Week 3 – Data Link Layer

COMP90007 Internet Technologies

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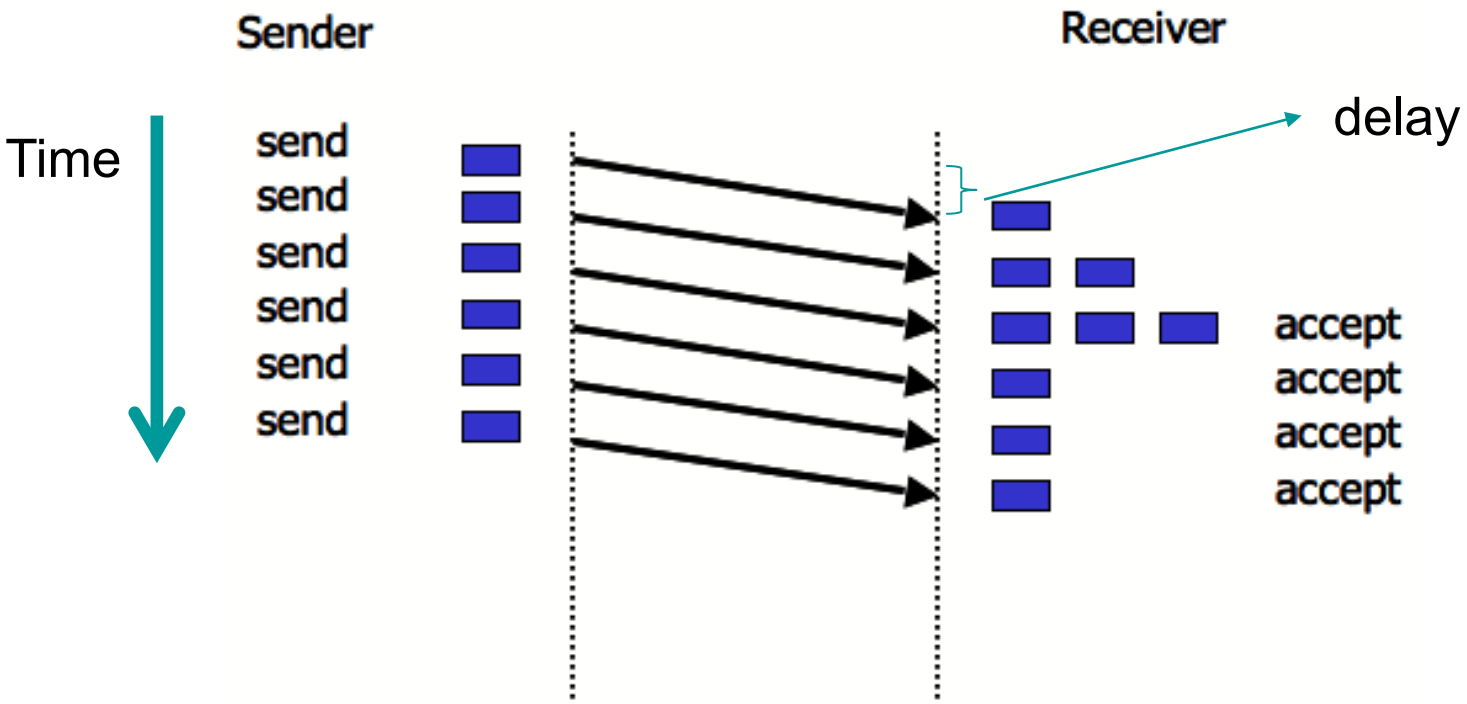
Flow Control

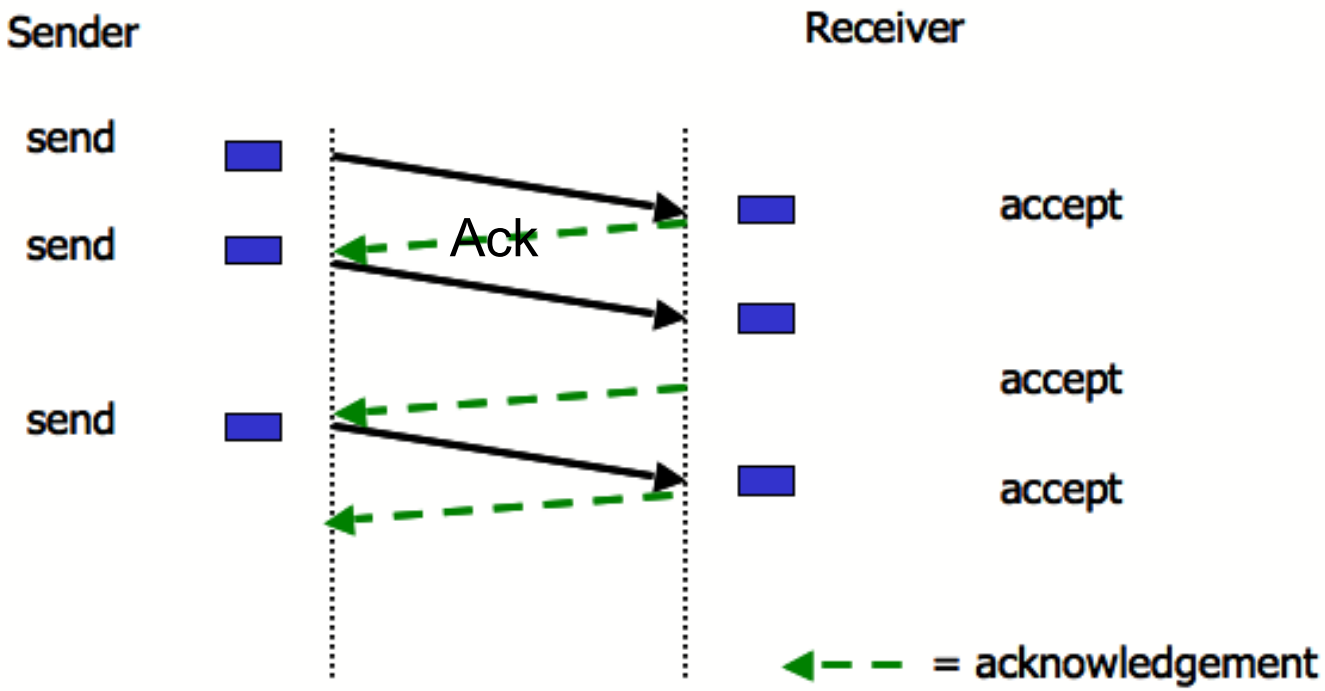
- So far we have discussed how to send single messages and now we will **look at a series of messages**
- The **fast senders vs slow receivers problem** requires a solution
- Principles to control when sender can send next frame
  - **Feedback based flow control** (usually used in Data Link layer)
  - Rate based flow control

A Very Simple Protocol



Acknowledged Transmission

Case: **fast sender / slow receiver**, the receiver's buffer space constrained

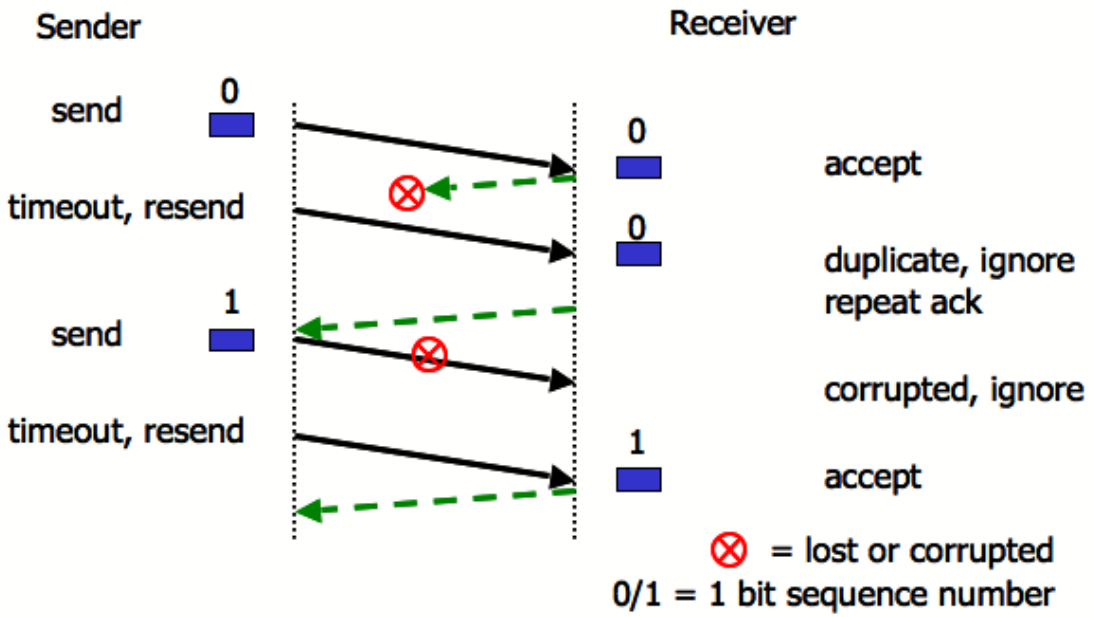


Noisy Channel Protocol

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

Stop and Wait Protocol

- ARQ (Automatic Repeat reQuest)
  - Ack and Timeout



Link Utilisation in Stop and Wait Protocols

Link Utilisation (U) measures efficiency in communication.

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

$\mathbf{T_p}$= Propagation delay;

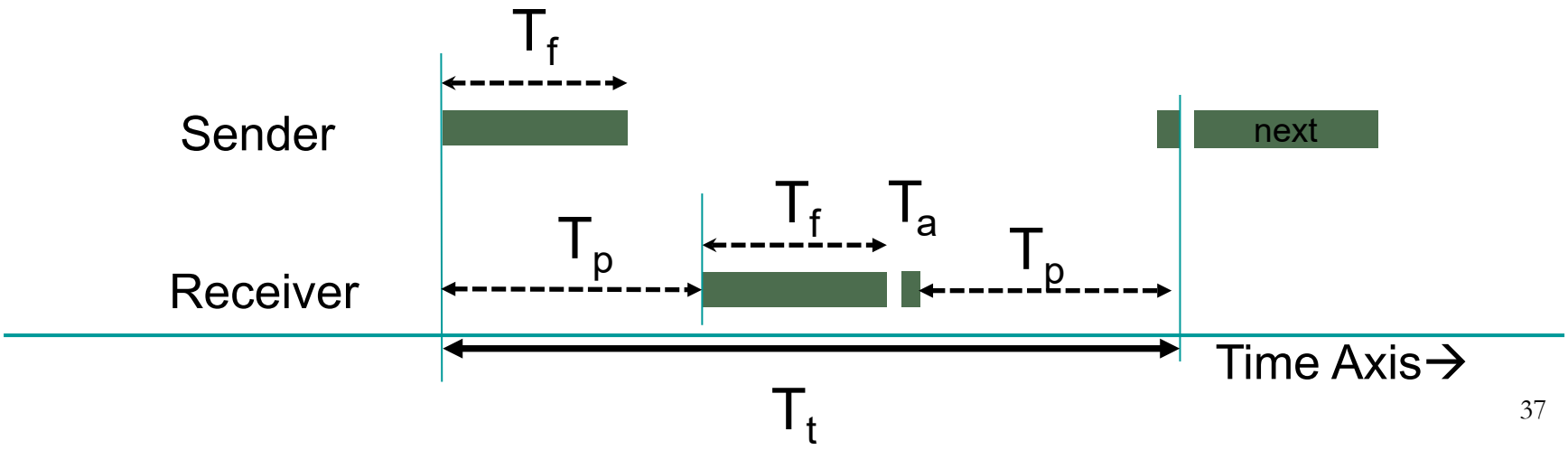
$\mathbf{T_a}$= Time for transmitting an Ack, and we can assume $T_a = 0$.

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

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

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

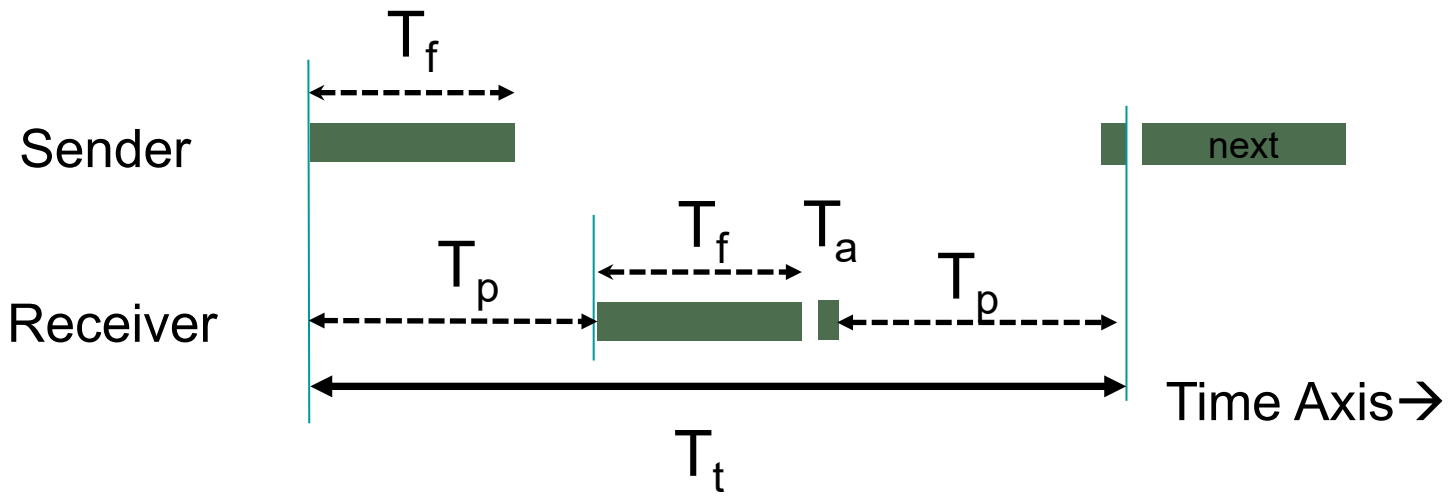


Link Utilisation in Stop and Wait Protocols

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

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

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

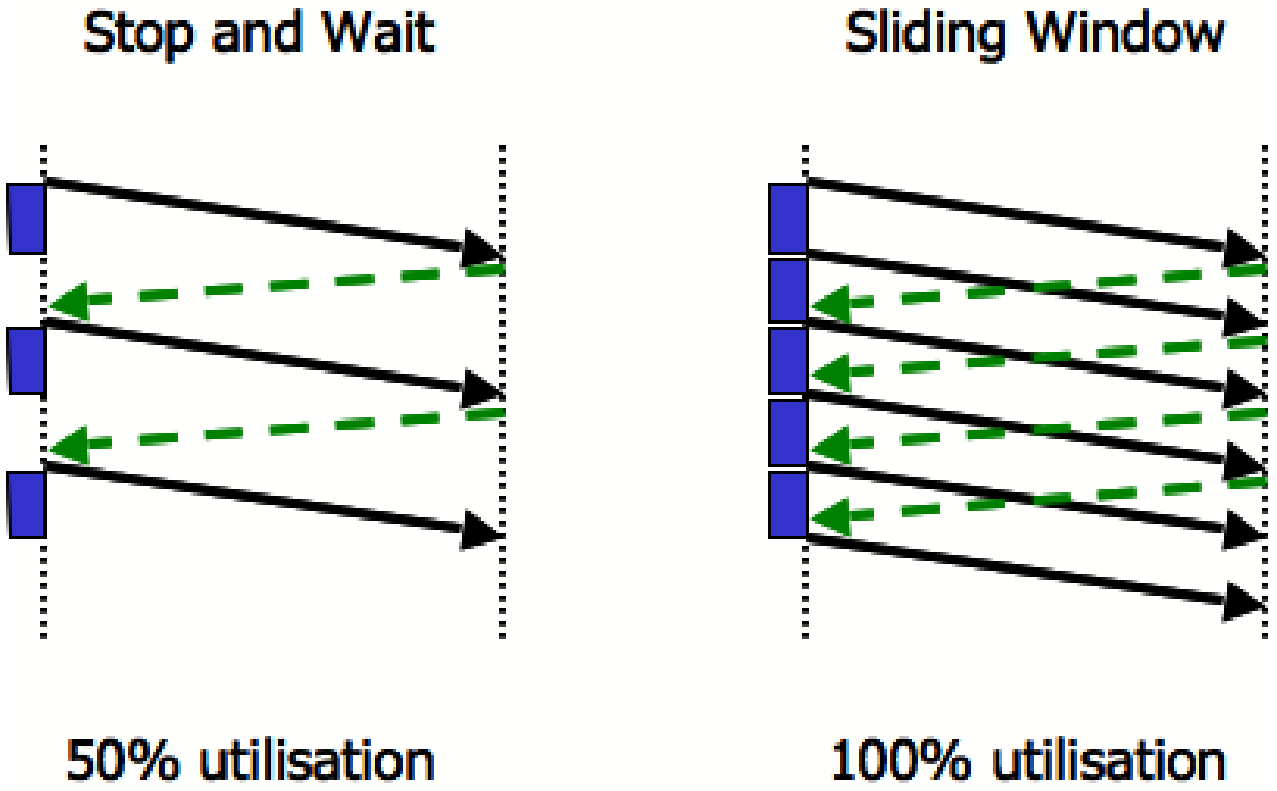


Sliding Window Protocols

- 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?

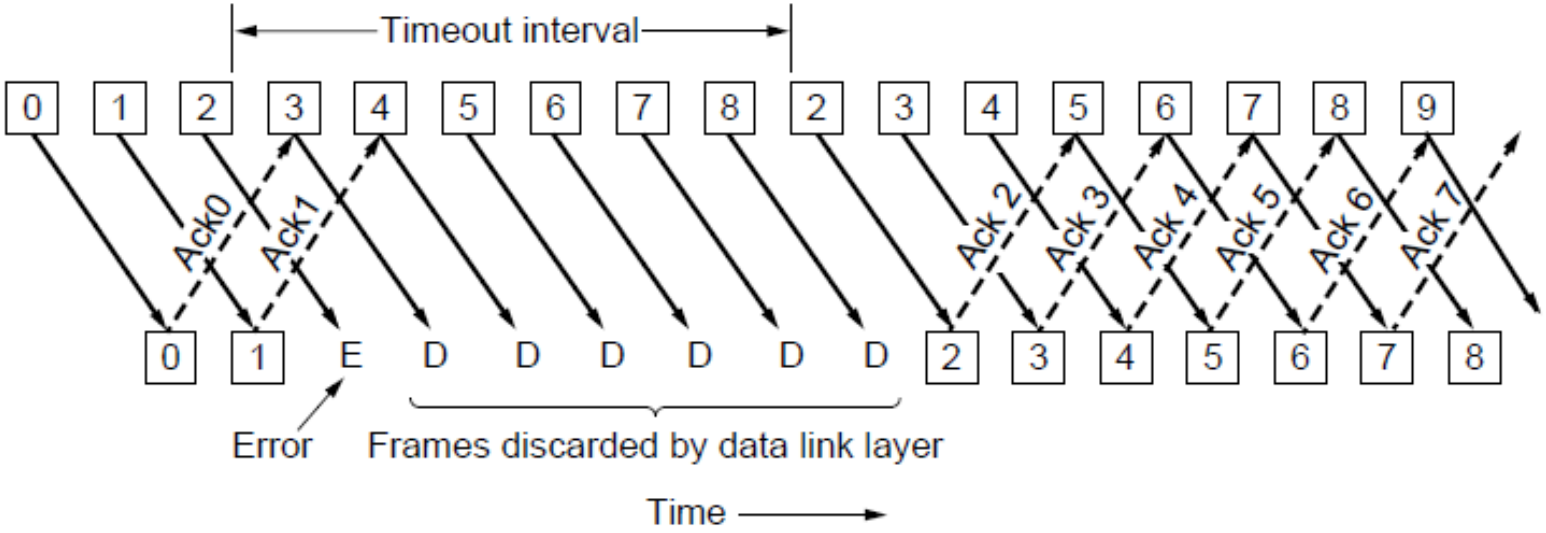
Sliding Window Protocols

- Link Utilisation:



Go-Back-N

- Senders don't need to wait for acknowledgement for each frame before sending next frame

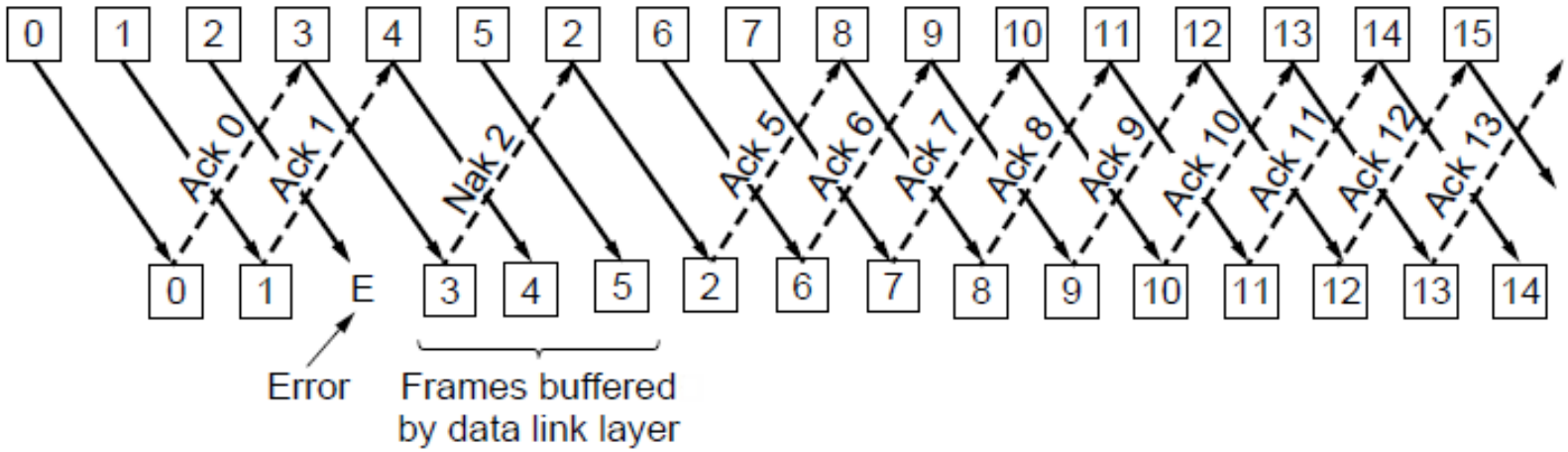


Receiver window size =1, Sender window size is N

- Long transmission times need to be taken into account when programming timeouts e.g., low bandwidth or long distance

Selective Repeat

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



Go-Back-N vs Selective Repeat

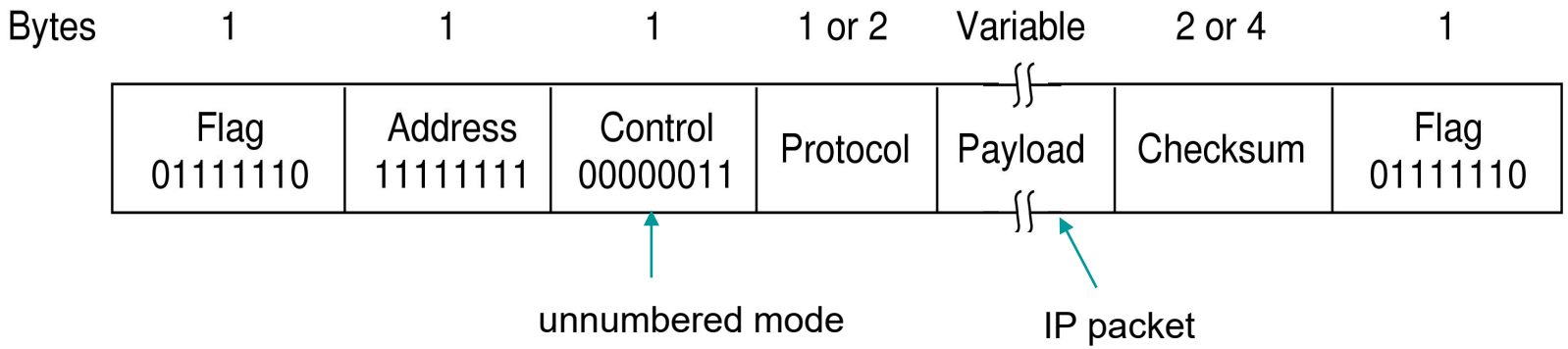
- Go-Back-N: receiver discards all subsequent frames from error point, sending no acknowledgement, until the next frame in sequence
- Selective Repeat: receiver buffers good frames after an error point, and relies on sender to resend oldest unacknowledged frames
- Trade-off between efficient use of bandwidth and data link layer buffer space

Examples of Data Link Protocols

- PPP (Point-to-Point Protocol)
- Packet over SONET
- PPP over ADSL

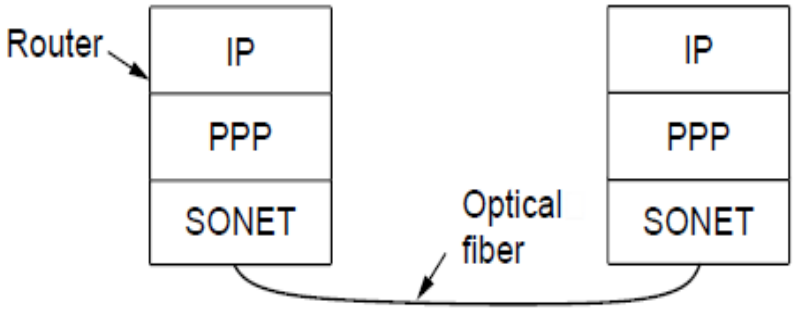
PPP

- PPP (Point-to-Point Protocol) is a general method for delivering packets across links
  - Framing uses a flag (0x7E) and byte stuffing
  - Default is unnumbered mode: connectionless unacknowledged service
  - Errors are detected with a checksum

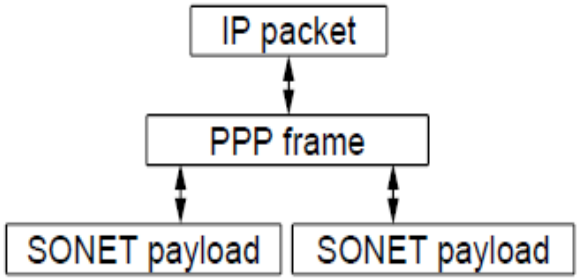


Packet over SONET

- Packet over SONET: carry IP packets over SONET optical fibre links
- Uses PPP (Point-to-Point Protocol) for framing



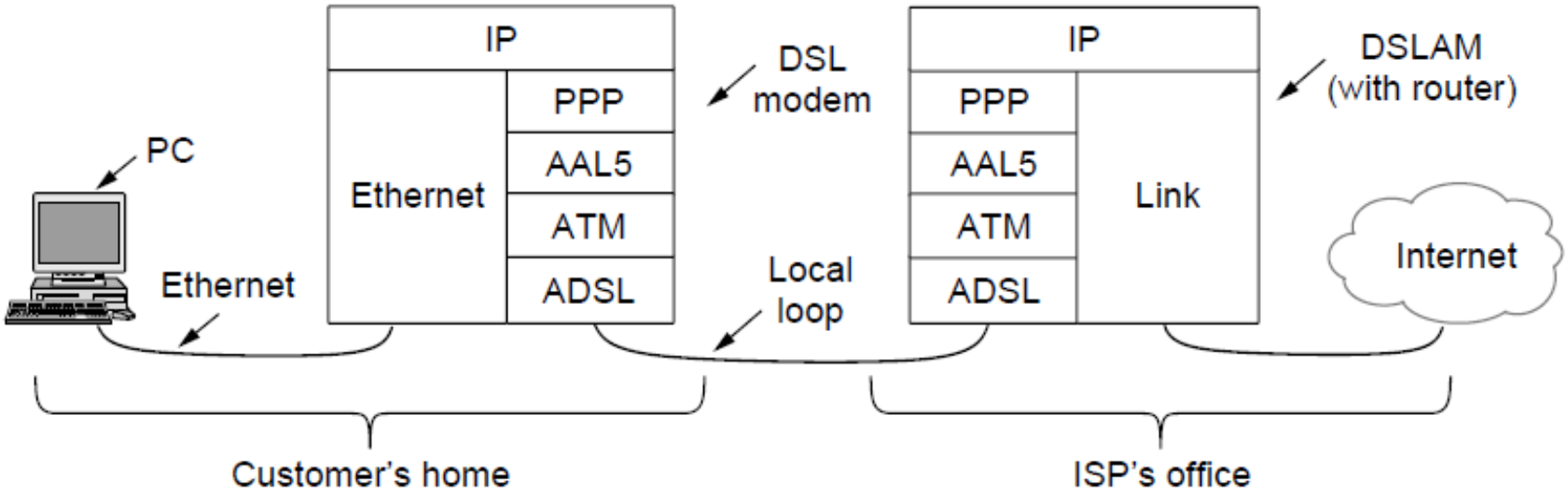
Protocol stacks



PPP frames may be split over SONET payloads

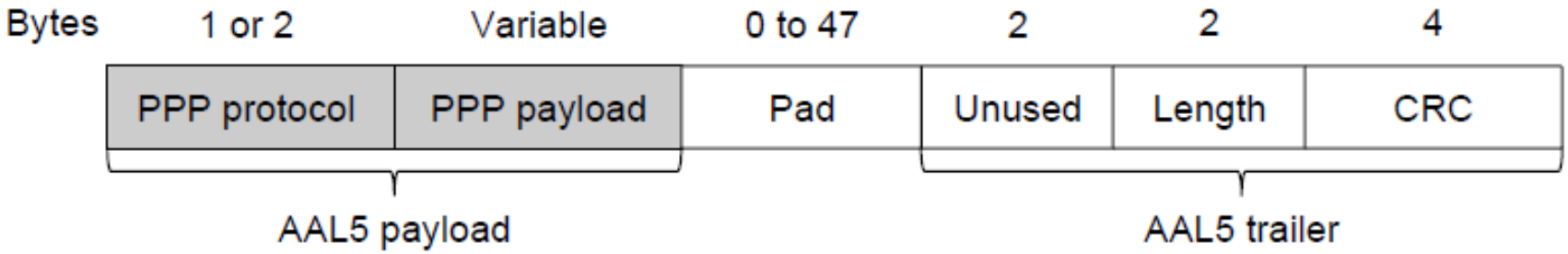
ADSL

- Widely used for broadband Internet over local loops
  - ADSL runs from modem (customer) to DSLAM (ISP)
  - IP packets are sent over PPP and AAL5/ATM (over)



ADSL

- PPP data is sent in ATM cells over ADSL
  - ATM is a link layer protocol that uses short, fixed-size cells (53 bytes); each cell has a virtual circuit identifier
  1) PPP frame is converted to an AAL5 frame (PPPoA)
  2) AAL5 frame is converted to ATM cells



Structure of AAL5 frame

which will be divided into 48-byte pieces, each of which goes into one ATM cell with 5-byte header