Week 4 – Data Link Layer Contd

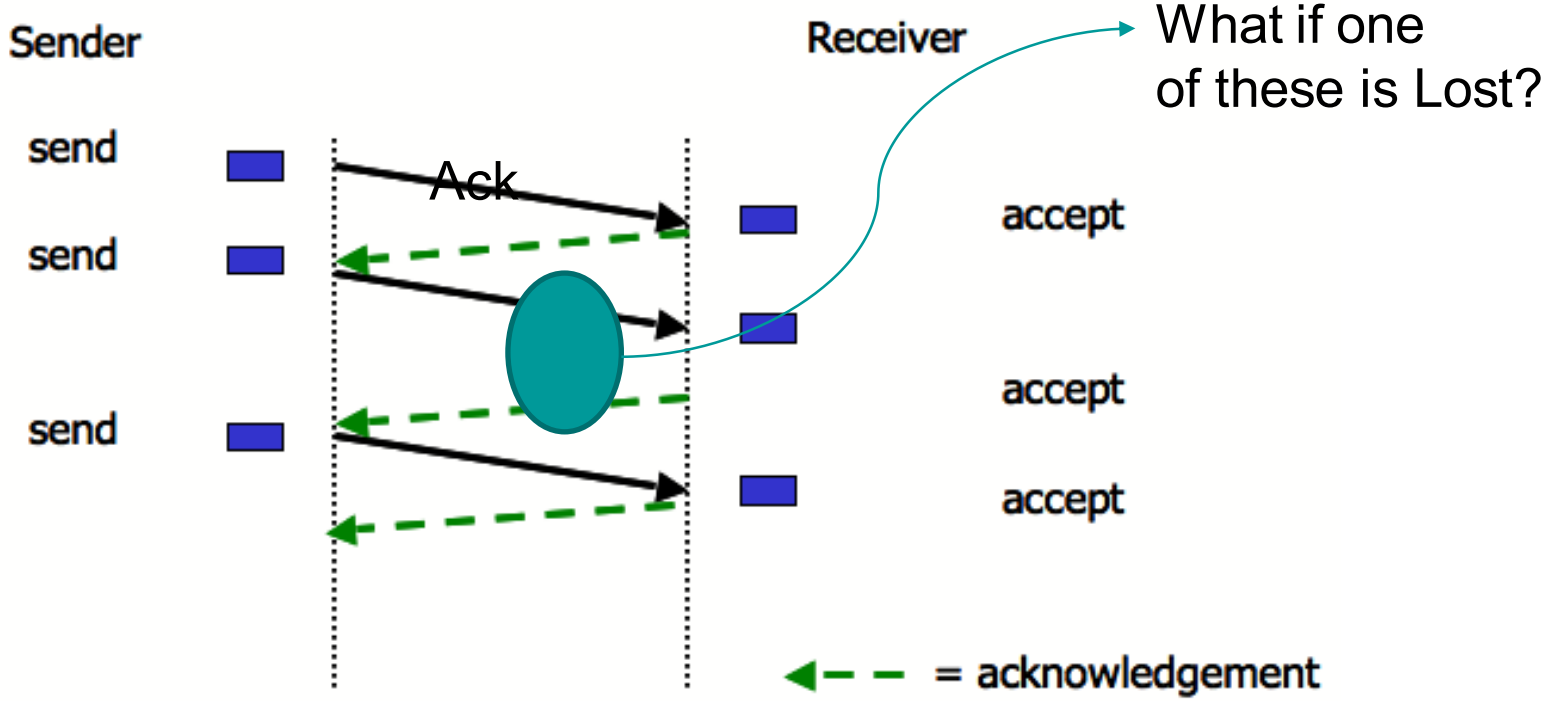
COMP90007
Internet Technologies

Reading

- Chapter 3 Continues
  - Note that some of the material is covered in slightly different order than what is given in the book

Are Acknowledgements Good for Flow Control Only?

Acknowledgements can be used for reliability as well, but we need one more construct to make them work for that purpose

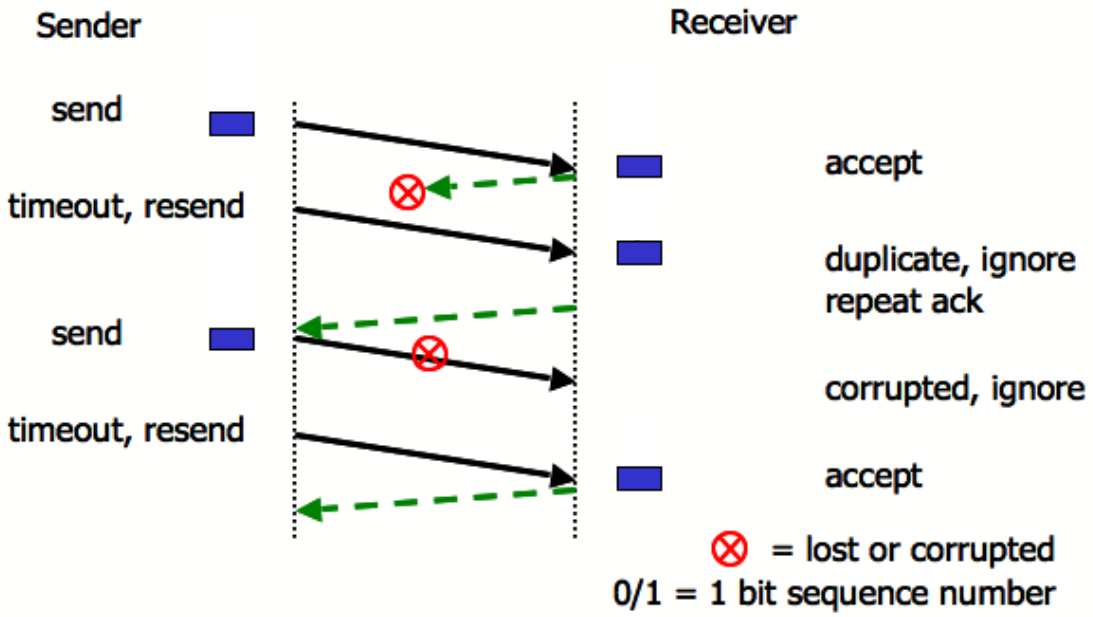


Noisy Channel Protocol

- Frames can be lost either entirely or partially
- Requires ***timeout*** *function* to determine arrival or non-arrival of complete frames
- We also need to make distinction between frames already sent/received and those being re-transmitted

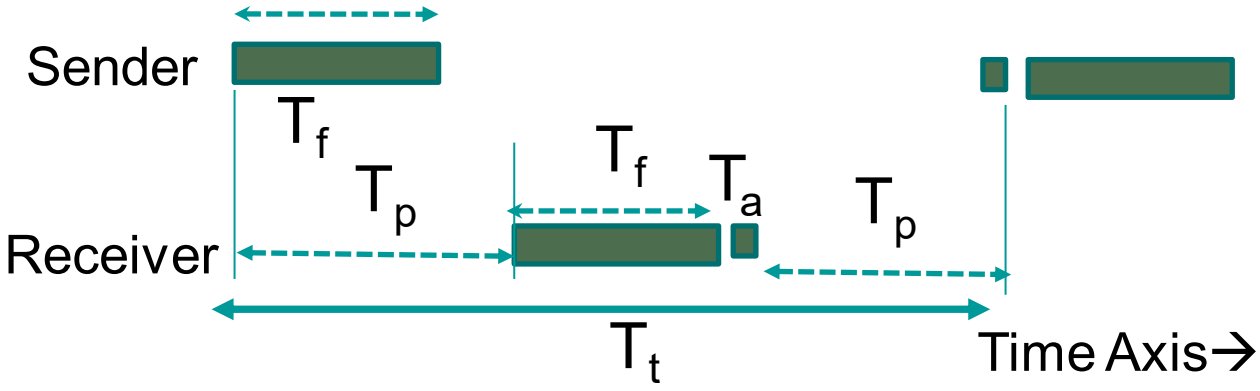
Stop and Wait Protocol

- Concept of ARQ (Automatic Repeat reQuest)
  - Ack and Timeout
- Stop and Wait
  - One bit Ack



Link Utilization in Stop and Wait Protocols

Efficiency in communication is measured by **Link Utilization (U)**



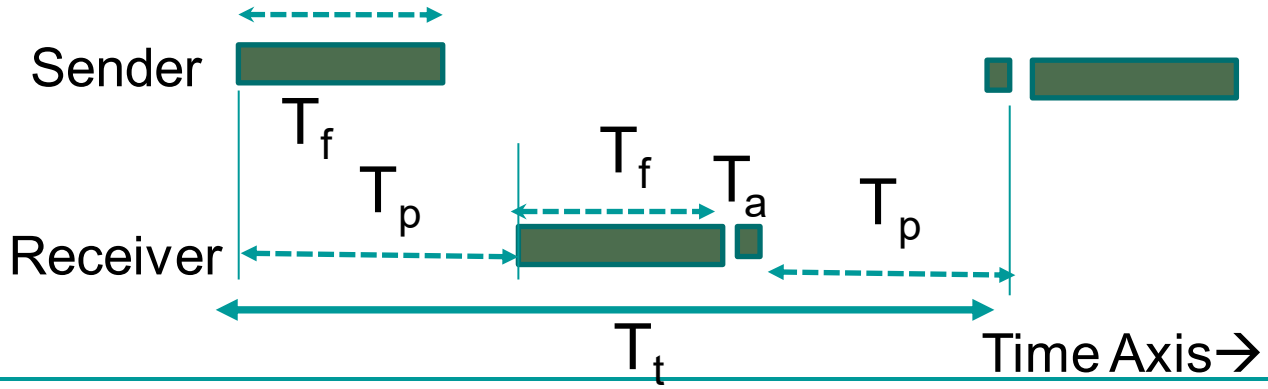
Link Utilization in Stop and Wait Protocols

Let **B** be the **bit-rate** of the link and **L** the **length of the frame**

T_f= Time needed to transmit a frame of length L,
T_p= Propagation delay of the channel,
T_a= Time for transmitting an Ack,

So we have $\mathbf{T_f = L/B}$. We can assume $\mathbf{T_a = 0}$. $\mathbf{T_t = T_f + 2T_p}$.

U = (*Time of transmitting a frame*)/(*Total time for the transfer*) = $\mathbf{T_f/T_t}$
We have then $U = T_f / (T_f + 2T_p) = (L/B) / (L/B + 2T_p) = \mathbf{L/ (L+ 2T_p B)}$.

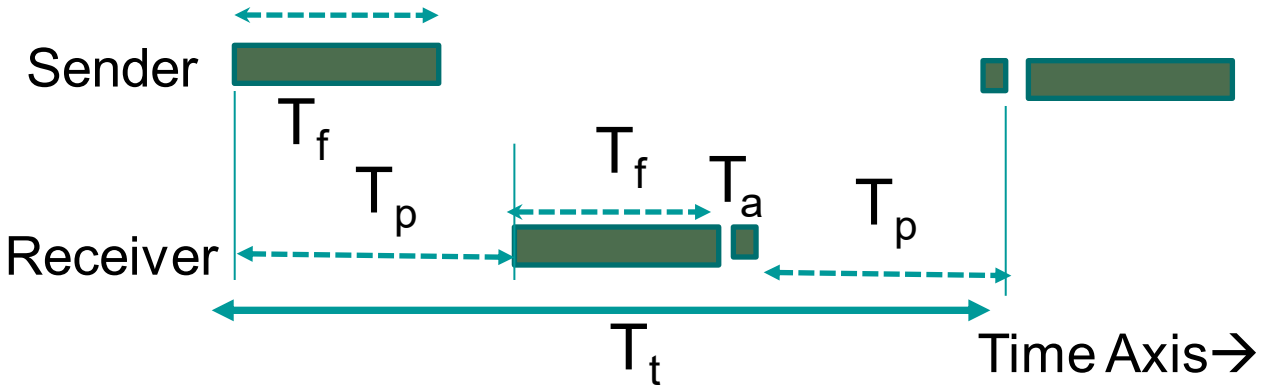


Link Utilization in Stop and Wait Protocols

U = (*Time of transmitting a frame*)/(*Total time for the transfer*) = T_f/T_t

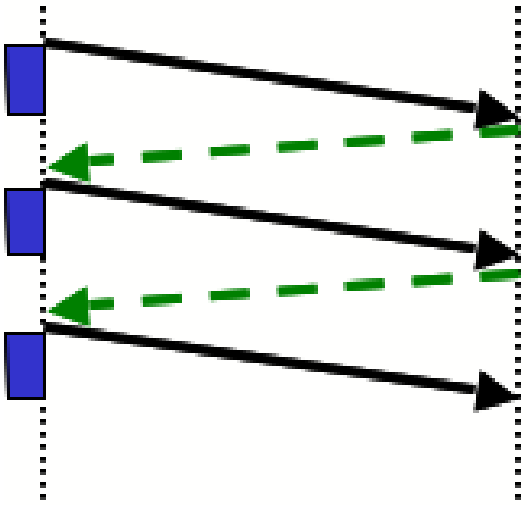
We have $U = T_f / (T_f + 2T_p) = (L/B) / (L/B + 2T_p) = L/ (L+ 2T_p B)$.

For example for a Link with B=1Mbps and T_p=50ms and frame size 10Kb:
$U= 10000/(10000+0.1*10^6)=1/11$



Link Efficiency

Stop and Wait



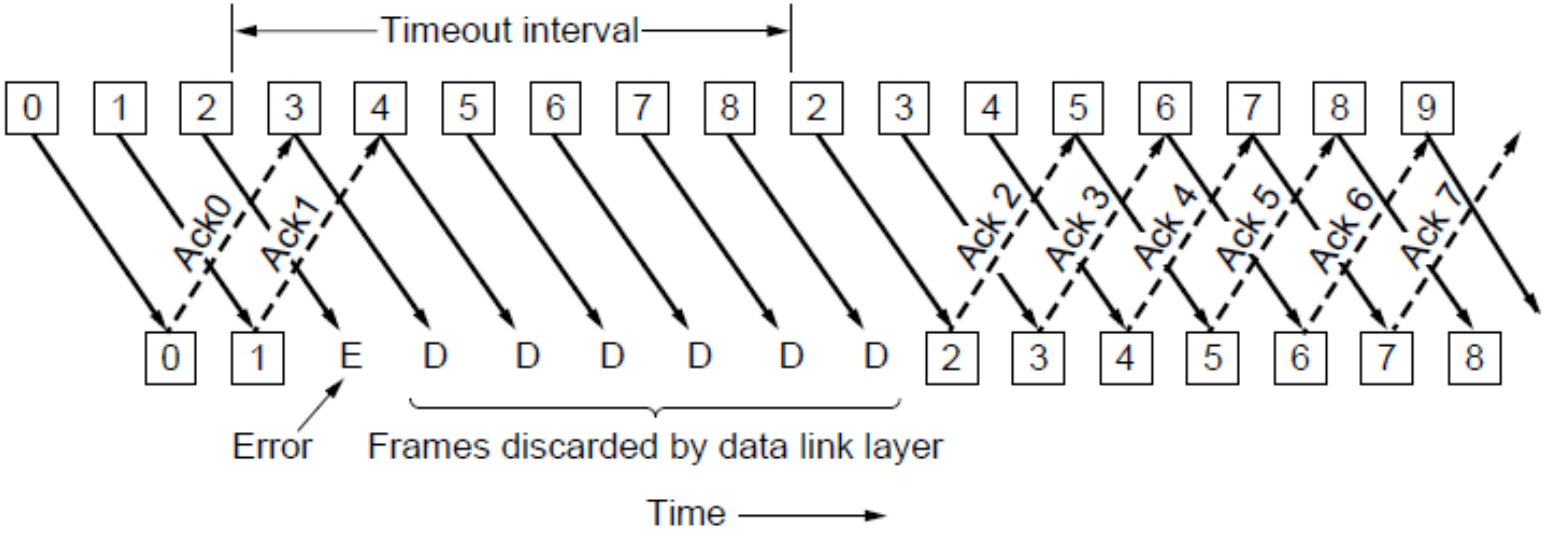
50% utilisation

Sliding Window Protocols

- Data is commonly transmitted in *both directions simultaneously*
- Sender *maintains a set of sequence numbers* corresponding to frames it is allowed to send (within the "**sending window**")
- Receiver maintains a set of sequence numbers corresponding to frames it is allowed to accept (within the "**receiving window**")
- Stop and Wait can be seen as a special case with window size 1

Protocol Using Go-Back-N

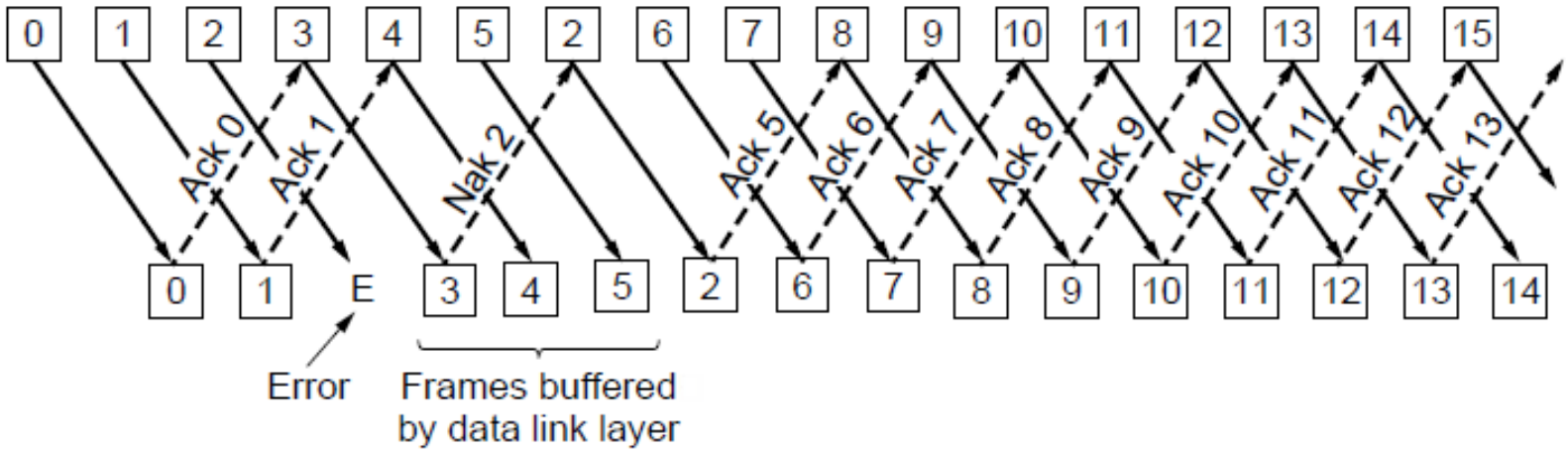
- Long transmission times need to be taken into account when programming timeouts e.g., low bandwidth or long distance
- Senders don't need to wait for acknowledgement for each frame before sending next frame



Receiver window size =1, Sender window size is N

Selective Repeat

- Receiver accepts frames anywhere in receive window
  - NAK (negative ack) causes sender retransmission of a missing frame before a timeout
  - Cumulative ack indicates highest in-order frame



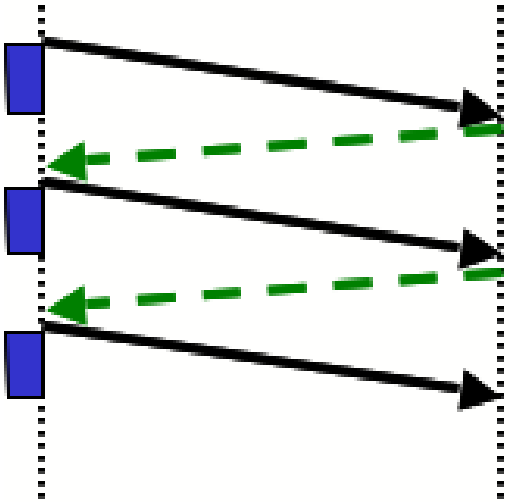
Go-Back-N vs Selective Repeat

- Go-Back-N: **receiver discards all subsequent frames** from error point, sending no acknowledgement, until the next frame in sequence
- Selective Repeat: **receiver buffers good frames** after an error point, and relies on sender to resend oldest unacknowledged frames

- *Trade-off between efficient use of bandwidth and data link layer buffer space*

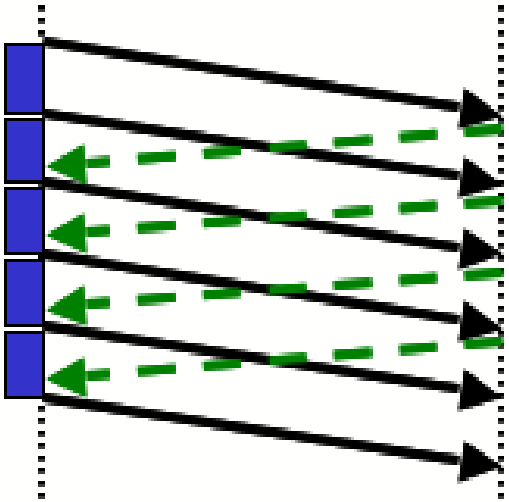
Link Efficiency Compared

Stop and Wait



50% utilisation

Sliding Window



100% utilisation

Last But Not Least: Some Example Data Link Protocols

- PPP (Point-to-Point Protocol)
- Packet over SONET
- ADSL (Asymmetric Digital Subscriber Loop)

PPP

- PPP (Point-to-Point Protocol) is a general method for delivering “messages” across links
  - Framing uses **a flag and byte stuffing**
  - “Unnumbered mode”, **connectionless unacknowledged service**, is used
  - Errors are detected with a **checksum,** actually similar to CRC