

Frame Relay Congestion Control

Raj Jain

Professor of Computer and Information Sciences

The Ohio State University

Columbus, OH 43210

Jain@ACM.Org

<http://www.cis.ohio-state.edu/~jain/>



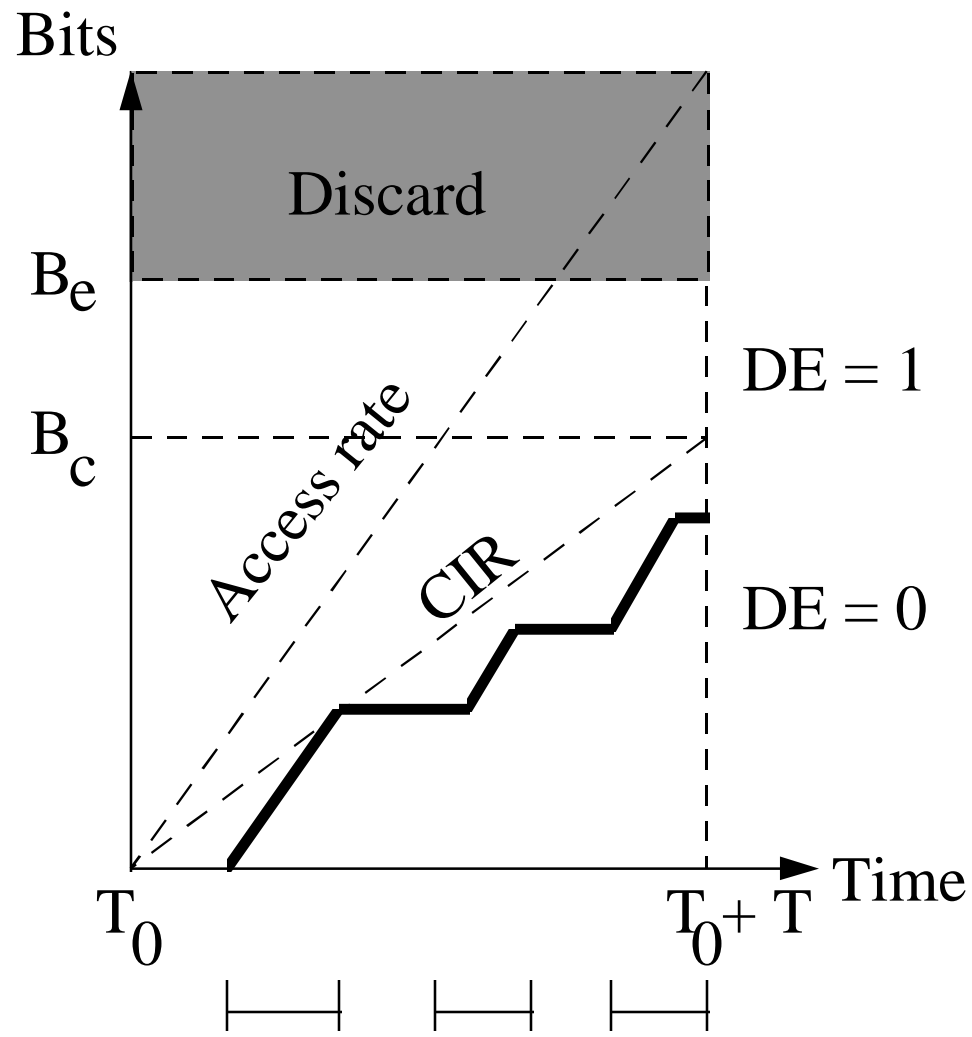
- ❑ Congestion avoidance vs recovery
- ❑ Discard control
- ❑ Explicit forward/backward congestion notification
- ❑ Implicit notification

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)

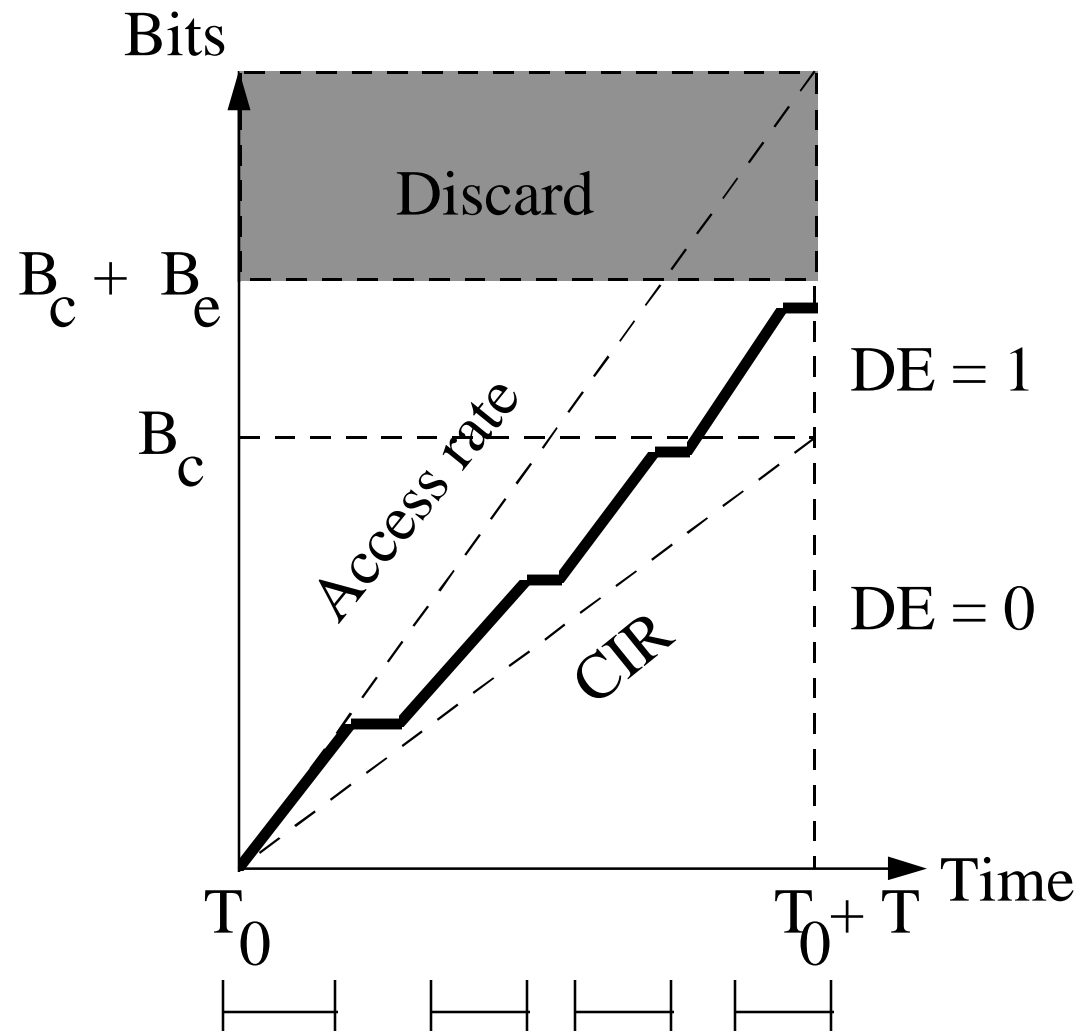
Discard Control

- ❑ 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 $B_e \Rightarrow$ Mark DE bit
- ❑ Over $B_e \Rightarrow$ Discard



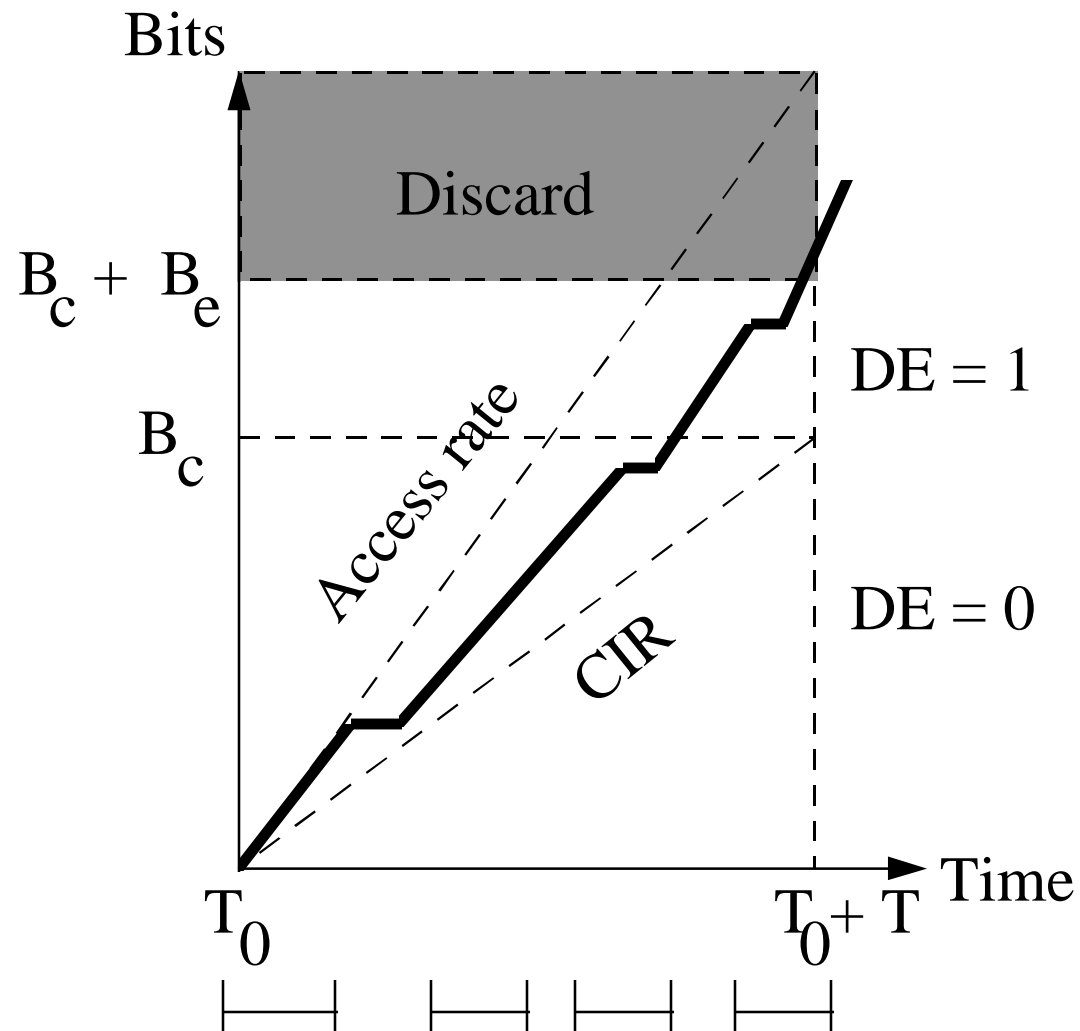
Frame 1 Frame 2 Frame 3

All frames with CIR



Frame 1 Frame 2 Frame 3 Frame 4

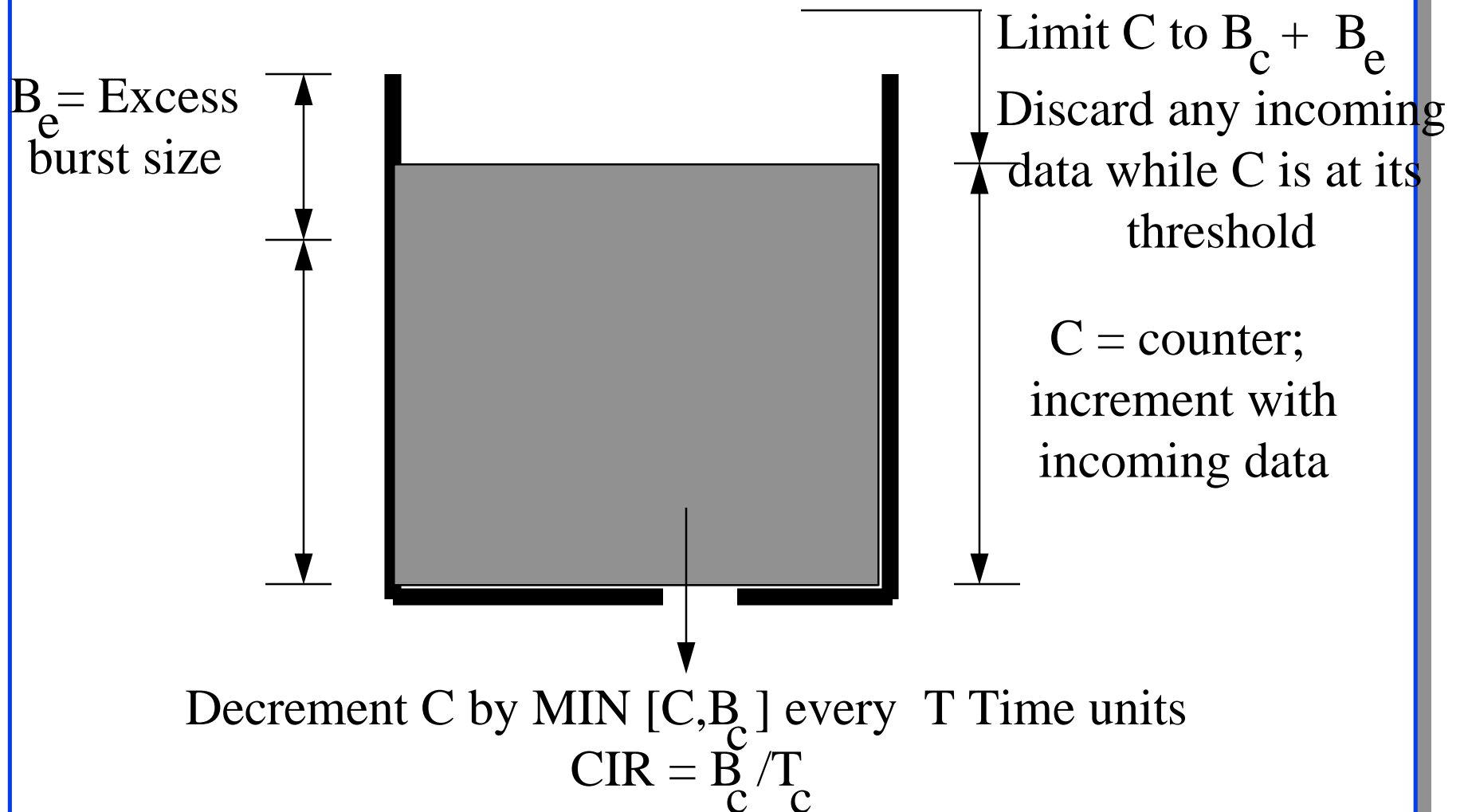
One Frame marked DE



Frame 1 Frame 2 Frame 3 Frame 4

One Frame marked DE; one frame discarded

Leaky Bucket Algorithm



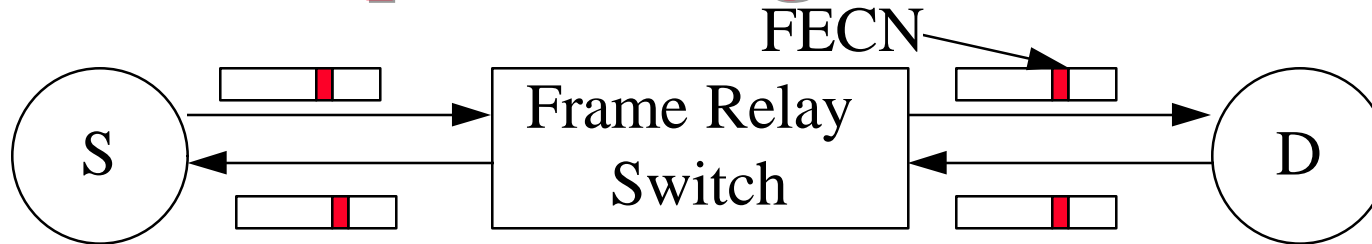
Performance Parameters

- ❑ Defined in I.233 Annex A and in T1.606 Section 4
- ❑ Used by commercial networks in customer contracts
- ❑ Throughput: Successful information bits/second.
- ❑ Transit Delay: first-bit in to last bit out. Over one or all networks.
- ❑ Residual error rate (RER): $1 - \text{Frames with no error} / \text{total frames}$
- ❑ Delivered Errored frames: Frames with undetected errors
- ❑ Delivered duplicated frames
- ❑ Delivered out-of-sequence frames
- ❑ Lost frames: Not delivered within a specified time

Performance Parameters (Cont.)

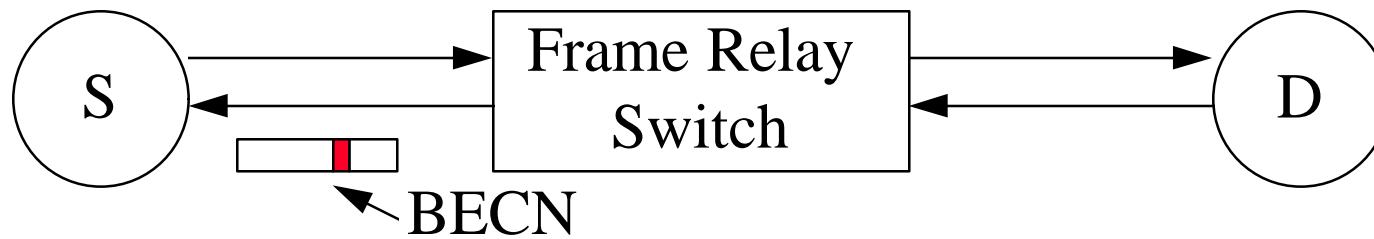
- ❑ Misdelsivered frames: Delivered to the wrong destination
- ❑ Switched virtual call establishment delay
- ❑ Switched virtual call clearing delay
- ❑ Premature disconnect
- ❑ Switched virtual call clearing failure

Forward Explicit Congestion Notification



- ❑ Source sets $FECN = 0$
- ❑ Networks set $FECN$ if $avg\ Q > 1$
- ❑ Destination tells source to increase/decrease the rate (or window)
- ❑ Start with $R = CIR$ (or $W=1$)
- ❑ If more than 50% bits set \Rightarrow decrease to $0.875 \times R$ (or $0.875W$)
- ❑ If less than 50% bits set \Rightarrow increase to $1.0625 \times R$ (or $\min\{W+1, W_{max}\}$)
- ❑ 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 the 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, $R = CIR$

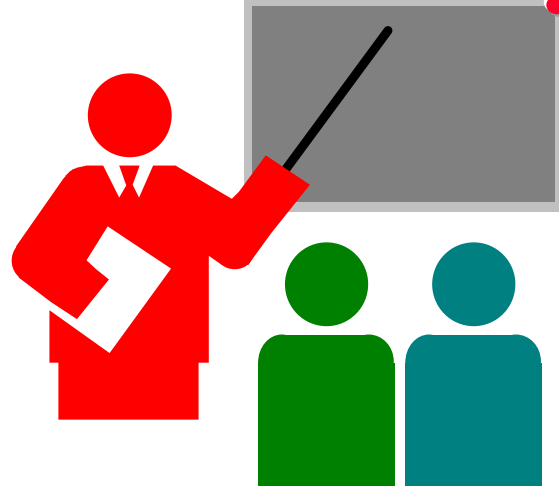
BECN (Cont.)

- ❑ 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 $\Rightarrow W = \max(W+1, W_{\max})$
- ❑ 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 W_{min} , Decrease by a factor α
- ❑ Increase by 1 after N frames
- ❑ Increase by 1 after W frames

Summary

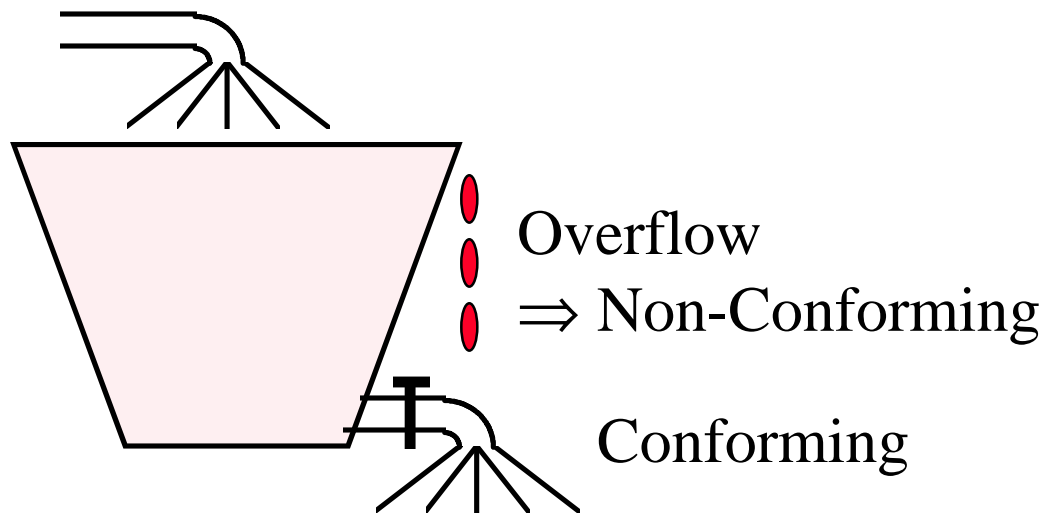


- ❑ Discard strategy: Leaky bucket
- ❑ Forward explicit congestion notification
- ❑ Backward Explicit congestion notification
- ❑ Implicit congestion control

Homework

- ❑ Read chapter 12 of Stallings' book

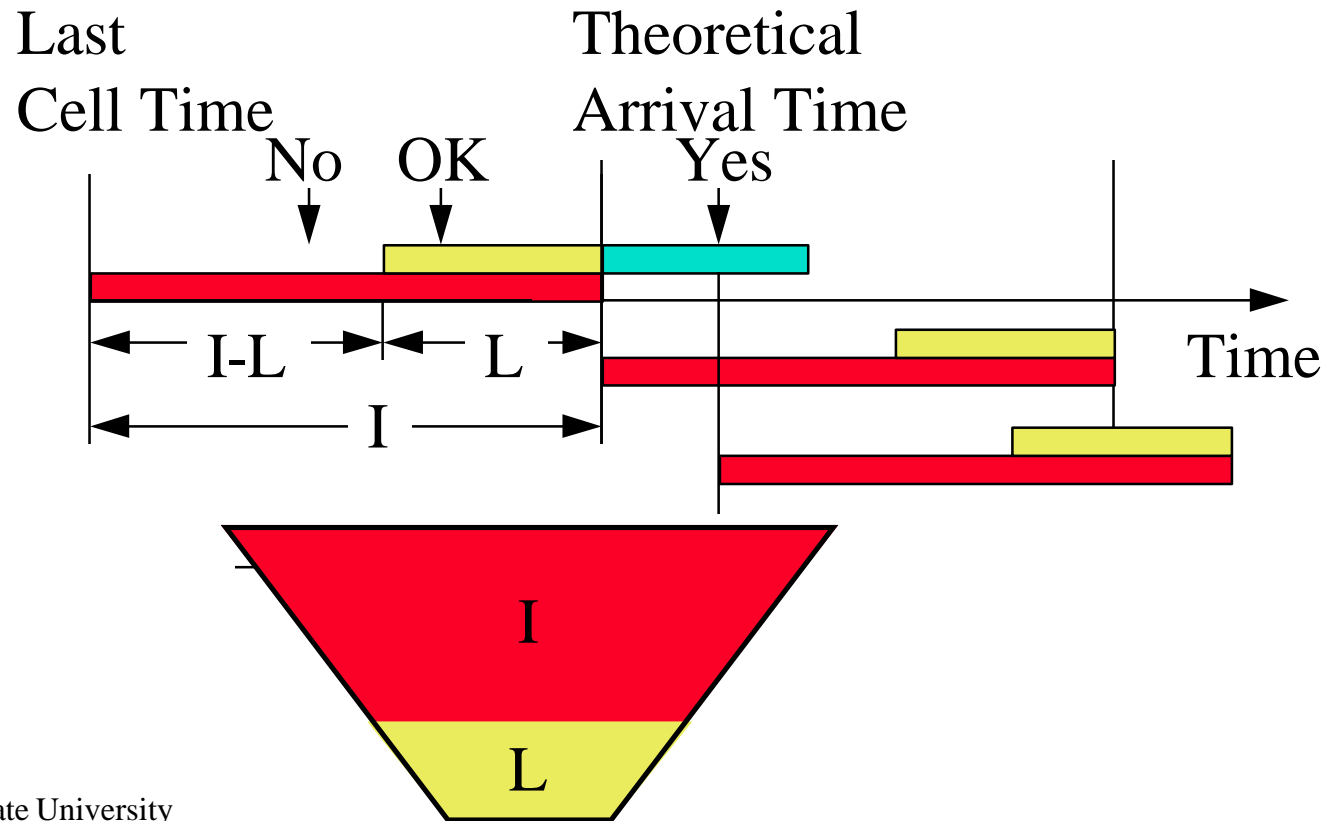
Leaky Bucket in ATM Networks



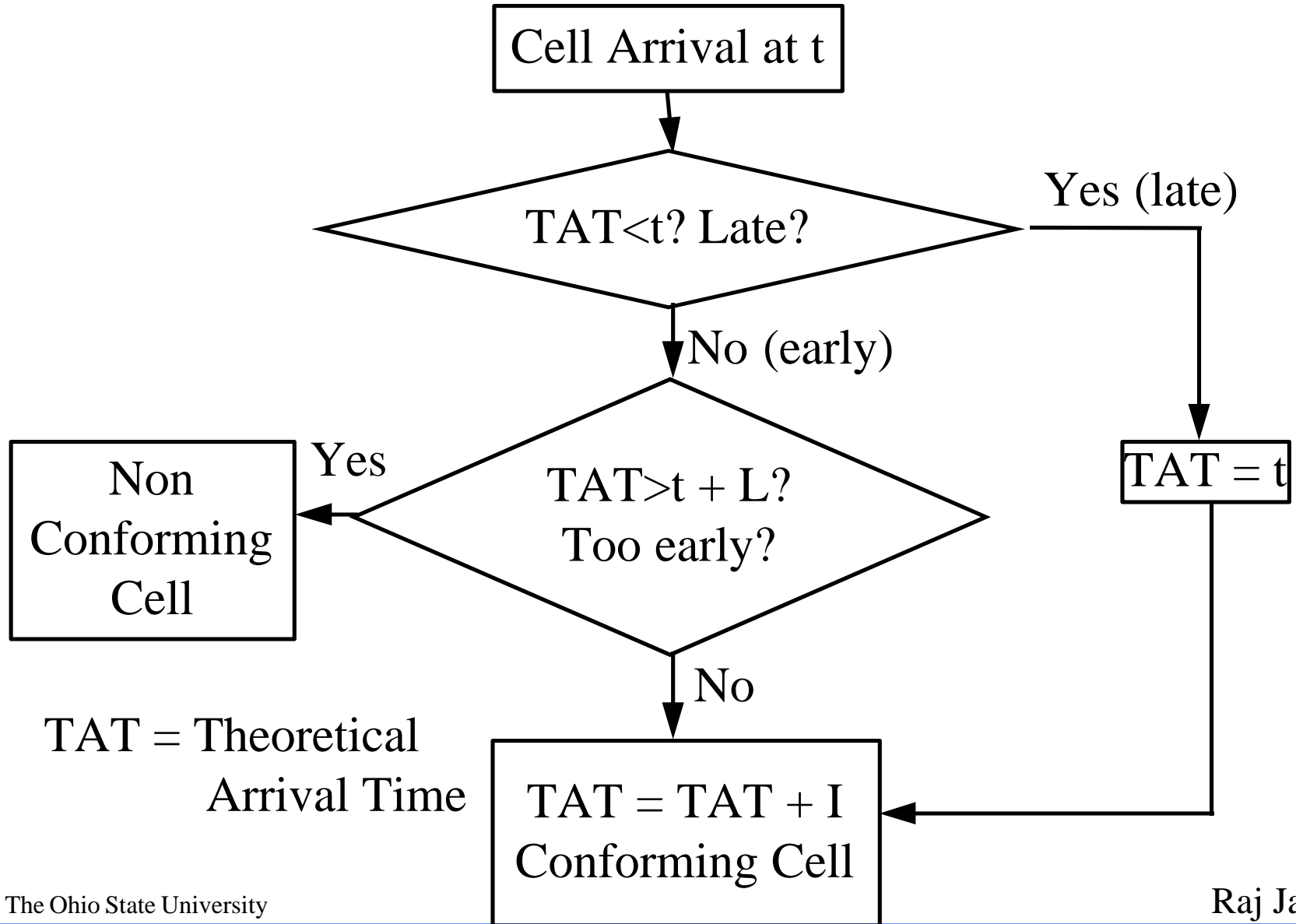
- ❑ Provides traffic shaping:
- ❑ Input bursty. Output rate controlled.
- ❑ Excess traffic can be discarded or admitted with $CLP = 1$

Generic Cell Rate Algorithm: GCRA(I, L)

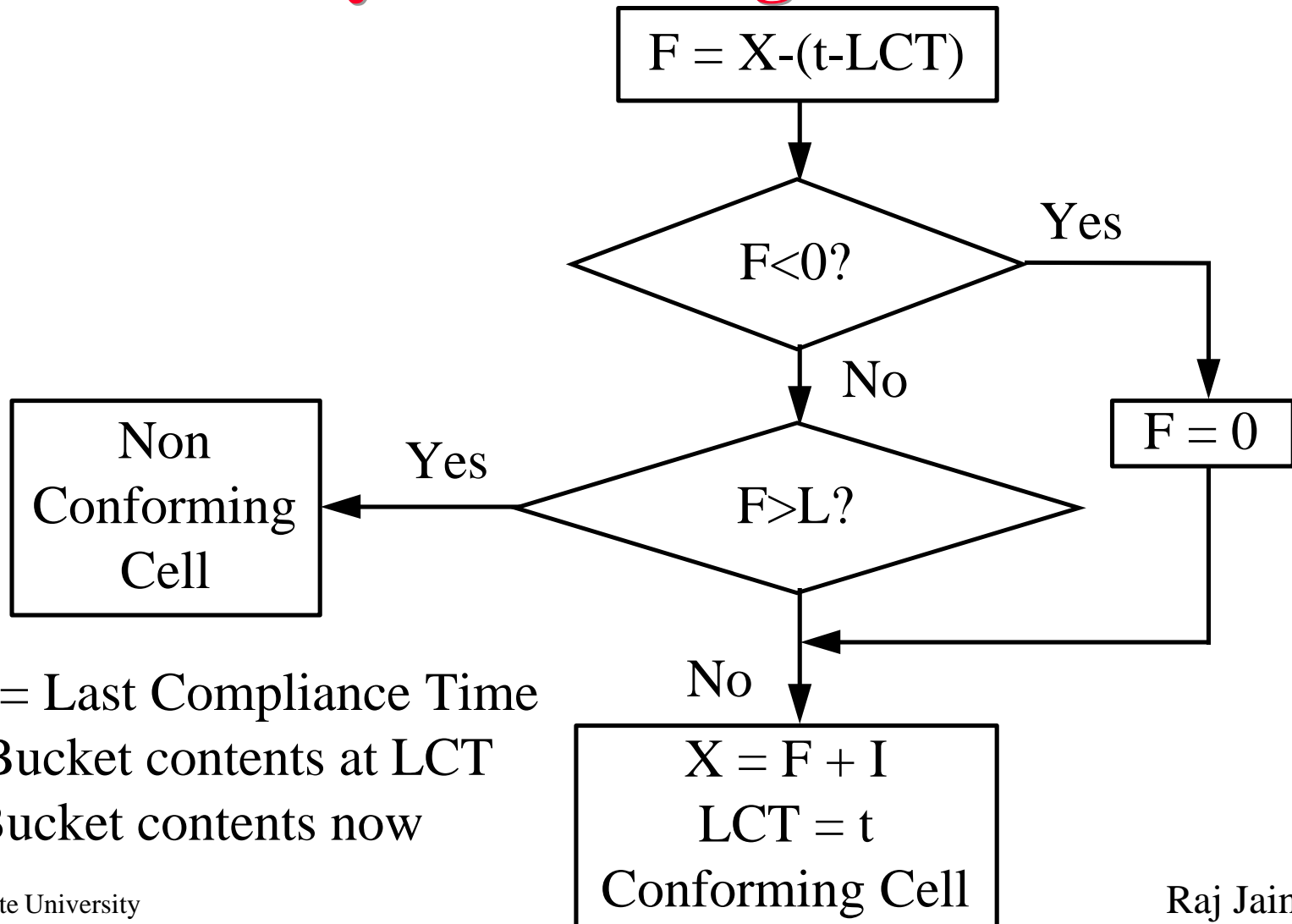
- I = Increment = Inter-cell Time = Cell size/PCR
- L = Limit \Rightarrow Leaky bucket of size $I + L$ and rate 1



GCRA(I, L): Virtual Scheduling Algorithm



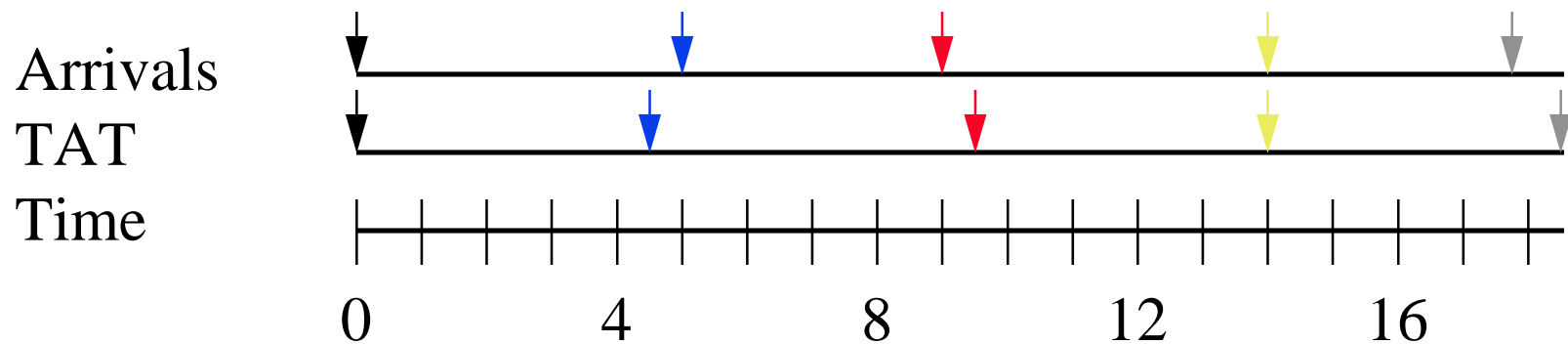
GCRA(I, L): Leaky Bucket Algorithm



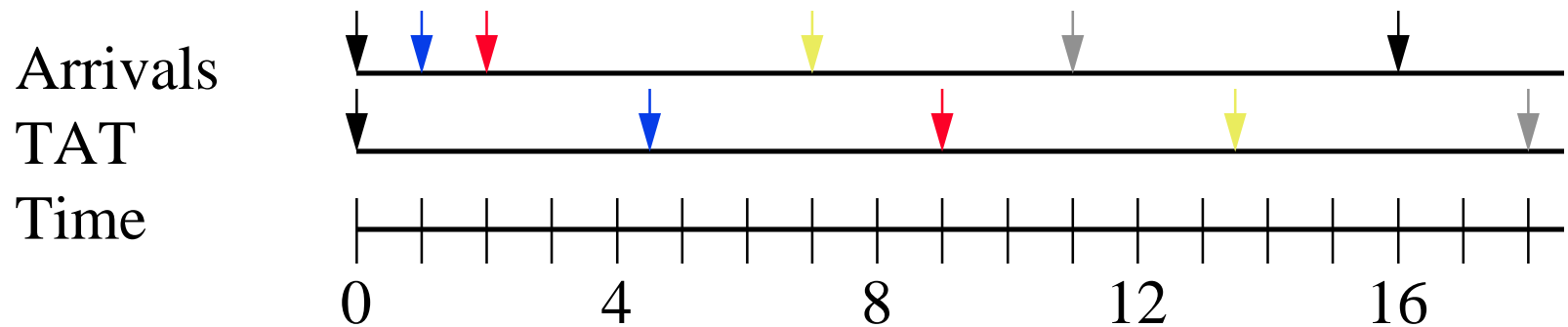
GCRA Examples

$\delta = \text{cell time} = 2.73 \mu\text{s}$ at 155 Mbps

□ GCRA(4.5 δ , 0.5 δ):



□ GCRA(4.5 δ , 7 δ):

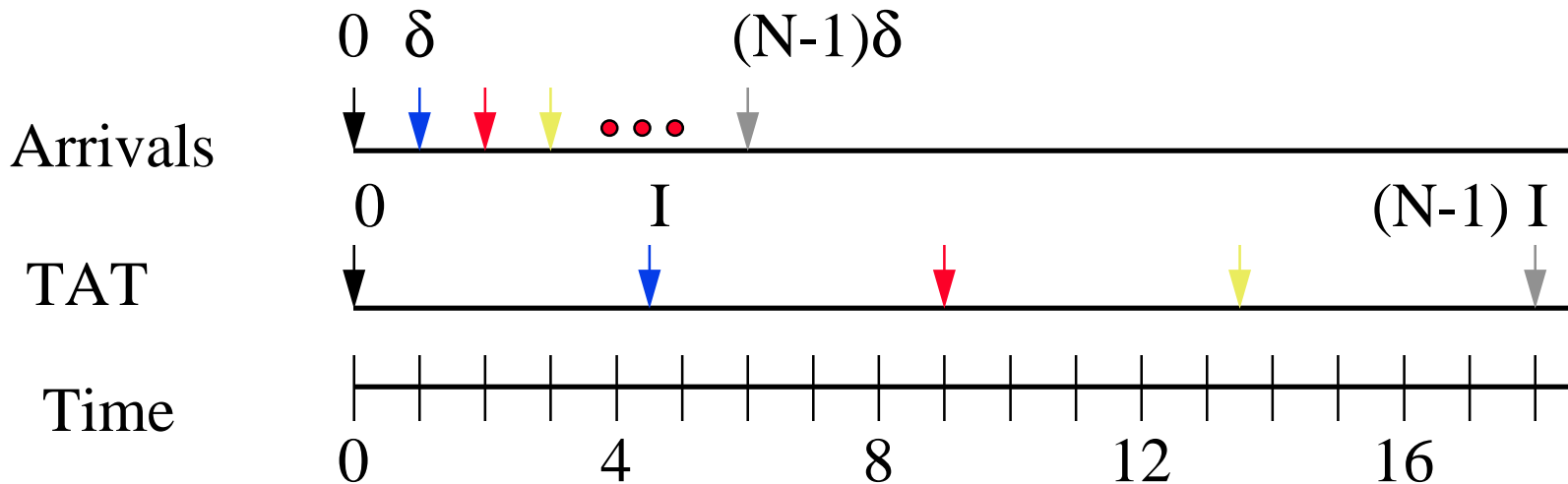


Maximum Burst Size (MBS)

δ = cell time at PCR, I = cell time at SCR, L =Limit

N = Maximum burst size

GCRA(I , L):



$$(N-1)I - (N-1)\delta < L$$

$$\text{MBS} = N = \text{Int}[1 + L / (I - \delta)]$$

$$L = (\text{MBS} - 1)(I - \delta)$$