DiffServ to IEEE 802.11 Mapping

draft-ietf-tsvwg-ieee-802-11-04

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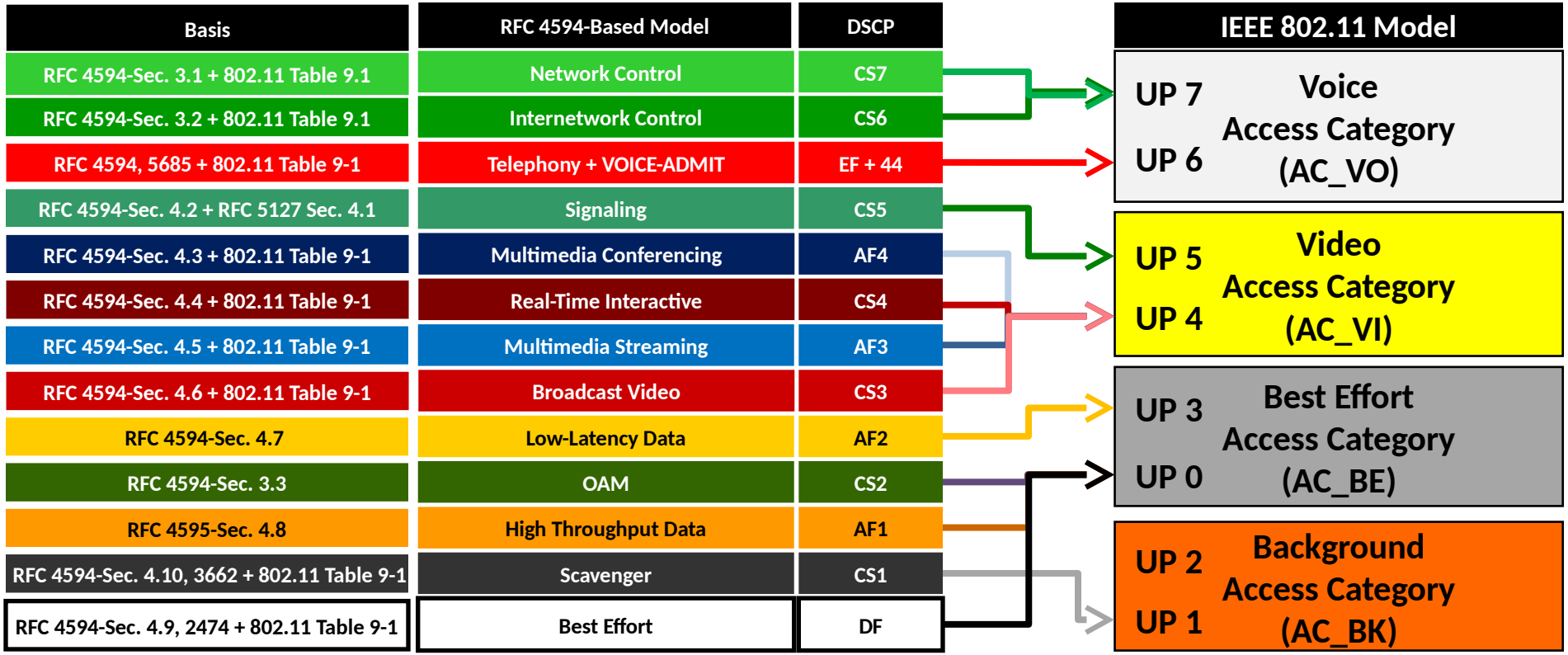
Problem Statement

- More traffic is sourced from wireless endpoints than wired*
- Quality of Service is not aligned between these networks
  - two independent standards bodies provide QoS guidance for these networks
- the purpose of this draft is to reconcile QoS recommendations
  - Goal: maintain consistent treatment between IP and 802.11 networks

*Source: **Cisco Visual Networking Index: Forecast and Methodology, 2016–2021 White-Paper**
http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html

Downstream DSCP-to-UP Mapping Model



https://tools.ietf.org/html/draft-ietf-tsvwg-ieee-802-11-04#section-4.3

Who is Using these Recommendations?

- **Cisco:** 10M+ APs running AireOS 8.1+ (2015 on)
- **Meraki:** 5M+ APs (2016 on)
- **Apple:** 688M+ iPhones/iPads running iOS 10+ (2016 on)
  ~100M+ Macs running MacOS 10.13 (fall 2017)

Sources:
Cisco Internal
Meraki Internal
https://www.apple.com/newsroom/2016/07/apple-celebrates-one-billion-iphones/
https://www.thurrott.com/mobile/ios/64193/apples-active-installed-base-in-now-over-1-billion-strong 'iOS user base … around 800M+'
https://developer.apple.com/support/app-store/ "86% of [iOS] devices are using iOS 10"
https://en.wikipedia.org/wiki/Usage_share_of_operating_systems#Worldwide_device_shipments

WGLC2 Pending Comments

- aversion to “trust”
- LE Draft
- Minor wording nits

Next Steps

- PS will be updated per all latest WGLC2 comments
- Request TSVWG chairs for a Shepherd Report and a recommendation to IESG

Appendix A:
WLAN QoS Considerations and Implementation Models

Why Consider Wireless QoS?

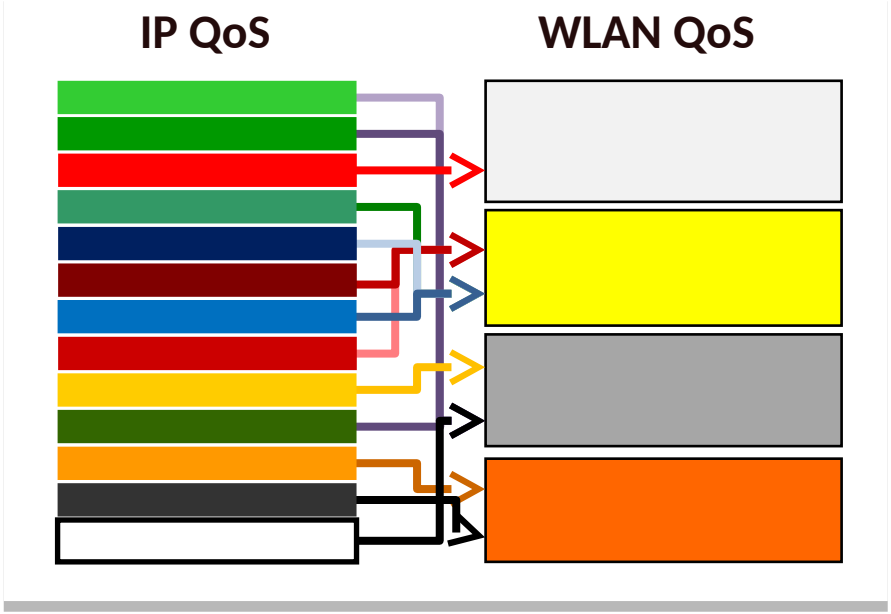
- QoS is like a chain:
  - it's only as strong as its weakest link

- The WLAN is one of the weakest links in QoS designs for three primary reasons:
  1) Typical downshift in speed (and throughput)
  2) Shift from full-duplex to half-duplex media
  3) Shift from a dedicated to a shared media

- WLAN QoS policies control ***both*** jitter and packet loss

Wireless QoS-Specific Limitations

- No EF PHB
- No AF PHB
- Non-deterministic media access
- Only 4 levels of service



WLAN QoS Improvements Quantified

Application	Original Metric	Improved Metric	Percentage Improvement
Voice	15 ms max jitter	5 ms max jitter	300%
	3.92 MOS (Cellular Quality)	4.2 MOS (Toll Quality)	
Video	9 fps	14 fps	55%
	Visual MOS: Good	Visual MOS: Excellent	
Transactional Data	14 ms latency	2 ms latency	700%

Reference: http://www.cisco.com/en/US/prod/collateral/wireless/cisco_avc_application_improvement.pdf

IEEE 802.11 User Priority (UP)

3 Bit Field allows for UP values 0-7

Reference: IEEE 802.11 Figure 8-1

IEEE 802.11 UP Values and Access Categories (AC)

IEEE 802.11 UP Value	IEEE 802.11 Access Category	Wireless Multimedia (WMM) Designation
7	AC_VO	Voice
6		
5	AC_VI	Video
4		
3	AC_BE	Best Effort
0		
2	AC_BK	Background
1		

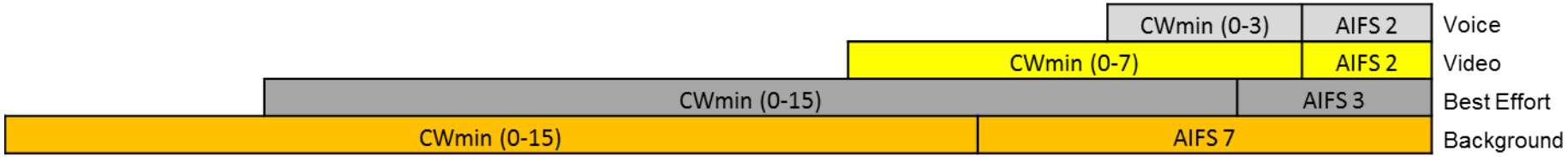
Reference: IEEE 802.11 Table 9-1

IEEE 802.11 Arbitration Inter-Frame Space (AIFS) & Contention Windows (CW)

- due to the nature of wireless as a shared media, a Congestion Avoidance algorithm (CSMA/CA) must be utilized
- wireless senders have to wait a ***fixed amount of time*** (the AIFS)
- wireless senders also have to wait a ***random amount of time*** (bounded by the Contention Window)
- AIFS and Contention Window timers vary by Access Category

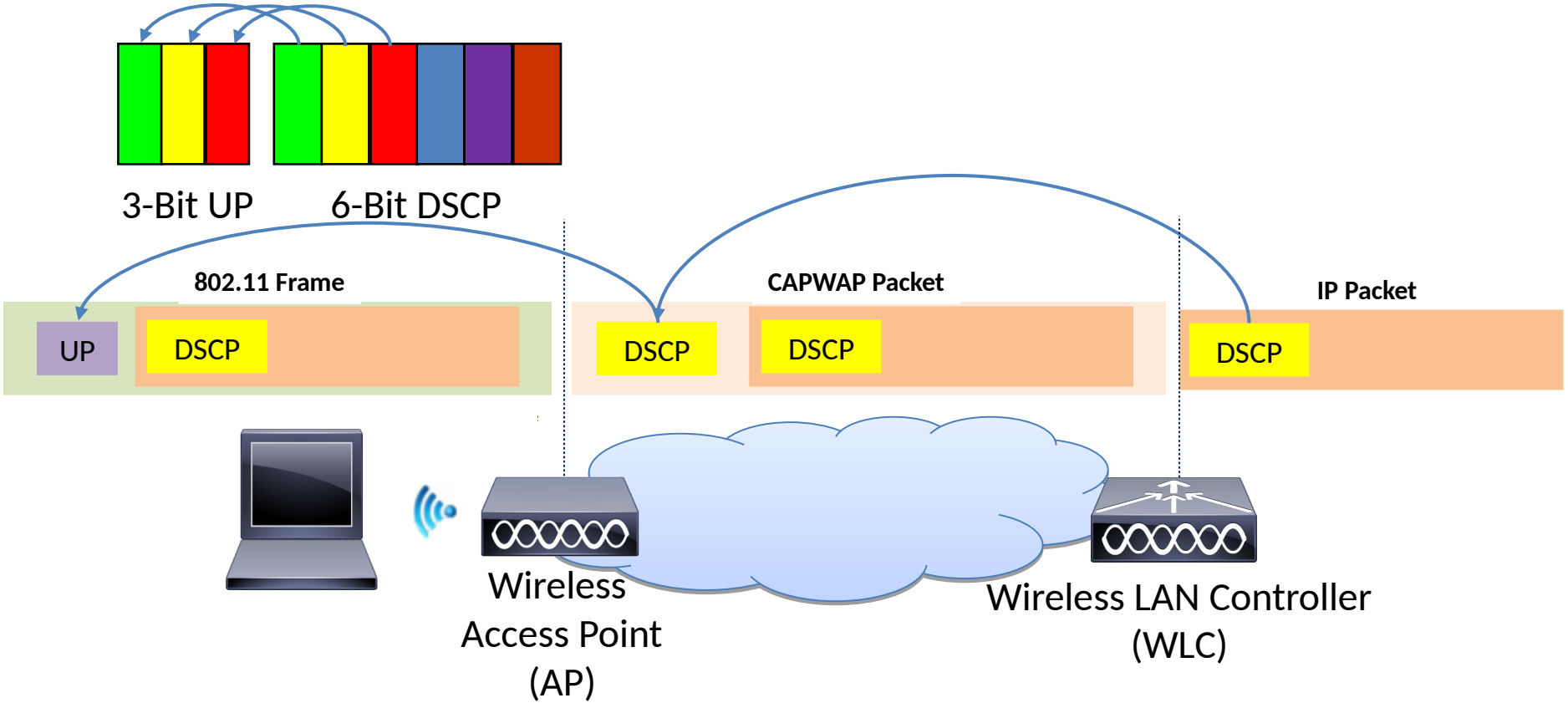
Access Category	AIFS (Slot Times)
Voice	2
Video	2
Best Effort	3
Background	7

Access Category	CWmin (Slot Times)	CWmax (Slot Times)
Voice	3	7
Video	7	15
Best-Effort	15	1023
Background	15	1023



Reference: IEEE 802.11 Table 8-105

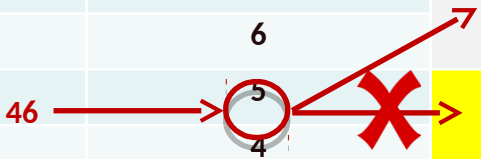
Downstream DSCP-to-UP **Default** Mapping



Default DSCP-to-UP Mapping Conflict Example

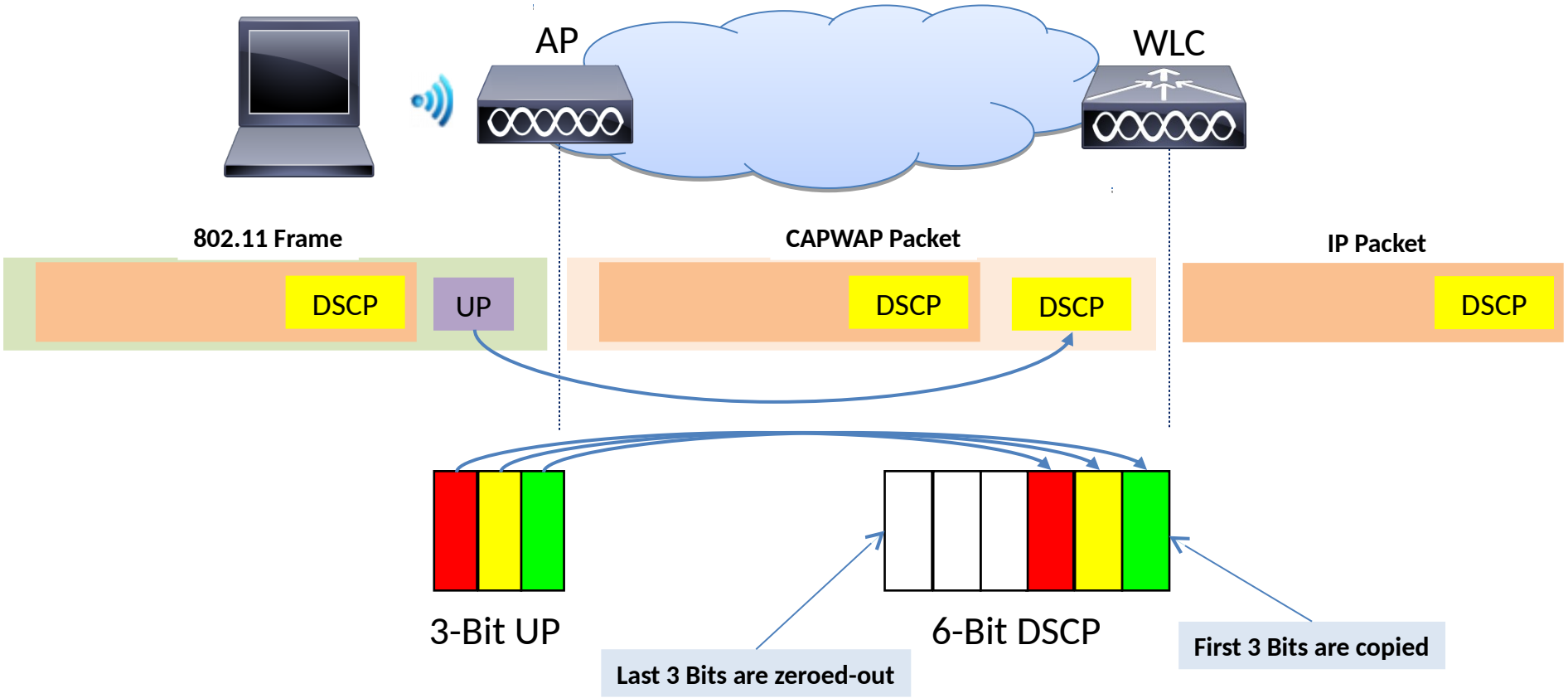
IETF PHB for VoIP: EF

DSCP	802.11 User Priority	802.11 Access Category
56-63	7	Voice (AC_VO)
48-55	6	
40-47	5	Video (AC_VI)
32-39	4	
24-31	3	Best Effort (AC_BE)
0-7	0	
16-23	2	Background (AC_BK)
8-15	1	

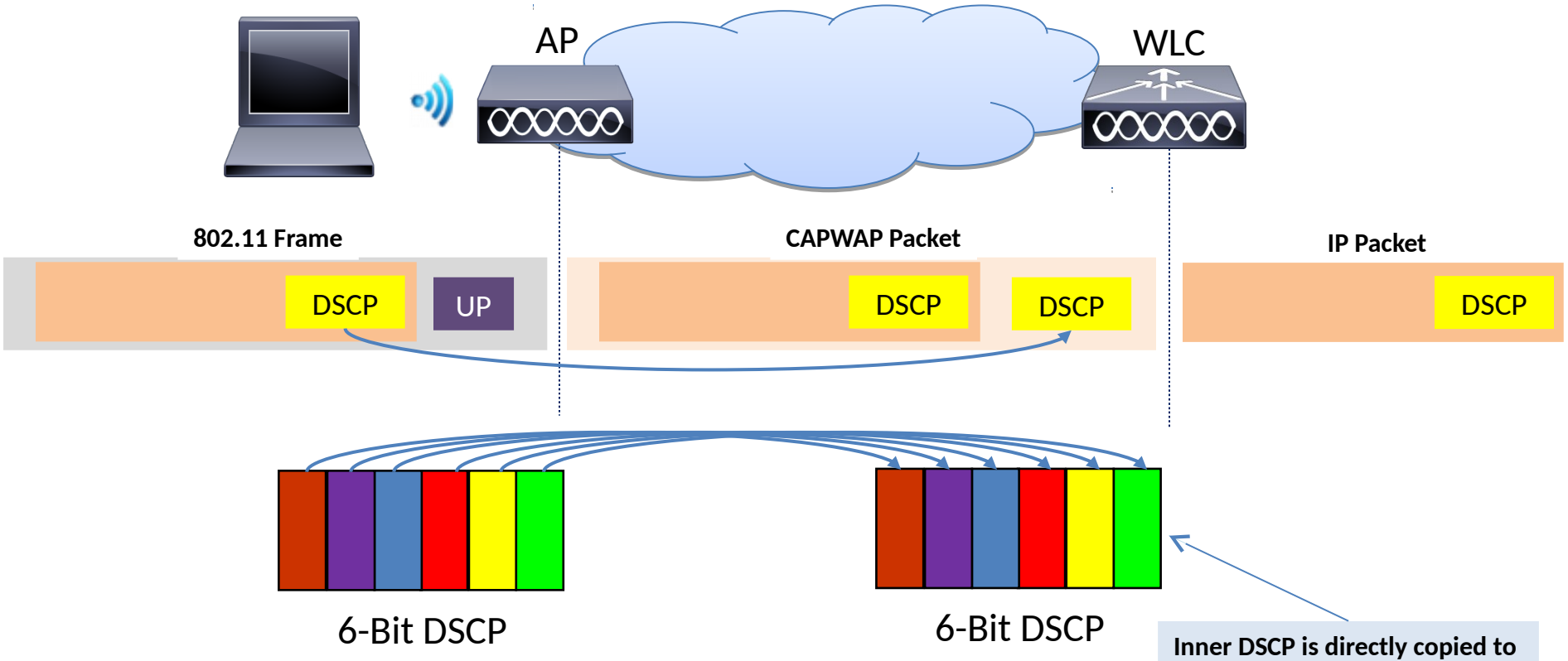


References: RRC 4594, RFC 3246, & IEEE 802.11 Table 9-1

Upstream UP-to-DSCP **Default** Mapping

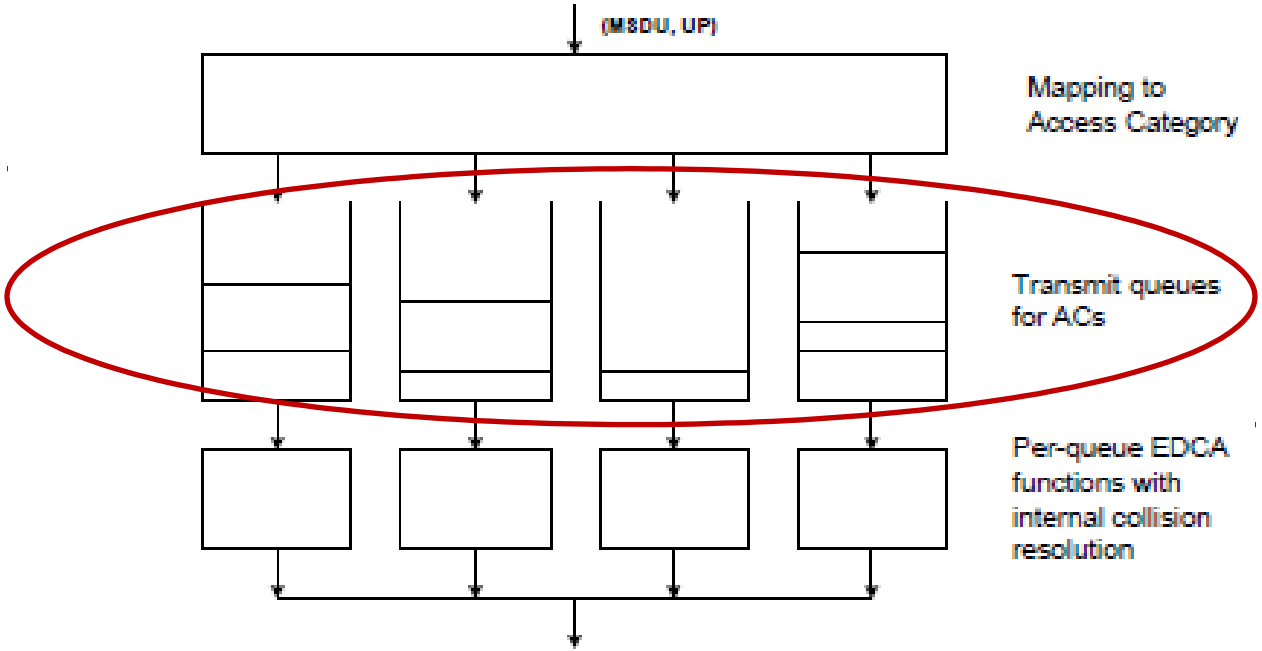


Upstream Model: DSCP-Trust



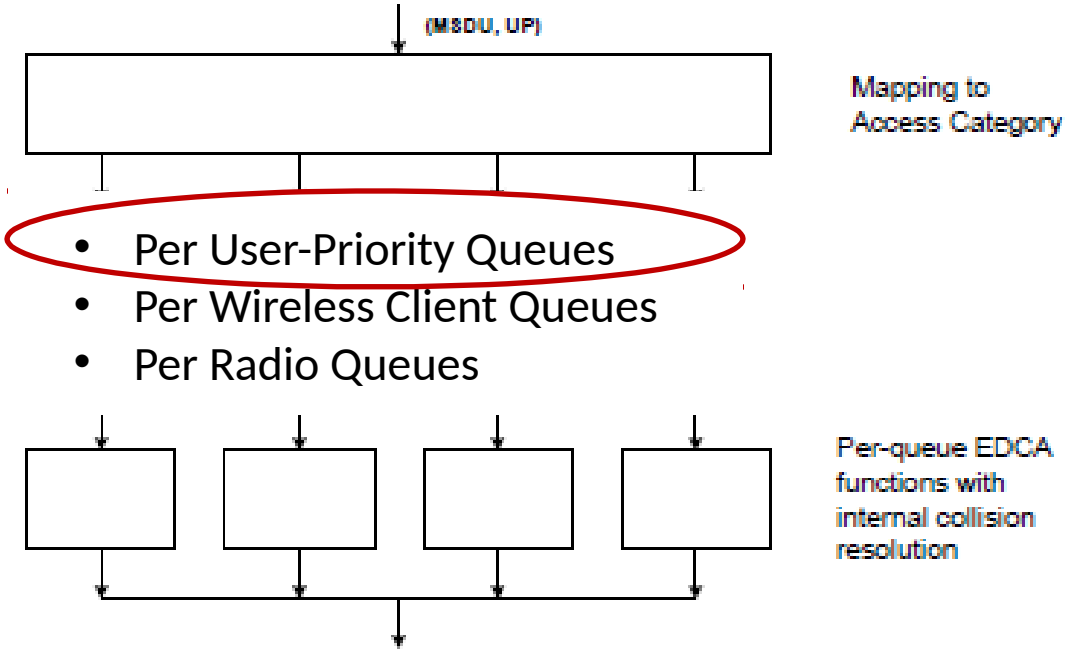
https://tools.ietf.org/html/draft-ietf-tsvwg-ieee-802-11-00#section-5.3

IEEE 802.11 **Reference** Implementation Model



Reference: IEEE 802.11 Figure 9-19

802.11 **Practical** Implementation Models



Reference: (Modified) IEEE 802.11 Figure 9-19

Appendix B:
Related Mapping Models

802.11 Example Enterprise
DSCP to UP/AC mapping

- These is an “example” mapping—not a “recommended” mapping per se
- Inconsistent interpretation of RFC 4594
- Inconsistent interpretation of 802.11
- Misleading to use 802.1d UP (vs. 802.11e UP)

Application Class	Per-hop behavior (PHB)	IEEE 802.1d User Priority	Access Category
Network Control	CS6	7	AC_VO
Telephony	EF	6	AC_VO
RT Interactive	CS4	6	AC_VO
Multimedia Conference	AF4x	5	AC_VI
Signaling	CS5	5	AC_VI
Broadcast Video	CS3	4	AC_VI
Multimedia Stream	AF3x	4	AC_VI
Low Latency Data	AF2x	3	AC_BE
High Throughput Data	AF1x	2	AC_BE
OAM	CS2	2	AC_BE
Standard	DF	0	AC_BE
Low Priority/Background	CS1	1	AC_BK

References: RFC 4594 & IEEE 802.11 Table V-2

IEEE 802.11 UP to DSCP Range
Mapping Example

- These are examples; not recommendations
- Several examples inconsistent with RFC 4594-expressed intent

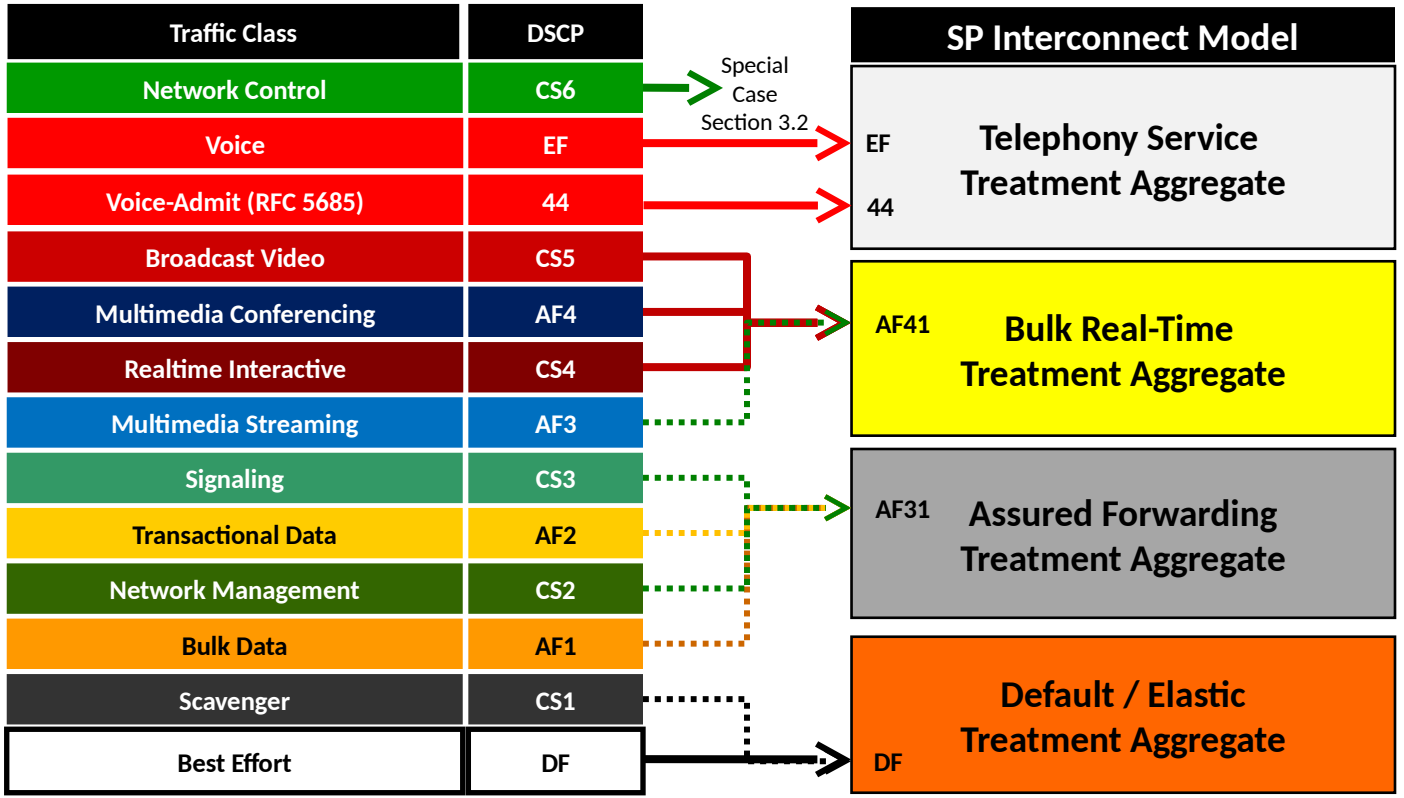
UP Range	DSCP Low		DSCP High
UP 0 Range	0	DF	0
UP 1 Range	1	CS1	9
UP 2 Range	10	AF1-CS2	16
UP 3 Range	17	AF2	23
UP 4 Range	24	CS3-AF3	31
UP 5 Range	32	CS4-AF4-CS5	40
UP 6 Range	41	EF	47
UP 7 Range	48	CS6-CS7	63

Notable PHB Inclusions

References: RFC 4594 & IEEE 802.11 Table V-3

DiffServ Interconnection Classes & Practice

- Proposes a simplified model for interconnecting SPs
- "Draws heavily" on RFC 5127
- Is intended for MPLS, but "is applicable to other technologies"
- This approach "is not intended for use *within* the interconnected (or other) networks"
- DSCPs may be remarked at the interconnection



References: draft-ietf-tsvwg-diffserv-intercon-01 & RFC 5127

Includes Recommendations from RFC 5127 (shown as dotted lines)

Appendix C:
Security Considerations

Security Considerations

Section 8

- The recommendations put forward in this document do not present any additional security concerns that do not already exist in wired and wireless devices
- In fact, several of the recommendations made in this document serve to mitigate and protect wired and wireless networks from potential abuse arising from existing vulnerabilities.

https://tools.ietf.org/html/draft-ietf-tsvwg-ieee-802-11-04#section-8

Security Considerations

Example WLAN DoS Attack 1

- **Attack Vector:** Flooding EF traffic
- **Attack Direction:** Downstream
- **Mitigation Strategy:** Policing EF marked packet flows, as detailed in [RFC2474] Section 7 and [RFC3246] Section 3

https://tools.ietf.org/html/draft-ietf-tsvwg-ieee-802-11-04#section-8.1

Security Considerations

Example WLAN DoS Attack 2

- **Attack Vector:** Non-Standard DSCP flooding to a preferred UP value (i.e. UP 4-7)
- **Attack Direction**: Upstream or Downstream
- **Mitigation Strategy:** It is RECOMMENDED that all packets marked to Diffserv Codepoints not in use over the wireless network be mapped to UP 0

https://tools.ietf.org/html/draft-ietf-tsvwg-ieee-802-11-04#section-8.2

Security Considerations

Example WLAN DoS Attack 3

- **Attack Vector:** Poorly programmed (or maliciously programmed) applications requesting their packets to be marked CS6 (network-control) or CS7 (reserved, network-control) by the wireless device OS, which otherwise is mapped to UP 7
- **Attack Direction**: Upstream
- **Mitigation Strategy:** It is RECOMMENDED that packets requesting a marking of CS6 or CS7 DSCP SHOULD be mapped to UP 0; furthermore, in such cases the wireless client operating system SHOULD remark such packets to DSCP 0 (this is because CS6 and CS7 DSCP, as well as UP 7 markings, are intended for network control protocols and these SHOULD NOT be sourced from wireless client endpoint devices)

https://tools.ietf.org/html/draft-ietf-tsvwg-ieee-802-11-04#section-5.1
https://tools.ietf.org/html/draft-ietf-tsvwg-ieee-802-11-04#section-8.2