Computer Network

Lecture-43

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Congestion Control and Quality of Service

QUALITY OF SERVICE

We can informally define quality of service as something a flow seeks to attain.

Flow Characteristics

There are four types of characteristics attributed to a flow: reliability, delay, jitter, and bandwidth.

Reliability

Reliability is a characteristic that a flow needs. Lack of reliability means losing a packet or acknowledgment, which entails retransmission. However, the sensitivity of application programs to reliability is not the same. For example, it is more important that electronic mail, file transfer, and Internet access have reliable transmissions than telephony or audio conferencing.

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Delay

Source-to-destination delay is another flow characteristic. Again applications can tolerate delay in different degrees. In this case, telephony, audio conferencing, video conferencing, and remote log-in need minimum delay, while delay in file transfer or e-mail is less important.

Jitter

Jitter is the variation in delay for packets belonging to the same flow. For example, if four packets depart at times 0, 1, 2, 3 and arrive at 20, 21, 22, 23, all have the same delay, 20 units of time. On the other hand, if the above four packets arrive at 21, 23, 21, and 28, they will have different delays: 21,22, 19, and 24.

For applications such as audio and video, the first case is completely acceptable; the second case is not.

Bandwidth

Different applications need different bandwidths. In video conferencing we need to send millions of bits per second to refresh a color screen while the total number of bits in an e-mail may not reach even a million.

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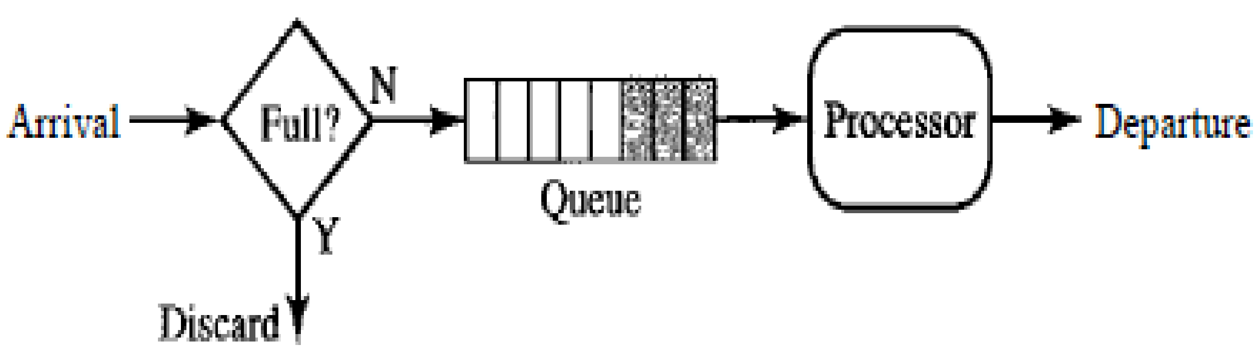
TECHNIQUES TO IMPROVE QoS

There are four common methods to improve the quality of service: scheduling, traffic shaping, admission control, and resource reservation.

FIFO Queuing

In first-in, first-out (FIFO) queuing, packets wait in a buffer (queue) until the node(router or switch) is ready to process them. If the average arrival rate is higher than the average processing rate, the queue will fill up and new packets will be discarded.



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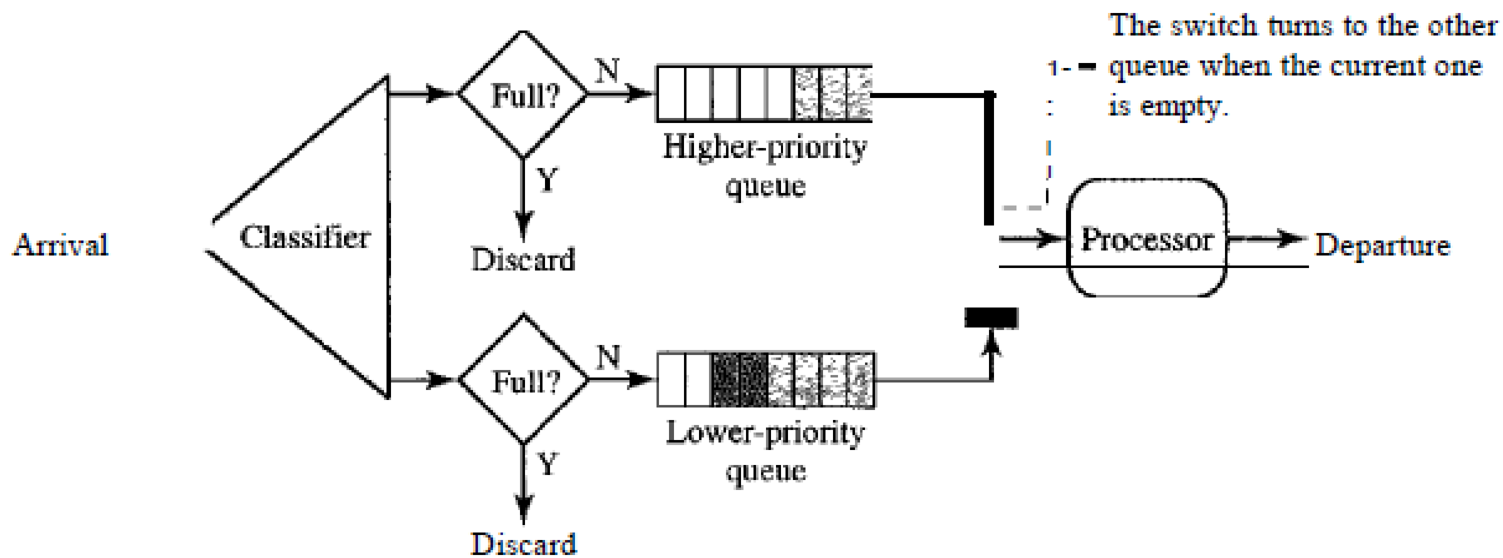
Priority Queuing

In priority queuing, packets are first assigned to a priority class. Each priority class has its own queue. The packets in the highest-priority queue are processed first. Packets in the lowest-priority queue are processed last. Note that the system does not stop serving a queue until it is empty. Following figure shows priority queuing with two priority levels.



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.

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Weighted Fair Queuing

A better scheduling method is weighted fair queuing. In this technique, the packets are still assigned to different classes and admitted to different queues. The queues, however, are weighted based on the priority of the queues; higher priority means a higher weight.

The system processes packets in each queue in a round-robin fashion with the number of packets selected from each queue based on the corresponding weight. For example, if the weights are 3, 2, and 1, three packets are processed from the first queue, two from the second queue, and one from the third queue.

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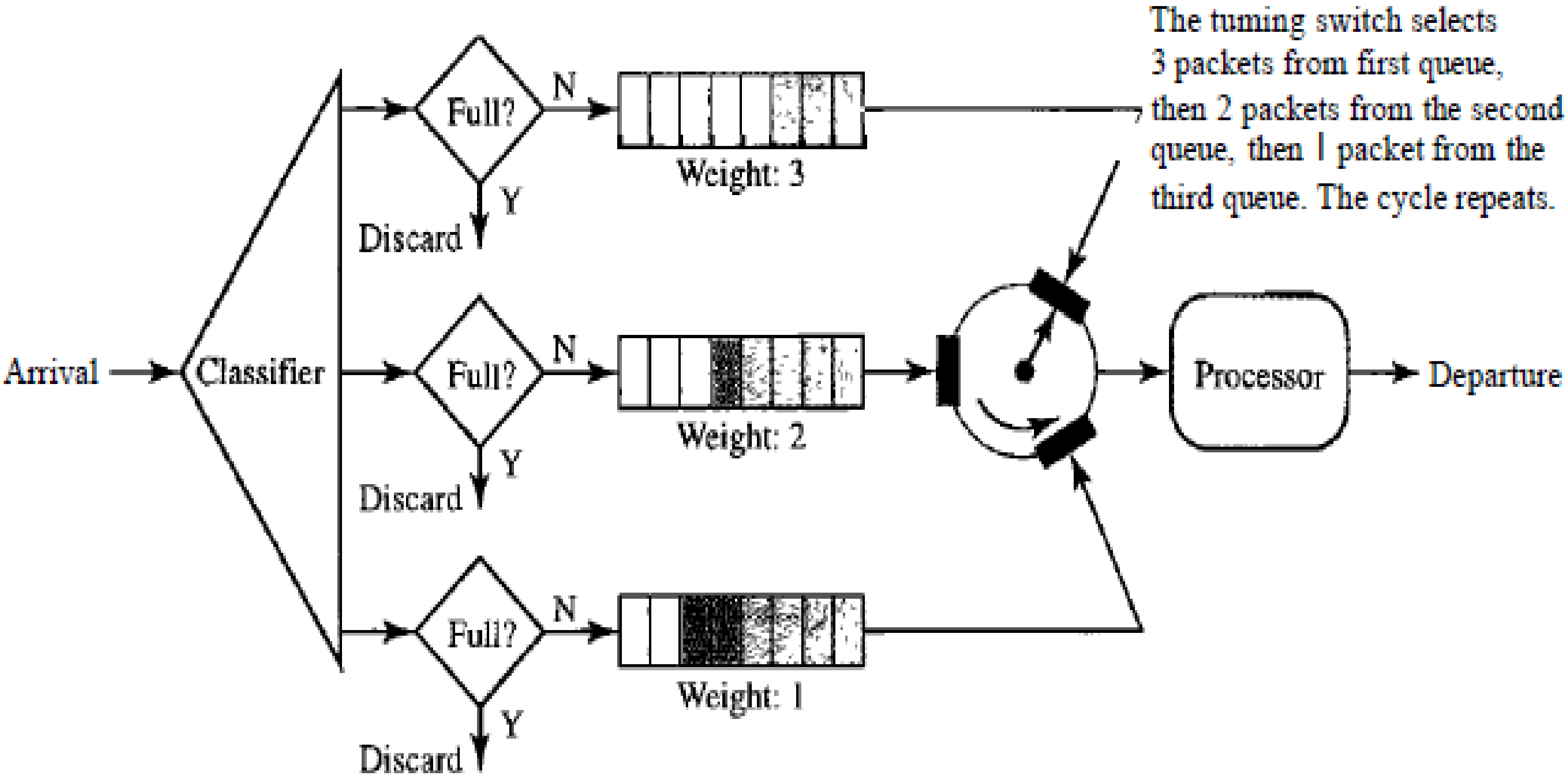

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Traffic Shaping

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

If a bucket has a small hole at the bottom, the water leaks from the bucket at a constant rate as long as there is water in the bucket. The rate at which the water leaks does not depend on the rate at which the water is input to the bucket unless the bucket is empty. The input rate can vary, but the output rate remains constant.

Similarly, in networking, leaky bucket technique can smooth out bursty traffic. Bursty chunks are stored in the bucket and sent out at an average rate. Following figure shows a leaky bucket and its effect.

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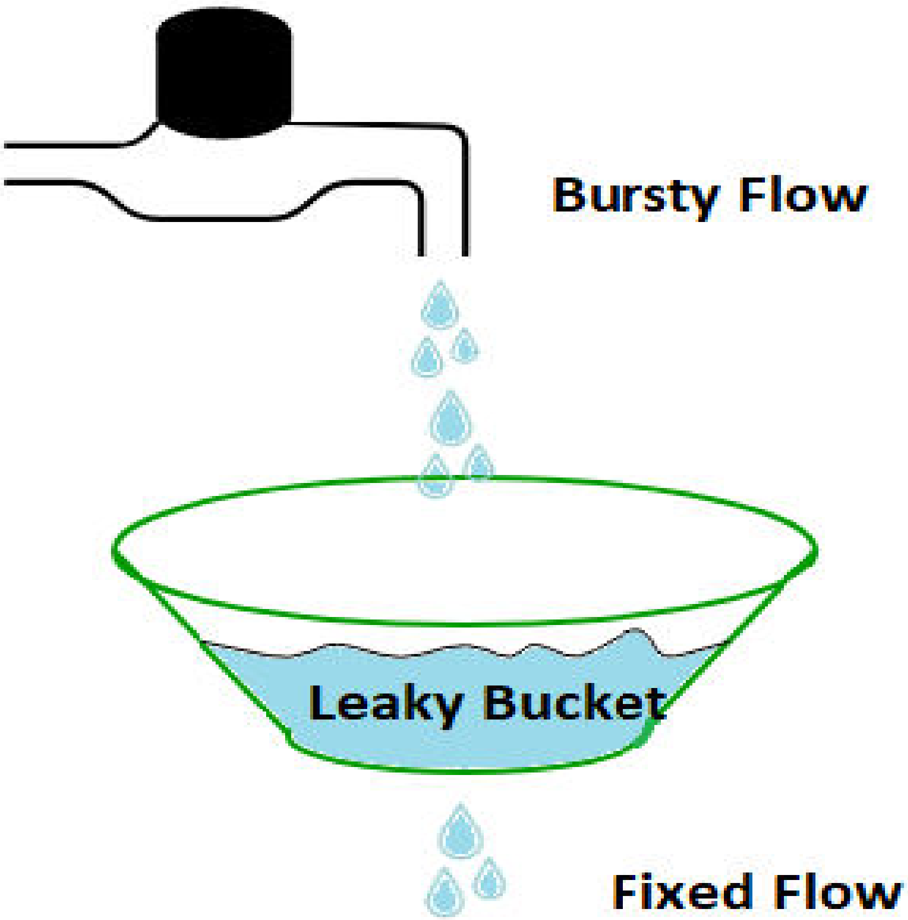

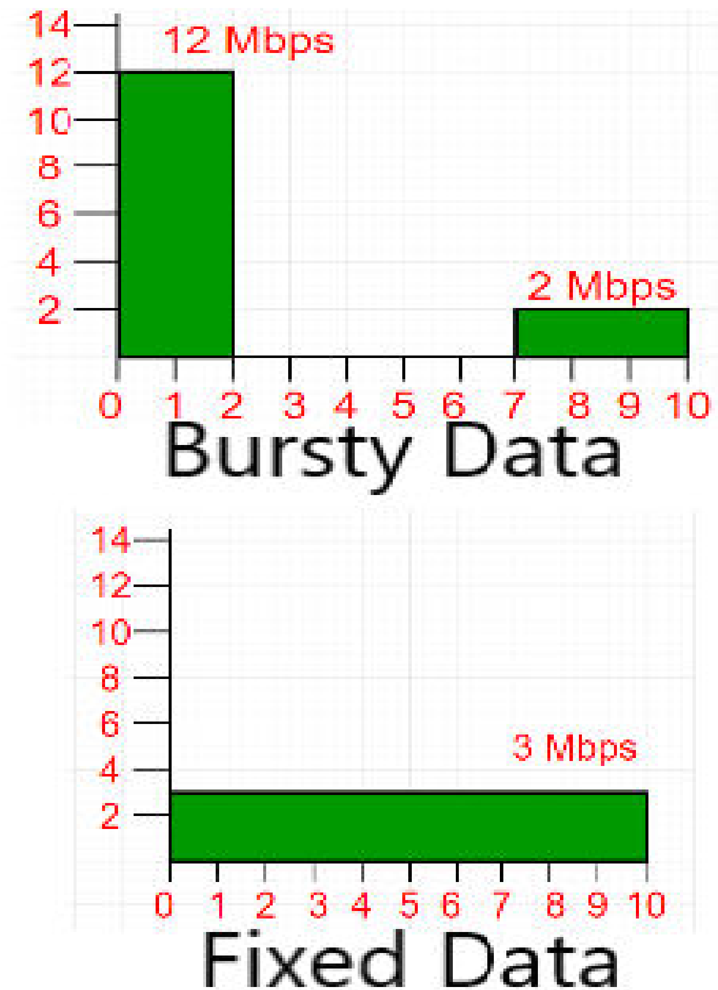

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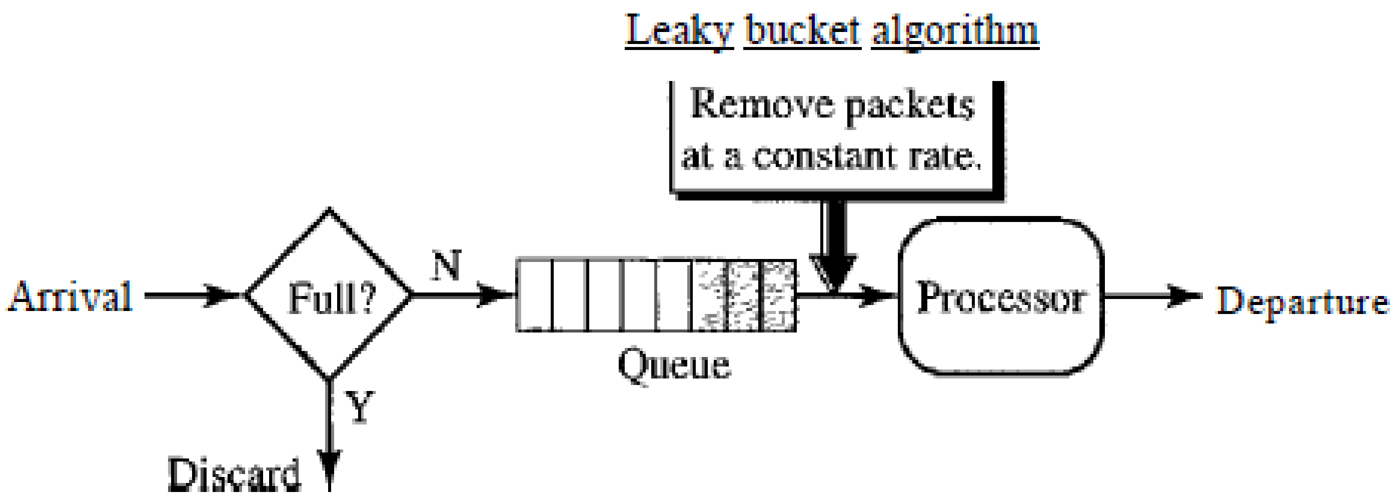
In this figure, the host sends a burst of data at a rate of 12 Mbps for 2s, for a total of 24 Mbits of data. The host is silent for 5s and then sends data at a rate of 2 Mbps for 3s, for a total of 6 Mbits of data. In all, the host has sent 30 Mbits of data in 10s. The leaky bucket smooths the traffic by sending out data at a rate of 3 Mbps during the same 10s.

Note: Leaky bucket may prevent congestion.

Leaky bucket implementation



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In above figure, FIFO queue holds the packets. If the traffic consists of fixed-size packets, then the process removes a fixed number of packets from the queue at each tick of the clock. If the traffic consists of variable-length packets, the fixed output rate must be based on the number of bytes or bits.

The following is an algorithm for variable-length packets:

1. Initialize a counter to n at the tick of the clock.
2. If n is greater than the size of the packet, send the packet and decrement the counter by the packet size. Repeat this step until n is smaller than the packet size.
3. Reset the counter and go to step 1.

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Token Bucket

The leaky bucket is very restrictive. It does not credit an idle host. For example, if a host is not sending for a while, its bucket becomes empty. Now if the host has bursty data, the leaky bucket allows only an average rate. The time when the host was idle is not taken into account.

On the other hand, the token bucket algorithm allows idle hosts to accumulate credit for the future in the form of tokens. For each tick of the clock, the system sends n tokens to the bucket. The system removes one token for every cell (or byte) of data sent. For example, if n is 100 and the host is idle for 100 ticks, the bucket collects 10,000 tokens. Now the host can consume all these tokens in one tick with 10,000 cells, or the host takes 1000 ticks with 10 cells per tick. In other words, the host can send bursty data as long as the bucket is not empty.

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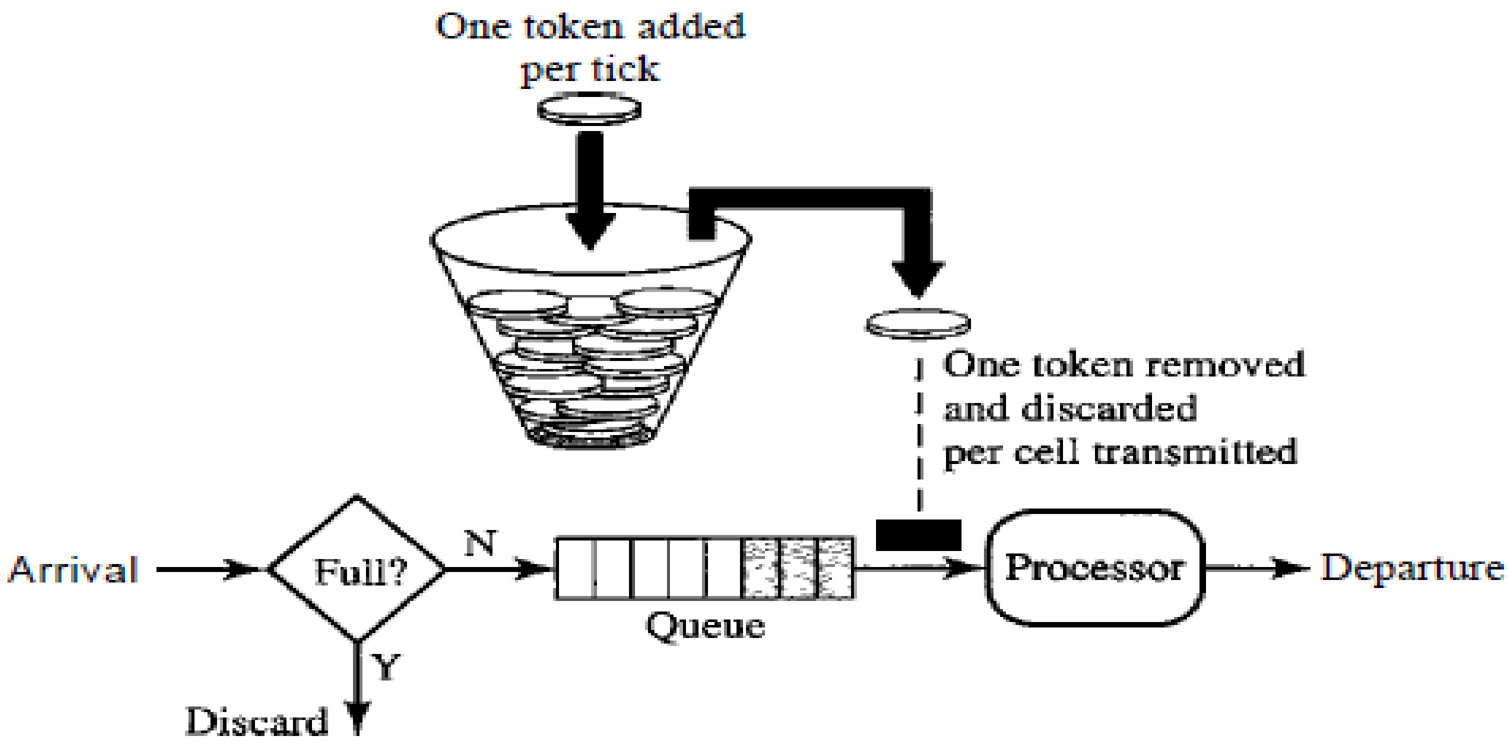
It is shown in the following figure:-



The token bucket can easily be implemented with a counter. The token is initialized to zero. Each time a token is added, the counter is incremented by 1. Each time a unit of data is sent, the counter is decremented by 1. When the counter is zero, the host cannot send data.

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AKTU Examination Questions

1. What are the services of Transport Layer?
2. Discuss TCP window management in detail. Also explain silly window syndrome and their solution.
3. What is Congestion? Differentiate between congestion control and flow control with example. Also discuss congestion prevention policies.
4. Provide few reasons for congestion in a network.
5. How does transport layer perform duplication control?
6. What is congestion? Briefly describe the techniques that prevent congestion.
7. Enumerate on TCP header and working of TCP and differentiate TCP and UDP with frame format.

Process-to-Process Delivery

8. Enumerate how the transport layer unsure that the complete message arrives at the destination and in the proper order.
9. Explain the three way handshaking protocol to establish the transport level connection.
10. Explain about the TCP header and working of TCP protocol and differentiate between TCP and UDP with frame format.
11. The following is the dump of a TCP header in hexa decimal format:

    05320017 00000001 00000000 500207FF 00000000

    (i) What is the sequence number?

    (ii) What is the destination port number?

    (iii) What is the acknowledgment number?

    (iv) What is the window size?
12. What do you understand by Quality of service, parameters? List various Quality of service parameters.

Process-to-Process Delivery

13. How does transport layer perform duplication control?
14. Enumerate on TCP header and working of TCP and differentiate TCP and UDP with frame format.
15. Explain the three way handshaking protocol to establish the transport level connection.
16. Enumerate how the transport layer unsure that the complete message arrives at the destination and in the proper order.