SWS, RWS, Max Sequence Number

- SWS $\leq$? MaxSeqNum – 1
- Why ? Suppose MaxSeqNum = 7
- Frames sent: 0, 1, 2, 3, 4, 5, 6, 7
- Suppose acks losts
  - Frames resent
- receiver expects 0, 1, 2, 3, .., 7
  - second batch but get duplicate avoid
- 0, 1, 2, 3, 4, 5, 6, 0, 1, 2, 3

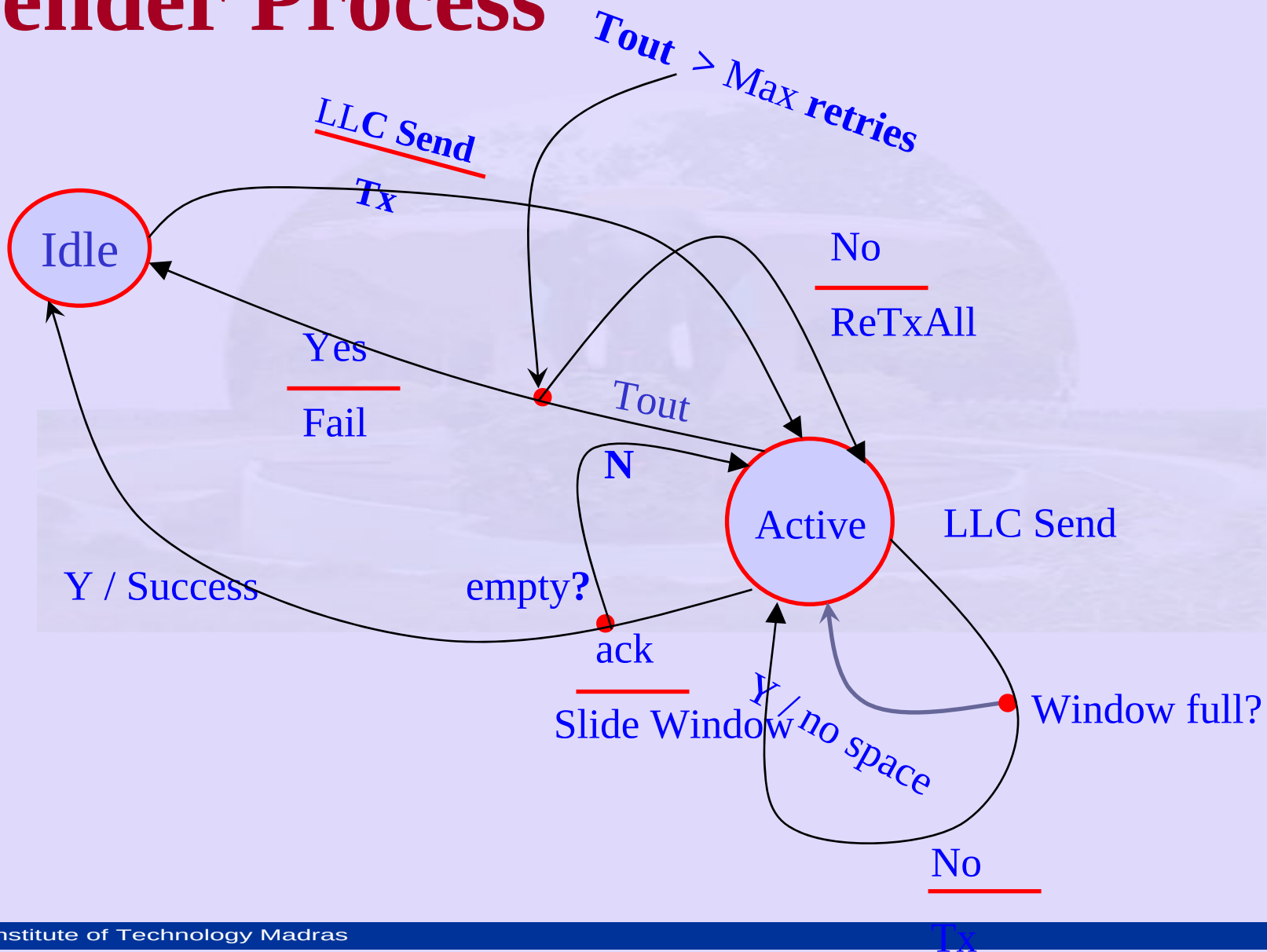
SWS, RWS, Max Sequence Number

- receiver knows there is a problem when RWS = 1
- what if RWS = SWS = 7
- Sender sends 0,1, 2, …, 6 successfully received – acks lost

SWS and RWS, Max Sequence Number

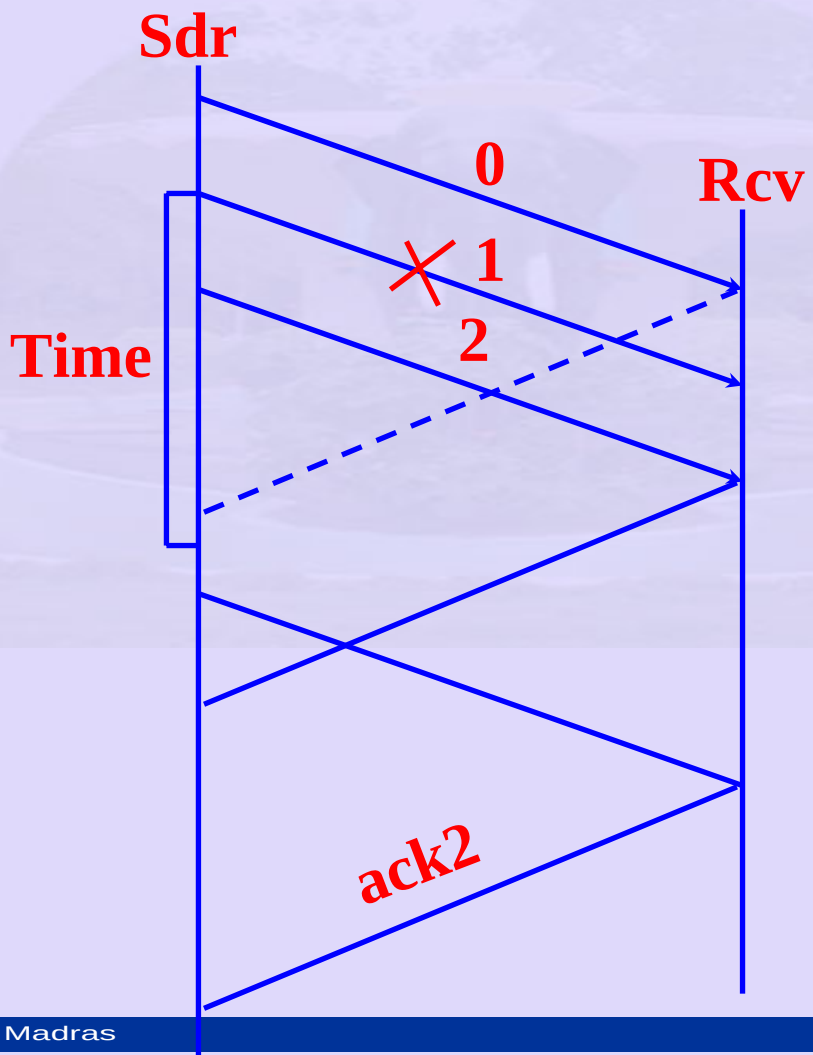
- Receiver expects 7, 0, …, 5
- Sender timeout – sends 0, ..., 6
- Receiver expects second batch
- Sender sends first batch 0, 1, 2, 3
- SWS $\leq$ (MaxSeqNum +1) / 2
- 0, 1, 2, 3 successfully received.
- Next sender sends 4, 5, 6, 7
- What is the rule for RWS < SWS in general?

FSM: Sliding Window Protocol: Sender Process

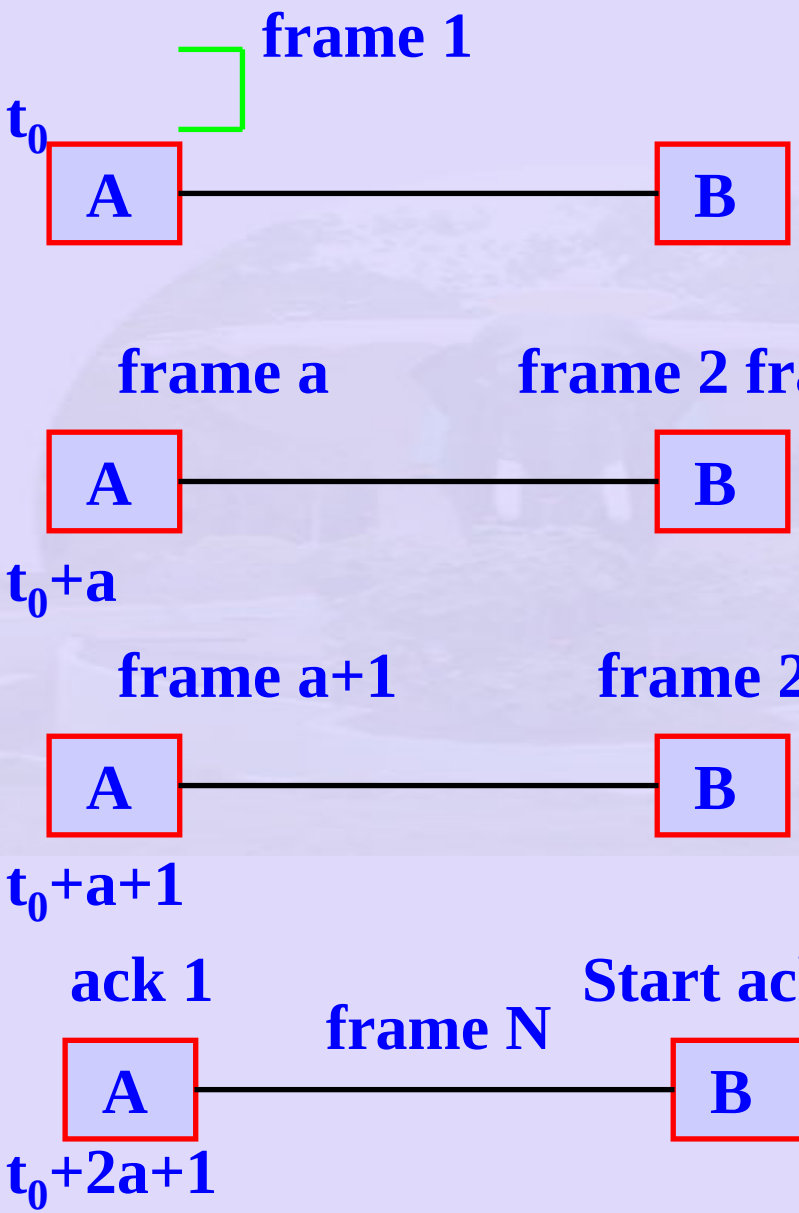


FSM: Sliding Window Protocol: Receiver process:

SWP – Timing Diagram



Sliding Window efficiency:



SWP: Efficiency

- Case 1: $N > 2a+1$
- A transmits continuously without pause
- $U = 1$
- Case 2: $N < 2a+1$
- $U = N / 2a+1$

SWP: Transmission with errors

- N_r = E [number of transmitted frames to successfully transmit one frame]

$$N_r = \sum_{i=1}^{\infty} f(i) P^{i-1}(1-P)$$

$$f(i) = 1 + (i-1)k$$

$$= \frac{1 - P + kP}{1 - P}$$

k is the number of retransmission of a frame

Approximation for k

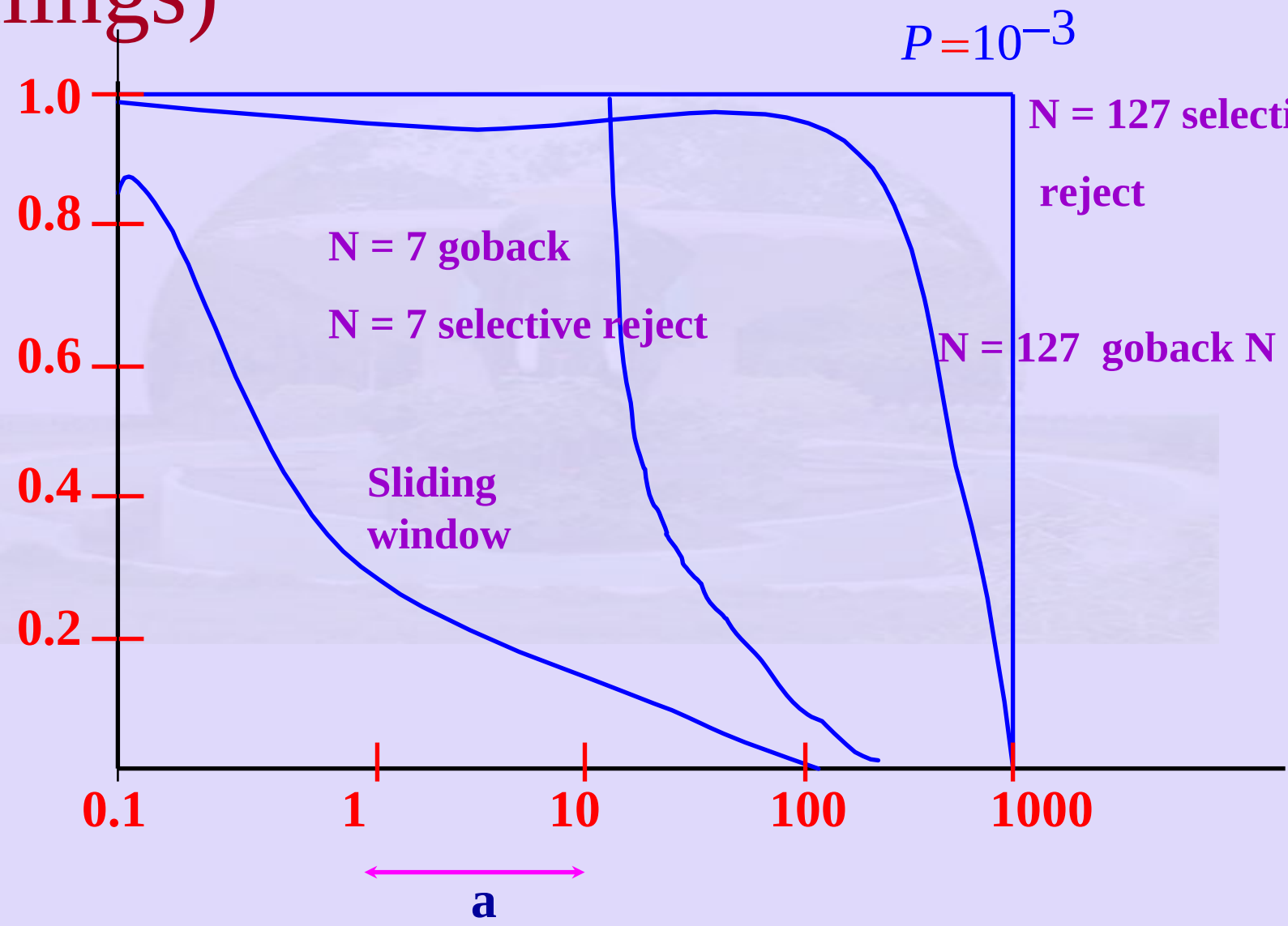
$$k = 2a+1, when \;\; N > 2a+1$$

$$k = N, when \;\; N < 2a+1$$

$$U = \frac{1-P}{1+2aP}, N > 2a+1$$

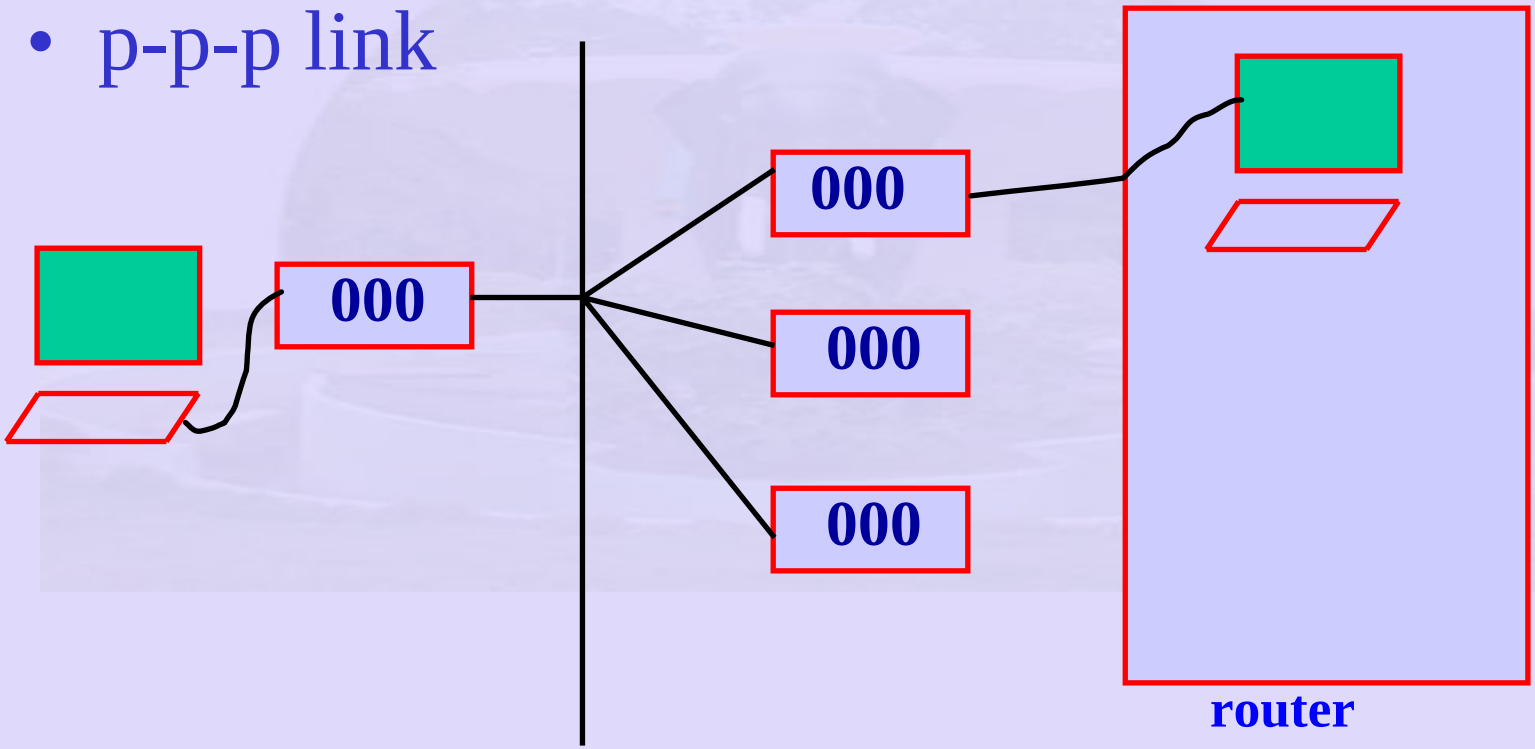
$$U = \frac{N(1-P)}{(2a+1)(1-P+NP)}, N < 2a+1$$

Utilisation for different protocols (Stallings)



DLL and the Internet

- p-p-p link



DLL and the Internet

- home PC calls ISP
  - home PC simple – character oriented terminal
  - shell account on hosts - time sharing machine
  - graphics based – PC acts as Internet hosts
  - all Internet services including graphics available.

DLL and the Internet

- How Home PC connects to the Internet:
  - PC calls ISP's router via modem.
  - After modem answers, establish a physical connection.
  - PC sends router a series of LCP packets in the payload of a PPP frame -
  - used to select PPP parameters & responses
  - NCP packets are sent to configure NWL options
  - PC wants to run TCP / IP stack
    - needs IP addresses
    - NCP for dynamic address allocation

DLL and the Internet

- NCP – Network Control Protocol
  - negotiate NWL options
  - independent of NWL protocol
  - separate for each type of NWL protocol

P-P-P

- Framing – fixed frame format
- Link Control Protocol
  - bring up lines, testing negotiation options, bring down lines
  - User sends ISP host IP packets & receives IP packets.
  - User finishes, NCP tears down connection, face IP address.
  - LCP shuts down DLL connection
  - Finally computer tells modem to hang up – release physical connection

HDLC- A P-P Protocol