VoIP Quality of Service - Basic Theory

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Intro

- What is Quality of Service (Qos)?
  - QoS and the PBX
  - Traffic Types
- VoIP
  - Traffic characteristics
  - VoIP concerns
- Operation and implementation of QoS

QoS

- When people say QoS, they are normally referring to the end result
  - i.e. I want my VoIP calls to always be of a high quality
- QoS can be used for good or for bad though!
  - ISPs shaping bit-torrent is uses QoS tools to *reduce* the quality of that traffic
- QoS tools allow us to manage traffic flows in a network
  - Through queuing, shaping, and dropping traffic
- All about *instantaneous* traffic loads

Why do we need QoS

- Well, we don’t always.
  - Only need QoS when there is not enough network resource to carry the traffic offered to it at any point in time

Legacy PABXs and QoS

- Even legacy TDM PABXs include QoS features
- TDM PABXs are circuit switch
  - A call has guaranteed bandwidth across a circuit end to end
  - No other traffic to worry about on the link
  - When there aren't enough circuits to carry the load, the call cannot take place
    - Call Admission Control (CAC)
    - Call Blocking

Legacy PABXs and QoS... ctd

- TDM PABXs generally utilise a separate signalling and media paths.
- No other traffic to ever worry about

VoIP Traffic

- Just a particular type of data traffic
- One that is very sensitive to underlying network performance
  - Users complain about bad quality calls
- Almost always operating on a ‘converged’ network which supports general IP traffic also

Data Traffic Characteristics

- Variable and inconsistent traffic patterns
  - Sometimes a little bit of bursty traffic, e.g. web browsing
  - Sometimes continuous high bit rate traffic - bittorrent and the likes
- May be symmetric or asymmetric traffic loads
- General non-real time data
  - Delays in traffic delivery (within limits!) not really an issue
  - Most protocols have built in re-transmission functions

Voice Traffic Characteristics

- Very consistent traffic flows
    - High PPS
    - Small packets
    - Different codecs present more or less of the above
- Always Real-Time traffic
    - We’re dealing with real, real-time traffic
    - No re-transmissions
    - Delay and delay variance (jitter) affect the ‘quality’ of the call

Voice Traffic Characteristics... ctd

- Generally runs on an existing ‘data’ network
  - Need some form of QoS to ensure traffic gets the priority you consider it needs
- VoIP - voice runs over your IP network
  - If your IP network is broken, then you can’t expect your VoIP devices to magically fix this!

Network concerns

- Queuing delays
- Congestion
- Serialisation delays
- Packet drops and performance on third party links (ISP, Carrier links, etc.)
    - over subscription of bandwidth
    - high latency and or jitter

VoIP Concerns

- Latency
  - High latency is bad for voice call ‘quality’ - we can live with it though
- Jitter
  - Jitter is really bad for voice call ‘quality’ - jitter buffers attempt to fix it
- Packet drops
  - Packet drops are really, really bad for voice call ‘quality’ - really hard to recreate a packet that we don’t receive!

Latency Sources

- Codec delay
- Processing delay
- Serialisation delay
- Queuing delay
- Propogation delay
- Jitter buffer delay

How much latency is too much?

- Generally 150ms one way is fine
- Any longer and conversations start to feel half-duplex
    - ‘Hi Dan, it’s Jonny here... over.’
    - ...
    - ‘Oh hai Jonny!... over’
    - ...
    - ‘Wow, only one of us can talk at a time!’
- Just like satellite based calls

Jitter

- Jitter is variance in inter-packet arrival times
    - variable delay
- Latency itself doesn’t garble voice traffic. Jitter does
- Normally caused by serialisation delays
    - small packet gets caught waiting for a large packet to transmit
- Or multiple traffic forwarding paths for the same flows resulting in packets taking different paths
    - per packet load balancing a bad idea

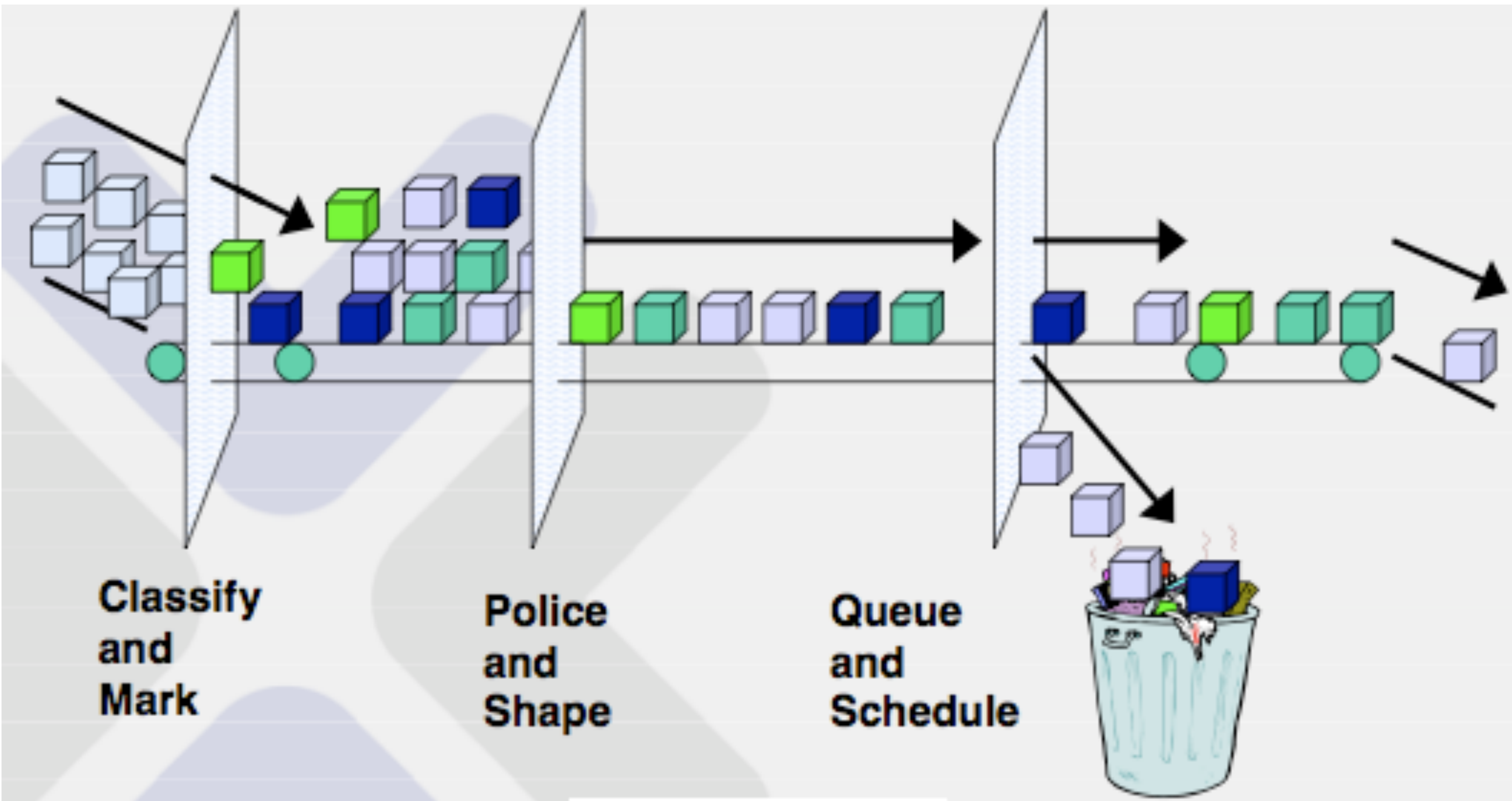
Dropped Packets

- If there is not enough bandwidth on a link for the presented load, traffic will be dropped
  - may be due to interface congestion
  - may be due to policers enforcing service parameters
- Bad physical layer can cause lost / corrupt packets

Prioritisation

- QoS based on providing priority to some traffic (VoIP, in our case) over others during times and at points of congestion
- Tell out network to prefer VoIP packets and treat them a little better than general data packets

QoS Components



Classify and Mark

- Inspect traffic and assign it to a ‘class’
  - L2/L3/L4 and higher information can be used
  - IP Addresses, protocol, port...
- Different platforms and different vendors provide different capabilities for this
- Markings
  - Class of Service (CoS) - Layer 2
  - Differentiated Services Code Point (DSCP) - Layer 3
  - EXP (experimental) bits - MPLS

Marking traffic

- Can be done as a result of classification on routers
- Set by hosts
- Set by VoIP devices themselves
- Need to decide on trust boundaries, and whether or not to trust incoming marks at any point in a network

Traffic Policing / Shaping

- Traffic shaping queues/buffers traffic and send it on at a uniform rate
    - a ‘soft’ approach
    - Provides higher link utilisation, at the expense of additional variable latency
- Traffic policing simply drops packets once the offered rates exceeds a threshold
    - a ‘hard’ approach
    - No additional latency or jitter, at the expense of lower link utilisation

Available tools

- Committed Access Rate (CAR)
  - provide rate limits on interfaces
- Low Latency Queuing (LLQ)
  - Always send voice packets first before other traffic
- Class Based Fair Weighted Queuing
  - Enhancement of LLQ that avoids starving other traffic types of bandwidth and a ‘fairer’ queuing mechanism
  - Provide a minimum bandwidth allocation for VoIP, can be used by other classes when not being used

Queuing / Scheduling

- Historical queueing methods
  - First In First Out (FIFO)
    - Just like in McDonalds
  - Priority Queuing (PQ)
    - E.g. airline checking. First/Business have separate queue
  - Custom Queuing (CQ)
  - Weighted Fair Queuing (WFQ)
    - Airline example, but First/Business counters occasionally take Economy

Modern Queuing

- Class Based Fair Weighted Queuing (CBWFQ)
- Weighted Round Robin (WRR)
  - Weights determine frequency of queue servince (WFQ, CBWFQ) or ratio of queue serving (WRR)

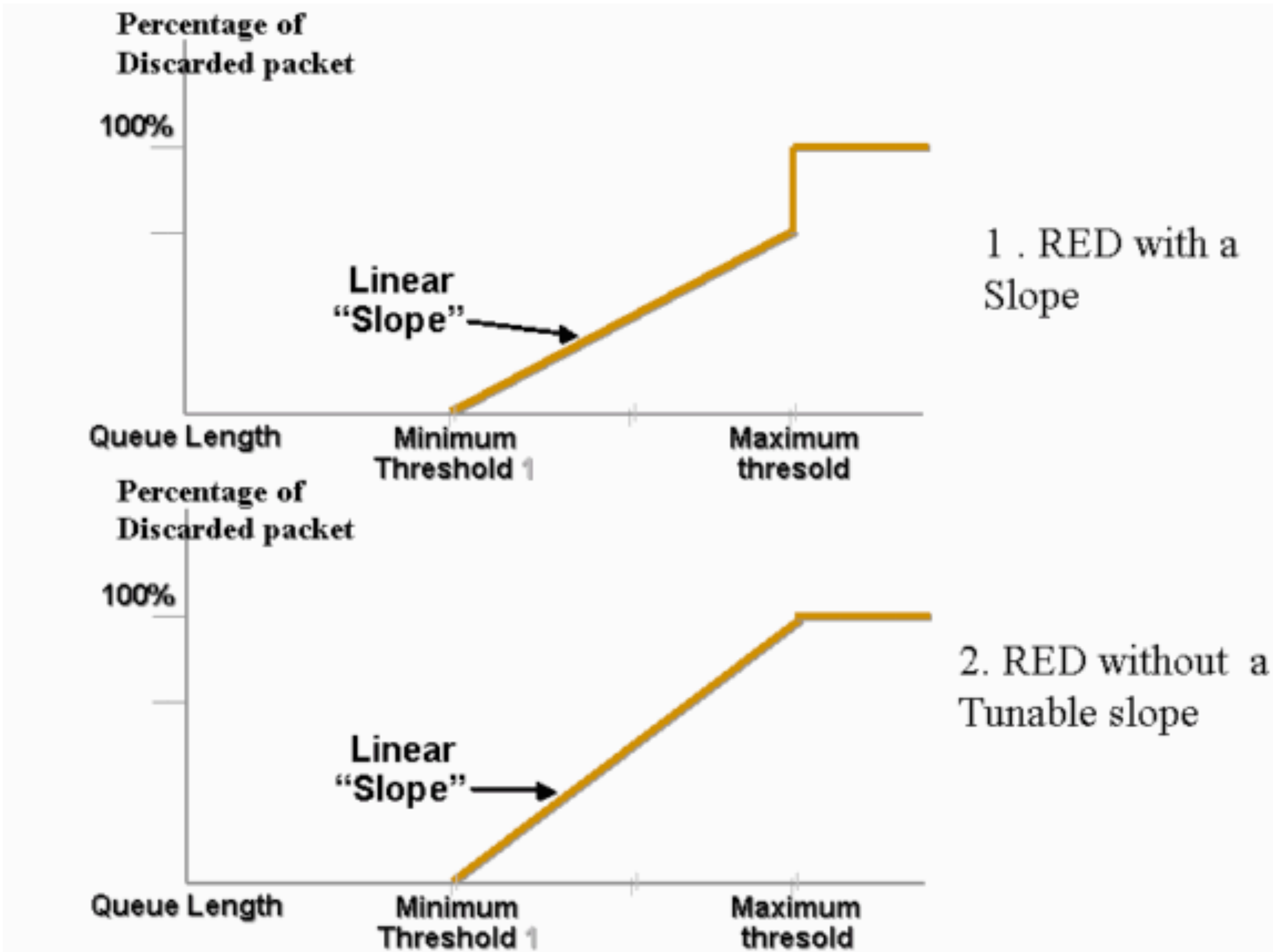
Packet Scheduling

- Priority Queuing for WFQ (PQ-WFQ)
  - older way of doing things
- Priority Queuing for CBWFQ (LLQ)
  - newer way of doing things

Packet Dropper Techniques

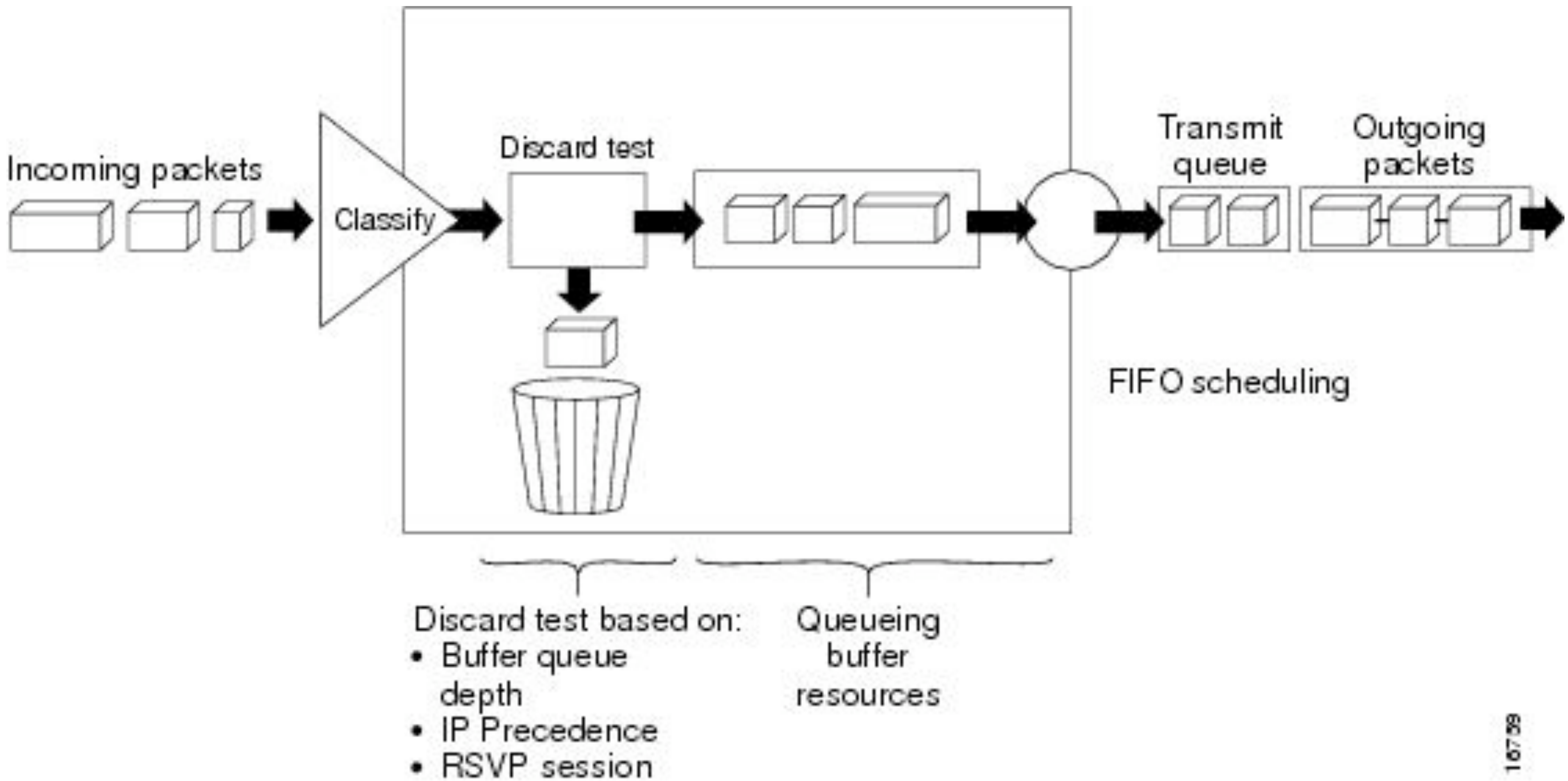
- Tail Drop
- Weighted Random Early Detection (WRED)
  - can be distributed (dWRED)
  - or flow based (FBWRED)

WRED



Percentage of
Discarded packet
100%
Linear
"Slope"
Queue Length
Minimum
Threshold 1
Maximum
thresold
1 . RED with a
Slope
Percentage of
Discarded packet
100%
Linear
"Slope"
Queue Length
Minimum
Threshold 1
Maximum
thresold
2. RED without a
Tunable slope

WRED... ctd

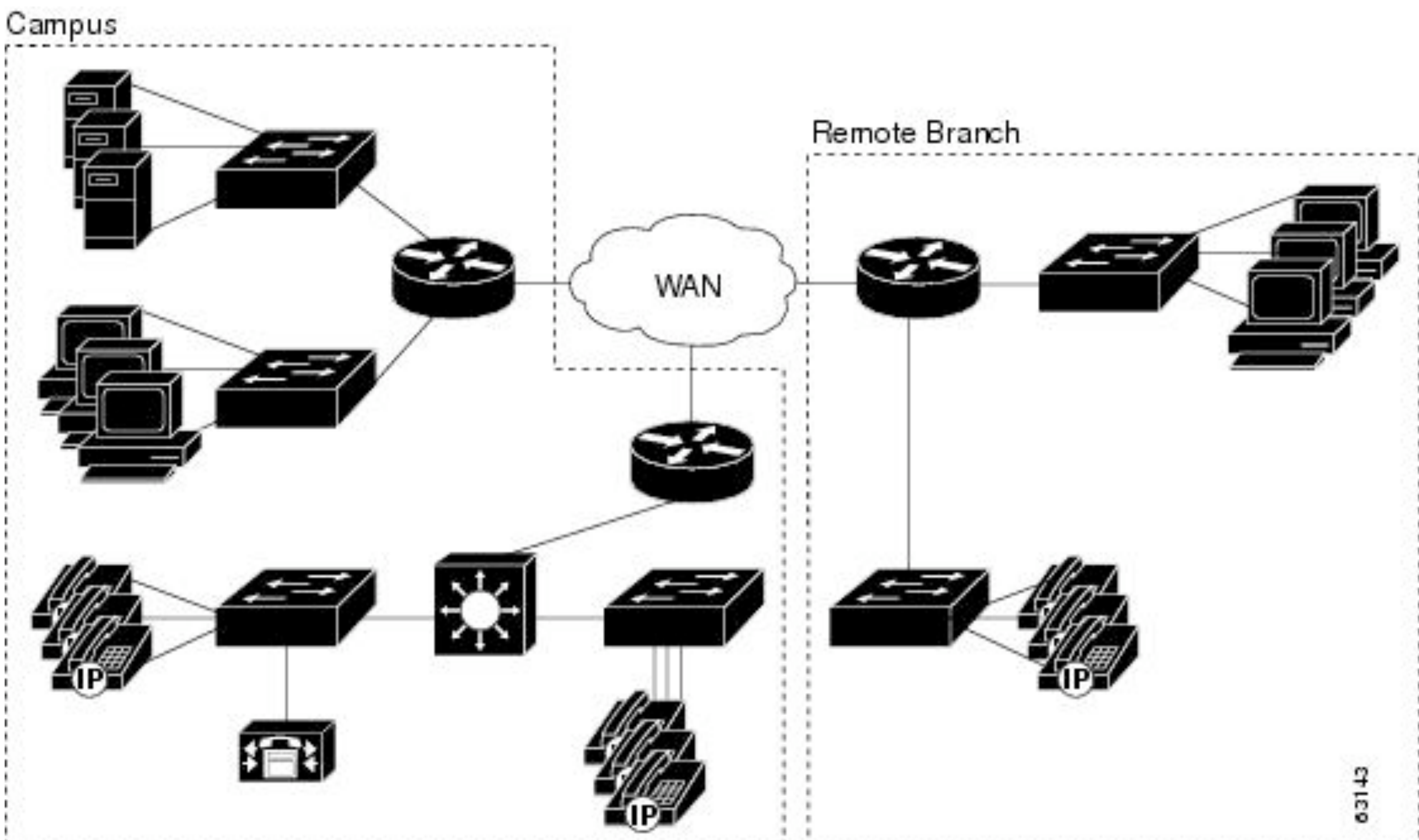


Incoming packets
Classify
Discard test
Transmit queue
Outgoing packets
FIFO scheduling
Discard test based on:
• Buffer queue depth
• IP Precedence
• RSVP session
Queueing buffer resources
16759

Where to implement QoS?

- Where ever there is a congestion point
  - WAN edge
  - Slow links
  - Aggregation points

Where to Apply QoS



Cisco QoS support

- We'll only look at the very basics here
- Modular QoS command line (MQC) on IOS
- Lots of knobs you can twiddle with...
    - WFQ, CBFWQ, LLQ, LFI, DSCP, CoS...