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Scribe notes for Lecture 14
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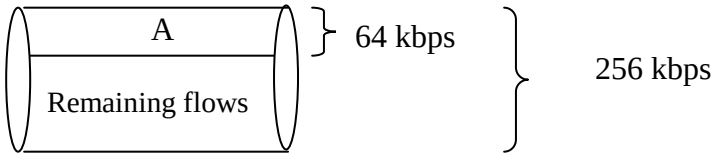
Differentiated Services

The current Internet provides one type of service that is best effort service. There may be users who want more services and less delay. To meet their requirements Differentiated Services are available. They are

1. Premium Service
2. Assured Service
3. Best effort Service

1. Premium Service:

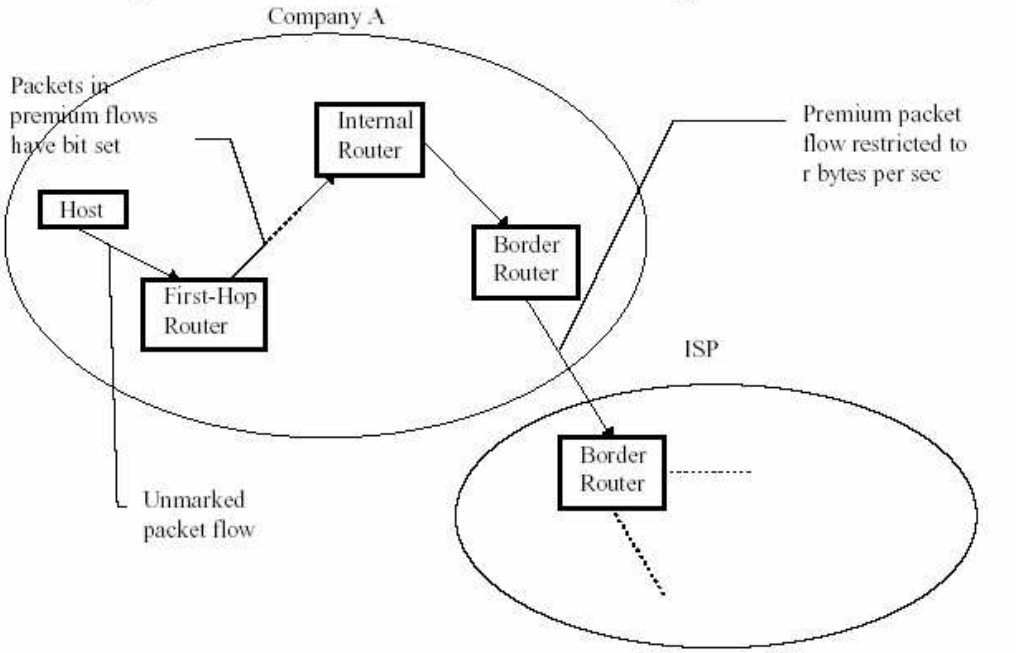
Some users require high quality of service. The ISPs render this kind of commercial service by providing the **virtual leased lines.** Virtual leased line means allocation of some portion of bandwidth to that user virtually. **If the premium user's traffic is low, then this bandwidth (allocated as virtual leased line) can be used for best effort service**. So premium user does not cause any congestion in the network. In Premium Service, unlike guaranteed service, even if additional bandwidth is free this would not be allocated to the user of Premium service.



In the above diagram the even if the traffic in the "Remaining flows "is low this bandwidth cannot be utilized by premium user A.

Implementation:
To implement the premium service first hop router will police and sets the premium bit. In forwarding path we classify the packets in to one of two queues on a single bit and service the two queues using simple priority, whereas policing and shaping is done at administrative or "trust" boundaries.

Figure 1. Premium traffic flow from end-host to organization's ISP



In the above figure there is an agreement between ISP and company A that the flow is restricted to 'r' bytes per second. First-Hop Router will set the premium bit and sends the packet to the internal router. The Border routers perform different tasks for incoming flow and outgoing flow. If the data rate is more than 'r' bytes per sec then there is a chance of loss of data.

Problems with Implementation:

1. Admission control is difficult: Let us consider an example to explain this.
   If the channel has bandwidth 1Mbps and there are 2 premium services which each require 700 kbps then it is not possible to allocate. So admission control is difficult.
2. Border routers must implement policing.

2. Assured Service: This is another kind of service. If bursts of data are encountered in the Premium service, then there is chance of data loss. Assured service will allow the data bursts. The packet is marked assured if the necessary tokens are available otherwise it is not marked.

The packet-drop probability is low when compared to best effort service. The packet with assured bit set will not be dropped until the threshold is exceeded. To implement assured service there is lot of mathematical overhead in admission control.

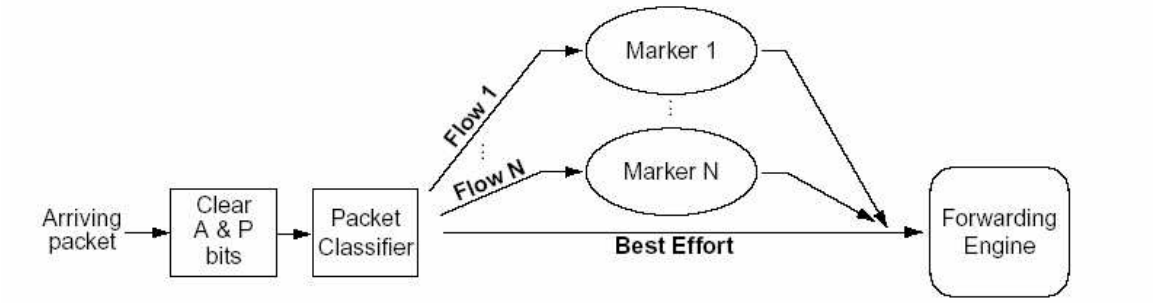
Assured service mechanism can be implemented using RED (Random Early Detection).Assured service maintains 2 types of thresholds. One is for packets with assured bit set and the other for all packets. Based on these thresholds the Assured service decides packet drop probability. Assured service will provide statistical rate guarantee.

Two bit Differentiated Services:

Here we use both P-bit and A-bit in header to get the advantage of both Premium service and Assured service. The advantage of Assured service is it can use excess bandwidth than Premium service.

The P-bit or A-bit will be set by the first hop router. The only possible sequences for P-bit or A-bit are 10(Premium service), 01(Assured service), 00(Best effort service).

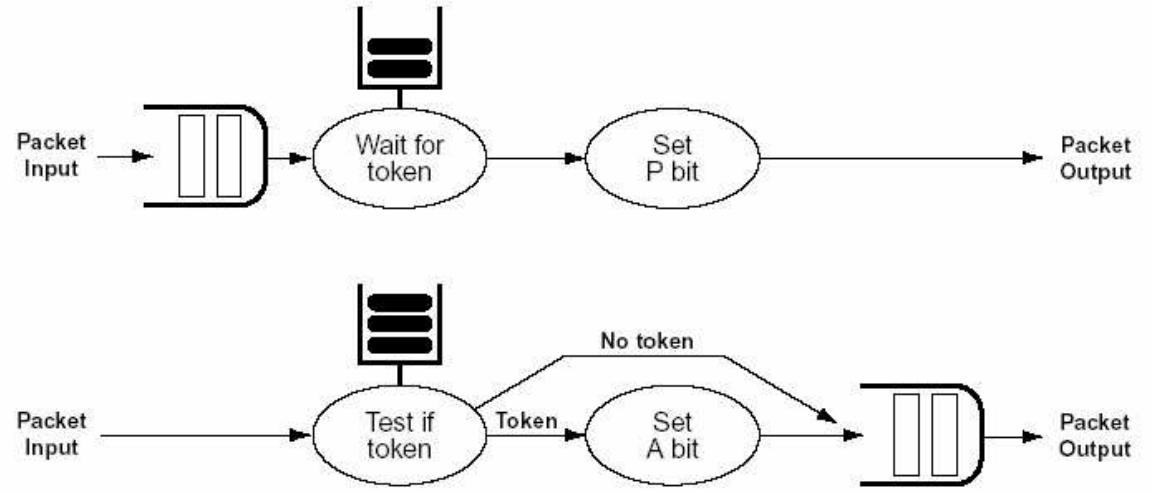
Two bit implementation:



The above diagram explains the functionality of leaf router. All arriving packets must have both A-bit and P-bit cleared , After which packets are classified based on their header information. If there is no match ,then those packets are immediately forwarded. If the header information matches with any of marker's information then the packet will pass through marker and get marked with A-bit or P-bit set.

Inner working of Marker is explained below,

Figure 3. Markers to implement the two different services

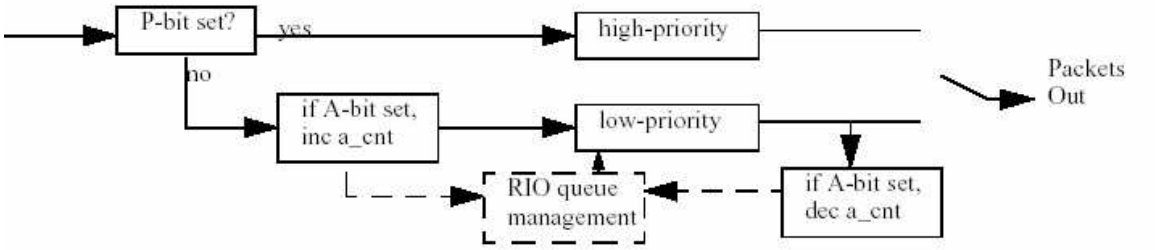


The first figure explains the Premium service Marker behavior. Premium flow packet have their P-bit set when there is token available otherwise the packet will wait for token. If incoming packet flow exceeds the profile's burst size the packets will be automatically dropped.

The second figure explains the Assured service Marker behavior. When token is present Assured flow packets have their A-bit set, otherwise it is unmarked and forwarded to forwarding engine.

	Token Present	Token Absent
Premium service	Set P-bit and forward Packet	Wait for token
Assured service	Set A-bit and forward Packet	Clear A-bit and forward Packet

Router Interface Architecture for Two bit Architecture:



Each output interface of a router must have two queues and must implement a test on the P-bit to select a packet's output queue. The two queues must be serviced by simple priority, Premium packets first. Each output interface must implement the RED-based RIO mechanism described in on the lower priority queue. RIO uses two thresholds for when to begin dropping packets, a lower one based on total queue occupancy for ordinary best effort traffic and one based on the number of packets enqueued that have their A-bit set.

Diff-Serv Architecture:

Main goal of Diff-Serv architecture is controlled sharing of organization's Internet bandwidth. This can be achieved by two ways.

1. Users can set bits in their packets and allocate bandwidths according to the policies.
2. Use the agents called **Bandwidth Brokers** who know all the policies and allocate the bandwidth according to the policies.

In the first way all the users may not know all the policies, So use of Bandwidth Brokers may have better bandwidth utilization.

Bandwidth Brokers:

-Bandwidth Brokers are configured with organizational policies
-There is only one Bandwidth Broker per domain
-keep track the current allocation of traffic
- accepts new requests
- checks the security issues
- allocates bandwidth for end to end connections with less state and simpler trust relationships.

Responsibilities of Bandwidth Broker:

1. Marked traffic allocations for their region is initialized and set up the leaf routers within the domain.
2. Manage the messages that are sent across boundaries to adjacent region's Bandwidth Broker.

- For security purpose Bandwidth Broker maintains policy database and keeps the information about the privileges of users.
- Only Bandwidth Broker can configure the leaf router which is important for security systems.

Allocation of Traffic:

1. When new allocation of bandwidth is required then request is sent to Bandwidth Broker.
2. Request may contain service type, target rate, maximum burst and time period when service is required.
3. Bandwidth Broker checks available bandwidth. If bandwidth is available and it is sufficient to meet the request then bandwidth is allocated for that flow and size of allocated bandwidth is removed from total available bandwidth and flow specification is reordered.
4. If the flow has outside the trust region ,the request must fall with in the class allocation through the next hop trust region. The hops must have bilateral agreement.
5. The requester's Bandwidth Broker informs adjacent region's Bandwidth Broker that will be using for some rate allocation.
6. Bandwidth Broker configures the leaf router with information about packet flow to be given at the time that the service commences.
7. This configuration is "soft state" which is periodically refreshed by Bandwidth Broker.