Announcements

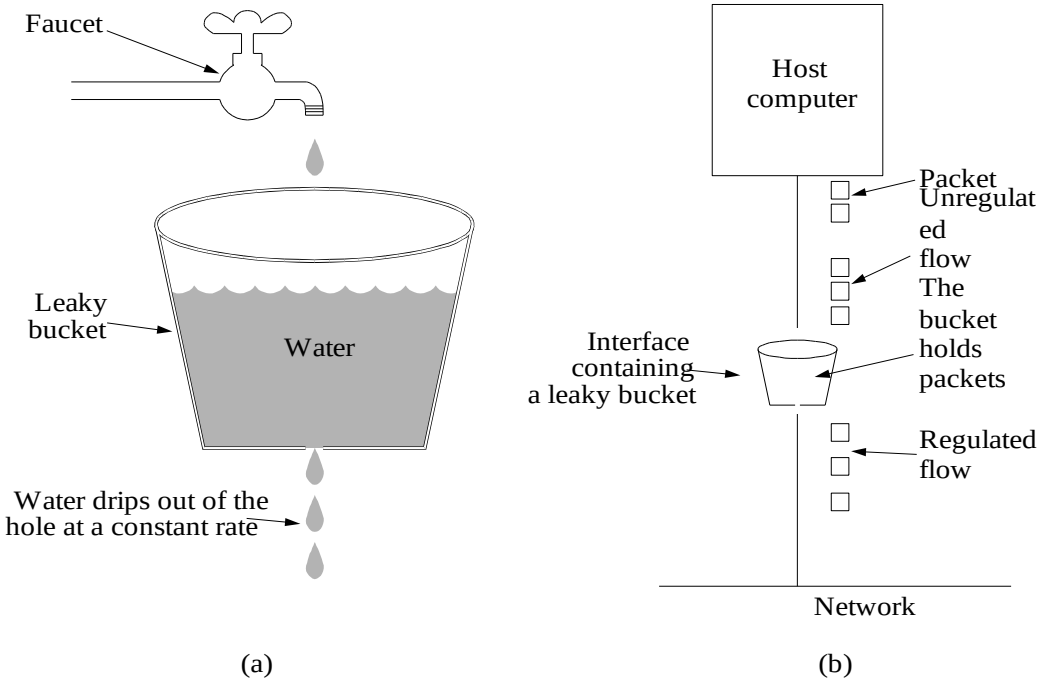
- This Lecture was presented by Dr. Shankar
- These are my lecture notes for similar topics, but not the ones used during this lecture.

Traffic Shaping

- Traffic tends to be bursty
  - great variation between min and max bandwidth used
  - this uncertainty leads to inefficient use of the network
- Flow Specification
  - user proposes a specific probability distribution
    - maximum packet size
    - transmission rate (min, max, or mean)
    - maximum delay
    - maximum delay variation (jitter)
    - quality guarantee (how strong is this agreement)
  - network can
    - agree to request
    - refuse it
    - counter offer

Leaky Bucket

- buffer accepts traffic at link rate
  - buffer has a bounded size (limits burst size that is accepted)
- output is limited to a lower rate
  - traffic is constrained to this rate



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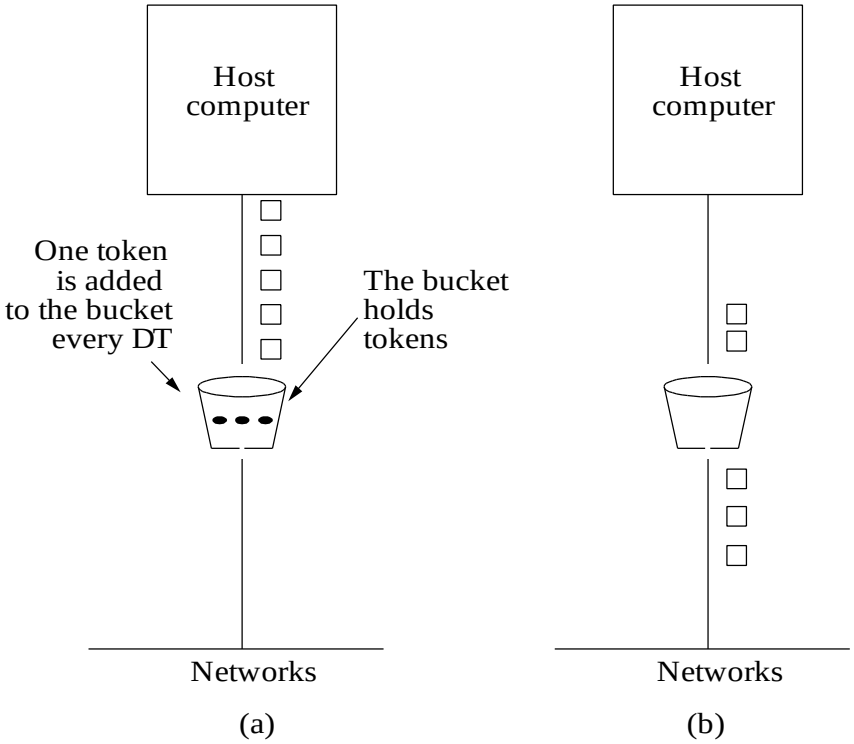
Token Bucket

- Bucket hold tokens (generated one every T seconds)
- Can save up to a fixed limit of n tokens
- When traffic arrives, it must a have token to be sent



- Max burst rate

  C - capacity of bucket

  S - burst length in seconds

  M - max output rate

  p - token credit rate

  C + pS = MS

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Congestion Control with Virtual Circuits

- Admission control
  - once traffic reaches a threshold, don't admit more VCs
  - doesn't correct current problem, but prevents additional congestion
- Alter routes
  - admit new connections
  - route them around "trouble" areas
- Negotiate traffic
  - establish parameters for volume and shape of traffic

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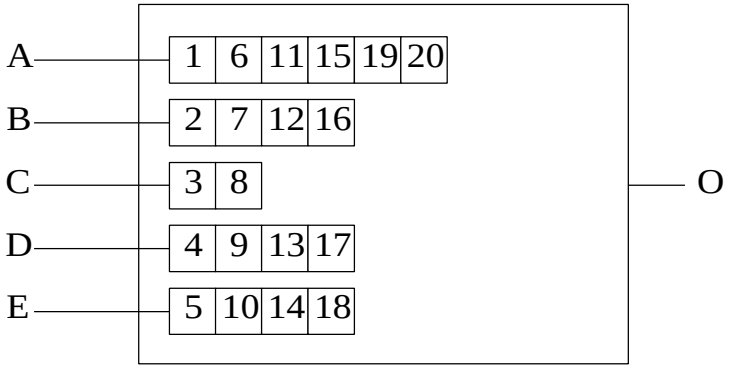
Fair Queuing

- Local (per router) congestion control
  - each output link has n queues, one for each sender
    - need to limit max queue size or buffers will be exhausted
  - use round-robin to select next packet to queue
    - can use per-packet or per-byte



(a)

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

(b)

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- Weighted Fair Queuing
  - can give different links different priorities
  - give higher priority length multiple slots per round