Frame Relay Congestion Control

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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 $T$
  $T = B_c / \text{CIR}$
- Excess Burst Size ($B_e$)
- Between $B_c$ and $B_e$ ⇒ Mark DE bit
- Over $B_e$ ⇒ Discard
Discard

\[ \text{Access rate} \]

\[ \text{CIR} \]

\[ \text{DE} = 1 \]

\[ \text{DE} = 0 \]

\[ T_0 \]

\[ T_0 + T \]

Frames 1 2 3

All frames with CIR
Bits

$B_c + B_e$

$B_c$

Discard

Access rate

CIR

DE = 1

DE = 0

$T_0$

$T_0 + T$

Frames 1 2 3 4

One Frame marked DE
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

\[ CIR = \frac{B_c}{T} \]
- 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)
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
Homework

- Read chapter 12 of Stallings’ book