

# Congestion Control

- **Goodput:** number of useful packets/sec

## Congestion Control Vs. Flow Control

- **Flow control:** in point-to-point transmission case, prevent sender sending data too fast and drown receiver.
- **Congestion control:** affect the ability of subnet to actually carry the traffic

## Load Shedding

When congestion control methods all fail, router have to discard packets. But application can give some packets priority to avoid to be discard.

## Qos (Quality Of Service)

- **bandwidth**
- **delay**
- **jitter:** variation of delay
  - jitter control method: router shuffle packets, router transmit packets with low TTL first and high TTL later.
  - jitter control is important in applications like Voice Over IP
- **reliability:** chance to loss packet

## Congestion Control Techniques

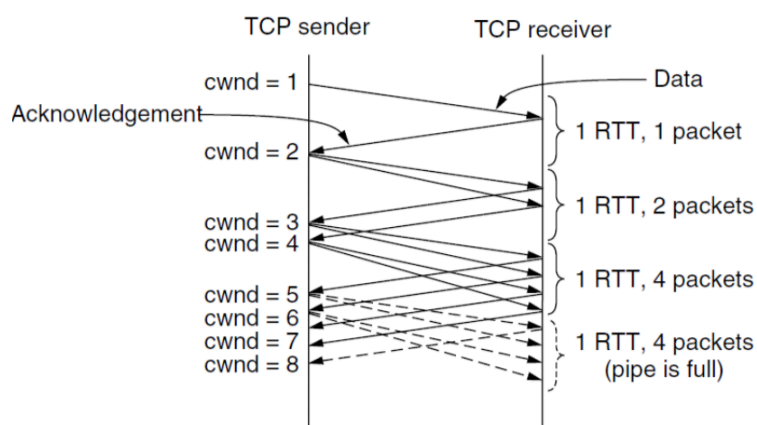
In network layer:

- **Over-provisioning:** 准备过量的 buffer, router CPU, bandwidth. Expensive and not scalable.
- **Buffering:** buffer received flow first, then delivery. Increase delay but smooth out jitter.
- **Traffic Shaping:** regulate average rate of transmission and burstiness of transmission.
  - leaky bucket: constant outgoing flow
  - token bucket: good at deal with burstiness of flow
- **Resource Reservation:** reserve bandwidth, buffer, CPU in advance
- **Admission Control:** when busy, router can reject new flow
- **Proportional Routing:** router split packet and reroute them to different routers
- **Packer Scheduling:** give priority to packets

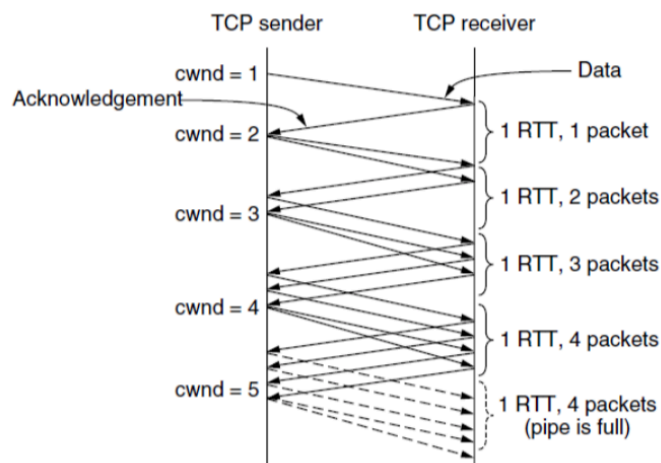
In transport layer:

TCP can ask sender to slow down. Sender manage congestion window, receiver set a receiver window once connection established.

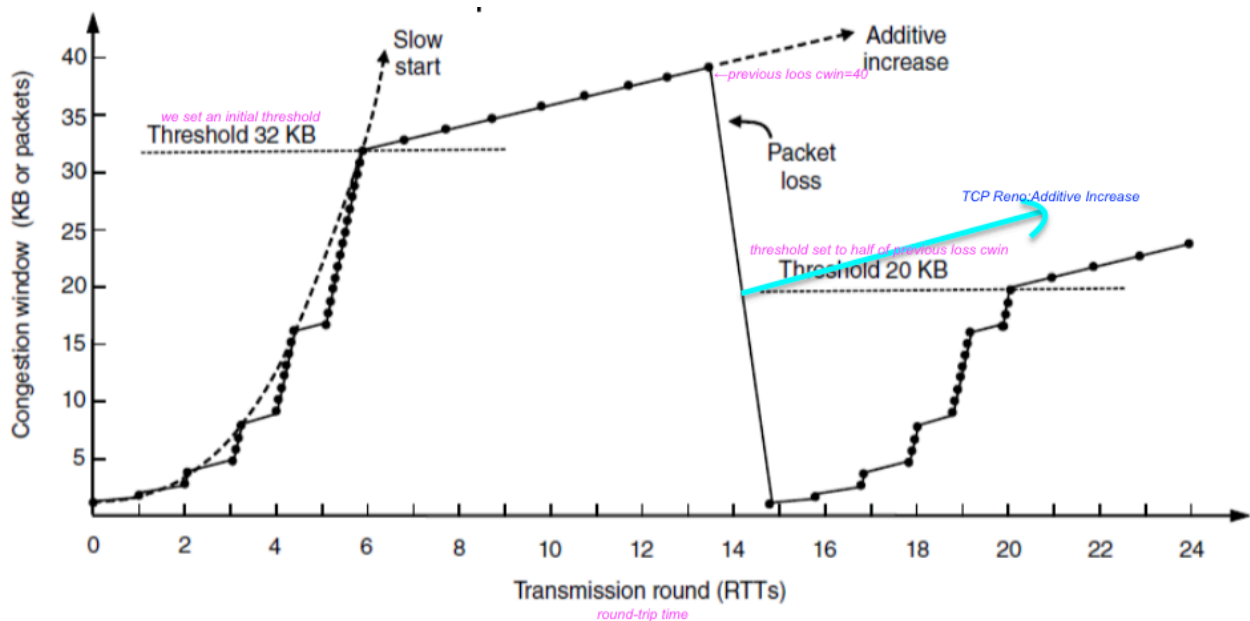
- **Slow Start:** 每次 sender收到一个 ACK, send back 2 segments.



- **Additive Increase:** 每次 sender收到所有上次的 ACK, 就多回复一个 segment.



- **TCP Tahoe:** first Slow Start then Additive Increase



## Summary Table For Policy Affecting Congestion

Layer	Policies
Transport	<ul style="list-style-type: none"> <li>• Retransmission policy</li> <li>• Out-of-order caching policy</li> <li>• Acknowledgement policy</li> <li>• Flow control policy</li> <li>• Timeout determination</li> </ul>
Network	<ul style="list-style-type: none"> <li>• Virtual circuits versus datagram inside the subnet</li> <li>• Packet queueing and service policy</li> <li>• Packet discard policy</li> <li>• Routing algorithm</li> <li>• Packet lifetime management</li> </ul>
Data link	<ul style="list-style-type: none"> <li>• Retransmission policy</li> <li>• Out-of-order caching policy</li> <li>• Acknowledgement policy</li> <li>• Flow control policy</li> </ul>