

QoS

A solution for a world
with multiple services



Who We are



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WHY ?

Q O S

NIKE QOS
BETTER
WORLD



Bandwidth growth

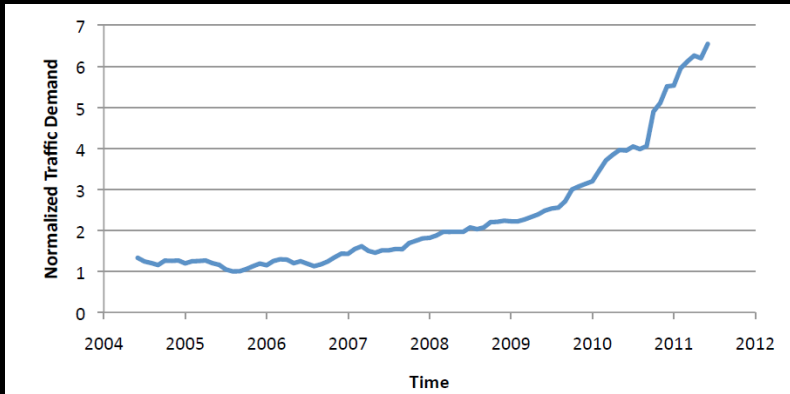


Figure 1. Monthly peak-time downstream network traffic, normalized to the minimum recorded level.

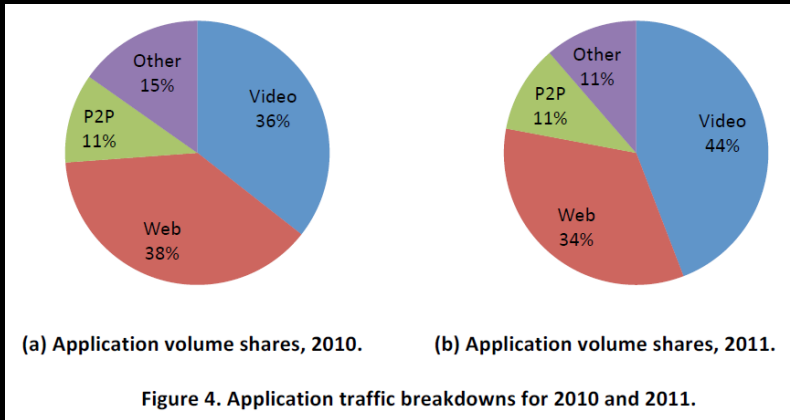
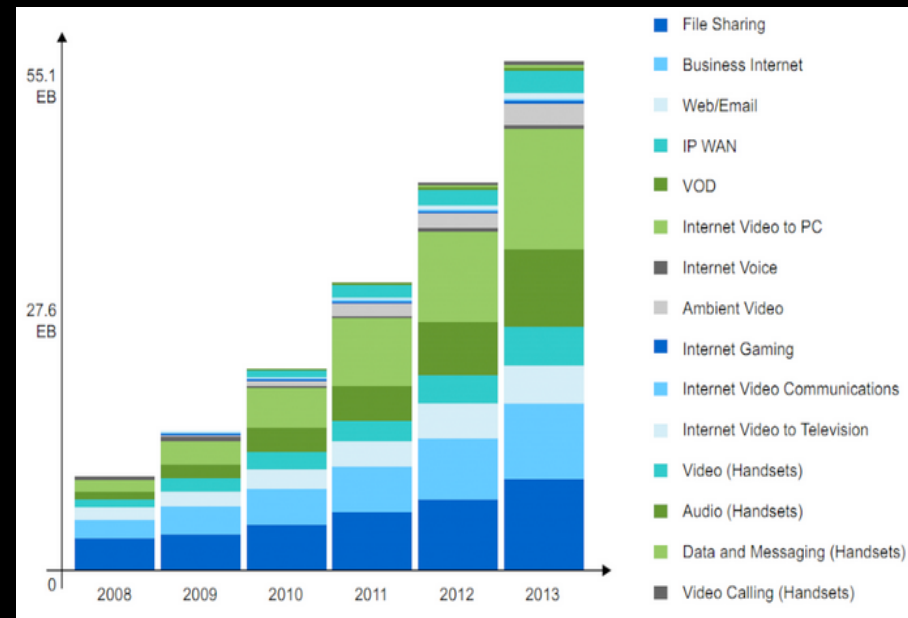


Figure 4. Application traffic breakdowns for 2010 and 2011.



The Enemies

- Delay
 - Serialization delay inversely proportional to BW
 - Shaping/Queuing delay (increases)
- Jitter
- Bandwidth congestion
- Packet Loss



The Victims

- VoIP, Videoconferencing
- Interactive Applications
- Business Critical Apps
- Network Management
- (P2P, illicit traffic)



The Saviours

- Shaping & Policing
- Queuing
- Congestion Avoidance
- Link Fragmentation & Interleaving ($< 2\text{Mbps}$)
- Header & Payload Compression ($< 2\text{Mbps}$)
- Admission Control
- Even More Bandwidth!



HOW ?

Implementing End-to-end QoS (DiffServices)

- Define Policies
- Classify & Mark
- Apply QoS Tools



Define Policies

LAN Categories:

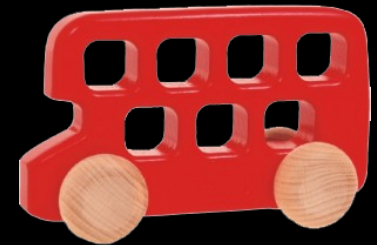
- Voice Payload
- Video Payload
- Voice & Video signaling
- Network Management
- Mission Critical Data
- Best-Effort
- Scavenger (less-than-best-effort)



Define Policies

ISP Categories:

- Gold
 - Low delay & jitter, Maximum BW
- Silver
 - Guaranteed BW, maximum delay & packet loss
- Bronze
 - Mass media Users



Comparing Requirements

Comparing Voice, Video, and Data QoS Requirements

	Bandwidth	Delay	Jitter	Loss
Voice Payload	Low to Medium	Low	Low	Low
Video Payload Interactive (2Way)	Medium	Low	Low	Low
Video Payload Streaming (1Way)	Medium to High	High	High	Low
Video Signaling	Low	Low	Medium	Medium
Voice Signaling	Low	Low	Medium	Medium
Data: Interactive, Mission Critical	Low to Medium	Low to Medium	Low to Medium	Medium to high
Data: Not Interactive, Mission Critical	Variable, typically high	High	High	Medium
Data: Interactive, Not Critical	Variable, typical medium	High	High	Medium
Data: Not Interactive, Not Critical	Variable, typically high	High	High	High

Classify

Where to classify: Define the Trust Boundaries

- At the Edges
- Perimeter
- At Distribution layer trust must be accepted!

Identify each App based on:

- Input interface
- MAC (or/dest)
- IP (or/dest)
- Port (or/dest)
- L7 Protocols



Marking

L2:

- CoS
- FR DE
- ATM CLP

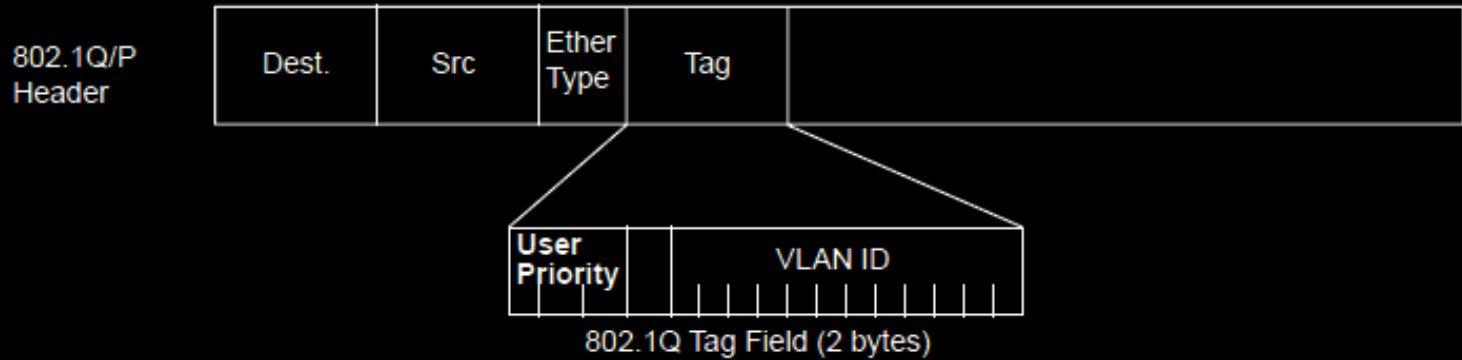
L3:

- IP Precedence, ToS Byte
- DSCP
- MPLS EXP

Remarking. PHB (Per Hop behaviour)



Marking - CoS



802.1p

Needs 802.1q tag

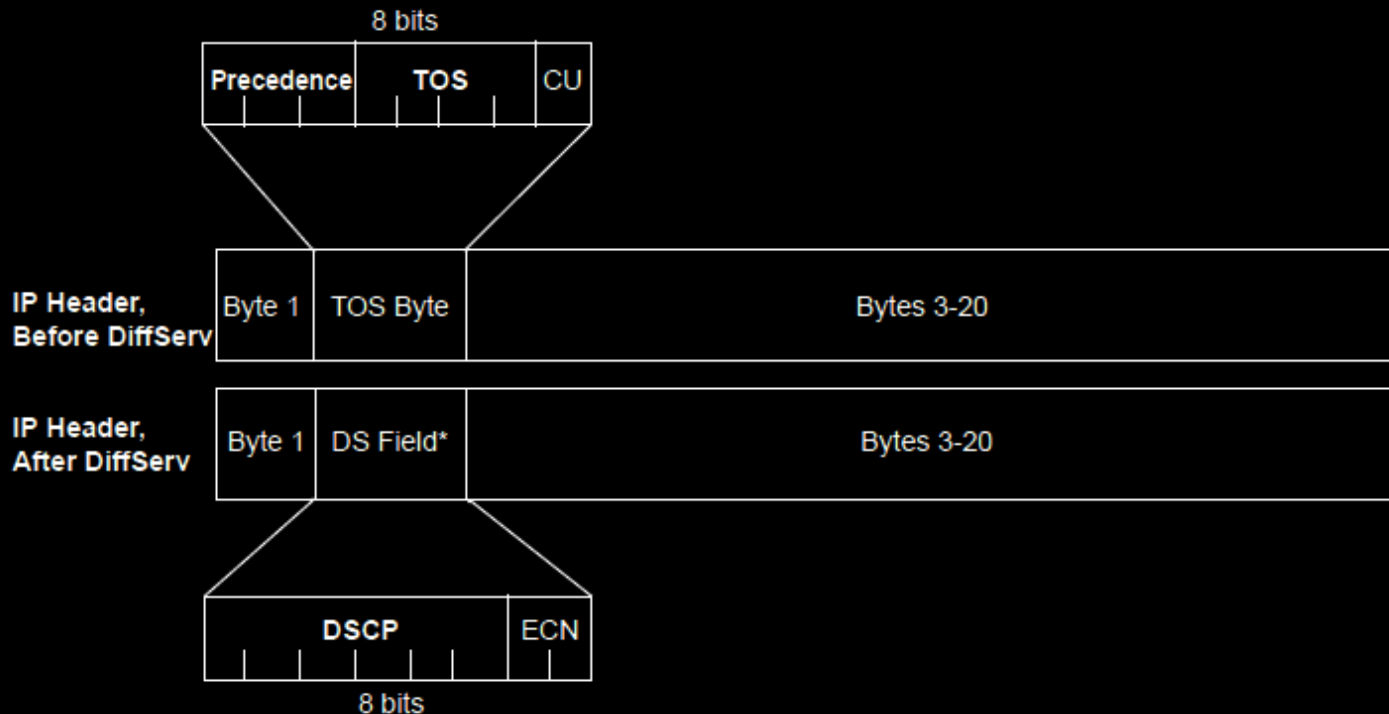
routine	0
priority	1
immediate	2
flash	3
flash-override	4
critic/critical	5
internet	6
network	7

Marking - IP Prec / DSCP

ToS Byte → IP Precedence 3 bits [0-7]

DSCP 6 bits (last bit is always 0) [0-62]

IP Precedence and IP DSCP Fields



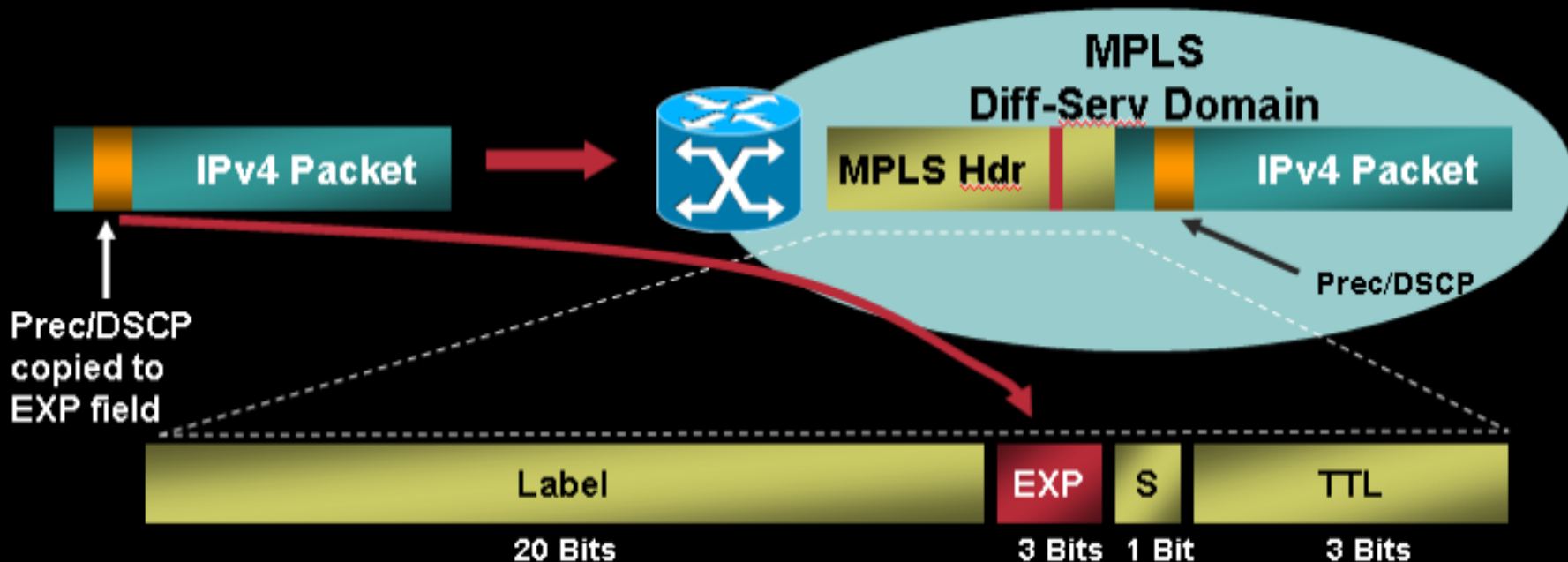
Marking - IP Prec / DSCP

DSCP Name	DS Field Value		IP Precedence
	Binary	Decimal	
CS0	000 000	0	0
CS1	001 000	8	1
AF11	001 010	10	1
AF12	001 100	12	1
AF13	001 110	14	1
CS2	010 000	16	2
AF21	010 010	18	2
AF22	010 100	20	2
AF23	010 110	22	2
CS3	011 000	24	3
AF31	011 010	26	3
AF32	011 100	28	3
AF33	011 110	30	3
CS4	100 000	32	4
AF41	100 010	34	4
AF42	100 100	36	4
AF43	100 110	38	4
CS5	101 000	40	5
EF	101 110	46	5
CS6	110 000	48	6
CS7	111 000	56	7

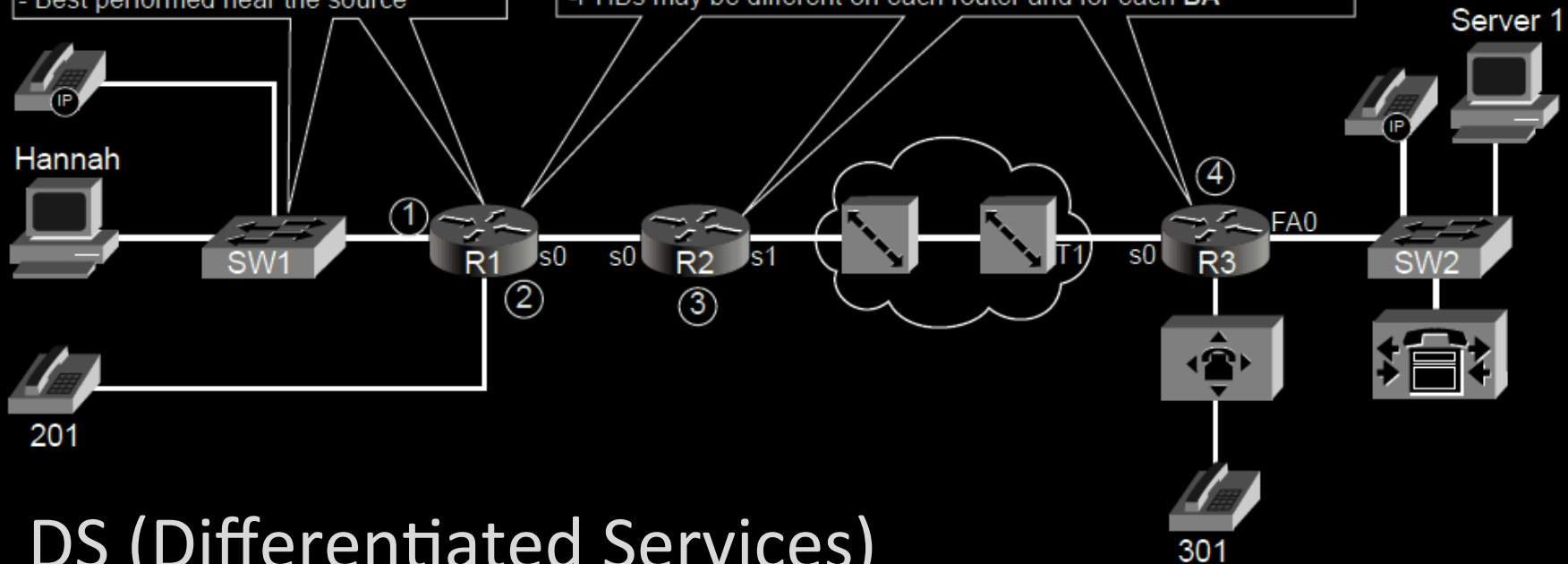
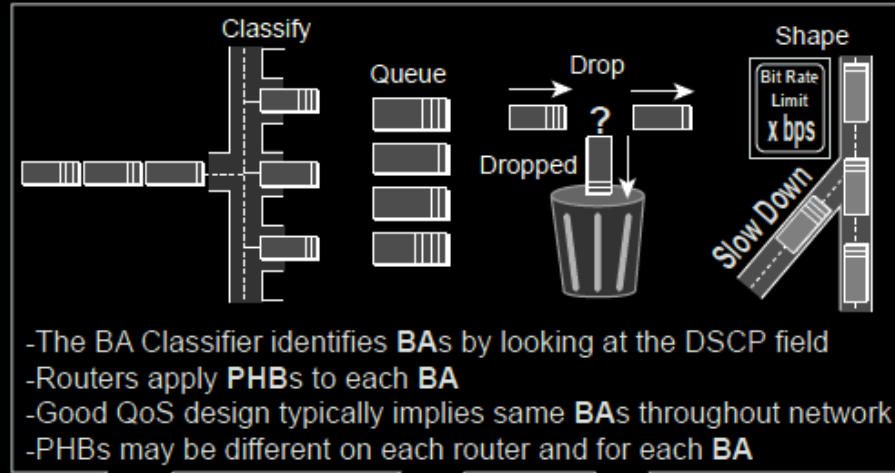
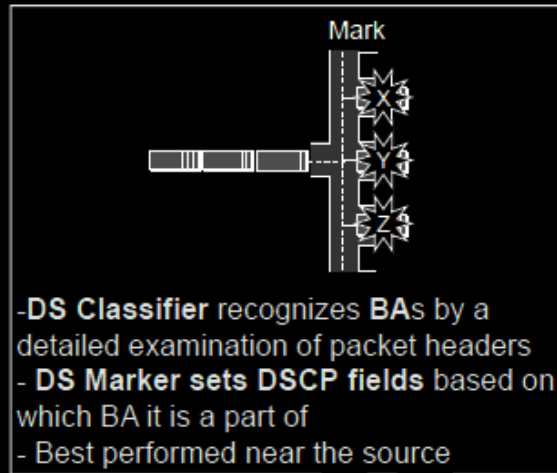
Marking – MPLS EXP

Types of Label Switched Paths:

- E-LSP: 3 bits (remember CoS/IPP?)
- L-LSP: 3+5 bits. Uses MPLS Label



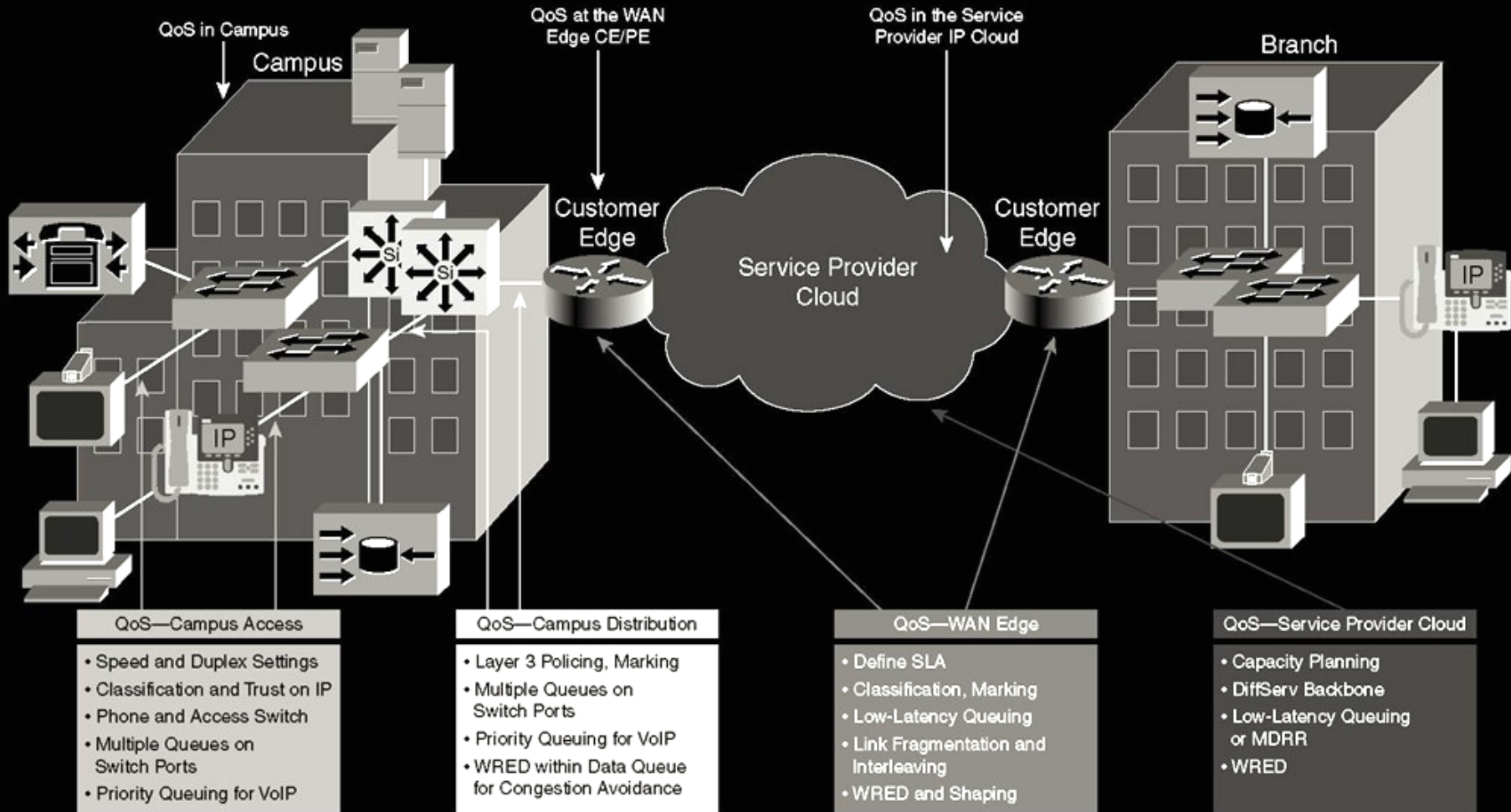
Remark - Per Hop Behaviour



DS (Differentiated Services)
BA (Behaviour Aggregate)

End-to-End QoS

End-to-End QoS = Enterprise QoS + Service Provider QoS



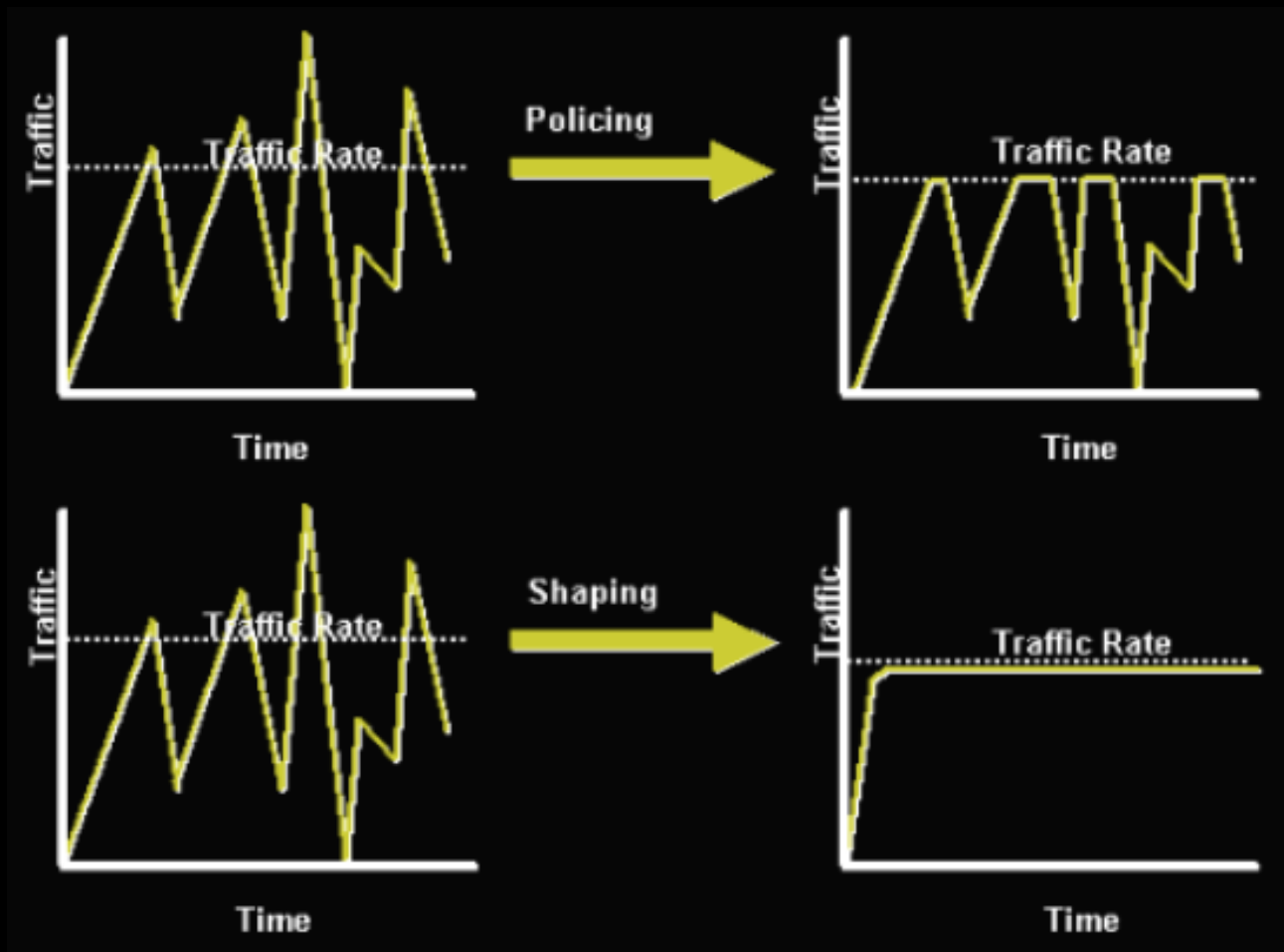
QoS Tools

- Shaping & Policing
- Queuing
- Congestion Avoidance
- Link Fragmentation & Interleaving (< 2Mbps)
- Header & Payload Compression (< 2Mbps)
- Admission Control
- Even More Bandwidth!

QoS Tools – Shape & Policing

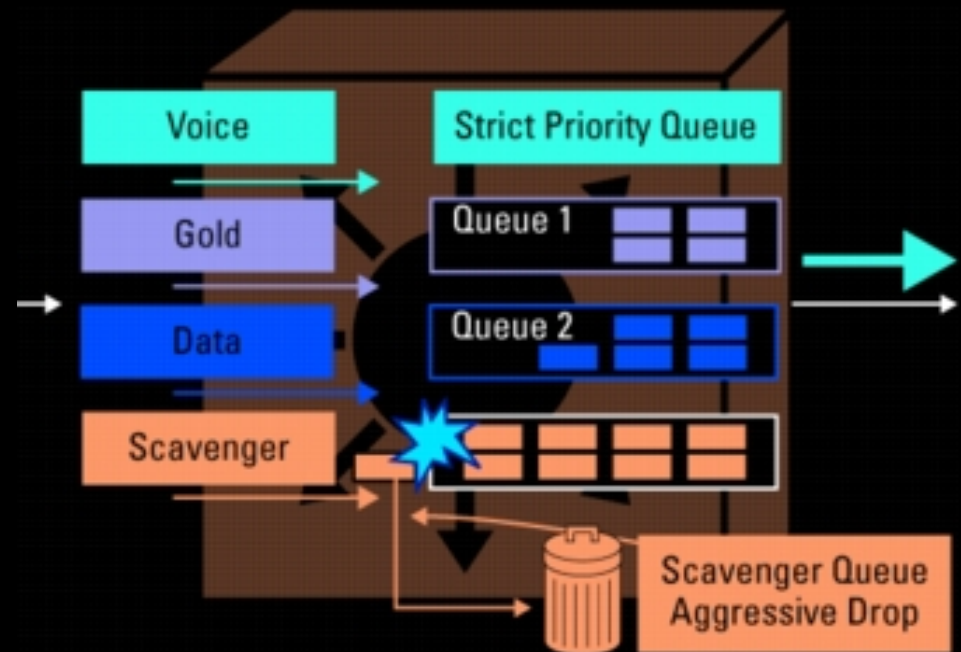
Policer: Discard Packets. In & out

Shaper: Buffer exceeding Packets. Out only



QoS Tools - Queuing

- TX-ring
- FIFO
- Fair queue
- Weighted queue (Class based)
- Priority queue



QoS Tools - Queuing

Queue Size:

The bigger, the better

When too much is not enough?

Bufferbloat !

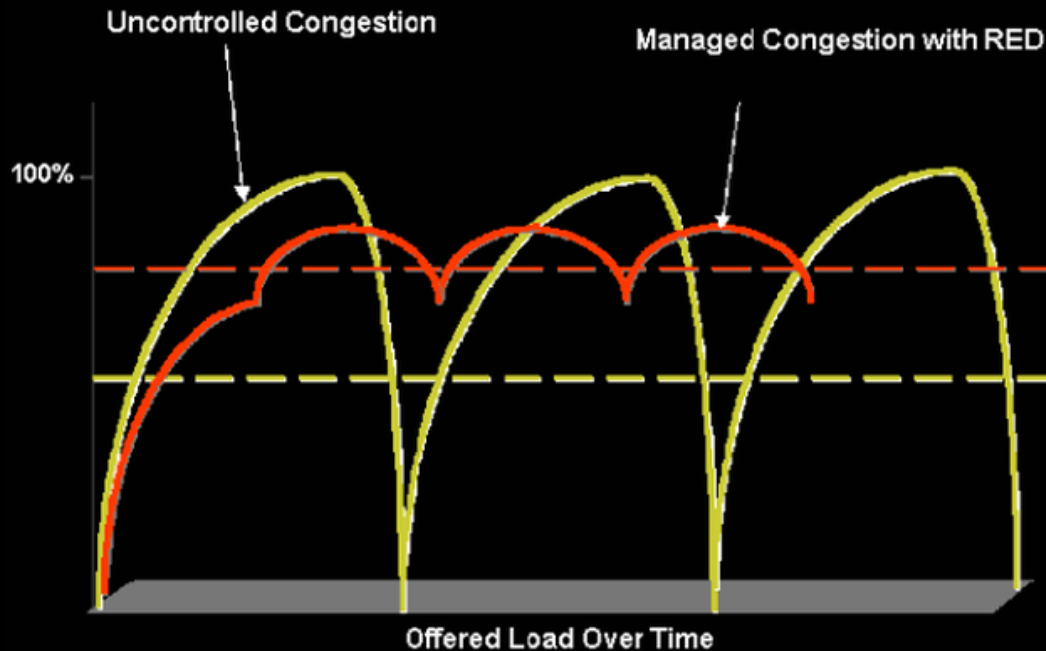


QoS Tools - Congestion Avoidance

RED / Weighted RED (WRED)

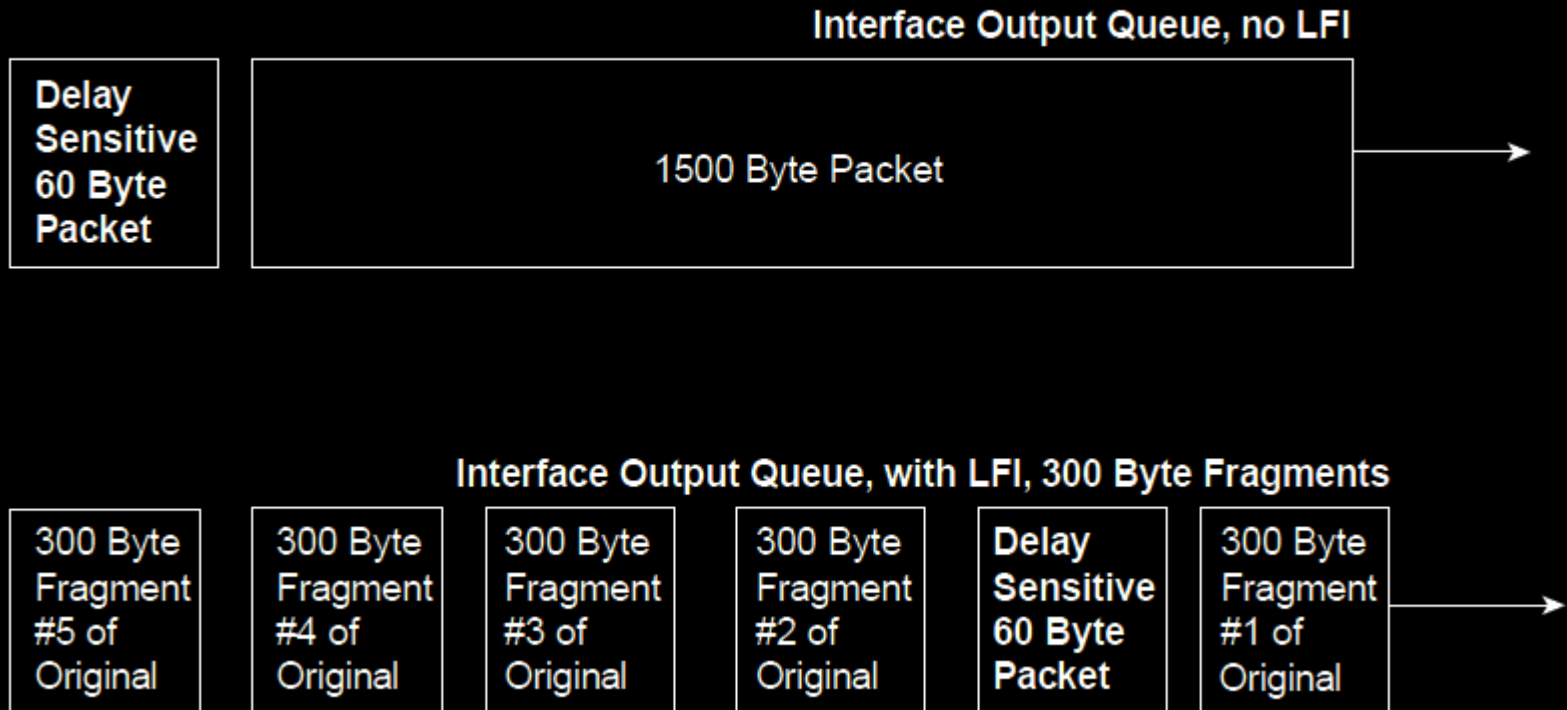
Problem: Global Synchronization

TCP Only!



QoS Tools - LFI

Basic Concept Behind LFI Tools



Useful for slow interfaces (<2Mbps)

QoS Tools – More Bandwidth!

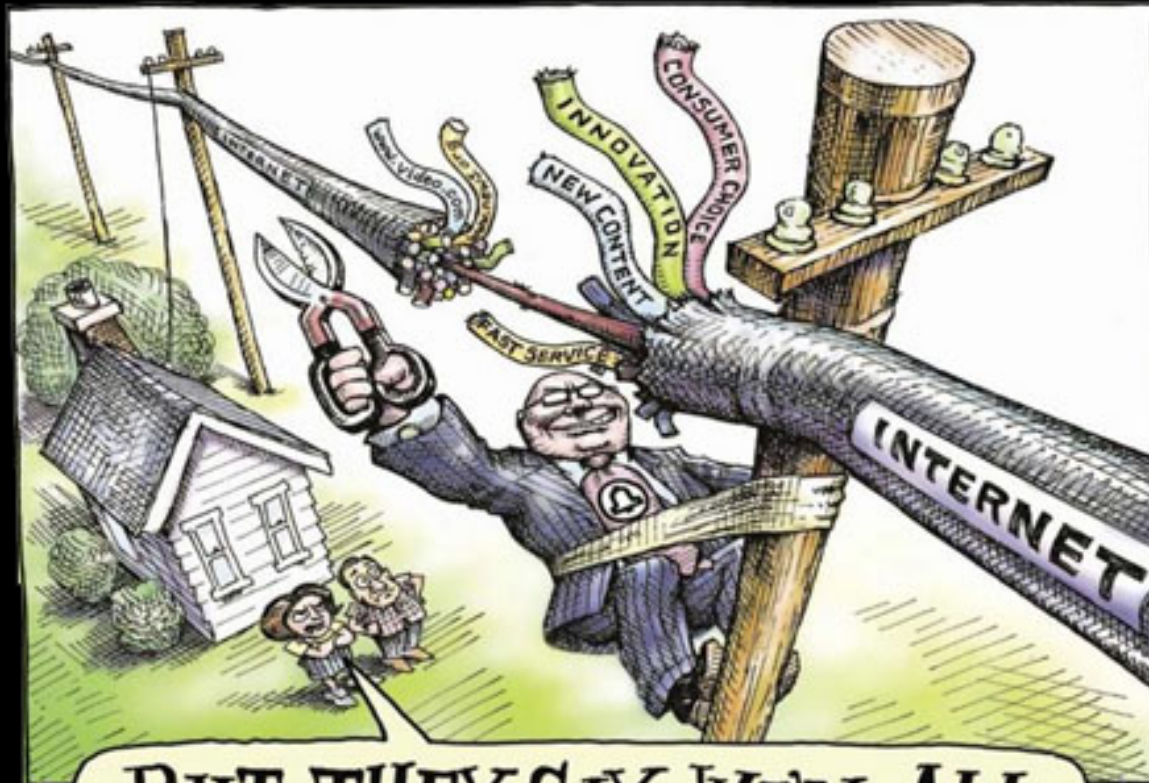
In an ideal world Bandwidth solves it all!



Hands on Lab

- Dynamips (GNS3)
- Switch C3560
- VmWare
- Wireshark / CacePilot Software

But... What about Net Neutrality ?



**BUT THEY SAY WE'LL ALL
BE BETTER OFF THIS WAY...**



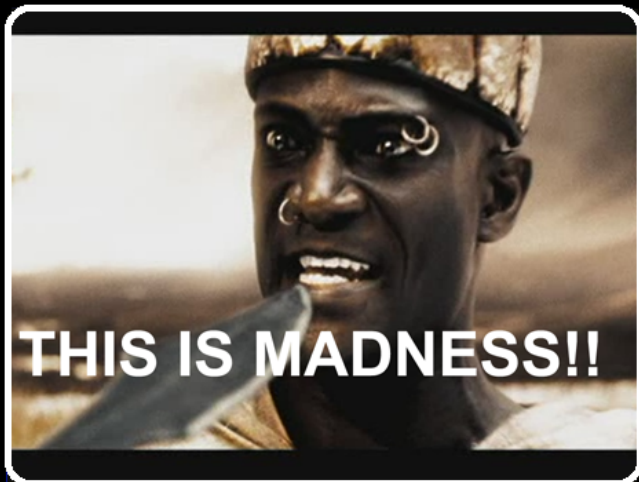
NET NEUTRALITY

ALL BITS ARE CREATED EQUAL

If we start to give preference to packets from one source what happens to all of the other, ordinary packets?

Gary R. Bachula, Vice President, Internet2

Thanks!



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