Data Link Layer (3)

COMP90007 Internet Technologies

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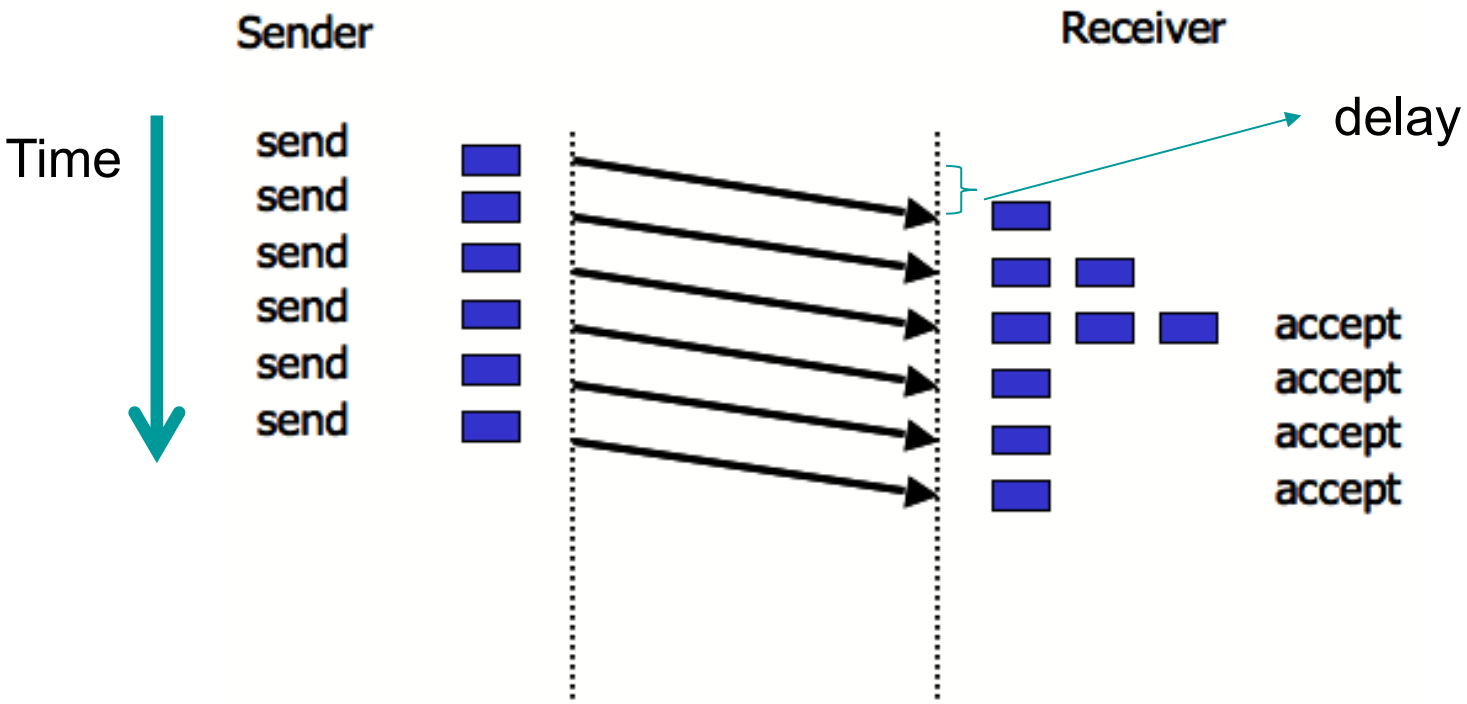
Flow Control

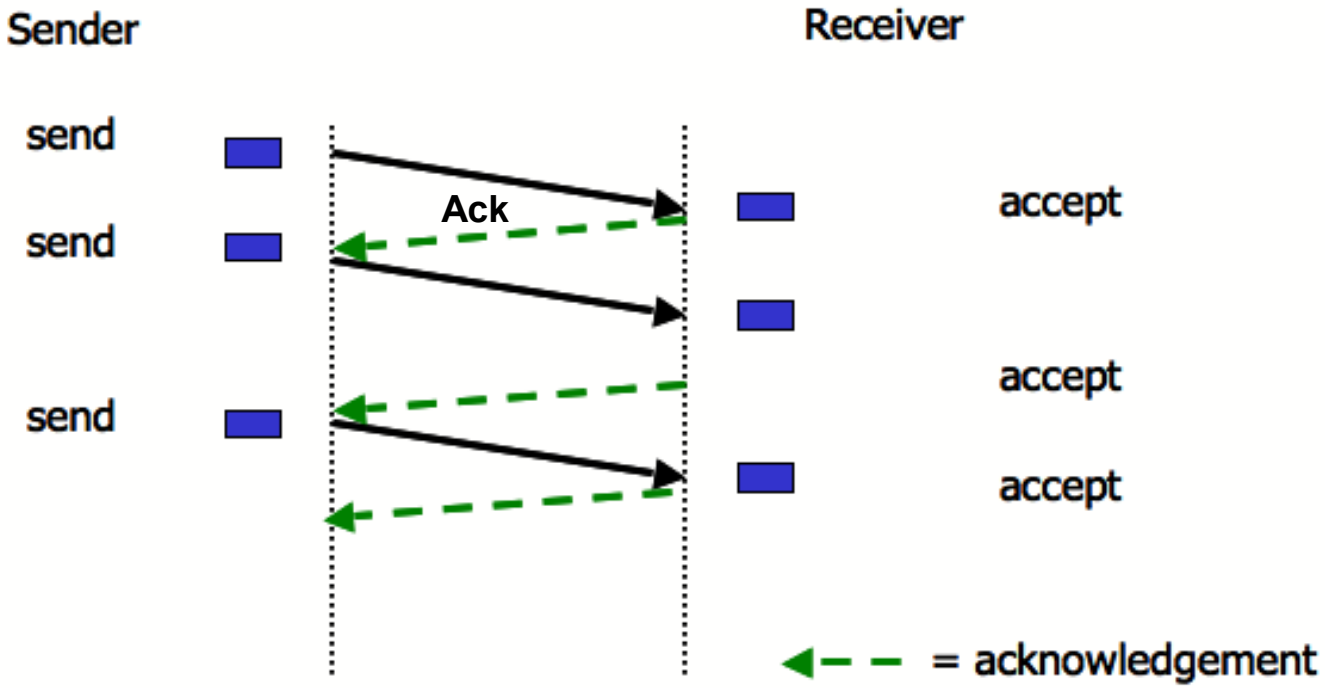
- Strategies to control when sender can send next frame
  - **Feedback based flow control**
  - Rate based flow control

A Very Simple Protocol



Acknowledged Transmission

- Case: fast sender vs. slow receiver, the receiver's buffer space constrained
- Requires acknowledgement

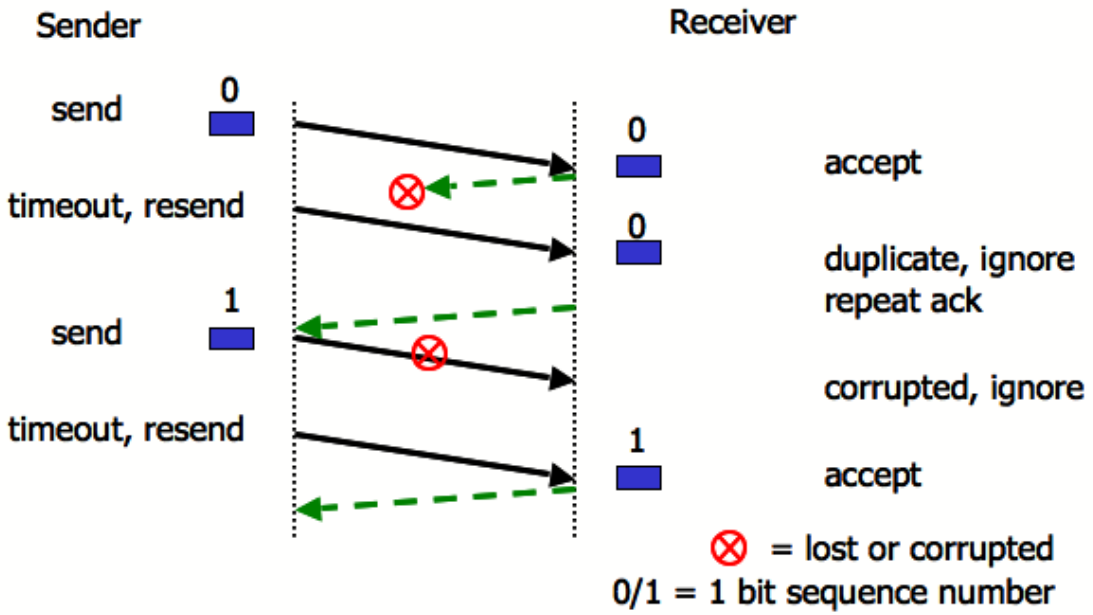


Noisy Channel Protocol

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

Stop and Wait Protocol

- ARQ (Automatic Repeat reQuest)
  - Ack, timeout, and sequence number



Link Utilisation in Stop and Wait Protocols

Link Utilisation (U) measures the efficiency of communication.

$\mathbf{T_f}$ = Transmission delay, time needed to transmit a frame of length L;

$\mathbf{T_p}$= Propagation delay;

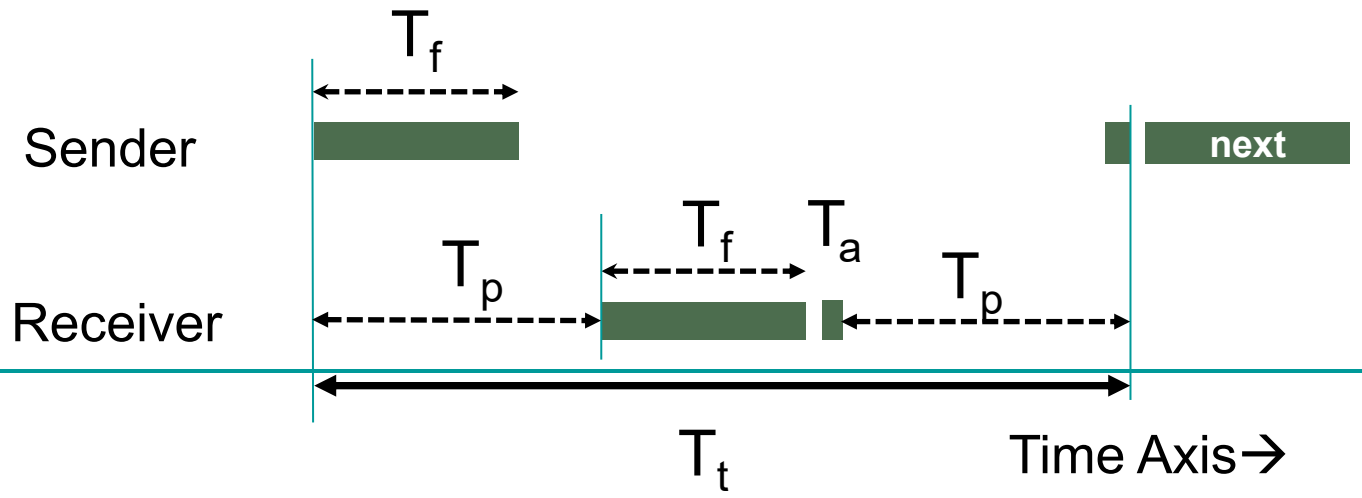
$\mathbf{T_a}$= Time for transmitting an Ack, and we can assume $T_a = 0$.

$\mathbf{T_t = T_f + 2T_p}$

U = (Time of transmitting a frame)/(Total time for the transfer) = $\mathbf{T_f / T_t}$

Given bit rate B and $T_f = L/B$, we have

$$\mathbf{U} = T_f / (T_f + 2T_p) = (L/B) / (L/B + 2T_p) = \mathbf{L/ (L+ 2T_p B)}.$$

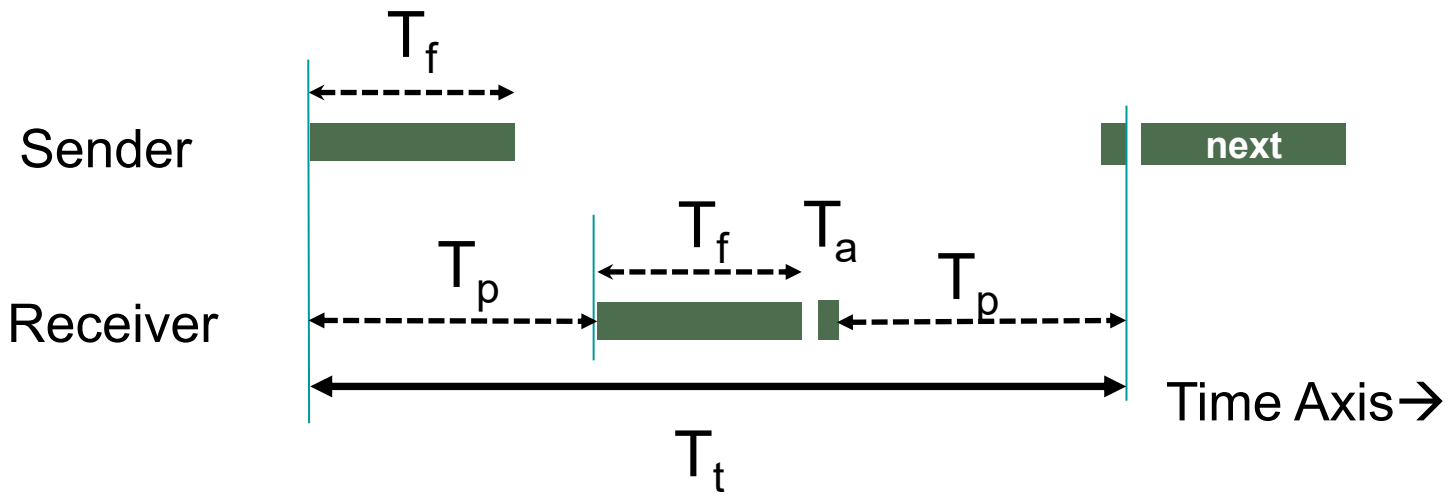


Link Utilisation in Stop and Wait Protocols

For a link with B=1 Mbps, T_p=50ms and frame size 10Kb, what is the link utilisation?

$$\mathbf{U = L/ (L+ 2T_p B)}$$

$$= 10000/(10000+2*0.05*10^6)=1/11$$

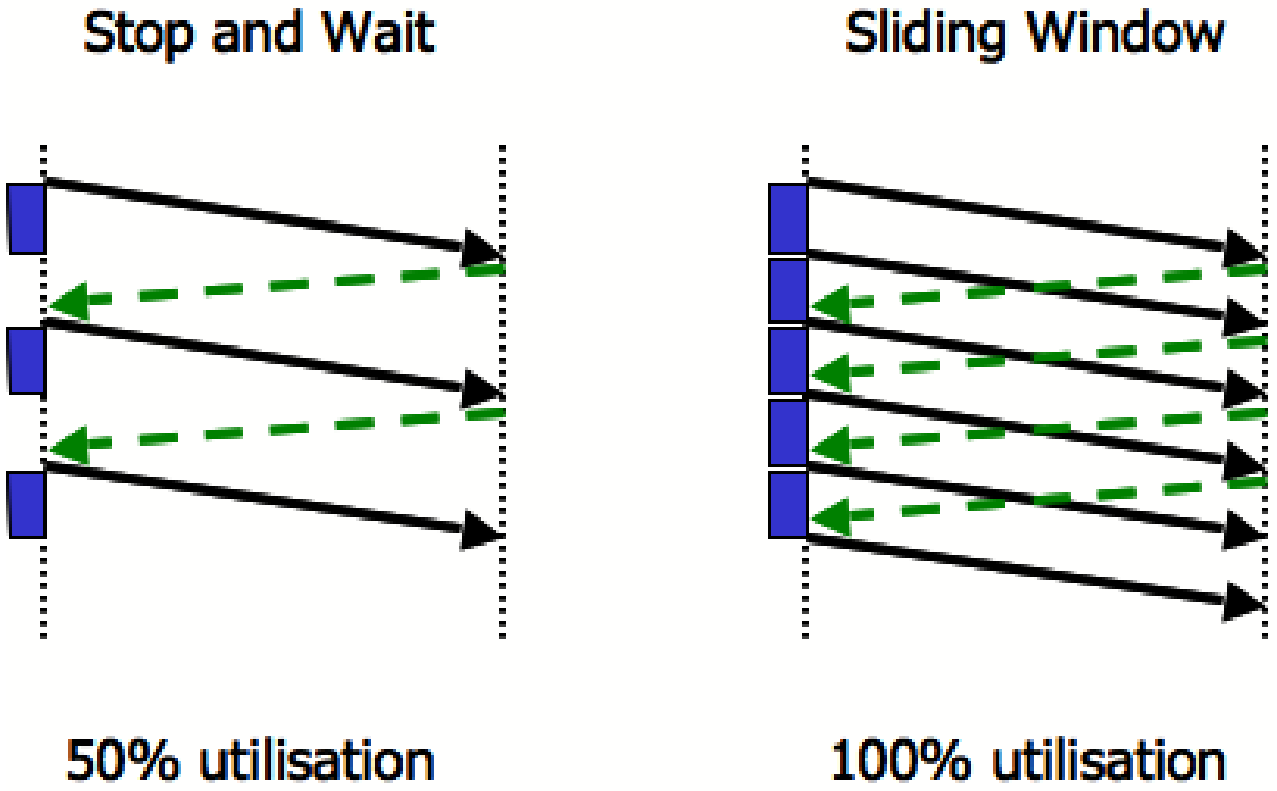


Sliding Window Protocols

- Sending window: Sender maintains a set of sequence numbers corresponding to frames allowed to send
- Receiving window: Receiver maintains a set of sequence numbers corresponding to frames allowed to accept
- What is the window size of Stop and Wait protocol?

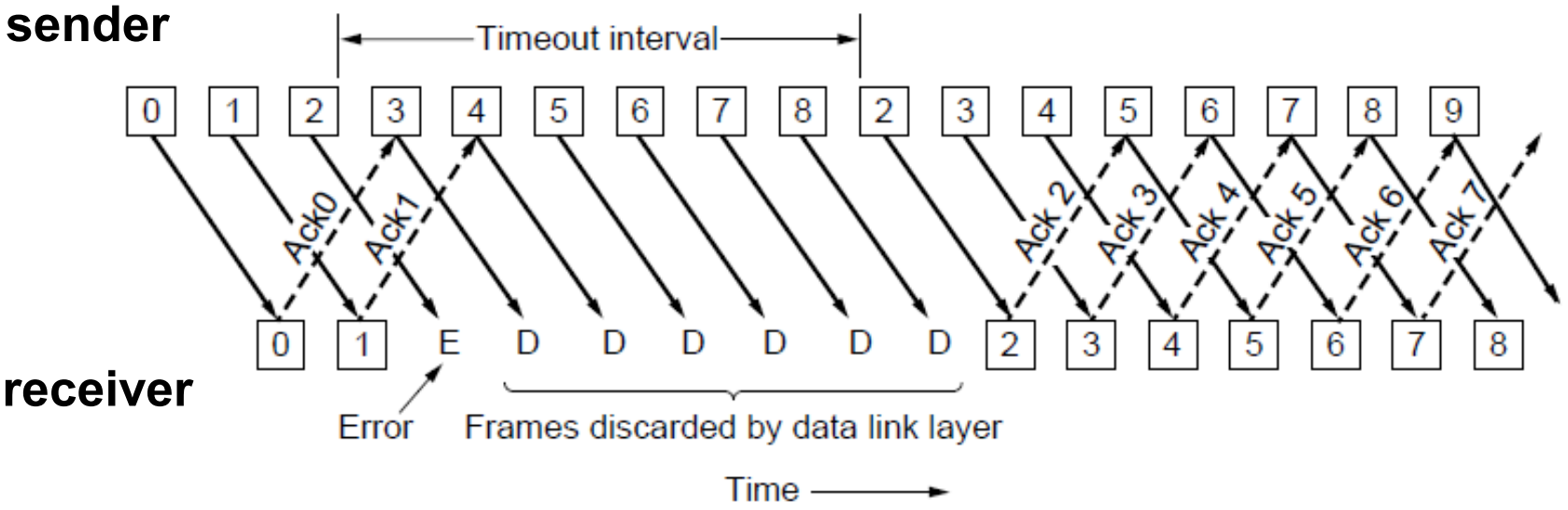
Sliding Window Protocols

- Link Utilisation:



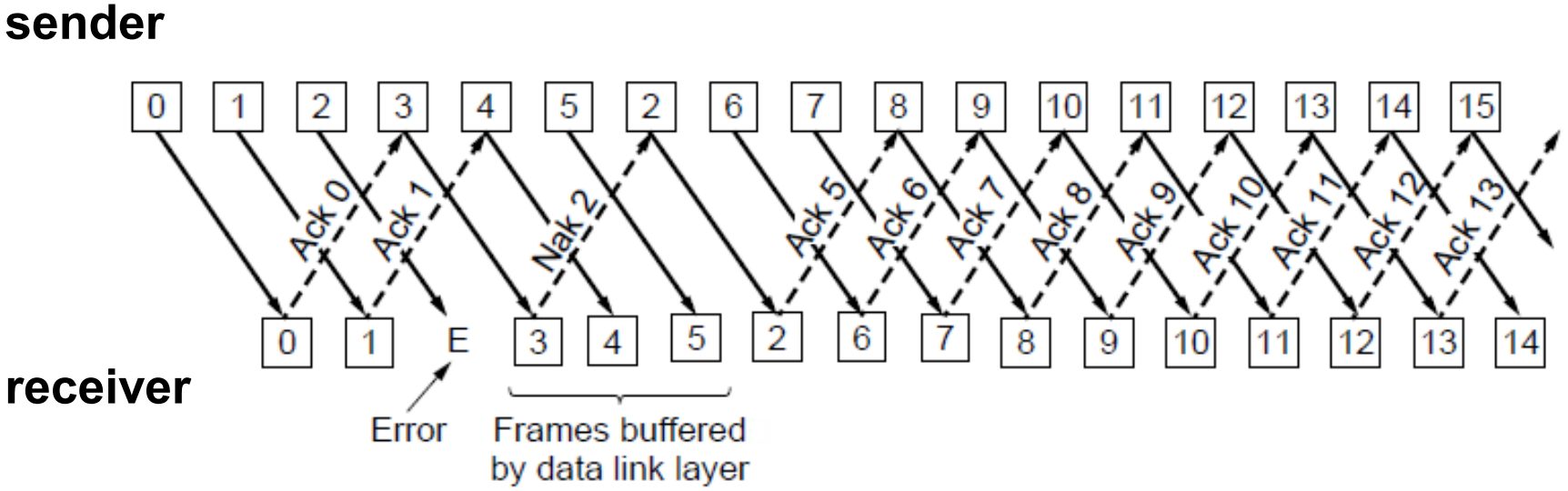
Go-Back-N

- Senders don't need to wait for acknowledgement for each frame before sending next frame
  - Receiver window size =1, Sender window size is N
  - Long transmission time needs to be considered when programming timeouts e.g. low bandwidth or long distance



Selective Repeat

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



Go-Back-N vs Selective Repeat

- **Go-Back-N**: receiver discards all subsequent frames from error point, sending no acknowledgement, until receiving 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