Operating Systems and Networks

Networks Part: Project 1

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Reliable Transport

Implement a reliable packet stream (not byte stream!)

- Packet drops
- Packet corruption
- Flow control
- Packet reordering

Fundamental Mechanisms

- Error Detection
  - Corrupt packets must be discarded
  - Implemented via Checksum
- Acknowledgements (ACK)
  - Small control packet to confirm the reception of a packet
  - When sender gets an ACK, sender learns that recipient has successfully gotten a packet
- Timeouts
  - If sender doesn't get an ACK after "reasonable" time, it retransmits the original packet

Naive Approach: Stop-and-Wait

- Algorithm
  - After transmitting one packet, sender waits for an ACK
  - If the ACK doesn't arrive in time, sender retransmits

- Disadvantage
  - Inefficient use of link's capacity

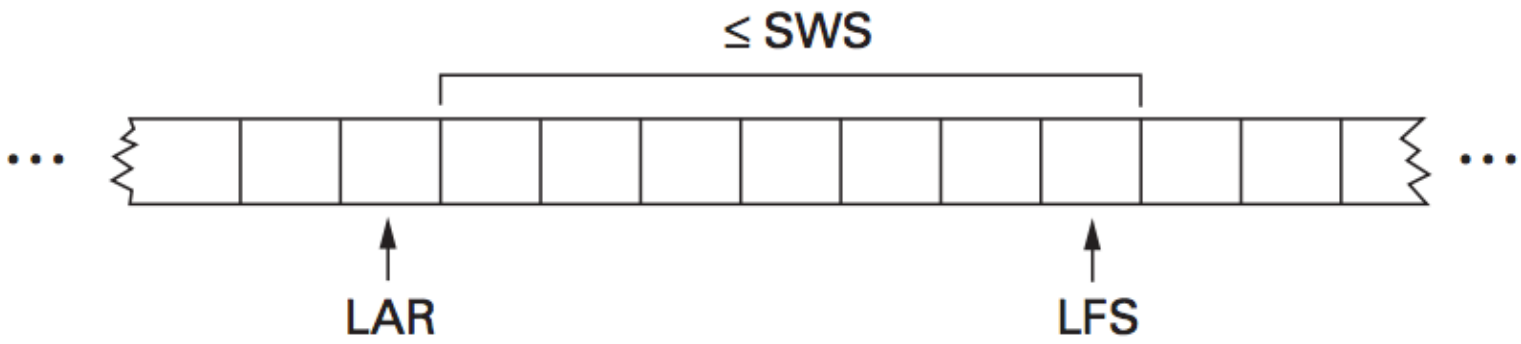
Sliding Window Protocol

- Objective: Better utilization of link bandwidth
  $\Rightarrow$ Sender is allowed to send multiple unacknowledged packets (how many?)

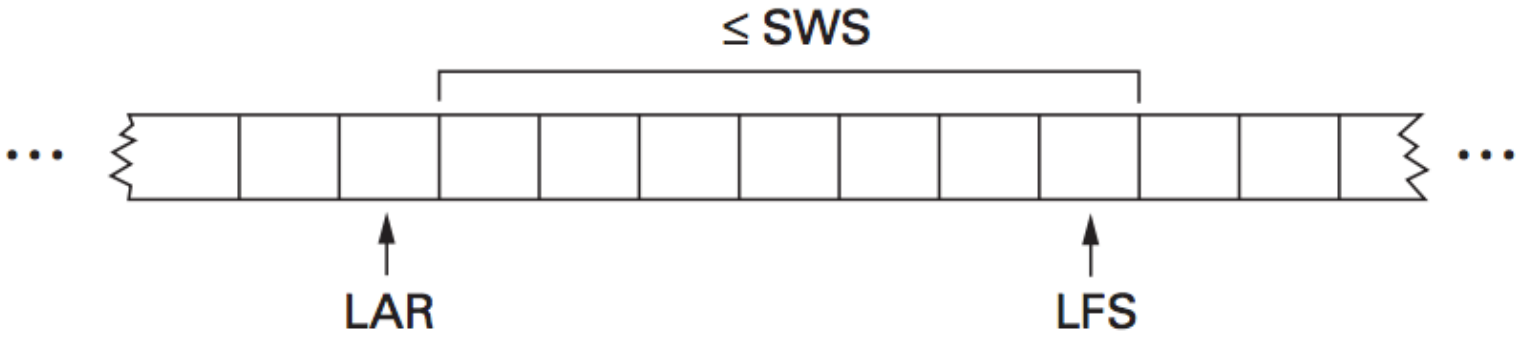
- Windows
  - Number of Unacknowledged packets are determined by Windows
    - Sender Window (SW)
    - Receiver Window (RW)
  - Requirement: Need to keep sender's and receiver's windows synchronized (how?)

Sliding Window: Sender

- Assigns sequence number to each frame (seqno)
- Maintain three state variables:
  - Send Window Size (SWS): max # of unacknowledged frames that sender can transmit
  - Last Acknowledgement Received (LAR): seqno of last ACK
  - Last Frame Sent (LFS)



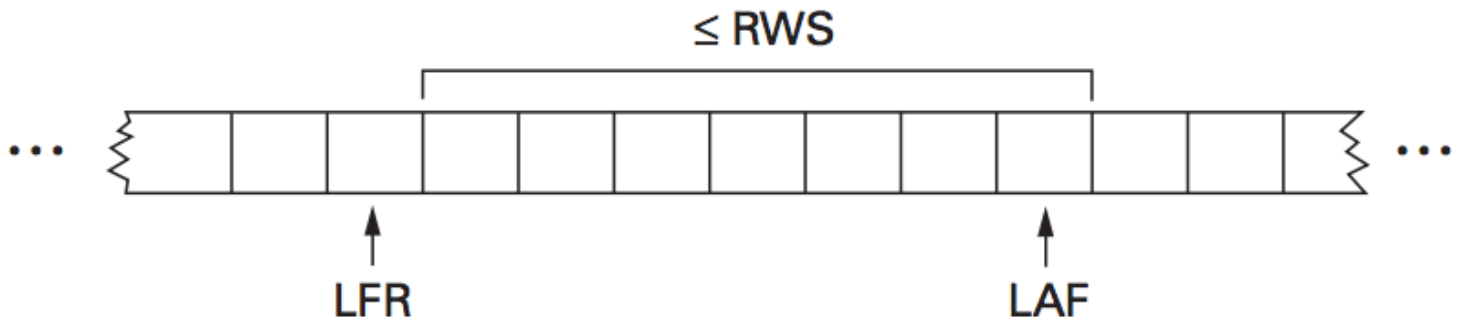
Sliding Window: Sender Invariant



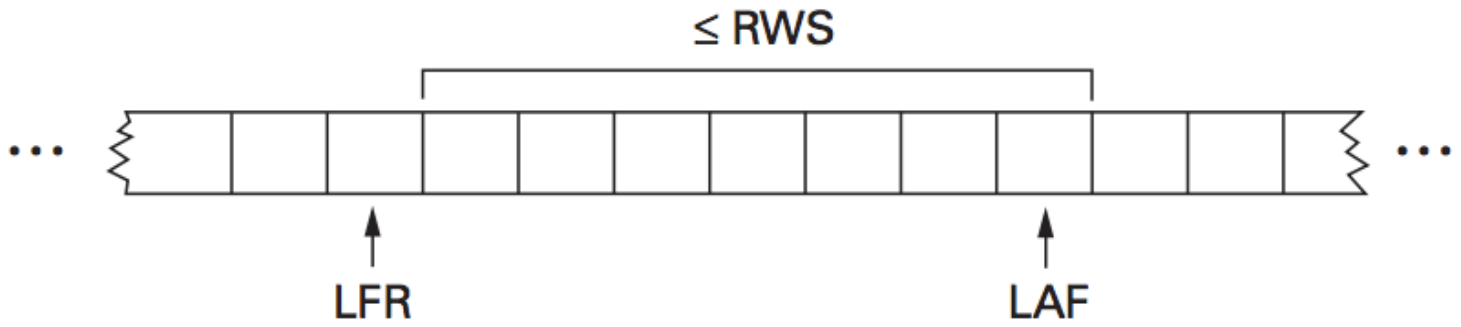
- Maintain invariant: LFS – LAR ≤ SWS
- Buffer up to SWS unacknowledged packets
- Associates timeout with each frame sent
  - Retransmits if no ACK received before timeout
- Advance LAR when ACK arrives
  - Another frame can be sent

Sliding Window: Receiver

- Maintain three state variables:
  - Receive Window Size (RWS): max # of out-of-order frames it will accept
  - Last Acceptable Frame (LAF)
  - Last Frame Received (LFR)



Sliding Window: Receiver Invariant



- Maintain invariant: LAF – LFR ≤ RWS
- When frame #seqno arrives:
  - if LFR < seqno ≤ LAF accept
  - if seqno ≤ LFR or seqno > LAF discard
- Receiver ACKs the next seqno it's expecting (CumACK)
  - LFR = CumACK – 1
  - LAF = CumACK + RWS-1

Questions

1. Can there be data after the EOF?
   - No

2. Can we assume that a reliable_state struct is destroyed by a call of the rel_destroy function if a EOF is read from the input AND an EOF is received from the other side.
   - No

3. Can we assume that every call to rel_timer updates all reliable_state structs
   - Yes, iterate!