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 $T$
  \[ T = \frac{B_c}{CIR} \]
- Excess Burst Size ($B_e$)
- Between $B_c$ and $B_c + B_e \Rightarrow$ Mark DE bit
- Over $B_e \Rightarrow$ Discard
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Bits

$B_c + B_e$

$B_c$

Access rate

CIR

Discard

$T_0$

$T_0 + T$

DE = 1

DE = 0

Frames

1

2

3

All frames with CIR

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5
One Frame marked DE

Frames 1 2 3 4

Time

CIR

Access rate

Discard

$B_c + B_e$

$B_c$

$T_0$

$T_0 + T$

DE = 1

DE = 0

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

Let $C$ be the 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

$C = \text{counter}$;
increment with incoming data

CIR = $B_c / T$
- 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)
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:
  - $S = \text{One frame interval}$
  - Start with $W=1$
  - First BECN $W = \max(0.625W, 1)$
  - Next $S$ BECNs $W = \max(0.625W, 1)$
  - $S/2$ clear BECNs $\Rightarrow W = \min(W+1, W_{\text{max}})$

- 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