Delay & Loss in packet-switched networks

Packet Delay

d(nodal) = d(proc) + d(queue) + d(trans) + d(prop)

- **processing delay**
  - check packet's bit errors
  - router unpacking packet, then choose poll for queue

- **queueing delay**
  - **traffic intensity (流量强度)**
    - L = packet length (bit)
    - a = average packet arrival rate
    - L * a = average bit arrival rate
    - R = link bandwidth (bps)
  - **traffic intensity = (L * a) / R**
    - (L * a) / R ~ 0: queueing delay small
    - (L * a) / R ~ 1: queue almost full or is full, queueing delay become large
    - (L * a) / R > 1: average delay infinite (infinite queue length), or packet loss (finite queue length)

- **transmission delay**
  - **time = L / R**
    - L = packet length (bit)
    - R = link bandwidth (bps)

- **propagation delay**
  - **time = d / s**
    - d = length of physical link
    - s = propagation speed in medium

traceroute (command line tool)
- sends three packets (3 probes <探针>)

Packet Loss: when packet arrives to full queue, packet is dropped (also known as lost)