Frame Relay Congestion Control

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Overview

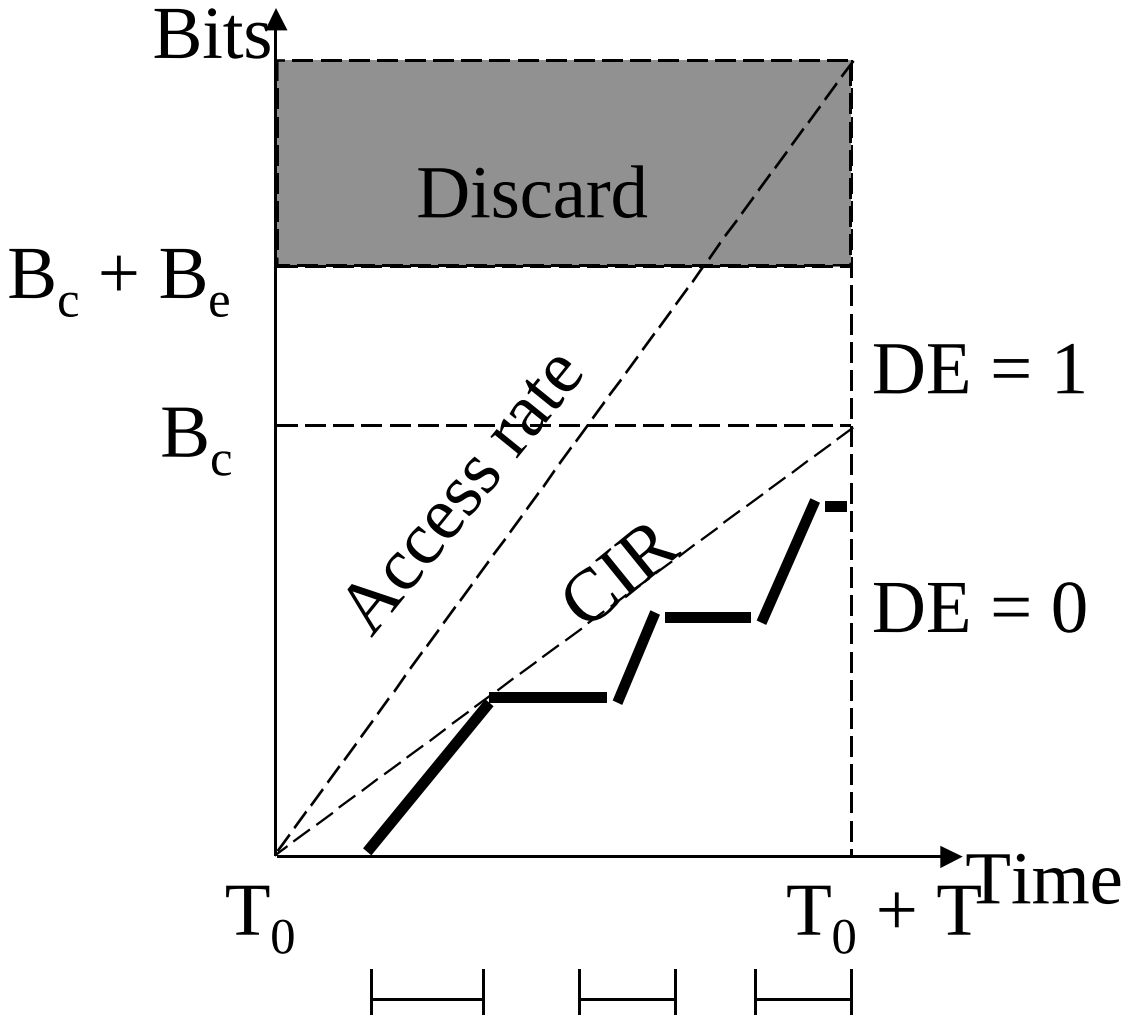
- Congestion avoidance vs recovery
- Discard control
- Explicit forward/backward congestion notification
- Implicit notification

Frame Relay Congestion Techniques

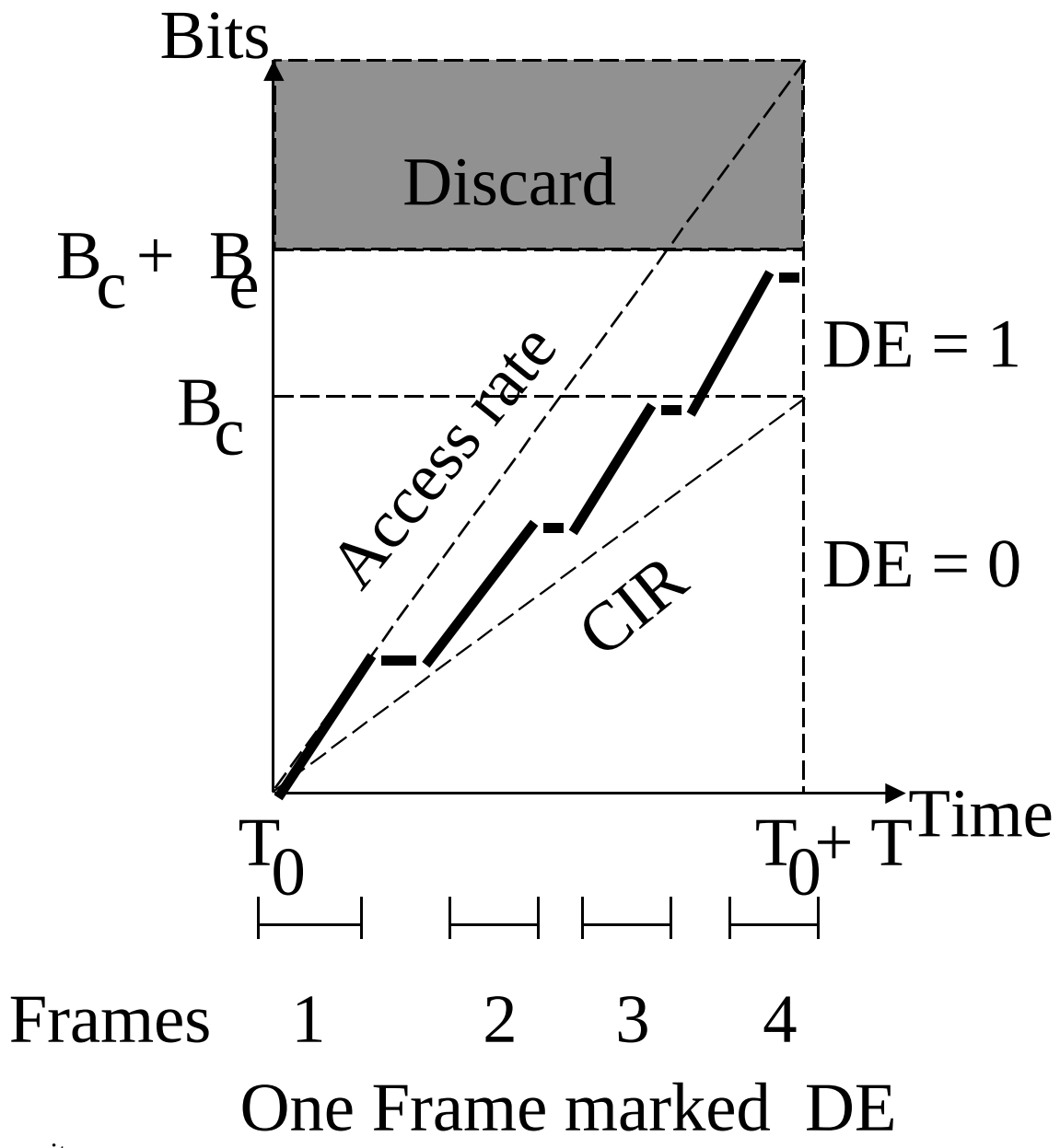
- Discard Control (DE Bit)
- Backward Explicit Congestion Notification
- Forward Explicit Congestion Notification
- Implicit congestion notification (sequence numbers in higher layer PDUs)

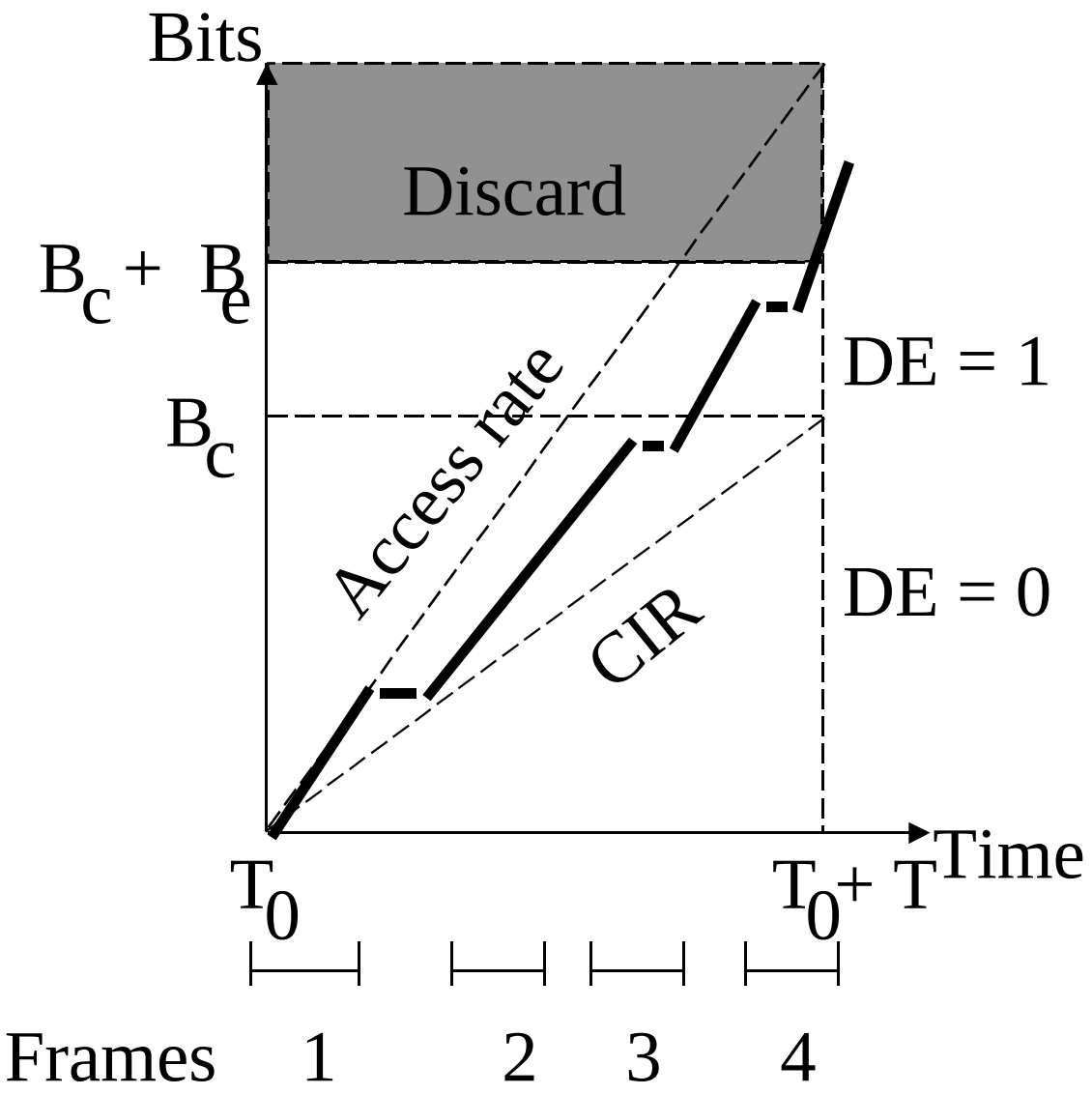
Discard Control

- Committed Information Rate (CIR)
- Committed Burst Size (B_c):
  Over measurement interval T
  $T = B_c/CIR$
- Excess Burst Size (B_e)
- Between B_c and $B_c + B_e \Rightarrow$ Mark DE bit
- Over $B_e \Rightarrow$ Discard



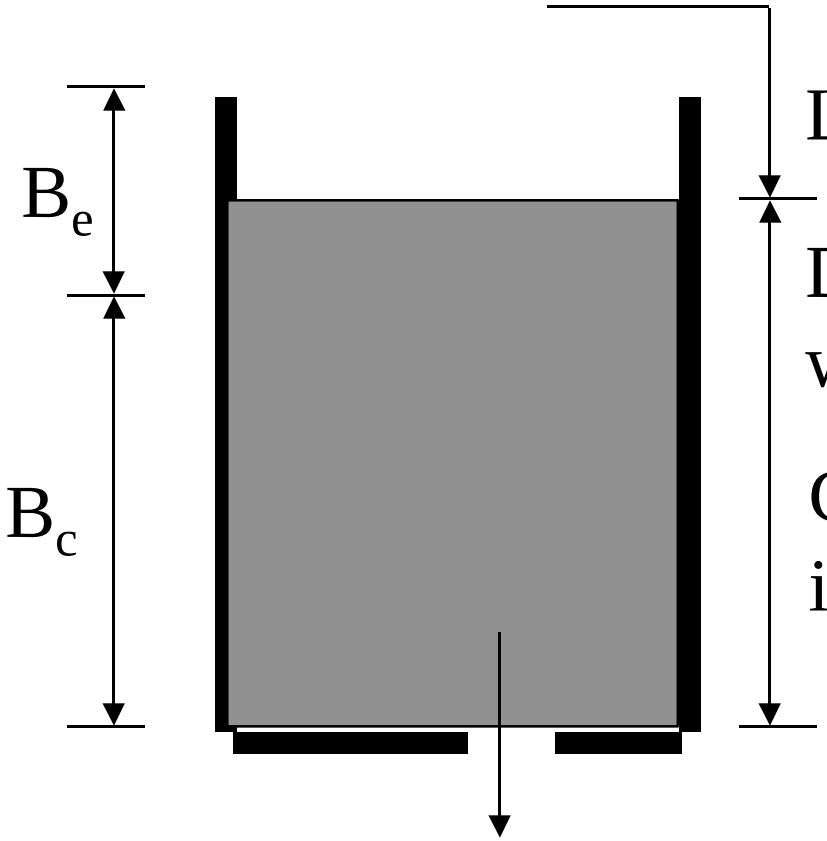
All frames with CIR


Bits
Discard
$B_c + B_e$
B_c
Access rate
CIR
DE = 1
DE = 0
Time
T_0
$T_0 + T$
Frames 1 2 3 4
One Frame marked DE



One Frame marked DE; one frame discarded

Leaky Bucket Algorithm



Limit C to B_c + B_e

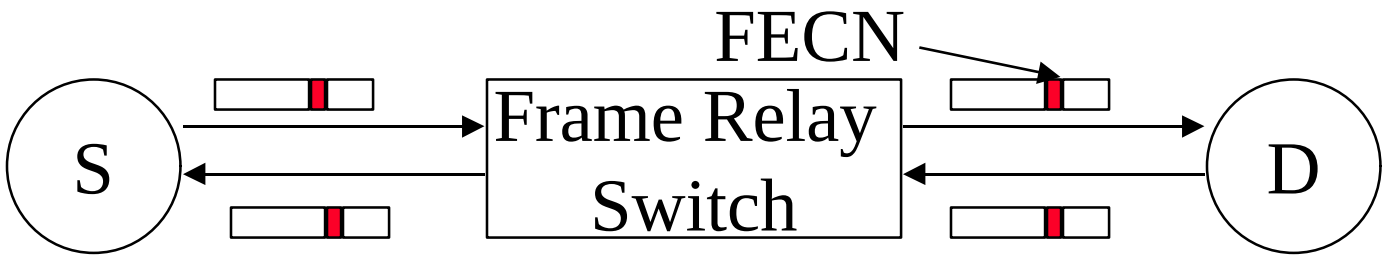
Discard any incoming data while C is at its threshold

C = counter;
increment with incoming data

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

CIR = B_c /T

FECN



- 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
  $\Rightarrow$ decrease to 0.875 × R (or 0.875W)
- If less than 50% bits set
  $\Rightarrow$ 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 CIR, 0.5 CIR, 0.25 CIR
- On S/2 BECNs clear: Slowly increase R = 1.125 R
- If idle for long, R = CIR

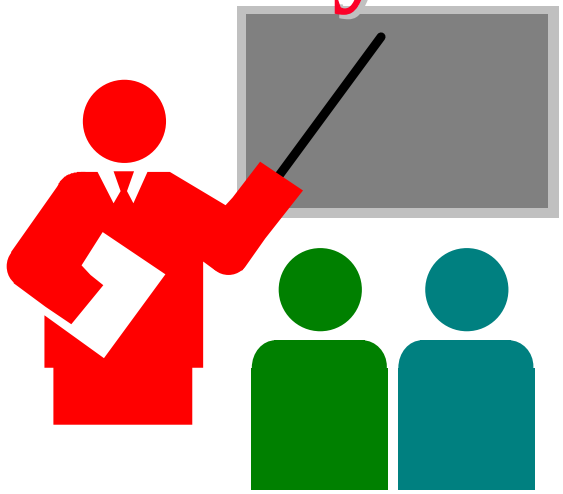
BECN (Cont.)

- 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, Wmax)
- 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 α
- 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