Frame Relay

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Pro ciences

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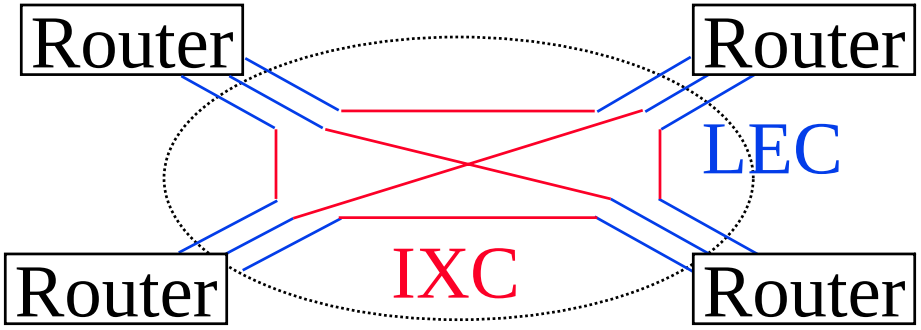
Overview

- What is Frame Relay?
- Why not leased lines or X.25?
- Frame formats and protocols
- Discard control
- Explicit forward/backward congestion notification

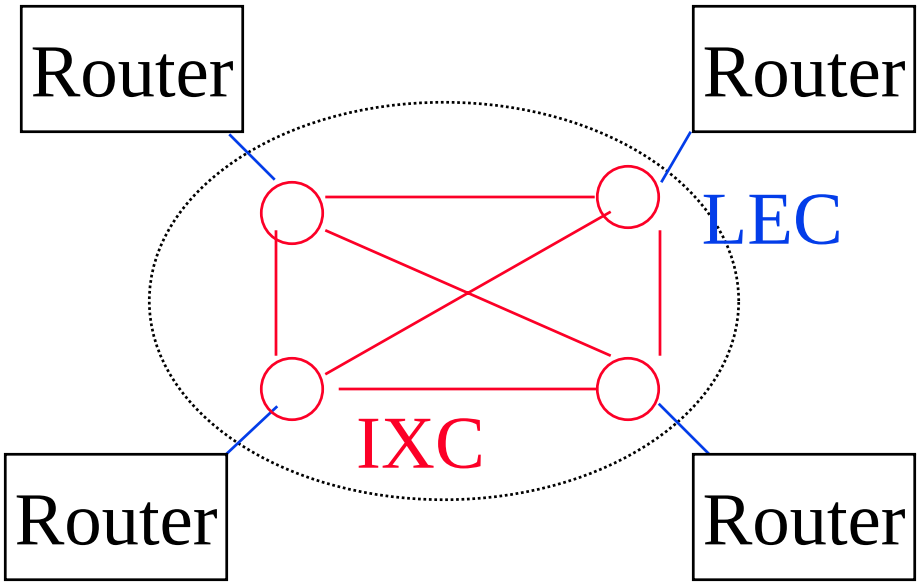
Problems with Leased Lines

- No user-to-user end-to-end signaling
- Multiple logical links ⇒ Multiple connections
- Four nodes ⇒ 12 ports,
  12 local exchange carrier (LEC) access lines,
  6 inter-exchange carrier (IXC) connections
- One more node ⇒ 8 more ports, 8 more LEC lines,
  4 more IXC circuits

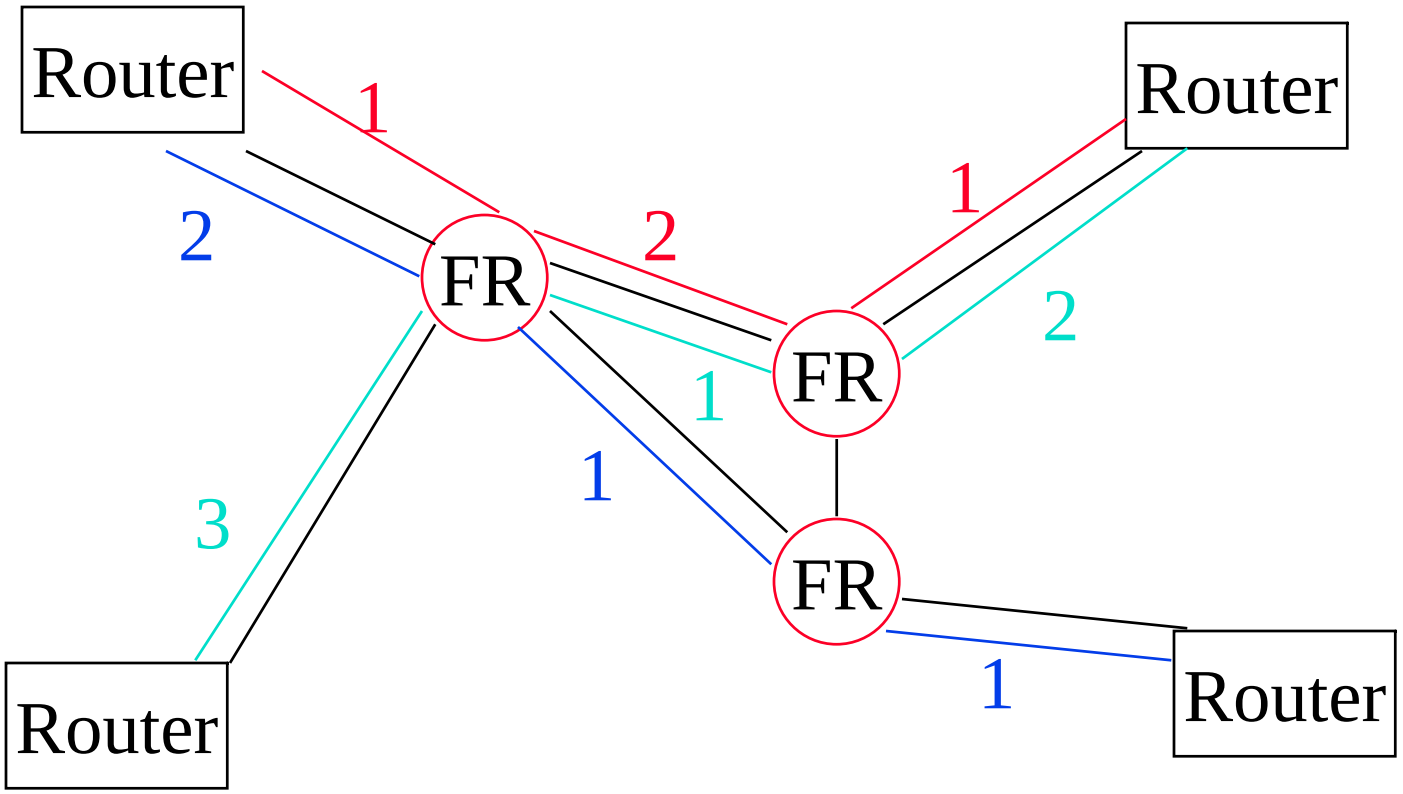


Solution: Frame Relay

- Four nodes: 4 ports, 4 LEC access lines, 6 IXC circuits
- One more node: 1 more port, 1 more access line, 4 more IXC circuits
- Share leased lines ⇒ Virtual Private Networks



Data Link Control Identifiers (DLCI)



Data Link Control Identifier

- DLCI = Virtual Circuit ID
- Only local significance
- Allows multiple logical connections over one circuit
- Some ranges preassigned
- DLCI = 0 is used for signaling

Frame Relay: Key Features

- X.25 simplified
- No flow and error control
- Out-of-band signaling
- Two layers
- Protocol multiplexing in the second layer
- Congestion control added

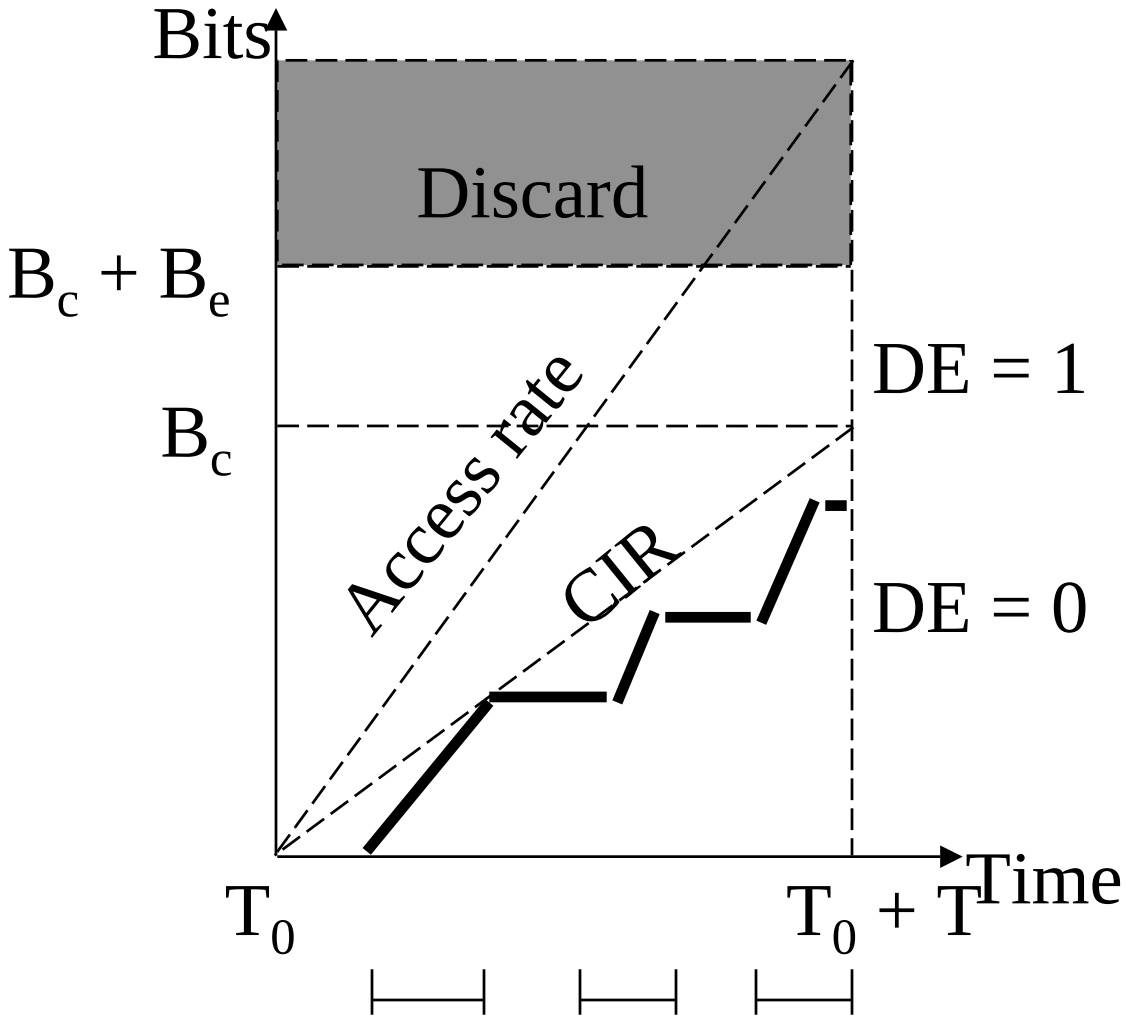
$\Rightarrow$ Higher speed possible.
X.25 suitable to 200 kbps. Frame relay to 2.048 Mbps.

Frame Relay Congestion Techniques

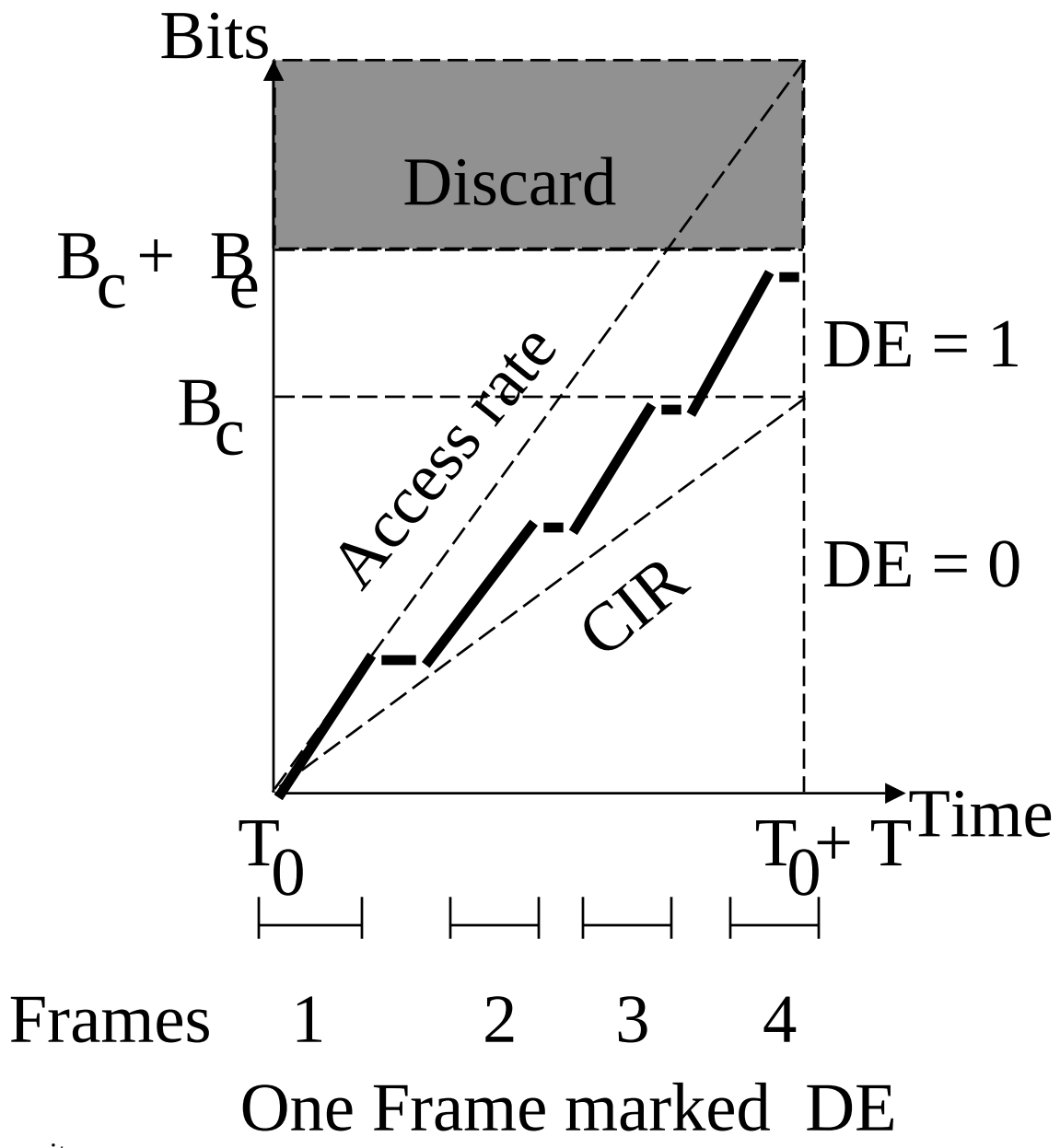
- Discard Control (DE Bit)
- Backward Explicit Congestion Notification
- Forward Explicit Congestion Notification
- Implicit congestion notification (sequence numbers in higher layer PDUs)

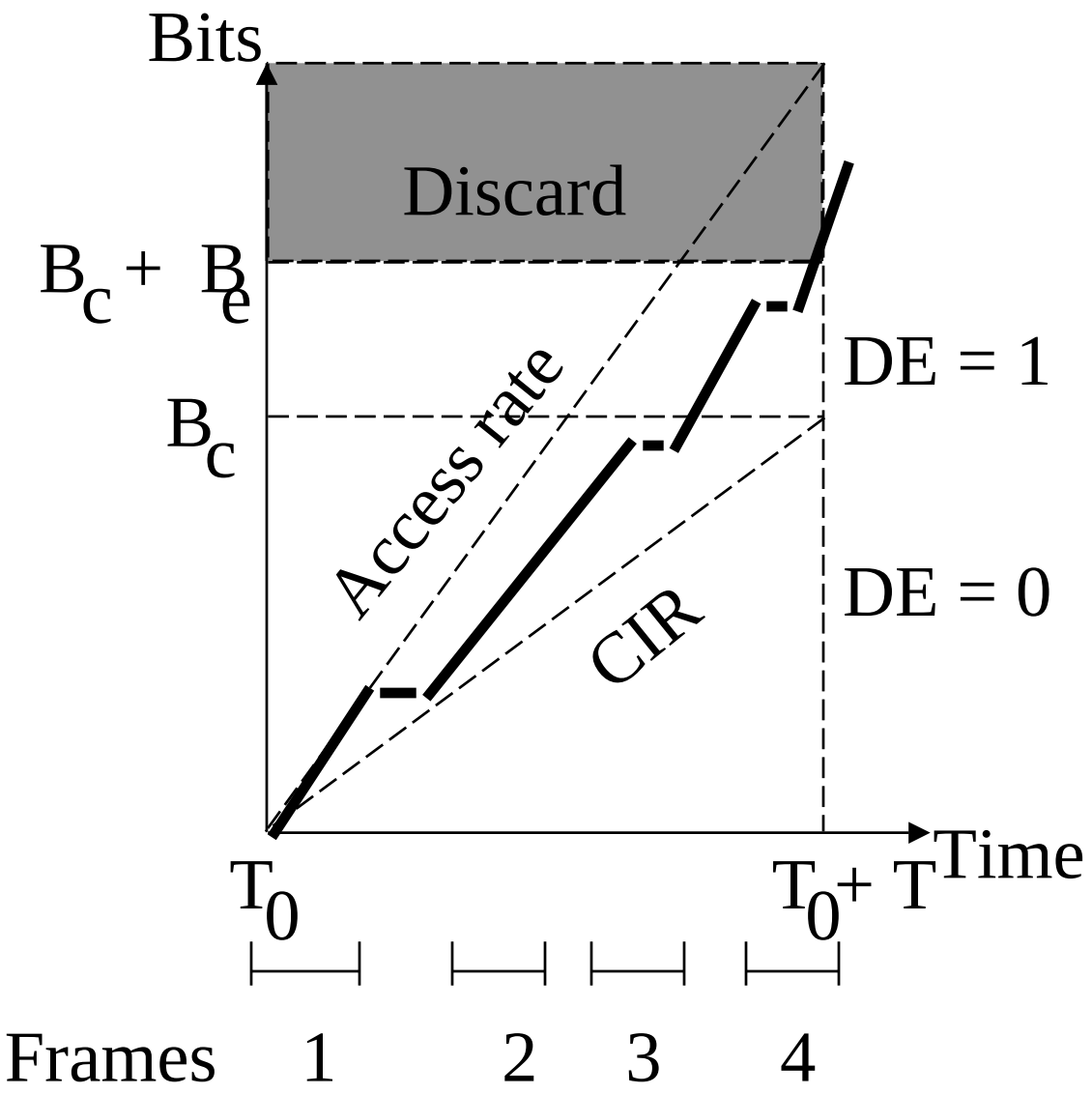
Discard Control

- 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



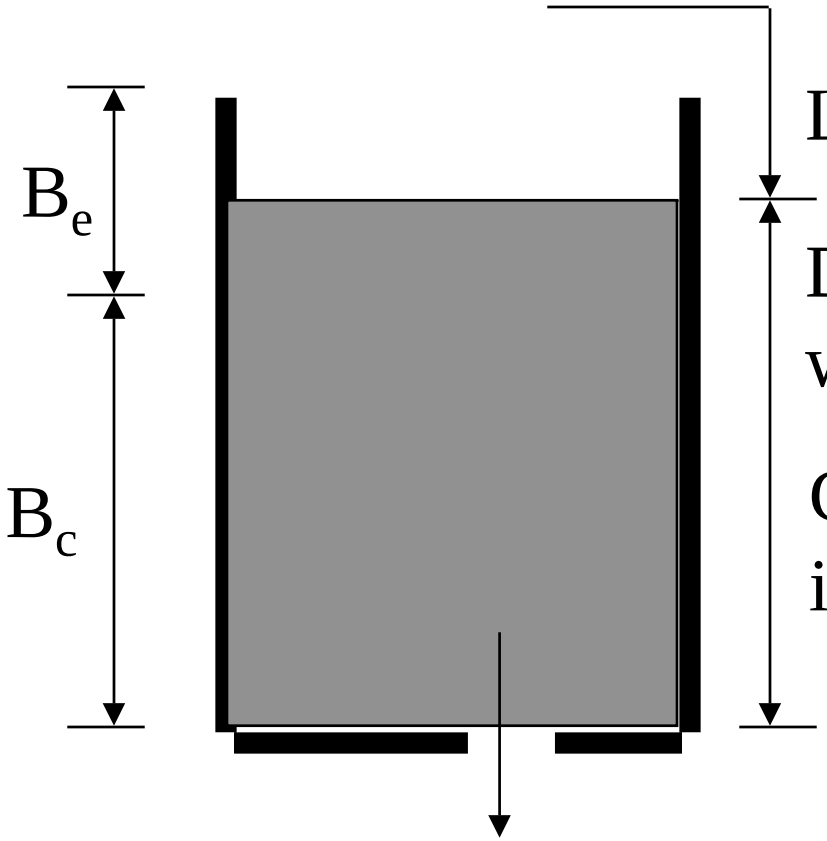
All frames with CIR


Bits
Discard
$B_c + B_e$
B_c
DE = 1
DE = 0
Access rate
CIR
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

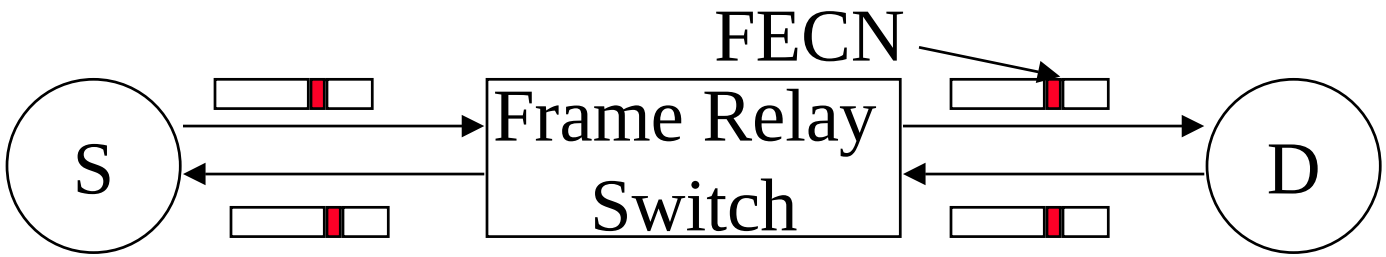
Discard any incoming data while C is at its threshold

C = counter;
increment with incoming data

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

CIR = B_c /T

FECN

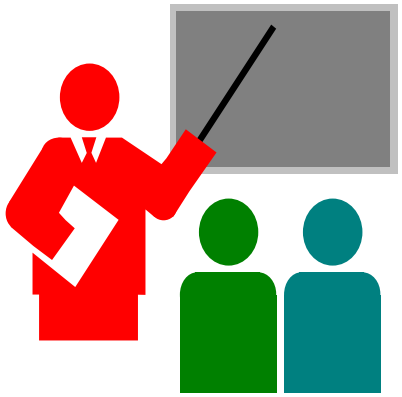


- Forward Explicit Congestion Notification
- Source sets FECN = 0
- Networks set FECN if avg Q >1
- Dest tells source to inc/dec the rate (or window)
- Start with R = CIR (or W=1)
- If more than 50% bits set
  $\Rightarrow$ decrease to 0.875 × R (or 0.875W)
- If less than 50% bits set
  $\Rightarrow$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

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



- X.25 designed for unintelligent devices over error-prone networks ⇒ Slow
- Frame relay = simplified X.25. Higher data rates.
- Discard strategy: Leaky bucket
- Forward/backward explicit congestion notification
- Implicit congestion control

Frame Relay Standards

ITU:

- I.122, Framework for Frame Mode Bearer Services, 1993.
- I.223, Frame Mode Bearer Services, 1992.
- I.370, Congestion management for the ISDN Frame Relaying Bearer Service, 1991.
- I.372, Frame Relay Bearer Service Network-to-network Interface Requirements, 1993.
- I.555, Frame Mode Bearer Services Interworking, 1992.

Standards (Cont)

- Q.922, ISDN Data Link Layer Specification for Frame Mode Bearer Services, 1992.
- Q.933, Signaling Specifications for Frame Mode Call Control, 1992.

ANSI:

- T1.606, Architectural Framework and Service Description for Frame-Relaying Bearer Service, 1990.
- T1.617, Signaling Specification for Frame Relay Bearer Service for DSS1, 1991.
- T1.618, Core Aspects of Frame Protocol for Use with Frame Relay Bearer Service, 1991.

Implementation Agreements

- FRF.1, The User-Network Interface (UNI)
- FRF.2, The network-to-network interface (NNI)
- FRF.3, Multiprotocol encaptulation
- FRF.4, Switched virtual circuit (SVC)
- FRF.5, Frame relay/ATM network interworking
- FRF.6, Frame relay service customer network management

Available from Frame Relay Forum, http://frame-relay.indiana.edu/

RFCs

- RFC 2115, “MIB for Frame Relay DTEs Using SMIv2,” Sept 1997.
- RFC 1973, “PPP in Frame Relay,” June 1996.
- RFC1604, "Definitions of Managed Objects for Frame Relay Service" by T. Brown, 03/25/1994, 46 pp.
- RFC1586 "Guidelines for Running OSPF Over Frame Relay Networks" by O. deSouza, M. Rodrigues, 03/24/1994, 6 pp.
- RFC1490, "Multiprotocol Interconnect over Frame Relay" by T. Bradley, C. Brown, A. Malis, 07/26/1993, 35 pp.