Network : Internet Operation

Jae Hyeon Kim

Reference

William Stalling, Data and Computer Communications 10/E, Prentice Hall

Internetwork Operation

- Consider mechanisms for handling growth in network traffic
  - from low-volume text based terminal/email
  - to high volume multi-media web/voice/video
- Historically, IP protocols gave best-effort datagram delivery to all services
- Now, applications want variety of QoS (Quality Of Service) in IP networks
  - explore some new network services and functions

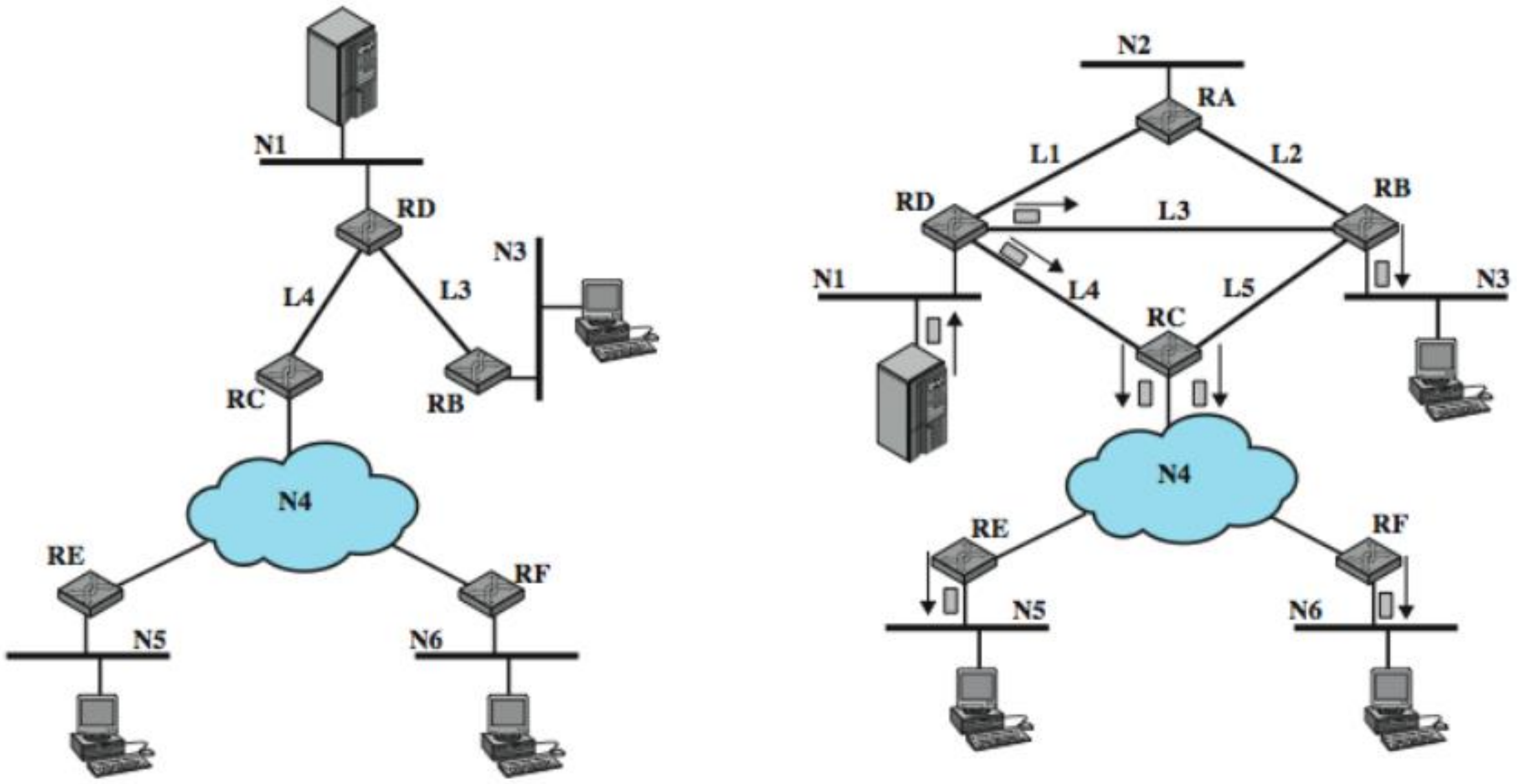
Multicasting

- Multicast means the act of sending a packet from a source to a number of members of a multicast group
- Has a number of practical applications
  - multimedia “broadcast”
  - teleconferencing
  - database
  - distributed computing
  - real time workgroups
- Have design issues in addressing / routing

LAN Multicast

- LAN multicast is easy
  - send to IEEE 802 multicast MAC address
  - since broadcast all stations will see packet, those in multicast group will accept it
  - only single copy of packet is needed
- But it is getting to be harder in internetwork environment
- IP includes addresses that refer to group of hosts on one or more networks =: multicast address
  - cf) IP address refers to an individual host on a particular network

Multicast Example



(a) Spanning tree from source to multicast group

(b) Packets generated for multicast transmission

Broadcast, Multiple Unicast, Multicast

- Broadcast a copy of packet to each network
  - if server does not know members of group
  - requires 13 copies of packet
- Multiple unicast
  - send packet only to networks that have hosts in group
  - 11 packets
- True multicast
  - transmit single packet along spanning tree
  - routers replicate packets at branch points of spanning tree
  - 8 packets required

Traffic Generated by Various Multicasting Strategies

	Broadcast					Multiple Unicast				Multicast
	S → N2	S → N3	S → N5	S → N6	Total	S → N3	S → N5	S → N6	Total	
N1	1	1	1	1	4	1	1	1	3	1
N2										
N3		1			1	1			1	1
N4			1	1	2		1	1	2	2
N5			1		1		1		1	1
N6				1	1			1	1	1
L1	1				1					
L2										
L3		1			1	1			1	1
L4			1	1	2		1	1	2	1
L5										
Total	2	3	4	4	13	3	4	4	11	8

Requirements for Multicasting

- Router have to forward more than one copy of packet
- Need convention to identify multicast addresses (IPv4 Class D or IPv6 prefix)
  - nodes/router translate between IP multicast addresses and list of networks containing group members
- Required for hosts to join/leave multicast group
  - which networks include members of given group
  - sufficient info to work out shortest path to each network
- Routing algorithm to calculate shortest path

Internet Group Management Protocol (1)

- RFC 3376 (IGMP v3) to exchange multicast group information between hosts & routers on a LAN
  - hosts send messages to routers to subscribe to and unsubscribe from multicast group
  - routers check which multicast groups of interest to which hosts
- IGMP operation : join
  - IGMP host wants to make itself known as group member to other hosts and routers on LAN
  - to join, the host send IGMP membership report message
    - sent in IP datagram with the multicast destination address
    - the group member routers receive & learn new member

Internet Group Management Protocol (2)

- IGMP operation : keeping list valid
  - routers periodically issue IGMP general query message
    - in datagram with all-hosts multicast address
    - hosts respond with report message
  - router needs to know at least one group member still active
    - each host in group sets timer with random delay
    - if timer expires, host sends report message
- IGMP operation : leave
  - host leaves group by sending leave group message to all routers static multicast address
  - router determines if it have any remaining group members using group-specific query message

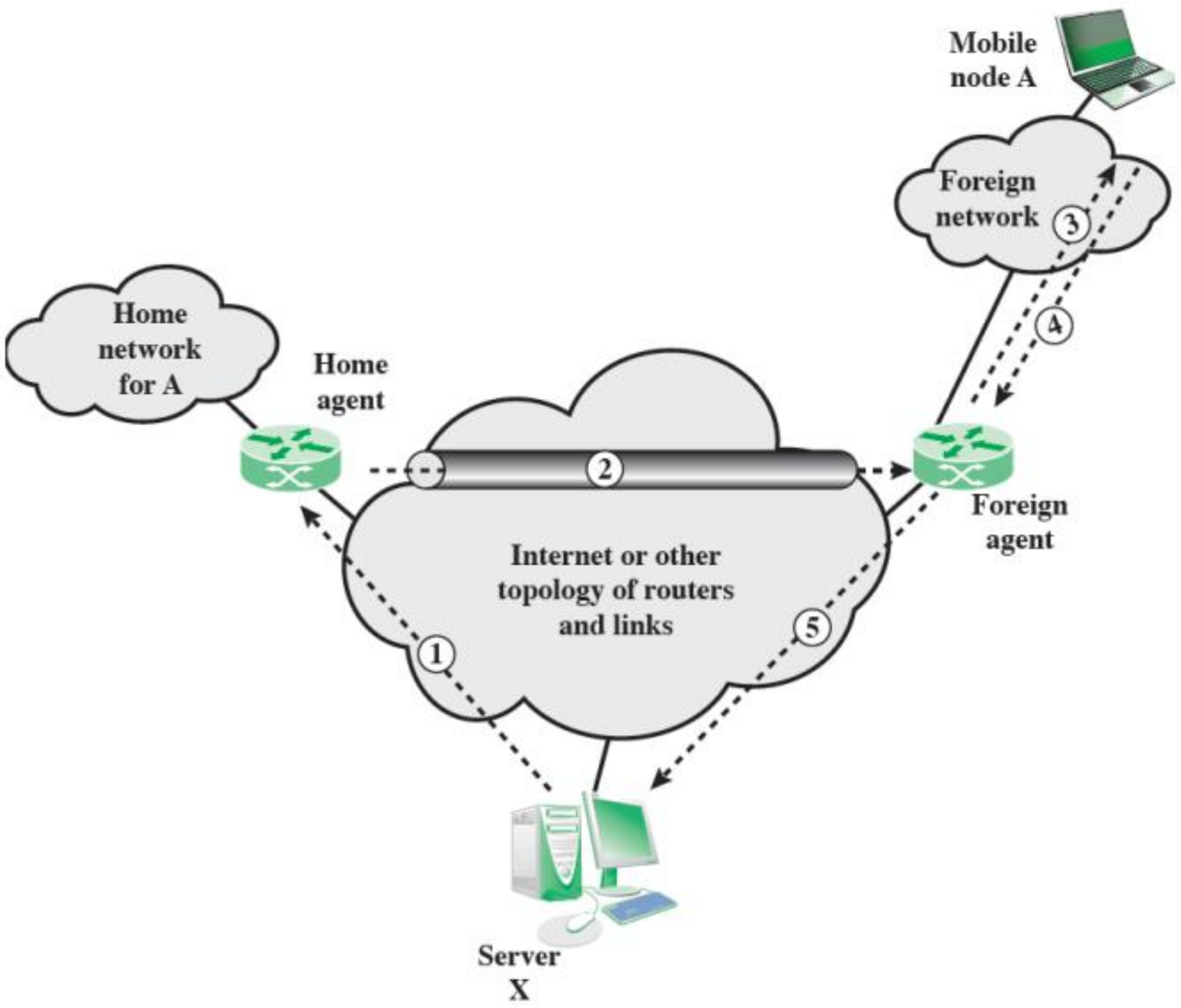
Mobile IP

- Enables computers to maintain Internet connectivity while moving from one Internet attachment point to another
- Particularly suited for wireless connections
- mobile implies:
  - a user is connected to one or more applications across the Internet
  - the user's point of attachment changes dynamically
  - all connections are automatically maintained despite the change of attachment

Basic Capabilities of Mobile IP

- Network discovery
  - used to identify prospective foreign agents, by means of beacon
  - then a care-of address is dynamically acquired for a temporary IP address of current network
- New address registration
  - the care-of address must be registered to home agent in order to redirect datagram reached to home to the foreign agent
  - authenticated registration procedure is used
- Datagram tunneling
  - forwards IP datagram from a home address to a care-of address

– Mobile IP Scenario



Internetwork Quality of Service

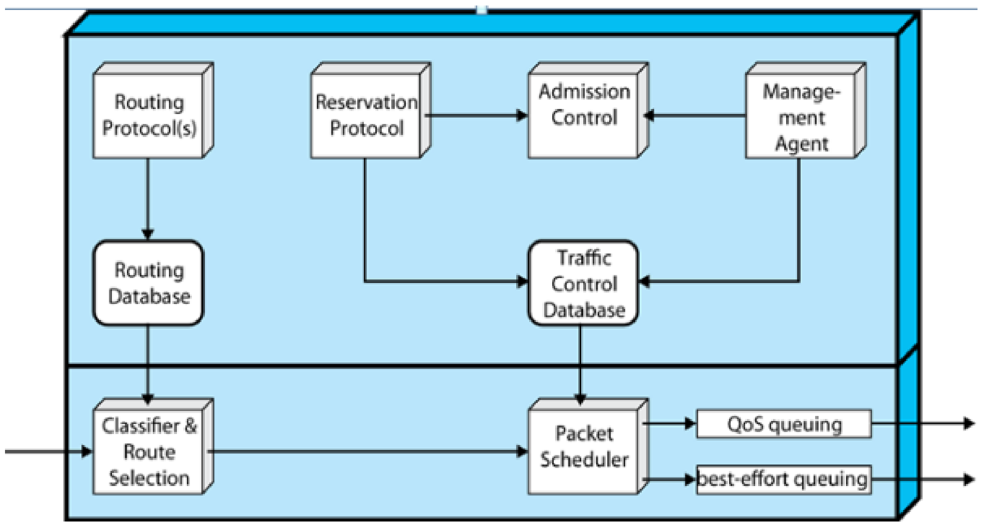
- Internet traffic continues to grow and change
  - demand for real-time responses
  - increasing use of audio, image, and video
  - heavy use of the World Wide Web
- Packet-switching technology with routers functioning as switches was not designed to handle voice and video
  - strong need to support a variety of traffic with QoS requirements within TCP/IP

Internet Traffic Categories

- Elastic traffic
  - can cope with wide changes in delay and/or throughput
  - traditional TCP/IP traffic
    - eg. FTP, email, telnet, SNMP, HTTP
- Inelastic traffic
  - does not easily adapt to network variations, e.g. real time traffic
  - requirements : throughput, delay, jitter, packet loss
- New Internet architecture requirements:
  - resource reservation protocol
  - elastic traffic still needs to be supported

ISA Approach

- Integrated Service Architecture (ISA)
  - intended to provide QoS transport over IP-based Internet
  - defined in RFC 1633
  - portions already being implemented in some routers
  - sharing capacity on congestion is the central design issue
- To manage congestion and provide QoS, it makes use of:
  - admission control
  - routing algorithm
  - queuing discipline
  - discard policy



ISA Services

- ISA service for a flow of packets is defined on two levels:
  - a number of general categories of service are provided, each of which provides a certain general type of service guarantees
    - guaranteed : service provides assured capacity
    - controlled load : tightly approximates the behavior visible to applications
    - best effort
  - within each category, the service for a particular flow is specified by the values of certain parameters
    - referred to as a traffic specification (TSpec)

Resource Reservation: RSVP

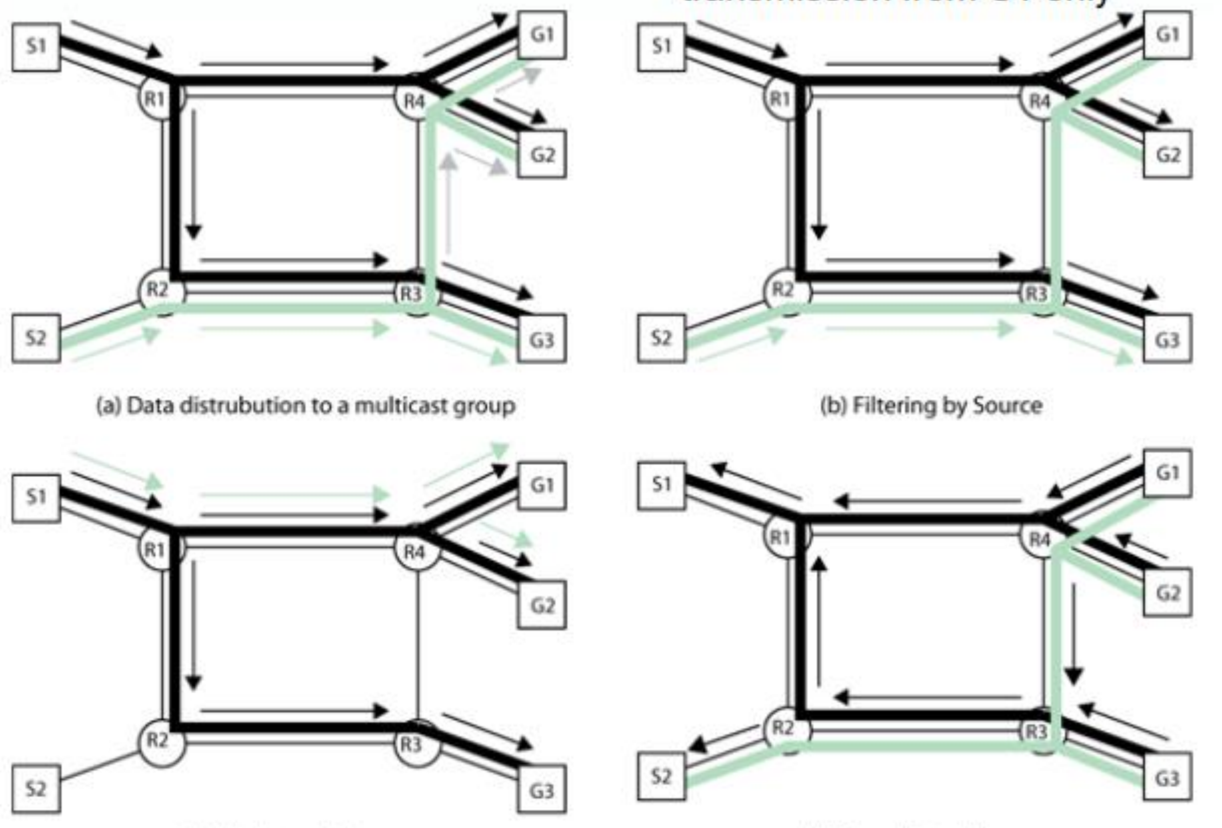
- Resource ReSerVation Protocol : RFC 2205
  - provides supporting functionality for ISA
- Applications reserves resources in-between routers to meet QoS
  - enables routers to decide ahead of time if they can meet the delivery requirement for a multicast transmission
- Goals and characteristics
  - unicast and multicast
  - receiver-initiated reservation
    - maintaining soft state in the Internet
  - providing different reservation styles
    - transparent operation through non-RSVP routers

Receiver-Initiated Reservation

- Since receivers specify the desired QoS, it makes sense for them to make resource reservations
  - different members of the same multicast group may have different resource requirements
  - QoS requirements may differ depending on the output equipment, processing power, and link speed of the receiver
  - routers can aggregate multicast resource reservations to take advantage of shared path segments

– RSVP Operation

G1 and G2 have requested transmission from S1 only



(a) Data distrubution to a multicast group

(b) Filtering by Source

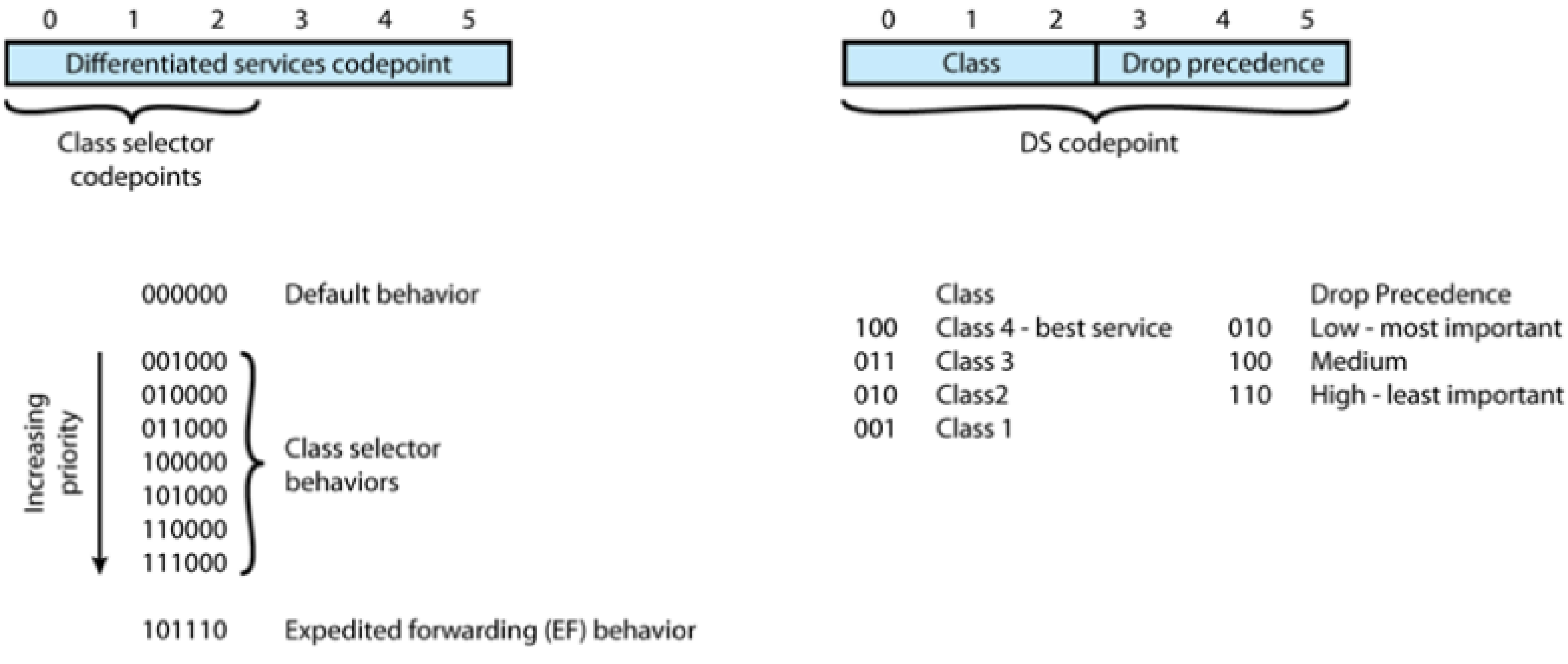
(c) Filtering a Substream

(d) Merged Resv Messages

Differentiated Services (DS)

- ISA and RSVP are relatively complex to deploy
- Designed to provide simple, low overhead tool
  - specified in RFC 2475
  - IP packets labeled for differing QoS using existing IPv4 Type of Service or IPv6 DS field, so no change to IP is required
- Key characteristics:
  - SLA(Service Level Agreement) is established prior to use of DS
  - DS is implemented in individual routers
  - most widely accepted QoS in enterprise networks

DS Field IPv6



(a) DS Field

(b) Codepoints for assured forwarding PHB

PHB(Per Hop Behavior)