

Computer Networks

By

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PART 5

Transport Layer

Chapter 24

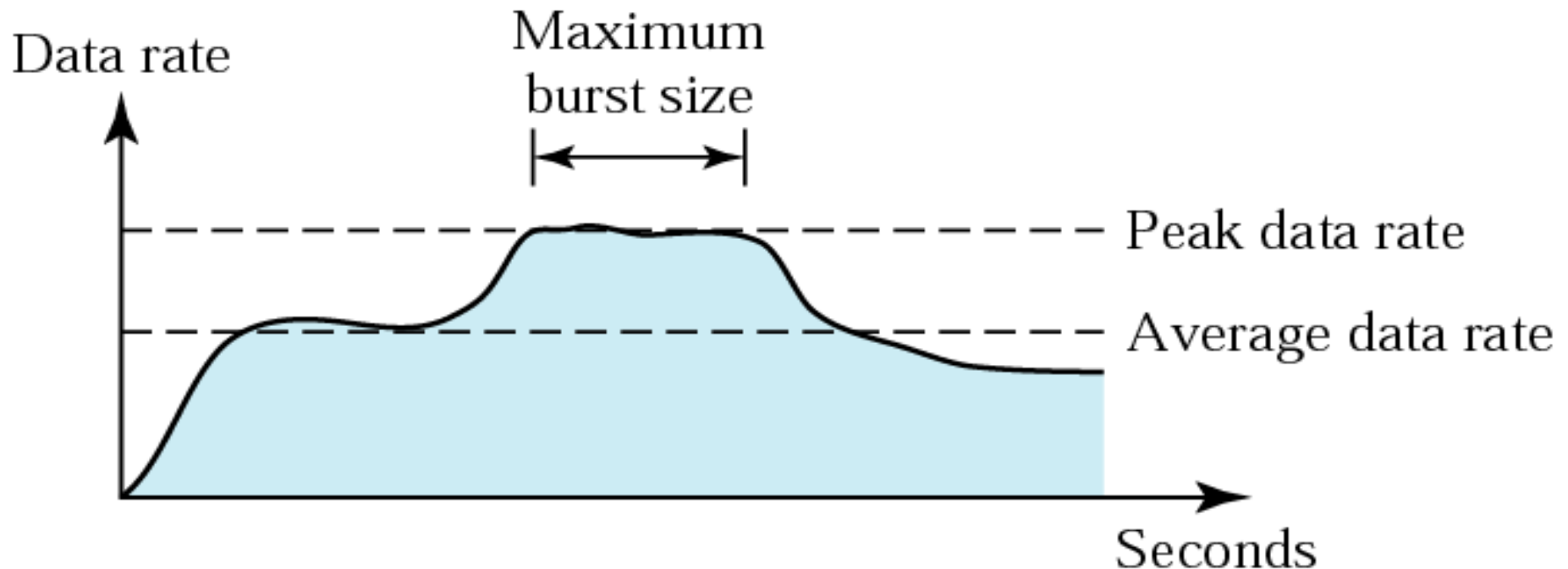
Congestion Control and Quality of Service

- **Data Traffic**
- **Congestion**
- **Congestion Control**
- **Quality of Service**
- **Techniques to Improve QoS**

Data Traffic

Traffic Descriptors

The main focus of congestion control and quality of service is data traffic. In congestion control we try to avoid traffic congestion. In quality of service, we try to create an appropriate environment for the traffic. So, before talking about congestion control and quality of service, we discuss the data traffic itself.



Data Traffic

Traffic Descriptors

The **average data rate** is the number of bits sent during a period of time, divided by the number of seconds in that period. We use the following equation:

$$\text{Average data rate} = \frac{\text{amount of data}}{\text{time}}$$

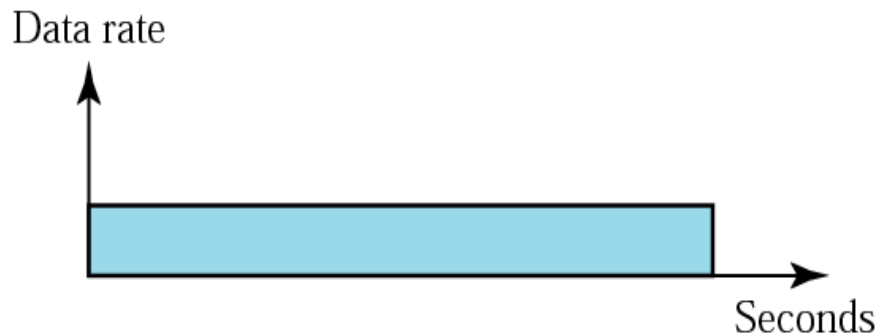
The **peak data rate** defines the maximum data rate of the traffic. In Figure 24.1 it is the maximum y axis value. The peak data rate is a very important measurement because it indicates the peak bandwidth that the network needs for traffic to pass through without changing its data flow.

Although the peak data rate is a critical value for the network, it can usually be ignored if the duration of the peak value is very short. For example, if data are flowing steadily at the rate of 1 Mbps with a sudden peak data rate of 2 Mbps for just 1 ms, the network probably can handle the situation. However, if the peak data rate lasts 60 ms, there may be a problem for the network. The **maximum burst size** normally refers to the maximum length of time the traffic is generated at the peak rate.

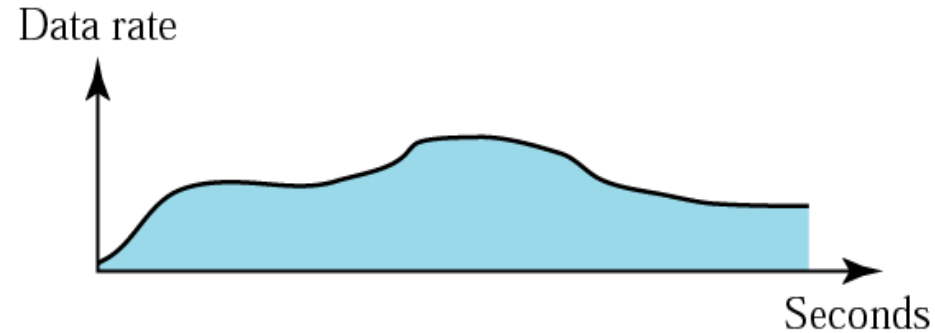
Data Traffic

Traffic Profiles

Constant Bit Rate (CBR)



Variable Bit Rate (VBR)



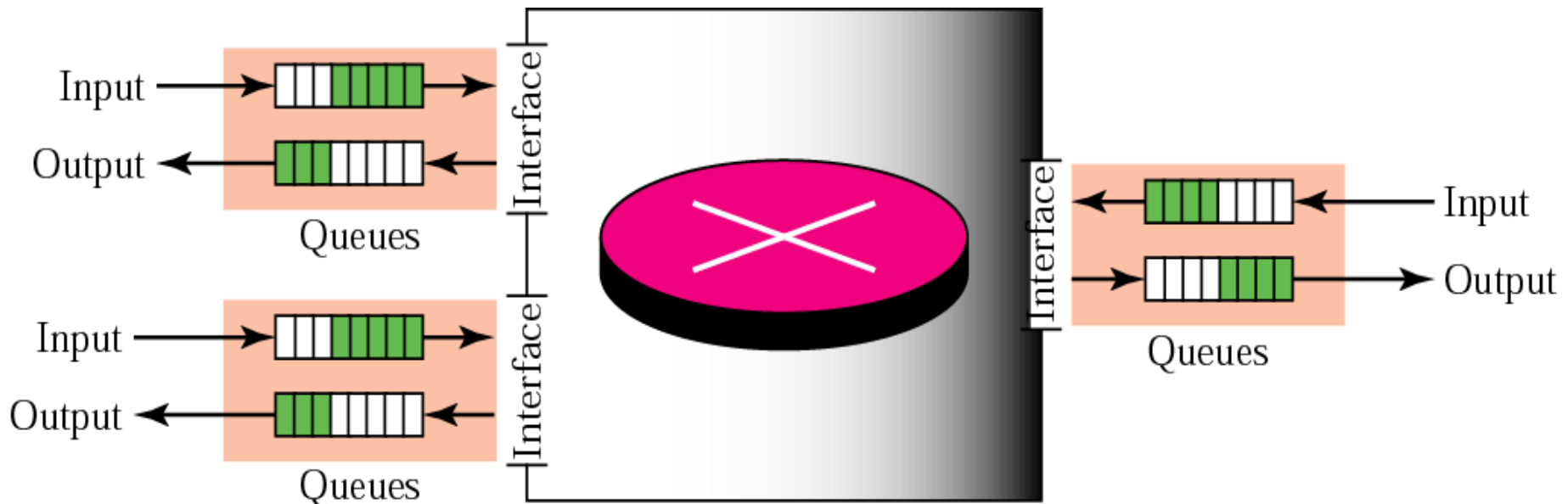
Bursty Data



Congestion

An important issue in a packet-switched network is **congestion**. Congestion in a network may occur if the **load** on the network—the number of packets sent to the network—is greater than the *capacity* of the network—the number of packets a network can handle. **Congestion control** refers to the mechanisms and techniques to control the congestion and keep the load below the capacity.

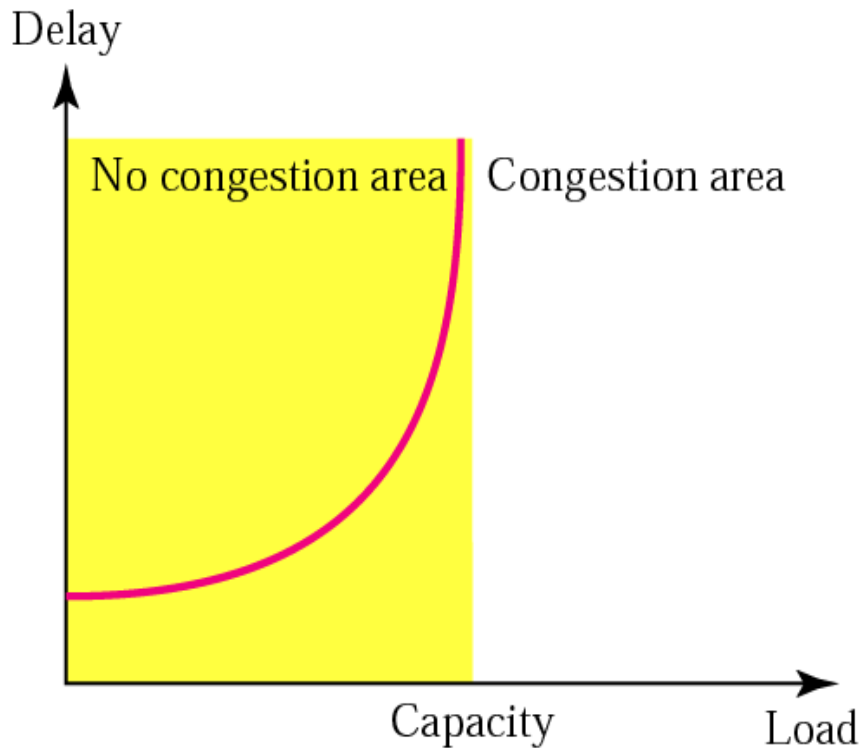
Queues in a Router



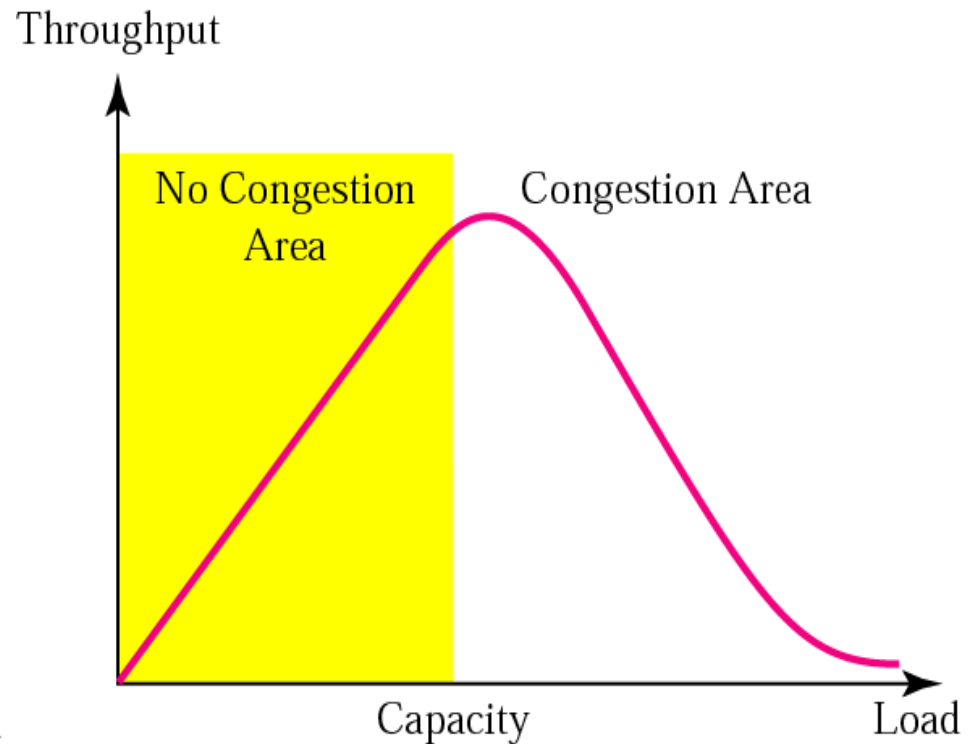
Congestion

Network Performance

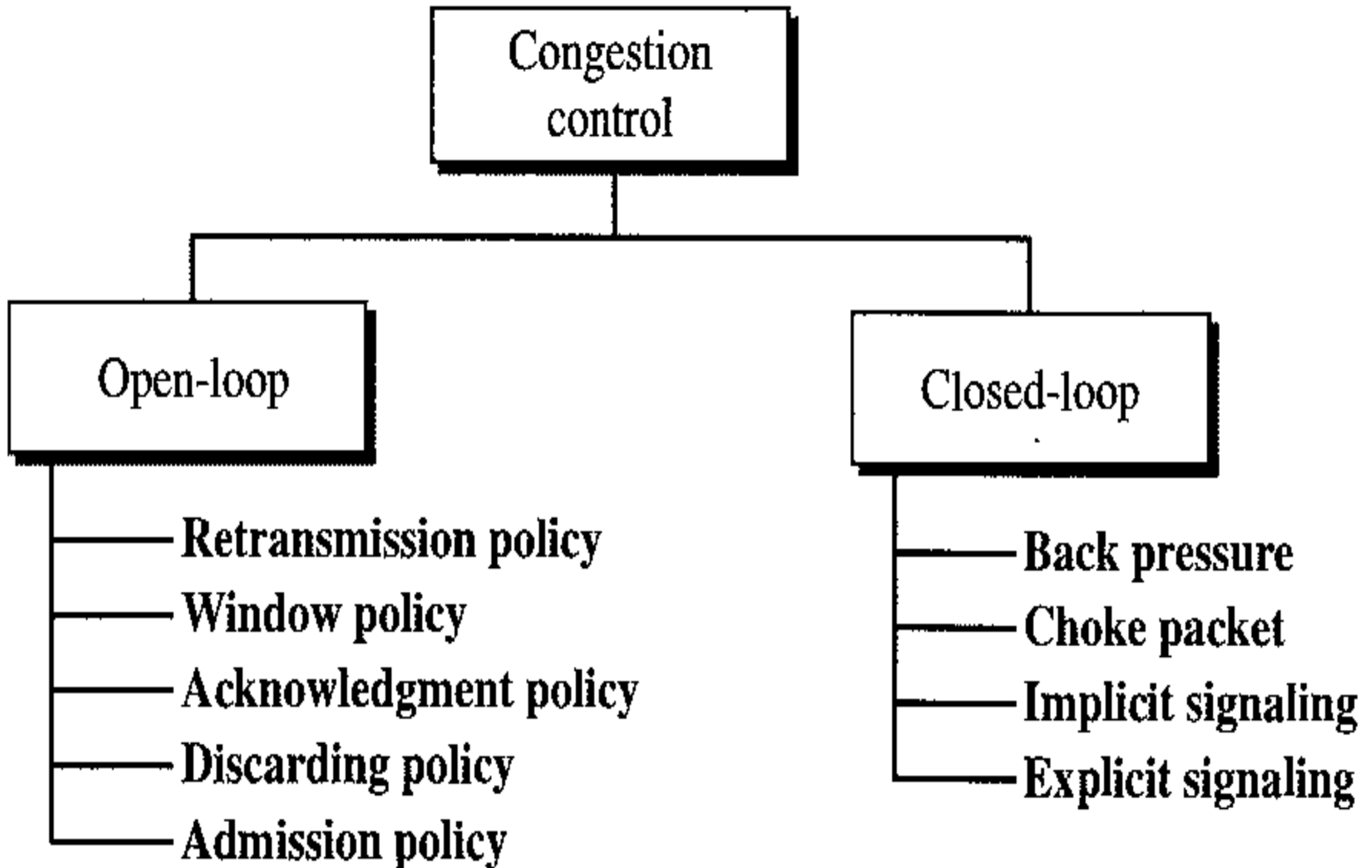
Delay Vs Load



Throughput Vs Load

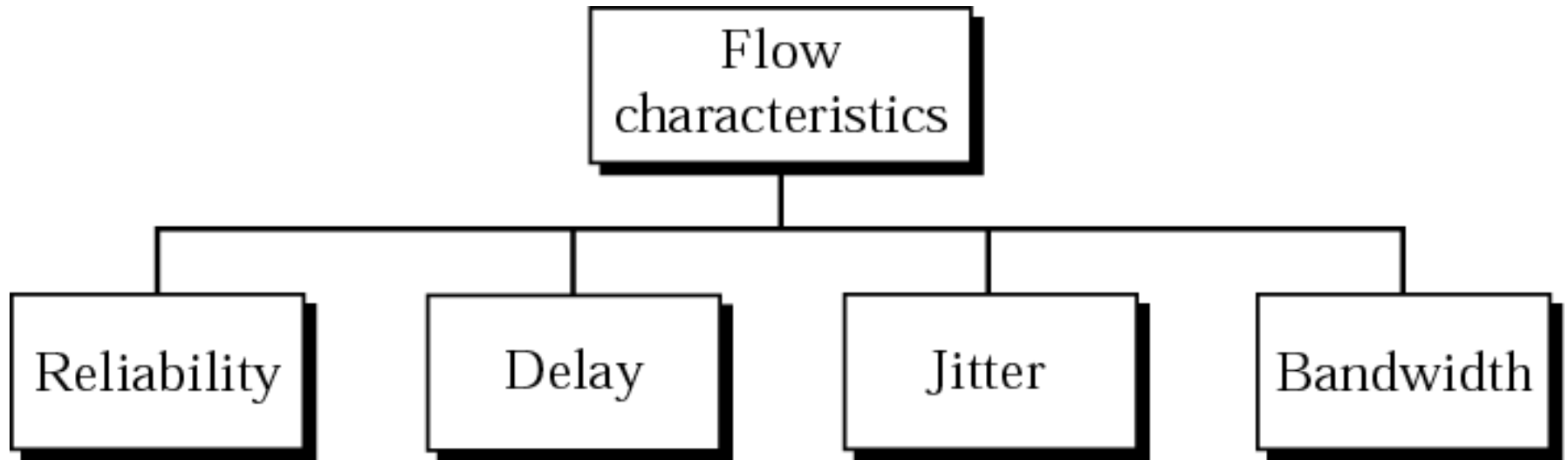


Congestion Control



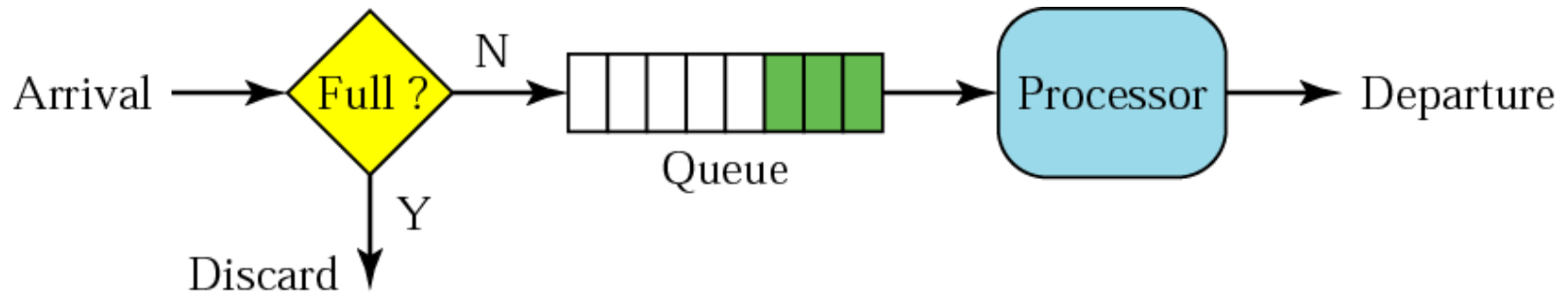
Quality of Service

Flow Characteristics

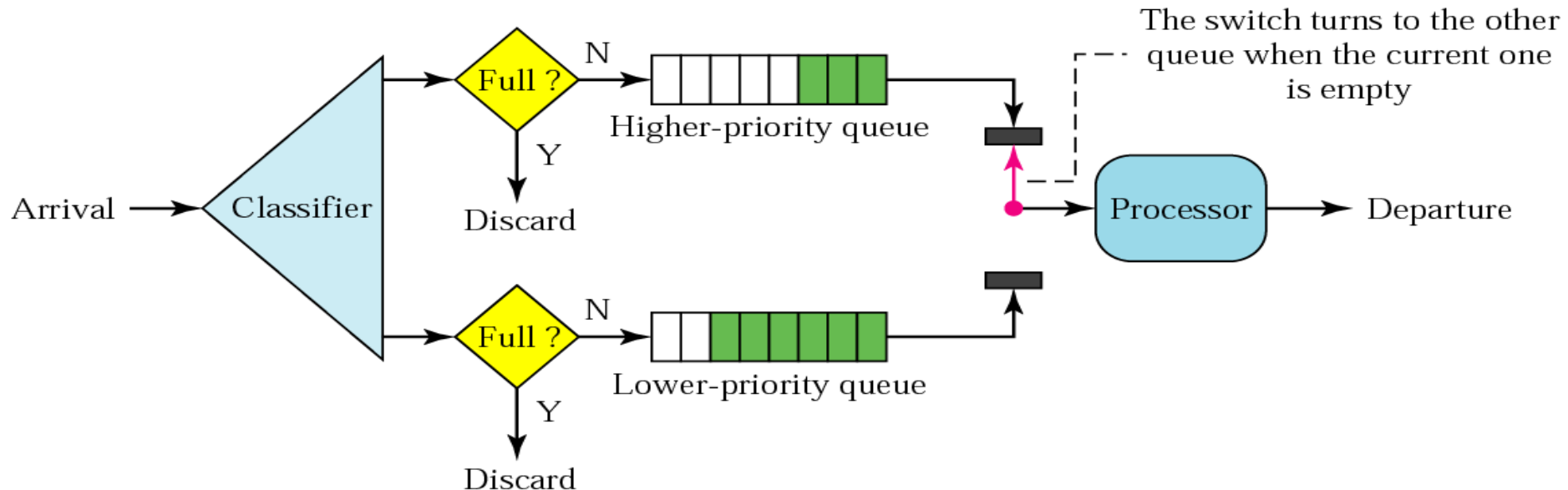


Techniques to Improve QoS

FIFO Queuing

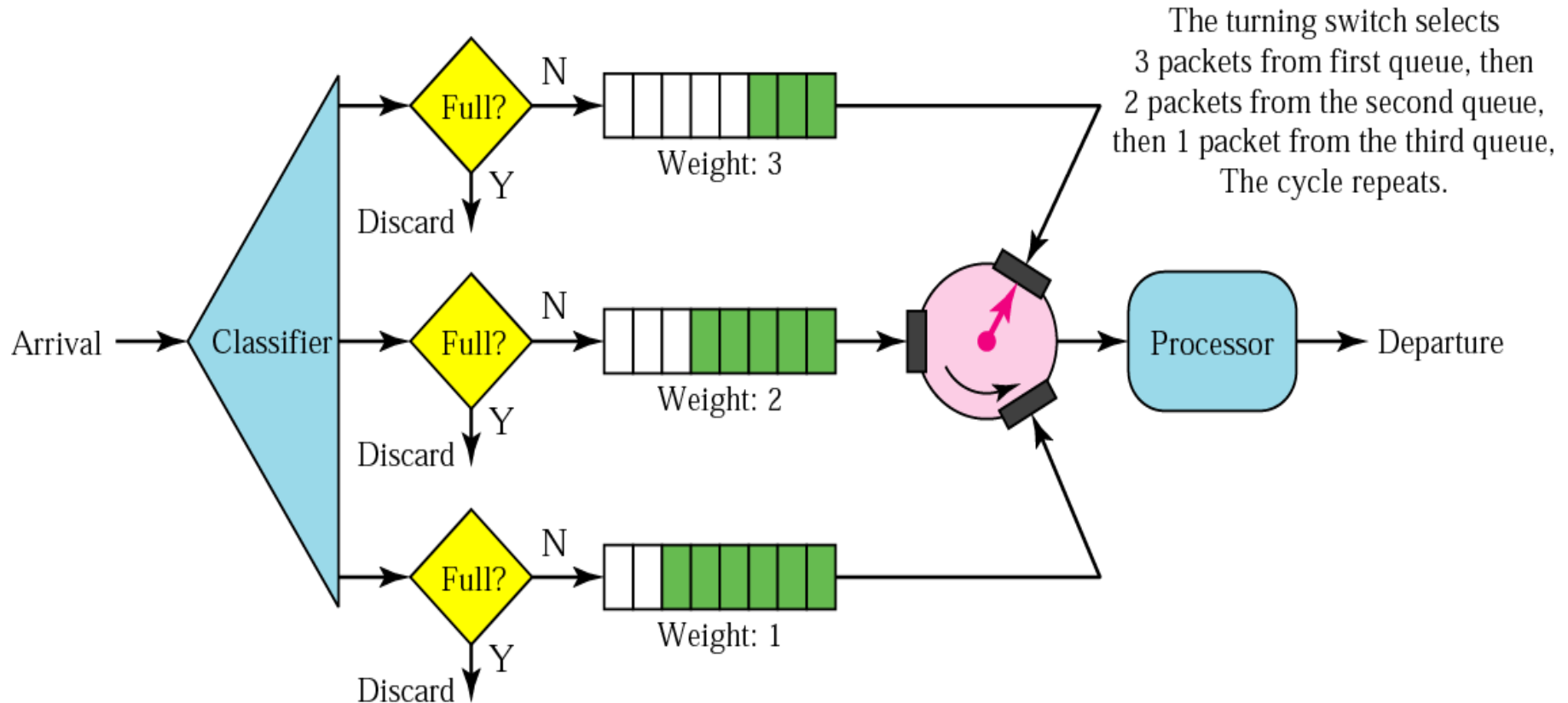


Priority Queuing



Techniques to Improve QoS

Weighted Fair Queuing

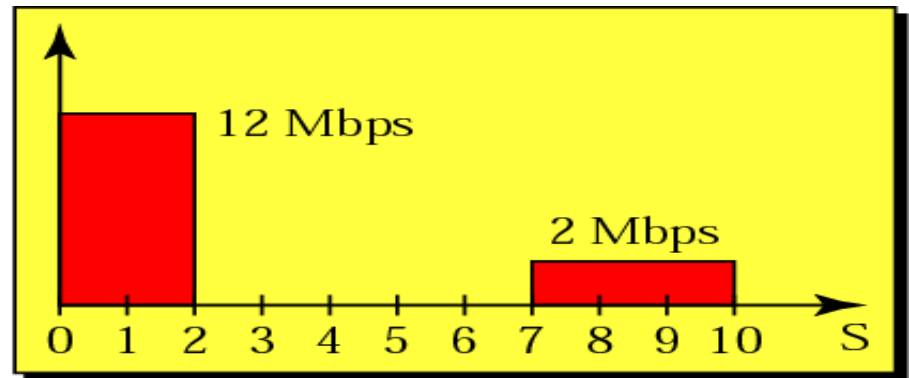
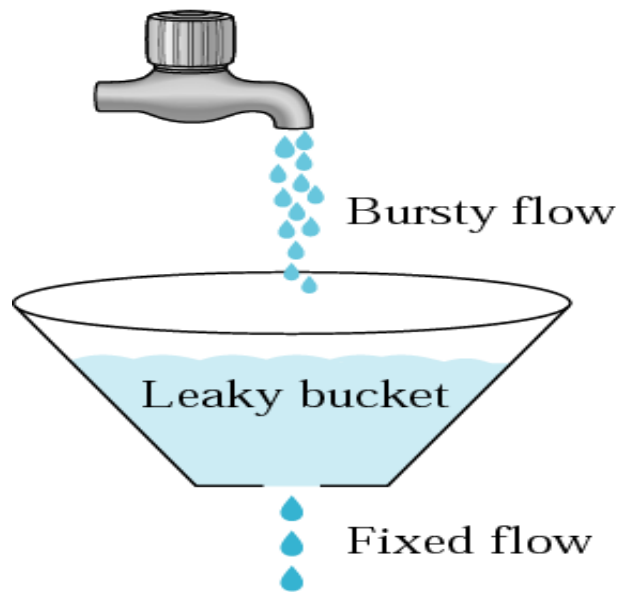


Techniques to Improve QoS

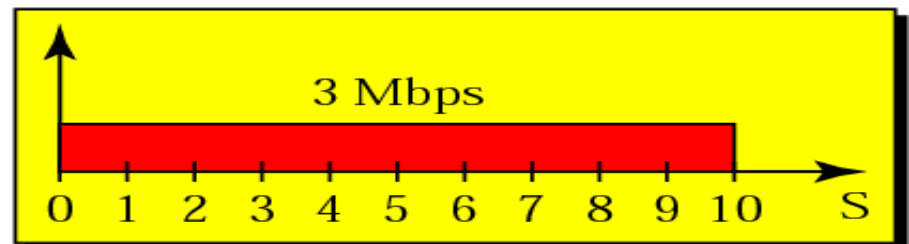
Traffic Shaping

Traffic shaping is a mechanism to control the amount and the rate of the traffic sent to the network. Two techniques can shape traffic: leaky bucket and token bucket.

Leaky Bucket



Bursty data

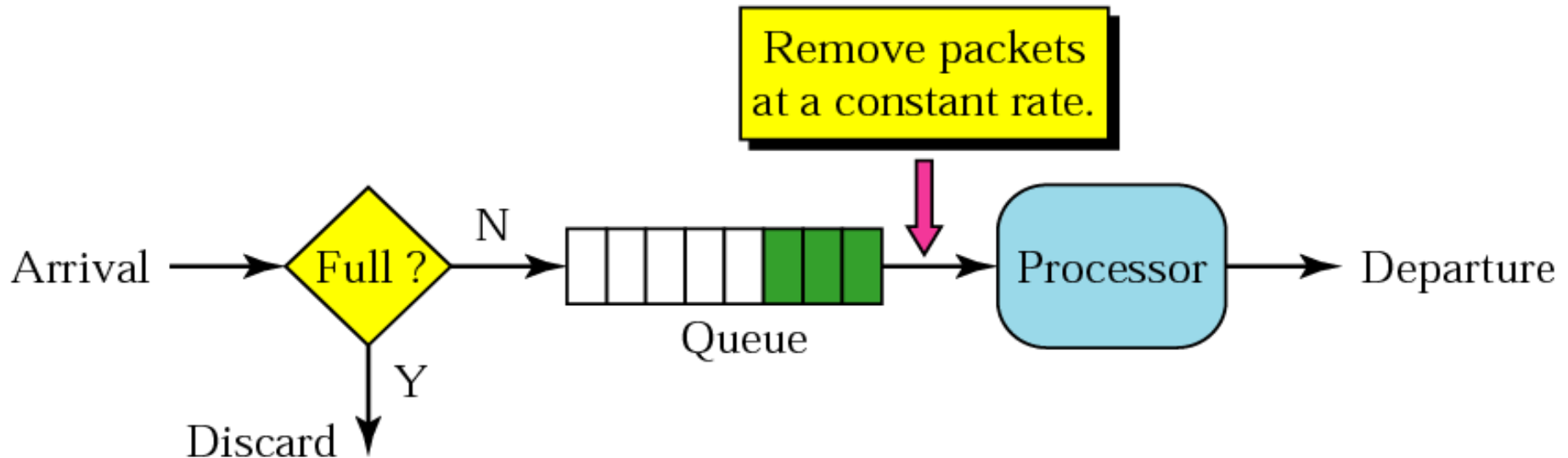


Fixed-rate data

Techniques to Improve QoS

Leaky Bucket

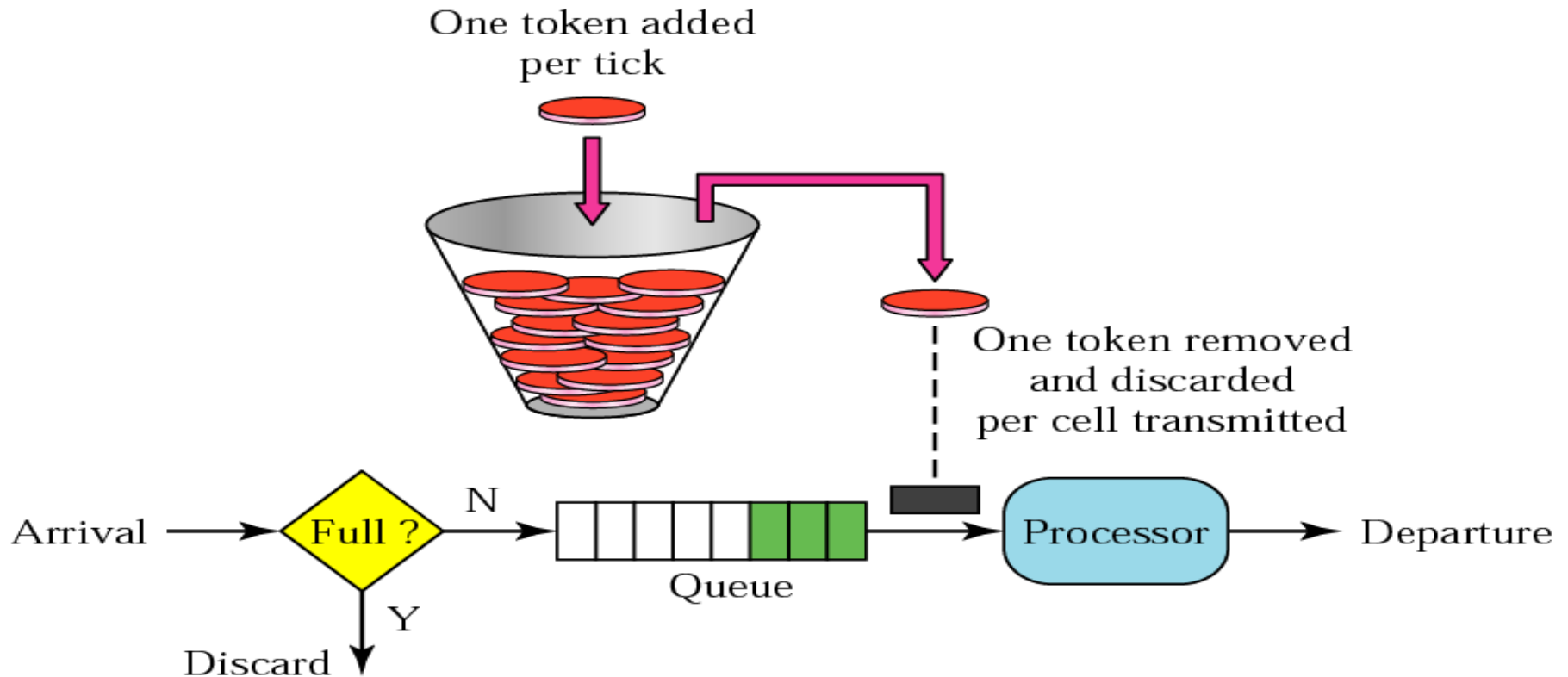
Leaky Bucket Algorithm



A leaky bucket algorithm shapes bursty traffic into fixed-rate traffic by averaging the data rate. It may drop the packets if the bucket is full.

Techniques to Improve QoS

Token Bucket



The token bucket allows bursty traffic at a regulated maximum rate.

Techniques to Improve QoS

Combination of Leaky & Token Bucket

The two techniques can be combined to credit an idle host and at the same time regulate the traffic. The leaky bucket is applied after the token bucket; the rate of the leaky bucket needs to be higher than the rate of tokens dropped in the bucket.

Resource Reservation

A flow of data needs resources such as a buffer, bandwidth, CPU time, and so on. The quality of service is improved if these resources are reserved beforehand. We discuss in this section one QoS model called Integrated Services, which depends heavily on resource reservation to improve the quality of service.

Techniques to Improve QoS

Admission Control

Admission control refers to the mechanism used by a router, or a switch, to accept or reject a flow based on predefined parameters called flow specifications. Before a router accepts a flow for processing, it checks the flow specifications to see if its capacity (in terms of bandwidth, buffer size, CPU speed, etc.) and its previous commitments to other flows can handle the new flow.