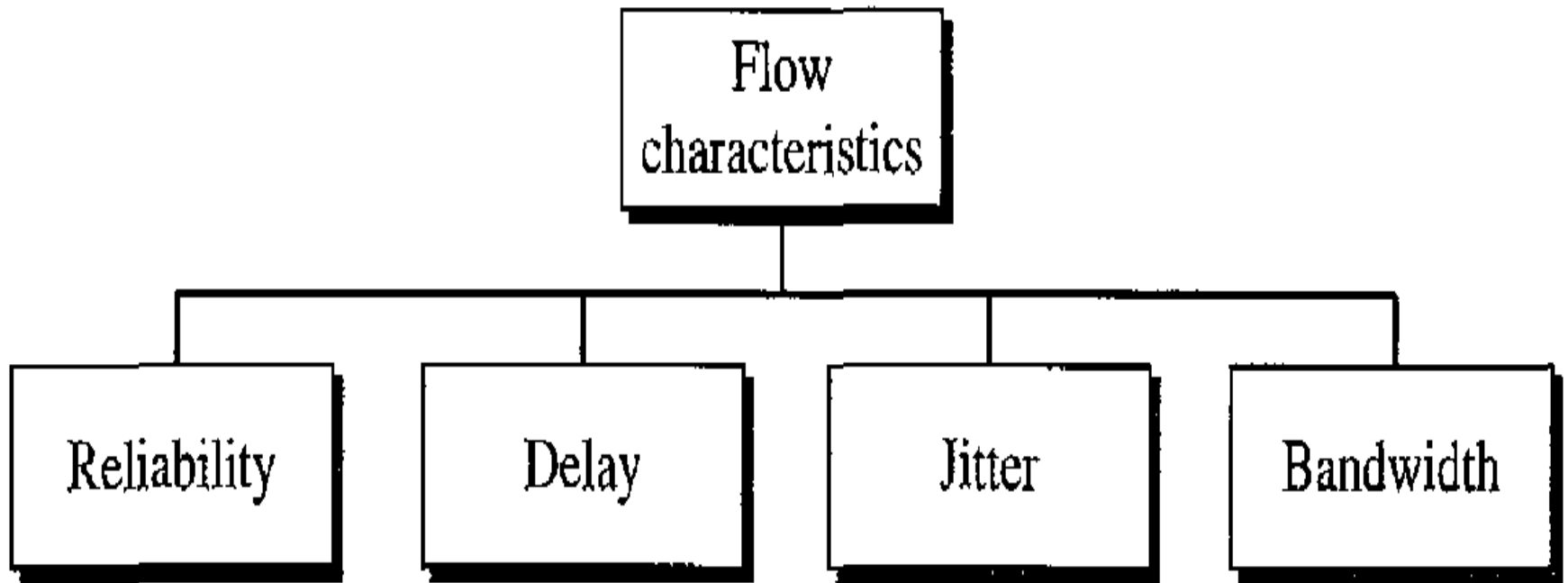


# Quality Of Service

# Flow Characteristics



# Flow Characteristics

- ***Reliability***

- Lack of reliability means losing a packet or acknowledgment, which entails retransmission.
- Reliability is more important in email than in audio conferencing.

- ***Delay***

- Source-to-destination delay
- Applications can tolerate delay in different degrees.

# Flow Characteristics

- Telephony, audio conferencing, video conferencing, and remote log-in need minimum delay.
- Delay in file transfer or e-mail is less important.
- ***Jitter***
  - Jitter is the variation in delay for packets belonging to the same flow.
  - Example 1: packets 0,1,2,3 arrive at 20, 21,22,23  
time of arrival 20.

# Flow Characteristics

- Example 2: 0,1,2,3 arrive at 20,22,21,23.
- Applications : audio and video uniform delay is important between the packets.
- High jitter means the difference between delays is large; low jitter means the variation is small.
- ***Bandwidth***
  - Different applications need different bandwidths.
  - Video conferencing we need to send millions of bits per second to refresh a color screen.

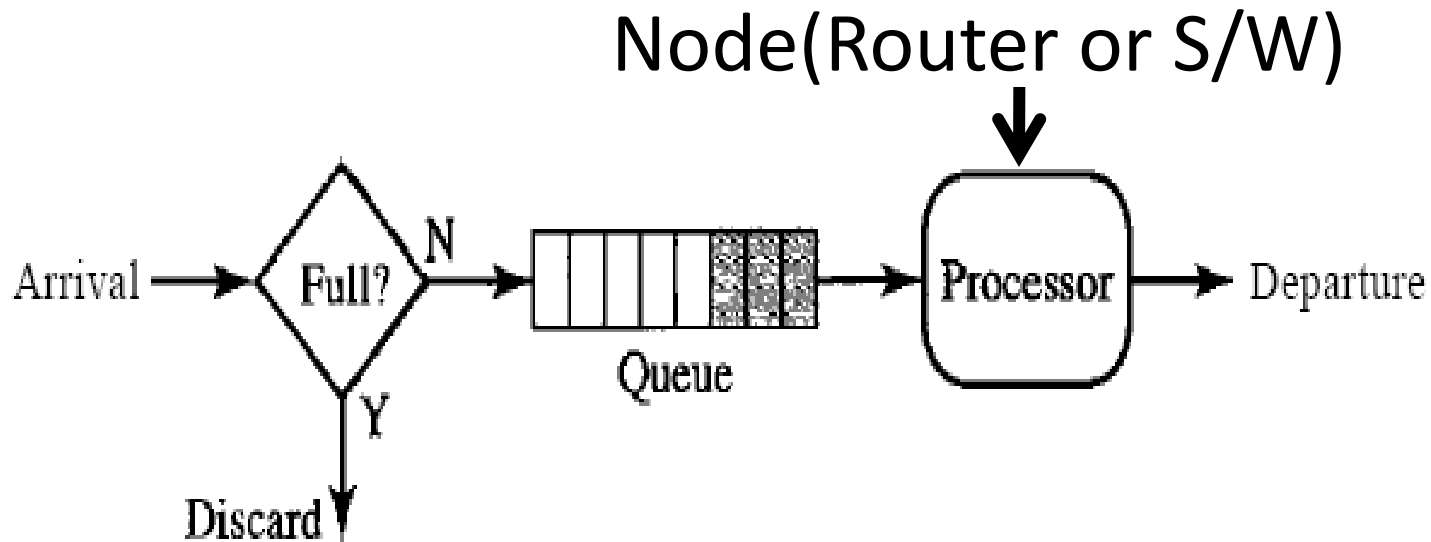
# TECHNIQUES TO IMPROVE QoS

- **Scheduling**

- Packets from different flows arrive at a switch or router for processing.
- A good scheduling technique treats the different flows in a fair and appropriate manner.
  1. FIFO queuing
  2. Priority queuing
  3. Weighted fair queuing

# TECHNIQUES TO IMPROVE QoS

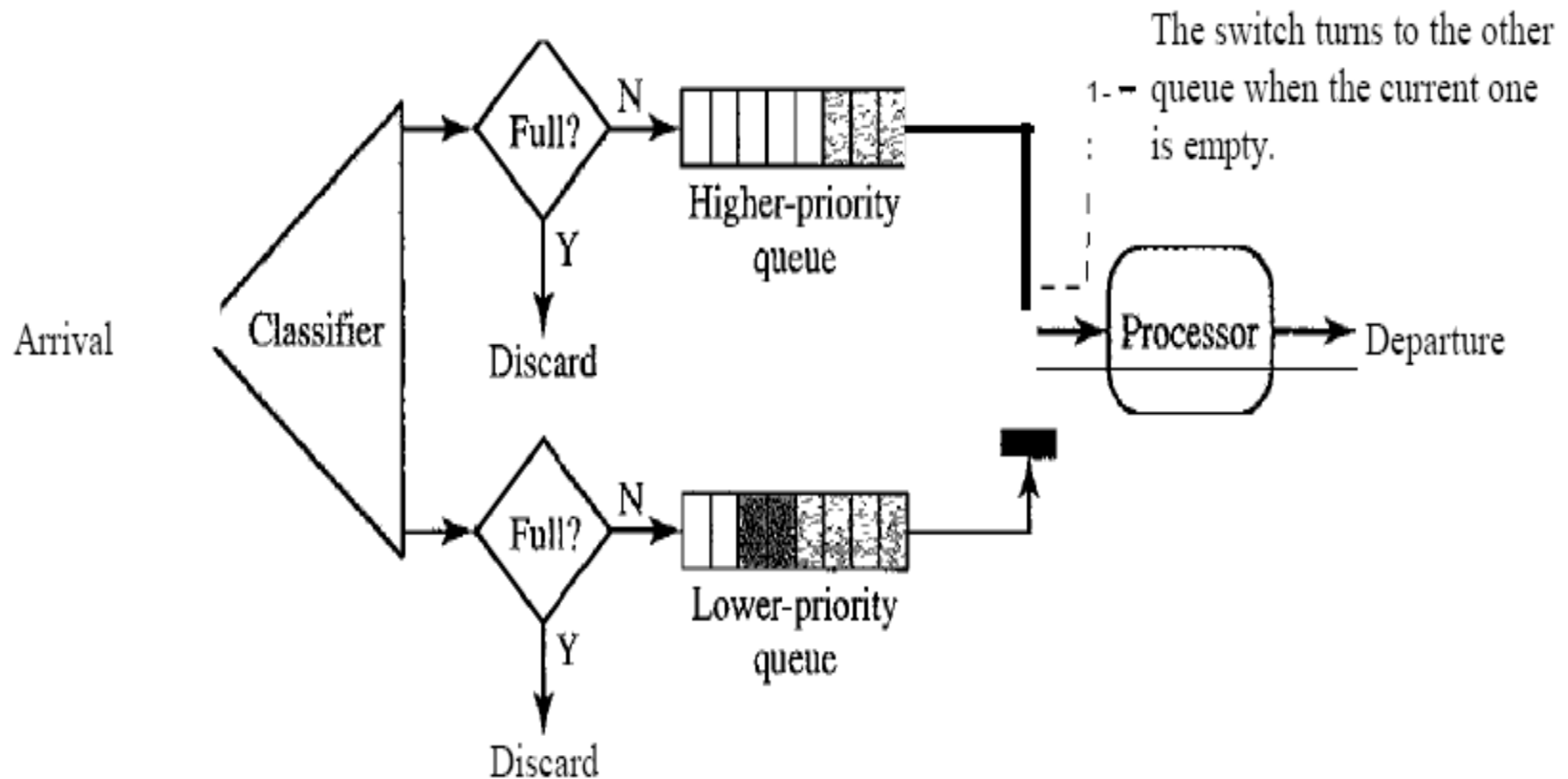
- **FIFO queuing**



- Example: wait for a bus at bus stop

# TECHNIQUES TO IMPROVE QoS

- Priority queuing



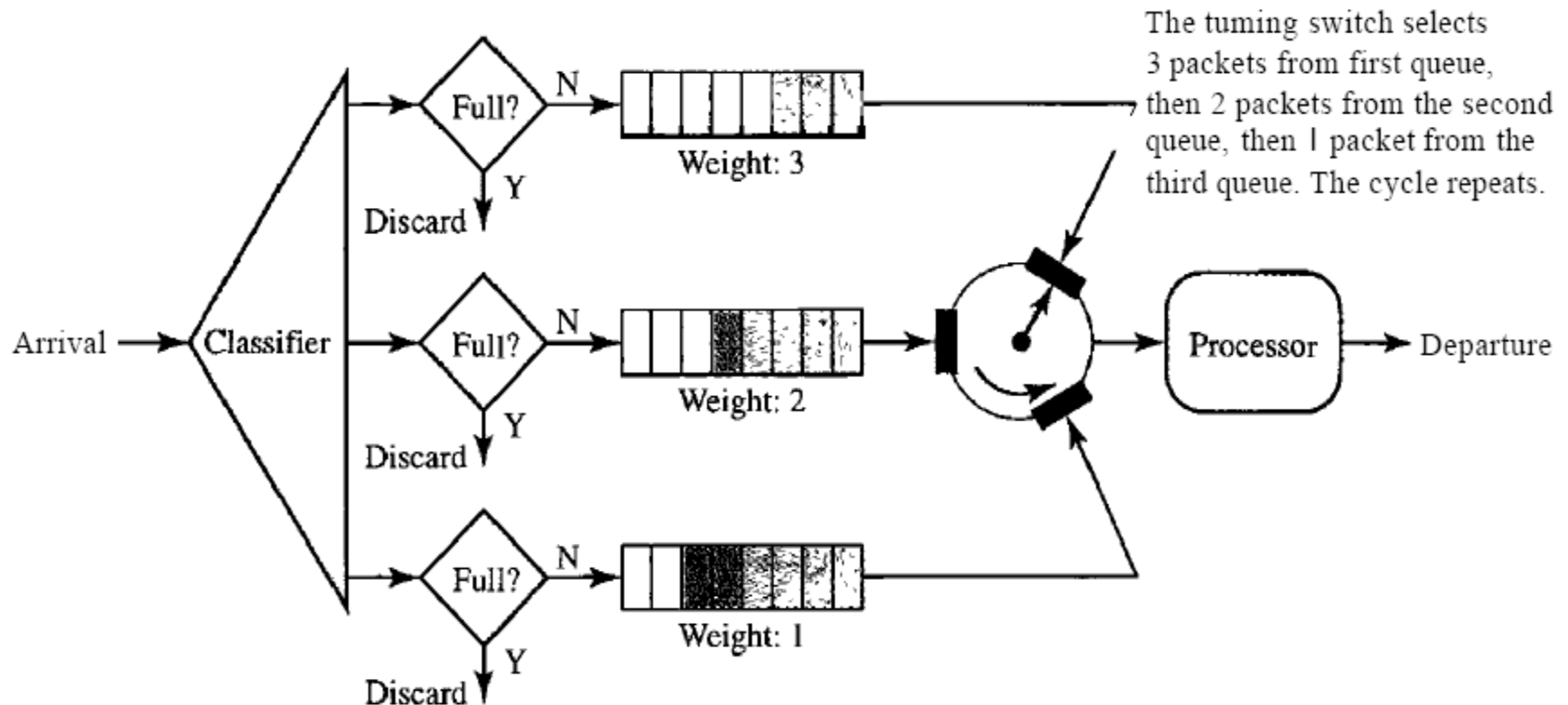


# TECHNIQUES TO IMPROVE QoS

- A priority queue can provide better QoS than the FIFO queue because higher priority traffic, such as multimedia, can reach the destination with less delay.
- Drawback of Priority Queuing  
***Starvation:*** of low priority queuing packets

# TECHNIQUES TO IMPROVE QoS

- Weighted fair queuing



# TECHNIQUES TO IMPROVE QoS

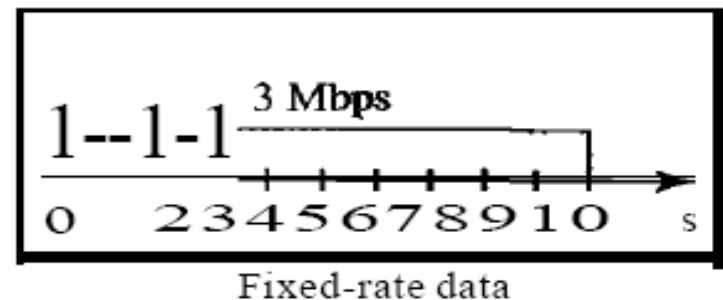
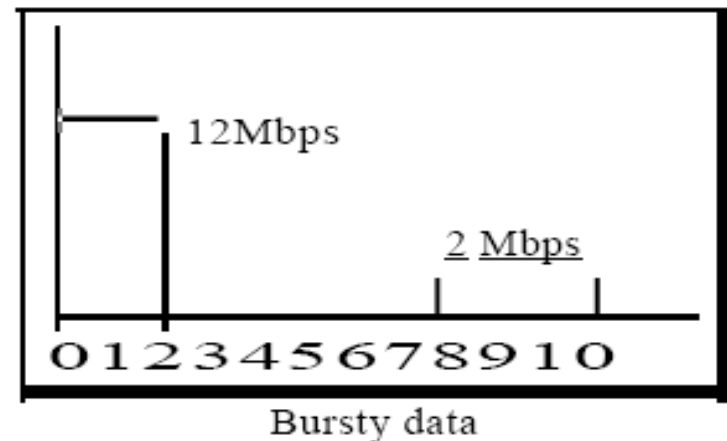
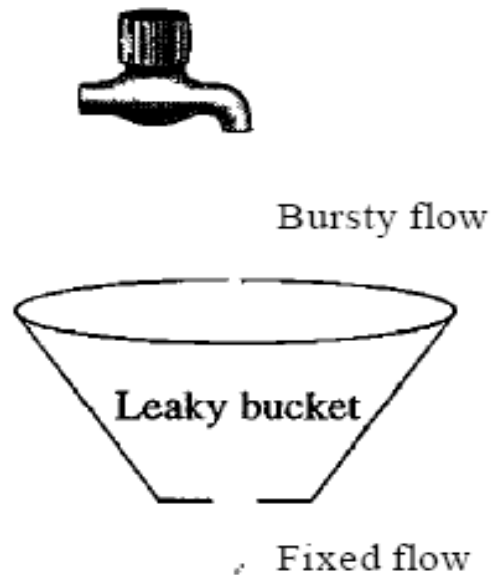
- A better scheduling method is weighted fair queuing.
- The packets are still assigned to different classes and admitted to different queues.
- If the system does not impose priority on the classes, all weights can be equal.

# 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.
    1. Leaky bucket
    2. Token bucket.

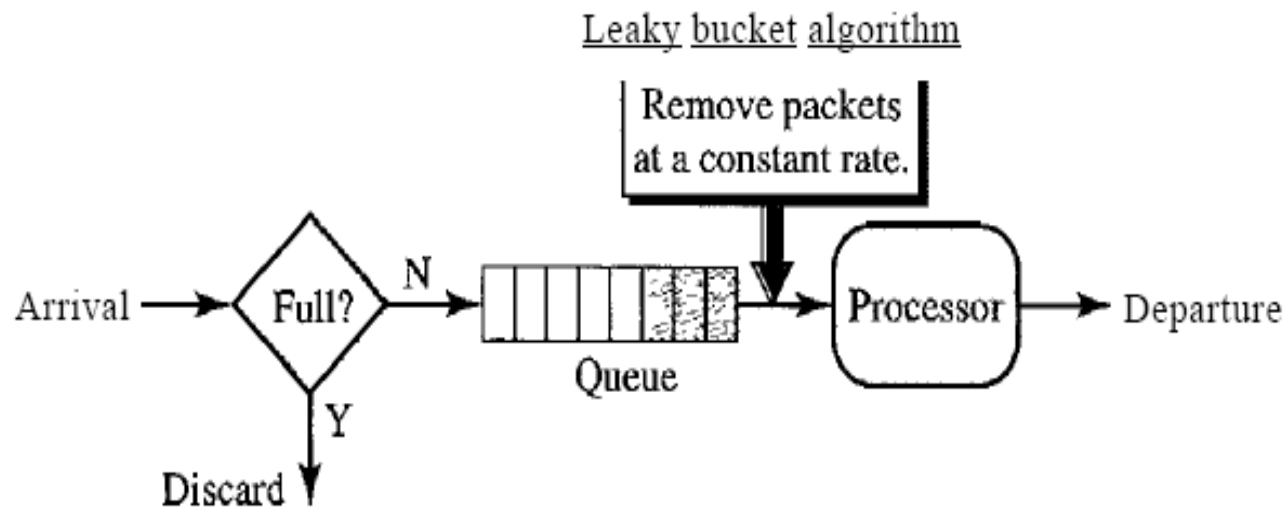
# TECHNIQUES TO IMPROVE QoS

- Leaky bucket



# TECHNIQUES TO IMPROVE QoS

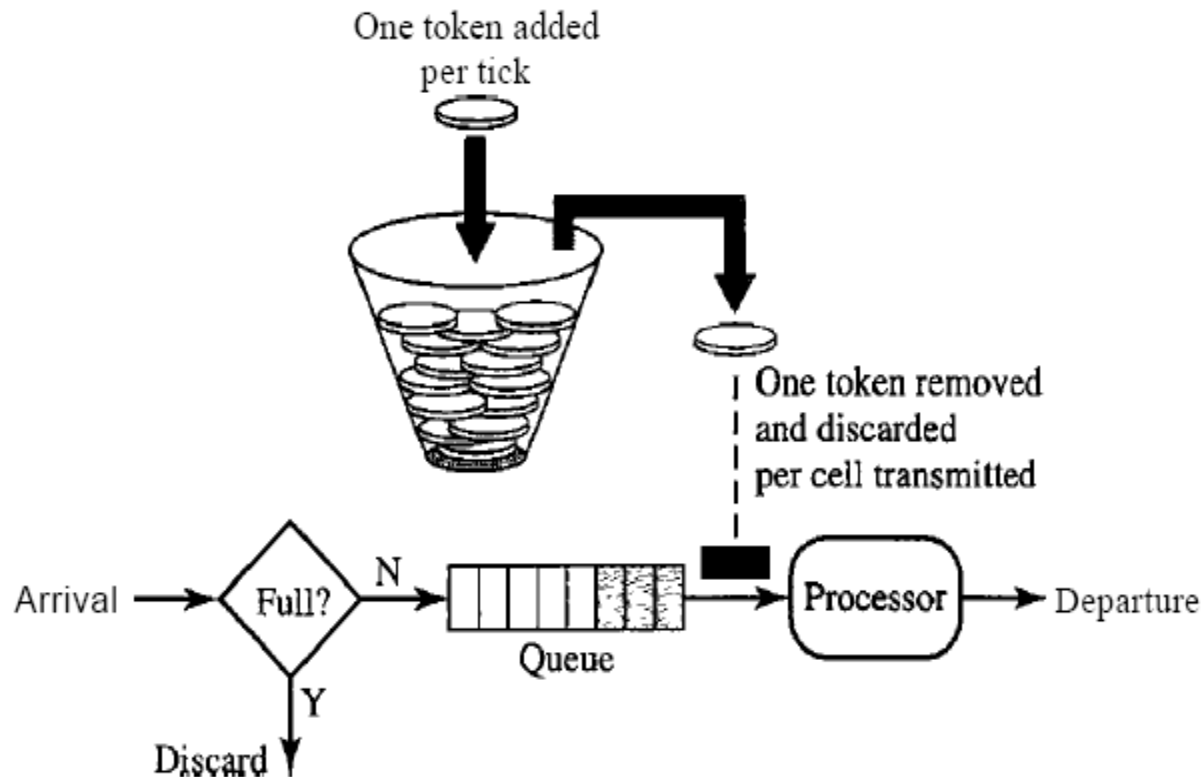
- **Leaky bucket implementation**



- 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**



- A token is added at every  $t$  time.

# TECHNIQUES TO IMPROVE QoS

- The token bucket algorithm as compared to leaky bucket allows output rate vary depending on size of burst.
- The token bucket allows bursty traffic at a regulated maximum rate.



## DIFFERENCE BETWEEN LEAKY BUCKET AND TOKEN BUCKET ALGORITHM

TOKEN BUCKET	LEAKY BUCKET
Token dependent.	Token independent.
If bucket is full token are discarded, but not the packet.	If bucket is full packet or data is discarded.
Packets can only transmitted when there are enough token	Packets are transmitted continuously.
It allows large bursts to be sent faster rate after that constant rate	It sends the packet at constant rate
It saves token to send large bursts.	It does not save token.

# TECHNIQUES TO IMPROVE QoS

- **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.

# 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.