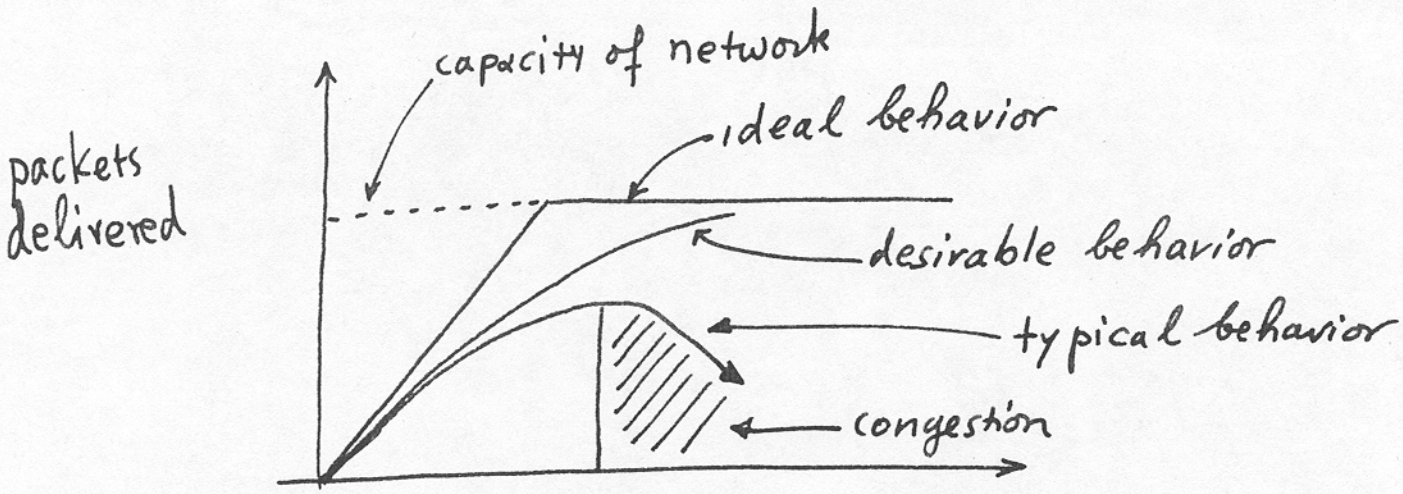
CONGESTION CONTROL

- What is Congestion? Situation when (offered) load is greater than the resources



- Can we add memory to routers in order to alleviate congestion? No

- How is congestion manifested?

  ⇒ Increase in packet loss

  ⇒ Increase in delay

- What is congestion and what is flow control

(textbook p. 375)

CONGESTION CONTROL MECHANISMS

⇒ What can we do to avoid congestion?

CONGESTION CONTROL.

- Open loop: blocking packets, scheduling } (Proactive)
- Closed loop: observe state of network, regulate sources and input traffic } (Reactive).

Congestion Prevention Policies

⇒ Mostly refers to open loop control

Layer	Policies
Transport	• Retransmission policy • Out-of-order caching policy • Acknowledgement policy • Flow control policy • Timeout determination
Network	• Virtual circuits versus datagram inside the subnet • Packet queueing and service policy • Packet discard policy • Routing algorithm • Packet lifetime management
Data link	• Retransmission policy • Out-of-order caching policy • Acknowledgement policy • Flow control policy

Fig. 5-23. Policies that affect congestion.

⇒ A number of parameters (coupled to policies) can be optimized so that congestion happens less frequently.

OPEN LOOP CONGESTION CONTROL:

a) Traffic Policing

b) Traffic Shaping.

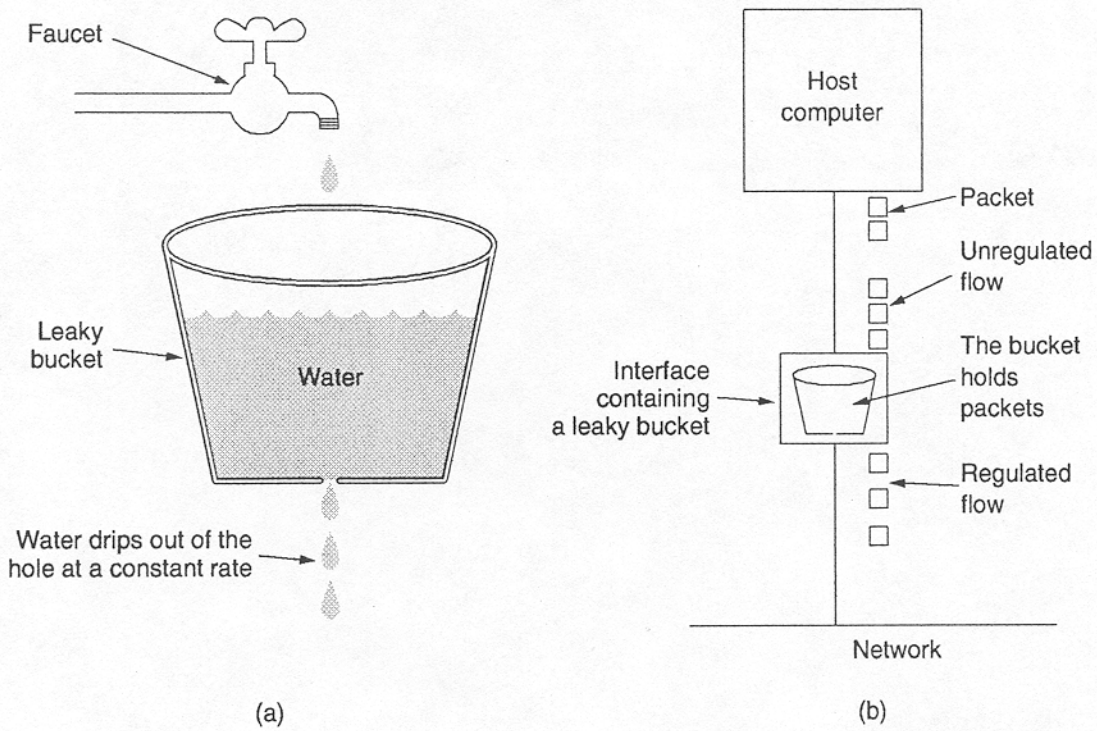


Fig. 5-24. (a) A leaky bucket with water. (b) A leaky bucket with packets.

Example: Source generates data at 25 million bytes/sec (200 Mb/s)

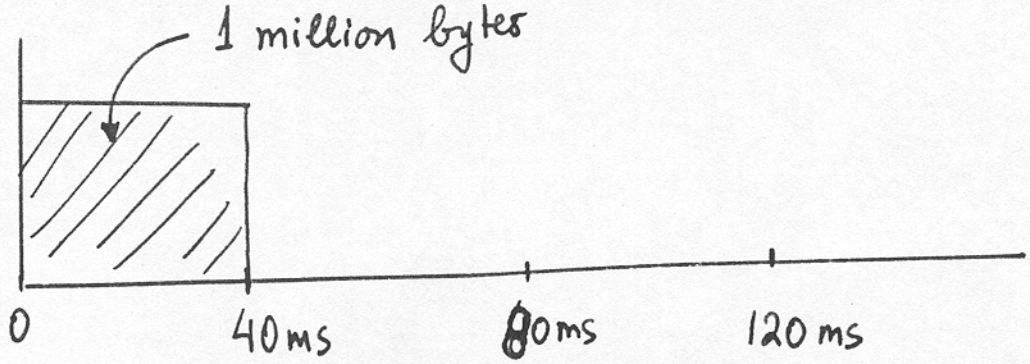
Network also runs at this speed for short time periods. For long intervals however network supports rates less than or equal to 2 million bytes/se

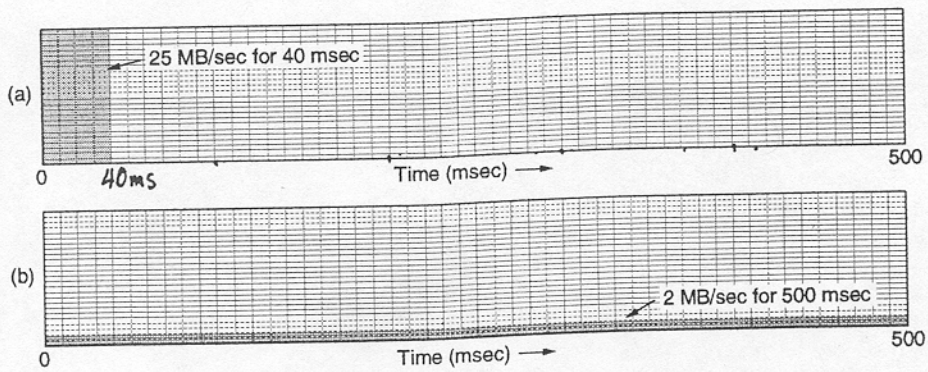
Assume data comes in 1 million byte bursts every 40 msec. To reduce the average rate to 2 Mb/s we can use a leaky bucket with $\rho = 2$ Mb/s and a capacity of 1 Mb.

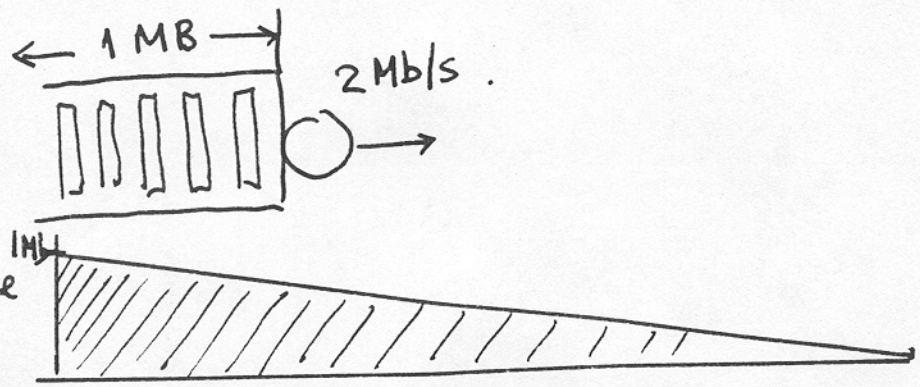
GRAPHICAL EXPLANATION OF EXAMPLE

Source

25 million bytes/sec, in bursts of 40 ms. each.
or 1 million bytes in 40 ms.







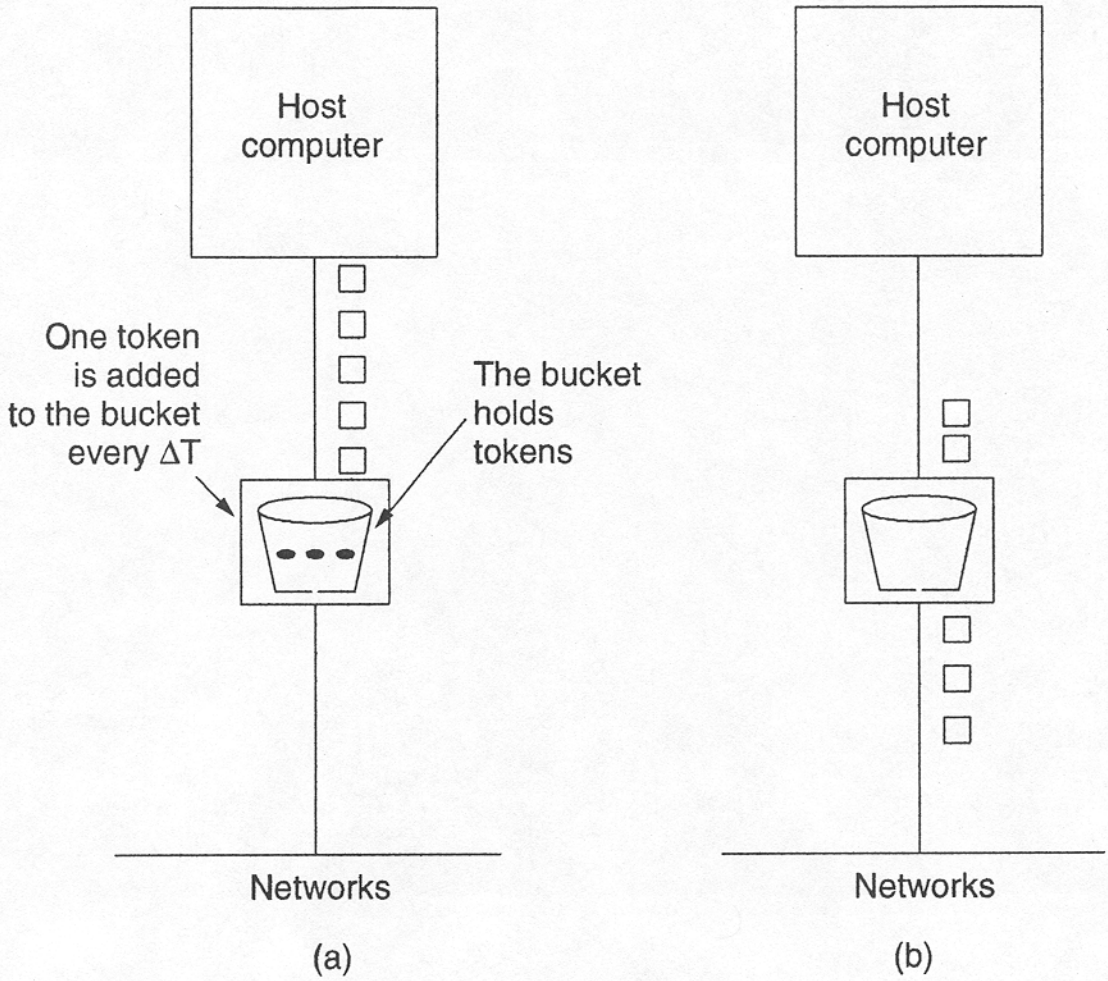


Fig. 5-26. The token bucket algorithm. (a) Before. (b) After.

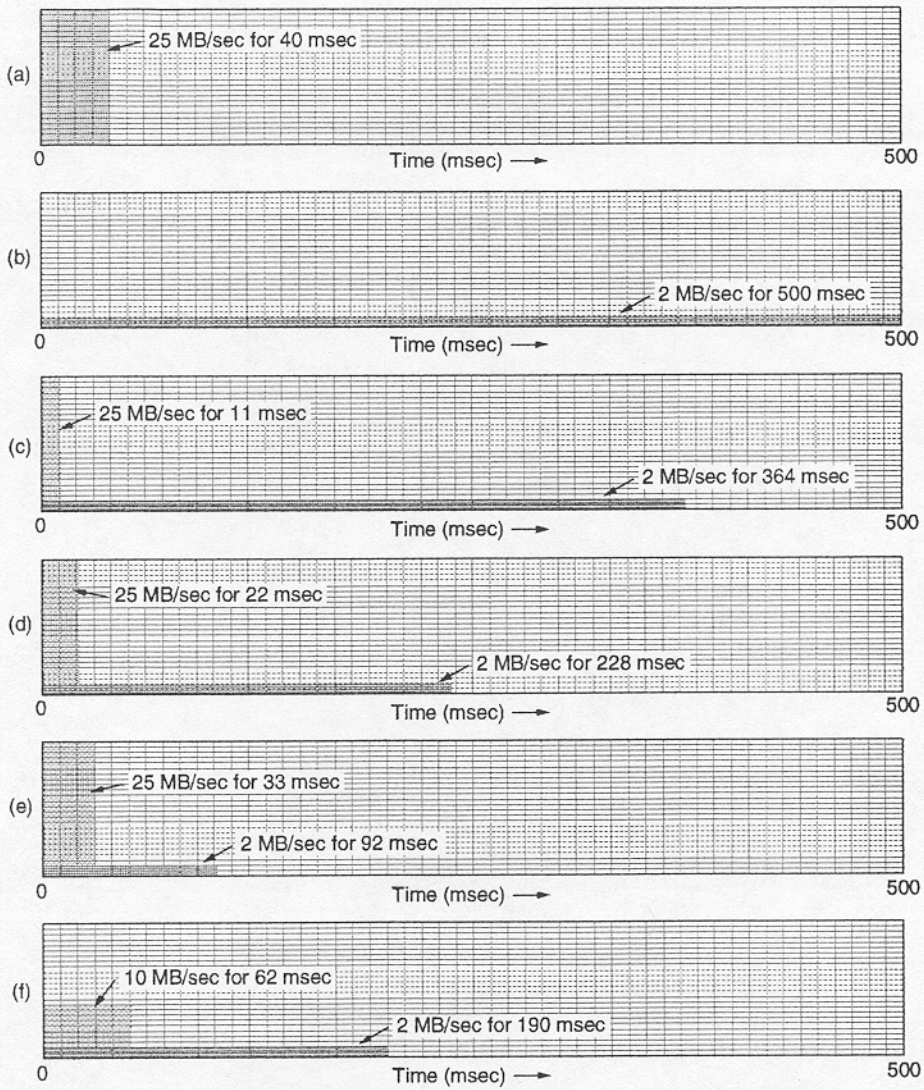
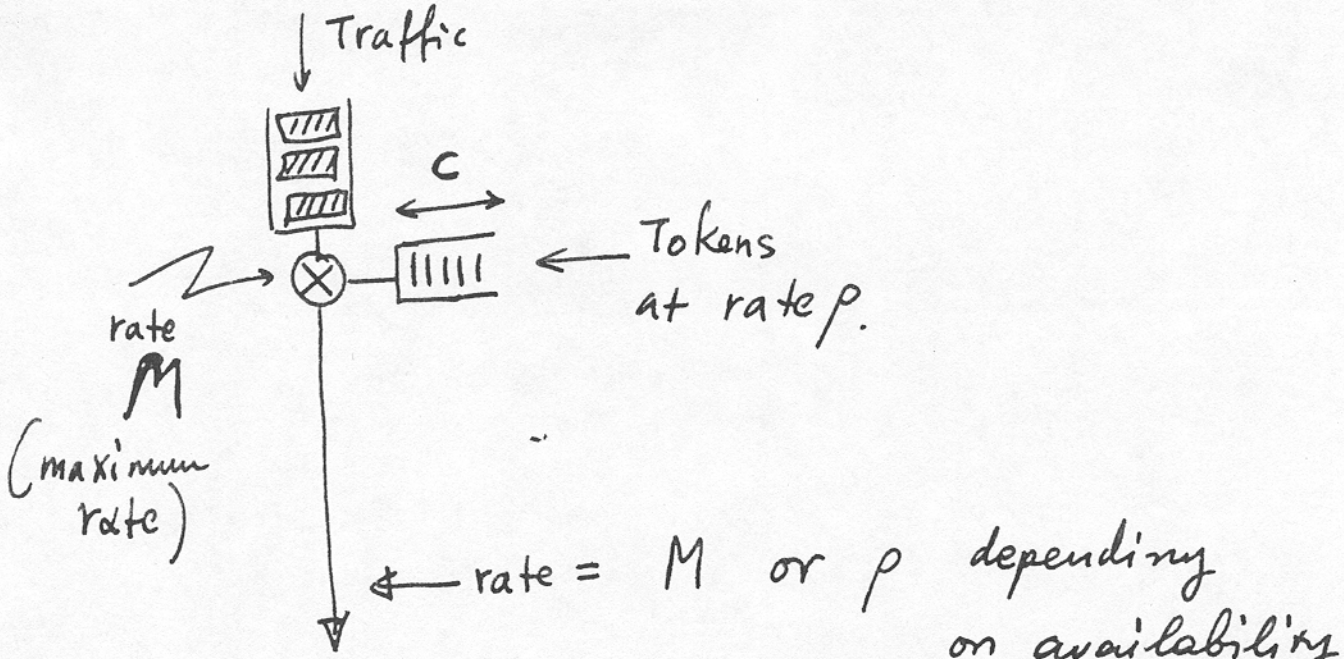


Fig. 5-25. (a) Input to a leaky bucket. (b) Output from a leaky bucket. (c) - (e) Output from a token bucket with capacities of 250KB, 500KB, and 750KB. (f) Output from a 500KB token bucket feeding a 10 MB/sec leaky bucket.

BURST SIZE CALCULATION



What is the maximum burst length in seconds?

Say it is S (it contains MS bits)

$$C + \rho S = MS$$

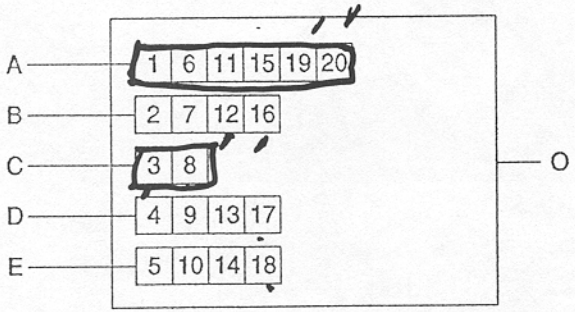
$$\Rightarrow S = \frac{C}{M - \rho}$$

Characteristics of the Input	Service Desired
Maximum packet size (bytes)	Loss sensitivity (bytes)
Token bucket rate (bytes/sec)	Loss interval (μsec)
Token bucket size (bytes)	Burst loss sensitivity (packets)
Maximum transmission rate (bytes/sec)	Minimum delay noticed (μsec)
	Maximum delay variation (μsec)
	Quality of guarantee

Fig. 5-27. An example flow specification.

Traffic Contract

Fair Queuing.



(a)

Packet	Finishing time
C	8
B	16
D	17
E	18
A	20

(b)

Fig. 5-29. (a) A router with five packets queued for line *O*. (b) Finishing times for the five packets.

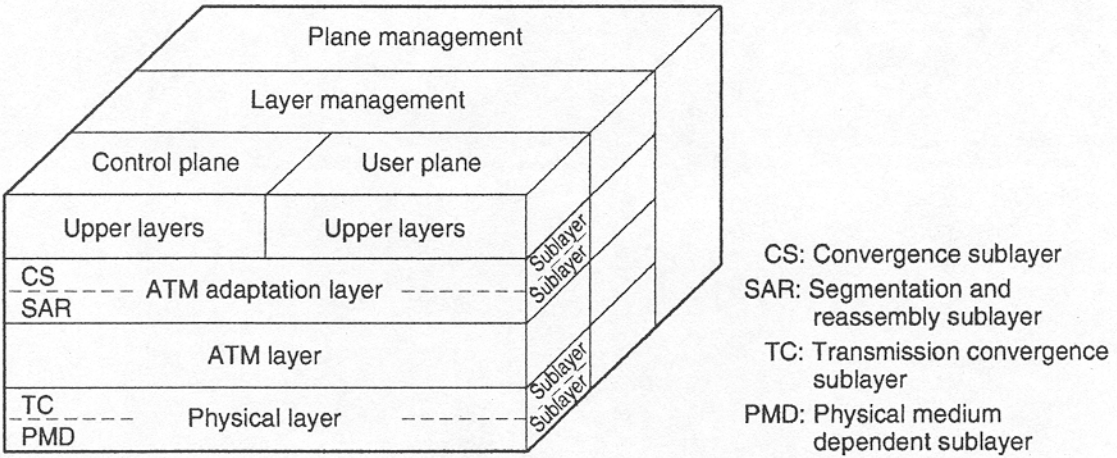


Fig. 1-30. The B-ISDN ATM reference model.