized, as enabling applications to mark DSCP is much more prevalent and accessible to programmers of wireless applications vis-a-vis trying to explicitly set UP values, which requires special hooks into the wireless device operating system

## AireOS Recommended QoS Mapping Configuration

**Note: This requires AireOS 8.1MR+**

### Step 1: Disable the 802.11 Networks and the Current QoS Map

```
(Cisco Controller) > config 802.11a disable network
(Cisco Controller) > config 802.11b disable network
(Cisco Controller) > config qos qosmap disable
```

### Step 2: Configure the UP-to-DSCP Maps

Even though DSCP will be trusted in the upstream direction (rather than implementing UP-to-DSCP Maps), specifying the UP-to-DSCP maps is a syntactical requirement. Additionally, the first line also has the additional benefit of mapping the whole DSCP range (0-63) to UP 0.

```
(Cisco Controller) > config qos qosmap up-to-dscp-map 0 0 0 7
(Cisco Controller) > config qos qosmap up-to-dscp-map 1 8 8 15
(Cisco Controller) > config qos qosmap up-to-dscp-map 2 16 16 23
(Cisco Controller) > config qos qosmap up-to-dscp-map 3 24 24 31
(Cisco Controller) > config qos qosmap up-to-dscp-map 4 32 32 39
(Cisco Controller) > config qos qosmap up-to-dscp-map 5 34 40 47
(Cisco Controller) > config qos qosmap up-to-dscp-map 6 46 48 62
(Cisco Controller) > config qos qosmap up-to-dscp-map 7 56 63 63
```

### Step 3: Configure DSCP-to-UP Mapping Exceptions

Only the exceptions noted in Figure 4 will be explicitly mapped to various UP values; all remaining (unused) DSCPs will continue to be mapped to UP 0.

```
(Cisco Controller) > config qos qosmap dscp-to-up-exception 46 6
(Cisco Controller) > config qos qosmap dscp-to-up-exception 40 5
(Cisco Controller) > config qos qosmap dscp-to-up-exception 38 4
(Cisco Controller) > config qos qosmap dscp-to-up-exception 36 4
(Cisco Controller) > config qos qosmap dscp-to-up-exception 34 4
(Cisco Controller) > config qos qosmap dscp-to-up-exception 32 5
(Cisco Controller) > config qos qosmap dscp-to-up-exception 30 4
(Cisco Controller) > config qos qosmap dscp-to-up-exception 28 4
(Cisco Controller) > config qos qosmap dscp-to-up-exception 26 4
(Cisco Controller) > config qos qosmap dscp-to-up-exception 24 4
(Cisco Controller) > config qos qosmap dscp-to-up-exception 22 3
(Cisco Controller) > config qos qosmap dscp-to-up-exception 20 3
(Cisco Controller) > config qos qosmap dscp-to-up-exception 18 3
(Cisco Controller) > config qos qosmap dscp-to-up-exception 16 0
(Cisco Controller) > config qos qosmap dscp-to-up-exception 14 2
(Cisco Controller) > config qos qosmap dscp-to-up-exception 12 2
(Cisco Controller) > config qos qosmap dscp-to-up-exception 10 2
(Cisco Controller) > config qos qosmap dscp-to-up-exception 8 1
```

### Step 4: Enable DSCP-Trust, the New QoS Maps and the 802.11 Networks

```
(Cisco Controller) > config qos qosmap trust-dscp-upstream enable
(Cisco Controller) > config qos qosmap enable
(Cisco Controller) > config 802.11a enable network
(Cisco Controller) > config 802.11b enable network
```