

# Quality of Service



# Motivation

- Quality of Service (QoS)
- Provide circuit-switched features in a packet-switched network
- Guarantees on rate, latency, and jitter
- Two approaches
  - Differentiated Services
  - Integrated Services



# Differentiated Services (DiffServ)

- IP provides “best effort” service
  - All packets treated equally
  - Anyone’s packets can be dropped when network is congested
- DiffServ
  - Class-based QoS
  - Coarse-grained
  - Each packet assigned a service class
    - Prioritizes packets
    - Higher priority ones sent first
    - Lower priority ones sent last or dropped
    - Priority FIFO queues

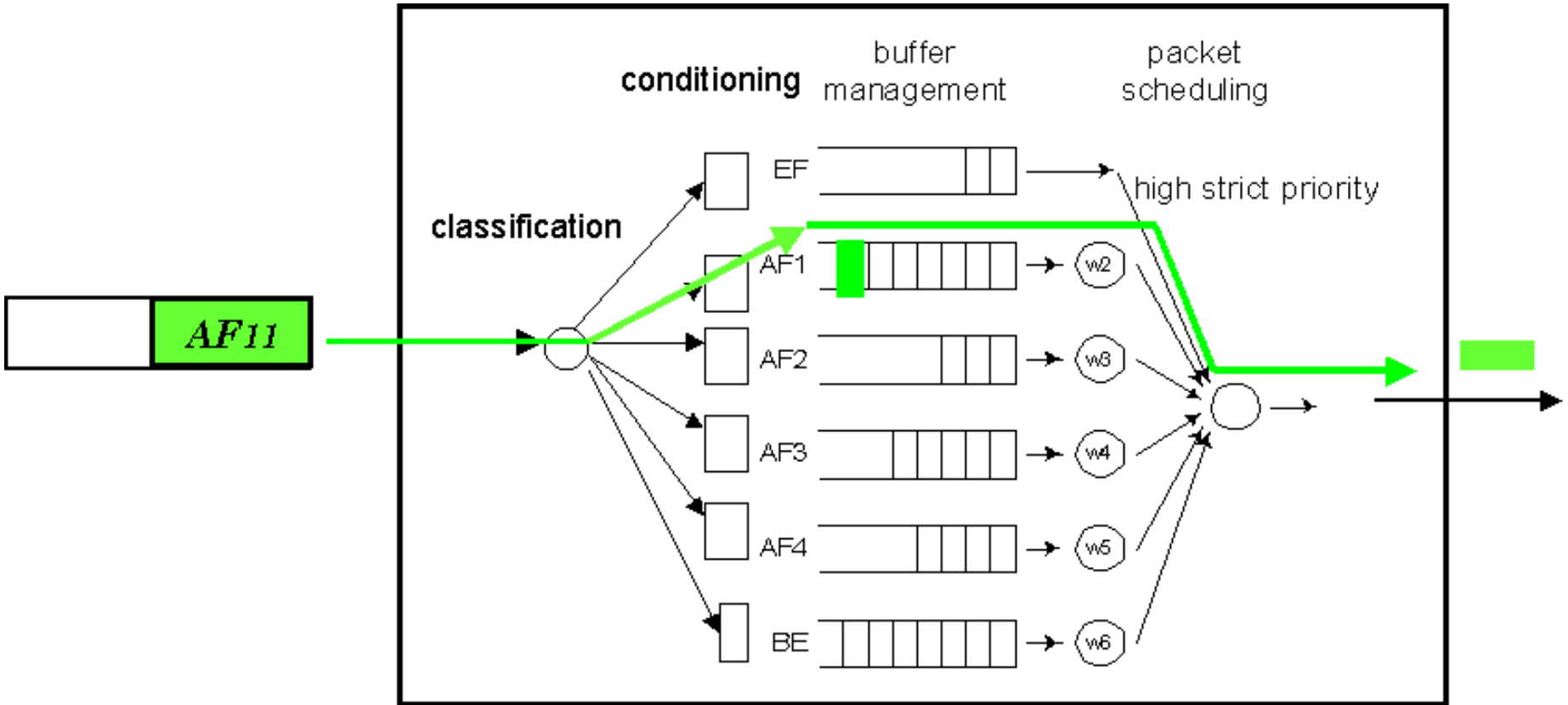


# DiffServ Implementation

- Differentiation based on Flow
- Assigned traffic class
- 8-bit DS field in IP header (TOS field)
  - 6-bit DiffServe Code Point (DSCP)
  - Theoretically  $2^6 = 64$  different traffic classes
  - Default per-hop behavior (PHB) = 000000
  - Expedite Forwarding PHB (highest priority)
  - Assured Forwarding PHB

	Class 1	Class 2	Class 3	Class 4
Low Drop	AF11	AF21	AF31	AF41
Med Drop	AF12	AF22	AF32	AF42
High Drop	AF13	AF23	AF33	AF43

# DiffServ Router



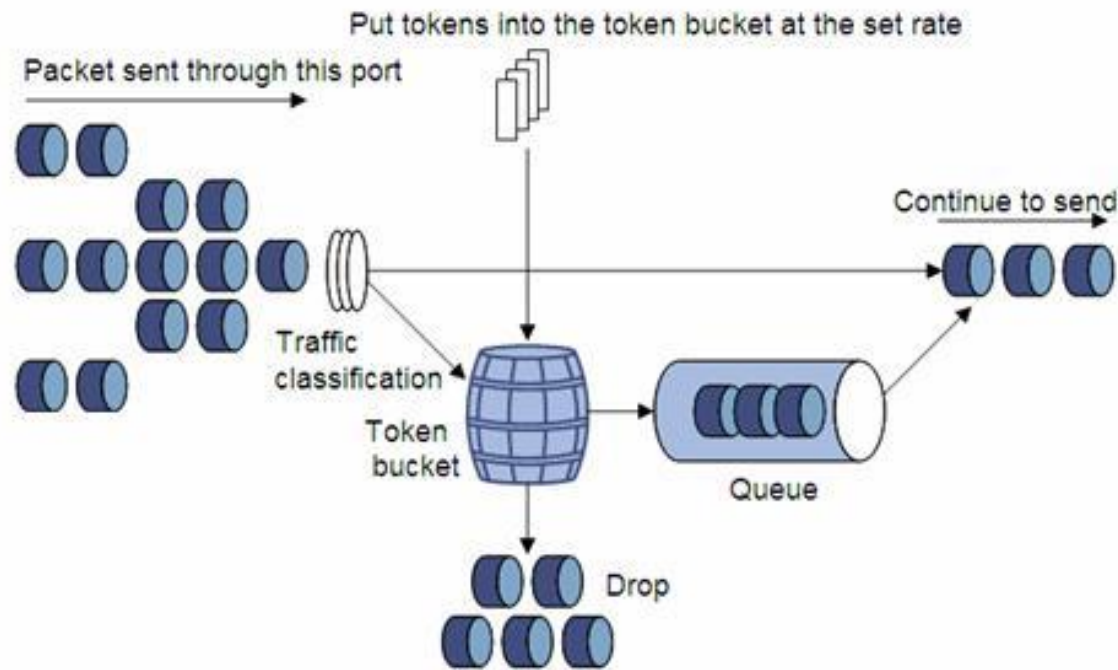
# DiffServ Pros/Cons

- Prioritization is flexible, each administrative domain can reclassify or ignore
- No advanced setup or registration required
- Different routers can treat DSCP very differently
- May waste resources getting packets through with highest priority only to have the dropped later on by a non DiffServ router



# Integrated Services (IntServ)

- Fine-grained QoS
- Requires additional protocols
- Token Bucket Flow Control



# Token Bucket

- Token bucket is like cell-phone roll over minutes
- If you get 500 min/month, normally if you don't use them they get thrown out
  - This caps you to 500 min/month
- With roll over minutes, let's say you can roll-over up to 1000 minutes
  - If you don't use all your minutes one month, you can save them for next month – perhaps you have a “burst” of calls the next month
  - You can only save up to 1000 minutes (size of your bucket)
  - This means that in the long term your average phone use will be 500 min/month, but some months may be larger, others smaller, but the long-term average will be under 500 min/month



# Resource reSerVation Protocol (RSVP)

- Provides admission control
  - Applications ask for guaranteed simplex service
    - Hosts or Routers can make requests
  - Routers decide whether the request can be accommodated
- Each flow receives a service class and a label
- Intermediate routers enforce reserved bandwidth



# IntServ Pros/Cons

- Fine-grained control
- Enforce complex QoS
- Requires state on routers, preconfiguration, complex policies

