Frame Relay
Congestion Control

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These slides are available at
http://www.cis.ohio-state.edu/~jain/cis777-00/
Overview

- Congestion avoidance vs recovery
- Discard control
- Explicit forward/backward congestion notification
- Implicit notification
Frame Relay
Congestion Techniques

- Discard Control (DE Bit)
- Backward Explicit Congestion Notification
- Forward Explicit Congestion Notification
- Implicit congestion notification
  (sequence numbers in higher layer PDUs)
Discard Control

- Committed Information Rate (CIR)

- Committed Burst Size ($B_c$):
  Over measurement interval $T$
  $T = \frac{B_c}{CIR}$

- Excess Burst Size ($B_e$)

- Between $B_c$ and $B_c + B_e \Rightarrow$ Mark DE bit

- Over $B_e \Rightarrow$ Discard
All frames with CIR
One Frame marked DE

Frames 1 2 3 4

Discard

$B_c + B_e$

$B_c$

Access rate

CIR

$T_0$ $T_0 + T$

$DE = 1$

$DE = 0$
One Frame marked DE; one frame discarded.
Leaky Bucket Algorithm

C = counter; increment with incoming data

Decrement C by \( \min\{C, B_c\} \) every \( T \) Time units

Limit C to \( B_c + B_e \)

Discard any incoming data while C is at its threshold

\[ \text{CIR} = \frac{B_c}{T} \]

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Forward Explicit Congestion Notification
Source sets FECN = 0
Networks set FECN if avg Q > 1
Dest tells source to inc/dec the rate (or window)
Start with R = CIR (or W=1)
If more than 50% bits set
  ⇒ decrease to 0.875 × R (or 0.875W)
If less than 50% bits set
  ⇒ increase to 1.0625 × R (or min{W+1, Wmax})
If idle for a long time, reset R = CIR (or W=1)
BECN

- Backward Explicit Congestion Notification
- Set BECN bit in reverse traffic or send Consolidated Link-Layer Management (CLLM) message to source
- On first BECN bit: Set $R = CIR$
- On further "S" BECNs: $R = 0.675 \times CIR$, $0.5 \times CIR$, $0.25 \times CIR$
- On $S/2$ BECNs clear: Slowly increase $R = 1.125 \times R$
- If idle for long, $R = CIR$
BECN (Cont.)

- For window based control:
  - $S =$ One frame interval
  - Start with $W=1$
  - First BECN $W = \max(0.625W, 1)$
  - Next $S$ BECNs $W = \max(0.625W, 1)$
  - $S/2$ clear BECNs $\Rightarrow W = \min(W+1, W_{max})$

- CLLM used if no reverse traffic
- CLLM = XID message on maintenance
  - DLCI = 1007 (decimal)
- CLLM contains a list of congested DLCIs
Implicit Congestion Control

- Decrease window on frame loss
- Increase window slowly
- Decrease by 1, Decrease to Wmin, Decrease by a factor $\alpha$
- Increase by 1 after N frames
- Increase by 1 after W frames
Summary

- Discard strategy: Leaky bucket
- Forward explicit congestion notification
- Backward Explicit congestion notification
- Implicit congestion control