Data and Computer Communications

UNIT-III
What Is Congestion?

- Congestion occurs when the number of packets being transmitted through the network approaches the packet handling capacity of the network.
- Congestion control aims to keep the number of packets below a level at which performance falls off dramatically.
- A data network is a network of queues.
- Generally, 80% utilization is critical.
- Finite queues mean data may be lost.
Queues at a Node
Interaction of Queues
Ideal Network Utilization

1. Infinite buffers
2. No signaling overhead
Effects of Congestion - No Control

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Backpressure

• if node becomes congested it can slow down or halt flow of packets from other nodes
  – cf. backpressure in blocked fluid pipe
  – may mean that other nodes have to apply control on incoming packet rates
  – propagates back to source
• can restrict to high traffic logical connections
• used in connection-oriented nets that allow hop by hop congestion control (eg. X.25)
• not used in ATM nor frame relay
• only recently developed for IP
Choke Packet

• a control packet
  – generated at congested node
  – sent to source node
  – eg. ICMP source quench
    • from router or destination
    • source cuts back until no more source quench message
    • sent for every discarded packet, or anticipated

• is a rather crude mechanism
Implicit Congestion Signaling

• transmission delay increases with congestion
• hence a packet may be discarded
• source detects this implicit congestion indication
• useful on connectionless (datagram) networks
  – eg. IP based
    • (TCP includes congestion and flow control - see chapter 17)
• used in frame relay LAPF (control protocol)
  – End-to-end
  – Capable of detecting lost frames and adjusting the flow of data accordingly
Explicit Congestion Signaling

- network alerts end systems of increasing congestion
- end systems take steps to reduce offered load
- Backwards
  - congestion avoidance notification in opposite direction to packet required
- Forwards
  - congestion avoidance notification in same direction as packet required
Explicit Signaling Categories

• Binary
  – a bit set in a packet indicates congestion

• Credit based
  – indicates how many packets source may send
  – common for end to end flow control

• Rate based
  – supply explicit data rate limit
  – nodes along path may request rate reduction
  – eg. ATM
Traffic Management

• fairness
  – provide equal treatment of various flows

• quality of service
  – different treatment for different connections

• reservations
  – traffic contract between user and network
  – carry best-effort or discard excess traffic
  – E.g. ATM, RSVP
  – Traffic policing
Congestion Control in Packet Switched Networks

• send control packet to some or all source nodes
  – requires additional traffic during congestion
• rely on routing information
  – may react too quickly
• end to end probe packets
  – adds to overhead
• add congestion info to packets in transit
  – either backwards or forwards
Frame Relay
Congestion Control

• minimize discards
• maintain agreed QoS
• minimize probability of one end user monopoly
• simple to implement
• create minimal additional traffic
• distribute resources fairly
• limit spread of congestion
• operate effectively regardless of traffic flow
• minimum impact on other systems
• minimize variance in QoS
FR Control Techniques

• difficult for frame-relay
  – Because of limited tools

• joint network & end-system responsibility

• techniques:
  – discard strategy
  – congestion avoidance
  – explicit signaling
  – congestion recovery
  – implicit signaling mechanism
# FR Congestion Control

## Table 13.1 Frame Relay Congestion Control Techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>Type</th>
<th>Function</th>
<th>Key Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discard control</td>
<td>Discard strategy</td>
<td>Provides guidance to network concerning which frames to discard</td>
<td>DE bit</td>
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<tr>
<td>Backward explicit Congestion</td>
<td>Congestion avoidance</td>
<td>Provides guidance to end systems about congestion in network</td>
<td>BECN bit or CLLM message</td>
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<tr>
<td>Notification</td>
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<tr>
<td>Forward explicit</td>
<td>Congestion avoidance</td>
<td>Provides guidance to end systems about congestion in network</td>
<td>FECN bit</td>
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<tr>
<td>Congestion Notification</td>
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<tr>
<td>Implicit congestion notification</td>
<td>Congestion recovery</td>
<td>End system infers congestion from frame loss</td>
<td>Sequence numbers in higher-layer PDU</td>
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</tbody>
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References