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

Max burst rate

- $C$ - capacity of bucket
- $S$ - burst length in seconds
- $M$ - max output rate
- $p$ - token credit rate

$$C + pS = MS$$
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
Congestion Control with Virtual Circuits

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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

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

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