Quality of Service · Part 1

Quality of Service Models

Best Effort · No QoS policies are implemented

Integrated Services (IntServ)
Resource Reservation Protocol (RSVP) is used to reserve bandwidth per-flow across all nodes in a path

Differentiated Services (DiffServ)
Packets are individually classified and marked; policy decisions are made independently by each node in a path

Layer 2 QoS Markings

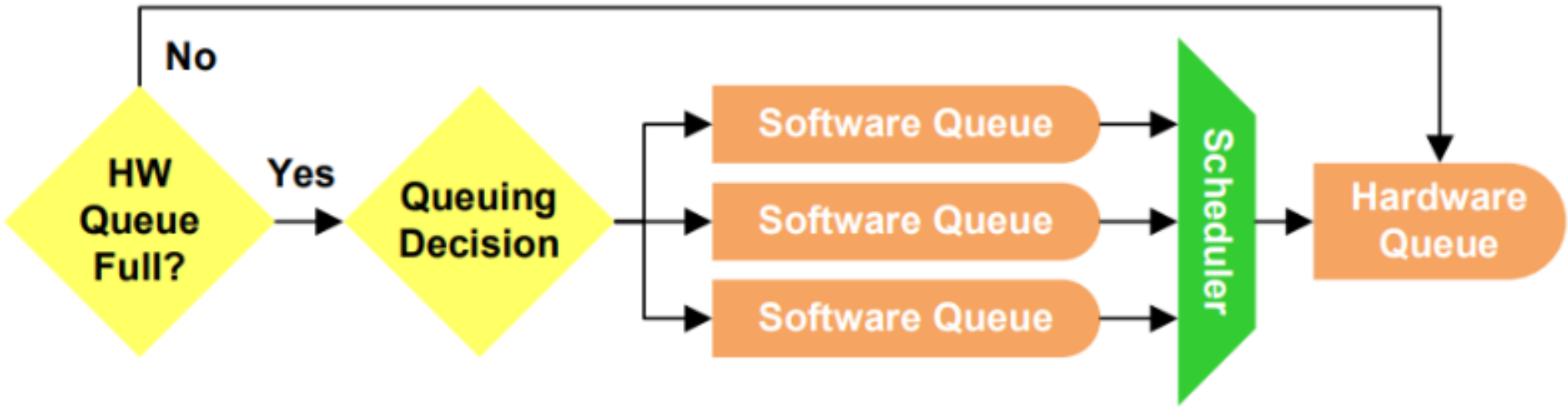
Medium	Name	Type
Ethernet	Class of Service (CoS)	3-bit 802.1p field in 802.1Q header
Frame Relay	Discard Eligibility (DE)	1-bit drop eligibility flag
ATM	Cell Loss Priority (CLP)	1-bit drop eligibility flag
MPLS	Traffic Class (TC)	3-bit field compatible with 802.1p

IP QoS Markings

IP Precedence
The first three bits of the IP TOS field; limited to 8 traffic classes

Differentiated Services Code Point (DSCP)
The first six bits of the IP TOS are evaluated to provide more granular classification; backward-compatible with IP Precedence

QoS Flowchart



Terminology

Per-Hop Behavior (PHB)
The individual QoS action performed at each independent DiffServ node

Trust Boundary · Beyond this, inbound QoS markings are not trusted

Tail Drop · Occurs when a packet is dropped because a queue is full

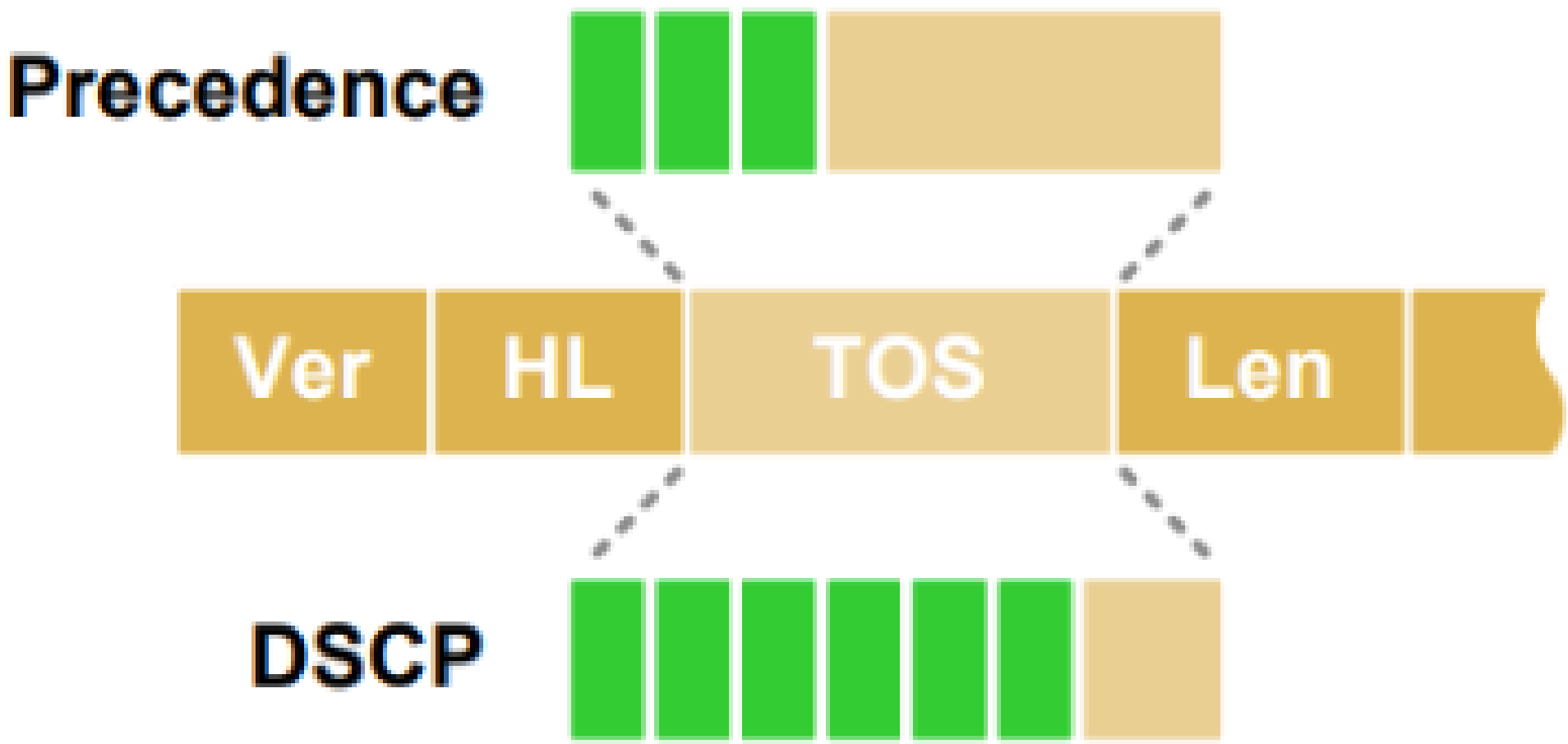
Policing
Imposes an artificial ceiling on the amount of bandwidth that may be consumed; traffic exceeding the policer rate is reclassified or dropped

Shaping
Similar to policing but buffers excess traffic for delayed transmission; makes more efficient use of bandwidth but introduces a delay

TCP Synchronization
Flows adjust TCP window sizes in synch, making inefficient use of a link

DSCP Per-Hop Behaviors
Class Selector (CS) · Backward-compatible with IP Precedence values
Assured Forwarding (AF) · Four classes with variable drop preferences
Expedited Forwarding (EF) · Priority queuing for delay-sensitive traffic

IP Type of Service (TOS)



Precedence/DSCP

	Binary	DSCP	Prec.
56	111000	Reserved	7
48	110000	Reserved	6
46	101110	EF	5
32	100000	CS4	4
34	100010	AF41	
36	100100	AF42	
38	100110	AF43	
24	011000	CS3	3
26	011010	AF31	
28	011100	AF32	
30	011110	AF33	

16	010000	CS2	2
18	010010	AF21	
20	010100	AF22	
22	010110	AF23	
8	001000	CS1	1
10	001010	AF11	
12	001100	AF12	
14	001110	AF13	
0	000000	BE	0

Congestion Avoidance

Random Early Detection (RED)
Packets are randomly dropped before a queue is full to prevent tail drop; mitigates TCP synchronization

Weighted RED (WRED)
RED with the added capability of recognizing prioritized traffic based on its marking

Class-Based WRED (CBWRED)
WRED employed inside a class-based WFQ (CBWFQ) queue